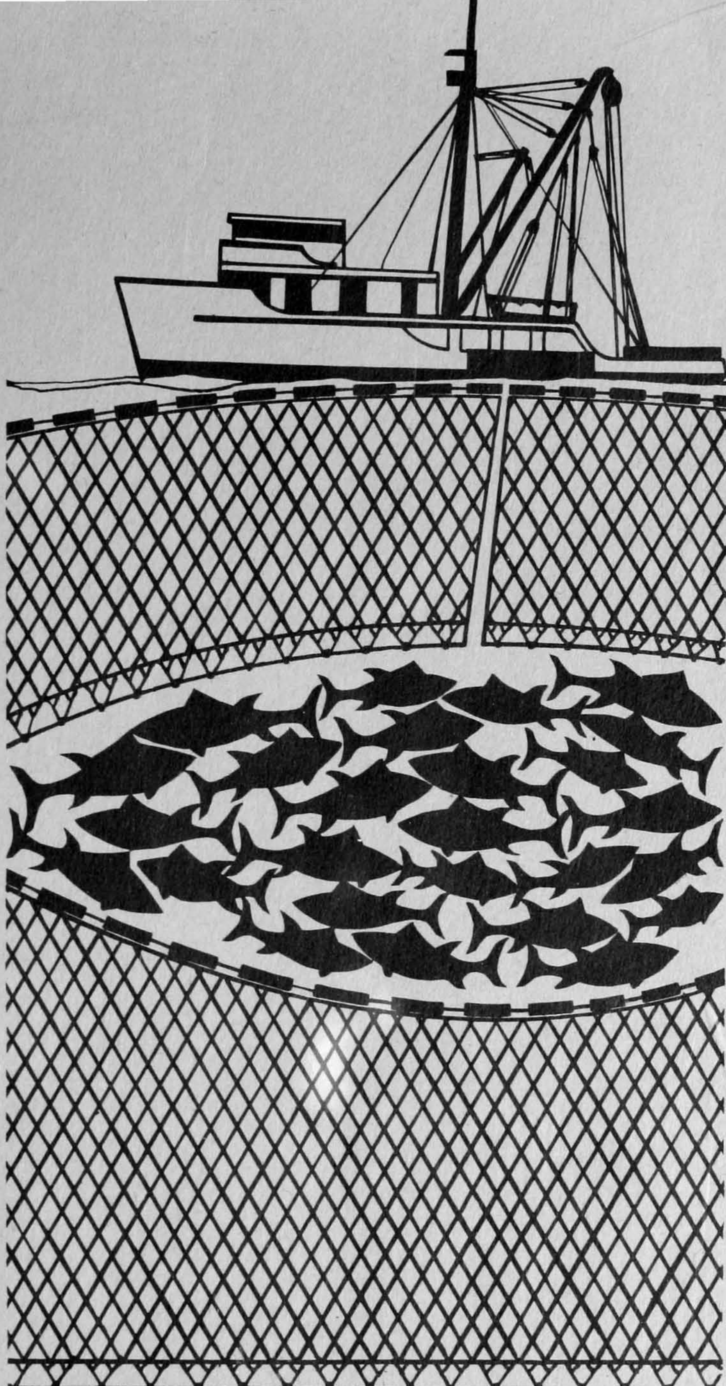

FISHERY INDUSTRIAL RESEARCH

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United States
Department of the Interior
Fish and Wildlife Service
Bureau of Commercial Fisheries

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ECONOMIC ASPECTS OF THE PACIFIC HALIBUT FISHERY

by James Crutchfield and Arnold Zellner

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ABSTRACT

Under international regulation by the Canadian and United States Governments, the Pacific halibut fishery, which once faced depletion, has been restored to a high level of productivity. Although the stocks of halibut now are adequately protected, economic weaknesses in the fishery prompted the study reported here.

This report discusses the basic theory of the regulation, analyzes its economic effects, and presents the conclusions drawn from the analysis and their implications for public policy.

CONTENTS

ECONOMIC ASPECTS OF THE PACIFIC HALIBUT FISHERY

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By the Convention of 1923, the Canadian and United States Governments established the International Fisheries Commission to initiate a program for the control of the halibut fishery of the North Pacific Ocean and Bering Sea.

Through its regulations, the Commission (now known as the International Pacific Halibut Commission) has exerted a profound and beneficial effect on stocks and annual yields of halibut. Since the regulatory program was started, the supply of Pacific halibut has grown steadily, an increasing proportion of the catch is of larger sizes commanding better prices, and the catch per unit of fishing effort has improved markedly.

The regulations also have profoundly affected the economic organization of the fishery. Not all of the effects, however, have been desirable. From the standpoint of the United States and Canadian economies as a whole, some of the economic gains from regulation have been dissipated by excessive use of labor and capital.

The Commission's ability to deal with these undesirable economic effects is severely restricted by the terms of the Convention, which define both its objectives and powers. These objectives and powers are based on concepts of conservation limited to the aspects of fishery biology as may be concerned with maximum physical yield.

There are two reasons why an economic study of the halibut program is desirable at this time: First, the compact and homogenous character of the halibut fishery, together with the excellent records maintained by the Commission, makes it possible to draw factual data of much greater reliability and coverage than is normally available in fishery research. Second, the broad problem of optimal use of renewable resources, such as the fisheries, has been greatly clarified in recent years by a series of important contributions from both economists and biologists, and it has become recognized that to obtain maximum benefit from the management of such resources requires the specialized skills of both.

A broadening of our understanding of economic as well as biological principles of regulation in the halibut fishery is significant for the future. The halibut case dramatically demonstrates the mutual benefits of scientific management to the participating countries, and it may well serve as a prototype for the extension of the principles of management to other fisheries as general economic growth presses more and more heavily on the resources of the sea. Any increase in agreement on objectives, methods, and results of such management will aid in reducing the formidable political barriers to these programs. The halibut case thus may help in formulating and securing acceptance of prac-

Note.—This work was financed by the Bureau of Commercial Fisheries under Contract No. 14-19-008-9355, with funds made available under the Act of July 1, 1954 (68 Stat. 376), commonly known as the Saltonstall-Kennedy Act.

tical research and control measures in other fisheries before need for these measures becomes critical rather than afterward.

This report is divided into three major parts. The first gives the basic theory of regulation and its application to the halibut fishery. The second analyzes the economic effects of halibut regulation. The third presents conclusions drawn from the analysis and examines their implications for public policy.

Part 1

BASIC THEORY OF REGULATION AND ITS APPLICATION TO HALIBUT FISHERY

Part 1 sets forth the historical and theoretical framework within which the present empirical study of the performance of the halibut fishery was conducted. The economic status of the industry today reflects both the path of development in its early years and the effects of the control program. The latter, in turn, could best be analyzed in terms of systematic theories of the biological behavior of the halibut population and the economic behavior of the industry under free and regulated fishing.

Part 1 is divided into four chapters. The first chapter provides a review of the early development of the fishery, its sudden rise to prominence in North American fresh and frozen markets, and the emergence of evidences of serious depletion in the 1920's. The next two chapters analyze the complex biological and economic characteristics that necessitate regulation of fishing effort and establish a set of criteria for optimal performance of a fishery under regulation. The final chapter describes the actual development of the Halibut Commission from the first investigative work in 1923 to the present comprehensive research and management program.

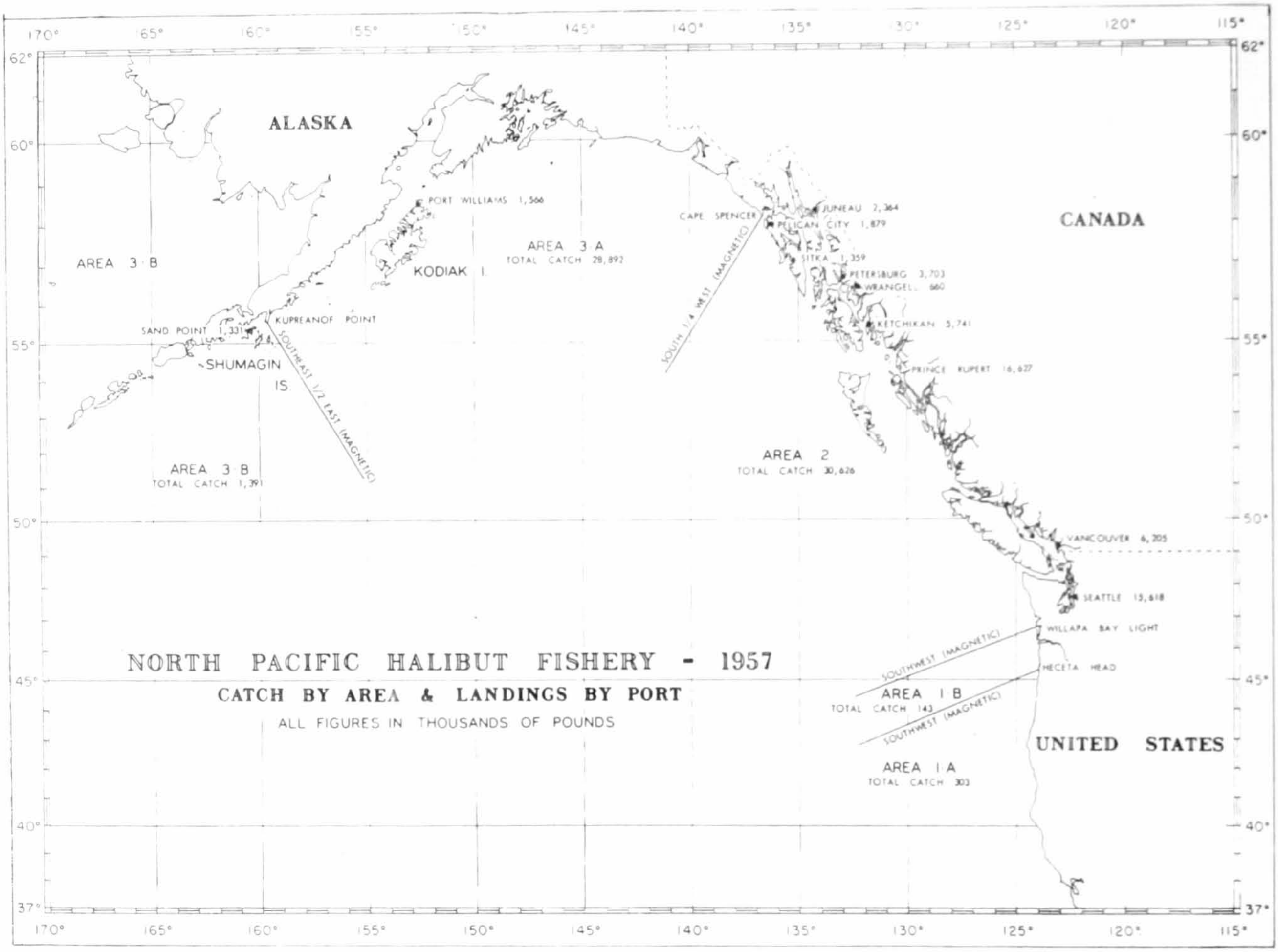

FIGURE 1.—North Pacific halibut fishery, 1957.

Chapter 1
PACIFIC HALIBUT FISHERY

NATURE OF THE RESOURCE

Characteristics, Supply, and Location

The halibut (*Hippoglossus* spp.) is a giant flounder found in northern waters off both coasts of North America. Its superb flavor, texture, and storage qualities have made it the object of intensive exploitation. The Atlantic stocks long since have been depleted to the point where specialized commercial fishing for halibut has all but ceased. In contrast, the Pacific grounds, under an unprecedented program of international control, have maintained their productivity, and they supply far more halibut than do all areas in the North Atlantic combined (table 1).

TABLE 1.—*Halibut landings, net dressed weight, heads-off, eviscerated, 1953–60*

Year	Landings		
	Pacific (U. S. and Canada)	Atlantic (U. S. and Canada)	Europe
	Million pounds	*Million pounds*	*Million pounds*
1953	60.5	4.2	20.5
1954	71.2	4.6	20.2
1955	59.1	4.1	18.6
1956	67.5	4.9	19.7
1957	61.4	6.8	24.1
1958	65.2	6.0	27.4
1959	71.7	7.3	....
1960	71.9	7.0(est.)	....

Note: Compiled from data by the International Pacific Halibut Commission.

The Pacific halibut lives on banks ranging in depth down to 250 fathoms. It is distributed from northern California to the Bering Sea, but the commercially significant populations now are found from the Washington coast northward. The accompanying map (fig. 1) indicates the general area covered and the principal ports from which the fleet operates.

Vulnerability to Depletion

Under a persistently strong market demand, three biological characteristics of the Pacific halibut make it peculiarly vulnerable to depletion:

1. It is a species that grows very slowly. The age at which 50-percent recruitment to the fishery is realized ranges from 7 to 11 years, depending on the area; and females do not mature sexually until they are about 12 years old. Medium-sized fish (from 10 to 60 pounds), which constitute the bulk of the commercial fishery, cover an age span from 7 to 18 years.
2. The various subgroups making up the stock are relatively immobile and tend to concentrate seasonally in well-defined areas. In broad terms, the stocks south and west of Cape Spencer, Alaska, comprise separate populations with little intermingling. Mobility among subgroups on the western grounds is fairly high, but on the more convenient and heavily exploited southern grounds, even the subgroups do not migrate over great distances.
3. The stocks on the grounds normally contain a wide range of ages, and some immature fish inevitably are caught and are destroyed during fishing operations.

EARLY DEVELOPMENT OF THE FISHERY

Effect of Railroad and Power Vessels

Although early exploration established the presence of abundant banks of halibut, it was not until the last decade of the nineteenth century, after the establishment of railroad communications with the populous eastern markets, that the Pacific halibut fishery became important (Thompson and Freeman, 1930). Initial efforts at opening trade with the East, however, were not wholly encouraging. The great distance involved—together with excessive freight charges, high costs of ice, and inexpert handling methods—resulted in repeated failures to transport halibut in marketable condition to eastern cities. Nevertheless the scarcity and high prices of Atlantic halibut induced large eastern dealers to continue the attempt to obtain marketable Pacific halibut. Largely through better trade connections established by these dealers, improved handling methods, and lower rail rates resulting from the greater volume of trade, the Pacific halibut fishery was able to develop into an industry of national importance.

The development and exploitation of the Pacific halibut fishery from 1888 to 1910 was primarily on local grounds. In the words of the International Fisheries Commission: "What is evident now should have been evident then, that the limit of the area fished was fixed, not by the presence or absence of halibut, but by the commercial practicability of establishing a paying fishery" (Thompson and Freeman, 1930). Since Puget Sound provided the most accessible rail communications with the markets, it was the first area to be exploited on a large scale. In contrast, the British Columbia fishery, known to be enormously productive, did not become commercially feasible until the introduction of steam vessels to convey the catch to western United States ports for transshipment to eastern cities. The same situation held true for the Alaska fishery, where commercial success depended upon the transshipment of the local schooner catch south on regular freight steamers. This conditioning of successful exploitation by the extent of the market rather than by the abundance of halibut was further reflected in the fact that at first, the steamers fished entirely in the winter when the halibut catch in the East was low and the price high. After Pacific halibut became more firmly established in the large eastern markets, owing to the decline of the Atlantic fishery, these large vessels began to operate all year and steadily increased in number.

As the southern grounds became depleted, the schooners, which had been equipped with power, began to frequent the British Columbia fishery in growing numbers. This intensified effort in the offshore grounds led to a constantly widening fishing area as yields on nearby banks declined. Halibut fishing, in terms of catch per unit of effort, was at a peak between 1904 and 1905.

First Scientific Investigation

In the years following, some of the best fishing grounds began to yield considerable numbers of discolored and poor fish. The proportion of smaller fish, commanding lower market prices, increased steadily, and as this situation continued, the trips were extended, more gear, bait, and ice were required, and the number of fishing days per trip was increased. The Canadian authorities, concerned over the decline in the supply of fish, sponsored the first serious scientific investigation of the fishing banks of the Pacific coast under the direction of William F. Thompson. The results, published in 1915, suggested strongly that populations on formerly productive banks were being reduced at a rapid rate.

Factors Facilitating Expansion

Frequent reports by both the United States and Canadian Governments and general statements in trade journals and newspapers pointed out that a significant shift of fishing effort to outer and deeper banks had begun by 1910. This shift was indicated by the marked increase in the proportion of the catch landed in Alaska. Also, a majority of the vessels built after that year were obviously designed for use on the northern offshore banks. The new vessels were powered by gasoline engines, and sails were relegated to use for auxiliary power. These engine-powered vessels enabled the fleet to extend its activities outward to new banks and thus to tap new sources of supply. Moreover, innovations were introduced that increased fishing efficiency. The electric light replaced the torch and oil lamp. Longlines set from the vessels themselves, enabling the gear and fish to be handled more rapidly, began to displace dory fishing. Power winches, capable of hauling in the gear from greater depths, became standard equipment, and the diesel engine, which provided greater fuel economy and safety, was widely adopted. The mechanical evolution of the fleet more than counterbalanced effects on costs due to depletion and therefore enabled the fishery to maintain output and earnings (Thompson and Freeman, 1930).

An equally important factor facilitating the expansion of the fishery to the highly productive offshore banks of central and western Alaska, was the development and enlargement of cold storage and ice manufacturing facilities in Alaska ports and Prince Rupert. This development increased the range of operations, reduced short-run price fluctuations, and supplied access to markets over longer periods of time.

Expansion to North and South

Upon completion of the western terminus of the Grand Trunk Railway, Prince Rupert provided a more northerly outlet for the movement of fish to eastern markets and began to replace Seattle and Vancouver as a principal port at which halibut are landed. This shift was assisted by the action of the Canadian Government, in 1914, extending to American vessels and dealers permission (1) to land and ship fish in bond to the United States, (2) to purchase provisions, ice, fuel, and bait, and (3) to take on crews.

The loss of control over the eastward flow of halibut caused Seattle organizations to appeal to the United States Government for aid. It was suggested that the new grounds off the coast of Oregon be developed. For a short time, this area yielded fairly good catches. A large proportion of the fish, however, were in unacceptable condition, and after 1915 landings from these grounds were of negligible importance (Thompson and Freeman, 1930).

Closed Season and Establishment of the Commission

This expansion of the fishery to north and south encouraged a substantial increase in capital invested by dealers in handling and storage facilities and by vessel owners in new powered craft to operate on the banks of the Gulf of Alaska. These vessels produced heavily in the mild weather of fall and early spring, with consequent seasonal lowering of prices. The heavy fresh landings also made it difficult to dispose of the increasing amounts of frozen fish.

A closed winter season began to receive consideration in trade discussions. The intent was to limit the large catches of poor-quality spawning fish and to provide a period each year for the sale of accumulated stocks of frozen fish free of competition from fresh landings. Closure, however, meant international cooperation; and disputes over the maintenance of the 3-mile limit to the approach of foreign vessels during fishing operations, restrictions upon port privileges, and tariffs had to be settled before joint action could be taken by treaty.

These important questions, together with the proposal for a closed winter season, were included in a treaty negotiated in 1919. Ratification by the United States Senate was blocked as a result of objections to the provisions for reciprocal port privileges and elimination of customs duties on halibut. Continued pressure from industry in both countries resulted in a new treaty in which these controversial items were omitted. This version, providing only for a closed season and establishment of an International Fisheries Commission for scientific investigation of the halibut, was signed in March 1923. Ratifications were exchanged the following year, and the first regulation involving a closed season running for 3 months was started in November 1924.

DEPLETION AND REGULATION

Trends Toward Destructive "Mining"

The establishment of rail communications to the large eastern markets and the solution of shipping and handling problems opened a wide gap between port prices and costs. Since the costs reflected easy production from accumulated stocks in an almost virgin state, fishing effort on the nearby banks quickly reached levels that lay outside sustainable long-run yield. Had the fishery remained static in scope and technique, this first surge would have settled eventually to an equilibrium, probably at a level well below the maximum yield, as depletion raised fishing costs and reduced profits.

The fishery, however, was not static. The combined effects of rapid improvements in marketing, transportation, and storage on the one hand, and in fishing gear, vessels, and propulsion on the other, offset the depressing effects of depletion for several decades. The fleet was able to extend its coverage northward and westward and to increase the intensity of effort on the established grounds without increasing costs significantly. The drop in catch per unit of effort from the initial high levels was to be expected as the older fish were removed. The alarming fact was that the decline showed little tendency to stop as a result of a new economic equilibrium. Technological progress, directed toward exploitation of a slowly growing accessible population, made destructive "mining" of the resource profitable down to a level of stocks and yields that threatened economic disaster to the industry.

Quotas

These trends became evident as the new Commission began to develop a consistent body of data. It is likely that the ability of technological improvement to counterbalance the increased cost of fishing due to depletion had about ended by 1930 and that the total catch would have begun to drop rapidly even at constant market prices. Be that as it may, the onset of the depression and the collapse of prices brought landings to their lowest level in decades. These developments made it possible to establish catch quotas at levels that would permit "net investment" in the stocks without serious curtailment of current fishing efforts and without industry resistance that would have been generated in more normal times.

Since the introduction of quotas, the size of the catch has been determined by the Commission rather than by economic forces alone. Minor exceptions have occurred, but these resulted from the inevitable "slippage" in precisely estimating actual landings after determination of the closing date. Despite substantial fluctuations in halibut prices, there is little doubt that the fleet would have taken larger catches (in the short run) in the absence of restrictions. As the stocks recovered, the quotas were adjusted upward. By 1957, the catch stood approximately 47 percent above the depression low and was well above the average for the period 1920–29. Even more dramatic evidence of the recovery of the resource is the rising trend in catch per unit of effort. Some critics (Burkenroad, 1948) have ascribed the recovery to natural fluctuations in abundance unrelated to fishing intensity. The data, however, point strongly to the conclusion that the timing and differential area distribution of the recovery tie it closely to the control program.

PRESENT STATUS

The fishery at present is carried on by a mixed Canadian and United States longline fleet composed of approximately 600 regular halibut vessels and a considerable number of others that land incidental fares. More than 2,500 fishermen derive a major part of their income from halibut and black cod, which is a related fishery. The total annual catch in recent years has averaged about 60 million pounds, with a value to fishermen ranging from $8 to $11 million. The halibut fishery is much smaller in terms of physical landings than are the dominant Pacific coast fisheries; namely, salmon, tuna, herring, and sardine. The bulk of these species, however, is canned or reduced to fish meal and oil. Only salmon exceeds halibut in value of catch entering fresh and frozen markets from the Pacific coast.

Halibut are landed in volume from Sand Point in central Alaska to Seattle. Most of the catch is assembled at railheads in Prince Rupert, Vancouver, and Seattle for shipment to eastern and southern markets. Approximately 75 percent of the Pacific halibut catch is marketed east of the Mississippi, primarily in the urban centers of the Midwest, Middle Atlantic, and New England States. The remainder moves into California and, in smaller amounts, to the other States in the western part of the country.

The fishery has not materially altered in technology since the thirties. Under the regulations, only longline gear can be fished for halibut, so the principal improvements have been in auxiliary gear, such as depth finders and electronic navigational aids. On the marketing side, however, the halibut industry has felt the impact of the revolution in the distribution of frozen foods. Quite apart from the effects of catch controls, the demand for halibut has shifted steadily toward the frozen form and, to a lesser degree, toward prepackaged portions.

SUMMARY

The Pacific coast of Canada and the United States now supplies most of the world's catch of halibut. The excellent market acceptance of this species has made it the object of intensive fishing effort. Its biological characteristics, however, raise the possibility of depletion through overfishing.

At the end of the last century, the Pacific halibut fishery became an important commercial operation after the opening of rail connections to major eastern consuming centers. The fishery developed rapidly, with depletion on nearby banks being masked by steady technological advances that extended the range and intensity of the fishing effort.

Concern over depletion was voiced as early as 1915. By the twenties it became a matter of vital interest to the Canadian and American Governments. After a scientific investigation of the fishery, the International Fisheries Commission (now known as the International Pacific Halibut Commission), created by the Convention of 1923, was empowered under the 1930 Convention to initiate a program of controlled fishing. Since 1932, quotas established under these regulations have determined the amounts landed. Recovery of the stock has been substantial, and the allowable catch has been increased periodically as the statistical evidence of rehabilitation permits. The fishery presently is operating at its highest levels in four decades.

The halibut fishery is of considerable regional economic importance, particularly in Alaska, and is high in value among individual species landed in the United States. Its great significance, however, lies not only in its intrinsic economic value but also in the lessons to be learned from the most thoroughly documented program of scientific management of a sea fishery yet undertaken.

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Chapter 2

THEORETICAL BASIS FOR MANAGEMENT

The preceding discussion emphasized the importance of the halibut fishery in providing employment and income to a significant number of fishermen and shoreworkers and in providing a continuing supply of highly valued protein food to consumers. The productivity and perhaps the very existence of the fishery were threatened because favorable cost-price relations induced fishermen to exploit the fishery heavily and because under these circumstances the biological properties of halibut are such that depletion became a distinct possibility.

To define the term "overfishing," to explain the reasons for its development, or to frame a regulatory program for its elimination is not possible without reference to the value of catch, the cost of fishing effort, and the resulting level and efficiency of fishing activity. Furthermore, the costs incurred by the fishing industry do not cease with delivery to the primary receiver at the port (port buyer). A full evaluation of a fishery and its regulation therefore must take into account the impact of alternative techniques on the costs of processing and marketing the catch.

The term fishery management is used throughout this study to denote control exercised by public authority over fishing activities. Unless otherwise indicated, it does not include the broad range of such governmental activities as are aimed at developing fishery technology, increasing the availability of capital to fishermen, and improving marketing. Fishery management as considered here is concerned with the improvement of the welfare of human beings—fishermen and marketers on the one hand and consumers on the other—by altering the conditions under which the resource is exploited. At each stage—formulation of goals, development of controls, and evaluation of results—it must deal with three sets of "restraints." From the biological viewpoint, the size and dynamic characteristics of the population of fish determine the weight (and size composition) of the catches that can be taken on a sustained basis. From the technological viewpoint, the state of knowledge provides limits on the catching power of individual fishing units using different gear and combinations of gear. From the economic viewpoint, the prices that consumers will pay for the fish and the costs of men, vessels, and gear constitute a further restraint. An "optimal" fishery program, however defined, must specify the "right" amount of fish to be caught and provide a framework in which it will be most profitable to take that amount in the most efficient manner.

The first section of the present chapter deals with the fundamentals of fishery population dynamics and reviews briefly the basic factors affecting the relation of yield to fishing effort; the second section deals with economic behavior in an unrestricted fishery; and the third section deals with economic behavior in a hypothetical case in which it is assumed that the fishery resource is privately owned.

FUNDAMENTALS OF FISHERY POPULATION DYNAMICS

The discussion in this section is necessarily overly simplified, but a minimum summary of the complex determinants of physical yield seems essential to an understanding of the issues involved. The starting point for any economic analysis of an industry is the determination of the relation between (1) physical inputs of labor, capital, and natural resource and (2) physical output of goods. This relation and the prices of productive services determine unit costs of outputs and, given the demand for the product, the output and price of the final product. In most types of business, we turn to the engineer and the production staff for a determination of the relation between physical inputs and outputs. In the fisheries, however, we turn to the biologist, since the determination of the relation between fishing effort and catch requires analysis of the response of a self-renewing organic body—the fishery population—to varying rates of predation by man.

Limitations of Data

Unfortunately, even the most intensive and skilled scientific investigator faces formidable limitations in providing the types of information required in fishery management:

1. The most obvious limitation is man's inability to see the basic resource. Our knowledge of the size, range, mobility, growth rate, and mortality rate of a fish population must rest on the scanty and somewhat unsystematic "sampling" provided by commercial catch records and on limited and expensive coverage through tagging and experimental fishing.
2. Equally serious is the problem of isolating a single sea fishery for separate study. The Pacific halibut, for example, is taken in waters that represent an enormously complex environment embracing a multitude of interrelated life cycles. A change in the intensity of man's efforts to catch a particular fish alters the whole pattern of these relations and induces a series of additional effects on the exploited populations.
3. Finally, the effects of any change in fishing methods or intensity work themselves out only after a long period, particularly in the case of long-lived, slow-growing species such as the halibut. In fact, the full adjustment period for any major change in the catch of halibut would extend over virtually the full professional workspan of a trained fishery biologist. Quite apart from the difficulty of running controlled experiments, the problem of disentangling the effects of changes in fishing intensity from random or cyclical fluctuations in biological determinants becomes more difficult as the adjustment period lengthens. Even in the case of the Pacific halibut, where a meticulous research program has provided unusually good statistical data, the relations among fishing effort, yield, mean size, and population cannot be detailed with mathematical precision. Management of a sea fishery must inevitably rest in greater or lesser degree on judgment, distilled out of intimate knowledge and experience, in interpreting partial information on the basic physical functions involved.

Size of Population

The size (aggregate weight) of a fishery population, given its general environment, is determined by two primary factors: (1) recruitment of new individuals and the growth of individuals, which provide additions to the stock, and (2) natural mortality (including the catch taken by predators), which results in continuous reduction. If the more fundamental determinants—such as food supplies and water temperatures—remain constant, the population will tend toward an equilibrium in which recruitment and growth are exactly offset by mortality even in the absence of fishing activity by man. The introduction of a commercial fishery means simply a higher loss to a new predator—man—and hence a smaller standing population.

Unfortunately, the relations involved are not simple and direct. Obviously, an increase in recruitment must result in a larger catch, increased natural mortality, or both; and an increase in the catch by man leaves fewer fish to die of old age, disease, or the activities of other predators. Each of the factors determining the size composition and aggregate weight of the population is itself dependent in part on population density. Egg production and recruitment, for example, may be reduced by a decline in population, while reduced demand on the food supply with thinning of the stock may result in more rapid growth. A further complication arises from interdependence of different stocks. It is quite possible that a reduction in the population of one species may result in an increase in another species, perhaps less valuable, which competes for the same food supply, and the change may not be reversible, though this does not seem to be so in the case of the Pacific halibut.

Effects of Fishing Effort and Gear Selectivity on Yields

From the standpoint of a fishing industry, the most significant physical relation is the range of yields associated with different levels of fishing effort and different types of fishing gear. Assuming, first, that a standard type of gear is employed, the effect of increased fishing mortality (which for present purposes may be taken as varying directly, though not necessarily proportionately, with fishing effort) may be analyzed in general terms as follows: At zero population or at maximum population in the natural state, the sustained yield (that is, the yield that can be taken continuously without reduction of the population) from the fishery is zero by definition. At very low levels of fishing, the yield will increase as effort increases, but at a decreasing rate. In effect, the reduction in population and average weight is more than offset by the reduction in loss from natural causes. Beyond some point, further increases in fishing will result in an absolute decline in physical yield, as the effects of decreasing population and average weight of fish become dominant.

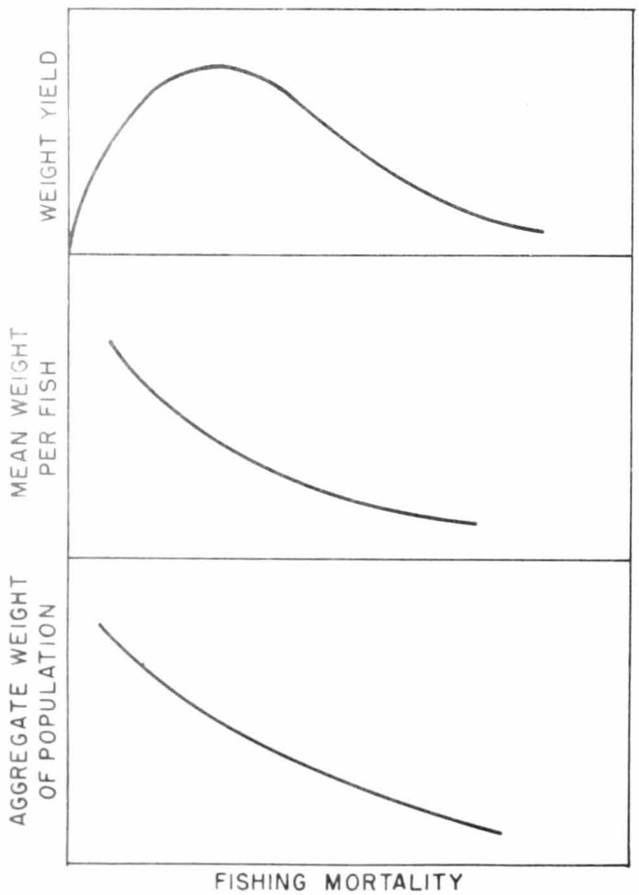

FIGURE 2.—Basic physical relation in exploited demersal fisheries.

It should be noted that the peak and subsequent decline in sustained yield with increased fishing mortality is not necessarily a result of decreasing numbers of recruits as the population declines. In the case with which we are concerned—a demersal sea fishery—the decline in yield in terms of weight results primarily from the fact that fish are caught at an earlier age and hence at a lower average weight as fishing effort increases. If, as seems quite possible, a relatively small number of mature fish can produce sufficient eggs to maintain recruitment, the low yields in heavily exploited fisheries may simply reflect the fact that too many fish are being taken soon after they are catchable and before they have grown to worthwhile size. In this case, even a very heavy fishing effort will not result in extinction; the yield will approach as a limit the weight that would be taken if all recruits were caught as soon as they are large enough to come in contact with fishing gear.

If, on the other hand, egg production and recruitment are sensitive to population size, or if other species crowd out the desired fish at low levels of population, extinction (at least in an economic sense) may be a real possibility.

It may therefore be assumed that the general functions relating fishing effort to sustained yield, population, and average weight of individual fish for a demersal sea fishery can be expressed graphically as indicated in figure 2.

Before proceeding further, we should emphasize that the forms of the relations shown in figure 2 are not of completely general applicability, but rest on the following three assumptions:

1. Decisions to increase or decrease fishing effort based on economic reactions to changes in costs or prices will lead to a new long-run equilibrium characterized by fishermen taking a new sustained yield. As indicated, however, the history of the halibut industry suggests that the fishery may be in disequilibrium over long periods. Given attractive prices, efficient fishing methods, and a long life cycle for the species, the full equilibrium adjustment may not be reached before extinction—economic, if not biological—is threatened.

From the standpoint of the fishing industry, the short-run effects of management decisions concerning catch limits may be so important as to modify drastically the path through which longer run objectives may be reached in practice.

2. The relations shown, although generally descriptive of demersal sea fisheries, do not necessarily apply to fisheries based on anadromous species, such as salmon. Our present knowledge of the biology of the more important pelagic species is too limited to say whether or not they react to fishing pressure in the same way.

3. Finally, the shape of the crucial function relating yield to fishing effort may be altered significantly if two conditions can be met: (a) the selectivity of the gear used can be altered and (b) the gear fished actually comes in contact with a wide range of ages and sizes of fish in the exploited population. For gear such as seines or trawls, which can be adjusted to reject small fish in varying degrees, the sustained yield in weight at a given level of fishing effort varies with the size of the mesh. Nets of very large mesh will show relatively small yields because only small numbers of older fish are taken. Nets of very small mesh will take large numbers of fish but at such an early age that the yield in weight will be lower than the possible maximum. At some intermediate size, the balancing of numbers against growth will yield a maximum steady catch (Beverton and Holt, 1957).

Simultaneous Adjustment of Gear Selectivity and Fishing Effort

Since variations in fishing effort change the size and age distribution of the exploited population, it follows that there will be a different optimum mesh size for each level of fishing effort. The yield curve resulting from the simultaneous variation of fishing effort and selectivity of gear will be of the form shown in figure 3.

The significance of this "eumetric" yield function may be considerable in some demersal fisheries. If the selectivity of the gear can be controlled, it is possible to achieve greater sustained yields than can be obtained from a fixed type of gear at all levels of fishing effort other than the one for which that gear is optimal. In addition, the yield curve will not decline at very high levels of effort (see fig. 3) if the fishing gear is adjusted to permit appropriate escapement of smaller fish. In effect, the yield will approach, as a maximum, the level that would be reached if an entire year class were taken at an age when its total weight is greatest; that is, at the age where the decrease in weight through mortality equals the increase in weight through growth of the survivors.

Simultaneous adjustment of both gear selectivity and fishing effort, if technically practical, would also affect the composition of the yield in a different manner than if fishing effort only is changed. Increasing effort, accompanied by an increase in the age of fish entering the exploited phase, would obviously reduce the size variation in fish taken and would in most cases be desirable from the standpoint of processors and marketers. It would, however, also produce wider variations in year-to-year catch, since effective fishing effort would be focused on a narrower range of year classes.

Since the halibut fishery is presently limited to longline gear, which offers little scope for alteration of selectivity with respect to age and size, the above analysis is of no immediate significance. Its potentialities and limitations, however, are discussed in a later section dealing with the possibility of experimental introduction of trawling or set net gear.

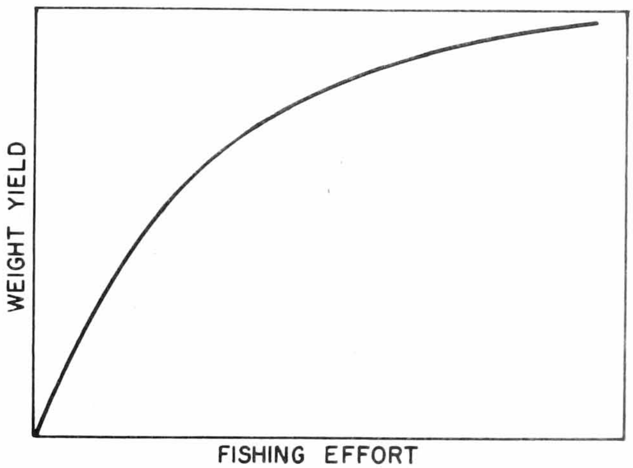

FIGURE 3.—Effort yield relationship in eumetric fishing; selectivity of gear adjusted for maximum yield at each level of fishing effort.

It cannot be emphasized too strongly that this discussion presents only the bare outlines of the long-run effects of fishing activity and rests on the assumption that density dependence is relatively unimportant. If not, the position and, in extreme cases, the form of the relations may be altered.

Although theoretical formulations are useful in establishing the area of biological research, only detailed, continuous, and expensive work can provide a quantitative basis for management.

ECONOMIC EQUILIBRIUM IN AN UNRESTRICTED FISHERY

Thus far we have been concerned solely with the general effects, in physical terms, of changing amounts of fishing effort after all adjustments are fully worked out. It can be concluded that for each level of fishing effort and each type of gear employed there will exist corresponding sustainable levels and compositions of population and yield. The yield will be at a maximum at some level of population between zero and that which would be established in the absence of fishing by man. Even if these relations were firmly established for a given fishery by empirical research, they cannot tell us which levels of fishing effort and yield will actually be established.

In economies like those of Canada and the United States, fishing is a commercial venture conducted on a profit basis. The amount of fishing effort in any given period depends, not only on the physical inputs in labor, capital, and management and on the resulting physical yield, but also on the prices paid and received. Given the basic biological and technical relations between effort and yield, different combinations of costs and product prices will result in different levels of fishing activity by profit-seeking enterprises.

Analysis of the process through which firms adjust to changes in costs, prices, and physical input-output relationships is a central part of conventional economic analysis and is as applicable to fisheries as to any other industry. There are, however, two important differences, the significance of which will be evident in the following discussion: One is that in fisheries and in other industries dealing with renewable resources, the size and composition of the basic resource vary with the level of production; and the other—and crucial—difference is the absence of private ownership of the basic resource. Within broad limits, a sea fishery is available to any national in the case of inshore fisheries in territorial waters, to nationals of two or more nations on the basis of an international convention, or to all fishermen in unrestricted operations.

Economic Adjustment in an Isolated Fishery

For clarity, we will deal first with the simplest case of a single, isolated fishery, exploited by identical units of fishing gear, with attention focused on long-run values; that is, at each level of fishing effort all biological and economic adjustments are assumed to be complete.

As indicated earlier, the long-run relation between fishing effort and yield may be represented generally in the form indicated in figure 2. If it is assumed that the price received by fishermen does not vary with the size of the catch, the yield function, expressed as money receipts, would have the same shape. (This assumption is not unrealistic for a single small fishery whose products are closely competitive with many others. If the change in price with increased or decreased landings is less than proportionate to the change in output, the curve would reach a maximum at the same level of fishing effort, but would be flatter.) On the further assumption that additional fishing effort simply requires more units of the same type, obtainable at the same money cost, a simple straight-line function relating total cost to fishing effort can be shown on the same diagram.

If the fishery is regarded as a public resource, open to all, the level of fishing effort will tend toward OA in figure 4. At this point, total receipts just cover total costs (including a minimum necessary return to the vessel owner). At any lower level of fishing effort, profits in excess of this minimum would be earned, and vessels would enter the fishery. At higher levels, returns would not cover total costs, and fishing effort would be curtailed. Some vessels would be diverted to other operations, and the usual reduction in number of vessels due to depreciation and losses would not be fully replaced. Obviously, any increase or decrease in prices received by fishermen, whether

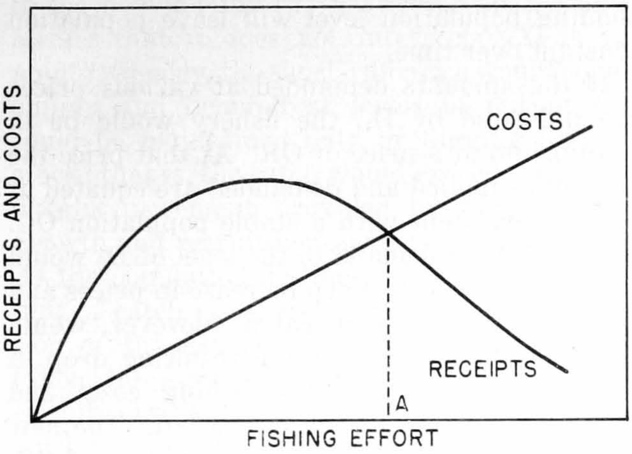

FIGURE 4.—Total money receipts and costs versus fishing effort in the biological overfishing case.

caused by an increase in retail demand or a reduction in the cost of marketing services, would increase or decrease fishing effort. Similarly, increases or decreases in fishing costs would restrict or stimulate fishing activity.

At the levels of money receipts and costs assumed in figure 4, it is evident that uncontrolled exploitation of a common-property fishery would lead to a smaller sustained physical yield than would be possible with less fishing effort and lower money costs. This apparent violation of sound business practice is a direct result of the fact that the basic resource is not "owned" by any decision-making unit. In technical terms, the rent that would normally accrue to the owner of a valuable resource, limited in quantity, is simply divided among all fishermen participating. With no restriction on new entry, efforts to increase profits by reducing fishing effort, individually or collectively, would simply result in more new vessels entering the grounds until all but necessary minimum profits are again wiped out.

This situation, which involves "overfishing" under any definition of the term, is not inevitable except under the assumed cost-price relationship implicit in figure 4. If the market price for the end product is low enough or if fishing costs are high enough, the fishery could be in equilibrium at outputs below maximum sustained physical yield. If no level of effort will produce sales sufficient to cover fishing costs, no commercial operation will be possible. These cases are illustrated in figure 5.

Conditions for Long-Term Equilibrium

This simplified formulation may now be restated to indicate more clearly the interaction of biological and economic factors.

Given the demand for the end product, the physical yield-effort function, and the costs of labor and capital inputs, the following conditions are required for long-term equilibrium in a commercial fishery:

1. The price of the end product must be such that amounts demanded and supplied are equal.
2. At that price, net returns to fishing units are just sufficient to maintain the existing level of fishing effort.
3. The catch at that level of output must be such that the aggregate weight and composition of the exploited population are stable.

Any change in the basic determinants of population, yield, price or cost, will involve interacting adjustments in both biological and economic factors until these conditions are again restored.

Changes in consumer demand.—Suppose, for example, that consumer demand increases. The resulting rise in price and profits will induce an increase in fishing effort and catch in the short run. This situation, however, is not sustainable, since the increased catch must result in a subsequent decline in population and an increase in the cost per pound of catch to the fisherman. Equilibrium will be restored only at a higher

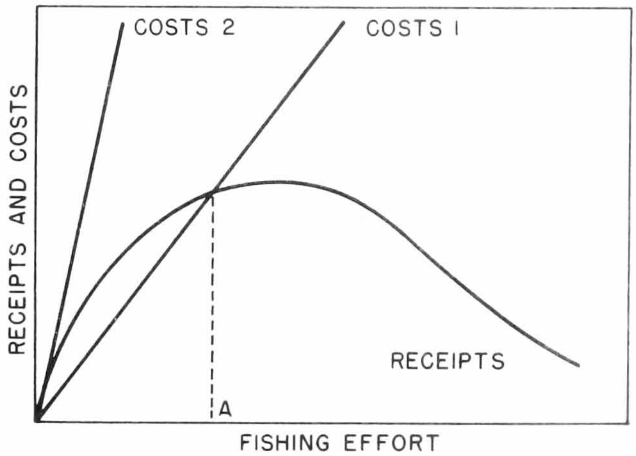

FIGURE 5.—Money receipts and costs versus fishing effort in two cases in which costs are so high (or receipts are so low) that biological underfishing results.

level of fishing effort, price, and cost, where profits are again just sufficient to maintain the new level of effort. The effect on catch and population depends on our starting point. If the initial equilibrium position was at a catch level below the maximum sustained yield, the catch will be increased (in weight), with a smaller population and average weight per fish. If it was at or beyond the maximum, equilibrium will be restored only at a lower sustained output.

Changes in fishing costs.—The results of a decrease in fishing costs (through improvements in gear or vessels, for example) may be traced in similar fashion. The initial effect would be an increase in profits at going prices, followed by an increase in effort and catch in the short run, and a decline in price as these supplies reach the market. Again, however, this situation is not stable over time. The increased catch reduces the population and raises production costs. As the full effects of the reduction in stock are felt, the catch falls back from its initial increase. Whether it settles at a new sustainable level above or below the starting point depends on the original position on the long-run yield curve. If the fishery was already being exploited at or beyond maximum physical yield, the end result of a cost-saving innovation would be a reduction of total catch and an ultimate increase in costs and prices.

Economic and biological equilibrium.—These relations are illustrated graphically in figure 6. (A mathematical formulation of the argument is presented in appendix 1.)

The various "supply curves," S–OA, S–OB, S–OC, show the amounts of fish that would be taken at various prices, given the costs of fishing. Since the yield in weight per unit of fishing effort will vary directly with the number of fish exposed to the gear, fishing costs per pound will vary inversely with the size of the population exploited. Thus, in figure 6, a relatively small population OA is associated with the supply curve S–OA, which shows the amounts fishermen would take at various prices. At a larger population OB, the amounts supplied at various prices, S–OB, would be larger, since the cost per pound of catching fish would be lower. The dotted line XX traces out the locus of points on each of these supply functions which are sustainable; that is, where the catch at the corresponding population level will leave population constant over time.

If the amounts demanded at various prices are indicated by D_1, the fishery would be in equilibrium at a price of OR. At that price the amounts supplied and demanded are equated at a level consistent with a stable population OC. An increase in demand to the level of D_2 would result initially in a sharp increase in prices and catch. The increase in catch, however, would not be sustainable, since the resulting drop in population would increase fishing costs and shift the supply function to the left. The new equilibrium would be reached at a price of OS, with output, costs, and prices above the previous stable levels, and a lower population. A further increase to D_3 would, after full adjustment, result in higher prices and costs, but with lower output—the biological overfishing case.

Effect of Excessive Demand

In each of these cases the industry moves toward a sustainable long-run position, although at any level of demand above D_2 the actual physical output will be reduced. But what

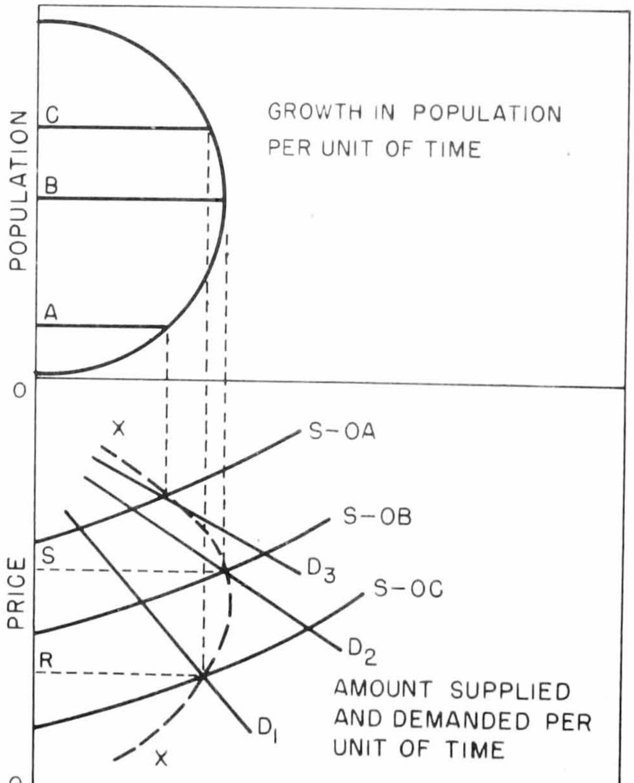

FIGURE 6.—Biological and economic equilibrium.

if the demand for the particular species is so strong that it does not intersect XX at any point? Clearly, the short-run price would equate supply and demand at levels of output that could be maintained only by digging into the stock; that is, the catch would exceed the annual weight increment provided by the excess of growth and recruitment over natural mortality. As the population declines, the average cost per unit of catch rises, and with it the supply function of the fishery. The decrease in quantity taken, however, still leaves the fishery in disequilibrium, and the process continues. If the level of recruitment becomes sensitive to population changes when the stock is seriously reduced, the danger of physical extinction may actually arise. Even if this is not the case, the ultimate equilibrium position may be so low that the industry, for all practical purposes, faces the prospect of economic extinction. This is probably the situation that occurred in the halibut industry.

This process is likely to be accentuated by economic forces accompanying the decline in population. Unless the end product is perfectly substitutable by others, its price will rise as depletion proceeds. The impact of both rising costs and prices is likely to accelerate efforts to improve the range and efficiency of fishing vessels, particularly if they cannot be shifted readily to other fisheries or nonfishing uses. Both effects obviously operate to reduce still further the level of catch at which long-run stability is reached.

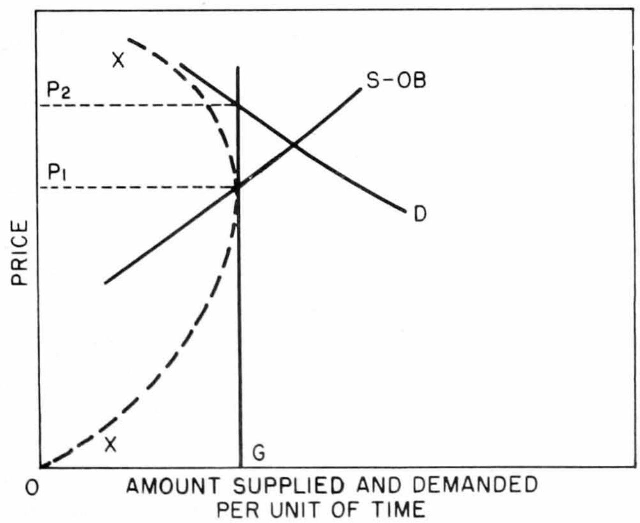

FIGURE 7.—Equilibrium with restricted catch.

Equilibrium with Restricted Catch and Free Entry

Even if the objective of maximum sustained physical yield is achieved, it is pertinent to point out the nature of the economic inefficiency that may be involved if no restriction on entry exists. To illustrate this, we reproduce certain elements of figure 6 in figure 7 (this analysis was originally put in this form by Turvey. See Turvey and Wiseman, 1957). Here OG is the maximum sustained yield. Consumers are willing to buy OG at a price P_2. Producers will be willing on grounds of profit-maximization to supply OG at the price of P_1. The difference between P_2 and P_1 would produce higher than competitive returns in the fishery—provided additional fishermen could be kept out. With no restriction on entry, more and more fishermen will enter, driving up costs, until returns in the fishery are just equal to the going competitive rate of return. Gains that could have been reaped by restricting entry have been dissipated by rising costs of production associated with excessive entry. If the demand curve DD shifts upward, as it would normally with increasing income and population, the potential return is dissipated by further cost increases. Moreover, the resultant shortening of the fishing season increases marketing costs as well. These effects are analyzed, with specific reference to the program of the International Halibut Commission, in chapter 5.

ECONOMIC EQUILIBRIUM UNDER PRIVATE OWNERSHIP OF A FISHERY

The analysis just given—which follows that of Gordon (1954), Scott (1955), and Turvey and Wiseman (1957)—makes it clear that a sea fishery open to all comers tends inevitably toward overexploitation. Leaving aside for the moment the problem of a precise definition of overfishing, a situation in which more fishing effort results in lower output, higher costs, and higher prices obviously makes no sense from the standpoint of producer, consumer, or the general public. The root of the problem lies in the simple fact that "everyone's resource is no one's resource." No single fisherman or group of fishermen has any incentive to restrict effort; to do so would merely result in capture of the fish by someone else. If price-cost relations are favorable, the "unclaimed rent" on a fishery is simply dissipated in excessive effort, higher costs, and depletion of the stock.

Essential Problem of Fishery Management

What would be the level of effort and catch if, in some way, a sea fishery were made the property of a private owner, with full power to exclude new entrants and to control the methods and intensity of fishing? Would the fishery then be exploited in a manner that would maximize its contribution to our welfare? These questions are of more than theoretical importance, for we will argue that the essential problem of fishery management is to provide the benefits of private ownership and use of scarce fishery resources. In order that the principles involved can be brought out, the following discussion ignores, for the moment, the obvious legal and technical difficulties of establishing individual property rights in a sea fishery. These aspects are discussed in a later section.

Assumptions

We assume (1) that the owner knows the approximate yields that can be sustained at different levels of effort, (2) that he wishes to find a single continued level of output which will maximize his current net returns, (3) that he expects prices and costs to remain constant, and (4) that sole ownership does not permit him to control the final consumer price of his product (that is, the product of this one fishery is sold in competition with other close substitutes which are readily available at current prices).

Maximization of Current Net Income

Conventional economic analysis indicates that the owner will operate at a level that will maximize the difference between total cost and total money receipts—in short, that will maximize net income. Expressed in other words, he will increase fishing effort only to the point where the last unit added contributes just enough to sales to offset the additional costs. Any further effort will add a constant (or increasing) amount to total cost while the catch will be increasing at a declining rate which reaches zero at maximum physical yield. It follows, therefore, that fishing effort would never be extended beyond that point except by miscalculation. Maximum physical catch would yield the largest net money return only in the limiting case where men and gear are completely costless. It is also apparent that improvements that lower fishing costs or increase the demand for fish at the port would lead to a new and higher level of fishing effort but never to the point where physical yield actually declines.

Maximization of Present Value

Unfortunately, this simple answer to the question of use of a resource by a private owner begs several vital problems that must concern either a private owner or a public body charged with management of a fishery. Once the resource is subjected to unified control, the rational objective becomes one of maximizing the present value of a stream of income over time. Thus the owner must consider the fact that he has a series of options as to the catch per unit of time. He can take more fish now and fewer later, or he can "invest" in the fishery by reducing the current take in order to have a larger stock available in some future period.

In addition, the decision as to the catch to be taken in the current and succeeding periods is affected by the rate at which future income must be discounted to indicate its present value. Income available next year is worth less than the same amount this year by an amount measured approximately by the going rate of interest on that sum. Expressed in other terms, it would not be worthwhile to reduce the current catch to get more in the future unless the additional yield is at least as great as he could have earned by taking the larger catch now and investing the returns at the current rate of interest. Profits would be maximized by adjusting the supplies available now and in each future period to bring present and discounted future returns into equality.

It is worth noting that this method of spacing or timing the rate of effort and yield to produce a maximum present value of the resource has nothing to do with the "time-horizon" of the owner. As long as his right to the resource can be transferred and as long as prospective buyers can borrow at going interest rates, he would be better off at any point in time to maintain this long-run maximizing procedure. He may not do so through ignorance, an urgent short-run need for cash at a time when willing buyers are hard to find, or imperfections in the market for loan-able funds, but the principle remains unchanged.

This view of the way in which a renewable resource, like a fishery, would be utilized by a private owner still rests on the assumption that he chooses among alternative positions on his long-run function—that is, among sustainable rates of catch. Actually, the problem is complicated further by the fact that a fishery stock, unlike a building or a piece of fixed capital equipment, is not only capable of producing a net yield of usable products but is itself composed of exactly the same products. In the short-run, therefore, increased effort will yield an immediate increase in output over and above the net yield; output will fall later, but only gradually as the effects of reducing the population show up in declining yields and rising costs of production.

Except for the immensely more complicated environmental factors (none of them observable directly), private operation of a fishery is similar in this respect to the raising of meat animals.

A mathematical statement and analysis of these problems is included in appendix 1 for those who may wish to follow through a rigorous demonstration. At this point, it is sufficient to indicate the general conclusions reached. The fact that future income (and consumption) is valued less than present income (and consumption) suggests that more will be taken now and less later than if the owner were solely concerned with maximizing current profits. A lower rate of interest lowers the cost of "investing" in fish stocks and increases the incentive to restrict current output in favor of expanded future yields.

The present catch (and thus the price of fish) will obviously be related to the owner's expectations regarding prices in the future. If, for example, he anticipates a steady increase as population and incomes rise, he would build toward higher output in the future by restricting current catch as long as the expected discounted gains from larger future sales exceeds current returns. During a period of prolonged depression it would pay to reduce the catch substantially and rebuild stocks for the subsequent recovery of the economy.

As indicated in appendix 1, it is not necessarily true that any single equilibrium level of effort, maintained continuously, would maximize present value. Under certain assumptions regarding demand and the relations among effort, yield, and population, it is quite possible that profit maximization would involve fluctuations in yield and population over time.

It should be clear that the biological overfishing case, in which effort is pushed to the point where physical yields actually decline, could not arise under private ownership of the resource. We can be certain that improvements in fishing, processing, or marketing techniques would not be dissipated in excessive entry, wastage of productive factors, or reduced physical yield. These are clearly improvements over the results that follow from unrestricted private enterprise where favorable price-cost relations lead to an actual reduction in physical yield with greater effort. But what of the equally likely case where unrestricted entry would not be carried to this extreme?

Economic Equilibrium Below Maximum Physical Yield

Consider the situation in which costs and prices are such that unrestricted fishing would result in an equilibrium at exactly the level of maximum sustained physical yield. A private owner would produce a smaller quantity, at which total receipts would be reduced, but by less than the reduction in total costs. Is the resource then underutilized? Is the private owner denying the consumer the benefit of greater production and lower prices in exploiting the fishery for his own economic benefit?

A full answer to these questions involves a series of extraordinarily complex problems that are beyond the scope of this study. In most cases, however, a satisfactory approximation can be offered along the following lines. The consumer of fish is not being bilked simply because output is not pushed to its physical limits. As indicated above, a private owner will increase output only to the point where additional revenues just offset additional costs. More fish could be taken on a sustained basis, but only at a cost greater than the value of the extra catch. The costs indicate what must be paid for labor and capital, and are determined largely by what that labor and capital could earn in other occupations. In commonsense terms, the consuming public would like more fish but would prefer more of other things that the additional inputs could turn out. If it be granted that market prices represent a fair approximation of the values placed on various end products, consumers as a group are best served when a dollar's worth of resources produces the same value in any of the several uses to which it can be put. As long as our desires exceed the capacity of our resources, more fish can only be obtained at the cost of other goods.

This conclusion would not hold, of course, if there were general unemployment; clearly it would be better to produce more fish than to let men and equipment stand idle. In the normal case, the profit-maximizing decisions of private owners would be likely to result in reasonably good allocation of resources from the standpoint of the economy as a whole. The fisheries would simply compete for factors of production on the same basis as any other industry, and any shortcomings in the operation of the market mechanism would be equally applicable to all.

There remain however other more valid qualifications to the generalization that elimination of the common property status of fisheries resources would ensure optimal utilization. We turn to these in the following chapter, which deals with the justification for and objectives of public management of fisheries such as the halibut.

SUMMARY

At each step in fishery management—formulation of objectives, development of control techniques, and evaluation of results—physical and economic factors are intermingled. Biology determines the weight and size of the catches that can be sustained. Technology limits the catching power of individual fishing units. Prices of final products and of inputs of labor and capital determine the amounts that will be taken by profit-seeking fishing enterprises.

Determining the physical input-output relations in an exploited fishery is an enormously complex task. The general form of the functions relating effort to sustained yield can be deduced, but even in the halibut case, where excellent statistical records have been maintained, it cannot be made precisely quantitative. Moreover, the actual level of effort and output in a commercial fishery cannot be determined from these data alone. Full equilibrium requires not only that the catch taken be sustainable but that the price received and the costs incurred are just sufficient to yield a competitive return to labor and capital.

Sea fisheries are common-property resources owned by no individual and therefore regarded as a free good by all. Under these conditions, fishing effort may be pushed to the point where sustained physical yields are actually reduced. What would normally accrue as rent to the owner of a resource is simply dissipated in excessive costs. Any improvement in fishing techniques or increase in market price will then reduce the catch still further as new vessels are attracted. Favorable cost-price relationships in the halibut fishery resulted in severe depletion. In the absence of regulation, the equilibrium level of catch might have been so low as to bring economic extinction to the fishery.

If a fishery resource could be privately owned and managed, there would be an incentive to maximize the net economic yield from the resource, and overfishing would not occur except through inadequate knowledge. There is no practical way in which the deep-sea halibut fishery could be converted to private ownership. If the total catch is restricted by public action, the economic rent from more rational exploitation will again be dissipated by excessive costs as new entrants are attracted to the fishery.

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Chapter 3

OBJECTIVES OF FISHERY MANAGEMENT

The discussion of chapter 2 leaves little doubt that unrestricted access to a fishery will not produce desirable results. Whatever definition of optimum fishing effort is employed, situations in which more effort and cost end in lower yield can only be regarded as inefficient. Moreover, overfishing in this sense cannot be considered as accidental or as a result of mistaken judgment on the part of fishermen. As long as the resource remains a free good, rational pursuit of profits by the individual fishermen leads inevitably to waste of the resource. Neither can this result be attributed to monopolistic practices by groups of fishermen or buyers. In fact, it appears that monoply on either side of the market would frequently result in better overall economic performance than would unrestricted common use of the fishery: the monopolist would have both the ability and the incentive to conserve, though not necessarily in the right degree.

In this chapter, we consider the case for the public management of a fishery, the choice of objectives, and the relation of objectives to regulatory techniques.

CASE FOR PUBLIC MANAGEMENT OF A FISHERY

If a fishery could be divided into separate units and disposed of to private owners, if these rights could be freely traded, if there would be enough separate owners to ensure competitive behavior, and if the individual owners had enough knowledge and financing to manage their holdings judiciously, then private ownership might suffice to prevent overfishing and to ensure efficient use of the resource. Many sectors of agriculture, forestry, and mining operate in this fashion with only minimal government participation, most of it designed to inform the owners of the requirements for profit maximization and to provide adequate financial sources.

Unfortunately, all of the "ifs" are large ones. Canadian and American legal systems do not forbid restriction of common access to fisheries, but they do require that everyone have a chance to obtain the restricted rights. The halibut fishery is actually exploited by two countries and—potentially—by others if American-Canadian views on the abstention principle are rejected. It is difficult to conceive of any practical way in which outright private ownership of small pieces of the resource could be achieved. If the fishery were sold to a private firm or group as a unit, the owner would undoubtedly find it profitable to restrict effort even more than the desired amount in order to exploit its monopolistic position by raising prices. Finally, the complexities of the physical and economic factors relevant to wise use of the resource suggest that private ownership would not be able to provide (or likely to use) the kind of research outlays necessary to approximate the right levels of effort over time.

It seems probable that only under some form of public control can maximum benefits be realized from fisheries subject to overfishing. This does not mean that management—in the sense of governmental action to limit fishing mortality—is required in every fishery if the resources of the sea are to be used effectively. Quite apart from the general American and Canadian distaste for government intervention in business activity, management of a fishery is itself a costly operation if it is to proceed on a basis of established facts and if it is to be made both equitable and enforceable. There is much to recommend the observation that the best management of fishing is to leave it alone until events show that intervention is necessary, or more precisely, until there is evidence that the potential benefits exceed the additional costs of management. Nevertheless, the history of fishery development in waters adjacent to major consuming nations demonstrates that the demersal and anadromous species are likely to require managing. The biological basis for a sound program cannot be built overnight, and the practical difficulties of implementing such a program become formidable when fishing fleets and short facilities overexpand. The full potential of fishery management will be realized only when its objectives are clearly defined and a set of techniques is developed to achieve them before the resource is badly depleted and before investment in the industry has become excessive.

CHOICE OF OBJECTIVES

Disagreement Among Experts

As the halibut case demonstrates, agreement among participating nations on the desirability of controlling a fishery is only a starting point, albeit a vital one. There remain equally vexing problems of agreeing on the objectives of management and the implementation and enforcement of a workable program. Disagreement on these fundamental questions is not that politicians and administrators have lagged responses to developments in the scientific aspects of the fisheries. The diversity of views with respect to management policies indicates that experts in the field disagree on objectives.

The roots of this situation lie in the complex interrelation of biological and economic factors involved in the fishing industry and therefore inherent in defining optimal fishing and the requirements of an ideal control program. The bulk of the analytical work underlying the theory and practice of fishery management has been done by biologists and reflects their natural concern with physical effects of fishing activity. A majority of biologists concerned with fishery management are, however, acutely aware of the influence of economic factors in shaping the development of the commercial fisheries and of the economic effects of regulation.

A few representative statements illustrate the point: Graham (1935) states that "the benefit of efficient exploitation lies more in economy of effort than in increase of yield or preservation of future stocks, though both of these purposes may also be served." Huntsman (1951) refers to the "continuing economic problem to insure sufficiently high take per unit of effort for profitable fishing." Beverton and Holt (1957), in their definitive study of the dynamics of fishery populations, are even more emphatic in declaring that the determinants of the ideal level of exploitation are economic and sociological as well as biological. Others—such as Herrington (1943), Nesbit (1943), and Foerster (1950)—choose to limit the term conservation to measures designed to increase the yield but recognize explicitly that fishery management requires consideration of economic and social conditions in the fishery and that maximum physical yield is itself an economic objective in part. Baranov, quoted in translation by Ricker (1958), recommends the quota system of regulation because, among other advantages, it creates a situation in which fishermen ". . . can use the greatest fishing power of their nets, and devote their means and energy not to a multiplication of fishing apparatus in pursuit of an impractical level of catch, but in a restriction and rationalization of this apparatus for attaining the highest economic return from the established quota." Ricker (1958) has extended considerably the discussion of the economic and social effects of regulation.

The International Pacific Halibut Commission, though legally restricted to measures designed to promote conservation only in the biological sense, has demonstrated its constant concern with the economic status of the industry. Wherever alternatives existed, the Commission has sought those that would best serve the joint interest of producers and consumers.

Only a few writers, notably Burkenroad (1953), have argued with unqualified approval for maximum physical yield as the only defensible objective of conservation measures. Others, such as Schaefer (1958), have recognized the possibility of a divergence between economic and purely physical maximization of yield but regard the former as impractical because of the existence of different economic maxima for different countries in shared sea fisheries.

Synthesis of Biological and Economic Factors

It thus would be unfair and inaccurate to say that the biological orientation of fishery conservation has meant that economic aspects have been ignored or that management has not set human welfare as a primary objective. Nevertheless, it can be stated that none of the writers mentioned has achieved a satisfactory synthesis of the biological and economic factors involved in the definition of optimal fishing and of the objectives of management. It would be surprising if they had. The necessary economic analysis requires no new theory, but it had not been applied systematically to the problems of a resource with the peculiar physical attributes of a fishery, and it is not simple.

Precisely the same statement can be made with respect to the few economists who have written on the basic economics of a common-property fishery resource. The analyses are rigorous and formally correct but have frequently been constructed on oversimplified assumptions about the biological factors linking fishing effort and yield and about the economic structure of the industry. It is not surprising therefore that practical control programs such as that of the International Pacific Halibut Commission have generally reverted to the simple objective of maximizing sustained physical yield.

Essence of Conservation

We do not question that conservation based on the objective of maximum sustained yield alone will generally produce better economic results than will unrestricted exploitation of intensively fished populations. We do argue, however, (1) that the very essence of conservation is to provide economic benefits, (2) that even programs pinned to the achievement of maximum physical yield are in fact geared in part to economic goals, and (3) that the maximum benefits of fishery management cannot be realized until its objectives are defined to include broader and more precise economic aspects, and its techniques are altered accordingly.

Need for Conservation of All Factors of Production

At this point, two questions are relevant. Why do we wish to prevent depletion of fish stocks? And why do we restrict fishing effort on some and not on others? Unless the end products of a fishery are valued at more than enough to cover production costs, no commercial operation would arise, nor would it be a matter of major concern if these species ceased to exist. The physical yield becomes meaningful only if the value of the product is assumed. The validity of maximum physical yield as an ultimate goal becomes even more clouded if we look at all fisheries available to a particular fleet rather than at a single species. It is probable, for example, that a greater weight of edible fish could be taken by diverting the Pacific halibut fleet to catching cod and rockfish (or, if American and Canadian tastes could be modified, even greater physical returns might be realized by harvesting dogfish). This diversion of the fleet would be regarded, properly, as nonsense—but only because the value of the end product and of money returns to fishermen would be reduced.

If it be granted that only economically useful species are worth conserving, it follows logically that the cost of taking the permitted catch is of vital concern. If maximum physical yield is the sole objective of regulation, it makes little difference how the necessary limitation of the catch is achieved. From the standpoint of the industry and the economy, however, there is obviously a vast difference between measures that limit fishing mortality by preventing the use of efficient techniques and those that accomplish the same end in ways that minimize the costs of fishing effort. Conservation of these other factors of production is no less important to society than is conservation of a particular fish population.

Economic Definition of Optimum Fishing

Let us approach the problem of defining optimum fishing from the "other side" (starting with economic principles), taking as our starting point the proposition that fishing is an industry. Like any other industry it contributes valuable products to the economy, but to do so it must use valuable inputs of productive services—labor, capital, and management—which (except under conditions of substantial unemployment) it purchases in competition with producers of other goods. If we may assume that market prices for goods reflect with reasonable accuracy the preferences of consumers, the basic economic objective, from the standpoint of society, is to see that the fisheries maximize net economic yield—the difference between the aggregate money value of output and the aggregate money cost of input needed to produce it (excluding, of course, money returns based on monopolistic restriction of output). It is desirable that this result be achieved by providing a situation in which the pursuit of profit by businessmen will result in output, prices, and costs that also maximize the industry's contribution to society as a whole. If unrestricted private enterprise produces some undesirable effects—overfishing, for example—the minimum necessary public restraints presumably should be imposed to reduce or eliminate them.

Viewed in this light, the performance of a fishing industry should be judged by the standards that have been developed as guides to public policy toward private enterprise generally. These may be summarized as follows:

1. *Output and factor allocation:* At first glance it might seem that, other things equal, the more production of a marketable fish the better. If our economy is at full employment, however, more fish can be produced only by giving up some output of other things. Thus, the proper objective is that output of fish at which the value of the last unit caught is just equal to the value of other things that would have been produced with the required inputs of labor, capital, and management (including additional fish that could be taken later by restricting output in the current period).
2. *Efficiency:* For optimum performance, the fishery should operate at the lowest possible costs for each level of catch. The market mechanism should reward those who achieve greater efficiency and weed out those who do not.
3. *Progressiveness:* Competition in the industry should provide maximum incentives to develop and adopt new techniques over time and to make use of new methods developed in other fisheries and other industries.
4. *Income distribution:* Returns from fishing should be distributed among participants on a basis that approximates their contribution to production. This requirement implies that incomes to labor and capital should be equal to those that they could earn in other occupations. A level of fishing effort based on exploitation of the inability of fishermen or vessel owners to move freely to other activity would not necessarily be optimal even if other requirements were met.
5. *Stability:* In an economy subject to changes in consumer demands and, particularly in the fisheries, to unpredictable changes in supply, perfect stability of production, price, and incomes is not possible. The reduction of necessary fluctuations to a minimum, however, must be regarded as an essential objective.

In short, an optimal fishery would be taking a catch at which the last units of effort add just enough to sales to cover the additional costs required (in terms of other production foregone). The kinds and combinations of boats, men, and gear would be such as to take that catch at the lowest possible cost. Over time, new developments in gear and methods would be adopted promptly to keep actual costs close to attainable minimum costs. With ready access to other occupations, fishermen and vessel owners would receive incomes as high as those available elsewhere.

This definition of optimal fishing in terms of product value and input costs does not imply that physical yields and their complex biological determinants are irrelevant or unimportant. The functions relating fishing effort to physical yield provide the essential information about alternative production possibilities, without which catch values and the cost of fishing effort cannot be determined. But the vital questions—which output is best and which combination of inputs is the most efficient—cannot be answered until the physical relations are translated into value and cost. The situation is exactly analogous to the case of a manufacturing firm. The engineer can provide estimates of various outputs that can be produced with different combinations of plant, equipment, labor, and materials. Only when the inputs and outputs are priced, however, can the manager decide which combination of inputs and which level of output yield the best profit.

Relation of Economic to Physical Yield

The relation of maximum net economic yield to maximum sustained physical yield may now be indicated.

1. Optimal fishing, under either definition, cannot extend beyond the point where additional effort actually lowers the physical yield. Such a condition makes even less sense in economic terms than in biological.
2. Under conditions of substantial unemployment, the two concepts would be nearly identical. Lacking employment opportunities for men and gear elsewhere, the real cost of fishing inputs is zero in terms of other production foregone, and the optimum physical yield would also maximize net economic returns (provided demand for the end product is elastic—in short, that the price does not fall more than proportionately with increased production).
3. If fishing inputs do cost something, in terms of other production foregone, the optimal level of fishing effort must always be lower than the level that maximizes physical yield. By definition, the marginal output approaches zero at the latter point, and the net addition to the value of the economy's output will fall short of the costs required to produce it.
4. The most significant difference relates to fishing costs. If maximum physical yield is our prime objective, then the cost of obtaining it is irrelevant. If, however, we are concerned with maximizing economic benefits from the fishery, optimal fishing effort must require that costs be minimized; that is, that we use no more inputs than are required and that we use them in the most efficient combination.

If, by changing fishing methods, a given physical yield can be obtained at lower cost in terms of labor and capital, then physical yield of other commodities or services could presumably be increased.

Need for Public Management

In the United States and Canadian economies, the forces of competition provide workable approximations to the standards of performance outlined above. In cases in which technological efficiency requires that the market be supplied by one producer, the industry is designated as a public utility and is subjected to regulation or public ownership. In other cases, interference with the working of market forces is restrained by antitrust legislation. The fisheries are generally competitive in structure, with sufficient buyers and sellers to prevent market control and with a product, for the most part, not susceptible to effective product differentiation through promotion of individual brands. Why, then, does free competition fail to produce satisfactory results? Why is public management of the resource required?

The analysis of the previous chapter provides the answer. With unrestricted access to a fishery, there is no incentive for any fisherman to maximize the return from the resource by using just the right amount of labor and capital. In terms of our standards of performance, the industry will invariably use more labor and capital than necessary. Efficiency is likely to suffer as returns are pinned to levels at which innovation and replacement are difficult to finance. The initial surge of vessels into the fishery during the early flush days, when accumulated stocks are being exploited, produces persistent overcapacity. It is far easier to get new capital into the fisheries than to get it out when the lagged effects of overfishing appear. Technological improvements, once the maximum physical yield is reached or exceeded, actually result in less output.

Although recognition of the effects of the common-property status of most marine resources provides useful generalizations about the historical development of many fisheries, it provides no easy solutions of the problems created. Private ownership would doubtless produce far better results, as it has in the case of land and forests, but there is simply no ready way to establish it in most sea fisheries. If we are to realize the maximum benefit from fishery populations that come under intensive pressure, some type of governmental stewardship is required.

RELATION OF OBJECTIVES TO REGULATORY TECHNIQUES

We feel that the general criteria for effective performance of an industry also define the broad objectives of government management where unrestricted private enterprise does not produce satisfactory results. To reduce these objectives to practical policies, however, requires consideration of a variety of complexities introduced by the biological characteristics of the fish population in question and the technological requirements of the fishing operation. If the program is aimed solely at the achievement of maximum physical yield, the determination of the right amount of catch is the prime concern, and the method of regulation need only be geared to the practical needs of effectiveness and enforceability. But if our prime concern is with the economic performance of the fishing industry, the effects of alternative types of controls on fishing costs, processing and marketing costs, and market prices become equally important. The problem is complicated further by the inevitable necessity of compromising biological and economic objectives to keep regulation within politically and practically acceptable limits.

Nevertheless, there are some aspects of fishery management that appear to be of general applicability. In the sense used here, management means administrative regulation that modifies the impact of fishing on the resource. (No consideration is given the alternative of full public ownership and operation of the industry, since it would not be acceptable to either of the governments involved in the halibut conservation program.) This regulation can take either of two broad forms. The first would include all measures that affect the size at which fish become subject to capture. It would embrace such controls as minimum mesh sizes, closure of nursery grounds, and the establishment of size limits. The second involves control of mortality due to fishing. Since mortality is a function of effective fishing effort, control must operate through the number of vessels, the effectiveness of the vessels and gear, the time spent in fishing, or the geographic distribution of fishing effort. The various methods may, of course, be used in combination.

Subject to some modification in specific cases, the following generalizations then become apparent:

1. If selectivity of gear can be varied, an increase in catch may be achieved with relatively slight (and measurable) changes in cost. There should be little conflict between biologist and economist where a simple change in the selectivity of the gear can increase sustainable yields.
2. Restrictions affecting the fishing power of vessels and gear or their efficient distribution over the fishing grounds are almost certain to boil down to reduction in catch by decreasing efficiency. In economic terms they may well be better than nothing, but such restrictions are obviously the least desirable techniques to use if others are available.
3. Restrictions on fishing time may be ineffective (in any sense) if they simply shift fishing pressure to the open season. To the extent that they do restrict the catch, they are likely to decrease overall industry efficiency unless vessels, gear, and shore facilities can be shifted, without loss, to other uses during the closure periods.
4. The type of regulation chosen may also influence market prices for a given catch in weight in two ways: (a) by increasing or decreasing the proportion of the catch falling within the size groups that yield the best price and (b) by increasing or decreasing seasonal fluctuations in the catch.
5. Regulatory programs cannot be considered individually if there is any mobility of gear and men among the fisheries concerned. Restrictions on the catch of one species may shift fishing pressure to others.
6. The only direct method of achieving a desired catch level is to control the amount of fishing effort. Regulation of the catch itself, without control over entry, is actually an indirect technique, operating through control of fishing time, fishing area, the fishing power of the boats and gear used, or some combination of these.

Once economic efficiency is accepted as one of the specific objectives of management, measures designed to reduce catch and effort by reducing efficiency (or which have that ultimate effect) are suspect. Less obvious, perhaps, is the desirability, on a cost basis alone, of minimizing the extent of public control. Methods of regulation that maintain the catch at desired levels only by preventing fishermen from doing things that would be individually profitable require detailed control over operations and an enforcement program that is both onerous and costly. Ideally, then, regulation should seek, as far as possible to establish conditions under which the profit motive works with, rather than against, sound management of the resource.

One of the intriguing possibilities that emerges from a definition of the conservation problem in economic terms is the possibility of reducing the administrative burden, on both regulator and industry, while increasing the gains in overall economic welfare. As long as the fishing capacity of the fleet exceeds that required to take the right amount of fish, the industry is in a state of economic disequilibrium that demands more detailed regulation and more enforcement. If, on the other hand, it were possible to reduce the economically desired effort to or near the optimum level, a great deal of detail—area boundaries, different closed seasons by area, some types of gear restrictions, for example—might be dispensed with or reduced substantially.

This is simply tantamount to saying that regulation aimed at approximating the results of ownership (by assuming general control on behalf of the public) may permit free competition among producers to do much of the rest of the job, with real incentives for cost reduction, technological improvement, and proper distribution of fishing effort over time and area. We may in this way bypass the troublesome legal and practical problems of conferring private property rights over specific parts of a fishery and the danger of monopolistic control over product prices, with even less interference with decisions of private businessmen in the fishery than our present methods require. In practical terms, the more complex objectives of economic maximization may result in easier and more effective management than under the apparently simple goal of maximum physical yield.

SUMMARY

The justification for public management of fisheries is found in the institutional factors that make private ownership impractical. Management is not necessarily required in all fisheries, particularly where fishing is light and the benefits would not offset the cost of establishing a scientific program.

There is substantial disagreement among fishery experts as to the objectives of management. Though biologists are aware of the importance of economic factors, the emphasis in applied conservation programs has been on the achievement of maximum sustained physical yield.

Although this concept of the goal of fishery management will produce better economic results than will unrestricted fishing, its apparent simplicity is misleading. Physical yield is important only if the value of the product is assumed. If sheer weight is the only goal, it would pay us to divert vessels from such scarce fish as halibut to more abundant species. Concentration on the goal of maximum physical yield ignores the equally important requirement that the catch be taken at the lowest possible cost. Net economic yield is thus a more appropriate objective of management.

The standards of performance applied to industry in general are equally applicable to the fisheries. Optimal fishing requires (1) that the right catch be taken with the minimum cost, (2) that the industry should be able to develop and adopt new and better techniques, and (3) that incomes to labor and capital should be equal to those that could be earned elsewhere and should be as stable as possible.

If these objectives of fishery management are accepted, it becomes important to assure the "right" catch (which will normally be less than the maximum physical yield) and to adopt techniques that provide maximum incentives for efficiency and progressiveness.

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Chapter 4

HISTORY OF REGULATION OF THE HALIBUT FISHERY

We turn now to a detailed review of the development of conservation regulations and objectives in the halibut fishery. The review will indicate that far from remaining static, conservation controls in the halibut fishery have been changed from time to time in an effort to produce improved management of the resource. This willingness to consider and effect changes in the regulations in the face of new conditions and developments in the fishery is, of course, a prime requisite for good management.

In this chapter, we consider the following five main topics: the Convention of 1923, the results of the Commission's investigations, the Convention of 1930, the regulations of 1932, and the changes since 1932.

CONVENTION OF 1923

Officially, the record of halibut conservation begins with the Convention of 1923, which came into force October 21, 1924 (Treaty Series, No. 701). The question of curtailing fishing effort for halibut had cropped up repeatedly in earlier years. From a scientific point of view, Thompson's study (1916), undertaken at the request of the Government of British Columbia, had already sounded a warning regarding the condition of the stocks. From the industry's point of view, curtailment was bound up with the desire for an improved level and stability of prices and yield per unit of effort. Discussions between the United States and Canada in 1918 and 1919 resulted in a proposed convention, but because controversies developed over details of tariffs and port privileges and intergroup rivalries, it was not ratified. Not until 1923 were the two Governments able to agree on the first steps toward a program divorced from partisan interest and based on objective research findings.

The general purpose of the Convention was to begin a thorough investigation of the life history of the Pacific halibut and the halibut fishery and to undertake, on the basis of recommendations stemming from that research, measures for its preservation and development. The Convention's most important contribution was establishment of the International Fisheries Commission (in 1953, the name was changed to International Pacific Halibut Commission), with two members from each country, and creation of a permanent staff to undertake the detailed research required and—at a later date—the task of formulating regulations. It was significant that the first Commissioners and the Director of Investigations were men thoroughly familiar with the fishery and dedicated to the concept of conservation.

The only regulatory measure included in the Convention of 1923 was the establishment of a winter closed season, running from November 16 to February 15, or as modified by the Commission. It was recognized that this closure could be of only limited effectiveness, but it did provide some tangible economic benefits to the fleet. More specific regulation was to await the establishment of a body of facts that would provide an objective basis for management.

RESULTS OF THE COMMISSION'S INVESTIGATIONS

Thompson's earlier work had established the fact that populations on the nearby banks were being cut down sharply. Although an initial reduction in stocks and average size was to be expected, the intensity of fishing effort, spurred by technological developments in fishing and marketing, had become so great as to raise serious questions regarding the achievement of equilibrium at a satisfactory level of catch. The evidence then available suggested strongly that the industry was headed for disaster once the geographic expansion north and west had run its course. But much remained to be done before the biological and statistical record could be regarded as sufficient to justify formulation of specific recommendations and, perhaps equally important, to convince the industry of the necessity of reducing fishing effort. The Commission devoted itself immediately to these tasks.

By 1928, the work had progressed to a point where the Commission felt it possible to propose specific recommendations regarding the need for regulations and the general form that they should take. (A full review of the research findings underlying these recommendations is beyond the scope of this paper. The interested reader will find thorough documentation in the various publications of the Commission.)

The basic conclusion emerging from the initial investigations of the Commission was anything but encouraging. The evidence pointed to serious depletion in the more accessible areas and a level of fishing activity that showed every sign of pushing the process much further. In earlier years the catch from the 600-square-mile area originally exploited was as great as that from the 1,800-square-mile area under investigation in the twenties. On the older grounds south of Cape Ommaney, Baranof Island, the total catch had declined from 50 million pounds in 1910 to 21 million in 1926, despite much greater fishing effort in the latter year. About 2½ times as many units of gear were required to take a catch only 40 percent of earlier levels. The catch per unit of effort on these grounds had dropped from 300 pounds in 1906 to less than 50 pounds at the time of the investigation and showed no tendency to stabilize at that level. The average size of fish landed had also declined markedly; from 1919 to 1926, the proportion of undersized fish (that is, fish that were graded into a lower price group in the trade) rose from 20 to 30 percent of the catch. Even on the western banks, which had come under exploitation at a much later date, the same tendencies were evident. The catch per skate declined from 160 to 100 pounds between 1923 and 1926, and there was a marked increase in the proportion of smaller fish (International Fisheries Commission, Report No. 1, p. 10–13).

Total landings had not declined during these years. As the Commission noted, the level of production had been maintained by extending fishing operations to new areas and by increasing the intensity of the fishing effort. The general situation was regarded as critical. In the Commission's words: "These illustrations demonstrate beyond a doubt that the fishery is in a very serious condition, and that the banks cannot stand the intensity of fishing to which they are subjected. The Commission is fully convinced that the conditions are so serious that no delay should be permitted in the adoption of additional conservation measures. In the light of the investigations made, such action is essential to the maintenance of the fishery."

The Commission's early work led to the conclusion that no single general regulation would be effective for the entire fishery. Tagging experiments had shown largely independent stocks of halibut on the banks along the Pacific coast, with various banks unevenly depleted—the degree of depletion generally decreasing and the proportion of spawners increasing as the distance from the market increased. The Commission could find "no such active interchange as would render regulations applied to one bank effective on all." In addition, the different banks vary considerably with respect to natural abundance, rates of growth, and physical characteristics.

In studying the effect of the closed season on the several main areas of the fishery, the Commission found that only one area was significantly affected—that on the eastern side of the Gulf of Alaska, between Cape St. Elias and Cape Spencer, in which there had been heavy winter fishing before the regulation. In contrast, the area including older, more depleted banks to the south of Dixon Entrance had for many years supported a summer fishery, so the regulation had little effect there. Also, the newer banks west of the Gulf of Alaska, which were of little importance before, had developed a considerable summer fishery since imposition of the regulation. Therefore: "The Commission finds that the fish thus protected by the closure were exposed to fishing that was increased in intensity during the open season and, consequently, the abundance on the banks has undergone a further decline due to a progressive depletion."

In support of this statement, the Commission pointed to the increase in total annual catch from 51.5 million pounds before the closed season to about 57 million pounds in 1927; the closed season had merely shortened the period of catch. The increased intensity was a direct result of the closed season, which made it more advantageous to expand effort during the other months. It was more expensive to fish in winter because of bad weather, loss of gear, and low morale of the men; with the elimination of the 3 winter months, the vessel owners were able to spend more time in overhauling their gear and boats, the market for frozen fish was steadier, and the grade of fish was generally regarded as better in the summer than in the winter. Thus the closure was said to be of economic benefit, and the Commission felt that fishing was bound to expand sufficiently to counterbalance the effect of the closure.

The Commission also expressed concern over the number of immature fish taken by the fleet. The market value of fish under 11 to 12 pounds was considerably lower than for the larger ones. Hence "investment" in growth of these fish to more marketable size would be desirable if it could be achieved without reducing unduly the effectiveness of fishing operations and if economic losses caused by mortality were not too great. Some of the small fish were seriously injured when jerked off the hook, which made size limits alone ineffective as a protective measure.

In general, the winter closed season, though desirable on economic grounds, could not be regarded as an effective regulatory technique of itself. The nonhomogeneous nature of the halibut stocks disclosed by the initial research indicated the necessity of an area approach. On many grounds, the closure did not affect fishing effort at all, whereas on others, it merely resulted in an increase in the intensity of fishing in the open season. It offered no protection to concentrated stocks of immature fish.

The Commission recommended a broad-based program aimed at more direct curtailment of the catch. The heart of the proposals lay in the request for authority to designate regulatory areas and to reduce fishing by limiting each until there was evidence that the yield had stabilized. The original area definitions sought—those banks south of Cape Spencer and those north and west—corresponded to a natural division of the fleet and to a fairly well-defined breaking point between the two broad population groups exploited by the fishery. In view of the uncertainties that remained, considerable latitude was requested to alter the area boundaries and scheduled catch reductions as dictated by subsequent developments.

The Commission also requested authority to close two areas deemed to be populated largely by small, immature halibut, and to prevent the use of fishing gear deemed unduly destructive. It indicated a desire to extend the closed season by 2 weeks at its beginning. Again, it was recommended that such provisions be given the necessary flexibility to deal with future developments as knowledge of the basic stock and of the reactions of the fleet to the new concept of regulation increased. Finally, it requested authority to license vessels fishing for halibut in treaty waters in order to ensure its ability to obtain the vitally needed statistical information and to control clearance to regulated fishing areas.

CONVENTION OF 1930

With these recommendations before them, the two Governments undertook, in the Convention of 1930 (Treaty Series, No. 873), to formulate an operative conservation program.

Under the second Convention, the Commission was continued as a research organization but was given greatly increased regulatory powers along the lines requested in its first major report. Since the broad framework of objectives and procedures laid down in 1930 has remained essentially unchanged in subsequent years, they might well be outlined briefly at this point.

Objectives

The stated objectives of the Commission were to make investigations and to issue regulations for protecting, conserving, and developing the stocks of halibut. It was made scrupulously clear at the outset that the newly conferred regulatory powers were not to be used to further purely economic ends. The commonsense interpretation placed on this provision by the Commission was clearly defined by Allen in an early statement: "The Commission can and does try to make its regulations interfere as little as possible with the economic conduct of the industry. But the Commission has no power to deal with commercial purposes. It can only protect and conserve." (Allen, 1936).

The fourth Convention, in 1953, broadened the wording of the Commission's objectives by specifying that its regulations be "designed to develop the stocks of halibut in the Convention waters to those levels that will permit the maximum sustained yield and to maintain the stocks at those levels. . . ." (Treaty Series, No. 2900). It is evident from the wording of the Commission's early reports that maximization of yield rather than stocks had, in fact, been the guiding principle even before the wording was altered. Its report for 1947 included the following statement: "The Commission's objectives are to rebuild the stocks to an approximate level of maximum yield and to stabilize them there."

Structure and Procedure of the Commission

The first Convention provided for four Commissioners, two from each country. Subsequently it was agreed that they were to be assisted by a permanent research staff and an Honorary Scientific Council. In view of the inherent delicacy of multinational regulatory work, the Commission and its staff have adhered rigidly to the specifications laid down at the outset: "The members of the Commission should not be advocates of any branch of the industry —dealers, fishermen, supply house men or vessel owners. Neither should they be sectional, with the idea that they would favor any state, province, or port," (Allen 1936). Both the composition of the Commission and the principles governing its selection were continued without alteration in the Convention of 1930. In 1953 the number of Commissioners was increased to six, with the additional requirement that: "All decisions of the Commission shall be made by a concurring vote of at least two of the Commissioners of each Contracting Party" (Treaty Series, No. 2900).

The Commission is charged under the treaty with periodic reporting of the results of its investigations and regulatory activity. In addition, the Commission maintains close liaison with all branches of the halibut industry. Through public hearings, formal meetings with various branches of the industry, and representations from interested parties, it has developed an excellent "two-way" channel for information and discussion.

The Commission's regulations carry the force of law in Canada and the United States, but the Commission has no enforcement powers. These powers are exercised by agencies of the two Governments under enabling legislation passed by both.

Regulatory Powers

The second Convention laid down regulatory powers for the Commission that followed closely the recommendations in the 1928 report. The closed season was extended to cover the period November 1 through February 15, with provision for alteration or suspension should the Commission deem it necessary. The Commission was authorized to divide the convention waters into separate regulatory areas, to limit the catch in each area, and to close "nursery grounds" found to be populated largely by small, immature halibut. The types and sizes of gear used in the halibut fishery were made subject to control should the necessity arise. Licensing of vessels to ensure compliance with statistical reporting requirements and control over departures were also brought under Commission control.

The real control element of the conservation program obviously lay in the power to define regulatory areas and to limit the amount of fishing by controlling the catches in each. The winter closure was desirable but of minor importance from the standpoint of its effects on yields, whereas the establishment of nursery grounds and ability to restrict the use of destructive gear were essentially preventive measures. The remaining powers were designed primarily to provide better compliance and to minimize the need for direct enforcement action. Control over fishing effort was actually exercised indirectly, through limitation of fishing time. Since the Commission had no authority to control the number of boats or their individual fishing efforts, the season was to close as soon as the Commission estimated that boats already departed for the grounds would complete the quotas.

REGULATIONS OF 1932

The program became operative in 1932, with the promulgation of specific regulations along the lines authorized by the second convention. The Convention waters were divided into four regulatory areas, of which areas 2 and 3 (the "southern banks" and "western banks") included the major producing sections. Catch limits were set at 22.5 million pounds in area 2 and 23.5 million in area 3; no limits were prescribed for areas 1 and 4. Licenses were required of all vessels and provided the reporting and clearance provisions required for statistical and compliance purposes. The Timbered Islet and Massett Banks were designated as nursery areas and closed to all fishing. The closed season was changed to run from November 1 through January 15, apparently with an understanding that each halibut vessel would voluntarily suspend operations for at least 1 month during the summer fishing season.

The theoretical basis for these first regulations is essentially that outlined in the first part of chapter 2 and need not be repeated in detail (Thompson, 1950).

In demersal fisheries such as the Pacific halibut, total yields may be relatively stable over wide range of fishing effort, though at some very low and very high levels of effort they may decline. Within these limits, the "normal yield" —that which just equals recruitment plus growth less natural mortality—can be maintained only if catch per set varies inversely and proportionately with effort (the number of sets of standard units of gear). If actual catch per set, for a given level of effort, lies above this function relating effort and "normal" catch per set, the population will decline and subsequent catches per set will decrease. Conversely, if actual catch per set is below the normal reciprocal function, the population and subsequent catch per set will increase.

The Commission's investigations resulted in an approximation to this normal yield, with the time-sequence of deviations in the proper relationship. The initial objective was therefore to reduce the catch by successive steps until a level was reached at which recruitment plus growth would provide an "investment margin" for rebuilding toward maximum physical productivity.

In retrospect, it appears that the actual catch limits set in 1932 (22.5 million pounds in area 2 and 23.5 million pounds in area 3), though based on an estimate of normal yield derived from a necessarily scanty statistical basis, were remarkably close to the target. Subsequent rates of recovery of average catch per unit of effort suggest that the initial quotas (and subsequent increases) held the catch to levels at which continued "investment" in the stocks and hence increased yields could be achieved. (See table 2 for annual quotas in the major regulatory areas.) The accident of a depression-induced decline in fishing effort made it possible to achieve this starting point immediately without substantial interference with the current level of operation of the fleet. In part by design and in part by circumstance, the rate of investment in rebuilding made economic sense as well as biological. The most rapid recovery would, of

TABLE 2.—*Fishing quotas*[1] *by areas in the Pacific halibut fishery, 1932–58 (exclusive of special seasons after 1951)*

Year	Quotas			
	Area 2	Area 3	Area 4	Total
	Million pounds	*Million pounds*	*Million pounds*	*Million pounds*
1932	22.5	23.5	...	46.0
1933	21.7	24.3	...	46.0
1934	21.7	24.3	...	46.0
1935	21.7	24.3	...	46.0
1936	21.7	24.3	...	46.0
1937	21.7	24.3	...	46.0
1938	22.7	25.3	...	48.0
1939	22.7	25.3	...	48.0
1940	22.7	25.3	...	48.0
1941	22.7	26.3	...	49.0
1942	22.7	26.8	...	49.5
1943	23.0	27.5	...	50.5
1944	23.5	27.5	...	51.0
1945	24.5	28.0	...	52.5
1946	24.5	28.0	...	52.5
1947	24.5	28.0	0.5	53.0
1948	25.5	28.0	0.5	54.0
1949	25.5	28.0	0.5	54.0
1950	25.5	28.0	0.5	54.0
1951	25.5	28.0	0.5	54.0
1952	25.5	28.0	...	53.5
1953	25.5	28.0	...	53.5
1954	25.5	28.0	...	53.5
1955	25.5	28.0	...	53.5
1956	26.5	28.0	...	54.5
1957	26.5	28.0	...	54.5
1958	26.5	28.0	...	54.5

[1] The table does not include landings from nonquota areas.

Source: International Fisheries Commission and International Pacific Halibut Commission, Pacific Halibut Fishery Regulations, 1932–58.

course, be achieved by complete prohibition of fishing, but the realities of the situation required what was, in fact, a much more defensible policy of increasing yields at a rate that may well have approximated the rate of return on other investments. Expressed less formally, the discounted benefits of a more rapid increase in stocks with more drastic curtailment would not have compensated for the further reduction of currrent output.

This basic framework of regulation has been continued to the present. This statement does not imply, that the development of practical policies has remained static. Perhaps the major achievement of the Commission and its founders was the boldness with which the urgent situation was faced. The first control program began with full recognition of the gaps in biological knowledge that still existed and of the possibility of unforeseen reactions by the fleet in response to the new controls. Policy, then, emerged out of experience, and the frequent changes made in subsequent years were not an evidence of weakness in the original conception of the program but rather of flexibility based on the steady expansion of knowledge of the resource.

CHANGES SINCE 1932

Dory Fishing

In 1933 the Commission indicated its intention of prohibiting dory fishing in order to reduce the mortality of undersized halibut. The prohibition was ordered in areas 1 and 2 in January 1935, but the order was subsequently suspended to provide adequate notice to the fleet. The action was finally taken in 1936, and later the prohibition was made effective in all areas. This action was not vigorously opposed by the industry. Quite apart from the desirability of reducing mortality among undersized fish, the trend was definitely away from dory fishing on grounds of safety and technical efficiency.

Nursery Areas

Continued research on the Massett and Timbered Islet nursery areas indicated that a substantial proportion of mature fish had accumulated. These areas were therefore opened in 1958 and 1959. Catch trends are under close observation to determine whether they should remain open.

Area Boundaries

Throughout the period since 1932, the boundaries of the various regulatory areas and closing and clearance dates in each have been changed fairly frequently. (Details of these changes may be found in the Commission's reports.) In part, this frequent change was necessary to meet practical problems of compliance. More important, however, these changes were necessary to adjust fishing effort more closely to differential changes in abundance on the various grounds. As the effects of the program began to show up in recovery of stocks and in more detailed statistical information, it became possible to increase the aggregate productivity of the fishery by closer subdivision of regulatory areas and more flexible handling of catch limits to direct the geographical distribution of fishing effort.

Incidental Catches

Another significant series of changes began in 1937. These regulations, issued under authority extended in the Convention of 1937, provided for the retention and sale, under permit, of halibut taken incidentally to fishing for other species. The amounts of halibut sold could not exceed 1 pound (dressed weight, head off) of halibut for each 7 pounds of other species, not including salmon (and, later, tuna). Subsequently, the Commission was given authority under the Convention of 1953 to control incidentally caught halibut taken during both open and closed seasons, and extended the permit privilege to Bering Sea crabbers under specified conditions.

These actions were taken for various reasons and also in a sensible move to avoid wasting halibut caught in the course of other fishing, principally for black cod. Some halibut are inevitably caught by these vessels. The Commission indicated at the outset its intention of revoking the privilege if it were abused, but revocation has not been necessary. The effect has been a small but useful addition to the supply of fresh halibut and to fishermen's incomes without perceptible effect on the overall program. The income from black cod operations has been so small, on occasion, that only retention of halibut has made the fishery worthwhile.

Restrictions on Net Fishing

In some respects the extension of the permit system for incidental halibut catches was an outgrowth of the continuing problem of gear restrictions. European experience indicated that heavy catches of spawning halibut could be taken with bottom set nets, and lacking the power to impose any other restriction on effort, the Commission felt that the use of such gear would threaten the entire program. Accordingly, such use was banned in 1938 before it could be adopted by American and Canadian halibut vessels.

A more serious problem arose with the spectacular growth of otter trawling on the Pacific coast in the late thirties. Within a few years after widespread adoption of this gear, the dragger fleet was pushing into areas where halibut might be taken. Some halibut grounds are obviously unsuited for trawling and presented no difficulties. In others, the possibility of a rapid expansion in effort by trawl gear, coming at a time when the shortening of the season was already causing concern, posed very serious problems. If the draggers used the same small-mesh trawls employed for the small demersal fish that made up the bulk of their catch, they could take excessive numbers of small halibut. Moreover, it might be profitable to trawl in areas populated largely by very small halibut. As the dragger fleet began to develop excess capacity, the threat of serious economic dislocation from unrestricted gear competition loomed larger—and with it, the possible threat of a breakdown in the entire control program.

These considerations, together with analysis of European experience with otter trawling in halibut waters, led the Commission to the conclusion that the fishery should be continued on a long-line basis only. In 1944, the regulations were amended to prohibit retention of halibut taken in nets of any kind or to possess halibut while nets are on board. The issue remains open as far as the trawler operators are concerned and has been discussed continually during the postwar period. Trawls with 12-inch mesh are permitted to retain incidentally caught halibut in some areas.

Shortening of the Season

A final policy question with which the Commission has been concerned involves the steady shortening of the season under quota regulation. A detailed analysis of the problems created by this response to increasing abundance is presented in subsequent chapters. At this point it may simply be noted that shortening of the halibut season has caused some difficulties, not only to the industry, but also to the Commission in achieving maximum yield from the resource.

As early as 1933, the industry undertook to lengthen the halibut season by a "voluntary curtailment system." Details of the arrangements varied from year to year, as each season's program was drawn up annually by representatives of fishermen and vessel owners from all halibut ports (the 1958 layover agreement is reproduced in appendix 2). In general, the essential techniques involved an enforced layover between trips and a catch limit per man per trip. The program undoubtedly achieved some degree of success, but there were inherent difficulties in compromising the conflicting views of the various groups—small boats versus large boats, Canadians versus Americans, port versus port. It is unlikely that any effective curtailment could have been maintained without the enforcement provided by union control over fishermen.

The fleets therefore requested on several occasions that the Commission itself provide the necessary enforcement by incorporating some form of layover provisions in its regulations. In 1938, the Commission found sentiment for such controls sufficiently strong to warrant a request to the Governments for treaty authorization. By the time the issue came up for serious consideration, however, the industry could not reach general agreement on the desirability of the proposal, and the matter was dropped.

Wartime problems, coupled with questions as to the legality of the voluntary program in the United States, pushed the question into the background temporarily. In 1946, the issue was again placed before the Commission. By this time, the season had shortened to the point where the purely biological aspects had assumed considerable importance. There was already considerable evidence that the fishery was heavily concentrated on those portions of the stock that were on specific grounds during the short open season, leaving other groups under-exploited. The seasons ended before seasonal peaks in availability of fish were reached on some of the known productive banks. It was thus possible to argue that a curtailment program designed to stretch out the total allowable catch was justified in terms of the biological definition of the Commission's regulatory powers. That very real economic benefits would accrue was a desirable byproduct but not the sole basis for such action.

This broader view was not accepted by both Governments. As a compromise, the Commission was authorized in the Convention of 1953 to establish multiple seasons in each area, thus permitting summer fishing on all grounds. This had already been accomplished in part during the period 1951–53 by subdividing area 2. In these years, three underfished areas of the coast were closed to fishing during the regular season and opened after the general closure. A material increase in total catch resulted from this shift in effort to underutilized subgroups. Since this shift represented only a partial solution to the interest of the fleet in curtailment, the voluntary layover technique was resumed in 1957 and has been continued since that time. The Commission cannot, of course, take any formal part in the layover program but does cooperate with the fleet on certain aspects in view of its obvious effect on the length of the fishing season.

SUMMARY

After several years of negotiation, the United States and Canada entered into a Convention for the preservation and development of the halibut fishery in 1923. Though it provided for a winter closed season as an interim measure, its major provision was the establishment of the International Fisheries Commission and the beginning of detailed studies of the Pacific halibut required for sound management of the fishery.

By 1928 the Commission's research had established the urgent need for direct control measures, and a series of recommendations were forwarded to the two Governments. The Convention of 1930 greatly broadened the regulatory powers of the Commission, and in 1932 the conservation program began along lines that have carried through to the present. The Convention waters were divided into regulatory areas, within which catch limits were established by the Commission. The new regulations also provided for Commission control over closed seasons, types of gear used, and closure of nursery areas populated by immature fish. All halibut vessels were licensed to assure control over clearances and compliance with essential statistical reporting requirements.

Since 1932, the regulations have been altered frequently to take account of developing knowledge of the stocks and of fleet practices under quota regulation. The Commission's powers were extended in 1937 and 1953 to provide for effective control of landings of incidental halibut catches and to distribute fishing pressure more evenly by providing for multiple seasons. Dory fishing and net fishing for halibut were prohibited by the Commission. The strict prohibition against the issuance of regulations designed solely for economic purposes has limited Commission action to those measures that would facilitate achievement of maximum physical yield.

This brief resume cannot do full justice to the magnitude of the research effort and analysis that lay behind initial regulations and the subsequent changes that were undertaken. Throughout its existence the Commission has performed its research and regulatory functions in the full light of public scrutiny. Though differences of opinion have developed between the Commission and other fishery scientists and between the Commission and the industry, the objectivity and care with which the program has been built are respected in all segments of the fishery field. The Commission has pursued its stated objective—rebuilding of the stocks toward a level of maximum sustained yield—in a steady, conservative way. Yet in year-to-year operations, it has demonstrated an unusual degree of flexibility in dealing rapidly with established reasons for change.

The really knotty, and at times insoluble, problems have arisen out of the rigid proscription of measures based on economic considerations alone. The shortening of the season under quota regulation was anticipated and its effects clearly outlined as early as 1946. Yet the Commission could not obtain the authority to correct, even partially, these emerging difficulties unless and until they had reached a point where physical yields would be adversely affected. The difficulty involved in establishing the principle of multiple seasons in special areas, despite its obvious advantages, points up the extent to which the program is limited by its purely biological conceptual framework. The effects of these limitations are discussed in the following chapter.

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Part 2

ECONOMIC EFFECTS OF THE HALIBUT PROGRAM

Part 2 presents the results of an empirical analysis of direct and induced effects of regulation on the economic performance of the halibut industry. Particular interest centers on the broader effects of quota regulation on processing and marketing, on the behavior of prices to fishermen, and on the incomes received by fishermen and vessel owners.

Chapter 5 deals with the general impact of controlled fishing on fishing costs, marketing costs, product quality, and concentration of purchases. The next two chapters analyze in greater detail the determinants of port area prices for halibut and the changes brought about by the imposition of catch quotas. The final chapters of Part 2 present the results of an extensive survey and statistical analysis of the earnings of halibut fishermen and of gross and net incomes to owners of halibut vessels for the years 1955–57 and 1953–57, respectively.

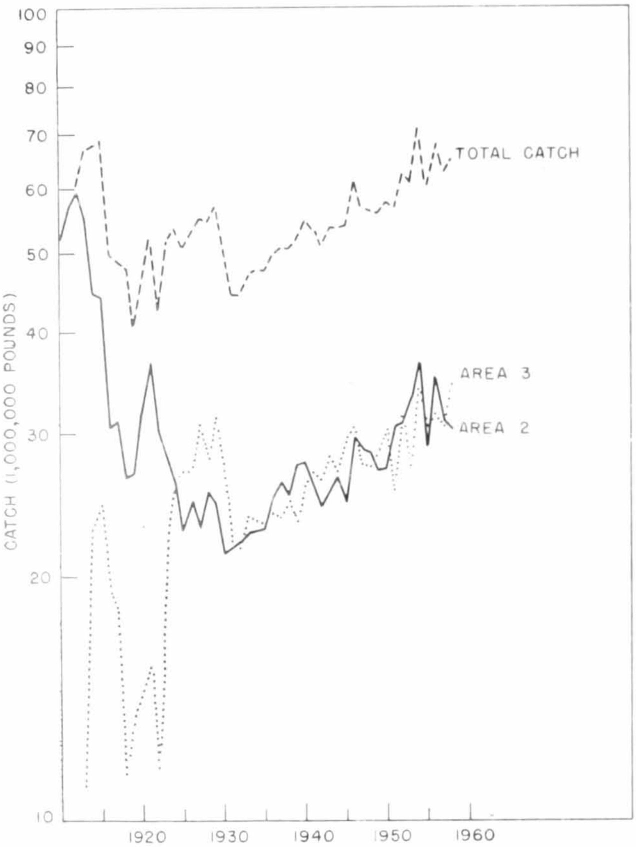

FIGURE 8.—Halibut catch by regulatory areas, 1910–58.

FIGURE 9.—Area 2: landings of halibut, standard units of gear fished, and catch per standard unit of gear, 1910–58.

Chapter 5

GENERAL EFFECTS OF THE HALIBUT PROGRAM

A number of economic effects of the short season have tended to increase costs. More vessels and men are engaged in the fishery than are required to take the quotas, and they must find alternative occupations during much of the year. The inherent risks of fishermen and marketers have been increased by the short season, and storage and interest costs to holders of frozen inventory are greater than they would be under an extended season. The orderly distribution of landings among halibut ports may be disrupted at times. The quality of fish at the point of final sale has been reduced by the long average storage period and the tendency of fishermen to land full loads on each trip in a race to secure the largest possible share of the quotas. The total effect on fishing and marketing costs of all these factors is significant.

There does not appear to be any evidence that competition in port markets has been affected by the control program.

The Commission has been fully aware of problems created by the reaction of the industry to quota controls but has little scope in dealing with them under its present legislative authority.

In this chapter, the physical effects and the economic effects of the halibut program are discussed. The question is then raised as to the possibility of reducing the excessive costs of producing and marketing the catch and thus of realizing even greater benefits from the halibut program.

PHYSICAL EFFECTS

A full assessment of the physical results of regulation of the halibut fishery is beyond the scope of this study. The reader interested in details of the Commission's findings with respect to recovery of the stock will find a full record in its annual reports and special studies. The controversy over the parts played by natural forces and by regulation in that recovery is beyond both the scope of this study and the professional competence of its authors. Accordingly, this chapter will merely summarize the known facts indicating the dramatic revival of the Pacific halibut population. Attention will be focussed primarily on the economic by-products of that revival—the response of the industry to increasing abundance against a background of quota regulation.

Figures 8 and 9 tell the story of the recovery of the halibut fishery in graphic terms. From a low of 44.2 million pounds in 1932, the total catch has shown a persistent upward trend. By 1939 the total catch had reached the average of the 1920's; and in the past 5 years, it has hovered around a level approximately 47 percent above the low point.

Impressive as these figures are, they do not indicate the true significance of the changes that have occurred. On the hard-pressed southern grounds, catch per skate, a term designating one complete length of longline gear, which can be taken as an index of abundance on the grounds, has increased very sharply, from 35 pounds in 1931 to more than 100 pounds in each of the years 1952–58. The number of standard units of gear fished on area 2 grounds reached a peak of 617,000 in 1929, when 24.6 million pounds were taken. In 1958, only 286,000 units were required for a catch of 30.5 million pounds. The increase in catch per skate has been less marked in area 3, which had not been depleted as extensively, but it is still substantial.

Can all of this be attributed solely to the Commission's efforts? Skeptics have pointed out that the recovery was greater than would be anticipated on the basis of the Commission's own theoretical and empirical model of the fishery and argue that both decline and rise were the result of long-term fluctuations in natural factors. Arrayed against this view are an impressive body of facts and qualified analyses. The decline in population and yield and the subsequent recovery was greatest in precisely those areas where fishing effort had been concentrated. The timing of the increase coincides with the curtailment of effort, first by the depression and then by the Commission. The biological characteristics of the halibut are such that modern fishing gear can make significant inroads on the stable, slowly growing stocks.

It may well be that the extent of the recovery is greater than the Commission anticipated in its original projections. This greater recovery could be due either to underestimates of factors making for growth of the stocks or to an actual shift in the determinants of recruitment and growth from natural causes. To argue, however, that all of the recovery is due to the latter does not appear reasonable.

The available data suggest that the fishery is now very close to the statutory objective of maximum sustained physical yield, given the present structure of regulation. Further improvements may still be possible, as the accumulation of statistical and research data enables the Commission to adjust the catch more closely to the various subpopulations in the fishery. On theoretical grounds it should also be possible to increase the aggregate catch to some extent by cropping more intensively recruits from unusually large year classes. In practice, however, it is doubtful that the precise identification of magnitudes required would permit this degree of flexibility.

TABLE 3.—*Size of regular halibut fleet* [1] *and number of fishermen, 1928–58*

Year	Vessels and boats			Fishermen		
	United States	Canadian	Total	United States	Canadian	Total
	Number	*Number*	*Number*	*Number*	*Number*	*Number*
1928	309	112	421	1,759	510	2,269
1929	368	106	474	1,936	463	2,399
1930	353	106	459	1,886	498	2,384
1931	323	114	437	1,648	503	2,151
1932	322	85	407	1,588	350	1,938
1933	301	83	384	1,569	334	1,903
1934	323	115	438	1,632	454	2,086
1935	303	129	432	1,637	494	2,131
1936	335	135	470	1,734	585	2,319
1937	373	158	531	1,852	652	2,504
1938	345	164	509	1,855	693	2,548
1939	335	180	515	1,906	760	2,666
1940	377	172	549	2,096	752	2,848
1941	397	179	576	2,247	833	3,080
1942	342	155	497	1,894	733	2,627
1943	354	165	519	1,979	791	2,770
1944	362	211	573	1,809	865	2,774
1945	413	178	591	2,090	893	2,983
1946	489	192	681	2,294	993	3,287
1947	469	220	689	2,189	1,208	3,397
1948	542	254	796	2,591	1,260	3,851
1949	523	230	753	2,586	1,194	3,780
1950	576	240	816	2,801	1,249	4,050
1951	542	278	820	2,665	1,412	4,077
1952	429	241	670	2,128	1,275	3,403
1953	412	249	661	2,030	1,310	3,340
1954	410	244	654	1,958	1,316	3,274
1955	403	214	617	1,907	1,162	3,069
1956	384	172	556	1,761	963	2,724
1957	461	198	659	1,997	1,065	2,962
1958	397	177	574	1,780	1,003	2,783

[1] For statistical purposes a "regular" halibut vessel or boat is defined as one fishing longline gear, usually landing at regular ports and usually crewed by at least two persons. (Information supplied by F. Heward Bell.)

Source: Pacific Fisherman Yearbook, passim.

ECONOMIC EFFECTS

The direct economic response to the rebuilding of the halibut stocks can be predicted readily. With increasing abundance, the catch per unit of effort rose rapidly; and if the entire increment were not to be "fished off" currently—if "reinvestment" in stocks were to continue—the actual number of sets would have to decline, even though the quotas were gradually increased. From the standpoint of economic incentive, the increasing population meant lower fishing costs per pound and an increase in the attractiveness of the halibut fishery relative to others (and perhaps to other occupations). Thus, despite the decrease in total effort required to reach quota limits, the number of boats and men engaged in the fishery would increase. As indicated in table 3, the number of regular halibut vessels passed its 1929 high in 1937. By 1941 the fleet had expanded by 41 percent over the 1932 level, and a surge of new entrants after World War II brought the number to 820—more than double the 1932 figure. In addition, the number of salmon trollers and small "camp boats" landing occasionally fares of halibut (not included as regular vessels) increased by leaps and bounds. In recent years, they have accounted for about 15 percent of the total catch from area 2.

Yet, the actual inputs required to take the

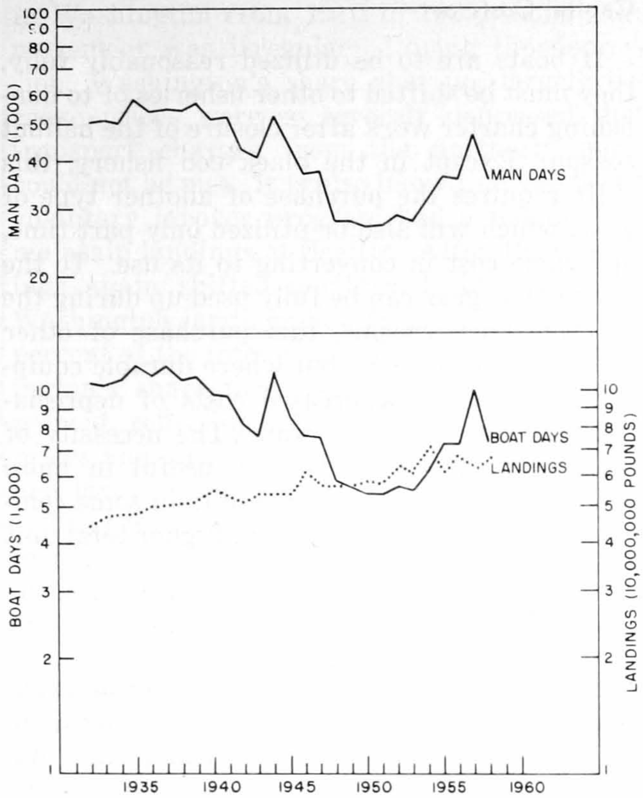

FIGURE 10.—Man days, boat days, and landings, 1932–58.

quotas were declining as the stocks were replenished. A rough index of capital and labor is provided by multiplying the number of regular boats and men by the number of fishing days allowed by the Commission. As figure 10 shows, the number of boat days and man days declined steadily until recent years. Even if the figures were corrected to eliminate required layover time during the 1930's and again from 1956 on, the trend is clearly downward, despite a steady increase in the total catch.

The Commission had no authority to prevent the influx of boats and could only respond by reducing the length of the seasons. A further push in this direction was provided by the mechanics of the quota system. With total catch fixed in each area, the individual boatowner and share fisherman had a strong incentive to take the largest possible share of that total, particularly in cases where the vessel was more or less specifically designed for longline fishing. Thus, the boats fished as intensively as possible and tended to deliver most of the catch to those ports that would permit a maximum number of trips to the areas fished. This tendency was offset to some extent by voluntary layover programs of the fleets in the 1930's and again in recent years, but these measures could not prevent the shortening of the seasons well beyond that which would be dictated by weather and the availability of fish. The magnitude of the decline in fishing days is evident from table 4.

The impact of these changes has affected both biological and economic aspects of the halibut operation. As indicated earlier, the Commission has become increasingly concerned by the prospect of unbalanced exploitation of the stocks. Clearly the sustainable physical yield could not be maximized if some segments of the population, available during the first few months after opening date, were producing the entire quota, whereas others coming on the fishing grounds later were hardly touched. This unbalanced exploitation could be rectified only in part by subdivision of areas and by multiple seasons.

In addition to complicating achievement of the Commission's purely biological objective,

TABLE 4.—*Length of halibut fishing season*

Year	Length			
	Regular season		Special seasons	
	Area 2	Area 3	Areas 1 and 2	Areas 3 and 4
	Days	*Days*	*Days*	*Days*
1933	206	268		
1934	172	241		
1935	[1]159	[1]270		
1936	148	233		
1937	135	218		
1938	120	212		
1939	120	211		
1940	104	179		
1941	91	167		
1942	75	163		
1943	66	146		
1944	[2]51	[2]194		
1945	46	147		
1946	42	111		
1947	[3]39	[3]109		
1948	32	72		
1949	34	73		
1950	32	66		
1951	28	56	10 (Areas 2B & 2C)	
1952	26	58	10 (Areas 2B & 2C)	18 (Areas 3B & 4)
1953	24	52	10 (Areas 2B & 2C)	25 (Areas 3B & 4)
1954	21	58	8 (Areas 1B & 2)	35 (Areas 3A & 3B)
1955	24	84	7 (Areas 1B & 2)	32 (Areas 3A & 3B)
1956	38	97	7 (Areas 1B & 2)	32 (Areas 3A & 3B)
1957	48	144	7 (Areas 1B & 2)	[4]
1958	59	119	7 (Areas 1B & 2)	[4]

[1] Fleet tied up voluntarily until April 1.
[2] Fleet tied up until May 20 in protest against OPA maximum price.
[3] Seattle fleet largely tied up until July 1, owing to dispute over crew shares.
[4] Area 3B had extended seasons in 1957 and 1958.
Source: Pacific Fisherman Yearbook, 1959, vol. 57, no. 2, p. 199; and Reports of International Pacific Halibut Commission.

the sharp reduction in the season has altered significantly the structure of both fishing and processing-marketing sectors of the industry. Some of these merely represent a rearrangement of operations; others appear to involve changes that increase the costs of catching and marketing any given quota. Individually, these factors do not appear overly important, but collectively they add up to a significant departure from our goal of minimum total cost for the outputs permitted. In the remainder of this section, these effects are explained briefly. In subsequent chapters their effects on actual earnings of fishermen and vessel owners are examined from sample survey data.

Overcapacity

The most serious problem arising out of the fleet's response to quota regulation is the fact that more boats and men are engaged in the fishery than are required to fill the quotas. Unless these boats and men would otherwise be completely idle (as in a serious depression) or can be shifted to other equally productive occupations after the halibut season, the economy is losing potential output and real income. A partial answer to the extent of this problem is provided in the analysis of incomes to fishermen and boatowners in the following chapters. At this point it may be noted that in 1951, 820 United States and Canadian vessels engaged regularly in the halibut fishery. This number was more than double the number participating in 1932, yet the total catch was only 27 percent higher, and the amount of fishing effort required to take the larger quota had actually declined substantially. The fleet in 1951 was 78 percent larger than that in 1929.

The abrupt decline in the number of regular halibut vessels since 1951 (interrupted only by the increase in 1957) is apparently a result of market forces external to the control program. Reasons for the economic pressure on the fishery are analyzed in detail in subsequent chapters, but in general it reflects excessive postwar expansion and the severe pinch imposed by substantial increases in costs, coupled with weakness in halibut prices. The latter is apparently associated with the rapid expansion of domestic production and imports of frozen groundfish fillets. Even in 1958, after 7 years of economic stress, the fleet was still 41 percent larger than in 1932.

Capital Costs

If boats are to be utilized reasonably fully, they must be shifted to other fisheries or to nonfishing charter work after closure of the halibut season. Except in the black cod fishery, this shift requires the purchase of another type of gear, which will also be utilized only part time, and some cost in converting to its use. To the extent that gear can be fully used up during the several short seasons, this purchase of other gear is of no concern, but where durable equipment is involved, increased costs of depreciation and obsolescence result. The necessity of building combination vessels, useful in more than one fishery, probably results in some compromises in design and thus in higher total unit costs.

Maintenance

There may be a tendency to undermaintain boats and gear during the season in the effort to achieve a maximum amount of fishing time. Associated with this problem in part is the serious cost to the individual vessel of a breakdown in the season. If only one trip is lost, boat and share incomes may be reduced by 20 percent or more. Other fishermen's incomes rise by an offsetting amount, of course, but the increased risk to the individual unit is not advantageous.

Distribution of Landings Among Ports

The geographic distribution of landings may be distorted over longer periods by concentration of vessels in ports nearest the grounds and, in the short run, by the tendency for landings to peak at two or three periods during the season and to clog handling facilities at particular ports. The latter effect is minimized, of course, by the demand for frozen inventories but would be eliminated only by excessive peak handling capacity at each port; otherwise, the distribution of concentrated landings may be dictated by the availability of port facilities rather than by the maximum return to be realized by a rational calculation of port prices and running costs.

It is difficult to segregate the effects of the short season from other factors that influence the geographic distribution of landings. As indicated in figure 11, landings in Alaska and British Columbia increased relative to landings in Washington from 1910 to 1929, though the movement was irregular. During the depression, Washington's share shot up, largely because prices were so severely depressed that transport charges from the northerly ports could not be met. It is also likely that the fleet's voluntary layover program had a tendency to maintain landings at Seattle. After 1938, landings again shifted northward; and by 1947, Washington landings had fallen to less than 20 percent of the total catch. From 1950 on Washington's share increased steadily to about 27 percent, reflecting both the weakness in halibut prices and, in recent years, the influence of the new layover program.

The general shift of landings to the north is, in part, simply a response to the development of better port facilities and increased ability to exploit the western grounds. On the other hand, the growth of freezing, handling, and storage capacity in the Alaska ports may well have been stimulated by the pressure on fishermen to reduce running time as the season shortened. On balance, it appears unlikely that the present distribution of landings is ideal from the standpoint of total costs in the processing-marketing sequence, but the amount of the additional costs imposed is probably not excessive.

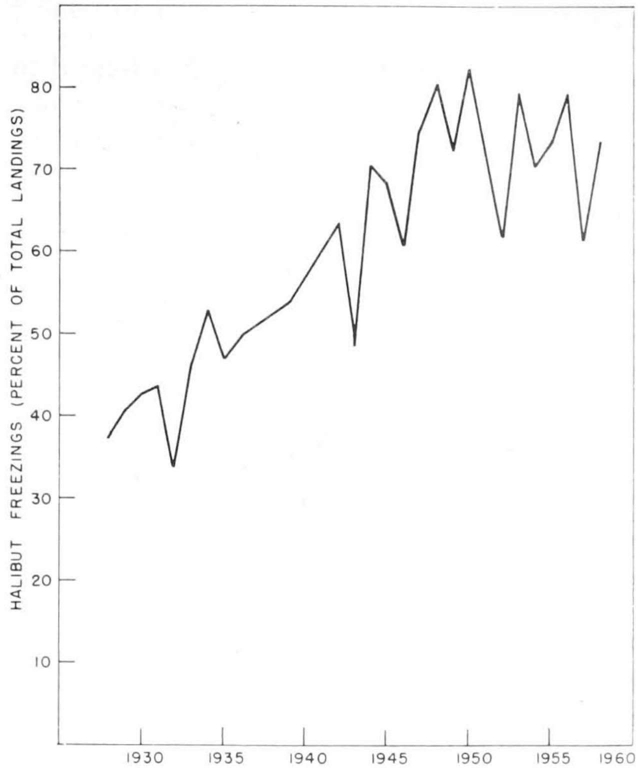

FIGURE 12.—Halibut freezings, 1928–58.

Freezing and Storage Costs

The short season inevitably imposes greater freezing and storage charges than would be required under an extended season. To a considerable extent, of course, the increase in the proportion of halibut frozen (fig. 12) reflects the general shift in consumer preference to frozen prepackaged fish that accompanied the revolutionary changes in frozen food distribution. The period of frozen storage, however, has inevitably increased, and with it the costs that must be borne in part by fishermen and in part by consumers. Since halibut is sold in competition with a wide variety of other fish and frozen fish, most of the increased marketing cost is reflected in lower port prices to fishermen.

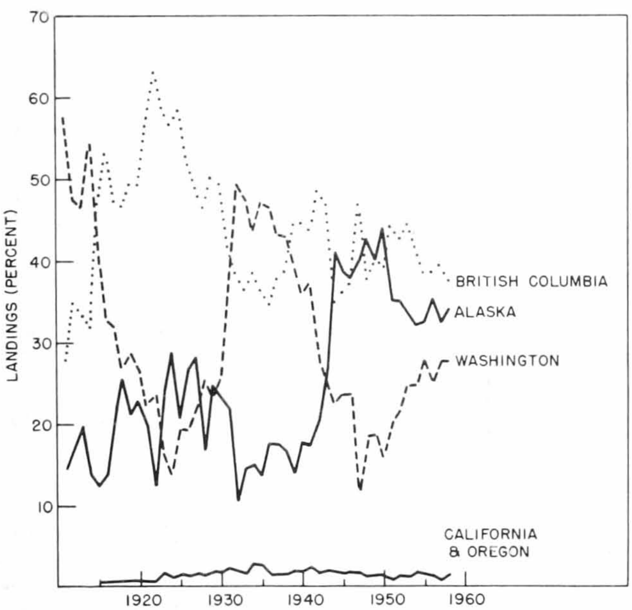

FIGURE 11.—Landings by section of coast, 1911–58.

At present the cost of freezing and 4 to 5 months' average storage is about 2.5 cents per pound as compared to 1.75 cents for freezing and an assumed average storage period of 1 month if landings were extended over a 9-month period. In addition, an estimated 0.25 cents per pound must be included for additional interest costs on funds invested in inventories. The total additional costs imposed by the greater frozen inventory requirements under the short season thus amounts to roughly 5 percent of the price received by fishermen in recent years.

Quality

The concentration of landings has tended to reduce quality, a matter of more than ordinary concern in a fishery with major markets east of the Mississippi and in California. The longer storage period obviously involves some loss of flavor and texture, which can be minimized only by careful (and more expensive) handling and reglazing. In addition, the short season effectively limits the number of trips that each vessel can make; therefore, a strong incentive exists to make the largest possible catch on each trip. In some cases this desire for large catches may be carried to the point of reducing the amount of ice carried and to loading fish on deck. It would require a substantial amount of downgrading in quality to offset the additional dollar returns from maximizing the catch on each trip. Finally, the occasional overloading of dealer-handling capacity resulting from bunching of landings in the short season results in some deterioration of quality.

Unfortunately, there is no way in which data on quality of fish landed can be compared over time. Frequently, No. 2 medium fish were reported with "chickens" and large fish when these were priced at the same level. Moreover, neither the grading standards nor the handling facilities have remained constant over the years. No data of any kind are available to indicate the crucial proportion of lower quality fish at the point of sale to the final user.

A significant number of individuals in all phases of the industry have expressed concern over the quality problem. Several out-of-state dealers interviewed stated specifically that the competitive position of halibut relative to fresh and frozen groundfish fillets (produced from various flounders and sole on the Pacific coast and from Pacific ocean perch) has been weakened in recent years because of uneven quality. Frozen fillets, in particular, can be handled, processed, and marketed very rapidly because groundfish are landed regularly throughout the year, and since the packaged items are normally branded, control of quality becomes mandatory for continued buyer acceptance. In the face of this type of competition, the sale of even an occasional lot of halibut in poor condition can seriously jeopardize demand for the product as a whole.

Marketing Risks

In addition to increased storage costs and quality problems, marketers of halibut are exposed to considerably larger market risks with very short seasons. The bulk of the halibut catch is sold in a national shipping market in competition with a very much larger quantity of seafood from all major producing areas. It is also closely competitive with other high protein foods, such as meat and poultry. Halibut prices at wholesale are therefore subject to a wide variety of forces originating in supply conditions wholly beyond the control (and frequently outside the immediate knowledge) of Pacific coast halibut dealers. As indicated in chapter 7 of this study, analysis of year to year fluctuations in halibut prices is extraordinarily difficult and cannot be reduced to even a moderately accurate forecasting formula.

In the face of this uncertainty with respect to market prices, the port buyer must acquire his entire year's supply in 2 to 3 months, and he or subsequent purchasers must bear the risk of windfall gains and losses in inventories held over the remainder of the year. To some extent, these risks are unavoidable: some inventory must be held to ensure a continuous smooth flow of product through marketing channels. There is a vast difference in the degree of risk involved

TABLE 5.—*Cumulative percentage of total landings purchased by largest dealers: Seattle, Ketchikan, and Prince Rupert (by weight)*

Dealers	1931	1939	1947	1955
	Percent	*Percent*	*Percent*	*Percent*
Seattle:				
Largest	26.2	24.4	20.6	15.6
Two largest	47.3	41.1	37.0	31.0
Four largest	75.4	73.1	61.3	60.0
Ketchikan:				
Largest	46.0	56.7	33.2	56.0
Two largest	75.4	75.6	55.8	85.6
Four largest	97.8	92.7	78.9	99.9
Prince Rupert:				
Largest	....	41.3	36.0	32.3
Two largest	....	58.6	65.7	59.8
Four largest	....	87.6	89.6	91.5
Three ports combined:				
Largest	....	18.2	17.0	13.8
Two largest	....	31.3	31.0	27.1
Four largest	....	53.5	48.7	49.0

Source: Dealer weighed-out weights from official data of International Pacific Halibut Commission.

under the present situation as compared with that which would prevail if landings were distributed over a longer period, and this greater degree of risk is reflected in prices paid to fishermen. A detailed analysis of the influence of the short season on port prices is presented in chapter 7.

Concentration of Purchases

The necessity of investing heavily in inventory with its attendant risk and of maintaining buying facilities in many port areas requires larger-scale operations by first receivers than would be necessary under an extended season. In addition, the existence of substantial overcapacity in the fleet could make possible collusion on buying prices, which could result in substantially increased dealer profits without reducing the catch.

Since the antitrust action of 1941, which resulted in a consent decree, there has been no concrete evidence of serious restriction in competition among port buyers. As indicated in tables 5 and 6, concentration of purchasing has declined in Seattle and has changed very little in Prince Rupert. Mobility of buyers and vessels among ports, the availability of fish through commission buyers, and the threat of cooperative marketing arrangements have sufficed to prevent serious abuse of the weaker bargaining position of the individual halibut vessel. Competition on the exchange is by no means perfect, but it is difficult to conceive of any other method of sale that could be as satisfactory.

Even if halibut buying were strongly collusive, it is not clear that general efficiency of the operation would be adversely affected. Presumably, a coalition of buyers would lower port prices to the point where the desired total catch could just be taken by the boats remaining in the fishery. Though this would represent a most undesirable situation from the standpoint of equitable distribution of the total income from the fishery, it would reduce some of the overcapacity in the fleet and, hence, the other costs resulting from excessive shortening of the season. For a variety of reasons, of course, collusive buying could not be considered an acceptable solution to the problem of the short season from the standpoint of fishermen or of the two Governments involved.

TABLE 6.—*Number of halibut buyers in Seattle, Ketchikan, and Prince Rupert, selected years*

Year	Seattle	Ketchikan	Prince Rupert
	Number	*Number*	*Number*
1931	11	8	..
1939	13	11	6
1947	17	12	..
1948	19	10	8
1955	17	5	7

Source: Official data of International Pacific Halibut Commission.

With few, if any, exceptions, these biological and economic side effects of the industry's response to quota regulation have been recognized by the Commission, either from its own investigations or from representations by the industry. In some instances, though not all, it has made specific recommendations for legislative changes that would have made it possible to deal with some of them more effectively. The problem is not one of faulty administration, but of the conception of the objectives of conservation held by the two Governments and written into the Commission's terms of reference. As long as measures designed to improve economic performance are beyond its authority (more specifically, as long as there exists no power to restrict entry to the fishery), the Commission is virtually powerless to prevent developments of the sort outlined above. Only if they also involve a reduction in physical yields do they fall within the purview of the program as presently authorized.

Obviously, any alteration of the objectives and techniques of halibut management would represent a significant change in the legislative basis of the program in Canada and the United States. The preceding qualitative analysis suggests that the principal gains, significant though they are, have been largely realized by consumers who are getting more halibut, at lower prices, than they would have gotten under unrestricted fishing. This reduced price to the consumer alone would appear to justify the program in economic terms, but a major question remains: can we eliminate or reduce the excessive costs of producing and marketing the catch and thus realize even greater benefits? In the following chapters the effects of the conservation program (and of some external factors) on port prices and on vessel and fisherman earnings are examined in an attempt to indicate the additional economic gains that may be possible under an expanded concept of the objectives of the program.

SUMMARY

The total catch of halibut has increased substantially since quota controls went into effect. Even more striking is the increase in catch per unit of effort, particularly in areas that had been subject to heaviest fishing. Though other factors affecting the natural environment may have contributed to recovery of the fishery, the timing and geographic distribution of the increase in stocks, together with the basic biology of the halibut, lends weight to the conclusion that the conservation program was largely the cause.

With the increase in stocks, returns to the individual vessel increased, and this contributed to a marked increase in the number of units fishing until 1950, when economic pressure brought some reduction. Since the Commission had no power to control entry, the length of time fishermen were permitted to take the quotas was reduced sharply. This reduction in length of season has brought about a number of changes in the structure of the industry, some of which have been disadvantageous.

The short season resulted in concentration of fishing effort on a limited portion of the stock and, hence, in a reduction in the attainable sustained yield. This result has been rectified in part by subdivision of areas and by multiple seasons.

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Chapter 6

ANALYSIS OF PORT PRICING OF HALIBUT: THEORETICAL CONSIDERATIONS

Under the share system of payment in the halibut fishery, variability of port prices directly affects the incomes of both boat owners and fishermen. Variability of port prices is also of great concern to port dealers and others carrying inventories of halibut.

The purpose of this chapter and the following one is to present a statistically documented theory of the temporal pattern of prices paid to producers in the halibut fishery. In particular, the results reported will indicate factors causing variation of port prices both during the year and from year to year.

To the extent that the following analysis provides an understanding of the factors producing temporal variability of port prices and suggests measures that can be instituted to reduce such variability and associated costs, it will represent a contribution of value both to the halibut industry and to the consumers of halibut.

The principal topics discussed in this chapter are the theory of intrayear port pricing, implications of the analysis, and effects of current conservation policy on intrayear pricing.

THEORY OF INTRAYEAR PORT PRICING

Since halibut fishing takes place over a short part of the year, many dealers find it profitable to build up inventories of halibut in order to supply consumers when fishing is prohibited. Thus one type of demand for halibut at the port is to fill inventories. A second type is the demand for fresh fish; this element of demand is present at some ports but not at all of them. A rough quantitative estimate of the relative importance of these two types of demand may be obtained by noting that the seasonal inventory buildup is about 40 million pounds, whereas total annual production is about 60 million pounds. The difference, 20 million pounds, represents sales of frozen fish from inventories and of fresh fish. Unfortunately, no figures are available to permit separate estimates of these two latter items. It is clear, however, that inventory demand is extremely important.

Since inventory demand is important and since those buying to fill inventories can and do buy at any of a number of ports in Washington, British Columbia, and Alaska, prices at various ports would be expected to exhibit a similar temporal pattern within any given year. At ports where there is a demand at the wholesale level for fresh fish, however, the pattern of port prices within a year should differ in certain respects from the pattern at ports where buyers purchase fish solely for inventory purposes. In particular, when landings are very light at a "fresh-fish" port, those buying halibut for the fresh-fish market will bid up the port price. When the price has risen above a certain level, those buying for inventory purposes will refrain from buying at this port and will purchase at other ports, particularly at those where the price has not risen. Thus at ports where there is a demand for fresh fish, a negative correlation between daily volume of landings and daily price should exist.

Buyer mobility also implies that at a particular port where the demand is purely to fill inventories, there may be no significant correlation between daily landings at that port and daily port price. That is, if landings at an "inventory" port are heavy, the price there does not necessarily drop, because buyers from other ports move in and bid up the price, which action by buyers keeps it in line with prices being paid at other ports. On the other hand, when landings are light at a particular port, the inventory buyers do not bid up the price but shift their purchases elsewhere. In what follows, this hypothesis of no correlation between price and landings at inventory ports will be tested with data relating to the market at Ketchikan, Alaska, where the demand is purely an inventory one.

It was stated above that prices at the various ports would exhibit a similar temporal pattern within a particular year, a pattern that is determined in the main by those purchasing fish for inventory purposes. A theoretical explanation of this intrayear pattern will now be developed.

At the beginning of each season, those who plan to buy halibut for inventory purposes face a number of given conditions. First, they know the inventory carryover from the previous year. Second, they know the quota or catch limit, since it is announced by the Commission prior to the opening of the fishing season. Third, they know what storage costs are. These three factors, taken together with a set of expectations regarding future prices for halibut, determine a desired level of end-of-season holdings that will be called H^d.

Relation Between Port–Price Change and Excess Inventory Demand

With the introduction of H^d, the total end-of-season holdings desired by all holders of inventories, it is now necessary to postulate a relation between port-price change and excess inventory demand. Excess inventory demand at any time during the season, say time t, is measured by the difference between H^d and actual holdings of inventories; that is, excess demand equals $(H^d - H_t)$, where H_t represents actual inventory holdings at the beginning of the t'th day. An excess of inventory demand over actual holdings at a particular time will exert an upward pressure on price. This statement is formalized mathematically as follows:

$$p_t - p_{t-1} = k\ (H^d - H_t), \qquad (1)$$

where $p_t - p_{t-1}$ is the change of port price from day $t-1$ to day t and k is a positive proportionality factor. An interpretation of the quantity k is that it represents the fraction of total excess demand that is effective on the t'th market day.

Variability of the Proportionality Factor k with Time t

That k is undoubtedly not constant throughout a single season is a reasonable inference in the light of the following analysis:

1. It may be argued that a particular amount of excess demand would exert more pressure on price if it were present late in the season than if it were present earlier. This greater pressure would exist because of a number of reasons involving particularly the effects of uncertainty and of imperfections in the capital market. Suppose that inventory holders as a group are 15 million pounds short of the amount with which they would like to end the season. If they are 15 million pounds short near the middle of the season, a certain amount of pressure will be exerted on the price at the middle of the season. On the other hand, if they are 15 million pounds short near the end of the season, the price would be subjected to much more pressure than in the former instance. One reason is that an individual planning to increase his holdings at the middle of the season realizes that he has to bear all the uncertainties associated with price throughout the other half of the season as well as the uncertainty associated with it in the out-of-fishing period. Those increasing their holdings at the end of the season bear only the latter uncertainty and therefore are willing to pay more to fill their desired inventory; in fact, the market forces them to pay more through competitive bidding on the exchange. Those who bought earlier are not going to permit latecomers to buy fish at bargain prices—prices so low that they do not cover the costs involved in bearing the additional uncertainty associated with buying earlier in the season.

   Further, it may be that some of the smaller holders find it impossible to get sufficient capital to finance the carrying of inventories over an extended period. Buying late in the season is one way of reducing inventory-holding time and the amount of capital tied up in inventories. Even with a 15-million-pound difference at the middle of the season between actual holdings and the desired end-of-season holdings, some of these smaller holders may decide to wait until near the end of season to buy because of capital restrictions. With the 15-million-pound shortage present near the end of the season, both small and large inventory holders are in the market, and the effect on price of such a shortage is much greater.

These considerations make it plausible to assume that k increases during the season; therefore, equation 1 is modified as follows:

$$p_t - p_{t-1} = (k_0 + k_1 t)(H^d - H_t) \qquad (2)$$

where k_0 and k_1 are positive parameters. (In what follows, the formulation, $p_t - p_{t-1} = (k_0 + k_1 t + k_2 t^2)(H^d - H_t)$ is also tested.)

2. The factor k in equation 1 might depend on the level of price. That is, the higher the price, the smaller might be the influence of a given amount of excess demand in forcing price change. Conversely, the lower the price, the larger will be the pressure of a given amount of excess demand. These propositions, however, neglect the role of expectations. If a high price is viewed as an indicator of still higher prices on subsequent market days, the higher the price, the greater will be the influence on price change of a given amount of excess demand. Reciprocally, if a low price is regarded as an indicator of still lower prices in the future, the pressure of a given amount of excess demand will diminish.

Although these expectational effects may be operative, very probably they are not systematic or important enough to produce a significant positive correlation between price change and the level of price with excess demand held constant. Rather, one might expect that the higher yesterday's price was, the more cautious buyers with a given amount of excess demand will be in pushing the price still higher, since they want to avoid being loaded with high-cost inventories. On the other side, if yesterday's price is low, a given amount of excess demand will exert a good deal of pressure on today's price because buyers rush in to stock up on low-priced fish. These considerations make it advisable to elaborate equation 2 in the following way:

$$p_t - p_{t-1} = -\lambda p_{t-1} + (k_0 + k_1 t)(H^d - H_t) \qquad (3)$$

with λ being a positive parameter.

No a priori restriction can be placed on the size of λ; however, if the market is to exhibit prices that do not "run away" in an upward or downward direction, $1-\lambda$ will have to be less than one. In fact, the size of $1-\lambda$ is intimately bound up with the degree of price stability exhibited in the market. This line of thought will be developed later.

Introduction of a, or Holdings

The next step in translating equation 3 into a form suitable for statistical treatment is the introduction of an empirical relationship. The seasonal inventory buildup during the regular season (roughly from the middle of May to the beginning of August) can be represented fairly well by a linear function; that is, by

$$H_t = a_0 + a_1 t \qquad (4)$$

where a_0 = beginning of season holdings, t = time measured from the first market day, and a_1 = daily increase in inventory holdings. (Plots of cumulative landings against time are almost linear, which is the basis for this statement. If all landings went into inventories, this is all that would be needed. In the present situation, it is also necessary to assume that sales of fresh fish and sales from inventories are made at a constant rate during the fishing season in order that equation 4 be valid. As a precaution, some calculations have been made under the assumption that equation 4 actually should involve a term in t^2.)

Introduction of C, the Carryover

A few words must be said about a_0, beginning of season stocks. In this analysis, it is important to differentiate a_0 from the carryover from the prior year, since there is an important quality difference between the current year's inventories and inventories carried over from the prior year. H_t is a measure of new holdings. To a certain extent, the carryover is substitutable for new holdings but not perfectly so. To make this consideration explicit, one finds it desirable to write,

$$a_0 = bC \qquad (5)$$

where C is the carryover from the previous year and b is some positive fraction between zero and one.

Deterministic Relationship

Upon combining equations 3, 4, and 5, one obtains the following relation:

$$p_t = (1-\lambda)p_{t-1} + [k_1(H^d - bC) - k_0 a_1]\,t - k_1 a_1 t^2 + k_0(H^d - bC). \qquad (6)$$

As it stands now, in deterministic form, this relation embodies the considerations presented above. It indicates, if as is to be expected, λ is less than one and greater than zero, that today's price is positively correlated with both yesterday's price, p_{t-1}, and time, t, and negatively correlated with time squared, t^2. (The coefficient of t is expected to be positive, since H^d is much larger than any of the other quantities involved.) As is reasonable, equation 6 indicates that on a particular day, the port price p_t will be higher the larger is H^d, all other things being constant. Further, again all other things constant, the larger H^d, the faster will be the rate of price increase (that is, the coefficient of t will be bigger). These conclusions are reversed with regard to the carryover, C. The larger the carryover, all other things constant, the lower the price level and the lower the rate of price increase. Finally, a supply consideration, the faster the fish are being landed, at all ports taken together, which means a larger a_1, the lower the rate of price change, again under the assumption that everything else is unchanged. These inferences relate to the general price pattern for all inventory ports. Relaxation of the ceteris paribus conditions surrounding these inferences will be treated later.

Problem of Stability

To look at the problem of stability, we must recognize that equation 6 is a first order difference equation, say, $p_t = \alpha p_{t-1} + \beta_1 t + \beta_2 t^2 + \beta_0$, where α and the β's may be associated with the coefficients in equation 6. The solution of this difference equation (see any text on difference equations for the simple mathematics) takes the following form $p_t = A\alpha^t + \alpha_0 + \alpha_1 t + \alpha_2 t^2$, with the constant A related to the initial price at the beginning of the season ($t=0$); that is, $A = p_0 - \alpha_0$, so that the expression for price on the t'th day becomes:

$$p_t = (p_0 - \alpha_0)\alpha^t + \alpha_0 + \alpha_1 t + \alpha_2 t^2. \qquad (6a)$$

In this form, it is seen that if the initial price of the season departs from α_0, this deviation of the price from the underlying pattern given by $\alpha_0 + \alpha_1 t + \alpha_2 t^2$ will gradually disappear in a non-oscillatory manner if α is less than one and greater than zero. If, statistical estimation yields an α outside the range zero to plus one, the possibility of systematic oscillations or explosive prices exists. Since this condition was not encountered in the work to be presented, no further discussion of this possibility will be given. Note that the smaller is α, the more quickly a departure from the "trend" disappears.

Introduction of the Stochastic Term, u_t

So far, the discussion has been carried forward in a deterministic framework. It is worthwhile to introduce a stochastic term to take account of the multitude of factors affecting port pricing that have not been introduced explicitly in the analysis. Further, upon analyzing pricing at a particular port, one may find that the seasonal price pattern at this port departs from the overall pattern because of market imperfections, such as lack of information regarding all port prices on the part of buyers. Such informational effects are probably best represented stochastically. Finally, in connection with pricing at a particular port, the influence of prices being paid at other ports must be considered. Since there are many port markets, the influence of prices at other markets on the demand at the market under consideration is a composite effect. Some prices elsewhere are out of line with the seasonal pattern in an upward direction and others in a downward direction, and therefore it seems that the net effect on pricing at the port under consideration can best be represented stochastically. That is, equation 6 should be rewritten to include a random disturbance term that incorporates the effects of market imperfections and of a multitude of outside factors affecting pricing at a particular port that have not explicitly been introduced. This is done in equation 6b where:

$$p_t = (1-\lambda)p_{t-1} + [k_1(H^d - bC) - k_0 a_1]\,t - k_1 a_1 t^2 + k_0(H^d - bC) + u_t \qquad (6b)$$

The term u_t is a stochastic element introduced to take account of all outside factors not explicitly included in the analysis. The statistical results will provide certain characteristics of this random element.

Since little is known about the probability distribution of u_t and of the probability distribution of the initial price of the season, it does not seem worthwhile to speculate about the properties of the solution to the stochastic difference equation in equation 6*b*. It is interesting to note, however, that the solution to 6*b* takes the following form: $p_t = u_t + \alpha u_{t-1} + \alpha^2 u_{t-1} + \ldots + \alpha^{t-1} u_1 + \alpha^t p_0 + f(t)$, where $f(t)$ is a nonstochastic function of time and $\alpha = 1 - \lambda$. Thus the variance of p_t depends on the variances and possibly the covariances of $u_1, u_2, \ldots, u_t$, the magnitude of $\alpha = 1 - \lambda$, and the variance of p_0, the initial price of the season. Further, the contribution of p_0 to the variance of p_t depends on the size of α, which will be estimated in what follows.

Equation 6*b* should provide a good representation of the intrayear pricing pattern at ports where the demand is an inventory demand. In view of the widespread interest in the possible effect of daily landings at a particular port on the price at that port, a further variable will be included in the statistical calculations; namely, daily volume of landings at the particular port under consideration. As mentioned above, it is quite probable that heavy landings at a particular inventory port do not depress price at that port because buyers from other ports move in to bid up the price. On the other hand, light landings are not accompanied by high prices, since buyers move to buy at other ports rather than bid up the price at a port with light landings. Thus, in the calculations relating to an inventory port, the daily volume of landings at that port may not exert a significant effect on price at that port. Relevant for the pricing pattern are total landings up and down the coast and the amount going into inventories each day, considerations that are included in equation 6*b*.

Inventory and Fresh–Fish Demand

Where there is both an inventory demand and a fresh-fish demand, as at the port of Seattle, daily landings will exert a direct effect on the level of port price, primarily through the demand for fresh fish. If landings are very light on a particular day, buyers of fresh fish will bid up the price to such a level that some or perhaps all inventory buyers will switch their purchases to other ports. With heavy landings on a particular day, the purchasers of fresh fish do not have to bid the price above the seasonal pattern in order to get the fish they need; the price is at a level set by inventory demand. Under this view, demand conditions at a fresh fish port are as shown in figure 13. It will be noted that the bend or kink in the curve represents the point at which inventory buyers shift out of this market. In the statistical calculations, attempts have been made to establish that such a bend or kink exists and to locate its position.

IMPLICATIONS OF THE ANALYSIS

Further implications may be drawn from the analysis leading to equation 6*b*, assuming that the quota fixed by the Commission is set at a particular level and that the carryover from the previous year is given. What then can be said about the seasonal price pattern in a short as compared with a long season? This question is particularly relevant for the halibut fishery, since the International Pacific Halibut Commission has been criticized for adopting a method of regulation that has led to an extreme shortening of the fishing season (Gordon, 1954; Crutchfield, 1955 and 1956), and has been urged to adopt measures that would lengthen it. Also, the American and Canadian halibut fleets have adopted a voluntary layover program that has as one of its effects a lengthening of the halibut fishing season. The actual and potential availability of institutional measures that are capable of varying the duration of the fishing season make it of the utmost importance to assess the effects of such measures on the intrayear temporal pattern of port prices.

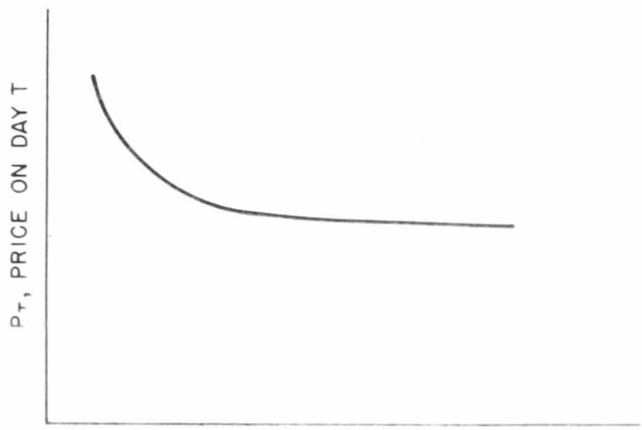

FIGURE 13.—Demand conditions at a "fresh-fish" port on a particular day of the season. As the season progresses, this curve shifts upward.

Given the catch limit or quota for a particular year and the carryover from the previous year, a change in the duration of the fishing season can affect the temporal pattern of pricing by its effects on: (1) the quantity a_1, the daily rate of inventory buildup, which appears in equation 6*b*, (2) the factor k in equation 1, which factor was set equal to k_0 plus $k_1 t$ in developing equation 6*b*, and (3) H^d, the desired inventory holdings at the end of the fishing season. The variation of each of these quantities accompanying a change in the duration of the fishing season will now be considered.

a_1, Daily Rate of Inventory Buildup

It is not difficult to establish that a_1, the daily rate of inventory accumulation during the fishing season will be larger for a short season than for a long season under the assumptions of the preceding analysis. Suppose that the fixed quota is denoted by $\overline{X}$ (the bar indicates that the variable is fixed or already determined by the conservation authorities); then the following relationship connecting $\overline{X}$ and a_1 holds:

$$\overline{X}=(a_1+s)\,m, \tag{7}$$

where s = the daily rate of sales from inventories plus the daily rate of fresh fish sales (assumed constant during the fishing season) and m = the number of days in the fishing season. Under these assumptions, it is clear that a lengthening of the season, an increase in m, will be accompanied by a decrease in a_1; conversely a shortening of the season will result in a larger a_1. (If data were available on daily forward prices, a more general analysis could be pursued that does not involve the assumption that a_1 and s are constant during a particular year. That is, equation 7 would be written: $X=\sum_{i=1}^{m}[a_1(t_i\ldots)+s(t_i\ldots)]$, where now a_1 and s are permitted to be functions of t and other variables.) Examination of equation 6*b* indicates that both the coefficients of t and t^2 will be affected in the following way: the coefficient of t will be reduced, and the coefficient of t^2 will become more negative, the shorter the season. That is, with a shorter season, more fish goes into inventories each day; the port price will rise less rapidly; and the rate of increase of the port price will be diminished. These effects were noted above under an "all other things unchanged" assumption. In making a comparison between a short and a long season, we find, as will be seen, that the "all other things unchanged" assumption is not satisfied. Therefore, some of the effects of a change in a_1 may be intensified or counteracted by other effects. This point will become clear from the considerations included in the following paragraphs.

k, the Fraction

It seems reasonable to expect that the quantity k, the fraction of excess inventory demand exerting a pressure on price on a particular day, in equation 1 will be greater in a short season than in a long one. That is, if the same desired level of inventories is present in a long season as is present in a short season (the validity of this assumption will be considered below), it is clear that, say, 10 days after the opening of the season, buyers in the short season with a given amount of excess demand will exert more pressure on the price than will buyers in a long season possessing the same excess demand. Thus in $k=k_0+k_1t$, used above, the parameters k_0 and k_1 will be larger (particularly the latter) in a short season than in a long season. (Actually k could be larger throughout a short season as compared with a long one if only k_0 were larger and k_1 remained unchanged. Given a shortening of the season, however, it is also very likely that k_1 also increases. See the earlier discussion concerning the introduction of k_1.) Such changes affect all terms but one in equation 6*b*. The rise in k_1 with a shortening of the season supplements the effect of the rise in a_1 to make the coefficient of t^2 more negative. Since these are the only two quantities involved in the coefficient of t^2, it is to be expected that the coefficient of t^2 will be more negative the shorter the fishing season (this without any qualification). The effects of changes in k_0 and k_1 on the coefficient of t are in opposing directions, so no such unqualified statement is possible; and further, since other quantities are involved in the coefficient of t, the situation is more complicated than that regarding the coefficient of t^2.

H^d, Desired End-of-Season Holdings

Finally, it is necessary to analyze the effects of changes in the duration of the season on the desired end-of-season holdings, H^d. Since this quantity plays an important part in the analysis and since its determination in a particular year is vitally connected with the conservation authorities' policies, special sections will be devoted to its determination and effects on pricing.

In-fishing-season and out-of-fishing-season. — The analysis of the supply and demand for storage presented in this section follows, with some modifications, the work developed by Kaldor (1939), Working (1948), and Brennan (1958).

To get at the determinants of H^d, it is useful to consider two periods; namely, the regular fishing period (involving m time intervals) and the period outside the regular fishing season (involving n time intervals). For each of these periods, there will be a consumer demand for halibut. Let the two demand functions be represented as follows:

$$P_T = f_T(Q^D_T) \qquad (8a)$$

$$P_{T+1} = f_{T+1}(Q^D_{T+1}) \qquad (8b)$$

where

P_T = the retail price of halibut during the fishing season

P_{T+1} = the retail price of halibut during the period outside the fishing season

Q^D_T = the quantity demanded at retail per time interval during the fishing season

Q^D_{T+1} = the quantity demanded at retail per time interval during the out-of-fishing-season period.

It will be noted that the demand relation within the fishing season, f_T, is different from that relating to the period outside the season, f_{T+1}. This difference may arise because of changes in exogenous factors, such as consumer income, the price of meat, and the prices of other fish products.

The following equations define supply conditions in the two periods:

$$Q^S_T = \frac{X_T - (H_T - H_{T-1})}{m} \qquad (9a)$$

$$Q^S_{T+1} = \frac{X_{T+1} - (H_{T+1} - H_T)}{n} \qquad (9b)$$

Equation 9a states that the quantity of halibut supplied to consumers per time interval during the fishing season (Q^S_T), is equal to total production (X_T) minus the inventory buildup during the season (end-of-season stocks, H_T, less beginning-of-season stocks, H_{T-1},) all divided by the number of time intervals in the fishing season (m). Similarly, equation 9*b* states that the quantity supplied to consumers in the out-of-season period per time interval, Q^S_{T+1}, is equal to production (X_{T+1}, which may be zero) plus the liquidation of holdings all divided by the number of time intervals, n, in the out-of-season period. Note that $H_T - H_{T+1}$ is out-of-fishing-season liquidation of holdings, since H_{T+1} represents holdings at the end of the out-of-season period (or the carryover for the following year). On the assumption that the retail price adjusts to equate quantity supplied and quantity demanded in both the within-fishing-season period and in the outside-the-fishing-season period, then $Q^S_T = Q^D_T$ and $Q^S_{T+1} = Q^D_{T+1}$ and equations 9*a* and 9*b* may be inserted in equations 8*a* and 8*b*, respectively, to obtain

$$P_T = f_T[(X_T - H_T + H_{T-1})/m] \qquad (10a)$$

$$P_{T+1} = F_{T+1}[(X_{T+1} - H_{T+1} + H_T)/n] \qquad (10b)$$

In equations 10*a* and 10*b*, certain variables may be regarded as predetermined. For example, X_T, production within the regular fishing season, is fixed by the International Pacific Halibut Commission. X_{T+1}, production outside the regular season, will be close to zero in all years without special seasons. In years with special seasons, production in the special seasons can be estimated fairly accurately, since the duration of special seasons is announced by the Commission. Finally, H_{T+1}, planned carryover for the next year, will be approximately zero, since there is substantial quality deterioration associated with keeping halibut in storage over long periods of time. Of course, in actuality, H_{T+1} may depart from zero because of errors in planning or unforeseen events during the year. Hereafter, variables that are considered as being predetermined will be written with a bar over them.

From equations 10*a* and 10*b*, it is possible to write:

$$P_{T+1} - P_T = f_{T+1}[(\overline{X}_{T+1} - \overline{H}_{T+1} + H_T)/n] - f_T[(\overline{X}_T - H_T + \overline{H}_{T-1})/m] \qquad (11)$$

It is seen that the price change from period T to $T+1$ is a function of just one endogenous variable, H_T, (end-of-fishing-season holdings), since all the remaining variables in equation 11 are predetermined. (Here n and m are considered predetermined; later, this assumption will be relaxed.) The price change is in general a decreasing function of H_T, a fact that is easily established from the usual properties of demand curves. Equation 11 represents the "demand for storage."

The fact that inventories of halibut are carried into the out-of-season period means that consumers are supplied with halibut over the entire year. Individuals who hold inventories thus supply a service to the economy. This function is usually referred to as "supplying storage." We now turn to a review of the determinants of the supply of storage.

Review of the determinants of the supply of storage.—The amount of halibut that a particular individual will want to hold at the end of a fishing season is, of course, determined by profit considerations. For each pound held, the revenue gain will be just the change in the forward price from period T to period $T+1$, or $P_{T+1}-P_T$. Then to maximize profits from holdings, the volume of holdings, H_T, will be pushed to the point where the expected price change is just equal to the marginal net storage cost (which can be derived from the total net storage cost). Total net storage cost is equal to the physical costs of storage, $O(H_T)$, plus cost associated with risk and uncertainty, $R(H_T)$, minus a convenience benefit derived from holdings, $C(H_T)$. Brennan (1958) has developed the following excellent definitions of the three components of total net storage cost and descriptions of the behavior of these cost components as the level of holdings changes:

The total outlay on physical storage is the sum of rent for storage space, handling or in-and-out charges, interest, insurance, etc. As the quantity of stocks held by a firm increases, the total outlay increases. Although for any single firm this cost may increase at either a constant or an increasing rate, it seems reasonable to suppose that the marginal outlay is approximately constant until total warehouse capacity is almost fully utilized (each firm can store all it wishes without affecting the cost per unit of the commodity stored). Beyond this level marginal outlay will rise at an increasing rate.

We should expect total risk aversion to be an increasing function of stocks. If a comparatively small quantity of stocks is held, the risk involved in undertaking the investment in stocks is also small. An unexpected fall in the price at which stocks must be sold will result in a relatively small loss to the firm holding stocks for later sale . . . . However, given the total capital resources of the firm, the greater the quantity of stocks held, the greater will be the loss to the firm from the same unexpected fall in the future price. There is probably some critical level of stocks at which the loss would seriously endanger the firm's credit position, and as stocks increase up to this point the risk incurred in holding them will steadily increase also—the risk of loss will constitute a part of the cost of storage. The marginal risk-aversion factor may be assumed to be either constant or, more likely, an increasing function of stocks held.

The costs of storage must be considered as charged against the business operation as a whole. Given day-to-day fluctuations in the market, a producing firm can meet a sudden and "unexpected" increase in demand by filling orders out of finished inventories or by adjusting its production schedule or by some combination of these. The convenience yield is attributed to the advantage (in terms of less delay and lower costs) of being able to keep regular customers satisfied or of being able to take advantage of a rise in demand and price without resorting to a revision of the production schedule. Similarly, for a processing firm the availability of stocks as raw materials permits variations in production without incurring the trouble, cost and perhaps delays of frequent spot purchases and deliveries. A wholesaler can vary his sales in response to an increased flow of orders only if he has sufficient stocks on hand.

The smaller the level of stocks on hand the greater will be the convenience yield of an additional unit. It is assumed that there is some quantity of stocks so large that the marginal convenience yield is zero.

The above considerations are represented graphically in figure 14 where marginal net storage cost ($MNSC$) is plotted against level of stocks (H_T). Also shown in figure 14 are the components of $MNSC$; namely, the marginal physical outlay curve (dO/dH_T), the marginal risk-aversion curve (dR/dH_T), and the marginal convenience curve (dC/dH_T). The $MNSC$ is equal to $dO/dH_T+dR/dH_T-dC/dH_T$; that is, to the sum of the marginal physical outlay and marginal risk aversion minus the marginal convenience yield. The curves in figure 14 relate to an individual firm.

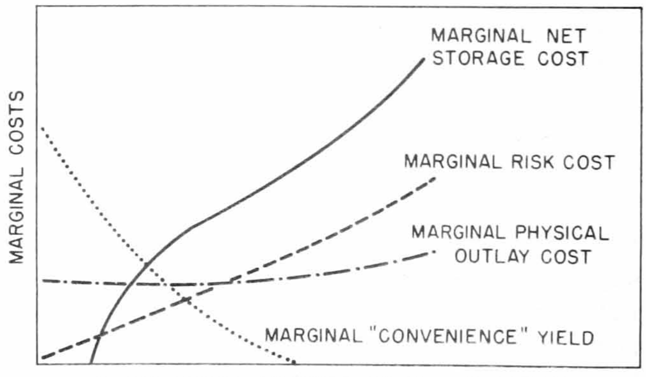

FIGURE 14.—Marginal net storage cost and its components.

With pure competition and no external economies or diseconomies in the storage industry, the aggregate supply curve of storage is the horizontal sum of all individual *MNSC* functions. This aggregate supply of storage relation, *SS*, is shown in figure 15, along with a curve designated *DD* to represent the demand for storage. The intersection of these two curves determines an equilibrium end-of-fishing-season level of holdings, H^d, and an equilibrium forward price change (OA in figure 15). The quantity, H^d, was referred to above in connection with equation 1, as a desired level of end-of-season holdings. The analysis involving consideration of the demand for storage and the supply of storage indicates why this level of holdings will be an equilibrium level.

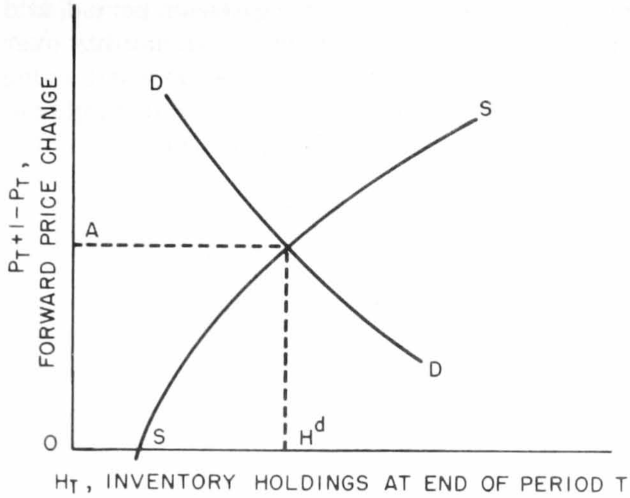

FIGURE 15.—Demand and supply for storage.

Effect of five variables on the size of H^d.—With this analysis set forth, it is not difficult within the present framework to study the effects of the following on the size of H^d:

1. Changes in the duration of the fishing season (that is, variations in m in equation 11).
2. Changes in the catch limit or quota imposed by the International Pacific Halibut Commission; that is, changes in $\overline{X}_T$.
3. Changes in the carryover, $\overline{H}_{T-1}$.
4. Changes in production in special seasons, $\overline{X}_{T+1}$.
5. Changes in certain other exogenously determined variables.

Clearly it is difficult to consider all changes together. The discussion therefore will be carried through under the assumption that only one specified change occurs and that everything else remains constant. Later on, several changes occurring together will be considered.

Changes in duration of season.—As mentioned earlier, the duration of the fishing season has been lengthened by the voluntary layover program instituted by the American and Canadian fleets in 1956 and continued to the present. A lengthening of the fishing season involves an increase in m and a decrease in n in equation 11, the demand-for-storage equation. Such variation in m and n leads to a downward shift of the demand-for-storage curve *DD* in figure 15. Also a lengthening of the fishing season will affect storage costs and thus the supply of storage. That is, the average time inventories are held will be affected by a change in the duration of the fishing season, and this will alter the elements that combine to give total storage costs and marginal storage costs.

(In an arithmetic sense, total storage costs equal the number of pounds held times the length of time these are held times the storage rate. The storage rate is, of course, so many cents per pound per month. Thus, since average holding time is affected by a change in the duration of the fishing season, total and marginal costs will be affected.)

In particular, it seems reasonable to expect that a lengthening of the fishing season will reduce the important absolute and possibly marginal risk costs associated with the holdings of halibut inventories from the fishing period into the out-of-season period. Given that marginal storage costs decrease, the supply of storage curve, *SS* in figure 15, should shift downward to the right. Thus the point of intersection is lower, which implies a smaller forward price change from the fishing period to the out-of-season period. It is our conjecture that, with a significant lengthening of the season, the shift in the demand curve DD is more pronounced than is the shift in the supply curve. (Note that the total volume of halibut carried is but part of the inventory holdings of those providing storage, and probably not a very large part for the larger storage suppliers. This conjecture implies that with a lengthening of the season, both the forward price change, $P_{T+1}-P_T$, and H^d_T decline. Thus with a lengthening of the fishing season, a smaller volume of holdings will be carried over to the out-of-fishing-season period, and the forward price will show less variability over the year. This result should be of great value to forward purchasers of halibut and should facilitate port dealers' selling operations to forward buyers.

Changes in carryover ($\overline{H}_{T-1}$).—An increase in beginning of season holdings, $\overline{H}_{T-1}$, all else constant, will produce an upward shift in DD and thus lead to an increase in H^d. That is, the larger the carryover the more the demanders of storage will want carried out of the fishing season period (T) into the out-of-season period ($T+1$). In actuality, the effect of an increase in $\overline{H}_{T-1}$, the carryover, on H^d may be counteracted by a lengthening of the season. That is, a large carryover will depress the level of port prices and will divert some boats from fishing halibut. With a given quota, this means that the season will tend to be lengthened with the associated effect on H^d described earlier.

Changes in regular season quota ($\overline{X}_T$).—An increase in the regular season quota ($\overline{X}_T$) will lead to an upward shift in DD, the demand for storage, and so to a larger H^d. Then the coefficient of t in equation 1 should increase with an increase in $\overline{X}_T$. However, this tendency may be counteracted if the increase in $\overline{X}_T$ is so great as to produce a lengthening of the fishing season.

Changes in production outside the regular season ($\overline{X}_{T+1}$).—If production outside the regular season ($\overline{X}_{T+1}$) increases, this increase will shift the demand for storage curve downward and so lead to a smaller H^d; that is, the amount of halibut carried out of the regular fishing season (T) into the period $T+1$ will be diminished. Also, such a change will reduce the forward price change, $P_{T+1}-P_T$. The results are summarized in table 7.

EFFECTS OF CURRENT CONSERVATION POLICY ON INTRAYEAR PRICING

With the results shown in table 7 and the former considerations regarding the port pricing pattern embodied in equation 6*b*, it is now possible to consider the effects of a lengthening of the fishing season, alone or in conjunction with other measures, under only moderately restrictive assumptions. It has been established that with a lengthening of the season with a given quota, the amount of fish going into holdings each day will be smaller than in a short season. That is, a_1 in equation 6*b* will be smaller the longer the season is, and this inverse relation means a larger coefficient of t and less negative coefficient of t^2. The effect of lengthening the season on k_1, discussed above, also leads one to expect a less negative coefficient of t^2 the longer the season. As regards the coefficient of t, since it is likely that k_1, H^d,k_0, and a_1 all decrease the longer the season is, the net effect on the coefficient is left in doubt. Finally, with regard to the term $k_0(H^d-bC)$ in equation 6*b*, the longer the season, the smaller will be this term, on the assumption that the carryover, C, is given.

If a lengthening of the season is accompanied by an increase in the regular season's permitted catch, there will be little change in the seasonal pattern of pricing, since the effects on a_1 and H^d of a lengthening of the season will be counteracted by an increase in the total volume of landings during the regular season. Further, the "forward price change," $P_{T+1}-P_T$, which would tend to be reduced, given a lengthening of the season, will now be increased by heavier production during the regular season. Thus the analysis suggests that some of the effects of a lengthening of the season on the price pattern will be offset if at the same time the regular season's quota is increased significantly. On the other hand, the effects of a lengthening of the regular season will be enhanced by an increase

TABLE 7.—*Summary of effects of different production conditions*

Increase in:	Effect on forward price change ($P_{T+1}-P_T$)	Effect on H^d (*ceteris paribus*)	Qualification [1]
Duration of regular season (m).	Decrease....	Decrease....	
Carryover ($\overline{H}_{T-1}$)..	Increase.....	Increase.....	If fishing season lengthened, this will lead to a smaller H^d.
Quota ($\overline{X}_T$)........	Increase.....	Increase.....	Some offset to the increase in H^d may occur if the fishing season's duration is lengthened due to the increased quota.
Production outside regular season ($\overline{X}_{T+1}$).	Decrease....	Decrease....	

[1] In all cases it is assumed that net marginal storage costs do not change.

in production in the special seasons. That is, increased production in the special seasons ($\overline{X}_{T+1}$) is associated with a decrease in H^d and a decrease in the forward price change $P_{T+1}-P_T$, two changes that are also associated with a lengthening of the season. Thus, the Commission, by establishing special seasons, has produced effects on the price pattern during the regular season, effects that resemble those associated with a lengthening of the season. That total output has been increased by the institution of special seasons rather than merely by an increase in the regular season's quotas has been fortunate, since this course of action, among other things, probably has led to less variable forward prices and a less sharply rising pattern of port prices during the regular season.

In the next chapter, we turn to the statistical calculations to determine to what extent these theoretical considerations are supported by the facts.

SUMMARY

An empirically verifiable theory of intrayear port pricing of halibut is developed that provides a framework within which to appraise the effects of various regulatory measures on the seasonal price pattern. Further, the analysis provides a basis for explaining year to year changes in both the level and seasonal pattern of pricing.

First in the theoretical considerations is a price-adjustment equation that relates daily change in price to excess inventory demand for halibut; that is, an equation that relates daily change in price to the difference between desired holdings and actual holdings of inventories on a particular day. Generally, the larger the deviation between desired holdings and actual holdings, the more rapidly will price change. It is recognized also that a given positive excess of desired stocks over actual stocks will exert more upward pressure on the port price if the price is at a low level than if it is at a high level and if this given positive excess is present late rather than early in the season. These considerations, as well as others, have been incorporated in a relationship explaining the observed temporal pattern of port price within the regular fishing season.

Second in the theoretical consideration is an exposition and application of the theory of storage to bring together in a meaningful fashion the factors determining the desired equilibrium end-of-season holdings of halibut. Among the factors that determine this quantity are several policy variables, such as the regular season's quota, the catch in the special seasons, and the duration of the regular season. Since the effect of these variables on the desired level of holdings can be predicted under ceteris paribus conditions and since the desired level of holdings appears in the relationship explaining the seasonal pattern of price, qualified inferences regarding the effects of changes in the policy variables on the intraseasonal pattern of pricing can be made. These inferences are presented at the end of the present chapter.

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Chapter 7

ANALYSIS OF PORT PRICING OF HALIBUT: EMPIRICAL RESULTS

In this chapter, the mathematical relations developed earlier are tested. The principal topics discussed are data employed, results of calculations, interyear changes in the price pattern, and summary of intrayear port pricing analysis.

DATA EMPLOYED

The port market data underlying the calculations relate to the years 1953 through 1957 and to the ports of Seattle and Ketchikan. Data for Seattle were collected from the records of the Seattle Fish Exchange, which show the hailed weight and the price per pound for each boat's catch. Similar data for Ketchikan, 1955 through 1957, were obtained from the Bureau of Commercial Fisheries Market News reporter in Ketchikan. For each market day, an average price for medium halibut was calculated by weighting the price received by individual boats by their respective hailed weights of medium halibut. The 1953 and 1954 data for Ketchikan were obtained from the Bureau's Seattle Market News Service daily fishery products reports. In these reports, the daily volume of medium halibut landed at Ketchikan is given, together with a range of prices paid on each market day. The midrange price was employed to represent the daily average Ketchikan port price for these 2 years. The data are presented in appendix 9.

The analyses of daily data refer to market days included in table 8.

RESULTS OF CALCULATIONS

The purpose of this section is to determine how well the model of pricing that was developed in chapter 6 fits the data for Ketchikan and Seattle during individual years. The results at Ketchikan are of particular interest because the price pattern there is not complicated by the demand for fresh fish. Results at Seattle offer an instructive contrast to those at Ketchikan because the price pattern is complicated by a large demand for fresh fish.

Ketchikan

In table 9 are shown the results of calculations pertaining to pricing at Ketchikan during the

TABLE 8.—*Periods included in the analysis of port pricing at Seattle and Ketchikan*

Year	Seattle		
	Period	Number of days in period	Number active market days
1953	May 21–July 17	58	38
1954	May 19–July 22	65	38
1955	May 16–Aug. 12	89	59
1956	May 25–Aug. 31	99	52
1957	May 3–July 26	85	55

Year	Ketchikan		
	Period	Number of days in period	Number active market days[1]
1953	May 1–July 14	75	30
1954	May 19–July 19	62	37
1955	May 16–Aug. 12	89	35
1956	May 24–Aug. 30	99	64
1957	May 5–Aug. 16	104	67

[1] The number of active market days is the number of days in the periods shown above on which medium halibut were sold. In the periods shown above there were landings on almost every market day. With the closing of particular areas (see table 4), landings fall to zero until the opening of special seasons. Since this represents a break in the continuity of seasonal port pricing, a break that differs from year to year, it was thought advisable to limit the analysis to the periods shown in table 8.

TABLE 9.—*Results of calculations relating to daily port pricing of medium halibut at Ketchikan, 1953–57*

Year	N[1]	Estimated relationships[2]	$\bar{R}^2$[3]	d[4]
1953	30	$p_t = 2.76 - 0.122Q_t + 0.791p_{t-1} + 0.0701t - 0.00107t^2$ (0.0885) (0.107) (0.0409) (0.000649)	0.950	1.648
1954	37	$p_t = 5.45 - 0.0264Q_t + 0.600p_{t-1} + 0.0985t - 0.00143t^2$ (0.0486) (0.139) (0.0408) (0.000553)	0.960	2.027
1955	35	$p_t = 5.13 - 0.0242Q_t + 0.472p_{t-1} + 0.0966t - 0.000813t^2$ (0.176) (0.141) (0.0259) (0.000276)	0.927	1.919
1956	64	$p_t = 6.82 - 0.0130Q_t + 0.604p_{t-1} + 0.0782t - 0.000548t^2$ (0.173) (0.0912) (0.0239) (0.000184)	0.980	1.942
1957	67	$p_t = 3.65 - 0.0150Q_t + 0.737p_{t-1} + 0.0351t - 0.000272t^2$ (0.0978) (0.0868) (0.0137) (0.000104)	0.965	1.940

[1] N is the number of observations or the number of active market days included in the analysis.

[2] Figures in parentheses are standard errors.

[3] $\bar{R}^2$ is the adjusted coefficient of determination.

[4] d is the Durbin-Watson test statistic employed to test the error term for possible autocorrelation. In every case it is possible to reject the hypothesis of autocorrelation. A "two-tailed" test at the 5-percent level of significance was employed. (Durbin and Watson, 1950—51).

Notation:

P_t=Average price of medium halibut on the t'th day (in cents per pound).

Q_t=Landings of medium halibut on the t'th day (measured in units of a hundred thousand pounds).

p_{t-1}=Average price of medium halibut on market day preceding the t'th day.

t=Time measured in days from the first market day.

years 1953–57. All relations have been estimated by employing the method of least squares. The values of the coefficient of determination demonstrate that the fits obtained are very good. This closeness of fit is evident from the plots of the actual and calculated prices shown in figures 16 through 20. In addition, it will be noted that almost all parameters appear to be significantly different from zero except for the coefficient Q_t, daily volume of medium halibut landed at Ketchikan. As mentioned earlier, this result is consistent with the notion that buyers are mobile and thus do not bid up the price at Ketchikan when landings are light and that they do not permit the price to sag much when landings are heavy relative to landings elsewhere. It will also be noted that all other estimates of coefficients are in agreement with the theoretical considerations presented earlier. The coefficient of p_{t-1} is between zero and one, roughly 0.7, which indicates that the effect of a temporary element of demand that raises price by 1 cent per pound will largely be dissipated after 3 or 4 days. Also, the coefficients of t and t^2 have their expected signs, positive in the first instance and negative in the second. Lastly, the coefficients of t^2 are more negative in the short seasons (see table 8) 1953 and 1954 than during the longer seasons

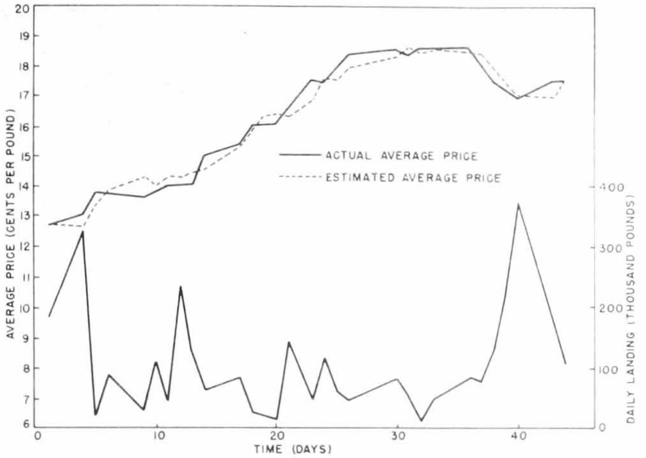

FIGURE 16.—Daily landings and average price of medium halibut at Ketchikan, 1953.

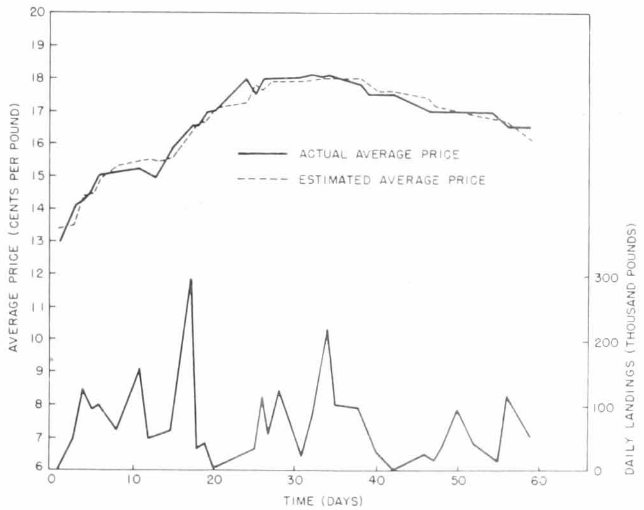

FIGURE 17.—Daily landings and average price of medium halibut at Ketchikan, 1954.

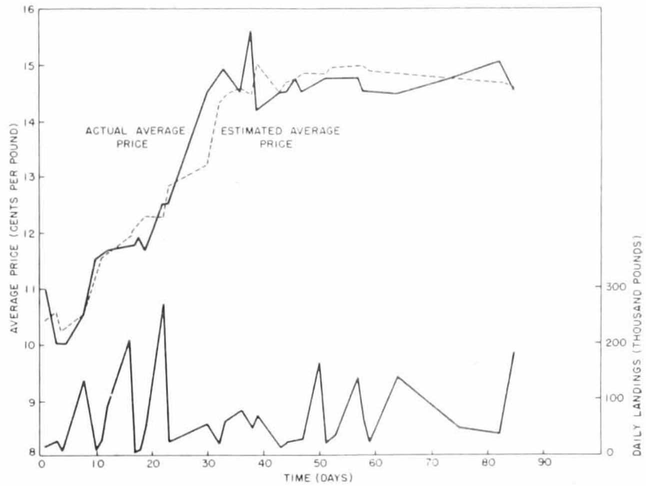

FIGURE 18.—Daily landings and average price of medium halibut at Ketchikan, 1955.

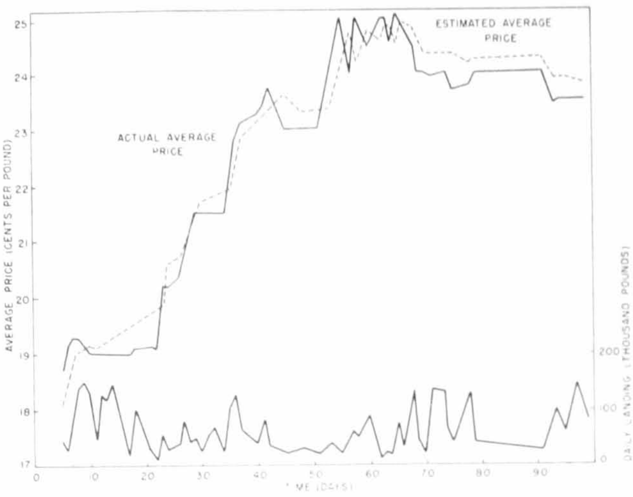

FIGURE 19.—Daily landings and average price of medium halibut at Ketchikan, 1956.

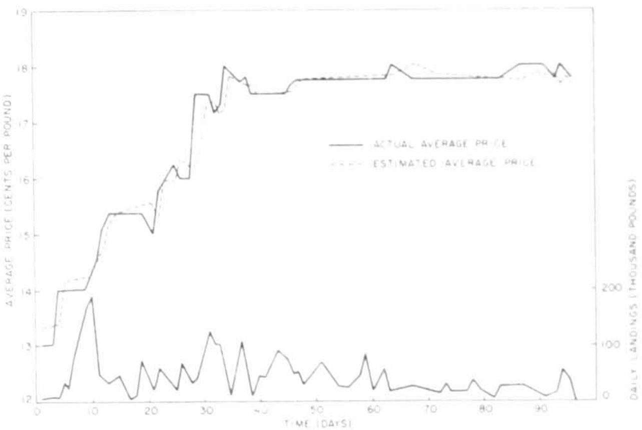

FIGURE 20.—Daily landings and average price of medium halibut at Ketchikan, 1957.

of 1955–57, a result that is consistent with the theoretical arguments.

To check further the appropriateness of the model, we thought it advisable to test for a possible effect of p_{t-2}, the price lagged 2 market days, on current price. A significant influence of p_{t-2} on current price would mean that a second-order-difference-equation adjustment process is operative rather than the first-order one considered earlier. Calculations with the data relating to Ketchikan, 1954–56, indicate no statistically significant effect of p_{t-2} on p_t. Further, the adequacy of the assumptions leading to terms in t and t^2 was tested by including a term in t^3. The coefficient of this term was not found to be significantly different from zero when 1953 and 1954 data for Ketchikan were employed.

Seattle

In table 10 and in figures 21 through 25, the first set of results pertaining to pricing at Seattle during 1953–57 are presented. As with the analysis of Ketchikan port pricing, all coefficient estimates have the expected algebraic sign and, in contrast to the Ketchikan results, daily landings at Seattle exert a statistically significant negative effect on the level of price. This inverse relation is evident from the plots of prices and landings in figures 21 through 25.

Early in every year, the price at Seattle is very high, a phenomenon not noted in the Ketchikan data. In large part, this high price at Seattle is due to the fact that landings are light during the first few days of the season and buyers are eager to be the first to send the new catch to market. Such early delivery undoubtedly provides the seller with a high return in money, in good will, and in prestige, which offsets the high price he pays for the fish.

Further, the high opening price at Seattle, year after year, gives individual primary producers a chance to get a high return. That is, the first boats landing fares get substantially more for their halibut than do boats landing

TABLE 10.—*Results of calculations relating to daily port pricing of medium halibut at Seattle, 1953–57*

Year	N[1]	Estimated relationships[2]	$\overline{R}^2$ [3]	d[4]
1953	38	$p_t = 8.88 - 0.574Q_t + 0.549p_{t-1} + 0.0776t - 0.00110t^2$ (0.189) (0.109) (0.0718) (0.00115)	0.662	2.374
1954	38	$p_t = 11.86 - 0.543Q_t + 0.436p_{t-1} + 0.122t - 0.00141t^2$ (0.0783) (0.0765) (0.0273) (0.000383)	0.878	1.825
1955	59	$p_t = 8.23 - 0.752Q_t + 0.533p_{t-1} + 0.0554t - 0.000418t^2$ (0.112) (0.0744) (0.0184) (0.000177)	0.877	2.152
1956	52	$p_t = 13.17 - 0.890Q_t + 0.479p_{t-1} + 0.0942t - 0.000589t^2$ (0.193) (0.0760) (0.0218) (0.000209)	0.908	1.953
1957	55	$p_t = 13.08 - 0.517Q_t + 0.338p_{t-1} + 0.0801t - 0.000422t^2$ (0.163) (0.0729) (0.0342) (0.00370)	0.710	2.073

[1] N is the number of observations or the number of active market days included in the analysis.

[2] Figures in parentheses are standard errors.

[3] $\overline{R}^2$ is the adjusted coefficient of determination.

[4] d is the Durbin-Watson test statistic employed to test the error term for possible autocorrelation. In every case it is possible to reject the hypothesis of autocorrelation. A "two-tailed" test at the 5-percent level of significance was employed. (Durbin and Watson, 1950–51).

Notation:

p_t=Average price of medium halibut on the t'th day (in cents per pound).

Q_t=Landings of medium halibut on the t'th day (measured in units of a hundred thousand pounds).

p_{t-1}=Average price of medium halibut on market day preceding the t'th day.

t=Time measured in days from the first market day.

several days later. Hence, every year, many boats try to be the first to return with a full hold. Of necessity, only a few can be the first to reap the benefits of high prices; the remaining fishermen land their catches under almost

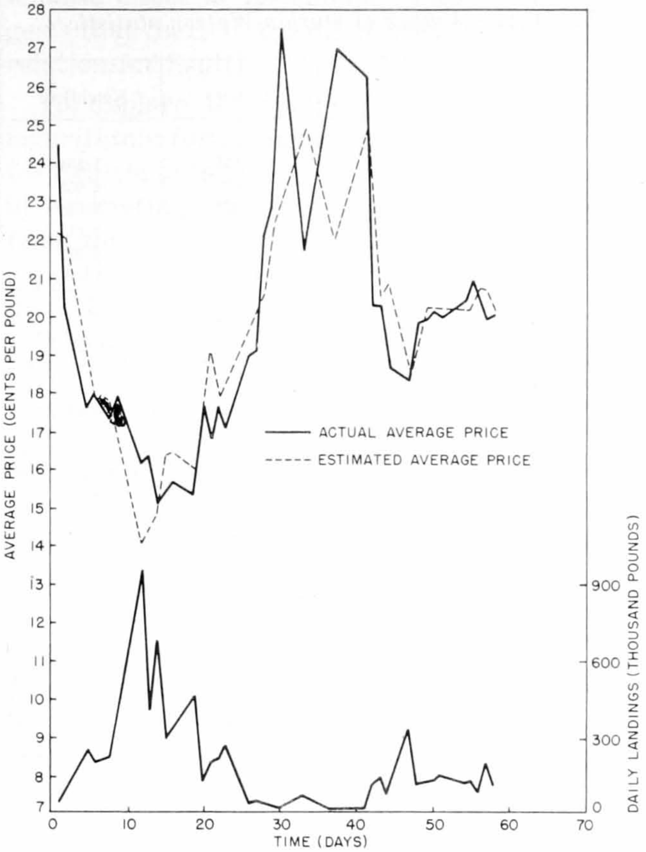

FIGURE 21.—Daily landings and average price of medium halibut at Seattle, 1953.

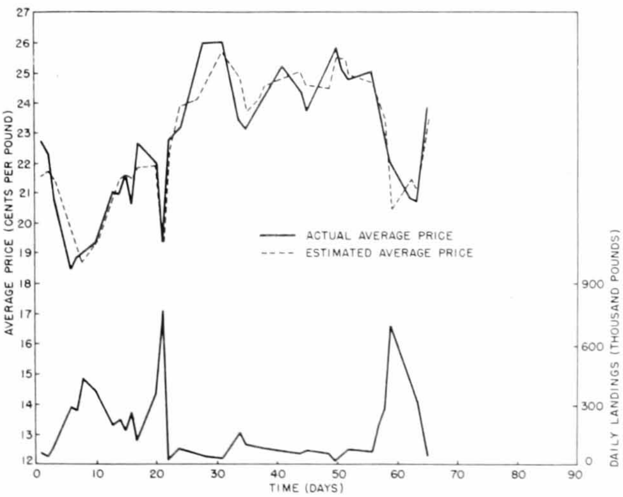

FIGURE 22.—Daily landings and average price of medium halibut at Seattle, 1954.

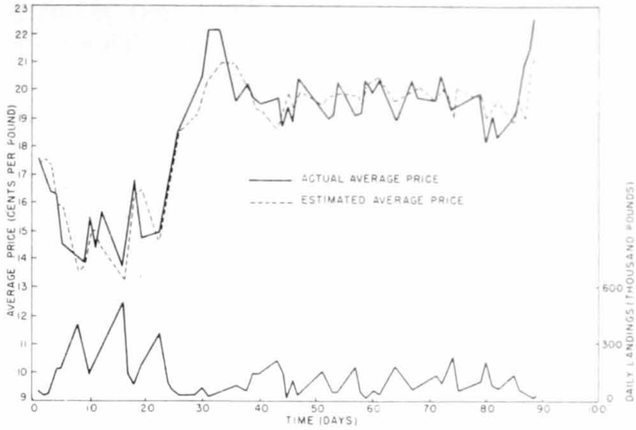

FIGURE 23.—Daily landings and average price of medium halibut at Seattle, 1955.

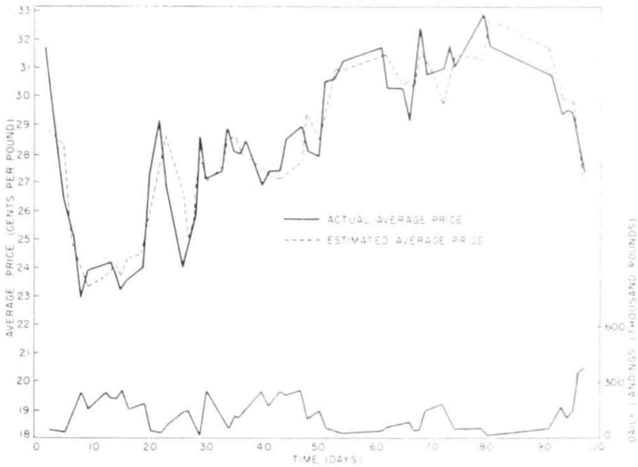

FIGURE 24.—Daily landings and average price of medium halibut at Seattle, 1956.

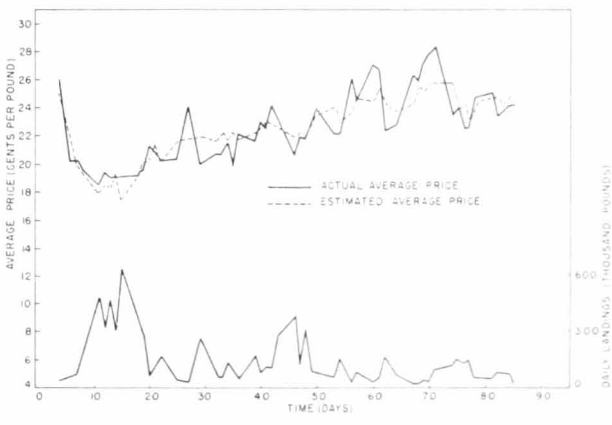

FIGURE 25.—Daily landings and average price of medium halibut at Seattle, 1957.

glut conditions (see plot of landings) about 8 to 12 days after the first market day. This peak in landings, which appears every year, is associated with a subsequent substantial decline in price. Calculations indicate that an additional 100,000 pounds thrown on the market will depress prices at Seattle by a maximum of 0.9 cents per pound. If daily landings remain up by 100,000, the full effect will amount to a maximum of 1.7 cents per pound fall in price, which would be established in about 2 to 4 days. This is labelled a maximum effect because of the kink or bend thought to be present in the demand curve at Seattle. That is, the price at Seattle on a particular day cannot drop below the value consistent with the inventory pattern of pricing. Thus there is a floor under Seattle prices, and as long as this floor is not encountered, the effect on price of an additional 100,000 pounds on the market will be roughly as stated above. If the floor is encountered, the effect will be less.

Several considerations, in addition to the qualitative ones presented above, support the contention that there is probably a kink or bend in the Seattle demand function. Note that with the use of linear functions, the fits obtained with the Seattle data are not as good as those obtained with the Ketchikan data. For the Ketchikan analyses, every coefficient of determination was over 0.9; whereas for the Seattle analyses, four out of five such coefficients were computed to be less than 0.908, with a range from 0.662 to 0.908. One reason for this difference could be that it is more difficult to "explain" variability of port prices at Seattle, since this market is inherently more unstable than is the one at Ketchikan. Although this difference in stability is a possibility, it was felt worthwhile to pursue the alternative hypothesis mentioned earlier; namely, that there is a kink or a bend in the function, so the linear function fitted to the data is not entirely appropriate.

The first step in checking this point was to plot the calculated residuals for the Seattle-fitted functions against daily volume of landings. For both light and heavy landings, the residuals tend to be positive; whereas for medium landings, the residuals tend to be negative. The kink or bend appears to be encountered when daily landings are about 50,000 pounds.

A more objective measure of this departure from randomness in the residuals is provided by the values of the Durbin-Watson statistic computed with the residuals ordered according to the volume of daily landings. For the 5 years included in the analysis, the results shown in table 11 were obtained:

TABLE 11.—*Values of Durbin-Watson statistic*[1]

Year	Seattle[2]	Ketchikan
1953	1.091	1.884
1954	1.639	2.055
1955	1.767	2.634
1956	2.018	1.817
1957	1.116	2.071

[1] Here in computing the statistic $d=\sum_{t=2}^{m}(u_t-u_{t-1})^2/\sum_{t=1}^{m}u_t^2$, the residuals have been ordered according to the size of the volume of daily landings.

[2] The results for 1953 and 1957 are consistent with the hypothesis of positive autocorrelation at the 5-percent level of significance, whereas the Durbin-Watson (1951) test fails to produce a conclusive result with regard to the value of d for 1954. A "one-tailed" test was employed utilizing tables given in Durbin and Watson (1950—51).

INTERYEAR CHANGES IN THE PRICE PATTERN

The results just shown indicate that the model of pricing developed fits the data for Seattle and Ketchikan rather well in individual years. The results now will be viewed to determine how well year-to-year changes in the pattern of pricing can be explained in terms of the theoretical considerations developed earlier. The results relating to Ketchikan will be given most attention, since the price pattern there is not complicated by the presence of a demand for fresh fish. From table 9, the following appear to be the most salient features of year-to-year variation in the pattern of pricing at Ketchikan:

1. The estimated coefficients of t^2 are more negative in the years 1953 and 1954 than in the years 1955–57.
2. The constant terms for 1953 and 1957 are smaller than are those for other years.
3. There is variation in the estimated coefficients of t over the period covered by the analysis.

The discussion of these year-to-year changes will be carried forward within the context of equation 6*b*, which is reproduced here for convenience.

$$p_t=(1-\lambda)p_{t-1}+[k_1(H^d-bC)-k_0a_1]\,t-k_1a_1t^2+k_0(H^d-bC)+u_t \quad (6b)$$

Upon comparing the values of the Durbin-Watson statistic in table 11 with those in tables 9 and 10, one sees that ordering the residuals according to volume of daily landings has reduced the value of the statistic in four of five cases in Seattle, whereas there was no such systematic effect in Ketchikan. This finding suggests that there is a bend or kink in the demand relation for Seattle.

To explore this point further, we fitted a logarithmic formulation of the demand relation for Seattle to the same data that were employed in estimating the linear functions. It is seen from the results in table 12 that the fits for the logarithmic formulation are better than are those for the linear formulation (see table 10). It is to be noted that, as with the linear formulation, the results for 1953 are such that the estimates of the coefficients of t and t^2 are accompanied by large standard errors—so large that it is not possible to reject the hypothesis that the coefficients of t and t^2 are zero. Why this is the case will be explored in the next section.

The estimated relations in table 12 indicate that for Seattle, a 10-percent increase in landings on a particular day will result in about a ½-percent decrease in price on that day. This indicates that the demand at Seattle is quite elastic. If, of course, daily landings rose by 10 percent and remained 10 percent higher, the effect on price would be greater than for landings that rose by 10 percent for a single day. In the case of a permanent increase of landings by 10 percent, the results in table 12 indicate that price would finally be lowered by about 1 to 2 percent. The fact that price falls far less than proportionately with an increase in landings is an extremely important finding, since it indicates that higher landings, although associated with slightly lower prices, provide a larger gross stock or gross revenue to the entire fishing fleet.

Coefficient of t^2

Equation 6b indicates that the coefficient of t^2 depends on a_1, the daily rate of inventory buildup during the fishing season, and k_1, the rate of increase in the fraction of excess stock demand exerting pressure on price at the beginning of the season.

With regard to a_1 in the years covered by the analysis, the best that can be done, given the available data, is to use the monthly figures on United States (including Alaska) and Canadian holdings to estimate the rate of inventory buildup in the years 1953–57. These figures are shown in table 13.

It is seen that the monthly rate of buildup is greatest for 1954 and next highest for 1953, whereas the rates for 1955–57 are somewhat smaller. Thus these figures are compatible with a higher a_1 for 1953 and 1954 than in the years 1955–57. Also, table 8 reveals that 1953 and 1954 were short seasons, whereas 1955–57 were long seasons, a fact that should make for a larger k_1 (as argued above) in 1953 and 1954 than in 1955–57. Thus the finding that the estimated coefficients of t^2 are more negative in 1953 and 1954 than in the years 1955 to 1957 is in good agreement with the specific theoretical considerations underlying the calculations.

TABLE 12.—*Results of calculations relating to daily port pricing of medium halibut at Seattle, 1953–57*

Year	N [1]	Estimated relationship [2]	$\overline{R}^2$ [3]	d [4]
1953	30	$\log p_t = 1.218 - 0.00131t + 0.0000277t^2 - 0.102 \log Q_t + 0.304 \log p_{t-1}$ (0.000981) (0.0000158) (0.01200) (0.0769)	0.887	2.189
1954	38	$\log p_t = 0.917 + 0.00198t - 0.0000213t^2 - 0.0485 \log Q_t + 0.408 \log p_{t-1}$ (0.000476) (0.00000668) (0.00566) (0.0680)	.911	1.844
1955	59	$\log p_t = 0.737 + 0.00171t - 0.0000132t^2 - 0.0540 \log Q_t + 0.510 \log p_{t-1}$ (0.000436) (0.00000425) (0.00742) (0.0716)	.894	2.456
1956	52	$\log p_t = 0.772 + 0.00157t - 0.0000105t^2 - 0.0318 \log Q_t + 0.503 \log p_{t-1}$ (0.000338) (0.00000317) (0.00653) (0.0729)	.866	2.116
1957	59	$\log p_t = 0.982 + 0.00161t - 0.00000964t^2 - 0.0448 \log Q_t + 0.336 \log p_{t-1}$ (0.000551) (0.00000601) (0.00867) (0.0684)	.781	2.157

[1] N is the number of observations or the number of active market days included in the analysis.

[2] Figures in parentheses are standard errors.

[3] $\overline{R}^2$ is the adjusted coefficient of determination.

[4] d is the Durbin-Watson test statistic which is employed to test the error term for possible autocorrelation. In every case it is possible to reject the hypothesis of autocorrelation. See Durbin and Watson (1950—51).

Constant Terms

The constant terms in the relations for Ketchikan (see table 9) will next be considered. (For this discussion the Seattle results are not included, since the presence of a demand for fresh fish complicates matters.) The constant terms for 1953 (2.76) and 1957 (3.65) are smallest, whereas that for 1956 (6.82) is the largest. Equation 6b indicates that the constant term is $k_0\ (H^d - bC)$, where H^d is the desired equilibrium level of holdings at end of fishing season, C is the carryover, k_0 is the fraction of excess stock demand exerted at the beginning of the season, and b is the fraction applied to the carryover to take account of quality changes. Most important in accounting for year-to-year changes in this term will be changes in C and H^d (k_0 and b are regarded as being fairly constant over the years covered). The figures in column 1 of table 13 showing trough holdings in the years 1953–57, are a close approximation to the carryover in each year. For convenience, these figures are presented in table 14 alongside values of the constant terms.

The carryover in 1956 was much smaller than in the other years shown and in this year the constant term (6.82) is much greater than for the other years. The carryover in 1954 is smaller than that in the remaining years (excluding 1956), and the constant term for 1954 is second highest. For the other three years—1953, 1955, and 1957—the carryover is about 8 million pounds, and the constant terms are lowest for these 3 years. Thus, the carryover plays an important role, as indicated by equation 6b, in determining the size of the constant term. To explain the variation in the constant term for the years 1953, 1955, and 1957 in which the carryover was about constant, one must give consideration to the factors producing year-to-year variation in H^d, the desired equilibrium level of end-of-season holdings. This quantity will also play a role in the discussion of the estimates of the coefficients of t.

In the previous discussion of the determination of H^d, emphasis was placed on isolating the influence of certain factors (carryover, length of season, size of quota, and catch in special seasons) while holding other things constant. Clearly, in year-to-year changes, other things such as consumer income, prices of products competing with halibut, and storage costs do not necessarily remain constant, and this fact must be taken into account in discussing variation in H^d from year to year. It is to be remembered that H^d represents the holdings that consumers wish carried over from the fishing period (T) into the out-of-fishing-season period ($T+1$) in a particular year and also the amount that holders of inventories find profitable to carry over. Looking at the demand or consumer side of the market, one sees that if consumer income rises substantially from T (the period roughly from May through August) to $T+1$ (the period from September through April of the next year), consumers will want a substantial amount of halibut carried over from the period from May to August into the period from September to April, much more than would be the case if consumer

TABLE 13.—*U.S. and Canadian peak and trough holdings of frozen halibut and computed monthly rate of inventory buildup, 1953–57*

Year	Trough holdings [1]	Peak holdings [1]	Rate of inventory buildup
	Thousand pounds	*Thousand pounds*	*Thousand pounds per month*
1953	8,191	42,335	8,536
1954	5,054	45,945	10,223
1955	8,242	37,168	7,232
1956	2,957	38,631	7,135
1957	8,026	34,367	6,585

[1] In each of the years covered by the table, trough-holdings figures are beginning-of-May holdings, while peak-holdings figures are beginning-of-September holdings except for 1956 in which peak holdings occurred at the beginning of October.

Sources: 1953–56 holdings for the United States and Alaska are taken from Anderson and Power (1956a, 1956b, 1957) and Power (1958). Canadian holdings are from Pacific Fisherman.

TABLE 14.—*Trough holdings and constant term (in equation 6b)*

Year	Trough holdings [1]	Constant term [2]
	Thousand pounds	
1953	8,191	2 76
1954	5,054	5.45
1955	8,242	5.13
1956	2,957	6.82
1957	8,026	3.65

[1] Taken from table 13, column 1. These figures are close approximations to the carryover (C) in each year.

[2] Taken from table 9 in which estimated price relationships for Ketchikan are presented.

income were to remain constant or to fall between these two periods. If consumer income goes up between these two periods, holders of inventories will find it profitable to increase the amount of halibut carried over, provided that there is not an offsetting increase in storage costs or other factors. Conversely, if income is expected to go down, holders will find it advisable to reduce the amount they carry over.

Similar considerations regarding the prices of competing products are also relevant. That is, if prices of meat, chicken, or fish other than halibut are expected to rise substantially between the periods from May to August and from September to April, holders of halibut inventories will find it profitable to carry over greater inventories in anticipation of some shifting of purchases from meat to halibut. Conversely, an expected fall in prices of these competing products will produce the opposite effect; namely, a lowering of the amount of halibut carried over. It thus is pertinent to view the behavior of consumer income, prices of competing goods, and storage costs in discussing year-to-year variation in H^d.

Table 15 shows the behavior of personal disposable income over the period covered by the price analyses. Of particular interest are the figures for 1953–54 compared with those for other years. It is seen that in 1953, income hardly changed in contrast with other years in which substantial increases in income were registered, particularly in 1955 and 1956. This would make for a substantially lower H^d for 1953 than in other years, providing that other factors did not operate to offset the influence of changes in income.

The behavior of the prices of products competing with halibut is shown in figure 26. It is to be noted that a general break in the prices of meat, fish, and chickens set in, beginning about 1951 or 1952. This trend of prices was probably the result of revised national farm policies coupled with rising imports of fish products. In 1953, these price effects intensified the effects of the income factor to lower further the amount of inventories that holders desired to carry over from the production period into the out-of-production period. Taken together with a carryover of about 8 million pounds at the beginning of the 1953 fishing season, it is not surprising that the constant term in the price relationship f r 1953, given by $k_0(H^d - bC)$ in equation 6b, was lowest in 1953. In 1955 and 1957, when the carryovers at the beginning of the fishing season were again about 8 million pounds, the income factor was acting powerfully to offset the effects of price declines in other products (note too that in 1957, meat prices and prices of other fish had begun to rise). The rise in income in

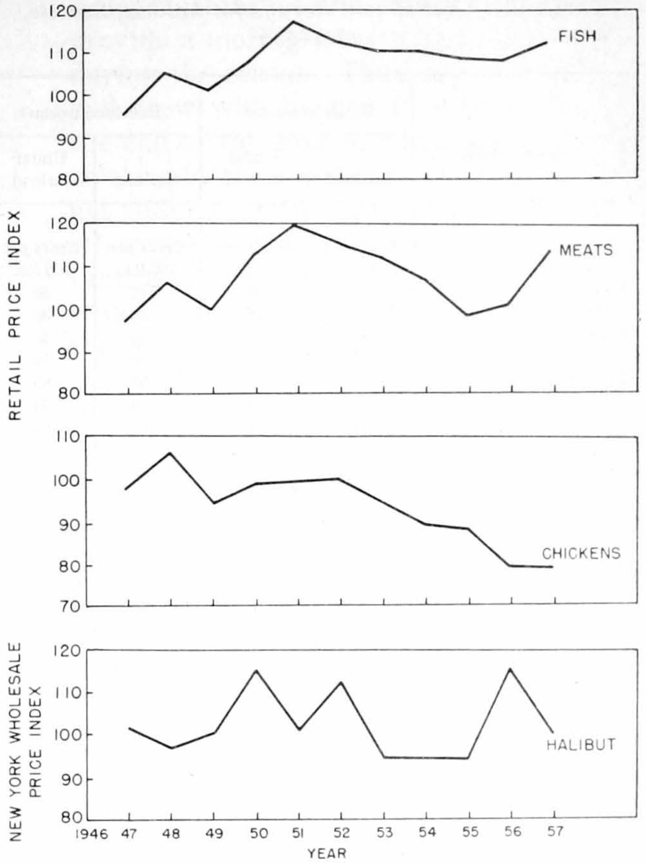

FIGURE 26.—Retail price index of selected foods and index of New York wholesale price of halibut for the seasonal years 1947–57, with 1947–49=100.

TABLE 15.—*United States personal disposable income, seasonally adjusted annual rates, 1953–58*

Quarter	1953-54	1954-55	1955-56	1956-57	1957-58
	Billion dollars	*Billion dollars*	*Billion dollars*	*Billion dollars*	*Billion dollars*
April-June	251.0	252.3	260.1	285.8	299.9
July-September	251.7	254.6	267.8	288.8	308.7
October-December	251.0	258.4	273.2	294.0	306.8
January-March	252.3	260.1	278.6	295.5	306.1

Source: 1953–1956: Survey of Current Business, July 1957, p. 28–29. 1957–1958: ibid., passim. (Some of these figures will be revised slightly in future issues of the S.C.B.)

TABLE 16.—*Cost of cold storage for halibut, Seattle, 1947–59* [1]

Effective dates	Fresh to freeze [2]		Received frozen [2]	
	Carload	Under carload	Carload	Under carload
	Cents per 100 lbs.	*Cents per 100 lbs.*	*Cents per 100 lbs.*	*Cents per 100 lbs.*
January 1, 1947 to	85	100	42	50
December 15, 1950	16.5	20	16.5	20
December 16, 1950 to	95	110	45	55
May 1, 1953	18	22	18	22
May 2, 1953 to	100	115	50	60
January 1, 1956	18	22	18	22
January 2, 1956 to	110	125	55	65
April 30, 1957	20	25	20	25
May 1, 1957 to	127	144	63	75
1959	23	29	23	29

[1] Rates may vary from plant to plant within a range of a few cents, but ordinarily tariffs of various plants are about the same.

[2] The first figure is for the first month, the figure directly underneath it rate monthly thereafter. A carload lot consists of 20,000 pounds or more.

Source: Courtesy of Diamond Ice and Cold Storage, Seattle.

1955 was particularly strong, amounting to $18.5 billion at the annual rate over the production years, as compared with rises of about $6 billion in 1957 and $1.3 billion in 1953. The strong effect of income in 1955 probably accounts for the fact that the constant term in the price relation for that year is somewhat larger than is the similar term for 1957, particularly when storage costs are taken into account (see below).

The behavior of storage costs will affect the volume that holders of inventories will wish to carry over from the production period to the out-of-production period. The cost, for example, of cold storage for halibut (table 16) remained unchanged from May 1953 through January 1956, rose slightly in the period January 1956 to April 1957, and then jumped considerably after May 1957. Also, interest rates for 1956 (table 17) and particularly 1957 were higher than over the years 1953–55. Thus, in 1957, storage costs rose to offset in some degree the positive influences on H^d of the income factor (which was much weaker than in 1955) and the rise in meat and other fish prices. For these reasons, the fact that the estimate of $k_0(H^d-c)$ for 1957 is somewhat higher than that for 1953 and yet not as great as that for 1955 appears reasonable.

Coefficient of t

Now view the estimates of the coefficient of t in the results for Ketchikan (table 9). Equation 6b indicates that this coefficient is $k_1(H^d-bC)-k_0a_1$. It is seen that the quantity H^d-bC, which figured in the discussion of estimates of the constant terms, also appears in the coefficient of t. In addition, the quantity a_1, the rate of inventory buildup, appears. A simple calculation will indicate the relative magnitudes of k_0 and k_1. Suppose the constant term $k_0(H^d-bC)$ is equal to 3.0, a value in line with those appearing in the estimated relations for 1953, 1955, and 1957 shown in table 9. Assume further that H^d-bC is equal to 35 million pounds (this assumption is reasonable, since peak inventories are in the vicinity of 40 million pounds and the carryover is in the neighborhood of 3 to 8 million pounds—see table 12). Then k_0 would be about 3/35. Now if the estimate of the coefficient of t is found to be 0.06, it is possible to determine k_1 from the following relation: $0.06=k_1(H^d-bC)-k_0a_1$, provided that a_1 is known. The figures in table 12 indicate a daily rate of inventory buildup of one-third of a million pounds per day. Therefore, $0.06=k_1(H^d-bC)-k_0a_1=k_1\ (35)-(3/35)\ (1/3)$. Since k_1 is the only unknown appearing in this last relation, its value can be calculated. The rough estimate, an order of magnitude estimate, is $k_1=0.0025$, about one-tenth the value of k_0. Thus, an approximate way to write the coefficient of t would be: $0.0025\ (H^d-bC)-0.029\ a_1$. This rough estimate provides an indication of the relative weights to be applied to changes in

TABLE 17.—*Business loan rates—averages of interest rates charged on short-term loans to business by banks in 19 selected cities of the United States, 1953–57* [1]

Quarter	1953	1954	1955	1956	1957
	Percent per year	*Percent per year*	*Percent per year*	*Percent per year*	*Percent per year*
January-March	3.54	3.72	3.54	3.93	4.38
April-June	3.73	3.60	3.56	4.14	4.40
July-September	3.74	3.56	3.77	4.35	4.83
October-December	3.76	3.55	3.93	4.38	4.85

[1] Estimates based on statistics reported by large banks in 19 leading cities. Short-term loans comprise loans maturing in 1 year or less.

Source: Board of Governors, Federal Reserve System (1958).

$(H^d - bC)$ and in a_1 in assessing year-to-year variation in the coefficient of t.

Again the discussion will revolve about the results for 1953, 1955, and 1957—years in which the carryover (see table 13) was about 8 million pounds. Table 13 indicates that the rate of inventory buildup was largest in 1953, next largest in 1955, and smallest in 1957. The difference, however, between 1955 and 1957 is small. Thus, on this count alone, the coefficient of t for 1953 should be smallest. As regards the quantity $H^d - bC$, as argued above, this quantity was smallest in 1953, next largest in 1957, and largest in 1955. The tentative conclusion from these considerations is that the coefficient of t for 1953 should be smaller than those for 1955 and 1957. In table 9, the following estimates are given for this coefficient (figures in parentheses are standard errors): 1953, 0.0701 (0.0409), 1955, 0.0966 (0.0259), and 1957, 0.0351 (0.0137). For 1953, the estimate, 0.0701, is accompanied by a large standard error–so large that it is not possible to reject the hypothesis that the true value of the coefficient is zero. This is not the case for either the coefficient for 1955 or for 1957. However, the standard errors are so large so that it does not appear possible to reject the hypothesis that these three coefficients are the same; additional results, comparable to the ones presented, are much to be desired.

SUMMARY OF INTRAYEAR PORT PRICING ANALYSIS

Perhaps the most valuable contribution of the analysis is that it provides a theoretical framework, in large measure empirically tested, for consideration of problems relating to port pricing of halibut (and possibly of other primary products). The framework is broad enough to incorporate the effects of certain important changes in conservation measures, the effects of the voluntary layover program, and the effects of changes in economic factors such as income and prices of other products. In essence, an important part of the structure within which halibut is priced has been revealed. Given knowledge of this structure, it is possible to talk more confidently of the probable effects on pricing of specific policy measures.

The major results flowing from the analysis of immediate relevance for pricing problems in the halibut fishery are the following:

1. A lengthening of the fishing season will provide a more gradual rise in port price during the season. Thus, the boat owner and crew who happen to miss a trip at the end of the season, when price is high relative to price earlier in the season, will not suffer as great a financial loss as they otherwise would. Also, and very important, a longer season will make for more stability in the wholesale price of halibut throughout the year. Such stability will greatly facilitate the business of dealing in halibut. The risk and costs associated with holding large inventories, a necessary state of affairs in short seasons, will be much reduced by a lengthening of the season.
2. Insofar as the voluntary layover program of the Fishing Vessel Owners' Association has resulted in lengthening the season, it has contributed to producing the effects mentioned above. Further, the effects of this program on the average level of port price should not be overemphasized, since (a) the amount by which the program has lengthened the season has not been large and (b) other economic factors, particularly consumer income, prices of meat, poultry, and other competing products, are much more important determinants of the average price in a particular season.
3. The Commission, bound as it is by provisions of the Treaty, has acted to lengthen the season in a special way; namely, by the creation of special seasons. The more halibut taken in these special seasons, the more gradual will be the rise in port price in the regular season. It would be desirable, however, to eliminate the break in the continuity of port deliveries made necessary by the special seasons, since it introduces an element of uncertainty for both boat owners and dealers. By having one continuous long season, the objectives underlying the institution of the special seasons (a more even rate of exploitation of the halibut stocks throughout the year and fishing banks at periods of peak abundance) would be achieved and also the uncertainty associated with a discontinuous season would be removed.
4. Finally, in setting the quota, the Commis-

sion should realize that it is affecting both the pattern and level of port prices. If there is some latitude in setting the quota, taking biological considerations into account, then the Commission should pursue policies that foster both intrayear and interyear price stability. The difficulties surrounding the framing and application of such measures should not be minimized. In terms of the above analysis, knowledge of H^d, the desired end-of-season stocks, would have to be known in advance. This knowledge could only be obtained (and then with difficulty) if forecasts of consumer income and prices of other products were available at the time when the quota is determined. It is hoped that the analysis presented above will serve usefully in an approach to this important problem.

SUMMARY

Statistical data relating to daily pricing at Ketchikan and Seattle for the years 1953 through 1957 have been employed to estimate and test the price-formation relation developed in the previous chapter. The results are quite satisfactory in that the relation fits the data rather well, and all estimated coefficients have algebraic signs consistent with theoretical considerations. Thus, a statistically tested explanation of many aspects of the pricing of halibut is the major contribution embodied in this chapter.

Some interesting findings of the empirical analysis are the following: Fluctuations in daily landings at Ketchikan, where there is only an inventory demand, exert no significant influence on the daily average Ketchikan price. At Seattle, however, where there is demand for fresh fish, fluctuations in daily landings do exert a significant influence on daily average price. The effects of, say, a 10-percent increase in daily landings amount to about a 1- to 2-percent decline in average price. These findings indicate that increased landings at Seattle are associated with slightly lower prices there and with higher aggregate fleet gross revenue, all other things being constant.

Analysis of year-to-year changes in the level and pattern of seasonal price movements suggests that beginning-of-year inventory carryover, consumer income, prices of other food products competing with halibut for the consumer's dollar, and costs of storing halibut play a role in explaining year-to-year changes in the seasonal pattern of pricing. It is also likely that lengthening of the season as a result of the voluntary layover program has tended to produce a more gradual rise (abstracting from the usual price decline that takes place early in the season at Seattle but not at Ketchikan) in prices during the season. Since, however, the duration of the regular season has not been increased substantially, this effect is not pronounced. Similarly, one effect of the special seasons instituted by the Commission is probably a slower rate of price rise during the regular season. It appears likely that a further lengthening of the regular season would result in a still more slowly rising port price throughout the regular season and that the institution of one long season would reduce substantially some of the price uncertainties for those who buy and sell halibut.

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Chapter 8

ECONOMIC SURVEY OF BOATS AND FISHERMEN

Surveys were made of the economic status of vessel owners and fishermen. A summary of the technical aspects of the surveys is presented to enable the reader to assess the significance of the findings.

SURVEY OF VESSEL OWNERS

The empirical findings of this study are based primarily on information pertaining to the operations of 50 Seattle boats in the halibut and black cod fisheries during the years 1953–57. In the development of the procedures used in this study, particular attention was given to the following three subjects:

1. Choice of time period.
2. Nature of the underlying data.
3. Characteristics of the sample of 50 boats.

Time Period

This study covers a 5-year period, since it is impossible to be certain that results pertaining to any single year are typical. What one person may consider to be a normal year may be regarded by another as being abnormal. This difference in opinion is particularly the case in commercial fisheries, where earnings are subject to large year-to-year fluctuations. With 5 years' data available, a truer representation of earnings and cost is obtained. In addition, these data provide information on annual fluctuations in earnings and costs. The particular period 1953–57 was chosen because it is the most recent one for which data could be obtained. Its length was thought to be sufficient to present an accurate portrayal of earning and cost conditions and yet not be so prolonged as to include years in the distant past when operating conditions differed greatly from those at present.

Nature of the Underlying Data

The basic data were obtained from the Federal Income Tax returns of the owners (with their permission) of the 50 boats included in the sample. (Supplementary data obtained from other sources are described below.) In view of the well-known penalties for fraudulent reporting of income, information obtained from these tax returns is probably more accurate than would be obtained from a mail questionnaire or possibly even from direct questioning of owners.

The data employed in the investigation were transcribed from worksheets utilized in preparing income tax returns for the 50 boats. The information obtained was checked against actual copies of the boat owners' income tax returns for the years 1953–57. Figures for the following items were obtained for each fishing operation or trip:

1. Gross stock (or gross sales revenue).
2. Gross stock expense.
3. Total crew expense.
4. Total boat share.
5. Master's share.
6. Unemployment insurance tax payments.
7. Social security tax payments.
8. Total amount available for manshares.
9. Individual manshare.

Definitions of some of these terms follow:

1. The gross stock (or gross sales revenue) represents all income of every kind from fishing operations. Sales revenue accruing

from the sale of catches constitute the bulk of gross stock.

2. The gross-stock expense includes such charges as those for custom fees, brokerage fees, cargo insurance, watchmen's fees, fish-inspector fees, lost gear, and stolen gear. (Also included in gross-stock expense under certain conditions are costs for radio receiving sets and rentals of depth recording apparatus.
3. Total crew expense includes charges for the following items: food, fuel oil, cylinder oil, cup grease, waste or rags, ice, salt, bait, condemned fishing gear, outfit insurance, dishtowels, broom and mop for living quarters, maintenance of baiting tent cover, maintenance of medicine chest, and certain radiotelephone charges.
4. The total boat share is equal to 21 percent of the net gross stock, that is, 0.21 times gross stock minus gross-stock expense. The figure 21 percent is the current boat share for boats operating from headquarters in the State of Washington; for those operating with headquarters elsewhere, it is 20 percent.
5. The master's share is 10 percent of the total boat share.
8. The total amount available for manshares is equal to the sum of the following items: gross stock less (a) gross-stock expense, (b) total boat share and (c) total crew expense. (For convenience, these relations are summarized compactly as follows:

Total boat share	=0.21	(gross stock minus gross-stock expense)
	=0.21	(net stock)
Total available for manshares	=0.79	(gross stock minus gross-stock expense) minus total crew expense
	=0.79	(net stock) minus total crew expense

9. The individual manshare equals the total available for manshares divided by the number of men aboard (including the master and/or owner if aboard).

Information on items 1 to 9 was available for all operations of the 50 boats in 1953–57. Since we were primarily concerned with operations of these boats in the halibut and black cod fisheries, it was necessary to identify and exclude all operations other than those relating to halibut and black cod. This task was accomplished by referring to the records of the International Pacific Halibut Commission to identify the halibut and black cod trips of the 50 boats over the 5-year period. The settlement dates for each trip or operation were shown on the income tax worksheets. These dates and dates of halibut and black cod trips in the Commission's records were used to separate halibut and black cod operations from other operations of the boats in the sample.

There was excellent agreement between the number of halibut and black cod trips shown for each sample boat in the Commission records and the number of such trips reported for income tax purposes. This agreement is important; had the Commission's records revealed a larger number of such trips than were reported for income tax purposes, the income figures presented below would be biased downward. The results, however, of the comparison of the Commission records with the income tax information reveal that there was no bias from this source.

After having identified the halibut and black cod trips of the boats in the sample, we calculated the yearly totals of items 1 through 9 above for halibut and black cod trips for each boat in the sample. As regards manshares accruing from halibut and black cod trips, no further information was required. To calculate income accruing to the boats from halibut and black cod operations required additional information as is clear from the following definitional accounting statement:

1. Total boat share.
2. Less sum of: master's share, Unemployment Insurance tax payments, and Social Security tax payments.
3. Less sum of: boat-insurance charge, repair and maintenance expense, supply and sundry expense, and depreciation charge.
4. Less: other owner expense.
5. Equals: boat's net income.

As mentioned above, income tax information on the items in lines 1 and 2 was available for halibut and black cod operations on a trip-by-trip basis; that is, the income tax returns showed an annual charge for each of the items in line 3, a charge that referred not only to halibut and black cod operations but to all operations of the boat. Thus it was necessary to allocate a portion of the annual charges in line 3 to halibut and black cod operations. The manner in which this allocation was effected is discussed in the following paragraphs.

In each year, the total time spent in all fishing and other income-producing operations and the time spent in halibut and black cod operations were determined for each boat in the sample (see appendix 10). With these times determined, it was possible to calculate the proportion of the total time during which the boat was actively engaged in income-producing operations; for example, 100 days in halibut operations, 50 days in black cod operations, and 100 days in other activities. In this case, the percentage of all active operating time spent in the halibut and black cod operations would be 60 percent; that is, 150/250 x 100. The percentages so calculated were applied to the following annual charges to obtain that portion of the total annual charge assigned to halibut and black cod operations: boat-insurance charge, repair and maintenance expense, supply and sundry expense, and depreciation charge.

The method described in the preceding paragraph involves the allocation of depreciation during the period when the boat is tied up (usually during the winter months) to the various operations of the boat in direct proportion to the time spent in these operations. Suppose, for example, that the annual depreciation charge for a boat is $1,000 and that the boat spends 80 percent of its operating time in halibut and black cod operations and 20 percent in other operations. Then, employing the method described above, we would charge $800 of the total $1,000 depreciation charge against halibut and black cod operations and $200 against all other operations. Further, if this boat were engaged in income-producing operations for 9 months and tied up for 3 months, then on the assumption that the depreciation rate for the two periods is the same, the charge for the active period would be $750 and for the inactive period, $250. If the boat depreciated more rapidly when in active operation than when tied up, the former figure will be higher, say $900, and the latter figure lower, say $100. In either case, however, the depreciation charged to the halibut and black cod operations by the method described above will be the same; namely, $800—that is, 80 percent of $750 plus $250 or 80 percent of $900 plus $100. Thus the depreciation charged to the halibut and black cod operations, as calculated, does not rest on the assumption that boats depreciate at the same rate when in active operation as when they are idle. The method does assume that depreciation charges are in direct proportion to the time spent in particular operations, an assumption that appears to be reasonable.

The annual boat-insurance charge, obtained from income tax returns, was allocated to various operations in precisely the same manner as was the annual depreciation charge; that is, in direct proportion to the time spent in halibut and black cod operations. As in the case of the depreciation charge, a difference in the insurance rate effective for periods when the boat is in active operation or for periods when the boat is inactive does not affect the charge allocated to halibut and black cod operations.

For purposes to be discussed in the following chapter, it was necessary to obtain supplementary information concerning the following items for each of the 50 boats: (a) market value, (b) estimated replacement cost, and (c) time spent by owners repairing and maintaining boats. For all but six of the boats, an estimated market value was obtained from records of the boat-owners' insurance cooperative. These estimated market values were determined at meetings of the insurance cooperative members to serve as a basis for computing insurance charges. It thus is felt that the estimates of market value are realistic.

Estimates of replacement costs for the boats in the sample were obtained from boat builders, who were provided with an extensive description of each boat. Since these same individuals had built and repaired a number of the boats, they were able to give informed estimates of replacement costs. These estimates, shown in appendix 11, are deemed sufficiently reliable for the purposes of this analysis.

With regard to item c, information on the time spent by owners in repairing and maintaining their boats was obtained through direct questioning of the owners. These figures are, of course, rough estimates and are treated as such. They serve as a basis for estimating one item of cost that is not included in the income tax returns. The relevance of this cost item to a correct determination of boat net income is discussed in a subsequent section.

Characteristics of the Sample of 50 Boats

The 50 boats included in the sample constitute almost one-third of the Seattle halibut fleet as defined by the International Pacific Halibut Commission. For 1956, the International Pacific Halibut Commission records list 165 regular Seattle halibut boats. Thus for that year, the sample coverage is 30.3 percent of the total. As mentioned above, the 50 boats included in the sample were those for which permission to utilize income tax information was obtained, and excellent records were readily available. The statistical information to be presented represents an accurate account of the experience of these 50 boats during 1953–57. To generalize about the whole fleet from the experience of 50 boats is of course an inference from a sample about a population.

The use of random sampling techniques would have been highly desirable for the purposes of making such inferences if (a) a response error were small, (b) costs associated with such a design were not exorbitant, and (c) the rate of nonresponse were small. Comments have already been made about items a and b. About item c, it is probable that the nonresponse rate with a random sampling design would have been high. For example, in the work of Buchanan and Campbell (1957), it is explained on page 100 that 826 names were randomly selected for interview. Of the 826 individuals selected, only 552 could be found, and of that 552, just 266 complete records were obtained. Thus, although the 826 represented 7.0 percent of the total number of licensed fishermen, about two-thirds of those in the sample failed to respond. Had random sampling techniques been employed in the present study, there is little reason to expect that the rate of nonresponse would have been different from that encountered by these Canadian investigators. In the survey of the Deep Sea Fishermen's Union membership, where random sampling techniques were employed, the rate of nonresponse was much lower than encountered in the Canadian investigation. With a high rate of nonresponse, the mathematical-statistical basis for drawing inferences about a population from a sample is impaired. Of course it is possible to resample the nonrespondents; however, this is a costly and often unsuccessful procedure. Simply put, it is difficult to determine whether or not the information obtained from respondents differs systematically from that relating to nonrespondents.

Some remarks must be made about the possibility of systematic differences between boats in the sample and boats in the entire Seattle fleet due to the method of selecting the boats to be sampled:

1. The owners of the 50 boats gave permission to use information from their income tax returns. That these owners gave such permission might differentiate them from other owners if the others were unwilling to extend permission to employ information from their income tax returns. All members of the Seattle Fishing Vessel Owners' Association agreed, however, to permit use of income tax data for the purposes of this study, and therefore no statistical bias arises on this account.
2. The records for these 50 boats are accurately and neatly kept. This might represent a source of bias if the quality and accuracy of the available records were associated with the ability and education of the owners. In this respect, however, it must be recognized that it is not the owner who assembles and calculates the results needed for income tax returns but the individual who prepares the returns for the owners. (Most owners employ the services of accountants and others to prepare the returns.) Unless there is an association between earnings and choice of an accountant, no bias can be expected to arise from this source.
3. Fortunately, in connection with the possible existence of systematic differences between boats in the sample and boats not in the sample, average manshares computed from the boat survey can be compared with average income from fishing as determined in the survey of the Deep Sea Fishermen's Union. It is found that the agreement between the two surveys on this score is excellent. That this agreement might have arisen because both sur-

TABLE 18.—*Distribution of 50 sample boats and of the 1956 Seattle halibut fleet according to net tonnage*

Net tonnage	1956 Seattle halibut fleet		Sample of 50 boats	
	Number	*Percent*	*Number*	*Percent*
19 and under	37	22.43	8	16.00
20–29	63	38.18	19	38.00
30–39	32	19.39	10	20.00
40 and over	33	20.00	13	26.00
Total	165	100.00	50	100.00

veys gave biased results must also be considered. A check on this possible source of bias was made by comparing the percentage of those who received unemployment compensation according to the survey of fishermen with a similar percentage calculated by the State Unemployment Insurance authorities. The close agreement on this score is further evidence that the results obtained not only adequately represent the 50 boats but that they probably also adequately represent all boats in the Seattle fleet.

It seemed advisable in reporting the results of the boat survey to present results for boats grouped by size (net tonnage) is employed throughout as a measure of size. The distribution of sample boats and of boats in the 1956 Seattle halibut fleet (from records of the International Pacific Halibut Commission) according to net tonnage is given in table 18.

It is seen that the percentage of smaller boats in the sample of 50 is somewhat smaller than in the population of boats and that the sample includes a greater percentage of larger boats than is in the population. For this reason the averages for each size class were weighted by the population percentages (the figures in column 2 of table 18) in computing overall averages.

SURVEY OF FISHERMEN

The second survey in this study is of the membership of the Deep Sea Fishermen's Union. The membership list of the union was reviewed with the assistance of the secretary, Mr. Clarence Nordahl. The names of superannuated and other inactive members were removed, yielding a list of the active members.

From the membership cards, information regarding the age of each fisherman was obtained, and from this information it was possible to use random sampling methods to obtain a sample for each of the four age classes: 34 and under; 35 to 49; 50 to 59; and 60 and above. Figures on the population size, the number in each age group, the size of sample for each age group, and the number of respondents in each age group are shown in table 19. Overall, a rate of response of 47.3 percent was achieved, which is high for a survey of this type and reflects the excellent cooperation extended by the members of the Union.

A copy of the questionnaire employed is presented in appendix 12. The questionnaire was made as short and simple as possible to minimize misunderstanding. At a meeting of the Union before the survey was begun, the members were requested to answer the questionnaires carefully. Many of the members filled out their questionnaires with the assistance of Mr. Nordahl. Upon receipt of other questionnaires, he also reviewed them for completeness and accuracy.

The questions asked in the questionnaire were designed to enable respondents to use existing records—such as W–2 forms and Unemployment Insurance records—in providing answers to as many questions as possible. The information obtained for each of the years 1955, 1956, and 1957 covered such items as (a) age, (b) total income reported for income tax purposes, (c) income from halibut and black cod fishing,

TABLE 19.—*Sample design and information relating to response for the survey of the Deep Sea Fishermen's Union*

Age group	Number [1] in union	Number in sample	Number responding	Relative number responding
				Percent
I (34 and under)	126	50	18	36.0
II (35–49)	311	70	29	41.4
III (50–59)	249	70	40	57.1
IV (60 and over)	228	70	36	51.4
Total	914	260	123	47.3

[1] The percentage distribution of Deep Sea Fishermen's Union members by age is as follows:

34 and under	13.79
35–49	34.03
50–59	27.24
60 and over	24.95
Total	100.00

(d) income from fishing other than halibut and black cod, (e) income from employment other than fishing, (f) Social Security income, (g) Unemployment Insurance benefits, and other items as shown on the copy of the questionnaire in appendix 12.

As in the boat survey, population weights were employed in computing overall averages. That is, averages for each of the four age groups shown in table 19 were calculated. These averages then were combined by weighting each average by the number of union members in that age group in the population. (From table 19 it is seen that the weights are 126/914, 311/914, 249/914, and 228/914.)

The reliability of results from this procedure can be checked in two ways: (1) against the average manshare results derived from the boat survey and (2) roughly against Unemployment Insurance data of the State of Washington. Both checks, to be described later, indicate that the results of the survey of fishermen are reliable.

INCOME AND COST CONCEPTS

Before the statistical results of these surveys are presented, it is necessary to examine closely the concepts of income and cost on which the results are based. Such examination is prerequisite to full understanding and correct interpretation of the findings.

With regard to boat net income, an accounting definition of this item presented earlier is reproduced again for convenience:

1. Total boat share.
2. Less sum of: master's share, Unemployment Insurance tax payments, and Social Security tax payments.
3. Less sum of: boat insurance, repairs and maintenance expense, supply and sundry expense, and depreciation.
4. Less: other owner expense.
5. Equals: boat's net income.

Master's Share

The first item requiring discussion is the master's share shown in line 2. The master's share, 10 percent of the total boat share, represents a payment to the master for services rendered over and above those rendered by other men aboard the vessel during fishing operations. If an owner serves as master aboard his boat, he assumes the responsibilities of the master and performs the services of the master; therefore, a charge must be made for such services to arrive at a true figure for boat net income; that is, the income accruing to capital. In such cases, 10 percent of the total boat share was employed to represent this charge, a percentage employed by owners who engage others to serve as captains aboard their boats.

Boat Insurance

The second item requiring discussion is boat insurance shown in line 2. Since all but 5 of the 50 boats in the sample carried 85 percent coverage (the percentages for the five boats differing from 85 are 100.0, 100.0, 89.3, 66.7, and 62.5), the insurance charge is computed on a similar basis from boat to boat.

Depreciation Charge

The third item—and a very important one—requiring discussion is the depreciation charge shown in line 3. As is well known, there are several alternative bases upon which depreciation charges for a capital asset may be computed. These are (a) original construction cost, (b) original cost to present owner, (c) current market value, and (d) replacement cost. These possible bases for computing a depreciation charge are discussed below:

(a) *Original construction cost.*—If original cost of construction were used as a base for computing current depreciation charges in this study, it would be necessary to have for each boat not only a record of original construction cost but also of costs of rebuilding boats in cases in which boats had been rebuilt, of costs of engines that replaced original engines, and of other equipment that had been purchased to replace original equipment. Since such information was not available, it was impossible to assess original-construction-cost depreciation charges.

(b) *Original cost to present owner.*—Depreciation charges based on original cost to present owner reflect in part past market values of boats and in part original construction cost. Charges calculated on this basis are reported for income tax purposes and will be referred to in what follows as Reported Depreciation. (In almost all cases the straight-line method of depreciation is employed for income tax purposes with a 20-year life for the hull and a 10-year life for the main engine.) As is clear, Reported Depreciation is not calculated on a uniform base. If, for example, a boat were built in the 1930's and remained the property of a single owner until 1954, the depreciation charge in 1954 would reflect at least in part the relatively low construction costs prevailing in the 1930's. If in 1955, the boat were sold, the new owner would employ the 1955 market value of the boat as his original cost, and the depreciation charge would probably be somewhat higher than the 1954 charge. Where boats change hands several times, this difficulty is compounded. This shortcoming of Reported Depreciation is recognized; however, it is not considered to be so important as to vitiate the conclusions drawn from the figures on Boat Net Income derived using the Reported Depreciation Charge.

(c) *Current market value.*—Depreciation charges computed on the basis of current market value are charges that are calculated on a uniform base; namely, 1957 market values obtained from insurance cooperative records. Thus, the depreciation charges for different boats are comparable. Since, however, the 1957 market value reflects—among other things—1957 construction costs, profitability of fishing, and original cost, it cannot be said that exactly the same depreciation charges would be obtained if market values for some other year had been used as a base. For calculation of depreciation on the basis of current market value, a depreciation rate of 5 percent per annum—the rate generally employed by marine surveyors, salvage corporations, etc.—was used. Thus, if the market value of a boat were $20,000 at the beginning of 1957, the depreciation charge for 1957 would be $1,000. It will be noted that the use of a rate of 5 percent per annum involves a depreciation charge that falls with the life of the asset, the so-called declining-balance method of computing depreciation.

Actually, since depreciation on market value is computed using a 5-percent rate applied to the total market value of the boat, it is likely to yield a lower depreciation charge than the Reported Depreciation Charge, which incorporates a 20-year life for the hull and a 10-year life for the main engine. On the other hand, the depreciation charge based on market value is probably higher than the Reported Depreciation Charge because early 1957 values of boats reflect the very profitable 1956 fishing season. With these two offsetting tendencies present, results will not be sensitive or dependent upon which depreciation charge is used as will be seen later.

(d) *Replacement cost.*—Depreciation calculated on the basis of replacement cost—that is, the current cost of a new vessel to replace a similar vessel in the fleet—will, under present shipbuilding costs, be much higher than depreciation calculated on almost all other bases. The reason for calculating depreciation on a replacement-cost basis is that this charge would be the depreciation charge borne by owners of new boats. If the fleet is to grow in size, new boats must be built; or even if the fleet is to maintain its present size, boats must be replaced as they wear out. Thus, for these considerations, it is relevant to present depreciation charges on a replacement-cost basis. The most conservative estimate was employed in calculating such a depreciation charge; namely, 5 percent of estimated replacement cost for each boat. Since the replacement-cost estimates are presented in appendix 11, the reader can, if he chooses, experiment with other rates.

Other Owner Expense

The fourth item requiring discussion is the "Other Owner Expense" shown in line 4. This item includes certain costs that are borne by the owner but that do not appear in the income tax figures. The boat owner's income includes in most cases the following elements: (a) income accruing to him because he supplies capital (the boat and other equipment) to the fishing operation, (b) income that he receives for supplying managerial services to the fishing enterprise, (c) a manshare and captain's bonus if he serves aboard the boat, and (d) income for work that he does himself in repairing and maintaining the boat. To isolate the return to capital (or the boat), we must subtract items (b), (c), and (d) from the owner's total income derived from fishing operations. The data in item (c) are readily accessible from income tax returns. The data in item (d) can be estimated roughly from information regarding time spent repairing and maintaining boats by owners, which was collected from the owners of the 50 boats included in the sample. Finally, an estimate of the value of managerial services supplied by the owners should be made. With items (a) through (d) estimated, it is possible to arrive at a figure that gives, except for several additional considerations, the income accruing to capital from fishing operations. It is this figure that is important in assessing trends in the size of the fleet. If capital's return in fishing is low relative to its return elsewhere in the economy, the fleet will contract. If it is high, capital will be attracted into the fisheries, and the fleet will expand.

It should be recognized that the following items of crew cost are charged against fishing operations: one-half of the Social Security payment, some costs associated with "wages—maintenance—and—cure," and costs of damages that crew members receive from negligence of owners. (It appears that fishermen receive maintenance and cure but not wages under present arrangements. "Cure" refers to the medical aspect of the fringe benefits provided fishermen by owners.) Insofar as owners supply labor to the fishing operations of a boat, it appears reasonable and logically consistent to charge one-half the owner-operator's Social Security payment, an equivalent owner-operator's "wages—maintenance—and—cure" expense, and an owner-operator's expense item for personal damages resulting from crew negligence against fishing operations. Where certain of these items are not included because of difficulty of estimation, the net figures for boat income, which will be presented later, must be recognized as overstating slightly the net income accruing to capital.

Since boats do not operate solely in the halibut and black cod fisheries, it is important to have a general view of the profitability of operations in each year. This need for a comprehensive view explains why results relating to all operations of the boats are presented. If boat net income for all operations is low relative to the value (on a replacement-cost basis) of capital invested in the boat and other fishing equipment, capital will not be invested in new boats, and boats that wear out will not be replaced.

Similarly, with regard to the survey of fishermen, it is important to determine total income from all sources as well as income from halibut and black cod fishing, which fishing, for most fishermen, supplies only part of their income. A summary figure, average income from all sources, can be viewed as an indication of the material well-being of fishermen. Comparisons of average fishermen's income from all sources and averages for other groups in the economy will then indicate roughly whether current levels of income for fishermen are high enough to hold labor in the fishery and to attract new labor.

SUMMARY

A major part of the study was devoted to surveys of the economic status of vessel owners and fishermen. The technical aspects of the surveys are presented in this chapter to enable the reader to assess for himself the significance of the findings.

The survey of vessel owners covered operations of 50 Seattle fishing boats in the halibut and black cod fisheries during 1953–57. This period is long enough to provide a reasonably accurate picture of costs and earnings and short enough to rule out significant changes in operating conditions. The basic data were drawn from Federal income tax returns, supplemented by other direct sources as required. The 50 boats are believed to be representative of the Seattle fleet as a whole.

Separate calculations were made to show earnings from total operations, from halibut fishing only, and from black cod fishing only. The income tax data were adjusted to reflect different methods of calculating depreciation and to include certain additional items of expense properly chargeable to operations of the vessel. All expenses not directly chargeable to individual trips were allocated to the various activities in proportion to the time spent in each. For purposes of evaluation, estimates of market and replacement values were obtained for each vessel in the sample.

The survey of fishermen was based on a random sample of the active members of the Deep Sea Fishermen's Union, classified into four age groups. The survey covered 1955–57. The questionnaire was designed to provide information on age, income, sources of income, and other items from existing records, such as W–2 forms and unemployment-compensation records. A response rate of 47.3 percent was achieved with no evidence of bias from nonresponse.

In computing overall averages from data gathered in both surveys, we employed population weights to provide an accurate representation of the fleet by size of vessel and of the fishermen by age group.

The surveys were designed to provide a cross-check of the average manshares derived from the boat data against reported incomes of fishermen. The latter were also checked against unemployment-insurance data. Both checks indicate that the results of the survey are reliable.

LITERATURE CITED

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1957. The incomes of salmon fishermen in British Columbia, 1953–54. Department of Fisheries of Canada, Ottawa, 110 p.

Part 3

CONCLUSIONS FROM ANALYSIS AND IMPLICATIONS FOR PUBLIC POLICY

The following chapters 9 and 10, in a summary of economic performance, draw together the findings of part 2 of this report. Actual results of industry operations under existing regulatory measures are evaluated in terms of the criteria set forth in part 1. Chapter 11, the final chapter of the report, indicates the significance of these conclusions for public policy and suggests specific changes to realize more fully the economic gains made possible by the successful rebuilding of the halibut stocks.

Chapter 9

ECONOMIC STATUS OF THE HALIBUT FISHERY

In this chapter, we present the results of surveys of boat incomes during 1953–57 and of fishermen's earnings during 1957–59 and then present the conclusions derived from these surveys.

BOAT INCOMES, 1953–57

Boat Income Before Deductions

The empirical results relating to boat income, before deduction of depreciation charge and "other special owner expense," are presented below. (This boat-income figure is the total boat share less the sum of master's share, unemployment insurance payments, social security expense, insurance, repairs and maintenance expense, and supply and sundry expense.) These results are not indicative of the return to capital, since the depreciation charge and "other special owner expense" should be charged against fishing operations. They are given to provide the reader with figures, unaffected by the estimates of depreciation and of other special owner expense, which may be compared with figures on replacement cost of boats and with net boat income after depreciation. In table 20, the average boat income from all fishing operations before depreciation and other owner expenses are deducted is presented for the years 1953–57 by net tonnage classes.

It is seen that average boat income before depreciation and other owner expense ranged from a low of $2,550 in 1955 to a high of $4,313 in 1956. Even before depreciation and other owner expense, these figures represent a very small percentage of the current replacement costs shown by the figures in table 21. It is significant that this fact is established using the boat income figures before deduction of depreciation charge and other owner expense; the result cannot be questioned on the grounds that the method of calculating the depreciation charge is incorrect. Although 1954 and 1956 were relatively good years, boat income before

TABLE 20.—*Average boat income from all fishing operations before deduction of depreciation and "other special owner expense" by net tonnage, 1953–57*

Year	Income for net tonnage of: 19 and under	20–29	30–39	40 and over	Average income
1953	$1,625	$3,524	$3,300	$1,810	$2,712
1954	3,125	3,842	4,700	3,427	3,765
1955	2,000	2,782	3,100	2,194	2,550
1956	2,625	4,346	5,600	4,897	4,313
1957	1,065	4,002	5,200	4,233	3,622

Source: Tables in appendix 13.

TABLE 21.—*Estimated replacement cost of sample boats according to net tonnage, early 1958*

Estimated replacement cost	Number of boats of net tonnage: 19 and under	20–29	30–39	40 and over
Dollars				
50,000– 59,999	3	0	0	0
60,000– 69,999	1	1	0	0
70,000– 79,999	2	4	0	0
80,000– 89,999	2	8	5	1
90,000– 99,999	0	4	4	4
100,000–109,999	0	2	1	5
110,000–119,999	0	0	0	1
120,000–129,999	0	0	0	2
Total	8	19	10	13
Average replacement cost	$68,750	$86,053	$91,000	$104,231

Grand average replacement cost=$86,768

Source: Estimates provided by two of Seattle's largest builders of fishing boats.

depreciation and other owner expense was low compared with the 1958 estimates of replacement cost shown in table 21.

Tables 22 through 24 provide estimates of boat income (before deduction of depreciation and other owner expense) derived from halibut and black cod operations combined and from halibut and black cod operations separately, for the years 1953–57.

TABLE 22.—*Average boat income from halibut and black cod trips before deduction and "other special owner expense" by net tonnage, 1953–57*

Year	Boat income for boats of net tonnage:				
	19 and under	20-29	30-39	40 and over	Average
1953	$1,750	$2,888	$2,900	$2,118	$2,481
1954	3,125	3,260	4,200	4,235	3,607
1955	1,750	2,518	3,600	2,118	2,475
1956	2,500	4,111	5,300	4,233	4,004
1957	1,349	2,942	5,500	3,486	3,189

Source: Tables in appendix 14.

TABLE 23.—*Average boat income from halibut trips before deduction of depreciation and "other special owner expense" by net tonnage, 1953–57*

Year	Boat income for a net tonnage of:				
	19 and under	20-29	30-39	40 and over	Average
1953	$1,625	$2,782	$2,800	$2,040	$2,378
1954	2,750	3,100	4,300	3,580	3,350
1955	1,500	2,358	3,700	2,272	2,408
1956	2,125	3,778	5,300	4,399	3,826
1957	1,211	2,306	3,700	3,542	2,418

Source: Tables in appendix 15.

TABLE 24.—*Average boat income from black cod trips before deduction of depreciation and "other special owner expense" by net tonnage, 1953–57*

Year	Boat income for a net tonnage of:				
	19 and under	20-29	30-39	40 and over	Average
1953	−$50	$528	$000	$500	$290
1954	550	361	−500	250	214
1955	625	450	−500	−917	316
1956	625	375	750	−83	412
1957	312	1,000	−250	250	453

Source: Tables in appendix 16.

TABLE 25.—*Percentage of boats not engaged in black cod operations, 1953–57*

Year	Relative number of boats by tonnage class of:			
	19 and under	20-29	30-39	40 and over
	Percent	*Percent*	*Percent*	*Percent*
1953	37.5	52.6	60.0	84.6
1954	37.5	52.6	80.0	69.2
1955	50.0	52.9	80.0	69.2
1956	50.0	57.9	80.0	75.0
1957	28.6	47.4	70.0	91.7

Source: Tables in appendix 16.

The figures reveal clearly that the black cod operation yields little in the way of income to the boats (and also, as will be seen, to fishermen). This situation is reflected in the fact that many boats do not operate in this fishery, as is shown by the data in table 25.

Why, then, do so many boats continue to operate in the black cod fishery? (The tables in appendix 16 show that many boats had negative income even before deduction of depreciation and other owner expense.) The answer seems to be that even though many owners do not cover total costs (see "boat income after depreciation"), this operation covers at least part of fixed costs, which have already been committed and will be charged whether the boats fish or not.

Boat Income After Deduction of Depreciation

We now turn to the figures for boat income after depreciation reported for income tax purposes. (As stated above, the depreciation charge reported for income tax purposes is generally computed employing the straight line method with a 20-year life for the hull and a 10-year life for engines.) These figures are presented in tables 26 through 29, which relate to all fishing operations, to halibut and black cod operations combined, and to halibut and black cod operations separately.

Comparison of these figures on boat income after reported depreciation with the replacement cost estimates presented in table 23 yields a bleak picture of the economic position of the halibut fleet. (Since the figures on boat income after depreciation based on 1957 market value reveal about the same general facts as do the figures in tables 28 to 31, they will not be pre-

TABLE 26.—*Average boat income from all fishing operations after deduction of depreciation charge reported for Federal income tax purposes,*[1] *1953–57*

Year	Boat income for boats of net tonnage of:				Average
	19 and under	20–29	30–39	40 and over	
1953	$750	$2,200	$1,400	$1,040	$1,487
1954	2,000	2,570	2,900	2,502	2,492
1955	1,000	1,192	1,600	1,424	1,050
1956	1,625	2,888	4,200	4,316	3,145
1957	781	2,782	4,000	3,735	2,760

[1] "Other owner expense" has not been deducted.
Source: Detailed tables in appendix 17.

TABLE 27.—*Average boat income from halibut and black cod trips after deduction of depreciation charge reported for Federal income tax purposes,*[1] *1953–57*

Year	Boat income for boats of net tonnage of:				Average
	19 and under	20–29	30–39	40 and over	
1953	$1,750	$2,412	$1,700	$1,810	$2,005
1954	2,875	5,380	3,000	2,888	3,858
1955	1,375	1,670	2,200	1,578	1,688
1956	1,875	2,915	4,250	4,000	3,157
1957	1,065	2,041	2,700	3,237	2,189

[1] "Other owner expense" has not been deducted.
Source: Detailed tables in appendix 19.

sented in the text but are presented in appendices 18, 20, 22, and 24.) Table 26, for example, indicates that average boat income from all fishing operations after deduction of depreciation was $3,145 in 1956 and $2,760 in 1957. Compare these figures with the average replacement cost of boats—about $87,000—and it can be seen why the fleet is declining. A person with $87,000 can find investments yielding from 3½ to 6 percent that are much safer than investment in a fishing boat—an investment that, according to the figures presented above, would probably yield not more than 3 percent.

Further, it is necessary to take into account the item "other owner expense" in order to arrive at the true net boat income. From information gathered from the owners of the 50 boats in the sample, the usual time spent by owners repairing and maintaining boats is 2 months each year. This is a labor input that should be charged against the fishing operation for the same reasons that an owner-operator's contribution to a fishing trip is rewarded by a manshare. The charge for such work, if it were performed in a shipyard, could easily exceed $1,000. If a charge of this magnitude were levied against the boat, the net boat income figures would be reduced substantially. In addition, each owner contributes managerial services to the fishing enterprise, a business cost not included in computing boat net income in tables 26 through 29.

Finally, if it is deemed appropriate to charge the fishing operation with one-half of the owner's Social Security payment and his expenses incurred because of crew negligence, the figures for the boat net income will be still lower.

Manshares from Boat Survey Data

Not only do owners fare poorly with regard to net boat income, but also fishermen do not obtain an adequate wage from the fishing operations. Under the share system, both boat income and crew income are dependent on total

TABLE 28.—*Average boat income from halibut trips after deduction of depreciation charge reported for Federal income tax purposes,*[1] *1953–57*

Year	Boat income for boats of net tonnage of:				Average
	19 and under	20–29	30–39	40 and over	
1953	$1,750	$2,358	$2,000	$1,732	$2,027
1954	2,500	2,464	3,100	2,888	2,680
1955	1,125	1,643	2,400	1,886	1,531
1956	2,000	2,915	4,300	4,067	3,209
1957	1,065	1,616	2,950	3,237	2,075

[1] "Other owner expense" has not been deducted.
Source: Detailed tables in appendix 21.

TABLE 29.—*Average boat income from black cod operations after deduction of depreciation charge reported for Federal income tax purposes,*[1] *1953–57*

Year	Boat income for boats of net tonnage of:				Average
	19 and under	20–29	30–39	40 and over	
1953	−$250	$28	−$750	−$875	−$388
1954	550	−139	−1,250	−350	−189
1955	688	000	−750	−1,250	−241
1956	500	188	000	−250	134
1957	50	800	−250	−250	218

[1] "Other owner expense" has not been deducted.
Source: Detailed tables in appendix 23.

output of the boat and the price of fish. With such an arrangement, it would be odd to find boat income low and crew income high.

The boat survey also provides data on manshares. In interpreting these data, one must remember that the figures given refer to what a fisherman would earn if he were aboard a boat for all fishing operations of that boat. Since not all fishermen remain aboard for all trips, the figures for manshares overstate what fishermen actually get from fishing. (Actual returns to fishermen are discussed in the following chapter.) It is of interest, however, to determine the maximum amounts that fishermen could have earned from fishing during 1953–57 on vessels included in the sample. These amounts are presented in table 30.

The reliability of these estimates may be established by comparing averages computed from the boat survey with averages computed from the survey of fishermen, shown in table 31. It will be noted, as is to be expected, that in each year the average boat manshare for all fishing is slightly higher than the average income received by fishermen from all fishing.

TABLE 30.—*Average boat manshare from all fishing operations on boats of the Seattle fleet by net tonnage, 1953–57*

Year	Boat manshares on boats of a net tonnage of:				Average
	19 and under	20–29	30–39	40 and over	
1953	$3,125	$3,511	$3,800	$2,791	$3,336
1954	4,250	4,624	4,550	3,792	4,359
1955	3,125	3,538	3,950	3,292	3,476
1956	3,688	5,366	5,500	5,217	4,986
1957	2,179	3,511	4,650	4,083	3,548

Source: Detailed tables in appendix 25. In appendices 26 and 27 similar detailed figures are provided for halibut and black cod operations combined and separately. See also appendices 29 and 30 where the details of the gross stock are presented.

TABLE 31.—*Comparison of average manshare and fishermen's incomes, 1955–57*

Year	Average boat manshare [1]	Average income of fishermen from all fishing [2]
1955	$3,476	$3,214
1956	4,986	4,600
1957	3,548	3,520

[1] Figures taken from table 30.
[2] Figures taken from table 38.

TABLE 32.—*Average total reported income [1] of union members by age group, 1955–57*

Year	Income for age groups of:				Average
	I (34 and under)	II (35–49)	III (50–59)	IV (60 and over)	
1955	$4,056	$5,155	$4,175	$3,056	$4,213
1956	5,611	7,086	5,750	3,917	5,728
1957	5,667	5,845	4,075	2,583	4,524
Averages:					
1955–56	4,334	6,120	4,962	3,486	4,970
1956–57	5,639	6,466	4,912	3,250	5,126

[1] Income as reported for Federal income tax purposes.
Source: Based on detailed data shown in appendix 31.

TABLE 33.—*United States personal income per family, 1955–57*

Year	Average family personal income before Federal tax
1955	$5,600
1956	5,910
1957	6,130

Source: U.S. Department of Commerce (1958).

FISHERMEN'S EARNINGS, 1955–57

The survey of fishermen's earnings was designed to throw light on the current income of halibut-black cod fishermen, on the importance of various sources of income in the total income of fishermen, and on other aspects of the material well-being of fishermen.

In table 36, fishermen's average income from all sources—fishing, employments other than fishing, unemployment benefits, and Social Security income—is presented for the years 1955–57 and for four age groups. The average income from all sources was $4,436 in 1955, $6,125 in 1956, and $4,896 in 1957. It is clear that although 1956 was a good year, both 1955 and 1957 were poor years, from the point of view of halibut fishermen. Further, the figures in table 32 reveal a marked and stable relation of income to age. Note that in every year, age group II (35 to 49) has the highest average income, whereas age group IV (60 and over) has the lowest. In general, average income rises from age group I to II and then falls from II to IV.

Comparison of Fishermen's Income with that of Others

In view of the year-to-year variability of fishermen's total income and a heavy concentration of fishermen in the upper age brackets (for example, 25 percent of the active union members were 60 years of age and over—comparisons between the average fishermen's income from all sources, presented above, and the average income for other groups in the American economy must be made with caution. If such a comparison is to be made, it is best to average 1955, 1956, and 1957 and to show figures for each age group separately, as in table 32. It is of interest to compare these figures with those given by the U.S. Department of Commerce showing average family personal income before Federal individual income tax liability—figures that include incomes of doctors, lawyers, and other professionals as well as less highly trained individuals. In 1955–56 and 1956–57, the average income for fishermen was $800 lower than for the average U.S. family. In part this difference reflects the proportionately larger number of oldsters in the population of fishermen, men whose incomes are lower than are those of younger fishermen. In addition, the figure for U.S. average family income includes families with more than one income earner. If all income accruing to the families of fishermen were taken into account—that is, if the income of working wives, for example, were added to the income earned by fishermen—the differential obviously would be smaller.

Lastly, part of a fisherman's income is in the form of food and lodging that he receives while serving aboard the boat. Although evaluation of this item of income is difficult, it probably accounts for a fairly significant part of the $800 differential mentioned above. On the other hand, the danger and the periods of very intensive work involved in fishing, the inconvenience and the other disadvantages of having to spend much time away from family, and the difficult living conditions aboard fishing boats, insofar as these are important to fishermen and others contemplating becoming fishermen, represent factors not taken into account in computing income. On balance, these latter factors would require a

TABLE 34.—*Average total fisherman's reported income per dependent by age of fisherman, 1955–57*

Year	Average total income per dependent[1] for fishermen in age group: I (34 and under)	II (35-49)	III (50-59)	IV (60 and over)	Average
1955	$1,587	$1,323	$1,725	$1,413	$1,491
1956	2,196	1,872	2,290	1,890	2,035
1957	2,261	1,535	1,735	1,308	1,633
Average 1955–56	1,892	1,598	2,008	1,652	1,763
Average 1956–57	2,228	1,704	2,012	1,599	1,834

[1] The fisherman is included as one dependent.
Source: Based on detailed data in appendices 31 and 32.

higher money income to attract new men to the labor force, but how much higher is difficult to say. As will be shown, most fishermen surveyed received income from a variety of sources, not only fishing. This fact of additional income means that the considerations of danger and so on relate to just a part of total income.

A second significant comparison involves fishermen's income from all sources per dependent claimed for income tax purposes and personal income per capita in the State of Washington, neighboring States, and British Columbia. In appendix 32, a table is presented showing the number of fishermen's dependents by age groups. Total fishermen's income in each age class, calculated from the information contained in appendix 31, was divided by the number of dependents in each age group to obtain the following results. The averages for 1955 and 1956, and 1956 and 1957—$1,763 and $1,834, respectively—may be compared with figures on per capita personal income (table 35) published by the U.S. Department of Commerce and the Canadian Department of Trade and Commerce.

Per capita personal income in Washington for 1955–56 averages about $2,000. This amount compares with a 1955–56 average for fishermen of $1,763 and a 1956–57 average of $1,834. Again it must be noted that the computation for fishermen is an understatement, since income of dependents other than the fisherman himself is not taken into account. The average fisherman's income per dependent is also lower than per capita income in the State of Washington, in part because of the fact that the former is more heavily weighted by the incomes of fishermen

60 years of age and over, whose total income per dependent is somewhat lower than that of younger fishermen. In addition, the other factors mentioned in connection with the earlier comparison of fishermen's income and average U.S. family income must be taken into account.

Table 35 also shows per capita personal income in other western States and British Columbia, from which labor might be attracted into the halibut fishery. For Oregon, Idaho, Montana, and British Columbia, per capita income is close to or below the 1955 and 1956 average fisherman's income per dependent; California's per capita personal income, however, is somewhat higher.

In summary, the above comparisons indicate (a) that the average income from all sources for fishermen (averaged over a "poor" year and a "good" year) in the Deep Sea Fishermen's Union is probably not above (when corrected for age and income concept) average U.S. family personal income before Federal income tax, (b) that average income per dependent for fishermen, averaged over a "poor" year and a "good" year and corrected for age and income concept, is probably not above per capita personal income in the State of Washington, and (c) that fishermen's income is very much more variable from year to year than are average U.S. family income and Washington State personal income per capita.

TABLE 35.—*Per capita personal income, 1954–57*

Year	Per capita personal income for:					
	Washington	Oregon	Idaho	Montana	California	British Columbia
1954	$1,961	$1,764	$1,484	$1,733	$2,186	$1,476
1955	1,990	1,858	1,506	1,844	2,330	1,534
1956	2,047	1,934	1,616	1,871	2,461	1,618
1957	2,128	1,914	1,630	1,896	2,523	

Sources: U.S. Department of Commerce (1958) and Dominion Bureau of Statistics (1958).

The importance of the variability of fishermen's incomes depends, of course, on the psychology of those who wish to and do become fishermen. If the gambling spirit and optimism of fishermen lead them to prefer a variable income over a stabler income equal to that elsewhere in the economy, this preference may be all that is required to keep labor in the fishery. If, however, variability of income is regarded as being disadvantageous, it is necessary to have fishermen's incomes average higher than those for alternative employments that provide more stable year-to-year incomes if the labor force in the fishery is to be maintained. In short, under the share system of compensation, both owners and fishermen carry the uncertainty associated with the fishing venture. On balance, it is likely that some payment for this function must be made to induce individuals to assume the burden of such uncertainty. If the payment is not forthcoming, there will be a steady drain on the supply of labor available to the fishery.

Further, not all of a halibut fisherman's income is derived from halibut and black cod fishing. The figures in table 36 show that in the main, halibut-black cod fishermen are part-time fishermen. In 1955, average income from halibut and black cod fishing was 50.7 percent of average total income; in 1956 and 1957, the corresponding percentages were 61.3 and 56.3, respectively. Probably the most important factors accounting for the part-time status of the halibut fishermen are the shortness of the halibut fishing season, the low average manshares derived from black cod fishing, and the attempts by individual fishermen to reduce income variability from year to year by securing income from more stable sources to supplement their highly variable income from fishing. Table 36 indicates that average income from employments other than fishing shows much less variability than does income from halibut and black cod fishing.

TABLE 36.—*Fishermen's average income from various sources, 1955–57*

Year	Average total income[1]	Average income from halibut and black cod fishing	Average income from other fishing	Average income from employment other than fishing	Average Unemployment Insurance benefits received
1955	$4,436	$2,251	$740	$1,168	$233
1956	6,125	3,756	629	1,405	262
1957	4,896	2,758	663	1,122	278

[1] Includes Social Security benefits. The importance of these benefits to older fishermen will be discussed below.

Source: Based on data in detailed tables in appendices 33–38.

Subpopulations

The figures above, relating to fishermen's income, refer to the total population of fishermen in the Deep Sea Fishermen's Union. It is also of interest to consider results relating to subpopulations of the total population. For example, in addition to considering the average receipts from Unemployment Insurance for all fishermen, it is equally important to calculate the average receipts for those who actually drew Unemployment Insurance benefits. Similarly, it is of interest to calculate (1) average income from employments other than fishing for just those who had such income and (2) average income from fishing other than halibut and black cod for just those who had this kind of income. Clearly, in the last case, since only a few members of the union do not derive some income from halibut and black cod fishing, the average income from this source for all union members will be closely similar to the average for those who derive income from this source. The same cannot be said of Unemployment Insurance benefits. A number of fishermen each year do not draw such benefits, and the average fisherman's compensation computed for all fishermen reflects this fact. Thus, the average Unemployment Insurance income received by those who draw such income will be higher than a similar average for all fishermen.

The survey of fishermen shows that 50.2, 63.4, and 67.4 percent of the union membership drew Unemployment Compensation for 1955, 1956, and 1957, respectively. For the benefit years 1954 to 1955, 1955–56, and 1956–57, the State of Washington Employment Security Department reports 65.6, 58.2, and 59.4 percent of all eligible fishermen drew Unemployment Compensation. (Nineteenth and Twentieth *Annual Reports*, State of Washington, Employment Security Department, July 1955 to June 1956, July 1956 to June 1957.)

The proportion of fishermen receiving zero income from particular sources is indicated in table 37. About two-thirds to three-fourths of the union members receive no income from "other fishing." It is also apparent that a substantial number of the members receive zero income from employments other than fishing and from Unemployment Insurance benefits.

As might be expected, the proportion receiving zero income from employment other than fishing rises with age. This is probably an indication that it is difficult for older fishermen to find alternative employments or that, since the older fishermen have fewer dependents and since some are in poor health, many choose not to take employment outside the halibut and black cod fishing season. Many of the older fishermen supplement their income in the out-of-fishing season period by drawing Unemployment Insurance benefits and Social Security income. In the 60 and over age group, the percentage drawing Unemployment Insurance benefits is very high 77.8, 83.3, and 72.2 percent for 1955, 1956, and 1957, respectively, (see appendix 39). Among younger fishermen, the corresponding percentages are not nearly so high, evidence that is consistent with the inference, mentioned above, that younger fishermen have alternative employment opportunities and a greater need or desire to take alternative employment.

TABLE 37.—*Percentage of Deep Sea Fishermen's Union members receiving zero income from various sources, 1955–57*

Year	Relative number of members who receive no income from:				
	Halibut and black cod fishing	Other fishing	All fishing	Employments other than fishing	Unemployment Insurance benefits
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
1955	13.7	65.7	7.4	46.1	49.8
1956	11.2	75.8	6.0	39.6	36.6
1957	5.5	68.9	3.4	39.4	32.6

Note: Percentages for each group have been weighted by population stratum weights to obtain the overall average percentages.
Source: Based on information contained in appendices 33–39.

The proportion receiving zero income from fishing other than for halibut and black cod is very high for those in the 34-and-under and also for those in the 60-and-over age groups. For the former group, this is probably an indication of their ability to find more lucrative employments outside the fisheries, whereas for the latter group, the factors mentioned in the previous paragraphs are undoubtedly important in this instance as well.

Income from Particular Sources

We now turn to the figures showing average income derived from particular sources. From the tables in appendices 34–39, summary table 38 has been constructed.

To complete the description of the income of fishermen, we will consider one additional item —Social Security income of the older fishermen (which was included in the concept of total income employed above). Information on income from Social Security is shown in table 39. It is seen in appendix 40 that a large fraction of those over 65 do not get such income. The average income from this source amounted to $758 in 1957, an average that includes all union members over 65 whether they got such income or not. For those in the 65-and-over age group who received such income, the average amount received was $1,000 in 1955, $833 in 1956, and $933 in 1957. These latter figures represent about a third to a fourth of average total income for this age group.

TABLE 39.—*Average Social Security income of fishermen 65 years of age and over, 1955–57*

Year	Average of such income for all in the age group	Average for those receiving such income
1955	$261	$1,000
1956	526	833
1957	758	933

Source: Data in appendix 40.

CONCLUSIONS

As in any statistical study, the conclusions to be drawn from the survey are limited by the reliability of data, the time period covered, and the adequacy of the samples used. As indicated in chapter 6, the data obtained in the present study were drawn from sources that provide a reasonably high level of accuracy and comparability. Cross-checks between the two surveys suggest that the primary data are reasonably accurate and that bias from nonresponse in the fishermen's survey is not of major importance. It would have been useful if the surveys could have covered a longer period. Even if the additional cost and time required are ignored, however, the accuracy and comparability of the figures would have diminished rapidly if we had attempted to carry them back to earlier years. In view of the mobility of men and boats, it is believed that incomes for the segments sampled are reasonably representative of the industry as a whole.

TABLE 38.—*Average incomes from various sources for union members having at least some income from the indicated sources*

Year	Halibut and black cod fishing	Other fishing	All fishing	Employments other than fishing	Unemployment Insurance benefits
1955	$2,587	$2,047	$3,214	$2,108	$397
1956	4,224	2,543	4,600	2,164	381
1957	2,905	1,955	3,520	1,708	404

Source: See appendices 34–39.

Note: We would not expect the average for all fishing to equal the sum of the averages for halibut and black cod fishing and other fishing since the all-fishing average includes those union members who have fished either or both of the two categories. For example:

Member	Halibut and black cod fishing	Other fishing	All fishing
Member A	$1,000	$1,000	$2,000
Member B	1,000		1,000
Average	1,000	500	1,500

Adequacy of Fishermen's Incomes

Unfortunately, it is not possible to compare fishermen's incomes directly with those of workers in other industries. Published data on earnings by industry group cannot be broken down to indicate variations by age groups, and the relatively high percentage of older men in the halibut fleet would require this information for comparability. In addition, the share method of compensation and the resulting variability of incomes in the fisheries make comparisons difficult. One can only guess at the positive effect of the hope for the "big year" and the negative effect of uncertainty about year-to-year earnings.

Nevertheless, the conclusion appears warranted that fishermen's total incomes have been at or slightly below levels that would just maintain the size and composition of the labor force. There has been no shortage of personnel to man the fleet, but the persistent increase in proportion of older men suggests that the younger fishermen, forced into part-time employment outside the fisheries, have tended to drift into other occupations.

The incentive for this shift may lie in the desire for an easier life, a stabler income, greater security in later years, or more rapid economic advancement than the fishermen's life can offer. This hypothesis, however, is only a partial answer. Presumably there must be some average level of earnings that would attract and hold young recruits, however hard the work or uncertain the pay. Another possible explanation is that the usual road up is from share-fisherman to master to boat owner; and the discouraging picture with respect to boat profits has made this road much less attractive in recent years. Moreover, postwar opportunities in the Northwest have provided a continuous outlet for younger fishermen at wages that could not be matched from the gross returns to the individual halibut vessel.

This tendency toward an older labor force does not necessarily represent a loss to the economy as a whole. It might be argued that if older men can be employed in the fishery at higher incomes than they could earn elsewhere, the shift in age-distribution of the labor force will result in greater production for the entire economy. On the other hand, there must be a limit beyond which continued loss of younger men will result in increasingly serious problems for the fleet as the efficiency of operations begins to decline. To some extent, the family relationship in the predominantly Scandinavian halibut fleet will continue to attract young recruits to fishing, but the effect of this relationship is bound to weaken over time. (Of the group covered in our sample, 10.6 percent of the total and 17 percent of those under 50 years of age were not U.S. citizens.)

Unemployment Compensation and Social Security

It is also somewhat disturbing to find that more than half of the fishermen in the sample received Unemployment Compensation in each of the 3 years (50.2 percent in 1955; 63.4 percent in 1956; and 67.4 percent in 1957). Although the proportion of fishermen who drew benefits increased with age, as would be expected, significant numbers of the younger men also received Unemployment Compensation each year. As indicated in appendix 33, the proportion of total income represented by Unemployment Compensation is not negligible. For the entire group, these payments accounted for about 5 percent of total income; excluding those who drew no Unemployment Compensation, the proportion ranged from 6 to 9 percent. Fishermen in the 50-to-59-year group derived 6 to 9 percent of their income from this source (8 to 11 percent if those who drew none are excluded). The corresponding figures for the group over 60 years of age were 13 to 17 and 15 to 24 percent. For those who received income from this source, the benefits were drawn for an average of about 12 weeks in each of the years 1955–57. The conclusion seems inescapable that only a fairly substantial addition to earnings from Unemployment Compensation and Social Security enables the fleet to maintain its labor force. This conclusion is not an argument against Unemployment Insurance; it is, however, disconcerting in a period that included at least 1 year of very good halibut prices and in which the economies of the United States and Canada were operating under near-boom conditions. If the proportion of younger men in the fleet continues to decline, dependence on Unemployment Compensation and Social Security payments will become even greater.

The survey also reveals that most fishermen in the younger age groups derive a substantial part of their income from other fisheries and from outside occupations. To some extent, the reliance on Unemployment Compensation reflects the inability to "mesh" the shifts from one fishing operation to another and from fishing to other types of work. In view of seasonal variations in the availability of various fish and in weather conditions on the grounds, some degree of intrayear mobility of fishermen is necessary and, from the standpoint of the entire economy, desirable. These shifts can never be made, however, without some loss of working time and income. To the extent that the halibut season has been shortened beyond the requirements of weather and availability of fish, some economic costs are imposed on fishermen and the rest of the economy.

Status of the Halibut Fleet

Vessel earnings during the period covered by the survey reveal that capital, also a part-time participant in the halibut fishery, has fared poorly. Boat incomes, expressed as a percentage of replacement costs, are well below levels that would attract new capital, particularly in view

TABLE 40.—*Average boat income from all fishing operations as percentage of replacement cost, 1953–57*

Basis	Boat income relative to replacement cost for boats of net tonnage of:				Average
	19 and under	20–29	30–39	40 and over	
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
Before depreciation...	3.0	4.3	4.8	3.4	3.9
After reported depreciation.	1.8	2.7	3.1	2.5	2.5

Source: Calculated from tables 18, 19, and 24.

of the physical and market risks inherent in fishing (table 40).

In light of these figures (table 40) it is not surprising that the general status of the U.S. halibut fleet has been deteriorating since 1951. There has been a net reduction in the number of regular halibut vessels in every year except 1957 (which followed the relatively successful 1956 season). The average age of the 50 vessels surveyed was 29½ years. Only in British Columbia has there been any addition or replacement by new vessels in the past decade. Virtually all new entrants to the halibut operation have come from other fisheries. In terms of available technology, the American halibut fleet must be regarded as overage and poorly equipped from the standpoint of crew comfort.

This situation cannot be attributed entirely to the conservation program. Along with other important segments of the American fishing industry, the halibut operation has felt the impact of the tremendous postwar increase in domestic production and imports of frozen fillets. The initial surge of prices after World War II attracted a large number of vessels into the Pacific coast fisheries, including the halibut operation. Finally, the prices of most goods and services comprising the principal operating expenses of halibut vessels have risen substantially since 1950, in step with the generally inflationary trend of the period (table 41).

Pinched between rising costs and higher wage rates in other occupations, on the one hand, and slightly lower product prices, on the other, the halibut fleet has inevitably run into financial difficulties. Although some boats have drifted out of the longline operation, the vessels still remaining are dividing the catch into segments smaller than will yield a satisfactory return.

Why has the "squeezing out" process failed to restore a normal return to capital? The answer lies partly in the nature of the investment in fishing vessels. A rapid increase in prices and profits, as in the early postwar years, quickly attracts new vessels. Once built, however, they cannot be driven out again if the new capacity proves to be too great. With reasonable maintenance, a fishing vessel is remarkably long lived; and as long as prices cover out-of-pocket costs and a wage to the owner, losses will be minimized by keeping the vessel in operation. Thus, from the standpoint of the fishing industry as a whole, excess capacity, once generated, tends to become chronic.

In addition, the boat income survey shows that earnings from other fisheries to which halibut boats could be diverted have been discouragingly low. Black cod, which can be taken with the same gear, yield barely enough to cover running costs and wages attractive only to older fishermen. The salmon fishery cannot be regarded as expansible and is already badly overcrowded. The otter trawl fishery, also overexpanded and facing stiff import competition as well, offers no great attraction, particularly since it requires expensive additional gear. As a source of added income for vessels fishing a short halibut season, other Pacific coast fisheries appear anything but promising. Total landings of all species in California, Oregon, Washington, and Alaska have actually fallen since 1933, although the number of fishermen has increased by 27 percent (table 42). There has been some decline in the number of small boats, but this decline was more than offset by an increase in the number of large vessels.

TABLE 41.—*Index of major costs, Pacific coast fishermen, 1950–55*

Item	Index for:					
	1950	1951	1952	1953	1954	1955
Rope (#1 Manila ¾ in.)......	217.3	255.7	228.7	228.3	212.0	210.9
Fuel oil (Diesel, Seattle).....	200.0	243.2	234.7	244.5	246.1	250.1
Lubricating oil..............	120.0	120.0	120.0	120.0	120.0	120.0
Ice (Seattle)................	134.0	140.7	160.9	164.1	173.5	174.3
Diesel marine engines:						
150 h.p..................	162.0	181.7	186.4	193.0	197.0	197.0
400 h.p..................	163.6	163.6	175.0	175.0	175.0	180.1
Hourly earnings, ship and boat building.	141.5	150.2	161.4	174.2	178.5	182.0
Deck paint..................	144.9	155.9	157.6	159.4	162.2	163.1

Source: Alexander (1957).

TABLE 42.—*Catch, fishermen, boats and vessels, Pacific Coast States and Alaska*

Year	Total catch	Fishermen	Boats	Vessels
	Thousand pounds	*Number*	*Number*	*Number*
1933	1,490,935	27,329	10,729	1,436
1957	1,192,300	34,550	9,060	5,312
Percentage change	−21	+27	−16	+256

Sources: Fiedler (1935) and Power (1959).

Without regulation, the halibut fishery would doubtless have been far worse off. The same picture of depressed earnings for the individual vessel would have been coupled with a much smaller level of landings and greater total effort. This conclusion, however, does not answer a broader question. Is the measure of success of the halibut program its ability to support more vessels at low incomes? Surely the gains reflected in a higher total catch taken with less than half the total fishing effort should enable the halibut industry to fare much better than those fishing industries subject to less effective conservation methods or to none at all. Expressed in another way, it should be possible to fare better by using only the inputs needed to take the quota each year and to meet the challenge of competitive products and imports with lower costs.

Some measure of the effect of lengthening the season by reducing the number of boats participating can be developed from the survey of boat income. Neglecting for the moment any consideration of the difficult practical problems involved, assume that the number of halibut vessels had been reduced sufficiently so that the remaining vessels could have made 8 to 12 trips rather than the average of 4 to 5 in the years 1953–57. An estimate of boat incomes and man-shares from halibut fishing can then be obtained by multiplying actual boat incomes and shares per trip by 8 to 12.

The resulting figures for boat income are shown in tables 43 through 45. When these figures are compared with actual vessel earnings (see tables 18 and 24), it is apparent that if the length of the halibut season were increased substantially, with a corresponding reduction in the number of vessels fishing, incomes to boat owners would be substantially higher even if they could find no off-season source of earnings.

TABLE 43.—*Calculated average boat income for eight trips in the halibut fishery, by net tonnage, Seattle fleet, 1953–57* [1]

Net tonnage	Estimated average boat income after reported depreciation in:				
	1953	1954	1955	1956	1957
19 and under	$5,616	$6,136	$2,384	$5,232	$2,632
20–29	5,872	4,176	3,392	4,896	3,240
30–39	5,152	5,664	4,880	7,936	5,080
40 and over	5,224	5,504	3,000	7,024	6,288
General average	5,545	5,168	3,376	5,984	4,072

Net tonnage	Estimated average boat income after depreciation on market value in:				
	1953	1954	1955	1956	1957
19 and under	$3,856	$8,160	$1,952	$2,936	$2,272
20–29	5,496	4,808	3,776	5,120	3,048
30–39	6,024	6,400	6,312	6,944	5,224
40 and over	3,520	4,440	1,816	5,560	4,688
General average	4,832	5,792	3,464	5,072	3,624

[1] Calculated as described in text.

TABLE 44.—*Calculated average boat income for 10 trips in the halibut fishery, by net tonnage, Seattle fleet, 1953–57* [1]

Net tonnage	Estimated average boat income after reported depreciation in:				
	1953	1954	1955	1956	1957
19 and under	$7,020	$7,670	$2,980	$6,540	$3,290
20–29	7,340	5,220	4,240	6,120	4,050
30–39	6,440	7,080	6,100	9,920	6,350
40 and over	6,530	6,880	3,750	8,780	7,860
General average	6,930	6,460	4,220	7,480	5,090

Net tonnage	Estimated average boat income after depreciation on market value in:				
	1953	1954	1955	1956	1957
19 and under	$4,820	$10,200	$2,440	$3,670	$2,840
20–29	6,870	6,010	4,720	6,400	3,810
30–39	7,530	8,000	7,890	8,680	6,530
40 and over	4,400	5,550	2,270	6,950	5,860
General average	6,040	7,240	4,330	6,340	4,530

[1] Calculated as described in text.

Moreover, the extent of the increase is, if anything, understated, since no account has been taken of the favorable effect of a longer season on marketing costs and risks, which would tend to increase average port prices. Similarly, the possible improvement in quality accompanying a longer season would increase average returns to both fisherman and dealer.

Tables 46 through 48 indicate the parallel increase in manshares if each vessel were able to make 8, 10, or 12 trips. This increase in manshares would not bring as large an increase in total earnings as to vessel owners, since the off-season earnings, particularly for younger fishermen, would be reduced. It indicates, however, the possibility of providing sufficient income to attract and hold a permanent group of fishermen deriving the bulk of their income from regular employment in the halibut operation.

SUMMARY

Incomes to vessel owners, even before deduction of depreciation charges and other expenses, were very low in the years 1953–57. When depreciation was charged off, the net return averaged only about 3 percent of replacement costs. The black cod fishery, which can be carried on with the same gear after the halibut season, did not yield enough to cover crew shares and running expenses in all cases, and other alternative off-season fisheries were also less profitable than halibut.

TABLE 45.—*Calculated average boat income for 12 trips in the halibut fishery, by net tonnage, Seattle fleet, 1953–57* [1]

Net tonnage	Estimated average boat income after reported depreciation in:				
	1953	1954	1955	1956	1957
19 and under	$8,424	$9,204	$3,576	$7,848	$3,948
20–29	8,808	6,264	5,088	7,344	4,860
30–39	7,728	8,496	7,320	11,904	7,620
40 and over	7,836	8,256	4,500	10,536	9,432
General average	8,316	7,752	5,064	8,976	6,108

Net tonnage	Estimated average boat income after depreciation on market value in:				
	1953	1954	1955	1956	1957
19 and under	$5,784	$12,240	$2,928	$4,404	$3,408
20–29	8,244	7,212	5,664	7,680	4,572
30–39	9,036	9,600	9,468	10,416	7,836
40 and over	5,280	6,660	2,724	8,340	7,032
General average	7,248	8,688	5,196	7,608	5,436

[1] Calculated as described in text.

TABLE 46.—*Calculated average one manshare for eight trips in the halibut fishery by net tonnage group, Seattle fleet, 1953–57* [1]

Year	Manshares on vessels of net tonnage of:				General average
	19 and under	20–29	30–39	40 and above	
1953	$5,384	$5,680	$6,912	$5,408	$5,800
1954	7,352	6,552	6,552	5,576	6,536
1955	5,552	4,248	4,792	4,512	4,696
1956	5,800	7,008	8,720	7,728	7,216
1957	3,440	4,592	6,376	6,144	4,992

[1] Calculated as described in text.

TABLE 47.—*Calculated average one manshare for 10 trips in the halibut fishery by net tonnage group, Seattle fleet, 1953–57* [1]

Year	One manshare on vessels of net tonnage of:				General average
	19 and under	20–29	30–39	40 and above	
1953	$6,730	$7,100	$8,640	$6,760	$7,250
1954	9,190	8,190	8,190	6,970	8,170
1955	6,940	5,310	5,990	5,640	5,870
1956	7,250	8,760	10,900	9,660	9,020
1957	4,300	5,740	7,970	7,680	6,240

[1] Calculated as described in text.

TABLE 48.—*Calculated average one manshare for 12 trips in the halibut fishery by net tonnage group, Seattle fleet, 1953–57* [1]

Year	One manshare on vessels of net tonnage of:				General average
	19 and under	20–29	30–39	40 and above	
1953	$8,076	$8,520	$10,368	$8,112	$8,700
1954	11,028	9,828	9,828	8,364	9,804
1955	8,328	6,372	7,188	6,768	7,044
1956	8,700	10,512	13,080	11,592	10,824
1957	5,160	6,888	9,564	9,216	7,488

[1] Calculated as described in text.

Fishermen in the halibut fleet received total annual incomes in 1955–57 averaging from $4,213 to $5,728. Incomes varied widely from year to year. There was a marked and stable relation between average income and age group. Virtually all fishermen received incomes from other sources than the halibut and black cod fisheries. Substantial numbers of fishermen in every age group drew Unemployment Compensation each year; the proportion of older fishermen receiving income from this source ranged from 72 to 83 percent.

Although this finding must be interpreted with caution, apparently earnings of fishermen have been at or slightly below levels that would maintain the size and age distribution of the labor force. About 5 percent of total income to fishermen was derived from Unemployment Compensation despite the generally prosperous condition of the economy as a whole in 1955 to 1957. Vessel owners, pinched between rising costs and relatively stable prices, did not earn returns that permit replacement of older vessels.

Calculations based on the survey data indicate that a reduced fleet operated over a longer season would produce substantial increases in earnings of both fishermen and vessel owners without affecting prices to consumers.

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Chapter 10

SUMMARY OF ECONOMIC PERFORMANCE

The economic performance of a fishery must be judged by reference to generally accepted standards. In this chapter the results of the industry's development under regulation are evaluated in terms of the criteria developed in chapter 4. The effects of the voluntary layover program are also analyzed.

CRITERIA FOR ECONOMIC PERFORMANCE

In chapter 4, we considered five criteria for economic performance of a fishery. These were (1) optimal output, (2) efficiency, (3) progressiveness, (4) proper distribution of income, and (5) stability of income, employment, and price. On a different level, we might have added an additional requirement: that the industry perform as well as possible with minimum intervention by government. In this chapter, the empirical findings of the study are used to evaluate performance of the halibut industry under regulation in these terms. Note that this is not an evaluation of the performance of the Commission as a regulatory body, since it is specifically prohibited from using its power to effect purely economic changes. It is, however, implicitly an evaluation of the concepts of management underlying the legislation of the two governments, which specifies the objectives and powers of the Commission.

Output and Allocation

Output.—The halibut program came into being at a time when the fishery showed evidence of severe depletion. The Commission therefore conceived its initial problem to be curtailment of the rate of catch to a point below the estimated additions to stock from recruitment and growth. Thereafter, it proposed to increase the allowable catch, as recovery of the population permitted, until (as later specified in its legislative charge) the maximum sustained physical yield was realized. In view of the inevitable gaps in knowledge of the basic parameters determining the size and composition of the halibut populations under alternative levels of fishing effort, no specific quantitative goals for annual rates of increase or ultimate stable yield could be specified. Instead, the initial curtailment was as deep as the depression-induced drop in effort would permit without serious dislocation of the industry. Subsequent increases were permitted at a rate determined by the developing statistical record of abundance and the desire to invest continuously until no further gains were forthcoming.

The theoretical discussion of chapter 4 raised certain fundamental questions as to the formal adequacy of the Commission's short- and long-term objectives. In particular, it was argued that neither the optimum catch (in the long-run terms) nor the optimum rate of rebuilding stocks can be determined without reference to prices and costs. With the time dimension introduced, the optimum catch is determined by present and prospective costs and value yields and by the rate at which future values are discounted to the present. The basic problem is thus one of investment in inventories and productive capacity. The optimum rate of replenishment is the one that yields a net economic return equal to the return that could be earned on other investment. In long-run equilibrium—with costs, prices, and the rate of interest given—the optimum catch is the one that maximizes the present value of the alternative income streams which the resource is capable of generating over time.

The detailed data on present and future magnitudes required to maximize economic returns in this formal sense are simply not available in the case of a sea fishery. At most we could expect only approximations, and the realities of a practical management program would probably rule out too-frequent changes in regulations with each shift, actual or anticipated, in costs, prices, and discount rates. There is, however, a hard and practical core of usefulness in the analysis. It is possible to use more of other resources than we should in an effort to maximize physical returns from a fishery, and it is possible to be excessively conservative in restricting present consumption to realize a future increase in yields. Has the halibut program, with its emphasis on physical yield, gone astray in terms of an economic definition of the proper catch?

The evidence suggests that it has not, despite the absence of any formal recognition of the role played by prices and costs in determining the optimum catch in any given period of time. In part, this adherence to economic realities is simply a matter of commonsense conservatism with respect to the goals actually envisaged. The effects of the Commission's regulations can be identified statistically only after a substantial period of time, during which the complicating effects of a host of other factors may intervene. Once a quota has been increased, a subsequent revision downward may encounter serious opposition and criticism by the industry. There are thus strong incentives, from the standpoint of scientific caution and public relations, to stay on the low side of the yield-effort function—precisely what would be required if output is to be held close to the point where marginal money yields and costs are equated. Whether the Commission exceeds or falls short of a catch level that would maximize net economic yields cannot be determined. The basic functions relating effort and yield are simply not known with that degree of precision (nor are they likely to be); and as indicated earlier, the technique of regulation has resulted in excessive costs. Nevertheless, if the Commission allows some margin in estimating the level of maximum physical yield, the likelihood of any serious overexploitation in economic terms is not great.

In fact, output may well have fallen short of optimum levels, defined in either biological or economic terms, because of the fleet's response to quota controls. It was pointed out in chapter 5 that inability to control entry has resulted in a severe shortening of the period in which the quotas are taken. Hence both biological and economic maxima are held to lower levels than could be realized if subgroups of the halibut stock could be exploited at rates that equalize marginal returns from each.

With respect to the rate of investment in the halibut stock—that is, the extent to which net increments to stocks exceeded the permitted catch—the same general answer emerges. The catch increased by roughly 50 percent from 1932 to 1958. Viewed in retrospect, this increase probably represented a reasonably defensible economic investment policy, though apparently no such considerations entered into the determination of the quotas. If it be granted that the biological model envisaged by the Commission was approximately correct, the initial decline in fishing effort caused by the collapse in halibut prices would have led to an increase in catch per set and to larger net money returns. Since fishermen and vessels had virtually no other employment opportunities during the mid-thirties, the increase in abundance would have been "fished out" as soon as prices recovered even moderately. With returns on other investments being low, a rational economic policy would thus have dictated restriction of current effort below this level to provide a larger yield for future years when both the expected general economic recovery and population growth promised higher economic returns from the fishery. Essentially the same result—though perhaps at different rates of increase in yield—would also follow a policy of revising quotas upward only after emergence of a clear upward trend in abundance (evidenced by increasing physical yield per unit of effort), with the amount of the increase nicely calculated to balance further growth against the pressure of the industry for improved economic returns.

Allocation.—When we evaluate the performance of the industry in terms of the allocation of productive factors between the halibut fishery and the rest of the economy, the picture is less satisfactory. For reasons detailed in chapter 5, the recovery of the halibut population resulted inevitably in an influx of vessels and men as unit costs of fishing fell. During the years prior to World War II, this influx involved no particular waste to the economy as a whole because of unemployment. Vessels and men otherwise idle might as well be engaged in dividing the catch of halibut into smaller segments. The growth in the size of the halibut fleet with rehabilitation added nothing to production, since the quota would otherwise have been taken over a longer season; but it did not subtract much, if anything, from the output of other goods and services elsewhere in the economy. In a sense, it could be argued that the economic rent from the halibut fishery was distributed as a form of work relief.

After postwar restoration of high levels of employment, the situation took on a different aspect. With ample productive opportunities for capital and labor elsewhere, optimal performance required that only vessels and men sufficient to take the permitted catch on a full-time basis be engaged in the halibut fishery. (As used here, the term "full-time" implies that most of the catch be taken by vessels and men who derive most of their income from halibut. Seasonal and random variations in the availability and prices of other species require some mobility among fisheries for optimal utilization of the fishery resources of the entire region.) This optimal employment of men and vessels has not been the case. Even after the severe pinch imposed by rising costs and virtually stable prices from 1950 to 1958, the fleet remains much larger than is required.

This excess size of fleet alone would not establish the fact of malallocation of labor and capital. If the part-time halibut vessels and fishermen could be absorbed smoothly into other operations which add an equal value to the output of the regional economy, no economic loss would result. The empirical evidence, however, indicates that this is not the case. Incomes earned by fishermen, and particularly by vessel owners, outside the halibut operation are significantly lower than are those earned in season, and there are substantial periods of idleness. Equally significant is the finding that most of the off-season vessel income and a smaller but still considerable part of the fishermen's income is derived from other fisheries. Some of these earnings represent a diversion of income from other fishermen with no corresponding increase in real output. As long as the halibut fishery remains part-time to a degree greater than overall mobility in the Northwest fisheries requires, excessive use of labor and capital and some loss of real output and income for the economy appear to be inevitable.

The degree of malallocation is less serious today than in 1950 only because a variety of factors have held down halibut prices and depressed vessel earnings severely enough to move many of them out of longline operations. Over the long run, it seems plausible to argue that growth in population and per capita incomes will eventually reverse the adverse trend of the past decade. If additional imports of fillets are subjected to increasing pressure through tariffs or quotas, this process will, of course, be speeded. Any increase in demand and price (or decrease in fishing or handling costs), however, will check the exit of vessels, and ultimately new entry will become attractive even if the catch is stabilized. In short, any future reduction in overcapacity can be achieved under present conditions only by depressing product prices or increasing the prices of inputs. Improvements in demand or cost conditions will provide a larger monetary pie, to be divided among more vessels, with no increase in real output and an actual increase in real input, which could otherwise turn out other goods and services.

Efficiency

The situation described above is inefficient from the standpoint of the Canadian and United States economies. The performance of the industry must also be analyzed from the standpoint of "internal" efficiency; that is, the extent to which costs of individual vessels and marketing firms are minimized for any given output.

The data on costs and earnings of halibut vessels do not permit any dependable analysis of the actual efficiency of existing boats relative to that of an ideal vessel designed and equipped specifically for halibut fishing. The fleet is so heterogeneous with respect to age, condition, power, adaptability to other fisheries, and auxiliary equipment that it is impossible to account accurately for differences in performance. Moreover, the earnings of a fishing vessel may well depend on the skill and experience of the skipper and crew to a greater extent than on the physical characteristics of the boat.

Nevertheless, some elements of the present industry structure affecting efficiency can be identified. In the twenties, the trend in halibut vessels was toward larger boats specifically designed for 8 to 9 months of longline fishing, in keeping with the trend toward larger and more heavily powered fishing vessels throughout the developed sea fisheries of the world. Since the technique of halibut fishing has changed very little since that time, it is likely that the effect of the short season, requiring the use of combination boats capable of other fishing operations, represents a necessary compromise with efficiency. The cost of extra sets of gear is a further burden.

It was pointed out in chapter 5 that shortening the season under quota regulation has imposed additional marketing costs that constitute a drag on the efficiency of the industry. In effect, higher storage and interest costs must be paid and greater market risks must be assumed to make available a product of lower quality. Requirements for peak handling and freezing capacity are increased, and the accuracy with which the flow of landings is guided to various ports via the mechanism of price is impeded. Individually, none of these effects is of major importance. Collectively they constitute a significant burden—particularly if the relative weakness of demand for halibut in recent years is traceable to irregularity of quality resulting from the short season.

Progressiveness

Vessels and the share system.—About 30 percent of the Seattle boats included in our survey were more than 29 years old. Many of them could be regarded as outdated by reference to modern marine engineering standards, and many are only partially equipped with electronic and other gear of established value to offshore fishing vessels. They offer less comfort and convenience to their crews than would be possible in new vessels. The gear and techniques used in actual fishing operations have changed very little in the past 30 years. The halibut fishery is no worse in these respects than are most other North American fisheries, but the successful rebuilding of its badly depleted resource under scientific management prompts the question, why is it not much better?

Part of the explanation for the apparent lack of technological progress has nothing to do with the conservation program, but rather with the effects of the share system. The gross boat share of the halibut fleet ranges from 21 to 22 percent of the gross expense, or about 20 to 21 percent of total proceeds from sales. Any improvement which increases the individual boat's share of the total catch will yield only one-fifth of the increase in gross money income to the boat owner, out of which must come the increased depreciation, interest, and maintenance costs associated with the new investment. To the extent that the new technique involves savings in crew expense items—such as fuel, ice, or bait—it raises crew incomes but leaves the boat share unchanged. Only if the owner is also master, and thus received a manshare, does he receive even a portion of the gain unless the lay agreement is changed. Under these arrangements, there is little incentive to alter vessels or gear in ways that involve a considerable financial outlay. In effect, the vessel and gear are built to conform to the lay agreement.

This is not to say that the share system is not, in other respects, a desirable—or even necessary—way of compensating fishermen in the longline fleet. A glance at the vessel returns given in the appendix makes it clear that there are wide variations in gross income among vessels in any season and among seasons for each individual vessel. A system of fixed monthly wages or even a piece rate would require large financial reserves to tide the owner over bad years and might well result in his being unwilling to pay a fixed wage high enough to hold crews. In addition, the share system, which makes the crewmen co-adventurers in part, not only spreads the inevitably high risks of fishing, but provides a direct incentive for teamwork and maximum effort during the season. The nearly universal use of this system throughout the world's sea fisheries cannot be attributed solely to tradition.

Ideally, of course, the dragging effect on investment and innovation might be overcome in part by making the boat share flexible, with the actual division being based on an equitable compensation to the owner for improvements that are clearly beneficial to both sides. In practice, however, there has been no strong disposition to put collective bargaining between halibut vessel owners and the Deep Sea Fishermen's Union on this basis. Interest in this method or any other means of stimulating improvement and renovation of the fleet has been pushed into the background by the level of boat earnings that has prevailed in recent years. As long as substantial overcapacity exists, it makes little economic sense to argue for increased investment, even if productivity of the individual vessel could be improved.

Restrictions on fishing gear.—There is another problem bearing on the progressiveness of the halibut operation that is related to the control program. It was pointed out in chapter 4 that the Commission has refused to sanction the use of set gill nets or otter trawls for halibut. This position is based primarily on a review of European experience with these types of gear in Atlantic halibut waters, with the conclusions extended to the environment of the Pacific halibut as established by its own investigations. In a report published in 1956, the Commission staff concluded that the use of nets would constitute a serious threat to the halibut stocks. Otter trawls, which would be usable on some of the Pacific grounds though not in others, were held to be excessively destructive of immature fish. The trawlers of the North Atlantic, though fishing primarily for other demersal fishes, have regularly landed thousands of pounds of extremely small halibut and have doubtless contributed to the severe depletion of the species. The set gill nets, on the other hand, were found to catch excessive numbers of mature spawners.

In 1959, Alverson, in a paper delivered at a conference on fishery management at the University of Washington, challenged these conclusions. He pointed out that the devastating effect of trawling on stocks of immature halibut rested on the assumption that a small-mesh cod end, designed for smaller demersal fishes would be used, as in the Atlantic fishery. If a larger mesh were employed, it might be possible to achieve even lower mortality among undersized halibut than with the essentially nonselective longline gear. Even more interesting, of course, is the possibility of using the inherent selectivity of the otter trawl to produce a larger sustained physical yield for each level of effort than would be realized with longline gear (see chapter 2).

The argument that otter trawling would result in an excessive total catch apparently implies that the same number of vessels would be engaged. If the Commission retained its power to limit the catch by area, the principal danger would be a further shortening of the season and even greater concentration on limited segments of the halibut population. Under present conditions, with no limitation on entry, this danger would be real indeed. If the use of otter trawls or set gill nets did in fact lower fishing costs, a rush of new vessels—new, at least, to the halibut fishery—could be expected; and since the older vessels cannot find ready alternative uses, severe economic pressure, a drastic curtailment of the time required to take the quota, and unbalanced distribution of effort would result.

If the rate at which the new technique is introduced could be controlled and if the total number of vessels could be reduced gradually, these undesirable results need not follow. The ultimate outcome would be a smaller fleet, using the type of gear that is most efficient in each area, with the total catch being determined as before. The problem is not inherent in the competitive testing of gear efficiency, but arises out of the absence of any authority to control directly the aggregate amount of fishing capacity and the rate at which new techniques are introduced.

This problem, however, is a sociological and political one, familiar in many industries. If we assume for the moment that the hardships that traditionally follow the introduction of a new method could be held to a satisfactory minimum, adequate performance of the halibut industry would require the right to introduce more efficient gear. If otter trawls proved impractical, because of bottom conditions or costs, there would be no problem. If such gear proved successful, then it would seem desirable to explore further the technical aspects of its effect on yields and alternative ways of providing for its orderly introduction to the commercial fishery.

It must be emphasized that there is no concrete evidence that net fishing would result in greater economic efficiency in the Pacific halibut fishery. The fact that it has proved to be so in most of the highly developed demersal sea fisheries suggests, however, that it may be. The point to be stressed is that the prohibition of any gear other than longlines by the Commission is probably necessary and desirable in the absence of any power to control entry into the fishery. If that restriction were modified, the possibility of increased efficiency through innovation would then warrant careful investigation. If research, on a controlled basis, establishes the potential superiority of other types of gear, the present restrictions on their use should be reconsidered to determine how and at what speed the industry could adopt them with a minimum of disturbance.

Income Distribution

The surveys suggest that the distribution of incomes from the halibut operation is not affected adversely by the control program except in the sense that failure to prevent excessive entry leaves all participants vulnerable to any sustained increase in costs or decrease in market price. Though there is some question as to the vigor of competition on the exchanges, it is evident that no fortunes are being made by deliberate collusion to depress buying prices. The division of the gross proceeds of the vessels, a matter of collective bargaining for many years, was thoroughly reviewed by the vessel owners and the Union in 1959, and only a slight revision of the boat share was considered.

With unrestricted entry to the fishery and reasonably active buyer competition, it is to be expected that total proceeds will, in the long run, yield just sufficient return to maintain investment in fishing and marketing and to hold the necessary labor force. The fact that earnings for some have fallen below those levels in recent years simply reflects the hard fact that it is much easier to get in when returns are attractive than to get out when they are not.

If entry were restricted—that is, if fishing effort were adjusted to maximize the economic rent on the basic resource—a distribution problem of real proportions would develop. Since the same catch could then be taken at lower cost, net proceeds may rise well above the minimum necessary to provide returns to labor and capital equal to what could be earned elsewhere. Should this excess be siphoned off by the two Governments, as custodians of the common resource? If so, by what means? These problems are discussed in the following chapter. We may simply note here that the absence of an income-distribution problem of this type in an industry based on a common property resource is more an evidence of excessive costs than of fully satisfactory operation.

Stability

As long as halibut are sold in competition with a wide variety of other more-or-less-substitutable seafoods, prices will be relatively volatile. As long as the share system remains an essential way of dealing with the risks of fishing, fishermen's wages will vary widely from year to year. And as long as the individual vessel's catch is a matter of luck, skill, and the weather, incomes of all participants in any single year will show a wide dispersion. Instability of money returns is an inherent part of virtually all fishing industries, whether regulated or not. Any evaluation of the halibut industry's economic performance must deal in relatives: are incomes less stable than they might be under other forms of economic organization and control?

The analysis in chapter 7 suggests that the conservation program has had some tendency to increase the intrayear and interyear instability of prices—and therefore of both vessel and fishermen's incomes—but the extent of the increase is not great enough to constitute a serious criticism of performance. Only in Seattle, where demand includes both fresh-market and frozen-inventory components, do we find substantial fluctuations in day-to-day prices with variations in landings. In other ports, the overriding importance of frozen inventory requirements makes day-to-day prices relatively insensitive to landings except when physical handling facilities are badly overloaded.

Within the season, however, the pattern of prices definitely reflects the influence of the short season, with lower prices in the early weeks and a more rapid increase thereafter than would prevail if fishing were extended over a longer period. The short season also makes it necessary for holders of inventories to estimate demand conditions over a longer period. This is virtually certain to result in mistakes in anticipating future market prices, and thus it increases year-to-year variability in prices. This effect shows up clearly in the behavior of the carryover.

It is quite possible, on the other hand, that incomes from the halibut operation (as opposed to prices) would vary less if the season were extended, simply because of the principle of large numbers. Bad weather on the grounds, a temporary shortage of fish in the area of operations, or mechanical breakdown may cause one or more trips to be unsuccessful. With an average of only four or five trips per season, there is less opportunity to average these out than there would be if the season were extended over 6 to 9 months.

This conclusion refers, of course, to the income from longline fishing only. Those fishermen who work ashore off-season might well find that full-time halibut fishing, even under an extended season, would still result in more variation in income than would a combination of halibut fishing and stable shore work. However, the fishermen whose primary source of off-season work is in other fisheries and most of the vessel owners would realize more stable incomes, since the principal alternatives are, if anything, subject to even more fluctuation in gross returns per trip.

VOLUNTARY LAYOVER PROGRAM

For several years prior to 1941 and again since 1956, the halibut fleets have attempted to offset the tendency toward a shorter season through limitations on the activities of the individual boat. Discussion of the effects of these efforts has been deferred to the end of this chapter, since they cut across several of the elements of market performance set up as standards.

It should be emphasized at the outset that the layover scheme has not been aimed at restricting the total catch of halibut nor has it had any such effect. A major purpose has been to increase the average price received by fishermen by reducing the periodic overloading of port facilities. In earlier programs, this scheme involved both extension of the fishing season and staggering of departure times to break the pattern of heavy deliveries. In addition, the enforced layover between trips is intended both to provide necessary rest for fishermen, as a health measure, and to allow time for more adequate in-season maintenance of boats and gear. As a side effect of the provision against other fishing activity during layover periods, the program also tends to discourage casual halibut fishing by boats not primarily engaged in longlining. In the prewar period, the vessel layover was reinforced by catch limits per man, but this provision has not been included in recent years because of its restrictive effect on the operation of the larger boats.

Since the total catch is not affected by the layover provisions, they have no direct effect on average consumer prices through the year. Given consumer incomes and preferences and the total catch as determined by the Commission, the market-clearing price is determined. Only if the actual level of demand is altered—by affecting the regularity of supplies or improved quality, for example—will retail prices be affected by the fleet's program.

The impact of the layover on intraseason port prices is likely to be positive—but for reasons other than the one most frequently advanced. If a major part of the catch of halibut were sold on the fresh market and thus had to be cleared daily, bunching of landings would produce sharp gyrations in prices from day to day. With the increasing dominance of storage demand for frozen fish, however, this tendency has been ironed out to a marked degree. The analysis of chapter 7 indicates that daily prices in Ketchikan, where virtually all landings are frozen, respond only slightly to fluctuations in receipts. Only when the capacity of port facilities is exceeded do we find sharp breaks in price. In Seattle, where there is an important demand for fresh fish, prices do respond more to variations in daily landings, but not to the degree characteristic of an auction dealing in nonstorable perishables.

The analysis of chapter 7 suggests that the layover results in slightly higher average prices to fishermen, not because it reduces variations in daily receipts, but because the extension of the season reduces marketing costs and the necessary allowance for risk on the part of inventory holders. The magnitude of the improvement cannot be estimated with precision, nor can the division of the savings between fishermen and port buyers. Two points, however, are evident: (a) some reduction in real costs must be achieved by lengthening the season in this way and (2) the increase in returns to fishermen and dealers does not come from any increase in consumer prices.

The effects on efficiency of the layover plan are mixed. The requirement that both men and vessels remain out of other fisheries during the 8-day rest period limits casual halibut fishing and reduces overcapacity in the fleet. On the other hand, it must increase the average period of idleness during which vessels and men make no contribution to output in any other activity. The significance of this effect depends largely on the actual use made of the layup time. If, in fact, the fishermen do require a rest of 8 days between trips for sustained working efficiency and if the owner of the vessel is able to do routine maintenance and repair work that would otherwise cut into later operations, the real cost of the idle periods is negligible.

On balance, there seems little doubt that under present Commission regulations the layover program represents an improvement over unrestricted fishing. It cannot be regarded as a fully satisfactory substitute for a program that would lengthen the season by reducing the number of regular halibut vessels. It cannot get at the fundamental problem of overcapacity without running afoul of the antitrust laws, and its effectiveness is limited by the necessity of compromising group interests and the absence of legal enforcement powers.

CONCLUSIONS

The halibut program is to be credited with a major role in the rebuilding of a valuable resource and the establishment of a level of sustained output far above what might have been expected under unrestricted fishing. The Commission has accomplished this rebuilding in the face of formidable problems of reconciling the interests of special groups within the fleet and of the two Governments concerned. The evidence of its firmness is recorded in the rising catch and its objectivity is shown by the unprecedented support and compliance given by the industry.

It is this very success in one dimension of the industry's performance that makes the weakness in others the more challenging. As long as the fishery remains open to all comers, every gain in physical productivity, price, or technical efficiency will invite new entrants and will dissipate all or part of the benefit to society. Until we recognize the necessity of conserving other resources as well as the halibut stock, the job must be considered only half done. Efforts by the fleet to improve efficiency by lengthening the season have been beneficial but are limited in their effect because such efforts do not deal with the root problem of overcapacity.

SUMMARY

The restriction on catch imposed by the Commission in 1932 and the rate at which quotas were increased were not based on economic considerations. Nevertheless, the conservative application of its biological criteria, modified by certain requirements of the industry, has produced catch quotas that probably did not deviate greatly from optimal levels in economic terms.

The tendency to increase the number of vessels and men participating in the halibut fishery did not impose serious costs in the economy during the 1930's when unemployment was widespread. Thereafter, however, the effect of quota regulation without restriction on entry has been to tie up resources that could have been used to better advantage in other industries. It has also reduced the efficiency of both fishing and marketing operations.

The halibut fleet has shown little technological progress during the past 20 years. In large part, this lack of progress is not a result of regulation but of the effects of the share system on the incentive to invest in new vessels and gear. Modernization of the fleet has also been impeded by the low level of vessel earnings in recent years. As long as entry remains uncontrolled, it is not practical to test new fishing methods that might be more efficient.

The conservation program has not had any recognizable effect on the distribution of income among fishermen, vessel owners, and marketers. It has resulted, however, in slightly greater variability of intrayear and interyear prices and incomes as a result of the severe shortening of the season.

The voluntary layover program undertaken by the halibut fleet has had some favorable effect on the length of the season and thus on prices and costs. Its benefits, are relatively small, since the program cannot be enforced legally and cannot deal with the fundamental problem of overcapacity.

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Chapter 11

POLICY IMPLICATIONS

We have proposed a set of objectives and standards of performance differing from those on vhich the present program of conservation is based. It is therefore incumbent on us to explore he differences in policy that follow from their application and to point out both the possibilities ind the pitfalls. Of pitfalls, there are many, since the proper policy of conservation is a broad ssue encompassing not only economic aspects but also biological, social, political, and legal ones. Although we have placed greatest emphasis on the economic aspects, we cannot overlook the other ·elevant considerations in discussing practical policies.

The halibut industry's economic problems are more or less those of the American and Canadian isheries as a whole. The biological aspects of halibut management are already on a firm basis, vith a solid statistical program, industry support of regulation, and close cooperation between he two governments. The halibut case thus presents a unique opportunity to integrate biological ind economic objectives in an attack on the troublesome problem of cost and earnings. If we can extend more fully the benefits of conservation to the individual vessel owner and fisherman and o the consumer, prospects for the entire fishing industry will be brighter.

We do not presume to offer final answers to the numerous problems that will arise in specific ipplications. This is a task for the Commission, its staff, and the industry leaders who have the lepth of knowledge and experience required to do the job. The remainder of this chapter is therefore restricted to a consideration of fundamental principles of regulation, their relation to economic objectives, and the possible response of the industry to alternative policies.

The entire problem of policy turns on the necessity of conserving the basic halibut resource. If, as in preregulation days, it is treated as a completely free good, open to all comers without restriction, disastrous overfishing results. If, as under the present quota system, the two governments jointly restrict fishing effort, overfishing in the biological sense can be prevented, but vith no control over the division of effort among individual vessels, the net economic gain created by control is dissipated in excessive costs. The essential problem is thus to manage the resource n such a way that the amounts of capital and labor employed in its utilization are not excessive. In particular, it is uneconomic to have a large fishing fleet taking the quota in a few months with vessels and men idle, or only partially employed in less productive fisheries, for the remainder of the year.

How is efficient economic management to be achieved? Private ownership of the halibut grounds by one firm is impossible on legal grounds, quite apart from the possible abuses of the monopoly that would be conferred. A sea fishery cannot be subdivided into separable units to ensure competitive behavior by a large number of individual private owners. On the other hand, even if government operation promised greater efficiency, which is questionable, such operation vould not be considered by either Canada or the United States. We can, however, find a middle ground, comparable to the situation in publicly owned forest and grazing lands in which the governments jointly assume "ownership" of the resource but provide for its use by private firms under terms that assure rational exploitation. In a sense, the assumption of public ownership was accomplished in the Convention of 1931, but the governments have never taken the further step of recovering the potential net yield that their control policies brought into being. Despite the restriction on total effort, the resource remains free to all users. The rent, which should accrue to the owner, simply supports more tenants than are required.

In this chapter, the principal topics discussed are (1) methods of reducing excess capacity, (2) objections to controlled reduction of the fleet, (3) proposals for further gear research, (4) administration, (5) alternative proposals, and (6) concluding recommendations.

METHODS OF REDUCING EXCESS CAPACITY

Analytically, two lines of policy might be considered: (1) charge the users of the resource enough to ensure that they can earn a competitive return only if the minimum number of optimal fishing units required to take the desired catch is employed or (2) restrict the number of units to that minimum level and allow the industry to divide the rent among fishermen, vessel owners, and dealers as it chooses.

Taxation of Fishing Enterprises

From a theoretical standpoint, the first method would be preferable. Given product prices and the costs of capital and labor inputs, there is some price for fishing rights—that is, a tax or license fee—that would permit just the right number of optimal vessels, fishing full time, to earn necessary returns while taking the desired total catch. This situation is precisely the one prevailing in the use of "owned" resources, such as agricultural land, where the owner of the land charges as much as the most efficient user can afford to bid–or employs the land himself if the total net return can thereby be increased. Technological changes leading to lower costs or an increase in prices would require a higher charge for use of the resource as the value of its marginal product increased, thus preventing excessive use of other factors that would otherwise be attracted by the higher returns. Distribution of fishing effort between southern and western grounds could be controlled by delineation of area, as at present, with differential charges.

Attractive as this proposal is in terms of simplicity and minimum direct interference with fishing operations, it presents serious weaknesses in actual application if used without other controls. The desired restriction of the number of vessels would be realized only on the assumption that the individual fisherman takes full account of the long-run effects of increased effort on yield. Once the fishery was stablized at the desired level of catch, it is assumed that new entrants would be deterred by the knowledge that more effort would lower the catch per vessel below the point where a satisfactory return could be earned. In the short run, however, new vessels would, in fact, add to the total catch in almost direct proportion to the increase in effort.

This is a variation of the familiar case of unstable equilibrium in a competitive industry with constant costs. For practical purposes the only reason for increasing costs would be the population effect of increased fishing effort, and this would show up only after a considerable lapse of time. Since it is far easier to attract new entrants than to drive them out, fluctuations in prices would tend to produce persistent excess capacity and chronically low incomes.

Even more serious is the implicit assumption that the halibut fleet operates in isolation. Actually, of course, longlining as a ready alternative for vessels engaged in many other fisheries in Northwest waters. What of the likely situation in which the halibut fleet is adjusted to a rental charge that permits just the right number of vessels to take the right catch, with earnings to labor and capital equal to those in alternative uses, while other fisheries are severely depressed? This situation would induce a shift into halibut, with at least a temporary increase in net returns to the new entrants. The resulting overcapacity and overexploitation of the halibut population would be selfcorrecting only as the effects on population, yield, and costs showed up in later years. More important, if earnings in the alternative fisheries remain at depressed levels, there is no way in which the rental charge or tax can achieve both optimal levels of catch and opportunity incomes in the halibut fishery. Use of the market price mechanism to assure the optimal level and composition of effort in one fishery requires that the same mechanism be used in all others from which vessels might be drawn.

Primary reliance on taxes or fees to hold the umber of units to an optimal level assumes that hysical input-output relations are reasonably table and easily quantifiable. Unfortunately hey are not, and the political pressures centerng on the fixing of the tax would preclude the legree of flexibility needed to cope with changng conditions in the fishery.

Moreover, we cannot ignore the persistence f overcapacity and depressed vessel earnings n the fisheries as evidence that reducing earnngs is a slow and difficult way of eliminating ubmarginal boats. If the problem were one of estraining the development of overfishing in iew industries—all handled in the same manner -the tax or license fee alone might suffice to roduce an approximation to optimal fishing. In he present case, overcapacity and subnormal essel earnings already exist, and it would take brave administrator to propose that the probem be solved by adding more costs as a means f correcting the low earnings. It is possible, of ourse, that a nominal license fee would elimiate many of the casual halibut boats and thus ncrease the earnings of the regular fleet. This ction, however, would involve at most only 10 o 15 percent of the catch and would take time o become effective.

estrictive Licensing without Taxation

At the other extreme, it would be possible to liminate the excess number of vessels directly, ithout attempting to impose a charge or fee, y requiring that all participating vessels be liensed and then reducing the number of licenses 1 accordance with a predetermined time schedle. The reduction could be adjusted to the noral attrition of the fleet by retiring licenses as essels were withdrawn from the halibut fishery r in cases where a licensed vessel did not paricipate in the fishery for a specified number of easons. The reduction might be accelerated, if esired, by joint Government programs of purhase and retirement of licenses.

Again, however, a Pandora's box of problems s opened in the application of a "cost-free" liensing plan. On the basis of our survey data, ven a relatively modest decrease in the number f regular halibut vessels—and a corresponding ncrease in the number of trips of those remainng—would raise incomes above opportunity evels. The licenses would, in effect, confer hares in ownership of the resource, and hence claims on the net rent that would arise as the aggregate cost of taking any given catch is reduced. The additional proceeds would be divided between share fishermen and vessel owners through collective bargaining and between both producer groups and marketers on the basis of the structure and competitiveness of the port markets.

If total inputs are reduced enough to realize significant economies, this rent raises profit opportunities that could disrupt the industry and lead to waste in other directions. It could, for example, lead license holders into a competitive race to build larger and faster vessels in order to get a larger share of the total permitted catch, even though such attempts would be self-defeating and might result in higher average costs for all boats. The first operator would do well indeed, but the end result would again be a dissipation of the rent in excessive costs. The gap between market prices and fishing costs might also induce dealers to acquire licenses, directly or indirectly, and could even attract large secondary wholesalers and chain retailers into bypassing existing primary dealers entirely. Similarly, the effective restriction on new entry might induce vessel owners to organize in an attempt to realize more fully the potential monopolistic gains from their privileged position. It is impossible to say a priori whether these developments would be detrimental to the general efficiency of the industry or not, or whether, even then, they would not leave the industry better off than it is under completely unrestricted entry. A policy, however, that is almost certain to cause rapid changes in the organization of the industry as the participants vie for the newly created economic rent must be viewed with uneasiness.

Recommended Program

To be effective and at the same time to win the necessary support, a program aimed at the reduction of unnecessary costs in the halibut industry will have to combine direct restrictions on total catch and the number of vessels with a tax or fee schedule that forces those remaining to pay at least part of the rent accruing from their limited access to the resource but that is imposed only after reduction in costs has raised incomes significantly. Above all, the program must move cautiously toward its objective. Such a plan might start with the licensing of all existing vessels for a period of perhaps 5 years. No new licenses would be issued. At the end of the 5-year period, all licenses would expire. Thereafter, reduction on a scheduled basis could be achieved in either of two ways: by auctioning a predetermined number of licenses, with open bidding, or by licensing all applicants at a fee sufficiently high to achieve the reduction in vessels and the extension of the fishing season. There are sound reasons, economic and strategic, for restoring a satisfactory level of returns before undertaking a tax or fee system designed to maintain it. On the other hand, it must be recognized that a reduction in the number of licensed vessels makes each remaining license an increasingly valuable property right. The licenses should therefore be made transferable.

This "staged" reduction would leave the potential fishing capacity of the fleet in excess of the total catch that should be taken. Indeed, it is highly unlikely that our knowledge of biological and economic factors would ever reach a degree of precision where the total effort would be safely entrusted to the licensed vessels with no other restriction. It would therefore be necessary to maintain the area quota technique, which has proved workable and acceptable and which could be employed with considerably more flexibility with a fleet of manageable proportions. The use of quotas would also enable the Commission to achieve a desirable geographic distribution of fishing effort.

The eventual disposition of licenses by periodic competitive bidding has much to recommend it. It would yield a price for licenses based on the close calculations of those best qualified to judge the economic return to be earned from the right to fish for halibut. It would provide an incentive to develop an efficient fleet, and there is a strong presumption that the high bids would come consistently from the more skillful fishermen. The sale of fishing rights by competitive bid would also provide a semiautomatic buffer to absorb the effects of changes in market prices and costs. During recent years, for example, the burden of low prices and rising costs would have been borne largely by the governments, as "landlords," in the form of lower rents, rather than by the individual vessel owner and the share fisherman.

This method of allocating restricted fishing rights would not be without its problems. It would require a decision (essentially political rather than economic) as to the sharing of the rights between Canadians and Americans. In addition, a license fee, whether a flat charge or a price determined by auction, becomes a fixed cost to the vessel owner. This cost obviously bears more heavily on the boats landing smaller fares. If, however, one ultimate purpose of regulation is to achieve greater efficiency in the individual operating unit, some displacement of the smaller combination vessels by vessels specifically designed for 9 months of offshore fishing is inevitable. The important point is to allow sufficient time for the readjustment and to follow this process with studies of cost and earnings. Another disturbing possibility, mentioned earlier, is the introduction of boats too large for efficiency in an attempt—obviously self-defeating in the end—to get a larger share of the catch and to spread the cost of the fishing right over more units of output.

These considerations suggest that a licensing program coupled with a uniform tax per pound of fish delivered might be the most desirable way of siphoning off excess returns as and when the curtailment of the fleet and the consequent extension of the season require it. It would not penalize the efficient small boat, but would discourage use of larger boats solely to gain greater load capacity and a greater share of the permitted catch.

Regardless of the technique employed, it would be neither possible nor desirable to compute precisely the true economic rent and to recover all of it for the governments. A considerable margin should be retained by the fishermen for their incentive. First call on the net amounts received by the two governments should go to cover expenses of the Commission and, if possible, to expand its budget for research. Since its operations are an integral part of the halibut fishery, its costs are properly chargeable to the rental received from the resource. Any receipt in excess of the Commission's requirements could be retained as general tax revenues, redistributed to the industry directly, or used to speed up the reduction in licenses by compensating holders for voluntary withdrawal.

It could be expected that a significant improvement in the economic position of the fleet, once realized, would necessitate further dereases in the number of vessels over time. For t least a decade, there has been virtually no re-lacement or thorough-going modernization of ie American fleet, because of its poor earnings. /ith the achievement of satisfactory profits, re-lacement of older vessels could be expected nd, with it, a steady increase in the fishing ca-acity of the fleet as a whole. Even if present estrictions on gear are maintained, it would be ossible and desirable to reduce the cost of fish-ng as the efficiency of the average vessel im-roves. This increase in efficiency, however, is ot likely to occur rapidly enough to cause seri-us dislocation and personal hardship.

OBJECTIONS TO CONTROLLED REDUCTION OF THE FLEET

Once an industry becomes adjusted to a situa-ion—however difficult it may be—any change—o matter how beneficial—will create problems or certain groups. The proposals presented ere will therefore encounter opposition on a umber of grounds. Some of the objections are nalyzed below.

It is argued that any curtailment of vessels 1 the halibut fishery will reduce employment pportunities and force fishermen into occupa-ions for which they are not trained and into reas where they may not wish to live. This dis-ocation of fishermen might be a serious problem it were proposed to reduce inputs rapidly. uch short-period action is not recommended. f the program is stretched over 5 to 10 years, ie necessary reduction can be accomplished rithout serious pressure on the present partici-ants. The halibut fishery, like any other indus-ry, has a stream of men who are leaving—some y aging and some by voluntary shifts to more romising occupations. If we simply cut off new ntry, which already is low, and provide suffi-ient time and advance notice of our objective, ie reduction in vessels and men can be accom-lished without serious hardship to present par-icipants.

Fundamentally, it must be emphasized that mploying more workers than is necessary for given output is a nonsensical objective—ex-ept possibly during general unemployment, hen it could be regarded as a form of work haring. The unprecedented growth in economic relfare in the western world has been achieved by getting more output with less inputs. Living standards in North America reflect our continuing success in meeting basic needs—particularly for food—with fewer and fewer resources, thus providing the basis for expansion of both capital and consumer goods industries. The record of the northwest regional economy in the postwar period indicates ample ability to absorb the small increase in the total labor supply that would result from a reduction in the halibut fleet. The question at issue is fundamental: do we use the gains of the conservation program to support more marginal fishing units or do we (1) provide better incomes for those individuals who are actually needed and (2) produce more of other things.

Suggestions that inputs be reduced might also be criticized on the ground of interference with private enterprise in the fisheries. We can only point out that the existence of the present program of control is a testimonial to the fact, now widely accepted by fishery biologists, that unrestricted private enterprise is self-destructive in the use of common-property resources. Policies which direct private initiative along channels that improve the lot of both producer and consumer are an inherent part of American and Canadian policy toward such resource-based industries as forestry and petroleum—and for essentially the same reasons.

A more serious problem concerns the effect of a reduction of units in the halibut operation on other regional fisheries. From the standpoint of the salmon, tuna, sardine and otter trawl fleets, which might be expected to receive some of the exodus, the solution to the halibut industry's problems is not an unmixed blessing. From the standpoint of the economy as a whole, much of the real saving achieved in the halibut fishery will run to ground if it simply shifts overcapacity to other fisheries already burdened with more boats and men than they can utilize fully. The hard fact is that there is too much capacity in virtually every major Pacific coast fishery. In the salmon fishery, for example, the problem has been so acute at times as to threaten the entire structure of catch controls.

The fact, however, that the other fisheries are burdened by overcapacity is no reason for abandonment of measures to improve the status of the halibut fleet. Rather, it suggests the need for a common set of objectives for management of the region's major fisheries. Achievement of that goal may well be a long time away, but a successful program to realize more fully the economic gains from halibut management would be a powerful stimulus to more effective use of these other resources.

GEAR RESEARCH

As indicated in the previous chapter, the Commission's actions limiting the halibut fishery to longline gear are probably justified under present conditions. There would be little point in adding new capacity as long as there exists an excessive amount already committed to the fishery.

If the size of the fleet can be reduced gradually to a point where the bulk of its operations is on a full-time basis, it would appear desirable to start a research program to determine the feasibility and relative costs of other types of gear. Experimental fishing under rigid control could provide factual answers to questions that are now matters of conjecture, without jeopardizing the longline fleet in any way. If the results indicate a significant cost advantage to other types of gear, it should be possible to provide for their slow and orderly introduction into commercial use, with priority being given to existing licensees who may wish to convert to the new types.

ADMINISTRATION

The adoption of some version of the program advocated above would require substantial modification of Canadian and American legislation authorizing the halibut program. It would also involve the assumption of new powers, with new objectives and criteria. The actual administration of these provisions would depend in large part on the judgment of the Commission as to its proper role. Simplicity of organization and the excellent record of the Commission and its staff suggest that it is best qualified to assume the added responsibilities, perhaps with the assistance of an advisory group specifically chosen to deal with economic aspects of the industry. If the Commission should feel it necessary to divorce its biological research and policy recommendations from economic considerations, a similar joint Canadian-American group would be required to formulate and administer policy with respect to control of fishing units. In either case, the present work of the Commission must continue—basic data on stocks, yield, and effort are even more essential if control is to be extended toward economic objectives. In addition, periodic sample surveys of the type undertaken in this study could provide, at little cost, necessary information on the economic status of the individual fisherman and vessel owner.

ALTERNATIVE PROPOSALS

Maximum economic benefits from the halibut fishery cannot be realized without restricting the number of fishing units that would otherwise enter. Admittedly, this restriction can be achieved only slowly and in the face of opposition—even from those who stand to benefit. If it proves politically impossible to move in the direction of reducing the number of units, can performance of the industry be improved within the present framework of "biological regulation only"?

A number of potentially useful—and less controversial—measures might be considered. The voluntary layover program has lengthened the season and has reduced costs slightly. Its effectiveness, however, could be increased if it were given legal status and administered by the Commission. This change would also permit the Commission to coordinate the layover program with its other regulations. At present, the Commission's suggestions with respect to the layover agreements are advisory only, and the terms of the layover agreements are dependent on a balancing of port and fleet interests, which rests too heavily on the personalities involved. Although there is no evidence that the layover technique has been misused—to restrict total output in order to raise prices, or to give one group of vessels an undue advantage—it would seem desirable to give the technique the benefit of review by an informed public body such as the Commission.

Even if a reduction in the fleet by public action is not feasible, it might be possible to win acceptance of a proposal to peg the number of vessels at the present level by licensing. If, as current data suggest, we are nearing the level of maximum sustained yield, there can be no argument for more vessels. Even this limited power to restrict new entry would prevent a recurrence of the needless surge of new vessels into the fishery, such as occurred in the late forties, and the subsequent difficult downward adjustment.

As an alternative to a layover program, enforced by the Commission, it might be worthwhile to explore the possibility of a control system based on total fishing time per vessel. Total fishing time required to approximate the desired catch in each regulatory area would be divided among vessels applying for permission to fish. Each boat would then be free to use its allocation at any time during a longer open season. This system would spread landings over a longer period, as some vessels would reserve their fishing time to take advantage of higher late-season prices or to fish banks where concentrations occur later in the year. It would also permit the individual vessel owner to coordinate halibut fishing with other fishing operations more closely than at present.

From an administrative standpoint, the feasibility of such a scheme depends on the accuracy with which fishing time can be converted into catch estimates. At best, it would probably result in wider fluctuations above and below the Commission's targets from year to year and would add a further element of uncertainty with respect to inventory policies of marketing firms.

CONCLUDING RECOMMENDATIONS

In brief, the possibility of realizing the full economic potential resulting from the successful rebuilding of the halibut stocks hinges on the reduction of inputs. At the same time, considerations of equity and political feasibility require that any change in this direction be made slowly and with the same cautious regard for observed results that has characterized Commission actions in the past. The suggested policy would therefore follow these steps:

1. License all existing participants in the fishery, without charge or with a nominal fee only, and issue no new licenses.
2. Initiate regular studies of costs and earnings of vessels and fishermen to provide a continuous check on the economic status of the fleet.
3. At the end of an announced interim period—say 5 years—undertake further reduction of licenses. Distribution of licenses between Canada and the United States would be determined by negotiations by the two Governments, adhering as closely as possible to the prevailing situation. The reduction could be undertaken directly, with competitive bidding for licenses at stated intervals, or indirectly by imposition of a tax on fish delivered. Under either method, the Governments would not receive any portion of the catch receipts until earnings had been restored to satisfactory levels.
4. Earmark the proceeds of any tax, license fee, or license auction first for application toward expenses of the Commission's research and regulatory operations. Any amounts above that could be used to speed retirement of licenses or to add to general revenues.
5. Undertake a research program to test the feasibility of other cost-reducing measures, such as the controlled introduction of new fishing methods proved to be more economical. First access to licenses for the use of new methods should be given to existing licensees.

The question, can performance of the industry be improved within the present framework of biological regulation, raised at the beginning of this section can be answered with a qualified affirmative. It is possible to move in the direction of more economical use of the halibut resource with restrictions on individual freedom no more onerous than those imposed on other resource-based industries. By extending the period of transition, the fundamental cause of the industry's economic problems can be corrected without unfair burdens on those now engaged in the industry. There is a growing awareness in the fleet of the vital importance of decreasing costs in the face of competitive pressures. This awareness—together with the long history of cooperation among the two governments, the Commission, and the industry—offers an unparalleled opportunity for further progress in this pioneer program of fishery management.

SUMMARY

The halibut industry, already on a sound factual and administrative basis, offers a unique opportunity to realize further economic gains from regulation. The core of the problem is the necessity of reducing the number of participating vessels and men to the minimum required to take the maximum permitted catch.

In theory, this reduction might be accomplished by a "rental charge" for the right to fish or by a tax alone, with the two Governments acting as sole owners of the basic resource. In practice, however, it would be difficult to achieve the proper degree of restriction and level of incomes without similar treatment of all alternative fisheries in the region.

A direct reduction in licenses without a tax or fee would result in a scramble for the economic rent that would arise as total costs were reduced and in possible disruption of the organization of the industry.

A practical program would have to proceed slowly, licensing all vessels initially, and allowing normal attrition to reduce the size of the fleet for a specified period of time. Thereafter, further announced reductions would be achieved through direct reduction of licenses, with competitive bidding for those offered, or through a tax or license sufficiently high to reduce applications for licenses. In any case, it would be essential to achieve satisfactory levels of earnings before instituting charges for fishing rights. This determination of satisfactory levels of earnings would require the initiation of regular studies of costs and earnings to maintain current information on the economic status of the fleet.

If control of entry is established, it would be possible to undertake a research program to test the efficiency of alternative fishing methods and to permit controlled introduction of those that appear desirable.

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APPENDIXES

Contents

Appendix I

MATHEMATICAL FORMULATIONS

In this appendix, simple mathematical formulations will be provided to supplement the verbal and graphical theoretical exposition presented in the text. First, the properties of a model of the population dynamics of an unexploited fishery will be explored. Then the model will be expanded to take into consideration the effects of economic exploitation of the fishery resource by man. Finally, a "micro" analysis of the management of a privately owned fish resource will be presented.

A MODEL OF AN UNEXPLOITED FISHERY

The basic relationship in this approach[1] to the behavior of an unexploited fish population is the following one:

$$\frac{dN}{dt} = rN(1 - N/Ns), \qquad (1)$$

where $\frac{dN}{dt}$ is the instantaneous rate of change of the fish population, N is the population at time t, and r and N_s are parameters, or fixed quantities.

Equation 1 states that the dependence of the natural growth rate, $\frac{dN}{dt}$, on the population, N, is such that it is zero when $N = O$ and when $N = N_s$, positive when $O < N < N_s$ and negative when $N > N_s$. When $N = \frac{1}{2} N_s$, the natural rate of increase attains a maximum. Further, over the range of positive growth rates, the relation is symmetrical about $N = \frac{1}{2} N_s$. As Beverton and Holt pointed out (p. 330), the few experimental studies supporting equation 1 refer to increase in numbers, not in weight. To assume that growth in population weight is also a symmetrical sigmoid involves some difficulties of which the assumption that "the increase of the population depends solely on its total weight and is independent of the age- and size-composition of the individuals comprising them" appears to be the most serious. They remark, however, that this approach "seems to describe well enough the essential features of the growth towards stationary states of the very few natural populations for which suitable data are available." For this reason it will be adopted in what follows.

The solution to the differential equation in (1) is the well-known logistic growth curve.

$$N = \frac{N_s}{1 - (1 - N_s/N_0)\, e^{-rt}} \qquad (2)$$

in which t is time, e is the natural logarithm base, and N_0 is the population at time zero or the initial population. The solution in equation 2 indicates that as time progresses the population will change from its initial value, N_0, and will finally reach the value N_s, the final stationary value. As equation 1 is written, this development of the population will take place without oscillations.

[Cunningham (1958:234) states that experimental studies with biological populations "almost invariably show a variation much like this (that shown by equation 2). However, instead of approaching the ultimate value (N_s) monotonically, there are usually overshoots and decaying oscillations about this value. Sometimes, even violent oscillations about this value are observed." He discusses the following modification of equation 1, a mixed difference-differential equation, the solution to which may exhibit such oscillations:

$$\frac{dN}{dt} = rN(1 - N_{t-n}/_{ns})$$

in which N_{t-n} is the population lagged n time periods. If such a model is applicable to the halibut case and if the parameters in the model assume appropriate values, perhaps a case could be made for natural fluctuations in the halibut population as Burkenroad suggests; however, as far as the authors are aware, there are no

[1] According to Beverton and Holt (1957), the approach pursued in this section, the "sigmoid curve" theory, was developed by Hjort, Jahn, Ottestad, and Graham, and subsequently adopted in essence by a number of other authors in discussing problems of fishery exploitation (for example, Sette; Baerends; and Schaefer). For additional references, see the bibliography in Beverton and Holt's work. Some shortcomings of this approach are noted by Beverton and Holt. They, however, do state: "the sigmoid curve theory, by making the simplest reasonable assumption about the dynamics of a population, is valuable as a means of obtaining a rough appreciation from the minimum of data." It is hoped that fishery biologists will be interested enough in the models presented in this appendix to make improvements in the biological aspects of the analysis.

empirical studies that have been carried through to test the validity of this modified form of equation 1.]

A MODEL OF AN EXPLOITED FISHERY

To take account of man's exploitation of the fish population, a model incorporating traditional economic considerations, as well as the biological considerations presented above, must be constructed. The elements of one such model are shown below:

Demand relationship: $X^d = a_1 p + a_0 \quad a_1 < 0, a_0 > 0$ (3)

Supply relationship: $X^s = b_1 p + b_2 N \quad b_1$ and $b_2 > 0$ (4)

Market—clearing: $X^d = X^s = X$ (5)

Biological constraint: $\frac{dN}{dt} = r\,N(1 - N/N_s) - X$ (6)

The demand and supply relationships indicate the quantity of halibut demanded per unit time, X^d, and the quantity supplied per unit time, X^s as functions of the price per pound and of the price per pound and the fish population, respectively. Since a_1 is negative, a negative dependence of X^d on price exists: the higher the price, the smaller the quantity demanded. With b_1 and b_2 positive, a positive dependence of quantity supplied on price and population exists: the higher the price with a given population the larger the quantity supplied to the market by fishing enterprises; also, the larger the population with a given price, the larger the quantity supplied. (In brief, it is assumed that $\frac{\delta X^d}{\delta p} < 0$, $\frac{\delta X^s}{\delta p} > 0$ and $\frac{\delta X^s}{\delta N} > 0$.) The market-clearing equation states that the variables in the model, price, and population adjust to equate quantity supplied to quantity demanded. Lastly, the biological constraint indicates that the net rate of change in the population is the natural rate of increase, given by $rN\ (1 - N/N_s)$ minus the amount taken by man per unit time, denoted by X.

To study the characteristics of the solutions to the model presented above, one finds it convenient to substitute X for X^d and X^s in the first two relations to obtain:

$$X = a_1\,p + a_0,$$

and

$$X = b_1\,p + b_2 N$$

Then upon multiplying the first of these last two equations by b_1 and the second by a_1 and subtracting the second from the first, it is possible to eliminate p and to obtain X in terms of N; that is

$$X = \frac{1}{b_1 - a_1}\,(b_1 a_0 - a_1 b_2 N)$$

This expression for X may then be substituted in the biological constraint (6) to yield

$$\frac{dN}{dt} = rN(1 - N/N_s) - \frac{1}{(b_1 - a_1)}\,(b_1 a_0 - a_1 b_2 N)$$

or

$$\frac{dN}{dt} + \frac{r}{N_s} N^2 - \left(r + \frac{a_1 b_2}{b_1 - a_1}\right) N + \frac{b_1 a_0}{b_1 - a_1} = 0. \quad (7)$$

This, then, is the fundamental equation for the population implied by the model. For convenience, it may be written as follows:

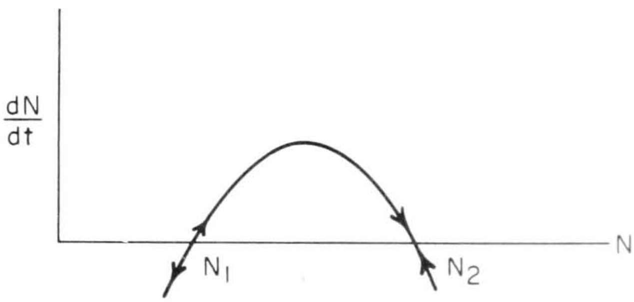
$$\frac{dN}{dt} + k_1\,N^2 - (r - c)\,N + k_0 = 0 \quad (7')$$

where

$$k_1 \equiv \frac{r}{N_s},\ c \equiv -\frac{a_1 b_2}{b_1 - a_1} \text{ and } k_0 \equiv \frac{b_1 a_0}{b_1 - a_1}.$$

Before obtaining an explicit solution to (7′), it is possible to infer some properties of the steady state solutions from phase-diagram considerations. That is, in a plot of $\frac{dN}{dt}$ against N, there will be two values of N for which $\frac{dN}{dt} = 0$ as shown in the figure below:

Phase Diagram for Equation (7′)



The phase diagram reveals that there are two values of the population, N_1 and N_2, for which the rate of change, $\frac{dN}{dt} = 0$; however, one of these, N_1 is an unstable solution since a slight change in the population produces a movement away from N_1. At a population equal to N_2, $\frac{dN}{dt} = 0$ and the solution is stable in the sense that with small disturbances the population will tend to reestablish at the level N_2. Explicitly,

$$N_2 = 1/2\,N_s\left[\,(1 - c/r) + \sqrt{(1 - c/r)^2 - \frac{4\,k_0}{r\,N_s}}\,\right] \quad (8)$$

is the value of the population associated with the stable solution. Graphically the solution corresponds to the intersection of the demand curve, supply curve, and sustained yield curve (see fig. . . in the text.) In general, the stationary equilibrium will involve a stable equilibrium population, N_2, which is smaller than the steady-state population, N_s, associated with the unexploited fishery.

The general solution to (7′) may be obtained as follows, given that two particular solutions, N_1 and N_2, are known. Insert the particular solutions in (7′) to obtain:

$$k_1N_1^2-(r-c)N_1+k_0=0$$

and

$$b_1N_2^2-(r-c)N_2+k_0=0$$

Subtract each of these equations from (7′) to obtain:

$$\frac{dN}{dt}+k_1(N^2-N_1^2)-(r-c)\ (N-N_1)=0$$

and

$$\frac{dN}{dt}+k_1(N^2-N_2^2)-(r-c)\ (N-N_2)=0$$

Divide both sides of the first of these two last equations by $(N-N_1)$ and both sides of the second by $(N-N_2)$; then subtraction of the first from the second yields:

$$\frac{1}{N-N_2}\frac{dN}{dt}-\frac{1}{N-N_1}\frac{dN}{dt}+k_1(N_2-N_1)=0$$

Now integration yields:

$$\log(N-N_2)-\log(N-N_1)+k_1(N_2-N_1)t+K_1=0$$

or

$$\frac{N-N_2}{N-N_1}=Ke^{-k_1(N_2-N_1)t}$$

where K is a constant of integration. Finally, this last expression may be put in the following form:

$$N=\frac{N_2-N_1Ke^{-k_1(N_2-N_1)t}}{1-Ke^{-k_1(N_2-N_1)t}} \tag{9}$$

Since $N_2>N_1$ and $k_1=\frac{r}{N_s}>O$, it is seen that as time progresses, N approaches N_2 the stable equilibrium solution.

While the model presented in equations (3)–(6) is an excellent starting point for the analysis of economic and biological changes in an exploited fishery, it suffers from at least one deficiency which is extremely important, namely, no allowance has been made for the effects of changes in income and technology, two factors which played a vital role in the halibut case. Consumer income, Y, should be included in the demand relationship and a technological improvement factor, T, should be included in the supply relationship. These two relationships now become:

$$X^d=a_1p+a_2Y+a_0, \tag{3'}$$

and,

$$X^s=b_1p+b_2N+b_3T. \tag{4'}$$

Both a_2 and b_3 should be positive indicating that the higher the level of income, all other things constant, the greater the quantity of halibut demanded, and the higher the level of technique or technology, the larger the quantity of halibut supplied, all other things constant. Both Y and T are viewed as exogenously determined factors. The simplest assumption that can be made regarding Y and T is that they are trend factors obeying the following relationships:

$$Y=\alpha_0+\alpha_1t \tag{10}$$

and

$$T=\beta_0+\beta_1t \tag{11}$$

where the α's and β's are parameters and t represents time.

If these modifications are introduced, the differential equation for N, equation (7) above, now becomes:

$$\frac{dN}{dt}+\frac{r}{N_s}N^2-(r+\frac{a_1b_2}{b_1-a_1})N+\frac{1}{b_1-a_1}[b_1a_0-b_1a_2Y-a_1b_3T]=0 \tag{12}$$

Remembering that $a_1<0$, it is seen that both Y and T have positive coefficients in (12). Thus the differential equation for N may be written as follows (a modification of (7′) which takes account of (10) and (11) above):

$$\frac{dN}{dt}+k_1N^2-k_2N+\delta_0+\delta_1t=0 \tag{13}$$

with k_1, k_2, and c as defined above, and

$$\delta_0\equiv\frac{1}{b_1-a_1}\ (b_1a_0+b_1a_2\alpha_0-a_1b_3\beta_0),$$

and

$$\delta_1\equiv\frac{1}{b_1-a_1}\ (b_1a_2\alpha_1-a_1b_3\beta_1).$$

The quantity δ_0 will be larger than zero and, with Y and T growing, δ_1 will also be positive.

The following method of obtaining an approximate solution to (13) is described by Cunningham (1958:250–253). Let

$$Z=\exp(k_1\int_0^t N dt).$$

Then equation (13) can be written in terms of Z as follows:

$$\frac{d^2Z}{dt^2}-k_2\frac{dZ}{dt}+k_1(\delta_0+\delta_1 t)Z=0.$$

Letting

$$Z=Y\exp\left(\int\frac{k_2}{2}dt\right) \text{ or } Y=Z\exp\left(-\int\frac{k_2}{2}dt\right),$$

this last equation becomes:

$$\frac{d^2y}{dt^2}+[k_1(\delta_0+\delta_1 t)-(\frac{k_2}{2})^2]Y=0$$

or

$$\frac{d^2y}{dt^2}+G(t)^2Y=0 \tag{14}$$

where

$$[G(t)]^2=k_1(\delta_0+\delta_1 t)-\left(\frac{k_2}{2}\right)^2.$$

An approximate solution to (14), the so-called WKBJ approximation, is

$$Y=\frac{1}{\sqrt{G}}[A\cos\phi(t)+B\sin\phi(t)],$$

where

$$\phi(t)\equiv\int G(t)\,dt.$$

Then, from above,

$$Z=Y\exp\left(\int\frac{k_2}{2}dt\right)=\frac{\exp\left(\int\frac{k_2}{2}dt\right)}{\sqrt{G}}[A\cos\phi(t)+B\sin\phi(t)].$$

Since

$$N=\frac{1}{k_1 Z}\frac{dZ}{dt}=\frac{1}{k_1}\frac{d}{dt}\ln Z,$$

where $\ln Z$ is the natural logarithm of Z, and

$$\ln Z=\int\frac{k_2}{2}dt+\ln[A\cos\phi(t)+B\sin\phi(t)]-\frac{1}{4}\ln G^2.$$

Then,

$$N=\frac{1}{k_1}\left[\frac{k_2}{2}+\frac{(B\cos\phi(t)-A\sin\phi(t))\frac{d\phi}{dt}}{A\cos\phi(t)+B\sin\phi(t)}-\frac{1}{4}\frac{\frac{dG^2}{dt}}{G^2}\right].$$

From the expression for G^2, given above,

$$\frac{dG^2}{dt}=k_1\delta_1.$$

Thus

$$N=\frac{k_2}{2k_1}-\frac{1}{4k_1}\frac{\delta_1}{\delta_0+\delta_1 t-\frac{k_2^2}{4k_1}}+\frac{1}{k_1}\frac{B\cos\phi(t)-A\sin\phi(t)}{A\cos\phi(t)+B\sin\phi(t)}\frac{d\phi}{dt},$$

or

$$N=\frac{1}{2}N_s(1-\frac{c}{r})+\frac{N_s}{r}\frac{\delta_1}{(r-c)^2-4(\delta_0+\delta_1 t)}+\frac{N_s}{r}\frac{B\cos\phi(t)-A\sin\phi(t)}{A\cos\phi(t)+B\sin\phi(t)}\frac{d\phi}{dt} \tag{15}$$

wherein use has been made of the definitions of k_1 and k_2. It is seen that as time progresses the second term in (15) approaches zero. The third term can give rise to oscillations. It is indeed interesting to observe that in a model without logarithms and with no oscillatory impressed force the approximate solution is characterized by an oscillatory component the characteristics of which, unfortunately, can not be specified precisely, given present inadequate knowledge of the values of parameters in the model.

MANAGEMENT OF A PRIVATELY OWNED FISH RESOURCE

In line with traditional economic theory, it is assumed that the owner of a fish resource will maximize discounted profits. Profits at time t are given by total revenue, pX, minus total costs, C; profits at time τ will then be given by:

$$\pi(\tau)=\int_\tau^\infty (pX-C)e^{-\delta t}dt \tag{16}$$

in which δ is the discount rate employed by the owner of the fish resource. It is necessary to find the time paths of output, input, and fish population which maximize $\pi(\tau)$. (In the present case price, p, is assumed constant.) This is the problem of management as viewed by the private owner of a fish resource. (It is assumed that this resource owner is one of many so that variations in his output rate do not influence market price, p.)

In maximizing (16), the owner of the fish resource is subject to three constraints: (a) a technological production function relating fishing effort E and population to output, (b) a cost function for inputs, and (c) a biological constraint. These are set forth below:

Production function: $X = aE^{\alpha}N^{\beta}$ (17)

Cost function: $C = bE$ (18)

Biological constraint: $\frac{dN}{dt} = rN\left(1 - \frac{N}{N_s}\right) - X.$ (19)

Except for the parameters, α, β and b, the only new quantity introduced is E, input of fishing effort per unit time. The production function resembles one used by Schaefer except for the fact that his condition that $\alpha = \beta = 1$ has not been adopted. To conform with the law of diminishing returns, it is assumed herein that α and β lie between 0 and 1. The cost function, precisely similar to that employed by Gordon and others, states that units of fishing effort are available at a constant cost per unit. Finally, the biological constraint is the same one employed in the previous section.

The problem of the private resource owner is then to maximize discounted profits subject to the constraints, (17) – (19), that is to determine the time paths for X, N and E consistent with the constraints which make discounted profits a maximum. In addition to a different specification of the production function, the approach outlined above differs fundamentally from that employed by all other workers in that the private owner is not assumed to take a sustained yield. He may do so if this is consistent with profit maximization; however, this is not a requirement of the present approach.

To show the importance of this latter modification, results flowing from former analyses will be contrasted with those given by the present approach. Formerly, Gordon, Schaefer, and others have employed models very similar if not identical to that shown below:

Production function:	$X = aEN$
Sustained yield restriction:	$X = rN(1 - N/N_s)$
Cost function:	$C = bE$
Profit equation:	$\pi = pX - C$

Note that the interest rate is ignored in this model. Now on substituting in the profit equation,

$$\pi = prN(1 - N/N_s) - \frac{br}{a}(1 - N/N_s).$$

The necessary condition for profit maximization, $\frac{d\pi}{dN} = 0$, yields the following stationary profit-maximizing population, N_m;

$$N_m = \frac{1}{2}\left(N_s + \frac{b}{ap}\right). \quad (20)$$

Since $\frac{N_s}{2}$ is the population compatible with a "maximum sustained physical yield," it is clear that the private resource owner takes less than a maximum sustained physical yield. Further, this formulation leads to the conclusion that the private resource owner will, in the process of profit maximization, operate with a fish population *larger* than that consistent with maximum sustained physical yield.

It is very interesting to note that introduction of a positive interest rate has no effect on N_m. This is obviously the case since the resource owner is assumed to take a sustained yield. That is, the sustained yield which maximizes profits in any period will also maximize discounted profits. Formally, the resource owner is now assumed to maximize discounted profits, $\pi(\tau)$, given by:

$$\pi(\tau) = \int_{\tau}^{\infty} (pX - C)\, e^{-\delta t} dt,$$

where δ is the interest rate. Maximization of the integral via an application of Euler's condition leads to the result given in (20). Thus within this model, the interest rate has no effect on the profit maximizing values of N, X, and E. This, it should be emphasized, is due to the ill-advised assumption that the resource owner is constrained to take a sustained yield.

If the sustained yield restriction in the above model is replaced by the biological constraint in (19), the profit-maximizing solution does depend on the interest rate. In fact (20) is the profit-maximizing population only if the interest rate is zero. In the present formulation, discounted profits are given by:

$$\pi(\tau) = \int_{\tau}^{\infty} (pX - C)\, e^{-\delta t} dt$$

$$= \int_{\tau}^{\infty} \left\{ p[rN(1 - N/N_s) - \dot{N}] - bE \right\} e^{-\delta t} dt$$

where $\dot{N} = dN/dt$. Since E can be expressed in terms of N and X and since $X = rN(1 - N/N_s) - \dot{N}$, from the biological constraint, the integrand is a function of N, $\dot{N}$ and t, say $I\ (N, N, t)$.

That is,

$$\pi(\tau)=\int_{\tau}^{\infty}[rN(1-N/N_*)-\dot{N}]\left[p-\frac{b}{aN}\right]e^{-\delta t}dt,$$

or

$$\pi(\tau)=\int_{\tau}^{\infty}I(N,\dot{N},t)\,dt.$$

Application of the Euler necessary condition for an extremum, $\frac{\delta I}{\delta N}-\frac{d}{dt}\frac{\delta I}{\delta \dot{N}}=0$, leads to the following value for the profit-maximizing population, N'_m:

$$N'_m=\frac{N_*}{4arp}\left[ap(r-\delta)+\frac{br}{N_*}+\sqrt{\left[ap(r-\delta+\frac{br}{N_*}\right]^2+\frac{8apbr\,\delta'}{N_*}}\right]. \quad (21)$$

It is interesting that once again a stationary population is a solution. Note too that in (21) there is a negative dependence of N'_m on the interest rate δ except for the second term under the square root sign which is small compared with other terms involving δ. Thus a rise in the interest rate leads the resource owner to reduce the fish population toward that compatible with a maximum sustained yield, thereby raising output. This can easily be seen by noting that the profit-maximizing value of output, X_m, may be obtained by substituting N'_m in the biological constraint given in (19).

Finally if the production function in (17) with α and β not necessarily equal to one is employed, the solution to the maximization problem is indeed complicated. In general it will involve both stationary and nonstationary solutions. In the particular case, $\alpha=\beta=\frac{1}{2}$ and $\delta=0$ which was chosen since it leads to the following relatively simple necessary condition for maximization:

$$\frac{d^2N}{dt^2}+\frac{1}{N}\left(\frac{dN}{dt}\right)^2+\left(\frac{2r}{N_*}N^2-\frac{2r}{N_*}N-r-\frac{2}{N}\right)\frac{dN}{dt}-\frac{3r^2}{N_*}N3$$
$$+\left(\frac{4r^2}{N_*}-\frac{2a^2pr}{b}\right)N^2+\left(\frac{a^2pr}{b}-r^2-\frac{2r}{N_*}\right)N+2r=0$$

Even under simplifying conditions, it is seen that the condition on N is complex. Particular stationary solutions may be obtained by solving the following equation:

$$\frac{3r^2}{N_*}N^3-\left(\frac{4r^2}{N_*}-\frac{2a^2pr}{b}\right)N^2+\left(\frac{a^2pr}{b}-r^2-\frac{2r}{N_*}\right)N+2r=0$$

The solutions to this cubic equation represent particular stationary solutions to the generalized problem under the special assumptions $\alpha=\beta=\frac{1}{2}$ and $\delta=0$.

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Appendix 2

1958 PACIFIC COAST HALIBUT LAYUP RULES

Adopted by
1958 Halibut Conference
Conferences held:
November 22 and 23, 1957
February 3 and 4, 1958

ORGANIZATIONS REPRESENTED:
- United Fishermen and Allied Workers Union
- Deep Sea Fishermen's Union of Prince Rupert
- Fishing Vessel Owners Association of B. C., Vancouver
- Fishing Vessel Owners Association of Prince Rupert
- Native Brotherhood of B. C.
- Pacific Trollers Association
- Deep Sea Fishermen's Union of Seattle
- Fishing Vessel Owners Association of Seattle
- Local 30, ILWU, Ketchikan, Alaska
- Ketchikan Vessel Owners Association
- Petersburg Fishermen's Union (Independent)
- Petersburg Vessel Owners Association
- Native Brotherhood of Alaska
- Juneau Vessel Owners Association
- Sitka Vessel Owners Association
- Hoonah Vessel Owners Association

PORTS REPRESENTED:
- Seattle and other Washington ports
- Vancouver, Prince Rupert, all other B. C. ports
- Angoon, Hoonah, Juneau, Kake, Ketchikan, Pelican, Petersburg, Sitka, and all other Alaska ports

ORIGIN AND OBJECT OF RULES

The layup rules listed in here have been worked out in a series of coastwise conferences and by meetings of halibut fishermen in all Pacific ports. The rules are designed to provide for some extension of the fishing season by establishing rest periods or layups and for more orderly delivery of the overall halibut production.

DEFINITION OF PORTS, PLANTS, AND CAMPS

HALIBUT PORTS: Points of landing halibut which have shorebased cold storage facilities and a regular fish exchange where trips are listed and bid for.

HALIBUT PLANTS: Points of landing halibut which have shorebased facilities for handling halibut.

HALIBUT CAMPS: All points of landing halibut OTHER THAN ports or plants as defined above.

RULES GOVERNING "HALIBUT VESSELS"

DEFINITION: "Halibut Vessel" is any vessel which lands halibut at ports or plants. All vessels with three or more men MUST land at ports or plants.

1. Halibut vessels must lay up 8 days between trips.
2. The Layup period shall start at 12 noon following arrival in port. In the event the vessel arrives in port after 12 noon, layup shall start at 12 noon of the following day. In Seattle the words "12 noon" shall be replaced by "2 p.m."
3. Layup time must be served either at the vessel's home port or plant of sale. Halibut vessels may travel from the port or plant of sale to their home port during layup. If they then leave from their home port and their home port is nearer the grounds than the port of sale, the standard traveling time shall be added to their layup period. Any United States halibut vessel which sells in Prince Rupert may travel to any port in Southeastern Alaska where enforcement agents with respect to the layup program are available,

in order to fit out. In such event, regular traveling time must be added.

4. There will be *no reduction in the regular lay-up between trips* in the event the vessel is forced to come into port or plant early with a partial trip of halibut due to a breakdown. If the breakdown holds the vessel in port longer than the regular layup period, days in excess shall be deducted from the next regular layup of the vessel concerned. THERE SHALL BE NO OTHER EXEMPTIONS.

5. There shall be NO EXEMPTIONS from the regular layup period on account of the Area 2 season closure being announced by the International Halibut Commission.

6. Vessels participating in the Area 2 second season may fish the allotted number of days without layup, otherwise the layup program will remain effective which means there will be no quick turn arounds to enable Area 3 vessels to participate and all vessels going out in the second season of Area 2 will have to complete 8 day's layup before proceeding to Area 3.

7. Any vessel which operates in Area 3B during the period from April 1 to May 4 shall be exempted from layup during the period providing such vessel lands its fish not later than May 6. At the end of the Area 3A fishing season, the layup program shall end for vessels clearing for Area 3B. Termination of layup shall take effect 8 days prior to the closure date of Area 3A and NOT upon announcement of closure by the Commission. This rule was adopted in compliance with a special request from the International Halibut Commission.

8. Crew members shall be required to take their 8-day rest period between trips and shall not be permitted to quit a vessel for the sole purpose of avoiding the 8-day rest provision.

9. Vessels and camp boats using longline gear for halibut shall *not be permitted* to change over to fishing for other species or use another type of gear during the layup or camp closures.

10. Penalty for leaving early: Any vessel which leaves from any port or plant ahead of its scheduled departure time as laid out in the rules shall have *one day's* layup time added to the next layup period for *each hour* of the violation. *Refusal to comply with the penalty will place the vessels on the unfair list and the crew will be suspended.*

11. Halibut vessels, planning to fish Area 3 on their next trip, may take advance layup in their home ports with a compensating deduction of layup on the following Area 3 trip, providing such following trip is landed in Alaska or in a northern British Columbia port other than the vessel's home port. In such cases the vessel may layup 12 days in home port and may after the following trip, have the layup away from home port reduced to 4 days. It shall be understood this will only apply in respect to advance layup and there shall be no deferred layup permitted.

RULES GOVERNING "CAMP BOATS"

DEFINITION: "Camp boat" is any one- or two-man halibut boat which makes delivery of halibut at camps.

1. Only one- or two-man halibut boats may deliver at camps, scows, or packers.

2. Once a one- or two-man halibut vessel makes delivery at a camp, scow, or packer, it is classified as a camp boat and must then make all deliveries at camps, scows, or packers, and *is not allowed* to deliver at ports or plants.

3. Conversely, any one- or two-man boat which delivers at a port or plant shall be classified as a halibut vessel and must NOT BE ALLOWED to deliver to camps, scows, or packers.

4. Camp boats landing halibut at camps, scows, or packers can fish 12 days, then must tie up for 8 days; then alternate 10 days' fishing and 8 days' tieup for the balance of the season.

5. All camp boats must complete their deliveries by 6 a.m. on the last day of each fishing period as shown below:

Camp Boat Fishing and Closed Periods

FIRST	Fishing Period:	6 a.m. May 4 to 6 a.m. May 16 (12 days)
	Closed Period:	6 a.m. May 16 to 6 a.m. May 24 (8 days)
SECOND	Fishing Period:	6 a.m. May 24 to 6 a.m. June 3 (10 days)
	Closed Period:	6 a.m. June 3 to 6 a.m. June 11 (8 days)
THIRD	Fishing Period:	6 a.m. June 11 to 6 a.m. June 21 (10 days)
	Closed Period:	6 a.m. June 21 to 6 a.m. June 29 (8 days)

* FOURTH Fishing Period: 6 a.m. June 29 to 6 a.m. July 9 (10 days)
Closed Period: 6 a.m. July 9 to 6 a.m. July 17

* It is very doubtful that the season will go beyond three fishing periods.

6. There will be NO EXEMPTIONS from the closed periods at the camps on account of the Area 2 season closure being announced by the International Halibut Commission.
7. Camp boats and vessels using longline gear for halibut shall not be permitted to change over to fishing for other species or use another type of gear during the layup or camp closures.
8. Camp boats which attempt delivery during closed periods shall turn over the proceeds to the Halibut Curtailment Fund. *Refusal to comply with this penalty will place the boat on the permanent unfair list. Union members will refuse to deliver halibut to any camp which accept halibut from any boat or crew on the unfair list.*
9. One- and two-man camp boats may land halibut at Butedale and Namu during the 12-day or 10-day open seasons but shall not be allowed to deliver halibut at Massett, Butedale and Namu during the 8-day camp closed seasons.

RULES GOVERNING SALMON TROLLERS

1. Ice packer trollers landing trips at ports or plants shall be allowed to deliver 3,000 pounds of halibut in any trip without being subject to any layup time. In the event more than 3,000 pounds of halibut are landed in any one trip, the vessel shall be subject to the 8-day layup unless such vessel had less than 50 percent halibut in such trip. The basic 3,000 pounds exemption shall apply to one trip in any 7-day period. If a troller lands between 2,000 and 3,000 pounds in a single trip and then lands over 2,000 pounds before the 7 days have elapsed, such vessel shall then be subject to the regular 8-day layup.
2. The day boat troll fleet delivering halibut at camps shall observe the same open and closed periods at the camps in respect to landing halibut as are applied to the one- and two-man halibut boats fishing at the camps, always provided that this ruling shall in no way affect their normal salmon trolling operations.
3. In the event ice packer trollers land halibut at camps during the first open period, they shall be expected to cease taking halibut during the 8-day closed period but may continue to troll for salmon. In order to ensure compliance with this ruling, no ice packer troller shall be permitted to land halibut during the second open period at the camps until the *sixth day* of such second open period. In the event any ice packer troller has been in camp during the last two days of the closed period and is cleared with the camp committee, such boat can land halibut at the camp any time during the camp open period. The same basic rules shall apply in succeeding open periods.
4. Ice packer trollers which land their first trip of halibut at a camp shall not be permitted to land halibut at any port or plant until the sixth day of the second open camp period. This would not prevent an ice packer from landing one trip at a camp and another at a port where both such deliveries are made within one regular open camp period.
5. The foregoing Rules do not apply to the second open season in Area 2 as determined by the International Halibut Commission.

HALIBUT LAYUP FUND PAYMENTS

In British Columbia, all halibut fishermen will contribute toward the Halibut Curtailment Fund on the basis of 50 cents per 1,000 pounds of halibut landed. On vessels owned by member firms of the Fisheries Association the standard deduction shall be 40 cents per 1,000 pounds. When settlements are made, this money is to be deducted and forwarded to the Halibut Curtailment Fund, care of the United Fishermen and Allied Workers Union in Vancouver. In the case of Prince Rupert vessels, care of the Prince Rupert Fishermen's Settlement Service.

STANDARD TRAVELING TIME BETWEEN PORTS

Please Note: These standard traveling times shall *only* apply in respect to *Rule 3* which basically covers traveling *towards* home port after landing a trip away from home port.

Seattle to Ketchikan .... 3 days
Seattle to Petersburg .... 3½ days
Seattle to Sitka or Juneau .... 4 days

Prince Rupert to Petersburg ...... 1 day
Vancouver to Prince Rupert ....2½ days
Vancouver to Bella Bella ....1½ days
Vancouver to Kyuquot ....1½ days
Victoria to Kyuquot ....1 day
Ketchikan to Petersburg ....½ day
Ketchikan to Juneau or Sitka ......1 day
Prince Rupert to Juneau or Sitka . 1½ days
Vancouver to Alert Bay ....1 day
Vancouver to Sointula ....1 day
Vancouver to Ucluelet, Tofino ......1 day
Victoria to Ucluelet, Tofino ....½ day

ATTENTION BOAT DELEGATES

1. You are responsible for a report to the Union office or other enforcement officer of the Lay-up Program *immediately* upon arrival in port.
2. You are responsible for checking out with your Union office or other enforcement officer when leaving port.
3. *Please Remember:* These Rules Are Your Rules and Only Your Full Cooperation Will Ensure Their Success.

Appendix 5

TOTAL CATCH, UNITS OF GEAR, AND CATCH PER UNIT, AREA 2, 1910–58

Year	Catch	Calculated number of units of gear fished	Catch per unit
	Million pounds	*Thousands*	*Pounds*
1910	51.0	188.7	271
1911	56.1	237.3	237
1912	59.6	339.5	176
1913	55.4	431.7	128
1914	44.5	359.8	124
1915	44.0	374.7	118
1916	30.3	265.4	114
1917	30.8	378.8	81
1918	26.3	301.9	87
1919	26.6	325.2	82
1920	32.4	387.1	84
1921	36.6	478.7	76
1922	30.5	488.5	62
1923	28.0	494.0	57
1924	26.2	473.0	55
1925	22.6	441.3	51
1926	24.7	478.0	52
1927	22.9	469.0	49
1928	25.4	537.3	47
1929	24.6	617.2	40
1930	21.4	616.3	35
1931	21.6	534.0	41
1932	22.0	445.1	49
1933	22.5	437.5	52
1934	22.6	410.9	55
1935	22.8	365.6	62
1936	24.9	458.8	54
1937	26.0	430.9	60
1938	25.0	363.0	69
1939	27.4	452.1	61
1940	27.6	440.4	63
1941	26.0	425.6	61
1942	24.3	378.2	64
1943	25.3	345.8	73
1944	26.5	314.2	84
1945	24.4	302.8	81
1946	29.7	351.2	85
1947	28.7	333.6	86
1948	28.4	312.2	91
1949	26.9	299.0	90
1950	27.0	281.7	96
1951	30.6	320.8	96
1952	30.8	251.8	123
1953	33.0	228.6	145
1954	36.7	274.0	134
1955	28.7	233.5	123
1956	35.4	274.2	129
1957	30.6	295.9	103
1958[1]	30.5	286.3	106

[1] 1958 data preliminary.
Note: While corrections have been made for obvious changes in efficiency of the gear over the years, the effects of other factors, such as weather, bait, stock size, area fished, etc., are being investigated.
Source: IPHC official data.

Appendix 6

BOAT TRIP, MAN DAYS, AND TOTAL LANDINGS, 1932–58

Year	Boat days	Man days	Total landings
	Number	*Number*	*Thousand pounds*
1932	105,006	500,004	44,487
1933	102,912	510,004	46,797
1934	105,558	502,726	47,547
1935	116,640	575,370	47,348
1936	109,510	540,327	49,468
1937	115,758	545,872	50,240
1938	107,908	540,176	50,241
1939	108,665	562,526	51,784
1940	98,271	509,792	54,307
1941	96,192	514,360	53,064
1942	81,011	428,201	50,759
1943	75,774	404,420	53,841
1944	111,162	514,876	53,630
1945	86,877	438,501	53,930
1946	75,591	364,857	60,837
1947	75,101	370,273	56,447
1948	57,312	277,272	56,118
1949	54,969	275,940	55,816
1950	53,856	267,300	57,649
1951	54,120	269,016	56,374
1952	55,610	282,449	62,823
1953	54,202	273,880	60,515
1954	60,822	304,482	71,206
1955	71,572	356,004	59,110
1956	71,724	356,396	67,505
1957	99,509	462,362	62,327
1958	72,324	350,658	65,034

Note.—Includes combined U.S. and Canadian fleets. Number of fishing days includes the regular fishing season plus the number of days allowed during the special fishing season which was inaugurated in 1951.
Source: Calculated from data in Table V-1, p. 94, and Table V-2, p. 97.

Appendix 7

LANDINGS BY SECTION OF COAST, 1911–58

Year	Relative landings				Weight of fish landed			
	California and Oregon	Washington	British Columbia	Alaska	California and Oregon	Washington	British Columbia	Alaska
	Percent	*Percent*	*Percent*	*Percent*	*Thousand pounds*	*Thousand pounds*	*Thousand pounds*	*Thousand pounds*
1911	....	57.79	27.85	14.36	....	32,900	15,854	8,177
1912	....	47.88	34.96	17.16	....	28,938	21,127	10,369
1913	....	46.45	33.58	19.96	....	30,912	22,347	13,284
1914	....	54.45	31.80	13.75	....	36,712	21,444	9,269
1915	0.40	41.20	46.20	12.20	273	28,327	31,769	8,387
1916	.51	32.20	53.44	13.85	253	16,104	26,723	6,928
1917	.61	31.89	47.10	20.40	299	15,592	23,030	9,977
1918	.78	26.58	46.85	25.79	297	10,096	17,793	9,796
1919	.79	28.33	49.64	21.23	321	11,462	20,084	8,591
1920	.69	26.80	49.50	23.01	324	12,580	23,233	10,802
1921	.59	22.48	56.98	19.95	307	11,795	29,892	10,467
1922	.83	23.49	63.32	12.37	351	9,982	26,906	5,256
1923	1.97	16.02	58.51	23.50	1,012	8,223	30,029	12,060
1924	1.15	13.98	56.45	28.41	610	7,429	29,997	15,098
1925	1.38	19.38	58.32	20.92	697	9,821	29,547	10,598
1926	1.18	19.24	52.76	26.83	617	10,093	27,681	14,077
1927	1.46	21.69	48.74	28.11	803	11,917	26,786	15,446
1928	1.30	25.68	56.15	16.86	707	13,935	30,467	9,151
1929	1.70	22.98	50.34	24.98	965	13,080	28,656	14,222
1930	1.54	25.42	49.42	23.63	760	12,583	24,466	11,698
1931	2.02	34.45	41.55	21.98	892	15,234	18,374	9,722
1932	1.94	49.45	38.32	10.29	865	21,998	17,046	4,578
1933	1.57	47.55	36.38	14.49	736	22,251	17,027	6,783
1934	2.86	43.57	38.51	15.05	1,361	20,718	18,313	7,155
1935	2.71	47.29	36.18	13.83	1,281	22,389	17,129	6,549
1936	1.43	46.48	34.37	17.72	708	22,995	17,001	8,764
1937	1.39	43.28	37.65	17.67	697	21,746	18,917	8,880
1938	1.40	42.96	38.83	16.81	705	21,582	19,507	8,447
1939	1.96	39.89	44.25	13.89	1,013	20,659	22,917	7,195
1940	1.87	35.83	44.39	17.91	1,014	19,461	24,106	9,726
1941	2.12	37.14	43.48	17.27	1,124	19,706	23,070	9,164
1942	1.56	29.67	48.46	20.31	792	15,061	24,597	10,309
1943	1.94	25.02	46.64	26.40	1,046	13,472	25,110	14,213
1944	1.63	22.30	34.97	41.10	876	11,957	18,756	22,041
1945	1.40	23.54	36.16	38.90	756	12,693	19,504	20,977
1946	1.53	23.52	37.02	37.92	931	14,312	22,524	23,070
1947	1.44	11.76	46.90	39.90	813	6,636	26,474	22,524
1948	1.06	18.47	37.57	42.90	595	10,367	21,083	24,073
1949	1.12	18.65	40.21	40.02	625	10,408	22,444	22,339
1950	1.25	15.50	39.22	44.02	723	8,938	22,613	25,375
1951	0.96	19.89	44.12	35.04	540	11,211	24,873	19,751
1952	1.10	21.37	42.48	35.05	693	13,426	26,687	22,017
1953	1.03	24.62	44.26	30.10	622	14,898	26,781	18,214
1954	1.49	24.67	41.38	32.18	1,061	17,780	29,464	22,901
1955	1.25	27.94	38.24	32.58	737	16,513	22,602	19,258
1956	1.14	25.05	38.40	35.42	772	16,907	25,919	23,907
1957	0.88	27.48	29.27	32.38	546	17,128	24,473	20,180
1958	1.07	27.36	37.60	33.96	697	17,786	24,453	22,088

Sources: 1888–1950: F. H. Bell, H. A. Dunlop and N. L. Freeman, "Pacific Coast Halibut Landings 1888 to 1950 and Catch According to Area of Origin," International Fisheries Commission Report No. 17 (Seattle, 1952) p. 10–11. 1951–57: Reports of the International Pacific Commission. 1958: Official data from International Pacific Halibut Commission.

Date	Q_t Landings of medium halibut	P_t Average daily price of medium halibut	P_{-1} Average daily price logged 1 market day	t Time
	Hundred pounds	*Cents*	*Cents*	*Days*
1956				
June 1	1,491	19.11	19.26	9
2	1,269	19.00	19.11	10
3	451	19.00	19.00	11
4	1,282	19.00	19.00	12
5	1,144	19.00	19.00	13
6	1,458	19.00	19.00	14
7	984	19.00	19.00	15
8	645	19.00	19.00	16
9	133	19.00	19.00	17
10	1,009	19.08	19.00	18
13	210	19.10	19.08	21
14	49	19.03	19.10	22
15	586	20.24	19.03	23
16	240	20.19	20.24	24
18	369	20.39	20.19	26
19	829	20.80	20.39	27
20	384	21.14	20.80	28
21	496	21.50	21.14	29
22	211	21.50	21.50	30
23	529	21.50	21.50	31
24	690	21.50	21.50	32
26	213	21.50	21.50	34
27	998	22.08	21.50	35
28	1,279	22.83	22.08	36
29	679	23.10	22.83	37
July 2	383	23.27	23.10	40
3	824	23.48	23.27	41
4	319	23.75	23.48	42
7	181	23.00	23.75	45
10	290	23.00	23.00	48
11	155	23.00	23.00	49
13	197	23.00	23.00	51
15	351	24.00	23.00	53
17	170	25.00	24.00	55
19	596	23.98	25.00	57
20	470	25.00	23.98	58
22	910	24.50	25.00	60
24	85	25.00	24.50	62
25	220	25.00	25.00	63
26	150	24.25	25.00	64
27	798	25.08	24.25	65
28	303	24.86	25.08	66
30	1,391	24.52	24.86	68
31	432	24.00	24.52	69
August 1	150	24.00	24.00	70
2	1,358	23.95	24.00	71
4	1,334	24.00	23.95	73
5	672	24.00	24.00	74
6	392	23.70	24.00	75
9	1,320	23.79	23.70	78
10	404	24.00	23.79	79
22	299	24.00	24.00	91
24	1,010	23.45	24.00	93
25	730	23.50	23.45	94
26	576	23.50	23.50	95
28	1,418	23.50	23.50	97
29	1,029	23.50	23.50	98
30	824	23.50	23.50	99
1957				
May 5	38	13.00	13.00	1
7	80	13.00	13.00	3
8	63	14.00	13.00	4
9	348	14.00	14.00	5
10	210	14.00	14.00	6

Date	Q_t Landings of medium halibut	P_t Average daily price of medium halibut	P_{-1} Average daily price logged 1 market day	t Time
	Hundred pounds	*Cents*	*Cents*	*Days*
1957				
May—Con.				
11	853	14.00	14.00	7
13	1,647	14.00	14.00	9
14	1,929	14.24	14.00	10
15	494	14.50	14.24	11
16	437	15.07	14.50	12
17	302	15.35	15.07	13
19	466	15.35	15.35	15
21	24	15.35	15.35	17
22	102	15.35	15.35	18
23	731	15.35	15.35	19
25	169	15.00	15.35	21
26	612	15.78	15.00	22
29	215	16.25	15.78	25
30	699	16.00	16.25	26
June 1	312	16.00	16.00	28
2	415	17.50	16.00	29
4	1,271	17.50	17.50	31
5	1,006	17.16	17.50	32
6	1,036	17.25	17.16	33
7	377	18.00	17.25	34
8	88	17.92	18.00	35
10	1,079	17.73	17.92	37
11	522	17.82	17.73	38
12	96	17.50	17.82	39
13	447	17.50	17.50	40
14	416	17.50	17.50	41
15	666	17.50	17.50	42
16	907	17.50	17.50	43
18	772	17.50	17.50	45
19	474	17.65	17.50	46
20	512	17.75	17.65	47
21	299	17.75	17.75	48
24	713	17.75	17.75	51
27	276	17.75	17.75	54
28	269	17.75	17.75	55
29	229	17.75	17.75	56
July 1	469	17.75	17.75	58
2	854	17.75	17.75	59
3	157	17.75	17.75	60
5	589	17.75	17.75	62
6	166	17.75	17.75	63
7	210	18.00	17.75	64
11	294	17.75	18.00	68
13	227	17.75	17.75	70
15	139	17.75	17.75	72
16	316	17.75	17.75	73
17	159	17.75	17.75	74
18	185	17.75	17.75	75
19	153	17.75	17.75	76
20	185	17.75	17.75	77
21	394	17.75	17.75	78
22	230	17.75	17.75	79
23	153	17.75	17.75	80
25	31	17.75	17.75	82
26	277	17.75	17.75	83
30	284	18.00	17.75	87
August 2	114	18.00	18.00	90
3	71	18.00	18.00	91
5	140	17.75	18.00	93
6	584	18.00	17.75	94
7	398	17.88	18.00	95
8	4	17.50	17.88	96
13	391	17.50	17.50	101
16	336	18.00	17.50	104

Data relating to Seattle pricing analysis

Date		Q_t Landings of medium halibut	P_t Average daily price of medium halibut	P_{-1} Average daily price logged 1 market day	t Time
		Hundred pounds	*Cents*	*Cents*	*Days*
1953					
May	21	465	24.57	24.57	1
	22	860	20.37	24.57	2
	25	2,571	17.60	20.37	5
	26	2,100	17.79	17.60	6
	27	2,261	17.60	17.97	7
	28	2,260	17.27	17.60	8
	29	3,559	17.94	17.27	9
June	1	9,602	16.18	17.94	12
	2	4,072	16.32	16.18	13
	3	6,811	15.06	16.32	14
	4	2,969	15.40	15.06	15
	5	3,333	15.71	15.40	16
	8	4,557	15.34	15.71	19
	9	1,285	17.61	15.34	20
	10	2,030	16.78	17.61	21
	11	2,226	17.62	16.78	22
	12	2,735	17.07	17.62	23
	15	400	19.00	17.07	26
	16	480	19.13	19.00	27
	17	280	22.00	19.13	28
	18	295	23.13	22.00	29
	19	200	27.50	23.13	30
	22	640	21.61	27.50	33
	26	140	27.00	21.61	37
	30	140	26.25	27.00	41
July	1	1,177	20.30	26.25	42
	2	1,445	20.36	20.30	43
	3	800	18.75	20.36	44
	6	3,365	18.31	18.75	47
	7	1,170	19.86	18.31	48
	8	1,245	19.96	19.86	49
	9	1,320	20.20	19.96	50
	10	1,560	20.01	20.20	51
	13	1,224	20.43	20.01	54
	14	1,315	20.99	20.43	55
	15	900	20.40	20.99	56
	16	2,085	19.89	20.40	57
	17	1,098	20.12	19.89	58
1954					
May	19	510	22.69	22.69	1
	20	354	22.33	22.69	2
	21	860	20.84	22.33	3
	24	2,905	18.47	20.84	6
	25	2,645	18.81	18.47	7
	26	4,271	18.99	18.81	8
	27	4,099	19.04	18.99	9
	28	3,612	19.35	19.04	10
	31	1,930	21.04	19.35	13
June	1	2,211	20.91	21.04	14
	2	1,552	21.60	20.91	15
	3	2,612	20.51	21.60	16
	4	975	22.73	20.51	17
	7	3,560	22.00	22.73	20
	8	7,605	19.48	22.00	21
	9	145	22.75	19.48	22
	11	790	23.19	22.75	24
	15	350	26.00	23.19	28
	18	290	26.00	26.00	31
	21	1,590	23.30	26.00	34
	22	975	23.06	23.30	35
	24	775	23.80	23.06	37
	25	856	24.25	23.80	38
	28	650	25.19	24.25	41
1954					
July	1	560	24.30	25.19	44
	2	678	23.67	24.30	45
	6	547	25.25	23.67	49
	7	167	25.88	25.25	50
	8	510	25.13	25.88	51
	9	725	24.75	25.13	52
	13	615	25.00	24.75	56
	14	1,935	24.13	25.00	57
	15	2,630	22.82	24.13	58
	16	6,895	22.00	22.82	59
	19	3,989	20.79	22.00	62
	20	3,220	20.68	20.79	63
	21	1,973	21.92	20.68	64
	22	350	23.88	21.92	65
1955					
May	16	430	17.56	17.56	1
	17	280	17.00	17.56	2
	18	400	16.39	17.00	3
	19	1,703	16.25	16.39	4
	20	1,736	14.46	16.25	5
	23	4,076	13.87	14.46	8
	24	3,067	13.76	13.87	9
	25	1,360	15.54	13.76	10
	26	2,283	14.34	15.54	11
	27	2,875	15.71	14.34	12
	31	5,260	13.62	15.71	16
June	1	1,485	15.02	13.62	17
	2	680	16.93	15.02	18
	3	1,834	14.68	16.93	19
	6	3,644	14.85	14.68	22
	7	2,428	15.54	14.85	23
	8	940	17.03	15.54	24
	9	450	17.79	17.03	25
	10	320	18.63	17.79	26
	13	335	20.01	18.63	29
	14	680	20.45	20.01	30
	15	255	22.13	20.45	31
	17	448	22.06	22.13	33
	20	898	19.54	22.06	36
	22	550	20.14	19.54	38
	23	1,500	19.60	20.14	39
	24	1,527	19.40	19.60	40
	27	2,255	19.62	19.40	43
	28	1,570	18.69	19.62	44
	29	239	19.25	18.69	45
	30	1,290	18.80	19.25	46
July	1	200	20.38	18.80	47
	5	1,690	19.22	20.38	51
	6	1,006	18.93	19.22	52
	7	465	19.01	18.93	53
	8	570	20.25	19.01	54
	11	1,830	18.99	20.25	57
	12	520	19.04	18.99	58
	13	200	20.25	19.04	59
	14	1,550	19.69	20.25	60
	15	296	20.25	19.69	61
	18	1,833	18.79	20.25	64
	21	570	20.25	18.79	67
	22	880	19.58	20.25	68
	25	1,380	19.52	19.58	71
	26	740	20.52	19.52	72
	27	1,560	19.58	20.52	73
	28	2,300	19.15	19.58	74
	29	460	19.30	19.15	75

Data relating to Seattle pricing analysis, 1953–57—Continued

Date	Q_t Landings of medium halibut	P_t Average daily price of medium halibut	P_{-1} Average daily price logged 1 market day	t Time
	Hundred pounds	*Cents*	*Cents*	*Days*
1955				
August 1	837	19.62	19.30	78
2	920	19.72	19.62	79
3	2,132	18.01	19.72	80
4	741	19.05	18.01	81
5	607	18.20	19.05	82
8	1,398	18.96	18.20	85
9	520	19.26	18.96	86
10	390	20.83	19.26	87
11	235	21.25	20.83	88
12	280	22.50	21.25	89
1956				
May 25	530	31.68	33.38	2
28	308	26.50	31.68	5
29	1,153	25.71	26.50	6
31	2,554	22.88	25.71	8
June 1	1,525	23.99	22.88	9
4	2,484	24.09	23.99	12
5	2,202	24.21	24.09	13
6	2,110	23.85	24.21	14
7	2,480	23.23	23.85	15
8	1,497	23.56	23.23	16
11	1,860	24.00	23.56	19
12	362	27.33	24.00	20
14	270	29.13	27.33	22
15	625	26.97	29.13	23
18	1,350	23.98	26.97	26
19	1,816	24.83	23.98	27
20	946	25.77	24.83	28
21	55	28.63	25.77	29
22	2,599	27.14	28.63	30
25	1,064	27.40	27.14	33
26	380	28.88	27.40	34
27	1,235	28.06	28.88	35
28	1,160	27.96	28.06	36
29	1,445	28.57	27.96	37
July 2	2,472	26.88	28.57	40
3	1,650	27.39	26.88	41
5	2,415	27.41	27.39	43
6	2,295	28.46	27.41	44
9	2,550	29.00	28.46	47
10	975	28.16	29.00	48
12	1,420	27.92	28.16	50
16	575	30.47	27.92	51
18	330	30.63	30.47	53
19	277	31.25	30.63	54
26	320	31.75	31.25	61
27	540	30.24	31.75	62
30	786	30.32	30.24	65
31	865	29.12	30.32	66
1956				
August 1	370	31.13	29.12	67
2	400	32.50	31.13	68
1956				
Aug.—Con.				
3	1,465	30.71	32.50	69
6	1,872	30.97	30.71	72
7	1,090	31.78	30.97	73
8	730	30.98	31.78	74
13	520	32.88	30.98	79
14	120	31.75	32.88	80
25	450	30.75	31.75	91
27	1,763	29.37	30.75	93
28	1,140	29.51	29.37	94
29	1,441	29.43	29.51	95
30	3,485	28.05	29.43	96
31	3,695	27.38	28.05	97
1957				
May 6	380	26.00	35.25	4
8	620	20.13	26.00	6
9	743	20.23	20.13	7
10	2,093	19.48	20.23	8
13	4,930	18.32	19.48	11
14	3,135	19.55	18.32	12
15	4,742	19.02	19.55	13
16	2,645	19.00	19.02	14
17	6,414	19.06	19.00	15
20	3,585	19.27	19.06	18
21	2,010	19.60	19.27	19
22	610	21.68	19.60	20
23	1,130	20.63	21.68	21
24	1,790	20.22	20.63	22
27	440	20.31	20.22	25
29	195	24.13	20.31	27
31	2,722	19.87	24.13	29
June 3	631	20.81	19.87	32
4	450	20.58	20.81	33
5	1,394	21.43	20.58	34
6	835	19.45	21.43	35
7	437	22.08	19.45	36
10	1,682	21.61	22.08	39
11	714	22.94	21.61	40
12	1,092	22.18	22.94	41
13	1,055	24.15	22.18	42
14	2,771	23.24	24.15	43
17	3,785	20.59	23.24	46
18	1,195	21.94	20.59	47
19	3,045	21.61	21.94	48
20	875	22.92	21.61	49
21	790	23.88	22.92	50
24	450	22.00	23.88	53
25	1,515	22.07	22.00	54
27	230	26.00	22.07	56
28	840	24.24	26.00	57
July 1	270	27.00	24.24	60
2	450	25.56	27.00	61
3	1,937	22.37	25.56	62
5	630	22.75	22.37	64

Appendix 10

ESTIMATES OF TIME SPENT IN EACH FISHERY

The method of estimating the time spent by a boat in each fishery is as follows:

From the settlement dates shown on the worksheets of the fifty sample boats, from which all income and expense items were tabulated, the number of trips each boat made in each year was obtained. These trips were identified as to halibut and/or black cod through the records of the International Pacific Halibut Commission. The beginning of halibut fishing for each boat was assumed to be the season opening date as announced by the Commission in each year. The total length of time spent in halibut fishing was taken as beginning on the opening date and ending on the last settlement date, if the halibut trips were consecutive. If there were other-than-halibut fishing trips (including black cod) interspersed with halibut trips through the year, the time spent halibut fishing was then computed from the opening date to the last settlement date preceding the other fishing trip and then beginning again from the day after the settlement of this other fishing trip to the next halibut settlement date. In cases where the first settlement shown for a boat was for a trip other than halibut, the average time spent in this other fishery (computed from the experience of this or other particular boats) was used to determine the time spent fishing before the opening of the halibut season.

The estimation of the time spent in the black cod fishery was similarly computed. Since practically all of the black cod trips are made near or at the close of the halibut fishing season, the estimation of time spent in black cod fishing is simply a matter of taking the number of days elapsed, starting from the day after the last settlement date, preceding the first black cod trip, to the last black cod settlement. Any interspersing of other-than-black cod trips (including halibut) were treated in a similar manner as were the halibut operations. These same computations were made for all the other fishing trips for each boat in order to arrive at the total time spent fishing in a single year. The number of days spent in the halibut and/or black cod fishery were then computed as a percentage of the total number of days spent fishing for each boat. This percentage was used to allocate the annual fixed expenses to the respective fisheries and thereby calculate the boat net income in each fishery.

A HYPOTHETICAL EXAMPLE MAY BRING OUT THE POINTS MORE CLEARLY.[1]

YEAR 19__

BOAT A				BOAT B			
Trips	Settlement date	Days fished	Time (days)	Trips	Settlement date	Days fished	Time (days)
Halibut	6/2	5/20[2]–6/2	14	Otter trawl	4/16	3/28–4/16	20[3]
Halibut	7/3	6/3–7–3	31	Halibut	6/8	5/20–6/8	20
Black cod	8/1	7/4–8/1	29	Halibut	7/3	6/9–7/3	25
Halibut	8/24	8/2–8/24	24	Halibut	8/1	7/4–8/1	29
Black cod	9/15	8/25–9/15	22	Tuna	9/10	8/2–9/10	40
Total days-All fishing			120				134
Total days-Halibut fishing			69				74
Total days-Black cod fishing			51				0
Percent of time spent halibut fishing			57.5				55.2
Percent of time spent black cod fishing			42.5				0

[1] The actual dates should not be taken too seriously. What is being demonstrated is the procedure used to arrive at time spent in the various fisheries.
[2] Assumed halibut season opening date.
[3] An estimated average time for this type of fishing.

Appendix 11

ESTIMATED REPLACEMENT COST OF 50 SAMPLE BOATS

Boat number	Cost	Boat number	Cost
	Dollars		*Dollars*
1	92,450	26	87,785
2	85,070	27	124,215
3	92,571	28	57,200
4	102,530	29	55,690
5	90,385	30	102,250
6	67,600	31	99,475
7	83,135	32	85,085
8	79,695	33	79,225
9	82,165	34	96,590
10	72,535	35	80,000
11	90,000	36	87,465
12	74,400	37	118,775
13	78,070	38	109,350
14	90,556	39	86,110
15	82,135	40	81,045
16	64,645	41	120,350
17	86,135	42	101,430
18	93,900	43	80,350
19	79,070	44	101,015
20	94,670	45	89,730
21	86,875	46	94,350
22	59,835	47	95,770
23	106,165	48	80,105
24	109,140	49	107,495
25	88,300	50	94,590

Note: Each estimate is an average of estimates received on each boat from two Seattle boat builders.

Appendix 12

QUESTIONNAIRE USED IN SURVEY OF FISHERMEN

DEEP SEA FISHERMEN'S UNION SURVEY OF MEMBERSHIP

All information provided by respondents will be regarded as highly confidential. The identification of respondents will not be divulged under any circumstances.

1. Name____________________ Age________
2. What is your citizenship? U.S. ( ): Other__________
3. How many dependents (including yourself) do you claim for income tax purposes at present?
4. How many of your dependents are under 16 years of age?______
5. What is your marital status? Single ( ); Married ( ); Widower ( ); Divorced ( ); Separated ( ).
6. What was your total income from all sources for each of the following years? (Give amount reported for Federal income tax purposes. If you do not have records, estimate your total income and place a check in the parentheses alongside your estimate.)
   1957 $________ ( ); 1956 $________ ( ); 1955 $________ ( ).
7. How much income in dollars did you get from each of the following:

	1957	No. of trips	1956	No. of trips	1955	No. of trips
a. Halibut and black cod fishing	$______	( )	$______	( )	$______	( )
b. Halibut fishing	$______	( )	$______	( )	$______	( )
c. Other fishing (specify)						
__________	$______	( )	$______	( )	$______	( )
__________	$______	( )	$______	( )	$______	( )
__________	$______	( )	$______	( )	$______	( )
d. Social Security payments	$______		$______		$______	
e. Other job or gainful employment (specify)	$______		$______		$______	

8. Did you draw unemployment insurance in:
   1957? Yes ( ); No ( ); How many weeks? ______ Total amount $______
   1956? Yes ( ); No ( ); How many weeks? ______ Total amount $______
   1955? Yes ( ); No ( ); How many weeks? ______ Total amount $______
9. What is the state of your health?
   Excellent ( ); Good ( ); Fair ( ); Poor ( ).
10. Have you been to see a doctor in the last twelve months? Yes ( ); No ( ).
    If you have been to see a doctor in the last twelve months, for what reason or reasons?
    Accident or sickness aboard vessel ( ) Explain __________
    Other reason or reasons ( ) Explain __________

Appendix 14

BOAT INCOME, HALIBUT AND BLACK COD OPERATIONS, BEFORE DEPRECIATION AND OTHER SPECIAL OWNER EXPENSE, 1953–57

Boat income here is defined equal to Total Boat Share less the sum of Master's Share, Unemployment Insurance Payments, Social Security Payments, Boat Insurance, Repairs and Maintenance Expense, and Supply and Sundry Expense. See Chapter 8 for definition of "Other Special Owner Expense".

Income	Net tonnage			
	19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1953				
Positive or zero				
0– 999	1	2	2	4
1,000–1,999	3	3	1	2
2,000–2,999	1	6	3	3
3,000–3,999	2	5	2	3
4,000–4,999	0	1	0	1
5,000–5,999	0	1	1	0
6,000–6,999	0	1	1	0
7,000–7,999	0	0	0	0
8,000–8,999	0	0	0	0
9,000–9,999	0	0	0	0
Subtotal	7	19	10	13
Negative				
0– 999	1	0	0	0
1,000–1,999	0	0	0	0
2,000–2,999	0	0	0	0
3,000–3,999	0	0	0	0
4,000–4,999	0	0	0	0
Subtotal	1	0	0	0
Total	8	19	10	13
Average	$1,750	$2,888	$2,900	$2,118
Overall average	$2,481			

Income	Net tonnage			
	19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1954				
Positive or zero				
0– 999	0	2	0	1
1,000–1,999	3	2	1	1
2,000–2,999	0	5	2	2
3,000–3,999	3	4	1	3
4,000–4,999	1	3	4	5
5,000–5,999	1	2	1	0
6,000–6,999	0	1	0	0
7,000–7,999	0	0	0	1
8,000–8,999	0	0	1	0
9,000–9,999	0	0	0	0
Subtotal	8	19	10	13
Negative				
1– 999	0	0	0	0
1,000–1,999	0	0	0	0
2,000–2,999	0	0	0	0
3,000–3,999	0	0	0	0
4,000–4,999	0	0	0	0
Subtotal	0	0	0	0
Total	8	19	10	13
Average	$3,125	$3,260	$4,200	$4,235
Overall average	$3,607			

Income	Net tonnage: 19 and under	20-29	30-39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1955				
Positive or zero				
0- 999	2	1	1	3
1,000-1,999	2	5	1	3
2,000-2,999	4	4	3	5
3,000-3,999	0	6	2	1
4,000-4,999	0	2	0	0
5,000-5,999	0	0	2	1
6,000-6,999	0	0	0	0
7,000-7,999	0	0	0	0
8,000-8,999	0	0	1	0
9,000-9,999	0	0	0	0
Subtotal	8	18	10	13
Negative				
1- 999	0	1	0	0
1,000-1,999	0	0	0	0
2,000-2,999	0	0	0	0
3,000-3,999	0	0	0	0
4,000-4,999	0	0	0	0
Subtota	0	1	0	0
Total	8	19	10	13
Average	$1,750	$2,518	$3,600	$2,118
Overall average	$2,475			
1956				
Positive or zero				
0- 999	2	2	0	1
1,000-1,999	1	1	1	1
2,000-2,999	2	1	0	2
3,000-3,999	1	3	3	2
4,000-4,999	2	5	2	1
5,000-5,999	0	3	1	3
6,000-6,999	0	3	0	0
7,000-7,999	0	0	0	1
8,000-8,999	0	0	2	1
9,000-9,999	0	0	1	0
Subtotal	8	18	10	12
Negative				
1- 999	0	0	0	0
1,000-1,999	0	0	0	0
2,000-2,999	0	0	0	0
3,000-3,999	0	0	0	0
4,000-4,999	0	0	0	0
Subtotal	0	0	0	0
Not fishing	0	1	0	0
Eliminated [1]	0	0	0	1
Total	8	19	10	13
Average	$2,500	$4,111	$5,300	$4,233
Overall average	$4,004			

[1] One boat was eliminated from sample in this year due to charter by the International Pacific Halibut Commission and the noncomparability of income and expense data.

Income	Net tonnage: 19 and under	20-29	30-39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1957				
Positive or zero				
0- 999	3	2	0	0
1,000-1,999	3	4	1	1
2,000-2,999	0	3	0	4
3,000-3,999	1	6	4	2
4,000-4,999	0	2	0	4
5,000-5,999	0	2	0	1
6,000-6,999	0	0	1	0
7,000-7,999	0	0	2	0
8,000-8,999	0	0	1	0
9,000-9,999	0	0	1	0
Subtotal	7	19	10	12
Negative				
1- 999	0	0	0	0
1,000-1,999	0	0	0	0
2,000-2,999	0	0	0	0
3,000-3,999	0	0	0	0
4,000-4,999	0	0	0	0
Subtotal	0	0	0	0
Not available	1	0	0	1
Total	8	19	10	13
Average	$1,349	$2,942	$5,500	$3,486
Overall average	$3,189			

Appendix 15

BOAT INCOME, HALIBUT OPERATIONS, BEFORE DEPRECIATION AND OTHER SPECIAL OWNER EXPENSE, 1953–57

Boat income here is defined equal to Total Boat Share less the sum of Master's Share, Unemployment Insurance Payments, Social Security Payments, Boat Insurance, Repairs and Maintenance Expense, and Supply and Sundry Expense. See Chapter 8 for definition of "Other Special Owner Expense".

Income	Net tonnage			
	19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1953				
Positive or zero				
0– 999	2	0	2	4
1,000–1,999	4	5	2	2
2,000–2,999	1	7	1	4
3,000–3,999	1	4	3	2
4,000–4,999	0	3	0	1
5,000–5,999	0	0	2	0
6,000–6,999	0	0	0	0
7,000–7,999	0	0	0	0
8,000–8,999	0	0	0	0
9,000–9,999	0	0	0	0
Subtotal	8	19	10	13
Negative				
1– 999	0	0	0	0
1,000–1,999	0	0	0	0
2,000–2,999	0	0	0	0
3,000–3,999	0	0	0	0
4,000–4,999	0	0	0	0
Subtotal	0	0	0	0
Total	8	19	10	13
Average	$1,625	$2,782	$2,800	$2,040
Overall average	$2,378			

Income	Net tonnage			
	19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1954				
Positive or zero				
0– 999	1	2	0	1
1,000–1,999	3	2	1	1
2,000–2,999	0	5	2	2
3,000–3,999	2	6	1	4
4,000–4,999	1	1	3	4
5,000–5,999	1	3	2	0
6,000–6,999	0	0	0	0
7,000–7,999	0	0	0	1
8,000–8,999	0	0	1	0
9,000–9,999	0	0	0	0
Subtotal	8	19	10	13
Negative				
1– 999	0	0	0	0
1,000–1,999	0	0	0	0
2,000–2,999	0	0	0	0
3,000–3,999	0	0	0	0
4,000–4,999	0	0	0	0
Subtotal	0	0	0	0
Total	8	19	10	13
Average	$2,750	$3,101	$4,300	$3,580
Overall average	$3,350			

Income	Net tonnage: 19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1955				
Positive or zero				
0– 999	4	2	0	2
1,000–1,999	0	3	2	4
2,000–2,999	4	7	3	4
3,000–3,999	0	5	2	2
4,000–4,999	0	1	0	0
5,000–5,999	0	0	2	1
6,000–6,999	0	0	0	0
7,000–7,999	0	0	0	0
8,000–8,999	0	0	1	0
9,000–9,999	0	0	0	0
Subtotal	8	18	10	13
Negative				
1– 999	0	1	0	0
1,000–1,999	0	0	0	0
2,000–2,999	0	0	0	0
3,000–3,999	0	0	0	0
4,000–4,999	0	0	0	0
Subtotal	0	1	0	0
Total	8	19	10	13
Average	$1,500	$2,358	$3,700	$2,272
Overall average	$2,408			
1956				
Positive or zero				
0– 999	2	2	0	1
1,000–1,999	2	1	1	0
2,000–2,999	2	2	0	3
3,000–3,999	1	2	3	2
4,000–4,999	1	5	2	0
5,000–5,999	0	6	1	4
6,000–6,999	0	0	0	0
7,000–7,999	0	0	0	1
8,000–8,999	0	0	2	1
9,000–9,999	0	0	1	0
Subtotal	8	18	10	12
Negative				
1– 999	0	0	0	0
1,000–1,999	0	0	0	0
2,000–2,999	0	0	0	0
3,000–3,999	0	0	0	0
4,000–4,999	0	0	0	0
Subtotal	0	1	0	0
Eliminated [1]	0	0	0	1
Not fishing	0	1	0	0
Total	8	19	10	13
Average	$2,125	$3,778	$5,300	$4,399
Overall average	$3,826			

[1] One boat was eliminated from sample in this year due to charter by the International Pacific Halibut Commission and the noncomparability of income and expense data.

Income	Net tonnage: 19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1957				
Positive or zero				
0– 999	4	3	0	0
1,000–1,999	2	5	2	0
2,000–2,999	0	6	3	4
3,000–3,999	1	4	3	2
4,000–4,999	0	0	0	4
5,000–5,999	0	1	0	1
6,000–6,999	0	0	1	0
7,000–7,999	0	0	0	0
8,000–8,999	0	0	0	0
9,000–9,999	0	0	1	0
Subtotal	7	19	10	12
Negative				
1– 999	0	0	0	0
1,000–1,999	0	0	0	0
2,000–2,999	0	0	0	0
3,000–3,999	0	0	0	0
4,000–4,999	0	0	0	0
Subtotal	0	0	0	0
Not available	1	0	0	1
Total	8	19	10	13
Average	$1,211	$2,306	$3,700	$3,542
Overall average	$2,418			

Appendix 16

BOAT INCOME, BLACK COD OPERATIONS, BEFORE DEPRECIATION AND OTHER SPECIAL OWNER EXPENSE, 1953–57

Boat income here is defined equal to Total Boat Share less the sum of Master's Share, Unemployment Insurance Payments, Social Security Payments, Boat Insurance, Repairs and Maintenance Expense and Supply and Sundry Expense. See Chapter 8 for definition of "Other Special Owner Expense".

Income	Net tonnage			
	19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1953				
Positive or zero				
0– 499	0	2	2	1
500– 999	1	1	1	1
1,000–1,499	0	1	0	0
1,500–1,999	1	2	0	0
2,000–2,499	0	0	0	0
2,500–2,999	0	0	0	0
3,000–3,499	0	0	0	0
3,500–3,999	0	0	0	0
4,000–4,499	0	0	0	0
4,500–4,999	0	0	0	0
Subtotal	2	6	3	2
Negative				
1– 499	1	2	0	0
500– 999	1	1	0	0
1,000–1,499	0	0	1	0
1,500–1,999	1	0	0	0
2,000–2,499	0	0	0	0
Subtotal	3	3	1	0
Not fishing	3	10	6	11
Total	8	19	10	13
Percent not fishing	37.5	52.6	60.0	84.6
Average	–$50	$528	$0	$500
Overall average	$290			

Income	Net tonnage			
	19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1954				
Positive or zero				
0– 499	2	1	0	2
500– 999	1	2	0	1
1,000–1,499	0	2	0	0
1,500–1,999	1	0	0	0
2,000–2,499	0	0	0	0
2,500–2,999	0	0	0	0
3,000–3,499	0	0	0	0
3,500–3,999	0	0	0	0
4,000–4,499	0	0	0	0
4,500–4,999	0	0	0	0
Subtotal	4	5	0	3
Negative				
1– 499	1	4	1	1
500– 999	0	0	1	0
1,000–1,499	0	0	0	0
1,500–1,999	0	0	0	0
2,000–2,499	0	0	0	0
Subtotal	1	4	2	1
Not fishing	3	10	8	9
Total	8	19	10	13
Percent not fishing	37.5	52.6	80.0	69.2
Average	$550	$361	–$500	$250
Overall average	$214			

Income	Net tonnage: 19 and under	20-29	30-39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1955				
Positive or zero				
0- 499	2	3	0	0
500- 999	1	3	0	0
1,000-1,499	1	1	0	0
1,500-1,999	0	1	0	0
2,000-2,499	0	0	0	0
2,500-2,999	0	0	0	0
3,000-3,499	0	0	0	0
3,500-3,999	0	0	0	0
4,000-4,499	0	0	0	0
4,500-4,999	0	0	0	0
Subtotal	4	8	0	0
Negative				
1- 499	0	0	1	1
500- 999	0	2	1	1
1,000-1,499	0	0	0	0
1,500-1,999	0	0	0	1
2,000-2,499	0	0	0	0
Subtotal	0	2	2	3
Not fishing	4	9	8	10
Total	8	19	10	13
Percent not fishing	50.0	47.4	80.0	76.9
Average	$625	$450	−$500	−$917
Overall average	$316			
1956				
Positive or zero				
0- 499	0	1	0	1
500- 999	2	3	2	0
1,000-1,499	0	1	0	0
1,500-1,999	1	0	0	0
2,000-2,499	0	0	0	0
2,500-2,999	0	0	0	0
3,000-3,499	0	0	0	0
3,500-3,999	0	0	0	0
4,000-4,499	0	0	0	0
4,500-4,999	0	0	0	0
Subtotal	3	5	2	1
Negative				
1- 499	0	3	0	2
500- 999	1	0	0	0
1,000-1,499	0	0	0	0
1,500-1,999	0	0	0	0
2,000-2,499	0	0	0	0
Subtotal	1	3	0	2
Not fishing	4	11	8	9
Eliminated [1]	0	0	0	1
Total	8	19	10	13
Percent not fishing	50.0	57.9	80.0	75.0
Average	$625	$375	$750	−$83
Overall average	$412			

Income	Net tonnage: 19 and under	20-29	30-39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1957				
Positive or zero				
0- 499	3	0	1	1
500- 999	1	3	0	0
1,000-1,499	0	1	0	0
1,500-1,999	0	1	0	0
2,000-2,499	0	0	0	0
2,500-2,999	0	1	0	0
3,000-3,499	0	1	0	0
3,500-3,999	0	0	0	0
4,000-4,499	0	0	0	0
4,500-4,999	0	0	0	0
Subtotal	4	7	1	1
Negative				
1- 499	1	2	1	0
500- 999	0	1	1	0
1,000-1,499	0	0	0	0
1,500-1,999	0	0	0	0
2,000-2,499	0	0	0	0
Subtotal	1	3	2	0
Not available	1	0	0	1
Not fishing	2	9	7	11
Total	8	19	10	13
Percent not fishing	28.6	47.4	70.0	91.7
Average	$250	$1,000	−$250	$250
Overall average	$439			

[1] One boat was eliminated from sample in this year due to charter by the International Pacific Halibut Commission and the noncomparability of income and expense data.

Appendix 17

BOAT INCOME, ALL FISHING OPERATIONS, AFTER DEPRECIATION REPORTED FOR INCOME TAX, 1953–57

Boat income here is defined equal to Total Boat Share less the sum of Master's Share, Unemployment Insurance Payments, Social Security Payments, Boat Insurance, Repairs and Maintenance Expense and Supply and Sundry Expense. "Other Owner Expense" has not been deducted.

Income	Net tonnage			
	19 and under	20-29	30-39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1953				
Positive or zero				
0- 999	1	1	2	2
1,000-1,999	2	4	1	1
2,000-2,999	1	5	2	1
3,000-3,999	1	2	0	3
4,000-4,999	0	3	0	1
5,000-5,999	0	1	1	0
6,000-6,999	0	0	1	0
7,000-7,999	0	0	0	0
8,000-8,999	0	0	0	0
9,000-9,999	0	0	0	0
Subtotal	5	16	7	8
Negative				
0- 999	2	1	1	3
1,000-1,999	0	2	1	1
2,000-2,999	1	0	0	0
3,000-3,999	0	0	1	1
4,000-4,999	0	0	0	0
Subtotal	3	3	3	5
Total	8	19	10	13
Average	$750	$2,200	$1,400	$1,040
Overall average	$1,487			

Income	Net tonnage			
	19 and under	20-29	30-39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1954				
Positive or zero				
0- 999	2	2	2	0
1,000-1,999	2	7	1	4
2,000-2,999	0	1	1	1
3,000-3,999	1	2	3	3
4,000-4,999	2	4	1	2
5,000-5,999	0	2	0	0
6,000-6,999	0	0	0	1
7,000-7,999	0	0	0	0
8,000-8,999	0	0	0	0
9,000-9,999	0	0	1	0
Subtotal	7	18	9	11
Negative				
0- 999	1	0	1	1
1,000-1,999	0	1	0	1
2,000-2,999	0	0	0	0
3,000-3,999	0	0	0	0
4,000-4,999	0	0	0	0
Subtotal	1	1	1	2
Total	8	19	10	13
Average	$2,000	$2,570	$2,900	$2,502
Overall average	$2,492			

Income	Net tonnage			
	19 and under	20-29	30-39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1955				
Positive or zero				
0- 999	1	5	0	4
1,000-1,999	4	2	4	3
2,000-2,999	1	4	0	1
3,000-3,999	0	3	0	2
4,000-4,999	0	0	2	1
5,000-5,999	0	0	0	0
6,000-6,999	0	0	1	0
7,000-7,999	0	0	0	0
8,000-8,999	0	0	0	0
9,000-9,999	0	0	0	0
Subtotal	6	14	7	11
Negative				
0- 999	2	4	0	1
1,000-1,999	0	1	2	1
2,000-2,999	0	0	1	0
3,000-3,999	0	0	0	0
4,000-4,999	0	0	0	0
Subtotal	2	5	3	2
Total	8	19	10	13
Average	$1,000	$1,192	$1,600	$1,424
Overall average	$1,050			
1956				
Positive or zero				
0- 999	2	2	1	0
1,000-1,999	2	1	0	1
2,000-2,999	2	3	3	3
3,000-3,999	0	5	0	1
4,000-4,999	1	4	1	0
5,000-5,999	0	1	1	2
6,000-6,999	0	1	0	1
7,000-7,999	0	0	2	3
8,000-8,999	0	0	0	0
9,000-9,999	0	0	1	0
Subtotal	7	17	9	11
Negative				
0- 999	1	1	1	1
1,000-1,999	0	0	0	0
2,000-2,999	0	1	0	0
3,000-3,999	0	0	0	0
4,000-4,999	0	0	0	0
Subtotal	1	2	1	1
Eliminated [1]	0	0	0	1
Total	8	19	10	13
Average	$1,625	$2,888	$4,200	$4,316
Overall average	$3,145			

[1] One boat was eliminated from sample in this year due to charter by the International Pacific Halibut Commission and the noncomparability of income and expense data.

Income	Net tonnage			
	19 and under	20-29	30-39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1957				
Positive or zero				
0- 999	2	2	1	1
1,000-1,999	2	3	0	2
2,000-2,999	0	4	1	0
3,000-3,999	1	3	2	5
4,000-4,999	0	2	0	2
5,000-5,999	0	1	1	1
6,000-6,999	0	2	0	0
7,000-7,999	0	0	1	0
8,000-8,999	0	0	1	0
9,000-9,999	0	0	1	1
Subtotal	5	17	8	12
Negative				
1- 999	1	2	2	0
1,000-1,999	1	0	0	0
2,000-2,999	0	0	0	0
3,000-3,999	0	0	0	0
4,000-4,999	0	0	0	0
Subtotal	2	2	2	0
Not available	1	0	0	1
Total	8	19	10	13
Average	$781	$2,782	$4,000	$3,735
Overall average	$2,760			

Appendix 18

BOAT INCOME, ALL FISHING OPERATIONS, AFTER DEPRECIATION COMPUTED ON VESSEL MARKET VALUE, 1953–57

Boat income here is defined equal to Total Boat Share less the sum of Master's Share, Unemployment Insurance Payments, Social Security Payments, Boat Insurance, Repairs and Maintenance Expense and Supply and Sundry Expense. "Other Owner Expense" has not been deducted.

Income	Net tonnage			
	19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1953				
Positive or zero				
0– 999	1	3	1	1
1,000–1,999	1	3	2	2
2,000–2,999	1	4	1	1
3,000–3,999	1	2	0	1
4,000–4,999	0	0	0	0
5,000–5,999	0	2	2	0
6,000–6,999	0	0	0	0
7,000–7,999	0	0	0	0
8,000–8,999	0	0	0	0
9,000–9,999	0	0	0	0
Subtotal	4	14	6	5
Negative				
0– 999	2	1	1	2
1,000–1,999	0	1	1	6
2,000–2,999	0	0	0	0
3,000–3,999	1	0	0	0
4,000–4,999	0	0	0	0
Subtotal	3	2	2	8
Not available	1	3	2	0
Total	8	19	10	13
Average	$500	$2,000	$1,875	–$38
Overall average	$1,232			

Income	Net tonnage			
	19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1954				
Positive or zero				
0– 999	1	2	0	1
1,000–1,999	2	4	1	2
2,000–2,999	2	2	2	5
3,000–3,999	0	3	2	1
4,000–4,999	0	4	1	0
5,000–5,999	1	0	0	1
6,000–6,999	0	0	0	0
7,000–7,999	0	0	0	0
8,000–8,999	0	0	1	0
9,000–9,999	0	0	0	0
Subtotal	6	15	7	10
Negative				
0– 999	1	0	1	2
1,000–1,999	0	0	0	1
2,000–2,999	0	1	0	0
3,000–3,999	0	0	0	0
4,000–4,999	0	0	0	0
Subtotal	1	1	1	3
Not available	1	3	2	0
Total	8	19	10	13
Average	$1,928	$2,375	$3,250	$1,731
Overall average	$2,316			

Income	Net tonnage: 19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1955				
Positive or zero				
0– 999	4	0	2	3
1,000–1,999	1	1	2	2
2,000–2,999	1	5	1	0
3,000–3,999	0	3	1	2
4,000–4,999	0	0	1	0
5,000–5,999	0	0	1	0
6,000–6,999	0	0	0	0
7,000–7,999	0	0	0	0
8,000–8,999	0	0	0	0
9,000–9,999	0	0	0	0
Subtotal	6	13	8	7
Negative				
0– 999	1	2	0	3
1,000–1,999	0	1	0	3
2,000–2,999	0	0	0	0
3,000–3,999	0	0	0	0
4,000–4,999	0	0	0	0
Subtotal	1	3	0	6
Not available	1	3	2	0
Total	8	19	10	13
Average	$786	$1,500	$2,500	$423
Overall average	$1,318			
1956				
Positive or zero				
0– 999	2	1	1	2
1,000–1,999	3	0	1	1
2,000–2,999	1	3	2	2
3,000–3,999	0	5	1	0
4,000–4,999	1	3	0	3
5,000–5,999	0	1	0	0
6,000–6,999	0	0	0	0
7,000–7,999	0	1	2	1
8,000–8,999	0	0	1	0
9,000–9,999	0	0	0	0
Subtotal	7	14	8	10
Negative				
0– 999	0	2	0	2
1,000–1,999	0	0	0	0
2,000–2,999	0	0	0	0
3,000–3,999	0	0	0	0
4,000–4,999	0	0	0	0
Subtotal	0	2	0	2
Not available	1	3	2	0
Eliminated [1]	0	0	0	1
Total	8	19	10	13
Average	$1,786	$3,188	$4,250	$2,833
Overall average	$3,009			

[1] One boat was eliminated from sample in this year due to charter by the International Pacific Halibut Commission and the noncomparability of income and expense data.

Income	Net tonnage: 19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1957				
Positive or zero				
0– 999	2	2	1	3
1,000–1,999	2	2	1	1
2,000–2,999	0	5	2	4
3,000–3,999	0	2	0	2
4,000–4,999	0	3	0	1
5,000–5,999	0	0	1	0
6,000–6,999	0	0	1	1
7,000–7,999	0	1	0	0
8,000–8,999	0	0	1	0
9,000–9,999	0	0	0	0
Subtotal	4	15	7	12
Negative				
0– 999	2	1	1	0
1,000–1,999	0	0	0	0
2,000–2,999	0	0	0	0
3,000–3,999	0	0	0	0
4,000–4,999	0	0	0	0
Subtotal	2	1	1	0
Not available	2	3	2	7
Total	8	19	10	13
Average	$500	$2,750	$3,375	$2,583
Overall average	$2,333			

Appendix 19

BOAT INCOME, HALIBUT AND BLACK COD OPERATIONS, AFTER DEPRECIATION REPORTED FOR INCOME TAX, 1953–57

Boat income here is defined equal to Total Boat Share less the sum of Master's Share, Unemployment Insurance Payments, Social Security Payments, Boat Insurance, Repairs and Maintenance Expense, and Supply and Sundry Expense. "Other Owner Expense" has not been deducted.

Income	Net tonnage			
	19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1953				
Positive or zero				
0– 999	1	1	4	3
1,000–1,999	2	6	1	3
2,000–2,999	2	6	2	3
3,000–3,999	2	2	0	3
4,000–4,999	0	1	1	0
5,000–5,999	0	2	1	0
6,000–6,999	0	0	0	0
7,000–7,999	0	0	0	0
8,000–8,999	0	0	0	0
9,000–9,999	0	0	0	0
Subtotal	7	18	9	12
Negative				
0– 999	0	0	0	1
1,000–1,999	1	1	1	0
2,000–2,999	0	0	0	0
3,000–3,999	0	0	0	0
4,000–4,999	0	0	0	0
Subtotal	1	1	1	1
Total	8	19	10	13
Average	$1,750	$2,412	$1,700	$1,810
Overall average	$2,005			

Income	Net tonnage			
	19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1954				
Positive or zero				
0– 999	0	1	2	0
1,000–1,999	3	3	2	2
2,000–2,999	1	1	1	5
3,000–3,999	2	3	3	2
4,000–4,999	2	1	1	2
5,000–5,999	0	1	0	0
6,000–6,999	0	2	0	1
7,000–7,999	0	2	0	0
8,000–8,999	0	2	1	0
9,000–9,999	0	3	0	0
Subtotal	8	19	10	12
Negative				
0– 999	0	0	0	1
1,000–1,999	0	0	0	0
2,000–2,999	0	0	0	0
3,000–3,999	0	0	0	0
4,000–4,999	0	0	0	0
Subtotal	0	0	0	1
Total	8	19	10	13
Average	$2,875	$5,380	$3,000	$2,888
Overall average	$3,858			

Income	Net tonnage			
	19 and under	20-29	30-39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1955				
Positive or zero				
0- 999	2	4	1	2
1,000-1,999	5	4	4	4
2,000-2,999	1	5	2	4
3,000-3,999	0	1	0	0
4,000-4,999	0	2	1	0
5,000-5,999	0	0	0	1
6,000-6,999	0	0	0	0
7,000-7,999	0	0	1	0
8,000-8,999	0	0	0	0
9,000-9,999	0	0	0	0
Subtotal	8	16	9	11
Negative				
0- 999	0	3	0	1
1,000-1,999	0	0	1	1
2,000-2,999	0	0	0	0
3,000-3,999	0	0	0	0
4,000-4,999	0	0	0	0
Subtotal	0	3	1	2
Total	8	19	10	13
Average	$1,375	$1,670	$2,200	$1,578
Overall average	$1,688			
1956				
Positive or zero				
0- 999	1	3	0	0
1,000-1,999	2	2	0	1
2,000-2,999	3	3	4	3
3,000-3,999	0	4	1	2
4,000-4,999	1	5	1	0
5,000-5,999	0	0	0	3
6,000-6,999	0	1	0	0
7,000-7,999	0	0	2	1
8,000-8,999	0	0	0	1
9,000-9,999	0	0	1	0
Subtotal	7	18	9	11
Negative				
0- 999	1	0	1	1
1,000-1,999	0	0	0	0
2,000-2,999	0	0	0	0
3,000-3,999	0	0	0	0
4,000-4,999	0	0	0	0
Subtotal	1	0	1	1
Not fishing	0	1	0	0
Eliminated [1]	0	0	0	1
Total	8	19	10	13
Average	$1,875	$2,915	$4,250	$4,000
Overall average	$3,157			

[1] One boat was eliminated from sample in this year due to charter by the International Pacific Halibut Commission and the noncomparability of income and expense data.

Income	Net tonnage			
	19 and under	20-29	30-39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1957				
Positive or zero				
0- 999	5	4	0	1
1,000-1,999	1	6	1	1
2,000-2,999	0	3	3	3
3,000-3,999	1	2	2	2
4,000-4,999	0	3	1	5
5,000-5,999	0	0	0	0
6,000-6,999	0	0	0	0
7,000-7,999	0	0	0	0
8,000-8,999	0	0	0	0
9,000-9,999	0	0	1	0
Subtotal	7	18	8	12
Negative				
1- 999	0	1	1	0
1,000-1,999	0	0	0	0
2,000-2,999	0	0	1	0
3,000-3,999	0	0	0	0
4,000-4,999	0	0	0	0
Subtotal	0	1	2	0
Not available	1	0	0	1
Total	8	19	10	13
Average	$1,071	$2,041	$2,700	$3,237
Overall average	$2,190			

Appendix 20

BOAT INCOME, HALIBUT AND BLACK COD OPERATIONS, AFTER DEPRECIATION COMPUTED ON VESSEL MARKET VALUE, 1953-57

Boat income here is defined equal to Total Boat Share less the sum of Master's Share, Unemployment Insurance Payments, Social Security Payments, Boat Insurance, Repairs and Maintenance Expense, and Supply and Sundry Expense. "Other Owner Expense" has not been deducted.

Income	Net tonnage			
	19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1953				
Positive or zero				
0– 999	1	0	3	5
1,000–1,999	4	5	1	4
2,000–2,999	0	5	1	2
3,000–3,999	1	2	0	1
4,000–4,999	0	2	0	0
5,000–5,999	0	0	2	0
6,000–6,999	0	0	0	0
7,000–7,999	0	0	0	0
8,000–8,999	0	0	0	0
9,000–9,999	0	0	0	0
Subtotal	6	14	7	12
Negative				
0– 999	0	1	0	1
1,000–1,999	1	1	0	0
2,000–2,999	0	0	0	0
3,000–3,999	0	0	1	0
4,000–4,999	0	0	0	0
Subtotal	1	2	1	1
Not available	1	3	2	0
Total	8	19	10	13
Average	$1,214	$2,125	$1,625	$1,269
Overall average	$1,652			

Income	Net tonnage			
	19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1954				
Positive or zero				
0– 999	1	1	1	1
1,000–1,999	2	3	2	3
2,000–2,999	2	5	0	4
3,000–3,999	1	5	3	3
4,000–4,999	1	1	1	0
5,000–5,999	0	0	0	0
6,000–6,999	0	0	0	1
7,000–7,999	0	0	1	0
8,000–8,999	0	0	0	0
9,000–9,999	0	0	0	0
Subtotal	7	15	8	12
Negative				
0– 999	0	1	0	0
1,000–1,999	0	0	0	1
2,000–2,999	0	0	0	0
3,000–3,999	0	0	0	0
4,000–4,999	0	0	0	0
Subtotal	0	1	0	1
Not available	1	3	2	0
Total	8	19	10	13
Average	$2,357	$2,438	$3,250	$2,346
Overall average	$2,559			

Income	Net tonnage			
	19 and under	20-29	30-39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1955				
Positive or zero				
0- 999	4	4	1	3
1,000-1,999	3	1	1	4
2,000-2,999	0	5	2	1
3,000-3,999	0	3	0	0
4,000-4,999	0	1	1	2
5,000-5,999	0	0	1	0
6,000-6,999	0	0	0	0
7,000-7,999	0	0	1	0
8,000-8,999	0	0	0	0
9,000-9,999	0	0	0	0
Subtotal	7	14	7	10
Negative				
0- 999	0	2	1	1
1,000-1,999	0	0	0	2
2,000-2,999	0	0	0	0
3,000-3,999	0	0	0	0
4,000-4,999	0	0	0	0
Subtotal	0	2	1	3
Not available	1	3	2	0
Total	8	19	10	13
Average	$928	$1,875	$3,000	$1,192
Overall average	$1,744			
1956				
Positive or zero				
0- 999	1	1	1	2
1,000-1,999	3	1	1	2
2,000-2,999	1	4	3	1
3,000-3,999	0	3	1	1
4,000-4,999	1	3	0	3
5,000-5,999	0	3	0	0
6,000-6,999	0	0	0	1
7,000-7,999	0	0	1	1
8,000-8,999	0	0	1	0
9,000-9,999	0	0	0	0
Subtotal	6	15	8	11
Negative				
0- 999	1	1	0	1
1,000-1,999	0	0	0	0
2,000-2,999	0	0	0	0
3,000-3,999	0	0	0	0
4,000-4,999	0	0	0	0
Subtotal	1	1	0	1
Not available	1	3	2	0
Eliminated [1]	0	0	0	1
Total	8	19	10	13
Average	$1,643	$3,250	$3,500	$3,083
Overall average	$2,905			

[1] One boat was eliminated from sample in this year due to charter by the International Pacific Halibut Commission and the noncomparability of income and expense data.

Income	Net tonnage			
	19 and under	20-29	30-39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1957				
Positive or zero				
0- 999	3	4	1	2
1,000-1,999	1	4	2	4
2,000-2,999	1	4	3	0
3,000-3,999	0	3	0	4
4,000-4,999	0	1	0	2
5,000-5,999	0	0	1	0
6,000-6,999	0	0	0	0
7,000-7,999	0	0	0	0
8,000-8,999	0	0	1	0
9,000-9,999	0	0	0	0
Subtotal	5	16	8	12
Negative				
0- 999	1	0	0	0
1,000-1,999	0	0	0	0
2,000-2,999	0	0	0	0
3,000-3,999	0	0	0	0
4,000-4,999	0	0	0	0
Subtotal	1	0	0	0
Not available	2	3	2	1
Total	8	19	10	13
Average	$833	$2,062	$3,125	$2,500
Overall average	$2,080			

Appendix 21

BOAT INCOME, HALIBUT OPERATIONS, AFTER DEPRECIATION REPORTED FOR INCOME TAX, 1953–57

Boat income here is defined equal to Total Boat Share less the sum of Master's Share, Unemployment Insurance Payments, Social Security Payments, Boat Insurance, Repairs and Maintenance Expense, and Supply and Sundry Expense. "Other Owner Expense" has not been deducted.

Income	Net tonnage			
	19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1953				
Positive or zero				
0– 999	2	1	2	3
1,000–1,999	3	8	2	3
2,000–2,999	2	5	3	4
3,000–3,999	1	3	0	2
4,000–4,999	0	2	1	0
5,000–5,999	0	0	1	0
6,000–6,999	0	0	0	0
7,000–7,999	0	0	0	0
8,000–8,999	0	0	0	0
9,000–9,999	0	0	0	0
Subtotal	8	19	9	12
Negative				
0– 999	0	0	0	1
1,000–1,999	0	0	1	0
2,000–2,999	0	0	0	0
3,000–3,999	0	0	0	0
4,000–4,999	0	0	0	0
Subtotal	0	0	1	1
Total	8	19	10	13
Average	$1,750	$2,358	$2,000	$1,732
Overall average	$2,027			

Income	Net tonnage			
	19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1954				
Positive or zero				
0– 999	1	2	2	0
1,000–1,999	3	6	1	1
2,000–2,999	1	6	2	6
3,000–3,999	1	2	3	3
4,000–4,999	2	2	1	1
5,000–5,999	0	1	0	0
6,000–6,999	0	0	0	1
7,000–7,999	0	0	0	0
8,000–8,999	0	0	1	0
9,000–9,999	0	0	0	0
Subtotal	8	19	10	12
Negative				
0– 999	0	0	0	1
1,000–1,999	0	0	0	0
2,000–2,999	0	0	0	0
3,000–3,999	0	0	0	0
4,000–4,999	0	0	0	0
Subtotal	0	0	0	1
Total	8	19	10	13
Average	$2,500	$2,464	$3,100	$2,888
Overall average	$2,680			

Income	Net tonnage			
	19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1955				
Positive or zero				
0– 999	4	5	2	2
1,000–1,999	3	6	4	5
2,000–2,999	1	5	2	3
3,000–3,999	0	1	0	1
4,000–4,999	0	1	1	0
5,000–5,999	0	0	0	1
6,000–6,999	0	0	0	0
7,000–7,999	0	0	1	0
8,000–8,999	0	0	0	0
9,000–9,999	0	0	0	0
Subtotal	8	18	10	12
Negative				
0– 999	0	1	0	1
1,000–1,999	0	0	0	0
2,000–2,999	0	0	0	0
3,000–3,999	0	0	0	0
4,000–4,999	0	0	0	0
Subtotal	0	1	0	1
Total	8	19	10	13
Average	$1,125	$1,643	$2,400	$1,886
Overall average	$1,531			

Income	19 and under	20–29	30–39	40 and over
1956				
Positive or zero				
0– 999	2	3	1	0
1,000–1,999	2	2	0	0
2,000–2,999	3	2	4	4
3,000–3,999	0	5	1	2
4,000–4,999	1	5	1	0
5,000–5,999	0	1	0	3
6,000–6,999	0	0	0	0
7,000–7,999	0	0	2	1
8,000–8,999	0	0	0	1
9,000–9,999	0	0	1	0
Subtotal	8	18	10	11
Negative				
0– 999	0	0	0	1
1,000–1,999	0	0	0	0
2,000–2,999	0	0	0	0
3,000–3,999	0	0	0	0
4,000–4,999	0	0	0	0
Subtotal	0	0	0	1
Eliminated [1]	0	0	0	1
Not fishing	0	1	0	0
Total	8	19	10	13
Average	$2,000	$2,915	$4,300	$4,067
Overall average	$3,209			

[1] One boat was eliminated from sample in this year due to charter by the International Pacific Halibut Commission and the noncomparability of income and expense data.

Income	Net tonnage			
	19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1957				
Positive or zero				
0– 999	5	4	1	1
1,000–1,999	1	8	1	1
2,000–2,999	0	4	4	3
3,000–3,999	1	1	1	2
4,000–4,999	0	1	1	5
5,000–5,999	0	0	0	0
6,000–6,999	0	0	0	0
7,000–7,999	0	0	0	0
8,000–8,999	0	0	0	0
9,000–9,999	0	0	1	0
Subtotal	7	18	9	12
Negative				
0– 999	0	0	0	0
1,000–1,999	0	1	1	0
2,000–2,999	0	0	0	0
3,000–3,999	0	0	0	0
4,000–4,999	0	0	0	0
Subtotal	0	1	1	0
Not available	1	0	0	1
Total	8	19	10	13
Average	$1,065	$1,616	$2,950	$3,237
Overall average	$2,075			

Appendix 22

BOAT INCOME, HALIBUT OPERATIONS, AFTER DEPRECIATION COMPUTED ON VESSEL MARKET VALUE, 1953–57

Boat income here is defined equal to Total Boat Share less the sum of Master's Share, Unemployment Insurance Payments, Social Security Payments, Boat Insurance, Repairs and Maintenance Expense, and Supply and Sundry Expense. "Other Boat Expense" has not been deducted.

Income	Net tonnage			
	19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1953				
Positive or zero				
0– 999	2	1	1	5
1,000–1,999	4	6	2	4
2,000–2,999	1	5	2	2
3,000–3,999	0	3	0	1
4,000–4,999	0	1	2	0
5,000–5,999	0	0	0	0
6,000–6,999	0	0	0	0
7,000–7,999	0	0	0	0
8,000–8,999	0	0	0	0
9,000–9,999	0	0	0	0
Subtotal	7	16	7	12
Negative				
0– 999	0	0	1	1
1,000–1,999	0	0	0	0
2,000–2,999	0	0	0	0
3,000–3,999	0	0	0	0
4,000–4,999	0	0	0	0
Subtotal	0	0	1	1
Not available	1	3	2	0
Total	8	19	10	13
Average	$1,357	$2,312	$2,125	$1,269
Overall average	$1,853			

Income	Net tonnage			
	19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1954				
Positive or zero				
0– 999	0	0	1	1
1,000–1,999	3	2	1	2
2,000–2,999	1	8	1	6
3,000–3,999	1	3	3	2
4,000–4,999	1	2	1	0
5,000–5,999	0	0	0	0
6,000–6,999	1	0	0	1
7,000–7,999	0	0	1	0
8,000–8,999	0	0	0	0
9,000–9,999	0	0	0	0
Subtotal	7	15	8	12
Negative				
0– 999	0	1	0	0
1,000–1,999	0	0	0	1
2,000–2,999	0	0	0	0
3,000–3,999	0	0	0	0
4,000–4,999	0	0	0	0
Subtotal	0	1	0	1
Not available	1	3	2	0
Total	8	19	10	13
Average	$3,071	$2,625	$3,375	$2,346
Overall average	$2,815			

Income	Net tonnage: 19 and under	20-29	30-39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1955				
Positive or zero				
0– 999	4	2	2	3
1,000–1,999	3	6	1	5
2,000–2,999	0	4	2	2
3,000–3,999	0	4	0	0
4,000–4,999	0	0	1	1
5,000–5,999	0	0	1	0
6,000–6,999	0	0	0	0
7,000–7,999	0	0	1	0
8,000–8,999	0	0	0	0
9,000–9,999	0	0	0	0
Subtotal	7	16	8	11
Negative				
0– 999	0	0	0	1
1,000–1,999	0	0	0	1
2,000–2,999	0	0	0	0
3,000–3,999	0	0	0	0
4,000–4,999	0	0	0	0
Subtotal	0	0	0	2
Not available	1	3	2	0
Total	8	19	10	13
Average	$928	$2,125	$3,125	$1,269
Overall average	$1,879			
1956				
Positive or zero				
0– 999	2	1	1	1
1,000–1,999	3	1	1	3
2,000–2,999	2	4	4	1
3,000–3,999	0	3	0	1
4,000–4,999	0	4	0	3
5,000–5,999	0	2	0	0
6,000–6,999	0	0	0	1
7,000–7,999	0	0	1	1
8,000–8,999	0	0	1	0
9,000–9,999	0	0	0	0
Subtotal	7	15	8	11
Negative				
0– 999	0	1	0	1
1,000–1,999	0	0	0	0
2,000–2,999	0	0	0	0
3,000–3,999	0	0	0	0
4,000–4,999	0	0	0	0
Subtotal	0	1	0	1
Not available	1	3	2	0
Eliminated [1]	0	0	0	1
Total	8	19	10	13
Average	$1,500	$3,188	$3,500	$3,167
Overall average	$2,866			

[1] One boat was eliminated from sample in this year due to charter by the International Pacific Halibut Commission and the noncomparability of income and expense data.

Income	Net tonnage: 19 and under	20-29	30-39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1957				
Positive or zero				
0– 999	3	3	1	2
1,000–1,999	1	5	2	4
2 000–2,999	1	6	3	0
3,000–3,999	0	1	0	4
4,000–4,999	0	0	0	2
5,000–5,999	0	0	1	0
6,000–6,999	0	0	0	0
7,000–7,999	0	0	0	0
8,000–8,999	0	0	1	0
9,000–9,999	0	0	0	0
Subtotal	5	15	8	12
Negative				
0– 999	1	0	0	0
1,000–1,999	0	1	0	0
2,000–2,999	0	0	0	0
3,000–3,999	0	0	0	0
4,000–4,999	0	0	0	0
Subtotal	1	1	0	0
Not available	2	3	2	1
Total	8	19	10	13
Average	$1,833	$1,625	$3,125	$2,500
Overall average	$1,913			

Appendix 23

BOAT INCOME, BLACK COD OPERATIONS, AFTER DEPRECIATION REPORTED FOR INCOME TAX, 1953–54

Boat income here is defined equal to Total Boat Share less the sum of Master's Share, Unemployment Insurance Payments, Social Security Payments, Boat Insurance, Repairs and Maintenance Expense, and Supply and Sundry Expense. "Other Owner Expense" has not been deducted.

Income	Net tonnage			
	19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1953				
Positive or zero				
0– 499	1	2	1	0
500– 999	0	1	0	1
1,000–1,499	0	1	0	0
1,500–1,999	1	1	0	0
2,000–2,499	0	0	0	0
2,500–2,999	0	0	0	0
3,000–3,499	0	0	0	0
3,500–3,999	0	0	0	0
4,000–4,499	0	0	0	0
4,500–4,999	0	0	0	0
Subtotal	2	5	1	1
Negative				
0– 499	0	1	1	1
500– 999	2	2	0	0
1,000–1,499	0	0	0	0
1,500–1,999	0	0	0	0
2,000–2,499	1	1	1	0
Subtotal	3	4	3	1
Not fishing	3	10	6	11
Total	8	19	10	13
Average	−$350	$28	−$750	−$875
Overall average	−$388			

Income	Net tonnage			
	19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1954				
Positive or zero				
0– 499	2	3	0	1
500– 999	1	1	0	0
1,000–1,499	0	0	0	0
1,500–1,999	1	0	0	0
2,000–2,499	0	0	0	0
2,500–2,999	0	0	0	0
3,000–3,499	0	0	0	0
3,500–3,999	0	0	0	0
4,000–4,499	0	0	0	0
4,500–4,999	0	0	0	0
Subtotal	4	4	0	1
Negative				
0– 499	1	2	0	2
500– 999	0	3	0	2
1,000–1,499	0	0	1	0
1,500–1,999	0	0	0	0
2,000–2,499	0	0	0	0
Subtotal	1	5	1	4
Not fishing	3	10	9	8
Total	8	19	10	13
Average	$550	−$139	−$1,250	−$350
Overall average	−$189			

Income	Net tonnage: 19 and under	20-29	30-39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1955				
Positive or zero				
0- 499	3	2	0	0
500- 999	0	1	0	0
1,000-1,499	1	1	0	0
1,500-1,999	0	1	0	0
2,000-2,499	0	0	0	0
2,500-2,999	0	0	0	0
3,000-3,499	0	0	0	0
3,500-3,999	0	0	0	0
4,000-4,499	0	0	0	0
4,500-4,999	0	0	0	0
Subtotal	4	5	0	0
Negative				
0- 499	0	3	1	0
500- 999	0	0	0	2
1,000-1,499	0	0	1	0
1,500-1,999	0	2	0	0
2,000-2,499	0	0	0	1
Subtotal	0	5	2	3
Not fishing	4	9	8	10
Total	8	19	10	13
Average	$688	$0	−$750	−$1,250
Overall average	−$241			
1956				
Positive or zero				
0- 499	0	2	1	1
500- 999	2	1	0	0
1,000-1,499	0	1	0	0
1,500-1,999	1	0	0	0
2,000-2,499	0	0	0	0
2,500-2,999	0	0	0	0
3,000-3,499	0	0	0	0
3,500-3,999	0	0	0	0
4,000-4,499	0	0	0	0
4,500-4,999	0	0	0	0
Subtotal	3	4	1	1
Negative				
0- 499	0	4	1	1
500- 999	0	0	0	1
1,000-1,499	1	0	0	0
1,500-1,999	0	0	0	0
2,000-2,499	0	0	0	0
Subtotal	1	4	1	2
Eliminated[1]	0	0	0	1
Not fishing	4	11	8	9
Total	8	19	10	13
Average	$500	$188	$0	−$250
Overall average	$134			

[1] One boat was eliminated from sample in this year due to charter by the International Pacific Halibut Commission and the noncomparability of income and expense data.

Income	Net tonnage: 19 and under	20-29	30-39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1957				
Positive or zero				
0- 499	2	1	0	0
500- 999	1	2	0	0
1,000-1,499	0	2	1	0
1,500-1,999	0	0	0	0
2,000-2,499	0	0	0	0
2,500-2,999	0	1	0	0
3,000-3,499	0	1	0	0
3,500-3,999	0	0	0	0
4,000-4,499	0	0	0	0
4,500-4,999	0	0	0	0
Subtotal	3	7	1	0
Negative				
0- 499	1	1	0	1
500- 999	1	1	1	0
1,000-1,499	0	1	1	0
1,500-1,999	0	0	0	0
2,000-2,499	0	0	0	0
Subtotal	2	3	2	1
Not available	1	0	0	1
Not fishing	2	9	7	11
Total	8	19	10	13
Average	$50	$800	−$250	−$250
Overall average	$218			

Appendix 24

BOAT INCOME, BLACK COD OPERATIONS, AFTER DEPRECIATION COMPUTED ON VESSEL MARKET VALUE, 1953–57

Boat income here is defined equal to Total Boat Share less the sum of Master's Share, Unemployment Insurance Payments, Social Security Payments, Boat Insurance, Repairs and Maintenance Expense, and Supply and Sundry Expense. "Other Owner Expense" has not been deducted.

Income	Net tonnage			
	19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1953				
Positive or zero				
0– 499	0	3	1	3
500– 999	0	0	0	0
1,000–1,499	0	1	1	0
1,500–1,999	1	0	0	0
2,000–2,499	0	0	0	0
2,500–2,999	0	0	0	0
3,000–3,499	0	0	0	0
3,500–3,999	0	0	0	0
4,000–4,499	0	0	0	0
4,500–4,999	0	0	0	0
Subtotal	1	4	2	3
Negative				
0– 499	1	3	1	2
500– 999	2	1	0	0
1,000–1,499	0	0	0	0
1,500–1,999	0	1	0	0
2,000–2,499	1	0	1	0
Subtotal	4	5	2	2
Not available	1	3	2	0
Not fishing	2	7	4	8
Total	8	19	10	13
Average	–$450	–$139	–$250	$50
Overall average	–$192			

Income	Net tonnage			
	19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
Positive or zero				
0– 499	1	1	0	0
500– 999	1	2	0	0
1,000–1,499	1	0	0	0
1,500–1,999	0	0	0	0
2,000–2,499	0	0	0	0
2,500–2,999	0	0	0	0
3,000–3,499	0	0	0	0
3,500–3,999	0	0	0	0
4,000–4,499	0	0	0	0
Subtotal	3	3	0	0
Negative				
0– 499	2	3	0	2
500– 999	0	2	0	3
1,000–1,499	1	1	1	0
1,500–1,999	0	0	0	0
2,000–2,499	0	0	0	0
Subtotal	2	6	1	5
Not available	1	3	2	0
Not fishing	2	7	7	8
Total	8	19	10	13
Average	$350	–$194	–$1,250	–$550
Overall average	–$348			

Income	Net tonnage			
	19 and under	20-29	30-39	60 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1955				
Positive or zero				
0- 499	2	3	0	0
500- 999	1	0	0	0
1,000-1,499	0	2	0	0
1,500-1,999	0	0	0	1
2,000-2,499	0	0	0	0
2,500-2,999	0	0	0	0
3,000-3,499	0	0	0	0
3,500-3,999	0	0	0	0
4,000-4,499	0	0	0	0
Subtotal	3	5	0	1
Negative				
0- 499	1	3	0	0
500- 999	0	1	0	1
1,000-1,499	0	1	1	0
1,500-1,999	0	1	0	0
2,000-2,499	0	0	0	1
Subtotal	1	6	1	2
Not available	1	3	2	0
Not fishing	3	5	7	10
Total	8	19	10	13
Average	$250	—$114	—$1,250	—$417
Overall average	—$313			
1956				
Positive or zero				
0- 499	1	1	2	0
500- 999	1	1	0	0
1,000-1,499	0	1	0	0
1,500-1,999	1	0	0	0
2,000-2,499	0	0	0	0
2,500-2,999	0	0	0	0
3,000-3,499	0	0	0	C
3,500-3,999	0	0	0	0
4,000-4,499	0	0	0	0
Subtotal	3	3	2	0
Negative				
0- 499	0	4	1	3
500- 999	0	0	0	1
1,000-1,499	1	0	0	0
1,500-1,999	0	0	0	0
2,000-2,499	0	0	0	0
Subtotal	1	4	1	4
Not available	1	3	2	0
Not fishing	3	9	5	8
Eliminated[1]	0	0	0	1
Total	8	19	10	13
Average	$375	$179	$83	—$375
Overall average	$94			

Income	Net tonnage			
	19 and under	20-29	30-39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1957				
Positive or zero				
0- 499	1	2	1	0
500- 999	0	0	0	0
1,000-1,499	0	1	0	0
1,50C-1,999	0	0	0	0
2,000-2,499	0	0	0	0
2,500-2,999	0	1	0	0
3,000-3,499	0	1	0	0
3,500-3,999	0	0	0	0
4,000-4,499	0	0	0	0
Subtotal	1	5	1	0
Negative				
0- 499	4	3	2	1
500- 999	C	0	0	0
1,0C0-1,499	0	1	0	C
1,50C-1,999	0	0	0	0
2,000-2,499	0	0	0	0
Subtotal	4	4	2	1
Not available	2	3	2	1
Not fishing	1	7	5	11
Total	8	19	10	13
Average	—$150	$639	—$83	—$250
Overall average	$144			

[1] One boat was eliminated from sample in this year due to charter by the International Pacific Halibut Commission and the noncomparability of income and expense data.

Appendix 25

BOAT MANSHARE FROM ALL FISHING OPERATIONS ON BOATS OF THE SEATTLE FLEET BY NET TONNAGE, 1953–57

Income	Net tonnage			
	19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1953				
0– 499	0	0	0	0
500– 999	0	0	0	0
1,000–1,499	0	0	0	2
1,500–1,999	3	3	0	3
2,000–2,499	0	1	1	0
2,500–2,999	0	3	1	2
3,000–3,499	1	3	4	2
3,500–3,999	2	3	0	2
4,000–4,499	1	1	1	1
4,500–4,999	1	2	1	1
5,000–5,499	0	3	1	0
5,500–5,999	0	0	1	0
Total	8	19	10	13
Average	$3,125	$3,511	$3,800	$2,791
Overall average	$3,336			

Income	19 and under	20–29	30–39	40 and over
1954				
0– 499	0	0	0	0
500– 999	0	0	0	0
1,000–1,499	0	0	0	0
1,500–1,999	0	0	0	1
2,000–2,499	1	1	1	1
2,500–2,999	0	2	1	1
3,000–3,499	1	2	1	2
3,500–3,999	1	2	1	2
4,000–4,499	2	2	1	3
4,500–4,999	0	4	1	1
5,000–5,499	2	0	1	1
5,500–5,999	1	2	1	1
6,000–6,499	0	2	1	0
6,500–6,999	0	1	0	0
7,000–7,499	0	1	1	0
Total	8	19	10	13
Average	$4,250	$4,624	$4,550	$3,792
Overall average	$4,359			

Income	Net tonnage			
	19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1955				
0– 499	0	0	0	0
500– 999	0	0	0	0
1,000–1,499	0	3	0	1
1,500–1,999	2	0	0	1
2,000–2,499	0	2	1	2
2,500–2,999	1	0	1	2
3,000–3,499	1	5	2	1
3,500–3,999	2	4	1	2
4,000–4,499	2	0	3	1
4,500–4,999	0	0	0	2
5,000–5,499	0	4	0	1
5,500–5,999	0	1	2	0
Total	8	19	10	13
Average	$3,125	$3,538	$3,950	$3,292
Overall average	$3,476			

Income	19 and under	20–29	30–39	40 and over
1956				
0– 499	0	0	0	0
500– 999	0	0	0	0
1,000–1,499	0	0	0	0
1,500–1,999	1	1	0	1
2,000–2,499	0	0	0	0
2,500–2,999	0	0	1	0
3,000–3,499	2	2	0	1
3,500–3,999	1	1	2	0
4,000–4,499	0	0	0	2
4,500–4,999	2	1	0	0
5,000–5,499	1	4	0	3
5,500–5,999	1	3	4	1
6,000–6,499	0	2	1	3
6,500–6,999	0	2	0	1
7,000–7,499	0	1	0	1
7,500–7,999	0	1	2	0
8,000–8,499	0	1	0	0
Total	8	19	10	13
Average	$3,688	$5,366	$5,500	$5,217
Overall average	$4,986			

Income	Net tonnage			
	19 and under	20-29	30-39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1957				
0- 499	0	1	0	0
500- 999	2	0	0	0
1,000-1,499	0	0	0	1
1,500-1,999	0	2	0	0
2,000-2,499	2	1	0	0
2,500-2,999	1	2	1	0
3,000-3,499	2	2	1	1
3,500-3,999	0	7	1	3
4,000-4,499	0	0	3	4
4,500-4,999	0	2	0	1
5,000-5,499	0	0	1	1
5,500-5,999	0	0	2	0
6,000-6,499	0	2	0	1
6,500-6,999	0	0	0	0
7,000-7,499	0	0	1	0
Not available	1	0	0	1
Total	8	19	10	13
Average	$2,179	$3,511	$4,650	$4,083
Overall average	$3,548			

Appendix 26

BOAT MANSHARE FROM HALIBUT AND BLACK COD OPERATIONS ON BOATS OF THE SEATTLE FLEET BY NET TONNAGE, 1953–57

Income	Net tonnage			
	19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1953				
0– 499	0	0	0	1
500– 999	0	0	0	3
1,000–1,499	4	1	0	2
1,500–1,999	1	8	2	2
2,000–2,499	0	2	3	2
2,500–2,999	0	1	1	1
3,000–3,499	3	1	2	1
3,500–3,999	0	3	0	1
4,000–4,499	0	1	0	0
4,500–4,999	0	1	1	0
5,000–5,499	0	1	1	0
5,500–5,999	0	0	0	0
Total	8	19	10	13
Average	$2,062	$2,716	$2,950	$1,752
Overall average	$2,422			
1954				
0– 499	0	0	0	0
500– 999	0	0	0	0
1,000–1,499	1	1	0	0
1,500–1,999	0	0	1	2
2,000–2,499	1	3	1	1
2,500–2,999	0	2	1	1
3,000–3,499	2	0	0	4
3,500–3,999	0	4	1	3
4,000–4,499	3	6	2	1
4,500–4,999	1	1	3	1
5,000–5,499	0	1	1	0
5,500–5,999	0	0	0	0
6,000–6,499	0	1	0	0
Total	8	19	10	13
Average	$3,438	$3,723	$3,850	$3,215
Overall average	$3,582			
1955				
0– 499	0	1	0	0
500– 999	0	1	0	0
1,000–1,499	0	3	1	2
1,500–1,999	3	0	0	2
2,000–2,499	1	3	2	2
2,500–2,999	1	2	2	2
3,000–3,499	1	4	4	3
3,500–3,999	2	4	1	2
4,000–4,499	0	1	0	0
Total	8	19	10	13
Average	$2,625	$2,610	$2,800	$2,560
Overall average	$2,640			
1956				
0– 499	0	0	0	0
500– 999	0	1	0	0
1,000–1,499	1	0	0	0
1,500–1,999	1	2	0	2
2,000–2,499	0	0	1	0
2,500–2,999	0	0	2	1
3,000–3,499	2	1	0	1
3,500–3,999	0	1	2	0
4,000–4,499	0	1	0	2
4,500–4,999	2	0	0	1
5,000–5,499	0	4	1	2
5,500–5,999	0	4	1	0
6,000–6,499	0	2	2	3
6,500–6,999	0	1	0	0
7,000–7,499	0	0	0	1
7,500–7,999	0	1	1	0
Not fishing	0	1	0	0
Total	8	19	10	13
Average	$2,375	$4,806	$4,650	$4,562
Overall average	$4,181			
1957				
0– 499	1	1	1	0
500– 999	2	1	0	0
1,000–1,499	0	2	0	1
1,500–1,999	0	1	0	0
2,000–2,499	2	3	1	2
2,500–2,999	1	3	2	2
3,000–3,499	0	1	3	1
3,500–3,999	1	4	0	3
4,000–4,499	0	0	0	2
4,500–4,999	0	2	1	1
5,000–5,499	0	0	1	0
5,500–5,999	0	0	1	0
6,000–6,499	0	1	0	0
Not available	1	0	0	1
Total	8	19	10	13
Average	$1,821	$2,875	$3,350	$3,250
Overall average	$2,806			

Appendix 27

BOAT MANSHARE FROM HALIBUT OPERATIONS ON BOATS OF THE SEATTLE FLEET BY NET TONNAGE, 1953–57

Income	Net tonnage: 19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1953				
0– 499	0	0	0	1
500– 999	1	1	0	3
1,000–1,499	4	2	0	1
1,500–1,999	1	6	4	3
2,000–2,499	0	3	3	3
2,500–2,999	0	4	0	0
3,000–3,499	2	1	1	1
3,500–3,999	0	2	0	1
4,000–4,499	0	0	1	0
4,500–4,999	0	0	1	0
Total	8	19	10	13
Average	$1,750	$2,239	$2,600	$1,752
Overall average	$2,102			
1954				
0– 499	0	0	0	0
500– 999	1	0	0	0
1,000–1,499	1	1	0	0
1,500–1,999	1	0	1	2
2,000–2,499	1	3	1	3
2,500–2,999	1	3	2	1
3,000–3,499	0	4	0	3
3,500–3,999	0	2	1	3
4,000–4,499	2	3	2	1
4,500–4,999	1	3	2	0
5,000–5,499	0	0	1	0
5,500–5,999	0	0	0	0
Total	8	19	10	13
Average	$2,219	$3,379	$3,650	$2,945
Overall average	$3,084			
1955				
0– 499	0	2	0	0
500– 999	3	1	0	0
1,000–1,499	0	2	1	2
1,500–1,999	1	1	1	2
2,000–2,499	1	5	1	3
2,500–2,999	0	6	3	2
3,000–3,499	2	0	3	3
3,500–3,999	1	1	1	1
4,000–4,499	0	1	0	0
Total	8	19	10	13
Average	$2,062	$2,186	$2,700	$2,445
Overall average	$2,309			

Income	Net tonnage: 19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1956				
0– 499	0	0	0	0
500– 999	0	1	0	0
1,000–1,499	2	0	0	0
1,500–1,999	1	2	0	2
2,000–2,499	0	0	1	0
2,500–2,999	2	0	1	1
3,000–3,499	0	1	1	1
3,500–3,999	0	3	2	0
4,000–4,499	0	2	0	2
4,500–4,999	3	3	0	1
5,000–5,499	0	1	1	2
5,500–5,999	0	3	1	0
6,000–6,499	0	0	2	3
6,500–6,999	0	1	0	0
7,000–7,499	0	0	0	1
7,500–7,999	0	1	1	0
Not fishing	0	1	0	0
Total	8	19	10	13
Average	$3,000	$4,306	$4,700	$4,562
Overall average	$4,140			
1957				
0– 499	3	2	1	0
500– 999	0	2	0	0
1,000–1,499	1	2	0	1
1,500–1,999	1	2	0	0
2,000–2,499	2	3	1	2
2,500–2,999	0	4	3	2
3,000–3,499	0	1	2	1
3,500–3,999	0	1	0	4
4,000–4,499	0	0	1	1
4,500–4,999	0	1	0	1
5,000–5,499	0	0	1	0
5,500–5,999	0	0	1	0
6,000–6,499	0	1	0	0
Not available	1	0	0	1
Total	8	19	10	13
Average	$1,107	$2,319	$3,250	$3,208
Overall average	$2,405			

Appendix 28

BOAT MANSHARE FROM BLACK COD OPERATIONS ON BOATS OF THE SEATTLE FLEET BY NET TONNAGE, 1953–57

Income	Net tonnage			
	19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1953				
0– 499	3	3	3	1
500– 999	1	1	1	1
1,000–1,499	0	3	0	0
1,500–1,999	1	1	0	0
2,000–2,499	0	1	0	0
Not fishing	3	10	6	11
Total	8	19	10	13
Percent not fishing	37.5	52.6	60.0	84.6
Average	$650	$1,028	$375	$500
Overall average	$711			
1954				
0– 499	2	3	2	1
500– 999	1	2	0	2
1,000–1,499	0	3	0	1
1,500–1,999	0	1	0	0
2,000–2,499	2	0	0	0
Not fishing	3	10	8	9
Total	8	19	10	13
Percent not fishing	37.5	52.6	80.0	69.2
Average	$1,150	$861	$250	$750
Overall average	$785			
1955				
0– 499	0	2	2	3
500– 999	3	4	0	0
1,000–1,499	0	4	0	0
1,500–1,999	1	0	0	0
2,000–2,499	0	0	0	0
2,500–2,999	0	0	0	0
Not fishing	4	9	8	10
Total	8	19	10	13
Percent not fishing	50.0	47.4	80.0	76.9
Average	$1,000	$850	$250	$250
Overall average	$647			

Income	Net tonnage			
	19 and under	20–29	30–39	40 and over
Dollars	*Number*	*Number*	*Number*	*Number*
1956				
0– 499	1	2	1	2
500– 999	1	3	1	0
1,000–1,499	1	2	0	1
1,500–1,999	1	1	0	0
Not fishing	4	11	8	9
Eliminated	0	0	0	1
Total	8	19	10	13
Percent not fishing	50.0	57.9	80.0	75.0
Average	$1,000	$875	$500	$583
Overall average	$772			
1957				
0– 499	2	5	3	1
500– 999	1	1	0	0
1,000–1,499	1	1	0	0
1,500–1,999	0	1	0	0
2,000–2,499	1	0	0	0
2,500–2,999	0	1	0	0
3,000–3,499	0	1	0	0
Not fishing	2	9	7	11
Not available	1	0	0	1
Total	8	19	10	13
Percent not fishing	28.6	47.4	70.0	91.7
Average	$950	$1,139	$250	$250
Overall average	$731			

Appendix 29

COMPOSITION OF GROSS STOCK OF THE SEATTLE FLEET[1] IN HALIBUT AND BLACK COD OPERATIONS, 1957

Item	Fleet total	Average per boat	Percentage breakdown
	Thousand dollars	*Dollars*	*Percent*
Gross stock	5,398.9	32,721	100.0
Gross stock expense	89.1	540	1.65
Net stock	5,309.8	32,181	98.35
Total crew expense	1,147.8	6,956	21.26
Total available for manshares	3,046.9	18,466	56.43
Gross boat share[2]	1,115.1	6,758	20.65

[1] The data for the Seattle fleet were estimated from the information obtained in the survey of 50 sample boats. Each component item, including the gross stock, was totaled for each of the sample boats and an average for each item was obtained for all boats in a particular tonnage class. These averages were then multiplied by the respective number of boats in each tonnage class in the whole Seattle fleet. The amounts appearing for each item, in each tonnage class, were then totaled to arrive at the total amount of each component item and gross stock for the whole fleet.

[2] Gross boat share equals 21 percent of net stock (which equals gross stock minus gross stock expense).

Appendix 30

COMPOSITION OF GROSS STOCK OF THE SEATTLE FLEET[1] IN HALIBUT OPERATIONS, 1957

Item	Fleet total	Average per boat	Percentage breakdown
	Thousand dollars	*Dollars*	*Percent*
Gross stock	4,674.9	28,333	100.0
Gross stock expense	76.2	462	1.63
Net stock	4,598.6	27,870	98.37
Total crew expense	980.7	5,944	20.98
Total available for manshares	2,651.0	16,066	56.70
Gross boat share[2]	966.9	5,860	20.68

[1] The data for the Seattle fleet were estimated from the information obtained in the survey of 50 sample boats. Each component item, including the gross stock, was totaled for each of the sample boats and an average for each item was obtained for all boats in a particular tonnage class. These averages were then multiplied by the respective number of boats in each tonnage class in the whole Seattle fleet. The amounts appearing for each item, in each tonnage class, were then totaled to arrive at the total amount of each component item and gross stock for the whole fleet.

[2] Gross boat share equals 21 percent of net stock (which equals gross stock minus gross stock expense).

Appendix 31

TOTAL REPORTED INCOME[1] OF UNION FISHERMEN, BY AGE GROUP, 1955–57

Total reported income	Age groups: I (34 and under)	II (35–49)	III (50–59)	IV (60 and over)
Dollars	*Number*	*Number*	*Number*	*Number*
1955				
0	2	0	0	0
1– 999	1	0	2	4
1,000–1,999	1	0	2	3
2,000–2,999	2	2	4	10
3,000–3,999	3	4	10	10
4,000–4,999	2	5	9	6
5,000–5,999	2	10	9	3
6,000–6,999	3	7	3	0
7,000–7,999	1	1	0	0
8,000–8,999	1	0	1	0
Total frequency	18	29	40	36
Averages (excluding those with zero income)	$4,562	$5,155	$4,175	$3,056
Averages (all cases)	$4,056	$5,155	$4,175	$3,056
Overall average (excluding those with zero income)	$4,283			
Overall average (all cases)	$4,213			
1956				
0	0	0	0	0
1– 999	0	0	0	2
1,000–1,999	0	0	1	3
2,000–2,999	0	0	0	7
3,000–3,999	3	1	7	6
4,000–4,999	3	2	5	8
5,000–5,999	6	4	11	5
6,000–6,999	3	8	6	4
7,000–7,999	2	4	5	1
8,000–8,999	0	7	3	0
9,000–9,999	1	2	2	0
10,000–10,999	0	1	0	0
Total frequency	18	29	40	36
Averages (excluding those with zero income)	$5,611	$7,086	$5,750	$3,917
Averages (all cases)	$5,611	$7,086	$5,750	$3,917
Overall average (excluding those with zero income)	$5,728			
Overall average (all cases)	$5,728			

Total reported income	Age groups: I (34 and under)	II (35–49)	III (50–59)	IV (60 and over)
Dollars	*Number*	*Number*	*Number*	*Number*
1957				
0	0	0	0	2
1– 999	0	0	1	4
1,000–1,999	0	0	2	6
2,000–2,999	1	0	7	11
3,000–3,999	5	2	10	7
4,000–4,999	1	6	8	3
5,000–5,999	3	8	8	3
6,000–6,999	3	7	3	0
7,000–7,999	3	5	1	0
8,000–8,999	1	1	0	0
9,000–9,999	0	0	0	0
10,000–10,999	1	0	0	0
Total frequency	18	29	40	36
Averages (excluding those with zero income)	$5,667	$5,845	$4,075	$2,735
Averages (all cases)	$5,667	$5,845	$4,075	$2,583
Overall average (excluding those with zero income)	$4,562			
Overall average (all cases)	$4,525			

[1] That is, income as reported for Federal income tax purposes.

Appendix 32

NUMBER OF FISHERMEN'S DEPENDENTS[1], BY AGE GROUPS, 1957

Dependents	Age group I (34 and under)	Age group II (35-49)	Age group III (50-59)	Age group IV (60 and over)
Number	*Number*	*Number*	*Number*	*Number*
1	4	0	7	7
2	3	5	19	13
3	8	6	6	11
4	3	8	5	5
5	0	8	1	0
6	0	1	2	0
7	0	1	0	0
Total frequency	18	29	40	36
Averages	2.56	3.90	2.50	2.39
Overall average	2.96			

[1] Including the fisherman himself.

Appendix 33

INCOME OF FISHERMEN FROM ALL SOURCES, BY AGE GROUPS, 1955–57

Income	Age group I (34 and under)	Age group II (35–49)	Age group III (50–59)	Age group IV (60 and over)
Dollars	*Number*	*Number*	*Number*	*Number*
1955				
0	2	0	0	0
1– 999	1	0	1	1
1,000–1,999	1	0	1	1
2,000–2,999	2	2	4	7
3,000–3,999	3	4	10	11
4,000–4,999	2	5	8	10
5,000–5,999	2	10	10	1
6,000–6,999	3	7	4	2
7,000–7,999	1	1	0	0
8,000–8,999	1	0	1	0
9,000–9,999	0	0	0	0
Not available	0	0	1	3
Total frequency	18	29	40	36
Average income (excluding those with zero income)	$4,056	$5,155	$4,423	$3,682
Average income (all cases)	$4,562	$5,155	$4,423	$3,682
Overall average (excluding those with zero income)	$4,506			
Overall average (all cases)	$4,436			

Income	Age group I (34 and under)	Age group II (35–49)	Age group III (50–59)	Age group IV (60 and over)
Dollars	*Number*	*Number*	*Number*	*Number*
1956				
0	0	0	0	0
1– 999	0	0	0	0
1,000–1,999	0	0	1	0
2,000–2,999	0	0	0	2
3,000–3,999	3	0	3	9
4,000–4,999	3	3	8	9
5,000–5,999	6	4	8	4
6,000–6,999	3	5	7	5
7,000–7,999	2	6	6	3
8,000–8,999	0	7	1	1
9,000–9,999	1	3	4	0
10,000–10,999	0	1	0	0
Not available	0	0	2	3
Total frequency	18	29	40	36
Average income (all cases)	$5,611	$7,293	$6,026	$4,924
Overall average (all cases)	$6,125			

Income	Age group I (34 and under)	Age group II (35–49)	Age group III (50–59)	Age group IV (60 and over)
1957				
0	0	0	0	0
1– 999	0	0	0	0
1,000– 1,999	0	0	2	6
2,000– 2,999	1	0	5	7
3,000– 3,999	4	2	7	11
4,000– 4,999	2	3	11	4
5,000– 5,999	3	10	8	3
6,000– 6,999	2	8	5	2
7,000– 7,999	4	5	1	0
8,000– 8,999	1	1	0	0
9,000– 9,999	0	0	0	0
10,000–10,999	1	0	0	0
Not available	0	0	1	3
Total frequency	18	29	40	36
Average income (all cases)	$5,778	$5,988	$4,449	$3,409
Overall average (all cases)	$4,896			

Appendix 34

INCOME OF UNION FISHERMEN FROM HALIBUT AND BLACK COD OPERATIONS, BY AGE GROUPS, 1955–57

Income	Age group I (34 and under)	II (35–49)	III (50–59)	IV (60 and over)
Dollars	*Number*	*Number*	*Number*	*Number*
1955				
0	6	3	4	4
1– 999	3	4	4	3
1,000–1,999	3	4	7	6
2,000–2,999	5	8	10	9
3,000–3,999	0	5	7	8
4,000–4,999	0	5	7	5
5,000–5,999	1	0	0	1
6,000–6,999	0	0	0	0
Not available	0	0	1	0
Total frequency	18	29	40	36
Average income (excluding those with zero income)	$2,000	$2,615	$2,671	$2,781
Average income (all cases)	$1,333	$2,345	$2,397	$2,472
Overall average (excluding those with zero income)	$2,587			
Overall average (all cases)	$2,251			
1956				
0	4	4	2	3
1– 999	2	1	3	4
1,000–1,999	1	1	4	4
2,000–2,999	2	0	2	7
3,000–3,999	4	4	4	4
4,000–4,999	3	5	8	6
5,000–5,999	2	6	11	4
6,000–6,999	0	6	3	4
7,000–7,999	0	2	1	0
8,000–8,999	0	0	2	0
Total frequency	18	29	40	36
Average income (excluding those with zero income)	$3,286	$5,020	$4,395	$3,470
Average income (all cases)	$2,556	$4,328	$4,175	$3,180
Overall average (excluding those with zero income)	$4,224			
Overall average (all cases)	$3,756			

Income	Age group I (34 and under)	II (35–49)	III (50–59)	IV (60 and over)
Dollars	*Number*	*Number*	*Number*	*Number*
1957				
0	0	0	3	5
1– 999	0	4	4	7
1,000–1,999	4	2	4	4
2,000–2,999	7	8	7	11
3,000–3,999	2	9	11	6
4,000–4,999	4	2	8	1
5,000–5,999	0	4	2	2
6,000–6,999	1	0	1	0
Total frequency	18	29	40	36
Average income (excluding those with zero income)	$3,056	$3,017	$3,176	$2,371
Average income (all cases)	$3,056	$3,017	$2,938	$2,042
Overall average (excluding those with zero income)	$2,905			
Overall average (all cases)	$2,758			

Appendix 35

INCOME OF UNION FISHERMEN FROM OTHER FISHING, BY AGE GROUPS, 1955–57

Income	Age group I (34 and under)	Age group II (35–49)	Age group III (50–59)	Age group IV (60 and over)
Dollars	*Number*	*Number*	*Number*	*Number*
1955				
0	15	15	22	30
1– 999	1	2	4	3
1,000–1,999	1	5	5	1
2,000–2,999	1	5	1	1
3,000–3,999	0	1	2	0
4,000–4,999	0	0	4	0
5,000–5,999	0	0	0	1
6,000–6,999	0	1	0	0
Not available	0	0	2	0
Total frequency	18	29	40	36
Average income (excluding those with zero income)	$1,500	$2,214	$2,312	$1,833
Average income (all cases)	$250	$1,069	$974	$306
Overall average (excluding those with zero income)	$2,047			
Overall average (all cases)	$740			

Income	Age group I (34 and under)	Age group II (35–49)	Age group III (50–59)	Age group IV (60 and over)
1956				
0	16	21	25	31
1– 999	1	3	2	2
1,000–1,999	0	0	6	1
2,000–2,999	1	2	2	0
3,000–3,999	0	0	1	0
4,000–4,999	0	2	2	1
5,000–5,999	0	0	1	0
6,000–6,999	0	0	0	1
7,000–7,999	0	0	0	0
8,000–8,999	0	1	0	0
Not available	0	0	1	0
Total frequency	18	29	40	36
Average income (excluding those with zero income)	$1,500	$3,000	$2,357	$2,700
Average income (all cases)	$167	$828	$846	$375
Overall average (excluding those with zero income)	$2,543			
Overall average (all cases)	$629			

Income	Age group I (34 and under)	Age group II (35–49)	Age group III (50–59)	Age group IV (60 and over)
Dollars	*Number*	*Number*	*Number*	*Number*
1957				
0	13	17	26	30
1– 999	3	1	7	3
1,000–1,999	1	4	3	2
2,000–2,999	1	2	1	0
3,000–3,999	0	2	1	0
4,000–4,999	0	1	0	1
5,000–5,999	0	1	1	0
6,000–6,999	0	0	0	0
7,000–7,999	0	1	0	0
Not available	0	0	1	0
Total frequency	18	29	40	36
Average income (excluding those with zero income)	$1,100	$3,000	$1,500	$1,500
Average income (all cases)	$306	$1,241	$500	$250
Overall average (excluding those with zero income)	$1,955			
Overall average (all cases)	$663			

Appendix 36

INCOME OF UNION FISHERMEN FROM ALL TYPES OF FISHING, BY AGE GROUPS, 1955–57

Income	Age group I (34 and under)	II (35–49)	III (50–59)	IV (60 and over)
Dollars	*Number*	*Number*	*Number*	*Number*
1955				
0	6	0	2	2
1– 999	1	1	3	4
1,000–1,999	2	0	2	5
2,000–2,999	8	10	9	8
3,000–3,999	0	10	7	9
4,000–4,999	0	6	11	5
5,000–5,999	1	0	4	3
6,000–6,999	0	2	0	0
7,000–7,999	0	0	0	0
8,000–8,999	0	0	1	0
Not available	0	0	1	0
Total frequency	18	29	40	36
Average income (excluding those with zero income)	$2,417	$3,466	$3,554	$2,941
Average income (all cases)	$1,611	$3,466	$3,372	$2,778
Overall average (excluding those with zero income)	$3,214			
Overall average (all cases)	$3,013			

Income	Age group I (34 and under)	II (35–49)	III (50–59)	IV (60 and over)
Dollars	*Number*	*Number*	*Number*	*Number*
1956				
0	2	2	1	2
1– 999	3	0	1	3
1,000–1,999	1	0	1	3
2,000–2,999	3	1	1	8
3,000–3,999	4	4	8	4
4,000–4,999	3	4	7	6
5,000–5,999	2	8	11	5
6,000–6,999	0	7	4	4
7,000–7,999	0	2	4	1
8,000–8,999	0	1	2	0
Total frequency	18	29	40	36
Average income (excluding those with zero income)	$3,062	$5,463	$5,064	$3,765
Average income (all cases)	$2,722	$5,086	$4,938	$3,556
Overall average (excluding those with zero income)	$4,600			
Overall average (all cases)	$4,338			
1957				
0	0	0	1	4
1– 999	0	0	2	5
1,000–1,999	1	0	3	5
2,000–2,999	6	5	10	12
3,000–3,999	6	11	10	5
4,000–4,999	4	5	7	2
5,000–5,999	0	5	5	3
6,000–6,999	1	1	2	0
7,000–7,999	0	2	0	0
8,000–8,999	0	0	0	0
Total frequency	18	29	40	36
Average income (excluding those with zero income)	$3,444	$4,224	$3,526	$2,594
Average income (all cases)	$3,444	$4,224	$3,438	$2,306
Overall average (excluding those with zero income)	$3,520			
Overall average (all cases)	$3,424			

Appendix 37

INCOME OF UNION FISHERMEN FROM EMPLOYMENT OTHER THAN FISHING, BY AGE GROUPS, 1955–57

Income	Age group: I (34 and under)	II (35–49)	III (50–59)	IV (60 and over)
Dollars	*Number*	*Number*	*Number*	*Number*
1955				
0	5	4	23	31
1– 999	0	3	7	0
1,000–1,999	3	10	4	2
2,000–2,999	4	9	2	3
3,000–3,999	3	3	2	0
4,000–4,999	0	0	0	0
5,000–5,999	2	0	1	0
6,000–6,999	1	0	0	0
7,000–7,999	0	0	0	0
Not available	0	0	1	0
Total frequency	18	29	40	36
Average income (excluding those with zero income)	$3,269	$1,980	$1,688	$2,100
Average income (all cases)	$2,361	$1,707	$692	$292
Overall average (excluding those with zero income)	$2,108			
Overall average (all cases)	$1,168			

Income	Age group: I (34 and under)	II (35–49)	III (50–59)	IV (60 and over)
Dollars	*Number*	*Number*	*Number*	*Number*
1956				
0	2	2	23	29
1– 999	2	3	4	4
1,000–1,999	3	8	7	0
2,000–2,999	5	12	3	0
3,000–3,999	0	1	2	3
4,000–4,999	3	2	0	0
5,000–5,999	2	1	1	0
6,000–6,999	1	0	0	0
7,000–7,999	0	0	0	0
Total frequency	18	29	40	36
Average income (excluding those with zero income)	$3,062	$2,278	$1,912	$1,786
Average income (all cases)	$2,722	$2,121	$813	$347
Overall average (excluding those with zero income)	$2,164			
Overall average (all cases)	$1,405			
1957				
0	2	3	23	27
1– 999	4	8	7	3
1,000–1,999	3	5	5	5
2,000–2,999	4	10	3	1
3,000–3,999	2	2	1	0
4,000–4,999	2	1	1	0
5,000–5,999	0	0	0	0
6,000–6,999	1	0	0	0
7,000–7,999	0	0	0	0
Total frequency	18	29	40	36
Average income (excluding those with zero income)	$2,438	$1,846	$1,559	$1,278
Average income (all cases)	$2,167	$1,655	$662	$319
Overall average (excluding those with zero income)	$1,708			
Overall average (all cases)	$1,122			

Appendix 38

UNEMPLOYMENT INSURANCE BENEFITS RECEIVED BY AGE GROUPS, 1955–57

Amount of benefit	Age group I (34 and under)	II (35–49)	III (50–59)	IV (60 and over)
Dollars	*Number*	*Number*	*Number*	*Number*
1955				
0	15	21	12	8
1– 99	0	3	2	0
100–199	1	1	4	1
200–299	0	2	2	2
300–399	1	1	1	2
400–499	1	1	5	3
500–599	0	0	3	1
600–699	0	0	3	5
700–799	0	0	5	6
800–899	0	0	0	4
900–999	0	0	2	1
Not available	0	0	1	3
Total	18	29	40	36
Averages (excluding those receiving no benefit)	$317	$200	$483	$614
Averages (all cases)	$53	$55	$335	$465
Overall average (excluding those receiving no benefit)	$396			
Overall average (all cases)	$233			
1956				
0	12	14	10	6
1– 99	1	6	0	0
100–199	2	3	4	0
200–299	1	5	6	4
300–399	0	1	4	5
400–499	0	0	2	3
500–599	0	0	3	1
600–699	0	0	2	2
700–799	2	0	2	4
800–899	0	0	3	7
900–999	0	0	2	2
Not available	0	0	2	2
Total	18	29	40	36
Averages (excluding those receiving no benefit)	$350	$157	$475	$600
Averages (all cases)	$117	$81	$350	$494
Overall average (excluding those receiving no benefit)	$381			
Overall average (all cases)	$262			

Amount of benefit	Age group I (34 and under)	II (35–49)	III (50–59)	IV (60 and over)
Dollars	*Number*	*Number*	*Number*	*Number*
1957				
0	12	10	7	10
1– 99	3	6	3	1
100–199	0	4	2	0
200–299	0	3	4	2
300–399	0	2	3	2
400–499	1	2	8	2
500–599	0	1	5	3
600–699	1	1	2	2
700–799	1	0	1	5
800–899	0	0	2	6
900–999	0	0	2	1
Not available	0	0	1	2
Total	18	29	40	36
Averages (excluding those receiving no benefit)	$333	$234	$453	$621
Averages (all cases)	$111	$153	$372	$438
Overall average (excluding those with zero income)	$404			
Overall average (all cases)	$278			

Appendix 39

NUMBER AND PERCENTAGE OF FISHERMEN RECEIVING UNEMPLOYMENT COMPENSATION, BY AGE GROUPS, 1955–57

	Age group							
	I (34 and under)		II (35–49)		III (50–59)		IV (60 and over)	
	Number	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*
1955								
Fishermen receiving unemployment compensation	3	(16.7)	8	(27.6)	28	(70.0)	28	(77.8)
Fishermen not receiving unemployment compensation	15	(83.3)	21	(72.4)	12	(30.0)	8	(22.2)
Total	18	(100)	29	(100)	40	(100)	36	(100)
Overall percentage receiving unemployment compensation	50.2							
956								
Fishermen receiving unemployment compensation	6	(33.3)	15	(51.7)	30	(75.0)	30	(83.3)
Fishermen not receiving unemployment compensation	12	(66.7)	14	(48.3)	10	(25.0)	6	(16.7)
Total	18	(100)	29	(100)	40	(100)	36	(100)
Overall percentage receiving unemployment compensation	63.4							
1957								
Fishermen receiving unemployment compensation	6	(33.3)	19	(65.5)	33	(82.5)	26	(72.2)
Fishermen not receiving unemployment compensation	12	(66.7)	10	(34.5)	7	(17.5)	10	(27.8)
Total	18	(100)	29	(100)	40	(100)	36	(100)
Overall percentage receiving unemployment compensation	67.4							

Appendix 40

SOCIAL SECURITY INCOME TO FISHERMEN OVER 65, 1955–57

Income	1955	1956	1957
Dollars	*Number*	*Number*	*Number*
0	17	7	3
1- 249	0	0	0
250- 499	1	2	0
500- 749	1	4	5
750- 999	1	3	3
1,000-1,249	2	2	4
1,250-1,499	0	0	0
1,500-1,749	0	0	0
1,750-1,999	1	1	1
Not available	0	1	1
Total	23	20	17
Average income (excluding those with zero income)	$1,000	$833	$933
Average income (all cases)	$261	$526	$758

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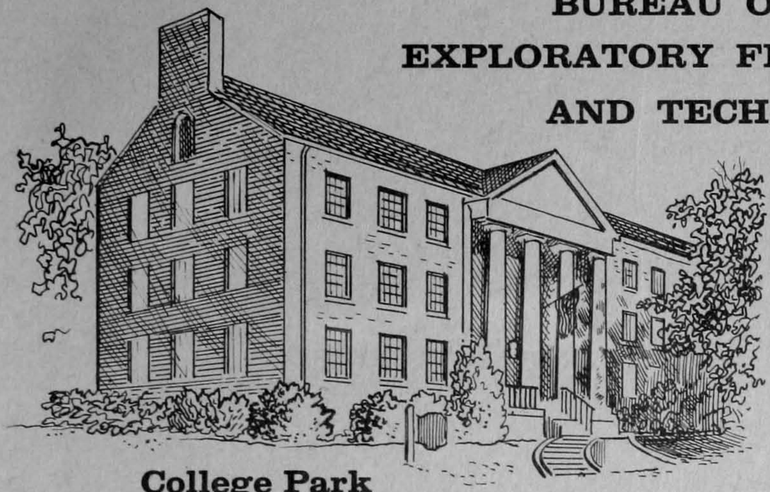

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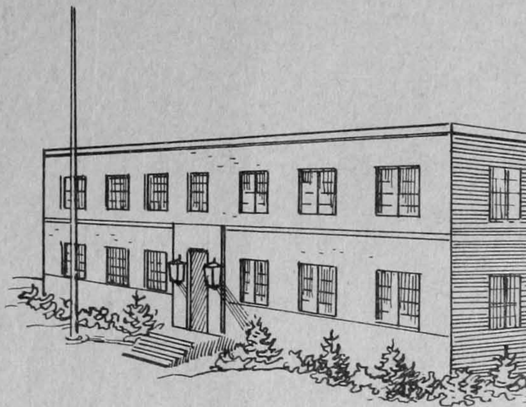

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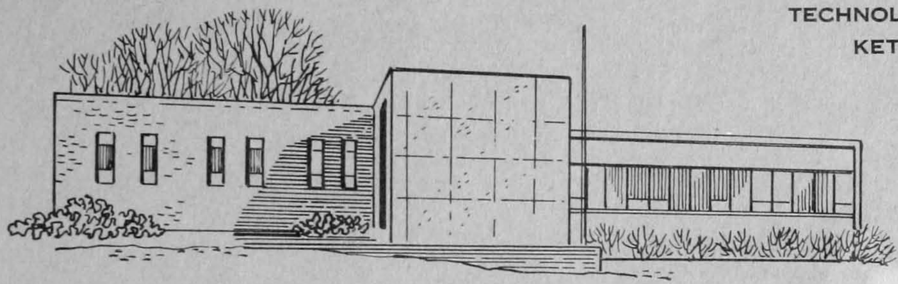

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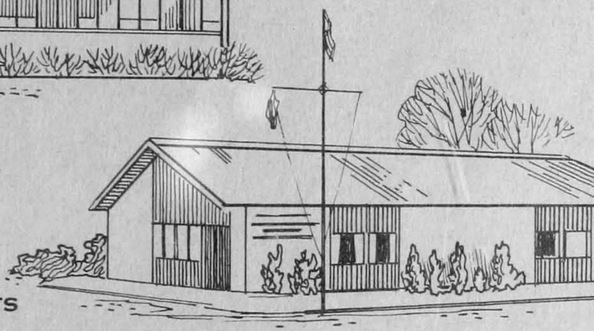

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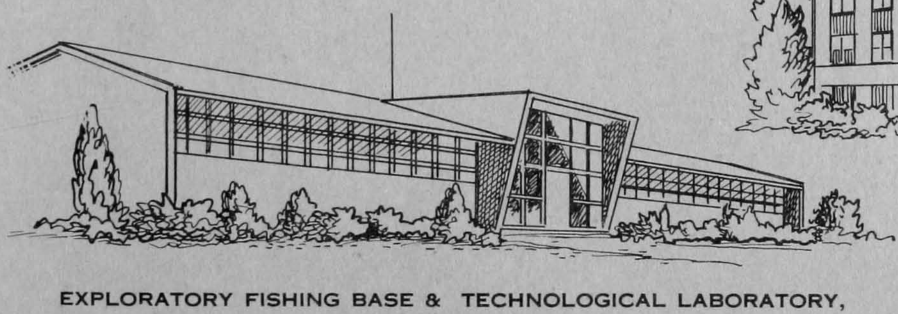

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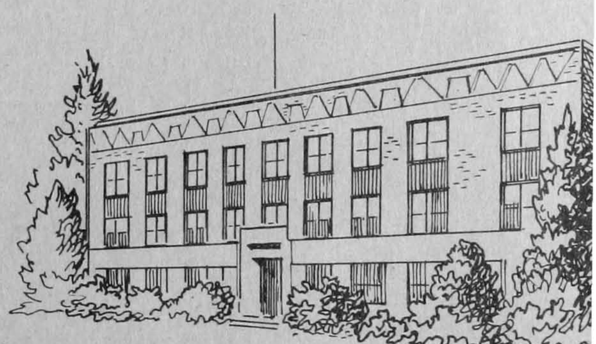

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