Studies in MARINE ECONOMICS

Commercial Seafood Industry of Oregon: a Comparison with other Regions of the United States

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INTRODUCTION

Closely related to the current general interest in our environment is a new fascination with the resources of the sea. What can we expect to receive from the sea? What do we stand to lose if the resources of the open seas are not managed properly? What can we do to gain more or lose less of the common wealth of the ocean? This particular study examines one source of ocean wealth—seafood—in the United States, particularly in the state of Oregon.

Section I is directed toward the role of seafood as a means of livelihood. Only employment in catching and processing seafood is described in this study, although harvesting and processing of seafood give rise to many additional jobs in related areas such as fishing gear and financial services. Thus our employment summary understates the role of seafood in providing employment and income to the state of Oregon.

Section II describes the seafood species caught at both the national level (United States as a whole) and the regional level. Description of seafood landings is given for all major regions of the United States so that some comparison between Oregon and the rest of the United States can be made.

Section III deals with the demand for seafood. The discussion focuses on the forces which lead consumers to value some seafood products more highly than others and to value various seafood products differently than non-seafood products.

This information has been arrayed so that the reader will gain some feeling for the role currently played by the Oregon seafood industry. It should then be possible to contrast Oregon's seafood industry with fishery-related activities in other areas of the United States. Adding the influence of the consuming public, a picture emerges reflecting the future directions of seafood harvesting, processing, and distribution in Oregon.

I. FISHERY PRODUCTION, EMPLOYMENT, AND INCOME IN OREGON

Income and employment are generated in Oregon directly from commercial fishing activity. In addition to the fishermen themselves, indirect benefits are generated in two directions. Benefits are induced by fishing activity through the purchase of inputs such as fishing gear, fuel, insurance, and financial services. And benefits also accrue from the landing of seafood, which produces jobs in processing, wholesaling, transportation, and retailing industries. While the entire impact of the commercial seafood industries is important to the Oregon economy, only selected dimensions of employment, income, and output in fishing and processing are featured in this report.

Catching Activities

The Bureau of Commercial Fisheries provides figures on the number of fishermen on vessels, boats, and shore in its annual statistical report.[1] These figures must be used with caution when comparisons are made, since no distinction is made as to the number of these fishermen employed on a regular or casual basis for the Pacific coast states. Regular fishermen are defined as those receiving more than one-half of their income from fish-catching activities. Fishermen receiving less than one-half of their income from catching activities are classified as casual.

One dimension of the importance of catching activities is given by the employment it affords. In order to reveal information of a more descriptive nature, the area in which fish were landed was divided into Columbia River and Coastal districts. Timber, tourism, recreation, and fishing activities provide the basic employment on which the districts depend. As indicated in Table 1, commercial fish-catching activities resulted in employment of 3,539 people

[1] U.S.D.I., U. S. Fish and Wildlife Service, Bureau of Commercial Fisheries, *Fishery Statistics of the United States.*

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in 1966. This figure is roughly the same as the one for 1959. Following 1959, the number of fishermen employed in catching activities declined until 1962. The table indicates that employment has varied somewhat from year to year since that time. This is a direct indication of the casual or part-time aspects of much fishery employment. The last two rows of the table serve as an indicator of the flexibility of many fishermen. Movement from one district to the other within a given year is common among both captains and crew members.

While there are only a few estuaries that serve as suitable Oregon ports for commercial seafood landings, it is incorrect to conclude that fishermen are of significance only in the counties that have ports. In fact, nearly half the commercial fishermen in Oregon live in non-coastal areas. Table 2 gives an indication of the volumes of seafood catch landed at Oregon ports. From this table it is evident that at least two of the counties receive relatively small quantities of commercial landings. Columbia and Lane, though bordering high-producing waters, are bases for an insignificant amount of landings.

In view of this observation, the information in Table 1 can be used again to clarify the sources of fishing employment. Employment in the Columbia River District is located almost entirely in Clatsop County. In turn, employment in fish-catching activities in Clatsop County is concentrated in and around Astoria. The most recent data available indicate that persons employed in these activities accounted for approximately 25 percent of the total employment in Clatsop County covered by the Social Security program during 1966.[2] The figure for the Coastal District Counties was substantially lower. In these counties, fish-catching employment was equal to 4.7 percent of "covered" employment. These figures show that a decrease in landings in Clatsop County would result in considerable disruption of business activity, as fishing employment is a large component in the economic base. This would also be true in the coastal counties, although the impacts would exhibit different characteristics.

The value to the fishermen of the commercial seafood catch in the Columbia River and Coastal Districts of Oregon is shown in Table 3. Unfortunately, these data cannot be directly interpreted as income generated to the State of Oregon or its residents. Oregon landings are often shipped by land to Washington or California for processing. Countering this, there are imports of fish into Oregon for processing, particularly tuna from Japan. The payments for landed fish to captains, crews, and boat-owners do not go solely to Oregon residents. Likewise, purchases made by crew members and boat-owners are not solely made in Oregon. A determination of contribution to state income would require information of import-export flows of both purchases and sales of commercial fishing operation. This calculation has not been developed in our report.

Processing Activities

The processing sector of the Oregon seafood industry actually consists of two rather distinct sub-sectors. Of the approximately 40 seafood processing establishments in 1968, there were only 5 that processed fish and shellfish in both canned and frozen forms.[3] The remaining 35 establishments make use of either canning or freezing processes. Oregon's fishing industry is essentially a seafood industry, i.e., only a small amount of landings are used for non-human consumption.

Processing establishments are located historically in port areas as well as physically tied to the geographical peculiarities of the coastline. These peculiarities render a few ports more favorable for landing and processing the catch. Five of the thirteen ports receiving commercial landings handled the majority of the 1968 catch (see Tables 4 and 5). The majority of landings during the five-year period, 1960-64, were also made in these ports (see Table 6). Therefore, for the last decade there has been no major change in the location of processing establishments. In fact, the five ports of Astoria, Tillamook Bay, Coos Bay, Newport, and Winchester Bay have gained an increasing share of total landings.

The number of people employed in seafood processing and wholesale establishments increased during the 1962-66 period (see Table 7). Employment in seafood processing and wholesaling activities depends largely on the volume of landings. The volume of landings fluctuated more in the 1962-66 period than did employment.

The distribution of processing and wholesaling employment among the coastal counties corresponds closely with the distribution of landings. Clatsop County establishments employed approximately 1,040 individuals on a full-time basis in 1970 (see Table 8). Employment in 1970 was primarily concentrated in two northern counties (Clatsop, Lincoln) and three southern counties (Coos, Curry, Douglas).

Catching and Processing Activities

The total number of persons employed in seafood harvesting and processing activities during 1966 was approximately 6,408 (see Tables 1 and 7). This figure represents the number of people directly employed in either catching or processing activities. This number does not include the people employed in businesses that provide various services to the seafood industry. Therefore, an estimate of the employment multiplier effects of changes in seafood industry employment is, though highly desirable, not available.

Employment in fishing activity is frequently seasonal. Employment in processing activities, while still seasonal, is much more regular than in fishing operations. Both preservation of seafood and imports permit smoothing out of seasonal fluctuations in employment. Crutchfield has suggested that additional stability and lower operating costs in the seafood industry would require drastic changes in fishery regulation.[4] The proportion of persons employed on a yearly basis (as opposed to a seasonal basis) has increased since 1962 (see Table 7). About 65 percent of

[2] U.S.D.C., Bureau of the Census, County Business Patterns, 1967.

[3] Oregon Department of Commerce, Economic Development Division, Census of Manufacturers, 1968.

[4] See Crutchfield, J. A., and G. Pontecorvo, *The Pacific Salmon Fisheries*, The Johns Hopkins Press, 1969, and Crutchfield, J. A., and A. Zellner, *Economic Aspects of the Pacific Halibut Industry*, Fishery Industrial Research, Volume 1, Number 1, U. S. Government Printing Office, 1963.

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employment at processing plants was non-seasonal in 1966 as compared to 60 percent in 1962.

The seafood industry, while important to the Oregon economy, is of rather small magnitude in comparison to some industries in Oregon. Nonetheless, it has been shown that the role is very substantial and important to certain ports in our coastal zone. It has been pointed out that these figures are an understatement of the importance of the seafood industries, since additional employment will occur in industries induced by and stemming from fishing and processing. As a final note, it may be added that commercial seafood industries are not unrelated to the tourist industries. Many visitors to our state will attest to the fact that a guided tour through a salmon or tuna processing plant was a memorable addition to their visit and an additional motivation to urge their friends to spend dollars on tourism in the State of Oregon.

Shipments of Oregon Fishery Products to Other Regions of the United States

Oregon seafood consists primarily of species well accepted in most markets. Salmon, crab, and shrimp in particular are examples of highly valued species that find increasing acceptance due to rising per capita incomes and an increasing number of seafood consumers. These species, along with tuna, generally can be thought of as the most likely to be exported in large quantities. Of the approximately 40 processors of fish and shellfish in Oregon, 9 processed seafood products for direct export in 1968. No accurate estimate of the size of the exports can be obtained without direct consultation with the exporting processors. Annual reports of the Oregon Department of Commerce, however, shed some light on the subject. Canned and cured products are exported by six of the nine exporting firms, while the three remaining firms export fresh and frozen packaged products. Salmon, crab, and tuna lend themselves to canning while the fresh and frozen fish are likely to be composed of salmon and groundfish fillets. Groundfish fillets and canned frozen shrimp are reaching Chicago fish markets in increasing quantities. New York's Fulton Fish Market receives large quantities of Oregon Dungeness crab meat.

Crutchfield and Forste in a 1967 report to the Bonneville Power Administration[5] provide some estimates of export activities of Oregon and Washington. They report 30 to 40 percent of the fresh salmon in Oregon and Washington is exported. Due to the perishability of fresh salmon and a marketing system not able to handle large quantities of fresh salmon for export to other states, canned salmon find large markets outside the state. In fact, nearly 95 percent of canned salmon is exported to northeastern, midwest, and southern markets. Up to one-half of Oregon tuna landings is ultimately shipped to California in frozen form for canning. The quantity of tuna exported in this raw form is highly correlated with good tuna fishing seasons. When weather conditions are favorable and albacore plentiful, fishermen generally experience higher than average catches. The result of this success alone can press Oregon's processing capacity to the limit. There are also albacore landings from California-based vessels that follow the albacore from California to Oregon waters. A minimum amount of time will be expended en route to port for unloading if a port located on the nearby Oregon coast is utilized and unloading time is reasonable. In addition to exports of raw tuna, much of the tuna processed in the state is shipped to outside markets. In fact, nearly three-fourths of the tuna processed in the state is shipped to out-of-state markets.

Data on exports of Dungeness crab are published infrequently. Crab fishing begins in early December and continues through mid-August. The crabs are marketed in two principal forms. In-state retail markets primarily sell cooked crab in the shell, with frozen crab meat being the primary form exported. Approximately 31 percent of crab landings reaches markets as fresh shelled crab.[6] The remainder is processed to remove the meat, which is then frozen. California absorbed 67 percent of the 1965-66 Dungeness crab landings. Another 9 percent of the 1965-66 Dungeness crab landings found markets in other areas, primarily Washington and the Rocky Mountain states.[7] There have been no major changes in the industry since the 1965-66 season that would render these figures grossly inappropriate for current use. Strong markets in San Francisco and Los Angeles exist for Oregon crab meat, and California uses virtually all of its crab landings domestically.

II. COMPARISON OF SEAFOOD RESOURCES AMONG REGIONS OF THE UNITED STATES

An Overview of National Seafood Resources

In the next section we note two important phenomena. First, per capita consumption of edible seafood has remained constant over time. Second, per capita utilization of all seafood products is rising over time. Since U. S. population is growing steadily, the consumption of edible seafood is expanding parallel to population growth and total utilization is growing significantly over time.

Important changes are taking place in the supply of the United States seafood products. There is a change in the composition of domestic supply. We are landing more fish in some ports and less in others. This change in composition is somewhat obscured by the fact that U.S. landings have remained relatively constant in weight for some time (see Table 9).

The gap between domestic supply and domestic use is filled by a rising level of imports (see Table 10). To some extent, rising imports reflect a growth in demand for seafood which is limited in domestic supply. It is also tied to the changing composition of local demand with imports of seafood not available off our own shores. These trends suggest arguments for better import channels and information about foreign fish supplies.

However, there are additional factors of concern to our domestic fishermen. Governmental treatment of fishermen appears to be more favorable in foreign nations. This problem is related to restrictive practices such as a combination of laws which have the practical effect of prohibiting United States fishermen from operating vessels constructed in foreign countries. United States fishermen also dislike the fact that many nations subsidize and give special treatment to their fishing fleets while the United States appears less concerned with its fishing fleets.

An additional concern to domestic fishermen is the large size of foreign fleets off U. S. coasts. Catches by foreign fleets pose a severe problem in comparing landings

[5] U.S.D.I., Bonneville Power Administration, Pacific Northwest Economic Base Study for Power Market, Volume II, Part 8, Fisheries, 1967.

[6] John R. Wix and James G. Youde, *Economics of the Dungeness Crab Industry*, (Corvallis, Oregon: Agricultural Experiment Station, December, 1967) p. 13.

[7] *Ibid.*, 15.

of seafood among regions of the country and trying to infer something about the resources in waters off those regions.

Foreign vessels, principally Russian and Japanese, are taking increasing amounts of fish and shellfish on the high seas off the United States. However, the United States catch on the high seas off foreign coasts declined from 464 million pounds in 1960 to 404 million pounds in 1970. The decline resulted from a smaller catch of groundfish off Canada. Groundfish (cod, cusk, haddock, ocean perch, pollock, and white hake) totaled only 29 million pounds in 1970—114 million pounds less than in 1960. The catch of tuna off Central and South America was 77.5 million pounds more than in 1960.[8]

The minor role U. S. fishermen play in foreign fisheries is closely indicated by the fact that over 90 percent by weight and over 85 percent by value of the U. S. catch is taken on or above the Continental shelf. Most of the catch taken beyond the Continental shelf is composed of tuna. Tuna likewise makes up most of the catch of our fleets in foreign waters. Of the 404 million pounds of U. S. catch taken in the high seas and off foreign coasts in 1969, 319 million pounds were composed of tuna landed in California. In turn, this 319 million pounds is the majority of the 348 million pounds of tuna landed in California. Albacore is the only tuna species caught predominantly off U. S. coasts (see Table 11).

Another inescapable detail of the U. S. catch is that it is dominated by a few species (see Table 12). Shrimp alone accounted for almost one-fourth of the value of the U. S. catch in 1968. Four species—shrimp, salmon, tuna, and crab—accounted for over half the value of U. S. landings in 1968.

It has been mentioned that U. S. consumption of seafood products has been rising steadily over time. This is partly due to increased use of fish for industrial purposes, but mostly because of growth of U. S. population. Per capita consumption of edible seafood has not changed significantly in 20 years (see Table 13). Any use of aggregate figures hides changes in composition. The relatively constant per capita consumption of canned fish hides a steadily falling per capita consumption of canned salmon and a steadily rising per capita consumption of canned tuna (see Table 13).

North Atlantic

The North Atlantic region includes the New England, Middle Atlantic, and Chesapeake fisheries. Bounded to the north by the famous groundfish producing area (Grand Bank) and to the south by an estuarine area (Chesapeake Bay), this region has ready access to the markets of the eastern seaboard. This oldest of United States fishery regions is also one of the most diversified. Low and high valued species of fish are available in the waters to meet the diverse demands expected of consumers in the large metropolitan areas of the eastern U. S. Shellfish resources of the region are used intensively, and demand for them can be expected to rise as disposable incomes in the area rise.

Cod, flounder, haddock, herring, and ocean perch are of considerable economic importance to this North Atlantic region. These edible species come almost exclusively from the fishing grounds northeast of New England. Landings of fish suitable for processing into fish meal and oil are relatively more numerous in the Middle Atlantic and Chesapeake fisheries. Lobsters, oysters, clams, and crabs represent the region's most important shellfish. Since 1950 shellfish production has never amounted to more than 20 percent of the region's total pounds landed. The value of shellfish on the other hand has ranged from 48 to 58 percent of total fishery value since 1950.

South Atlantic and Gulf

The South Atlantic and Gulf of Mexico regions are characterized by the relative absence of a sizable harvest of edible fish species. Fish landings that could be used for human consumption made up 11 percent of the total pounds landed and 14 percent of the total value of fishery products in 1966. Shellfish landings, of which oysters and shrimp are the prime contributors, have been approximately 20 percent of total landings and consistently above 70 percent of the total value of landings. The combination of fish and shellfish landings destined for human consumption amount to 31 percent of total landings. Landings of fish not to be used for human consumption represented 69 percent of the total pounds landed in 1966, but only 16 percent of the total value of fishery landings of the region.

The combination of a large volume of landings made possible by extensive exploitation of nonfood fish and a high dollar value to fishery products flowing from the shellfish landings contributes to the region's importance in the nation's fishing industry. Since the large development of the nonfood fish and shellfish segments of the region's fishery resources in the latter part of the 1950's, approximately one-third of the value and more than one-third of the volume of national landings have originated in the region. Shrimp and menhaden are consistently the most important species; supply projects for these economically important species favor continued expansion of the volume harvested. These important species, however, are particularly susceptible to pollution in the estuarine areas that serve as nursery grounds. Maintenance or expansion of recent catches depend on man's influence in the estuarine areas of the region.

Pacific Southwest (California)

While the Continental Shelf reaches far out from land in the Bering Sea and in the Gulf of Mexico and is moderately extended in the Gulf of Alaska and off New England, the Continental Shelf area off California is relatively narrow and the potential yield of bottom fish is relatively small. While there are fair amounts of Dungeness crabs in near-shore waters, these appear to be nearly fully utilized.

The future of the California fisheries is tied to the relatively rich sources of fish species in deep water. Tuna, mackerel, anchovy, and salmon landings make up the major portion of fish landings. The collapse of the sardine catch in the early fifties reduced fish landings by approximately two-thirds. The result has been to increase the importance of the remaining species. After the collapse of the sardine fishery, the region's contribution to the volume and value of the nation's fishery landings also diminished. California now ranks fourth in both volume and value of the five regions. However, after allowing for a relatively small catch in the Hawaiian Islands, a growing volume in the Pacific Northwest and a small volume in the North Atlantic, the United States tuna fishery is essentially that found off California. Aside from imports, this fishery is the only major source of tuna available to the country. The California tuna fleet is generally recognized as one of the most efficient and progressive fishing fleets in the country.

[8] U.S.D.C., National Oceanic and Atmospheric Administration, National Marine Fisheries Service, *Fisheries of the United States, 1970,* C.F.S. No. 5600, p. 6.

Alaska

The state of Alaska can be thought of as a fishery region due to its geographical isolation from other regions, its immense coastal area and the uniqueness of some of its commercially harvested species. Salmon is Alaska's largest and most complex fishery. Five types of salmon make up the annual catch. Pink and sockeye salmon landings combined frequently represent 75 percent of salmon landings. In fact, salmon landings consistently yield over 90 percent of fish landings by volume and 80 percent of fish value. Halibut and sea herring constitute nearly all of the remainder.

The value of shellfish landings has been increasing since 1960. Intensive fishing of king crab has resulted in large catches of this highly valued species. Dungeness crab and shrimp are also landed in sizable amounts.

Alaskan waters produce not only large quantities of fish and shellfish; they also yield high-value species known for their acceptance throughout the country. In addition to the unique attributes that characterize the harvested species in Alaska, it must be noted that virtually no final market for the processed product exists in the region itself. Halibut, salmon, and king crab have few good substitutes. Consequently, the region can easily maintain its export market to other regions of the U. S. and abroad as well.

Pacific Northwest

The Washington and Oregon fisheries that comprise this region represent a blend of the Californian and Alaskan regions. Salmon populations, the oldest of the region's fisheries, begin to increase in importance as one leaves northern California waters and follows the coast northward. The lack of shellfish in California disappears as shrimp, crab, and oyster landings become commonplace. The region marks the northern limit of the west coast tuna fishery. The tuna fishery in these northern waters is based on the albacore tuna. Albacore constitute the bulk of the tuna landings, with small quantities of other tuna species also landed in some years. Salmon landings, though not of the magnitude found in Alaskan waters, constitute the predominant part of total fish landings.

Since 1950 more than 80 percent of the region's annual catch of fish and shellfish has consisted of fish. Aside from a recent effort to develop the hake resources of the region, fish are used almost exclusively for human consumption. Shellfish landings generally range from 12 to 19 percent of the total weight of landings. However, the presence of high-value shrimp, crabs, and oysters has resulted in shellfish values forming a greater portion of the region's total fishery value than fish landings.

Comparison of Seafood Resources

Value per pound of seafood landed reveals the nature of the fishery resources exploited by each region. Table 14 gives the average value per pound of seafood landed by region since 1965. Large catches of highly valued salmon, halibut, shrimp, and crab have been responsible for the Northwest's high value per pound of landings. The fishery regions of the west coast have higher values per pound landed than do the larger regions of the east and gulf coasts. The dominant role of highly priced species is due to the lack of a sizable exploitation of fish from Pacific waters suited to non-edible uses. These non-edible fish, though valuable for industrial purposes, command a lower price than do the edible species.

While an overall comparison of potential United States fish catch is quite difficult, some suggestive information is given in the report of the Panel on Marine Resources of the President's Commission of Marine Science, Engineering, and Resources. Of the various areas discussed above, the coastal waters adjacent to New England are the least promising for future expansion. This oldest of American fishing grounds has produced declining fish yields for our fishermen for several years.

Other regions will probably expand. However, expansion of offshore fisheries depends upon the level of effort by foreign fishing fleets while expansion of shellfish (mainly shrimp, crab, lobster, and oysters) and anadromous species (mainly salmon and shad) depend critically upon the level of pollution and wise use of the coastal zone.[9]

III. DEMAND FOR SEAFOOD

Factors Affecting Demand for Edible Seafood

"The primary determinants of the demand for fish and shellfish are: (1) the level of personal income per capita; (2) aggregate size and rate of growth of the population; (3) tastes and preferences, including the influence of customs reflecting religious practices and national origin; (4) price and availability of closely substitutable products, of which meat and poultry are the most important."[10] Thus begins the discussion of demand characteristics in the definitive new report compiled for the President's use in making decisions affecting marine resources. The demand characteristics are defined for human consumption and will be developed more fully below, since most of our seafood industry is concerned with direct human consumption. However, as there is a large undeveloped source of industrial fish products off our shores, a brief discussion of nonedible fish products and their demand characteristics will be developed as well.

Once one has achieved a "subsistence" level of income, increases in income will not result in any increase in purchases of food—sheer bulk tastes having become satiated. Increases in income will be devoted largely to nonfood goods and services, with a certain portion going to a changing mix of methods used to satisfy food tastes. In other words, instead of more food, the individual will substitute more expensive and more fully processed foods for the earlier selection.

The satisfaction of demand for food as a whole and the inability to substitute food for nonfood and vice versa is important, but for our analysis it is very important to note that what is true for the whole is not true for every part. Research studies have shown that as income rises, the demand for meat tends to rise more rapidly than the demand for seafood. However, demands for some kinds of fish rise rapidly with income, while demands for other kinds of fish decline. Another often neglected point is that while per capita quantity consumption of fish does not rise, per capita expenditure on fish consumption does rise in the United States as income rises. The rise in expenditure is due to both the substitution toward expensive species and the use of fish products associated with more processing and marketing services.

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[9] For a more complete discussion, see *Marine Resources and Legal-Political Arrangements for their Development*, Volume 3, Panel Reports of the Commission of Marine Science, Engineering, and Resources, (Government Printing Office: 1969) pp. VII 21 to VII 31.

[10] *Ibid.*, p. VII 8.

A change in income triggers different types of reactions; responses to price vary in a similar way. While the demand for food is not highly responsive to price changes, the aggregate demand for chinook salmon caught in the Columbia river might be highly responsive to price changes.

Income and relative prices of fish species can become quite important in defining the demand for fish products. For food demand, animal behavior of man will dictate much of what quantity per man will be sought, but in the choice of which food to consume other characteristics of food take over. Thus, desires related to religious belief may preclude meat from a diet at all times or on certain days. If fish is not also excluded as during Lent, this may increase the demand for fish; if fish is also precluded as it is by some religious groups, the net effect may be to decrease the demand for fish. Bell[11] concluded that recent changes by the Catholic Church (especially the abolition of meatless Fridays) have significantly lowered the prices of fish in New England. While Bell's analysis was not statistically significant, it did confirm previous expectations of the effect of religious dietary habits.

In addition to desires to behave in certain social patterns, demand for fish may also be affected by cravings other than sheer food bulk. Dislike of fishy tastes is a very important phenomenon. It can be a constraint on total fish consumption. It may influence choice of species. It may alter fishing activities as well as the nature of resources devoted to processing and marketing of fish food products.

Brief consideration of the forms which edible fish products take may be useful in understanding the demand for these products and, at the same time, shed some light on the ways that processing, marketing, and distribution may affect fish consumption. "The oldest and the least expensive form of preserving fish is curing, which includes salting, drying, smoking, pickling, and fermenting."[12] As might be expected, cured fish become smaller components of both total food and seafood consumption as incomes rise. Thus, while this form of utilization is quite important in underdeveloped nations, it is of negligible importance in the United States. One exception to this trend may be of interest to the Oregon economy. Small portions of beef jerky, individually packaged, are becoming quite popular. Dry-smoked salmon and tuna may become luxury products for informal entertaining.

The relative importance of fresh fish consumption has also declined. This decline is due largely to the rise in use of frozen fish and will undoubtedly continue as new methods such as freeze-drying and irradiation provide products which maintain their quality over a significant period of time. "Fish tend to deteriorate immediately after being caught. One of the earliest changes that takes place is autolysis, during which certain enzymes digest the tissues causing a softening or partial liquefaction of the tissues and a change in flavor and odor. In red meats, this process is called ripening and is desirable in that it produces a tender juicy meat of good flavor. In fish, however, the results are highly disagreeable to the human palate."[13]

[11] Bell, F. W., "The Pope and the Price of Fish," *American Economic Review*, December, 1968, pp. 1346-1350.

[12] Christy, Francis T., Jr. and Anthony Scott, *The Common Wealth in Ocean Fisheries: Some Problems of Growth and Economic Allocation* (Baltimore, 1965), p. 25.

[13] *Ibid.*, pp. 28-29.

Another form of fish utilization is of particular importance to Oregon. Canned fish, primarily salmon and tuna, is an established component of fish consumption in the United States and certain other high-income countries. The past 40 years have seen a decline in canned salmon consumption and a very significant increase in canned tuna consumption and both may be expected to continue. This shift, however, is due more to supply changes.

Perhaps a brief mention may be appropriate for a new method of fish utilization currently being studied. In the next section we will discuss fish meal, which is particularly important as a feed for poultry and swine. Laboratory research is currently finding ways to neutralize some unpleasant odors and tastes in meal and manufacture fish flour known as fish protein concentrate (FPC). This commodity could be used as an additive to bulk foods consumed by undernourished people to remove protein deficiencies. It has been also suggested that fish flour could be an important component of diet foods and prepared casseroles.

Hammonds and Call[14] have recently pointed out that the price of FPC is yet to be determined but is not likely to be clearly above or clearly below that of other protein additives. They show that the degree of use of FPC will depend critically upon its functional characteristics. Currently the most common protein ingredients are derived from milk, soybeans, eggs, and various hydrolized proteins. These ingredients not only provide protein, but aid in emulsion stability, help to prevent collapse of frozen products, provide whitening power, bind water, bind fat and ground meat particles, improve texture, and otherwise improve the food product. Thus the role of FPC depends critically upon technological research for ways of exploiting the favorable functional characteristics of fish, eliminating undesirable characteristics, and yet being available at low cost.

Factors Affecting Aggregate Demand for Industrial Seafood Products

While the direct consumption of seafood products in the diets of United States citizens has remained relatively constant for many years (from 10 to 12 pounds per capita), the total consumption of seafood products has been rising over time (see Table 15). The first three columns in Table 15 are stated in round weight; that is, the first three columns show the total weight of all fish products caught and imported. The last column is stated in edible weight, showing only the weight directly consumed by people.

While U. S. consumption of fish and shellfish has risen directly proportionate to population, total utilization of fish and shellfish has increased far more rapidly than population; the divergence is due to the increased industrial use of seafood largely for animal feed.

The major industrial products are a) marine animal oil, b) marine animal scrap and meal, and c) fish solubles. In addition, there are products from oyster shells and buttons from fresh-water mollusk shells, agar-agar, fish feed pellets, and animal food. Irish moss extracts, kelp products, leather products, fish fins, liquid fertilizer, colored chips,

[14] Hammonds, T. M., and D. L. Call, *Utilization of Protein Ingredients in the U. S. Food Industry, Part II, the Future Market for Protein Ingredients*, Cornell University Agricultural Experiment Station, A.E.R. Res. 321, August, 1970.

pearl essence, crab shells, shell lime and dust, and miscellaneous seaweed products.[15]

The increasing proportion of fish utilization accounted for by production of fish meal, oil, fertilizer, and other industrial materials is a worldwide trend. The percentage of world catch reduced to meal, oil, etc., rose from 34 percent in 1964 to 48 percent in 1969 (see Table 16).

Fish meal is a protein concentrate that is taken from raw fish by the process of cooking, pressing, and drying, and is used principally as an additive for poultry and hog feeds. The demand for fish meal has been well described by Christy and Scott:

> Fish meal is becoming an increasingly important constituent of the rations fed to poultry and swine. This accompanies the shift from a farm-type to a factory-type production, exemplified in the United States by the development of the commercial broiler. Such production depends heavily upon purchased formula feeds rather than upon home-grown grains. The formula feeds, in turn, make use of high protein concentrates, such as fish meal, soybean meal, meat scraps, and tankage, feather meal, blood meal, etc. One advantage that fish meal has over the others is that it contains an unidentified growth factor (called UGF) that stimulates rapid growth. This fish factor is of considerable value up to a level of 2½ percent of the total feed ration of commercial broilers. Beyond that level, little additional growth stimulus is obtained, but fish meal continues to be an important source of amino acids up to a level at which fish meal makes up about 7½ percent of the broiler diet. At this level, the broiler does not need more amino acids, but can continue to receive other values from fish meal including energy, minerals, and vitamins. However, a negative factor begins to develop at higher levels of fish meal in the ration. For broilers, more than 10 percent of fish meal in the ration tends to lead to fishy flavors in the meat and to an unacceptable product, although this varies quite a bit for kinds of fish, methods of processing, and methods of feeding.[16]

One of the limitations on marketing fish meal is the fact that the chief protein additive-soybean meal is substantially cheaper. Nonetheless, fish meal is a source of animal protein with a structure of amino acids (the building blocks of animal life) highly useful as a component of animal feed.

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[15] U.S.D.I., U. S. Fish and Wildlife Service, Bureau of Commercial Fisheries, *Fisheries of the United States . . . 1968*, C.F.S. No. 5000, pp. XVII-XIX.

[16] Christy and Scott, *op. cit.*, p. 43.

APPENDIX

Sixteen Detailed Statistical Tables

Table 1. Number of Fishermen on Vessels, Boats, and Shore by District in Oregon, 1962-1967[1]

	1962	1963	1964	1965	1966	1967
Columbia River						
Fishermen on vessels	653	743	611	875	1,209	1,426
On boats & shore	767	756	604	633	654	916
Sub-total	1,420	1,499	1,215	1,538	1,863	2,342
Coastal						
Fishermen on vessels	877	905	988	968	1,417	2,014
On boats & shore	630	626	693	812	818	1,057
Sub-total	1,507	1,531	1,681	1,780	2,235	3,071
Total not exclusive of duplication	2,927	3,030	2,896	3,318	4,098	5,413
Total exclusive of duplication	2,651	2,707	2,586	2,984	3,539	not available

Sources: U.S.D.I., U. S. Fish and Wildlife Service, Bureau of Commercial Fisheries, *Fishery Statistics of the United States*, 1962-1967.

[1] Vessels defined as having a capacity of 5 net tons or over. Boats defined as having a capacity of less than 5 net tons.

Table 2. Landings of Fish and Shellfish at Selected Oregon Ports by Pounds and Percent, 1969

County and port	Lbs.	% of all landings
Columbia River District[1]		
Clatsop County		
Astoria	41,704,751	52.5
Columbia County	.....	.....
Coastal District		
Coos County		
Bandon	277,141	.3
Coos Bay	13,089,139	16.1
Curry County		
Brookings	3,786,359	4.8
Gold Beach	24,025	.03
Port Orford	1,676,545	2.1
Douglas County		
Winchester Bay	4,078,960	5.1
Lane County		
Florence	22,207	.03
Lincoln County		
Depoe Bay	550,789	.7
Yaquina Bay	10,066,121	12.7
Waldport	22,186	.03
Tillamook County		
Pacific City	320,668	.4
Netarts Bay	13,140	.01
Tillamook Bay	3,878,019	4.9

Source: Fish Commission of Oregon.

[1] The Figures for the Columbia River District are of *ocean-caught* fish and shellfish. The Columbia River and its tributaries yielded 6,083,459 pounds of commercially caught salmon and other food fish, but the specific Oregon ports at which the landing of the catch occurred was not available.

Table 3. Ex-Vessel Value of Landings by District in Oregon, 1962-67 (millions of dollars)

District	1962	1963	1964	1965	1966	1967
Columbia River	4.41	4.50	3.66	5.26	5.96	7.63
Coastal	3.42	3.18	3.37	3.56	5.20	8.65
Total	7.83	7.68	7.03	8.82	11.16	16.28

Sources: U.S.D.I., U. S. Fish and Wildlife Service, Bureau of Commercial Fisheries. *Fishery Statistics of the United States*, 1962-67.

Note: The above table was compiled from a more detailed table in the source report.

Table 4. Percentage of Oregon Commercial Landings for Selected Species of Foodfish and Shellfish by Port, 1969

Port	Salmon	Steelhead	Trawl fish	Shrimp	Tuna	Crab
Astoria	4	100	53	26	74	40
Alsea	0	....	....	....	....	[1]
Bandon	2	....	[1]	....	[1]	[1]
Brookings	6	....	6	1	2	12
Coos Bay	15	....	16	35	9	16
Depoe Bay	2	....	[1]	....	[1]	2
Florence	[1]	....	[1]	....	....	[1]
Gold Beach	[1]	....	[1]	....	[1]	[1]
Yaquina Bay	9	....	9	14	14	13
Pacific City	3	....	[1]	....	[1]	....
Port Orford	2	....	2	2	[1]	9
Tillamook	3	....	[1]	21	[1]	5
Waldport	....	....	....	....	....	[1]
Winchester Bay	4	....	13	[1]	[1]	1
No Port Specified[2]	49	....	....	....	....	....

Source: Fish Commission of Oregon

[1] Less than 1 percent.

[2] This arises because the Columbia River catch is not reported by receiving port. However, the majority of this catch is landed at Astoria.

Table 5. Landings and Percentage of Oregon Commercial Landings in the Five Largest Ports,[1] 1969

Port	Lbs.	%
Five Largest[1]	72,816,990	85.1
All others	12,729,038	14.9
Total	85,546,028	100.0

[1] Five largest ports are Astoria, Tillamook Bay, Coos Bay, Yaquina Bay, and Winchester Bay.

Source: Fish Commission of Oregon.

Table 6. Percentage of Oregon Commercial Landings for Selected Species of Foodfish and Shellfish by Port, 1960-64

Port	Chinook	Coho	Trawl fish	Shrimp	Tuna	Crab
Astoria	10	18	61	24	72	22
Alsea	....	....	....	....	....	1
Bandon	3	3	....	....	....	....
Brookings	22	7	1	22	1	17
Coos Bay	29	23	11	49	13	20
Depoe Bay	2	9	....	....	....	1
Florence	9	8	....	....	1	1
Gold Beach	NA	NA	NA	NA	NA	NA
Newport	17	20	19	11	13	22
Pacific City	1	1	....	....	....	....
Port Orford	4	4	....	3	....	9
Tillamook	1	3	1	....	....	6
Winchester Bay	2	4	7	....	....	....

NA = Not Available.

Source: Fish Commission of Oregon.

Table 7. Number of Employees in Seafood Processing and Wholesaling Establishments, Oregon, 1962-67

Year	Average for season	Average for year
1962	2,003	1,208
1963	1,994	1,191
1964	2,257	1,540
1965	2,535	1,681
1966	2,869	1,884
1967	3,455	2,275

Source: U.S.D.I., U. S. Fish and Wildlife Service, Bureau of Commercial Fisheries, *Fishery Statistics of the United States*, 1962-1967.

Table 8. Population in Selected Counties and Employment in Seafood Processing Establishment by County for Oregon, 1969

County	Population[1] (1970)	(Employment 1969) Total[2]	Canned & cured seafood processing[3]	Fresh & frozen seafood processing[3]
Clatsop	28,473	7,641	855	185
Coos	56,515	14,064	0	354
Curry	13,006	2,860	101	12
Douglas	71,743	17,936	305	0
Lincoln	25,755	5,699	10	192
Linn	71,914	17,738	4	0
Multnomah	556,667	233,418	114	17
Tillamook	17,930	3,371	29	52

[1] U.S.D.C., Bureau of the Census, Advance Report, Final Population Counts, Oregon, PC (VI)—39, December, 1970.

[2] U.S.D.C., Bureau of the Census, County Business Patterns, 1969.

[3] Oregon Department of Commerce, Division of Planning and Development, Directory of Oregon Manufacturers, 1970.

Note: The figures for employment in seafood processing give employment for seafood processing firms. This is not the same as employment in seafood processing since it doesn't account for firms which primarily process food other than seafood, but do process some seafood.

Table 9. U.S. Catch of Fish and Shellfish, 1946-1970

Year	Landings (Millions of lbs.)	Value (Millions of $)
1946	4,467	313
1947	4,349	312
1948	4,513	371
1949	4,804	343
1950	4,901	347
1951	4,433	365
1952	4,432	364
1953	4,487	356
1954	4,762	359
1955	4,809	339
1956	5,268	372
1957	4,789	354
1958	4,747	373
1959	5,122	346
1960	4,942	354
1961	5,187	362
1962	5,354	396
1963	4,847	377
1964	4,541	389
1965	4,777	446
1966	4,366	472
1967	4,055	440
1968	4,116	472
1969	4,292	518
1970	4,884	602

Source: U.S.D.C. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, *Fisheries of the United States, 1970*, C.F.S. No. 5600, p. 4.

Table 10. Supply of Fishery Products, 1959-70 (round weight basis)

Year	Domestic catch Million *lbs.*	%	Imports Million *lbs.*	%	Total Million *lbs.*
1959	5,122	60.5	3,338	39.5	8,460
1960	4,942	60.1	3,281	39.9	8,223
1961	5,187	54.2	4,383	45.8	9,570
1962	5,354	51.4	5,054	48.6	10,408
1963	4,847	42.4	6,587	57.6	11,434
1964	4,541	37.7	7,490	62.3	12,031
1965	4,777	45.3	5,758	54.7	10,535
1966	4,366	35.0	8,103	65.0	12,469
1967	4,055	29.0	9,936	71.0	13,991
1968	4,116	23.8	13,161	76.2	17,277
1969	4,292	36.4	7,510	63.6	11,802
1970	4,884	42.6	6,576	57.4	11,460

Source: U.S.D.C. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, *Fisheries of the United States*, 1970, C.F.S. No. 5600, p. 42.

Table 11. Domestic Catch from Waters off the United States and on the High Seas off Foreign Coasts, 1970

Area and species	Water off U.S. coast Thousand lbs.	High seas off foreign coasts Thousand lbs.	Total Thousand lbs.
Atlantic and Gulf States; TOTAL	3,239,885	50,015	3,289,900
Great Lakes & Mississippi River States; unclassified			
TOTAL	128,900		128,900
Hawaii; unclassified			
TOTAL	11,000		11,000
Pacific Coast States:			
Alaska, Washington, and Oregon:			
Bottomfish (Wash-Ore)	34,131	26,969	61,100
Halibut	33,621	1,079	34,700
Salmon	390,054	46	390,100
Tuna	.....	5,100	5,100
Unclassified	268,428	172	268,600
California:			
Tuna			
Albacore	27,976	2,124	30,100
Bluefin	319	8,581	8,900
Skipjack	463	75,837	76,300
Yellowfin	139	232,061	232,200
Other	344,949	1,751	346,700
U.S. TOTAL	4,479,865	403,735	4,883,600

Source: U.S.D.C., National Oceanic and Atmospheric Administration, National Marine Fisheries Service, *Fisheries of the United States, 1970*, C.F.S. No. 5600, pp. 6-7.

Note: The above table is condensed from a more complete table in the source report.

Table 12. Relative Value of the Catch, by Species, 1968

Species	Value (Millions of $)	% of total value	Quantity (Millions of lbs.)	% of total quantity
Shrimp	115	23.1	299	7.2
Salmon	67	13.5	330	7.9
Tuna	47	9.5	294	7.1
Crabs	44	8.9	255	6.1
Oysters	32	6.4	62	1.5
Lobsters, Northern	25	5.1	33	0.8
Clams	21	4.2	67	1.6
Flounders	17	3.5	158	3.8
Menhaden	18	3.5	1,375	33.1
Haddock	9	1.9	71	1.7
Scallops, Sea	15	3.0	14	0.3
Catfish & Bullheads	7	1.5	33	0.8
Lobsters, Spiny	5	1.1	7	0.2
Halibut, Pacific	4	0.8	26	0.6
Snapper, Red	4	0.8	12	0.3
Other	65	13.1	1,125	27.0

Source: U.S.D.C., National Oceanic and Atmospheric Administration, National Marine Fisheries Service, *Fisheries of the United States, 1970*, C.F.S. No. 5600, pp. 14-15.

Table 13. U. S. Per Capita Consumption of Commercially-Caught Fish and Shellfish, 1946-1970 (pounds of edible meat)

Year	Fresh & frozen	Canned salmon	Canned tuna	Other canned	Cured	Total
1946	5.9	1.4	0.7	2.1	0.7	10.8
1947	5.8	1.3	0.8	1.7	0.7	10.3
1948	6.0	1.6	0.9	1.9	0.7	11.1
1949	5.8	1.6	0.9	2.0	0.6	10.9
1950	6.3	1.4	1.1	2.4	0.6	11.8
1951	6.3	1.4	1.2	1.7	0.6	11.2
1952	6.2	1.4	1.3	1.6	0.7	11.2
1953	6.4	1.3	1.4	1.6	0.7	11.4
1954	6.2	1.1	1.4	1.8	0.7	11.2
1955	5.9	1.0	1.4	1.5	0.7	10.5
1956	5.7	1.1	1.6	1.3	0.7	10.4
1957	5.5	1.0	1.6	1.4	0.7	10.2
1958	5.7	1.1	1.8	1.4	0.6	10.6
1959	5.9	0.9	1.9	1.6	0.6	10.9
1960	5.7	0.7	2.0	1.3	0.6	10.3
1961	5.9	0.8	2.1	1.4	0.5	10.7
1962	5.8	0.9	2.1	1.3	0.5	10.6
1963	5.7	0.9	2.0	1.3	0.5	10.6
1964	5.9	0.7	2.0	1.4	0.5	10.5
1965	6.0	0.9	2.3	1.2	0.5	10.9
1966	6.0	0.8	2.3	1.2	0.5	10.8
1967	6.0	0.5	2.4	1.4	0.5	10.8
1968	6.2	0.7	2.4	1.2	0.5	11.0
1969[1]	6.4	0.7	2.4	1.1	0.5	11.1
1970[1]	6.6	0.7	2.5	1.2	0.4	11.4

Source: U.S.D.C., National Oceanic and Atmospheric Administration, National Marine Fisheries Service, *Fisheries of the United States, 1970*, C.F.S. No. 5600, pp. 64-65.

[1] Preliminary.

Table 14. Average Ex-Vessel Price Per Pound of Fish and Shellfish Landings, by Region, 1965-69

Region	Year				
	1965	1966	1967	1968	1969
	$ per pound				
North Atlantic	.085	.099	.106	.108	.132
South Atlantic and Gulf of Mexico	.077	.096	.099	.097	.097
California	.111	.121	.100	.120	.108
Pacific Northwest	.139	.151	.156	.174	.188
Alaska	.143	.139	.127	.165	.205

Source: U.S.D.I., U. S. Fish and Wildlife Service, Bureau of Commercial Fisheries, *Fisheries of the United States*, 1965-1969.

Note: The above table was compiled from several tables in the source report.

Table 15. Per Capita Consumption and Utilization of Commercially-caught Fish and Shellfish

Year	Per capita utilization			Per capita consumption[2] (lbs.)
	Domestic catch[1] (lbs.)	Imports[1] (lbs.)	Total[1] (lbs.)	
1950	32.5	10.9	43.4	11.8
1951	29.3	15.3	44.6	11.2
1952	28.8	20.8	49.6	11.2
1953	28.7	16.1	44.8	11.4
1954	29.8	17.7	47.5	11.2
1955	29.5	14.2	43.7	10.5
1956	31.7	13.9	45.6	10.4
1957	28.3	14.1	42.4	10.2
1958	27.6	16.1	43.7	10.6
1959	29.2	19.1	48.3	10.9
1960	27.7	18.4	46.1	10.3
1961	28.6	24.2	52.8	10.7
1962	29.1	27.5	56.6	10.6
1963	25.9	35.3	61.2	10.6
1964	24.0	39.5	63.5	10.5
1965	24.9	30.0	54.9	10.9
1966	22.5	41.8	64.3	10.8
1967	20.7	50.8	71.5	10.8
1968	20.8	66.9	87.7	11.0
1969	21.5	37.6	59.1	11.1
1970[3]	24.2	32.5	56.7	11.4

Source: U.S.D.C., National Oceanic and Atmospheric Administration, National Marine Fisheries Service, *Fisheries of the United States, 1970*, C.F.S. No. 5600, pp. 63-64.

[1] Round weight. [2] Edible weight. [3] Preliminary.

Table 16. Estimated Use of the World Catch, 1964 and 1969 (live weight basis)

Manner used	1964	1969
	Billion lbs.	Billion lbs.
Marketed Fish	39.95	39.68
Frozen	11.73	18.96
Cured	18.56	17.86
Canned	9.72	12.79
Reduced to meal, oil, etc.	34.24	47.62
Miscellaneous purposes	2.20	2.20
Total	116.40	139.11

Source: U.S.D.C., National Oceanic and Atmospheric Administration, National Marine Fisheries Service, *Fisheries of the United States, 1970*, C.F.S. No. 5600, p. 19.