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THE ALASKAN CLAM FISHERY: A SURVEY AND ANALYSIS OF ECONOMIC POTENTIAL

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16. ABSTRACT This report is concerned with the economic potential of the Alaska clam industry. It was determined that economic potential analysis required information on clam species, stocks and trends in stocks; the current status of the industry with respect to structure, operations, markets served and volume of activity; the regulatory environment in which the industry must operate; and the economic environment in which the industry must compete. Each of these topics is addressed in this report. The report is divided into four basic chapters. Chapter I is devoted to a summary of the factors affecting economic potential. Chapter II provides an overview of the historical development of the clam fishery in Alaska from its inception to the present. In Chapter III the regulatory environment is described; the obstacles to the industry's growth inherent in this environment are considered in detail. Chapter IV describes the harvesting, processing and marketing of clam products. Chapter V draws on the earlier chapters and other information to assess the overall economic environment and its implications for the future of the fishery. (Author extracted)

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THE ALASKA CLAM FISHERY:

A SURVEY AND ANALYSIS OF ECONOMIC POTENTIAL

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PREFACE

A study of the economic potential of the Alaska clam industry was undertaken at the urging of Donald Rosenburg, currently Director of the University of Alaska Sea Grant Program. The clam resources of Prince William Sound have been studied for several years under a project funded by Sea Grant. The biologists associated with this project soon recognized that there was a need to go beyond a study of the biological aspects of Alaska clam resources to an investigation of their economic potential.

A two-phase study attempting to answer the most significant economic questions about the Alaska clam fishery was initiated in 1973. The first phase, the results of which are the subject of this publication, has been concerned with an overall assessment of the economic potential of the industry. For reasons which will become obvious as the reader proceeds, this assessment is based almost exclusively on information about razor clams harvested in Southcentral Alaska. This publication is the result of research sponsored by the Alaska Sea Grant Program, cooperatively supported by NOAA Office of Sea Grant, Department of Commerce, under Grant #04-5-158-35 and by the University of Alaska with funds appropriated by the State of Alaska.

The second phase of this research, to be completed during 1975, will attempt to identify the specific cost of production and final product price conditions necessary to make significant expansion of the clam industry feasible. This will involve a comparison of the costs of harvesting with dredge-based technology with that of the conventional hand-labor method and a forecast of future price movements.

The appropriate format of an analysis of the economic potential of an industry is determined by the nature of the industry in question and the type and amount of information available. In the case of the Alaska clam fishery an analysis of economic potential required, and available information allowed, a historical assessment of the industry, an examination of the regulatory environment at the harvesting and processing levels, and an analysis of the current marketing and economic status of the clam fishery. The aggregate of this information provides the basis for an analysis of the industry's potential.

The gathering of information for this study has been hampered by a situation which, if it were not for the considerable assistance of a number of individuals and agencies, would have precluded the construction of an adequate information base: much of the available information, particularly that relating to the historical development of the industry, is unrecorded; it is contained instead in the knowledge of numerous individuals who have had some relationship with the industry – from State regulatory agency employees to journalists to industry operatives. Information obtained in this way, about a multi-faceted and highly complex industry environment, is sometimes contradictory and often subject to varying interpretations.

It is hoped that this report will be useful in clarifying the issues related to the industry's potential for development. Heretofore, much of the available information has not been in written form and thus not available to other than a few knowledgeable individuals. Additionally, there are many scattered written sources, upon which this report draws, which contain information pertinent to the industry's potential. Indeed, the primary objective of the first year's research has been to draw together in one place, and lend organization to, the extensive amount of disjointed information. The resulting information base provides the foundation required for analysis of the industry's potential. Finally, a view of the industry as a component of a larger national clam supply system and as part of the state and national economies has, until now, been lacking.

A very large number of people have assisted the authors in the information-gathering stage of this research project. While it is not possible to list everyone who assisted, mention should be made of certain individuals who were especially generous in giving their time and information. They are Kenneth Torgerson, Alaska Department of Health and Social Services; Carl Rosier, Alaska Department of Fish and Game; Robert Scott, U.S. Food and Drug Administration; Jim Reardon of the Alaska Board of Fish and Game; John Wiese, contributing fisheries author, the Institute of Social, Economic and Government Research; and Ben Young, clam harvester and dredge engineer. Particular mention must be made of the work of Richard Nickerson, Biologist, Alaska Department of Fish and Game, who has worked tirelessly for the removal of certain regulatory barriers to the expansion of the razor clam fishery. His work has provided much of the data base necessary for readmission of the State of Alaska to the National Shellfish Sanitation Program.

The thoughtful and constructive comments of the following reviewers of this manuscript are also gratefully acknowledged: Howard Ness, economist, National Marine Fisheries Service; Dr. Richard Nevé, Institute of Marine Science, University of Alaska; A. J. Paul, marine zoologist, Institute of Marine Science, University of Alaska; Dr. Paul Reichardt, Department of Chemistry and Institute of Marine Science, University of Alaska; Kenneth Forgerson, Alaska Department of Health and Social Services; and William Workman Department of Economics and Institute of Agricultural Sciences, University of Alaska. The authors also wish to acknowledge the research and editorial assistance of Myra Helms, graduate student, University of Alaska; the editorial assistance of Helen Stockholm, Director of Publications, Institute of Marine Science, University of Alaska; and the typing assistance of Kate Barr.

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CHAPTER I

INTRODUCTION AND SUMMARY OF FINDINGS

INTRODUCTION

This report on the economic potential of the Alaska clam industry is based on a study that is part of the University of Alaska Sea Grant Program, Clam Research Project.[1] The initial objective of the economics portion of this project has been to assemble all available information relevant to an assessment of economic potential.[2] In the case of the clam industry it was determined that economic potential analysis required information on clam species, stocks and trends in stocks; the current status of the industry with respect to structure, operations, markets served and volume of activity; the regulatory environment in which the industry must operate; and the economic environment in which the industry must compete. Each of these topics is addressed in this report.

This report is intended as a vehicle to disseminate the information gathered in a manner which will be useful to existing and potential industry operatives (who will be making decisions concerning entry into the industry or expansion of existing effort); the political process (which must make decisions on funding support for the regulatory effort upon which the industry's growth partially depends); the regulatory agencies (which will be monitoring the rate of utilization of clam resources and the quality of clam products); and to other interested parties less immediately associated with the industry. It is hoped that this report will be especially useful in facilitating the formulation of informed public policy with respect to Alaska's clam resources and that it will contribute toward reducing the extreme uncertainty, among those operating or potentially operating in the industry, that has hampered the industry's growth for at least the past decade.

The remainder of this chapter is devoted to a summary of the factors affecting economic potential. Chapter II provides an overview of the historical development of the clam fishery in Alaska from its inception to the present. While much of this material is not

[1]This study was made possible by the financial support of USDC, NOAA, Sea Grant Program, Grant No. 04-3-158-35.

[2]Much of the information was collected in an unpublished M.B.A. Thesis by Charles Smelcer "The Economic Potential of the Clam Industry in Alaska", May, 1974, University of Alaska, Fairbanks.

strictly pertinent to the potential of the clam fishery, it is helpful for understanding its present depressed status. In Chapter III the regulatory environment is described; the obstacles to the industry's growth inherent in this environment are considered in detail. Chapter IV describes the harvesting, processing and marketing of clam products. Chapter V draws on the earlier chapters and other information to assess the overall economic environment and its implications for the future of the fishery.

SUMMARY OF FINDINGS

Economic Potential

In some respects Alaska clam resources are typical of many of the State's other resources. Past and present production of clams has not approached the estimated sustainable yield;[3] there are potential conflicts between commercial and recreational uses of the resource (especially in the Cook Inlet area); and full commercial utilization of Alaska's clam resources is restrained by the set of economic factors that have always been a barrier to the expansion, or, in some cases even the initiation, of economic base industries – transport cost, higher labor costs and technologically less sophisticated capital stock. In other respects, however, the clam industry is atypical. Stocks are located geographically in such a manner as to preclude foreign fishing effort; the clam industry has been subjected to a maze of regulations, principally due to the potential for paralytic shellfish poisoning that has, for the past two decades, reduced the industry to a level of relative insignificance; the 1964 earthquake had an extreme adverse impact on some of the most productive source beaches around Cordova; and there is relatively little knowledge about the size and location of stocks and about many important biological characteristics pertinent to effective planning for resource utilization and conservation.

On balance, these attributes reflect, or are contributing factors to, an adverse past environment for expansion of the clam industry. Recent changes on the regulatory front and impending changes in clam harvesting techniques, however, make the future of the

[3] The true sustainable harvest is unknown, but estimates place it in the neighborhood of 50 million pounds (shell weight) per year. The maximum catch in Alaska has been only one-tenth that amount and, in recent years, has not exceeded one-fiftieth of that amount.

industry much more promising than the recent past. In terms of obtaining the past peak annual production levels of around five million pounds shell weight (1,750,000 to 2,000,000 pounds of meat) there is a significant potential for expansion of the clam industry over the next decade. Landings of five million pounds are approximately twenty times greater than those achieved in recent years. This estimate of potential is predicated on the actual occurrence of four probable events. First, the State of Alaska must be readmitted to the National Shellfish Sanitation Program (NSSP). Membership status will allow Alaska processors to apply for certification as interstate shippers which will allow them to ship their fresh or frozen eviscerated razor clam products in interstate commerce. The interstate market in fresh and frozen clams has been closed to Alaska processors since 1954. It is very likely that final approval of the State's membership application will occur before the 1975 harvesting season.[4]

Second, the expansion of the industry is predicated upon the ability of the industry to compete with alternative sources of supply, primarily with clams harvested on the East Coast but, to a lesser extent, also with the imported products from Canada, Japan and South Korea. The ability to compete is primarily dependent upon the development of an environmentally safe and productive dredge. The introduction of such a dredge will reduce the cost and increase the amount and reliability of the supply of clams to processors. Dredges are not only potentially much more productive in terms of basic cost comparisons (given the size and relative wage structure of the aggregate fisheries labor force), they also have the advantages of allowing harvesting at other than low-tide periods and of extending the harvestable area outward to the subtidal zone.

If dredge-based technology is not introduced, both the high cost and the unreliable source of supply characteristic of the hand harvesting in recent years will impede the growth of the industry.[5] Based on the dredge experiments conducted in Alaska in recent years, it appears likely that a dredge will be developed that can meet the specifications of

[4]Final approval for the State of Alaska Shellfish Sanitation Program was received on March 10, 1975, from the Food and Drug Administration. Alaska is now a regular member of the National Shellfish Sanitation Program.

[5]There is nothing inherently unreliable in the hand-harvesting labor force. The source of supply from this labor force can be unreliable if, as appears to generally be the case, employment in the clam industry is secondary employment for a labor force primarily employed in the other primary fisheries, i.e., salmon and crab.

the Alaska Board of Fish and Game. Subsequent to such development there may be difficulty in deciding conflicts between hand harvestors and dredge harvestors over access to the three approved beach areas. If such is the case, economic efficiency considerations will weigh in favor of the use of dredges. Equity considerations, on the other hand, will probably weigh in favor of hand diggers who can claim prior use. To the extent that equity considerations prevail in such a manner that the introduction of dredges is impeded, the growth of the industry will likewise be delayed.

Third, more resources will need to be devoted to source-beach certification and monitoring if processors are to have a sufficient source of supply to warrant a major processing effort and if harvesters are going to expand the harvest to past-peak levels or beyond. Expansion of source beaches is critical in another respect: the application of dredge-based technology in harvesting will depend upon there being sufficient certified-beach area to allow both dredge harvesting and the maintenance of stocks. Even if the effect of dredging on clam population proves to be beneficial, dredges will be sufficiently productive to require a system of beach rotation. A system of beach rotation, designed to insure the continuity of harvesting activity, will, in turn, necessitate a larger number of certified beaches than presently exist. Presently, three beaches are certified with combined beach area of approximately fifteen miles (see description of certified beach areas below, Chapter IV, p. 51) and sustainable yield of around one and a half to two million pounds. Landings in 1973 were only a small fraction of that amount.

Under the present agreement between the State of Alaska and the Food and Drug Administration, future beach certifications will be restricted to razor clam beaches (due to both the relatively fewer incidences of paralytic shellfish poison and the relatively lower concentrations of toxin characteristics of razor clams).[6] Nevertheless, after the State has proven its ability to comply with the provisions of the NSSP, it is likely that the State can obtain approval to certify beaches containing other species of clams.

Finally, a potentially important factor is the existence of the market for clams as dungeness crab bait. This has been the primary market for Alaska clams in recent years. Because this market does not depend on certified beaches for its supply (even though most

[6]This restriction does not apply if the product is to be marketed intrastate only. Thus, the state could certify a butter clam beach with the restriction that the harvest be marketed only within Alaska or exported to consenting countries.

of the bait razor clams harvested in recent years have come from the certified beaches), the bait-clam harvesting effort could be transferred to uncertified beach areas. If this occurs, along with the other developments mentioned, the potential growth of the industry will be favorably affected. In addition, a harvesting effort on uncertified beaches would have the favorable effect of assisting the identification of the most productive new razor clam beaches. Such identification is crucial to maximizing the public- and private-sector return on any additional resources devoted to expanded beach certification.

To summarize, the significant growth potential of Alaska's clam industry will be increasingly realized over time if: (1) Alaska obtains and maintains membership in NSSP; (2) environmentally safe clam dredges are introduced; (3) more resources are devoted to source beach certification and monitoring, and (4) harvesting effort for bait razor clams is displaced to noncertified beaches. Given the probable occurrence of these events, it is not unrealistic to expect annual harvests of around five million pounds shell weight within the next decade. The value to the fisherman of such a harvest will likely be in excess of $2 million. From the processors viewpoint, a price of $0.40 per pound shell weight amounts to a meat weight (basic input) cost of around $1.15 per pound, assuming 35 per cent recovery (or $0.95 per pound assuming 42 per cent recovery).[7] Assuming conservatively a price to the wholesaler of around $1.80 per pound, an annual harvest of 1,750,000 pounds meat weight (from the 5 million pounds shell weight) would have a value of around $3.2 million entering the wholesale level. Direct fisheries tax revenue of around $20,000 (assuming fresh and frozen products) would accrue to the state as well as several thousands of dollars in miscellaneous license fees. Additionally, the income generated in the harvesting, processing and transporting of clams and from the subsequent rounds of respending of that income is taxable under the State's income and business license taxes.

The Alaska Clam Resource

It has been estimated that there are sufficient clam resources in Alaska to sustain an annual harvest of around fifty million pounds (U.S. Department of Interior, Bureau of Commercial Fisheries, 1968). Even if this estimate is reasonably accurate, however, this

[7] Non edible viscera obtained in processing for human consumption would potentially have value as bait. The above recovery factors do not allow for this additional recovery.

basic source of supply is severely restricted by regulation. At present, the effective source of supply for human consumption is the razor clam resource of Southcentral Alaska. The effective source of supply for nonhuman consumption (for use as crab bait) is not at present restricted by regulatory factors. However, buyer preferences restrict the harvest to the razor clam which is harvested primarily from the three approved beaches and contiguous areas in Southcentral Alaska.

The supply restrictions in the fresh and frozen components of the human-consumption market result from the product quality regulation of the State of Alaska and the U.S. Food and Drug Administration. The basis for these regulations is, in turn, the periodic existence of, and the difficulty in guarding against, paralytic shellfish poisoning in Alaskan clam-harvesting areas. The National Shellfish Sanitation Program (NSSP) is the institutional device established to protect consumers from paralytic shellfish poison (PSP) and other sanitary hazards originating in shellfish products entering interstate commerce. Alaska, after two decades of nonmembership, is currently being readmitted to membership status in the NSSP. The program requires an expensive system of beach certification and monitoring. Thus, one limiting factor in the industry's growth potential is the amount of funding provided by the Alaska Legislature to the three state agencies responsible for enforcement of the provisions of the NSSP. The three state agencies, operating jointly under a Memorandum of Understanding, are the Departments of Fish and Game, Health and Social Services and Public Safety.

Restrictions on the canned product side of the human-consumption market are due to adverse economic factors as well as regulatory restraints. Source beaches for clams that are to be used for canned-clam products must be approved by the Alaska Department of Health and Social Services; after this approval the properly prepared canned product is free to enter the interstate market. The provisions of the NSSP do not apply to this product form. Alaska-produced canned-clam products are not competitive, however, with alternative sources of supply, even on the West Coast and Alaska markets. The inability to compete finds its origin in the higher costs of harvesting and processing in Alaska and the greater difficulty of exploiting any product superiority when the product is in canned form (fresh or frozen razor clam steaks or strips are generally considered to be the most desirable product form for this species). Another barrier to the re-emergence of Alaska as an

important supplier of canned clams is the uncertainty faced by processors with respect to a dependable and sufficiently large source of supply to warrant introduction of a canning line.

In summary, the effective source of supply for commercial harvest is, at present, the razor clam stocks in Southcentral Alaska. The total supply is much greater;[8] the resource covers much of the coastal area of the state from Southeastern to Western Alaska and encompasses many species, of which the razor clam (*Siliqua patula*), butter clam (*Saxidomus giganteu*) and cockle (*Clinocardium nuttalli*) are potentially the most important commercially. Some observers within the Alaska Department of Fish and Game estimate the stocks of hardshell clams to be of much greater potential than the stocks of razor clams. If the latter is the case, new beach certifications should reflect this fact once the State has demonstrated its ability to comply with the provisions of the NSSP in its razor-clam program and thereby obtains permission to certify other than razor clam beaches. The admission of new beach areas and species is necessary before the industry can expand to its historical peak production levels and beyond.

Clam Harvesting Technology

The traditional method of sport and commerical harvesting of razor clams in Alaska is hand digging with a specially designed shovel. A skilled digger can dig between 200 and 300 pounds per four-hour tide; a few highly skilled individuals can dig substantially more. Although there is considerable variation, the shell weight price to the fisherman has doubled from around $0.30 per pound in 1971 to around $0.60 per pound in 1974. Given the recovery factor of between 35 and 42 per cent, the meat weight price is very sensitive to changes in the shell weight price. The meat weight price is the basic input cost to the processor if the product is to enter human consumption channels.

An alternative technique for commercial harvesting is the use of a mechanical or hydraulic dredge. While dredge-based technology is being used on the East Coast to harvest soft-shell and surf clams, no such dredge has been modified for successful application to Alaska beach conditions. A sufficient number of attempts have been made in recent years

[8] See Baxter (1968) and Feder and Paul (1974) for descriptions of Alaska clam species.

(in a period in which the economic incentive to innovate has been minimal at best) to suggest that the introduction of an acceptable and successful dredge is likely to occur soon.

As mentioned, an important precondition to the expansion of the Alaska clam industry is the introduction of an environmentally safe dredge. In the absence of such introduction, it is unlikely that Alaska canned-clam products will enter the interstate human-consumption market in significant quantity. This is true because the high costs of harvesting by hand, when coupled with the higher cost of processing in Alaska, renders the price required to cover cost and profit uncompetitive with dredge harvested East Coast clams. The fact that one can buy East Coast and Japanese produced canned clams in retail grocery stores in Alaska, but cannot find razor clam products originating in Alaska, attests to the competitive disadvantage facing the Alaska clam industry in producing a canned-clam product. It is likely that some processing for the fresh and frozen market will be attempted, even in the absence of dredge harvesting, once the state is readmitted to the NSSP, but the profitability of these efforts will be highly sensitive to variations in the price paid to harvesters.

Marketing of Alaska Clam Products

Inasmuch as Alaska fresh and frozen clam products have been effectively excluded from the human-consumption market in recent years, there is little basis in past experience on which to make judgements as to potential markets for the products of an expanded Alaska clam fishery. Nevertheless, it can be expected that the Pacific Coast states will be the initial market exploited. This presumption is based on the fact that in these states per capita consumption of clams is relatively high; these states are net importers of clam products, there is a relatively high degree of familiarity with the razor clam among consumers in these states, and there is a large existing institutional market (restaurants and clubs primarily) for frozen clam products. In the latter market the Alaska razor clam is likely to enjoy a significant degree of buyer preference.

Alaskan processors interested in exploiting the Pacific Coast market prefer either a wrapped or large canned (five pound) frozen product. The product itself will be either whole clams, clam steaks or clam strips. Only one processor interviewed expresses an inclination to ship the product fresh in large vacuum sealed cans. There is little general

interest among processors at present for producing a canned-clam product (whole or minced clams), although one processor is known to be experimenting with a canned minced razor clam product. The lack of general interest in a canned product is due to the inability to compete with East Coast canned-clam products which enjoy cost advantages at both the harvesting and processing levels. As already mentioned, however, the introduction of dredges and the certification of more beach area could make the canned market an important one for the future.

Another important market for razor clams is among dungeness crab fisherman. This market, located geographically in Alaska, Washington, and Oregon, has absorbed virtually the entire Alaska clam harvest in recent years. The razor clam enjoys a substantial degree of buyer preference as evidenced by statements of crab fishermen concerning its superiority as crab bait and by the apparent willingness of buyers to absorb substantial price increases. The bait market has not been the only significant existing market, it also is a significant potential market for additional razor clam production. Supply shortages have been characteristic of this market for a number of years, indicating that there is unmet potential. While the amount of the potential is difficult to assess it is likely that a doubling of present harvest could be sold in this market at a price of around $0.45 per pound shell weight. Demand in the bait market at a particular time is, of course, closely related to the status of the dungeness crab fishery.

Demand, Supply and Prices

The demand for clams in the U.S., on the Pacific Coast and in Alaska, will be growing over the rest of this century, even if per capita consumption of clams remains constant, as a result of the growth of population. Abstracting from possible significant changes in consumer tastes, which are not predictable, per capita consumption may grow as a result of both the growth in consumer real income over time and future changes in the relative prices of food fishes which will almost certainly favor clams. Even small increases in per capita consumption will result in a rate of demand growth in excess of the rate of growth in population.

United States and world estimated clam supply potential is large relative to present landings. Consequently, Alaska will not necessarily experience drastic increases in demand for its clam resources solely as a result of the depletion of existing supply sources. Nevertheless, as mentioned, there is a relatively large potential for Alaska clam resources on the West Coast human-consumption market.

The real price of U.S. and world clam landings is not expected to increase very significantly over the next several decades, particularly in comparison to the real price increases which will be experienced by most other food fishes. This result follows from the very large unexploited stocks of clam resources in the Northwest and West Central Atlantic and the Northeast Pacific compared to the expected growth in U.S. demand. Under these conditions the Alaska clam fishery must not only overcome regulatory constraints if it is to make significant inroads on the U.S. human-consumption market, it must also introduce technology which will permit landings at or near the U.S. real price.

Limited Entry

As applicable to the clam fishery, limited entry poses some interesting problems.[9] In the near term, entry limitation may be required on the three presently certified beaches if, as is likely, the opening of razor clams to the interstate human-consumption market significantly increases demand. Not only might decisions have to be made with respect to the number of units but also with respect to type of harvesting gear. Given the development of a highly productive dredge and a significant expansion of certified beach area, one can envision an effective combined program of beach rotation and limited entry.[10] Based strictly on efficiency considerations, a system of competitive bidding for access would be desirable. Not only would such a system ensure that the most efficient harvesting methods would be utilized but it would minimize the informational input required by regulators.

Given the current infant status of the fishery, incentive to develop unexploited clam resources should be an important consideration. One method which may provide sufficient

[9] At present, limited-entry provisions do not apply to the clam fishery as it is not classified as a distressed fishery by the Commercial Fisheries Entry Commission.

[10] Such a combined program is especially important in view of the poor recruitment and slow growth of clams observed on beaches in Alaska (Feder and Paul, unpublished).

economic incentive would be to initially allow open entry on unexploited beaches with subsequent access allowed on a noncompetitive basis to harvesters initially developing a beach for a period of several years. Harvesters would then be allowed to control access for that period subject only to the normal harvest restrictions.

In one sense, the imposition of a limited entry program in the clam fishery poses a unique challenge and opportunity to regulators. There are relatively few harvesters who can claim past dependence and present injury when a program is initiated. Consequently, there should be little reason why the immediate objective of the program should not be to maximize economic returns from the use of clam resources. The realization of this objective can be approximated in practice if entry is limited in each control area to the minimum number of efficient units necessary to produce the allowable harvest, the latter set at or somewhat below the maximum sustainable yield level.

CHAPTER II

HISTORY OF THE ALASKA CLAM FISHERY

INTRODUCTION

This chapter will examine the past record of the Alaska clam fishery as it has evolved to its present status. The outstanding features of the industry have been its instability and its persistent long-run decline. Production levels of the industry, as shown in Figure 1, have experienced extreme variation since the fishery inception in the early 1900's. At its best the harvest approached five million pounds shell weight and extended to two clam (razor: *Siliqua patula*; butter: *Saxidomus gigantea*) and one cockle (*Clinocardium nuttalli*) species.[1] At its worst, in the early 1920's and again in the middle 1960's, the harvest was less than 50 thousand pounds. At no time, however, has the fishery recovered to equal the production levels it achieved immediately after the initial growth of the late teens of this century.

It is nevertheless apparent that the fishery can recover to equal or exceed its earlier performance. The potential of the industry will be determined by the economic, biological, technological and political environments of the present and future rather than those of the past. Future success will require adaptation to current market forces, the application of modern technology and the management of clam resources in a manner conducive to sustained stocks while at the same time allowing the use of efficient techniques.

EARLY HISTORY AND DEVELOPMENT OF THE ALASKA CLAM FISHERY

The clam fishery in Alaska had its beginning as an independent industry in 1916. Although butter clams had been canned in Southeast Alaska in years prior to 1916, such operations were usually incidental to the primary activity of canning salmon and did not warrant separate processing facilities. By 1916 the demand for clams had risen to the point that the razor clam beds near Cordova, Alaska attracted commercial attention. The first attempt to exploit them commercially was made by two companies that equipped canneries

[1] See Feder and Paul (1974) for biological information pertaining to these and other Alaska clam species.

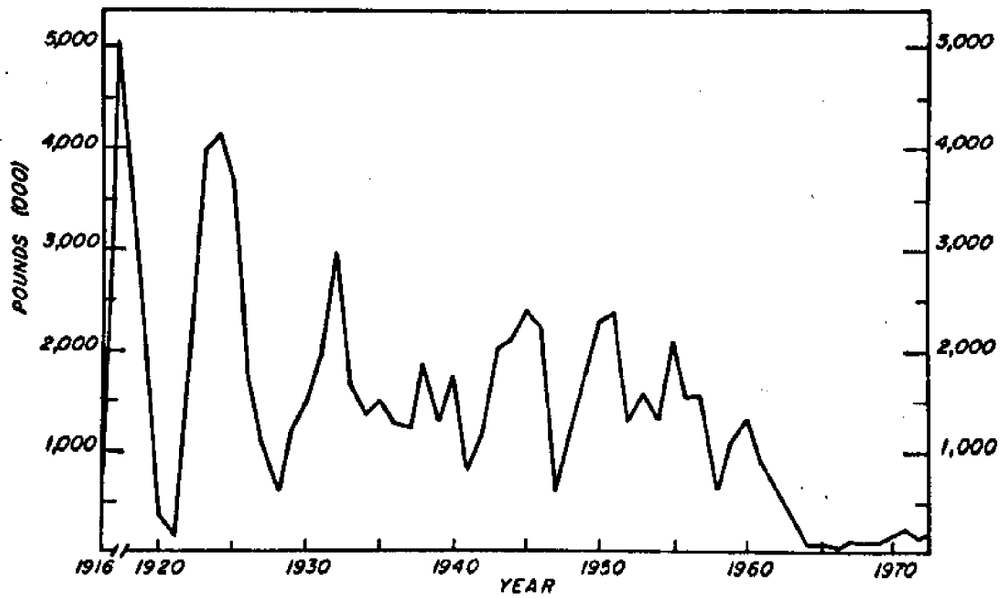

Figure 1. Alaska clam landings (shell weight) 1916-1973.
Sources: U.S. Department of Interior, 1916-28, 1942-59; Pacific Fishermen Yearbook, 1929-41; Alaska Department of Fish and Game, 1960-1973.

at Cordova. The Lighthouse Canning and Packing Company and the Pioneer Packing Company were the first two firms to engage in the Alaska clam fishery on a full time basis. Total investment in the clam canning industry in 1916 (in 1916 dollars) amounted to $157,943 with 78 persons employed in the fishery and 10,093 cases produced at a wholesale value of $35,622 (U.S. Dept. of Interior, Fish and Wildlife Service, 1916).

The first attempt to can razor clams occurred in 1902 when a Washington State firm made an abortive attempt at commercialization. In 1913 a successful attempt was made in Washington and was followed by Oregon, Alaska and Canadian ventures (Sweazey, 1944, p. 18). The Alaska razor clam industry developed as an extension of razor clamming on the ocean beaches of Washington and Oregon (Wiese, 1968, p. 1). The combination of Alaska's abundant supply of clams and an increased demand that Washington and Oregon could not satisfy made operations in Alaska commercially feasible (Brooke, 1950, p. 49).

The canning of razor clams in Alaska initially gave promise of becoming an industry of some importance. It was generally believed that the Alaska razor clam beds were extensive, accessible and perhaps capable of supporting an independent industry for some time (U.S. Dep.. of Interior, Fi ı and Wildlife Service, 1920). From a high production of 93,343 standard cases (48-½ pound) in 1917 the Alaska pack declined to a low of 1,600 cases in 1921. This contraction was caused by the exhaustion of the Cordova clam beds, and the consequent higher rate per pound of clams demanded by commercial clam diggers, and to generally depressed economic conditions (Brooke, 1950, p. 49). Only one cannery processed clams in 1920 (U.S. Dept. of Interior, Fish and Wildlife Service, 1920).

In the early 1920's new razor-clam beds were discovered at Snug Harbor (Cook Inlet), Kukak Bay (Alaska Peninsula) and Alitak (Kodiak area) and the Alaska clam pack increased again in the mid 1920's. At Kukak, on the mainland opposite Kodiak Island, a large cannery thrived from the late 1920's to the early 1930's, and at Polly Creek, on Cook Inlet, a small cannery operated for several years in the mid 1920's. Cordova remained the center of activity during this period. In the late 1920's some of the canneries failed to process clams due to unfavorable market conditions; as a result the pack for these years was lower (Brooke, 1950, p. 51).

Production increased in the early 1930's and by 1932 Alaska produced more than half the total Pacific Coast pack of 123,006 cases of razor clams. However, in 1932 the

overworked beaches, cold winter and heavy storms hastened the process of depletion of the razor clam beds. The U.S. Government, responsible for the management of commercial fisheries in Alaska, became concerned at the imminent prospect of loss of this important industry and established regulatory controls on the Alaska clam fishery (Sweazey, 1914, p. 18). After 1922, when the regulatory controls were established, the clam fishery produced at a fairly uniform level; the sustained harvest exceeded one million pounds (Fig. 1).

The butter clam is plentiful along the coast of Southeast Alaska and is the most abundant species of clam in that area. The butter clam fishery in Southeastern Alaska was renewed in 1930 with an initial catch of 25,000 pounds having a value of $720 to the fishermen (Lehman, 1965, p. 4). The industry continued until 1942 with no appreciable expansion. After 1942 the wartime demand for shellfish products provided sufficient incentive to increase production. During 1943-46 an established butter clam fishery developed; but the growth was interrupted by the discovery of a toxin, paralytic shellfish poison (PSP), in the canned butter clam product by the Food and Drug Administration (FDA). By 1946 Southeastern Alaska processors (five canneries) had been annually producing a pack valued at $170,000 (Anderson and Powers, 1950). This fishery was a winter fishery offering employment and income during the otherwise "slack" season. The toxicity problem led ultimately to the collapse of the butter clam industry in Southeast Alaska (Magnusson and Carlson, 1951, pp. 1-2). A fairly extensive survey of the clam producing beaches of the region revealed that moderately toxic clams were so widely distributed that closure of well defined areas would be impractical. The toxin was found to be present at all times of the year and, as a result, the commerical harvest of the butter clam was severely limited. Small packs have been tried from time to time, but the fishery has never recovered (Lehman, 1965, p. 4).

By 1946 exploitation of the Alaska razor clam resource was being closely controlled through size limits and harvest quotas. The razor clam beaches in the territory were considered to be in good condition and there was a resumption of the westward-moving tendency by Alaska canneries. It will be remembered that in the mid 1920's the clam fishery had grown westward to the Alaska Peninsula (Kodiak area) and the Cook Inlet area; however, the years of depression forced it back to the Cordova area (Pacific Fishermen Yearbook, 1947).

Clamming's contribution to the economy of Alaska declined significantly in the late 1950's due principally to the higher cost of catch and production in Alaska, competition from dredge harvested East Coast soft-shell and surf clams and enforcement of public health regulations relating to the toxicity problem in fresh and frozen clam products (Wiese, 1968, p. 2). Alaska was a member of the National Shellfish Sanitation Program (NSSP) from around 1927 to 1954. The U.S. Public Health Service withdrew the state from the program due to the severe toxicity problem in the hardshell clam stocks within the state and the apparent inability of the state to meet the provisions of the program (Jensen, 1965, p. 2). The state was re-admitted to the NSSP in March, 1975.

The Alaska Good Friday earthquake of 1964 caused significant damage to the clam beds of Southcentral Alaska and, as shown in Table 1, the commerical harvest since then has not fully recovered. The Prince William Sound-Copper-Bering River region suffered extensive clam mortality as a result of the land rise of about six feet. In Prince William Sound, the clam habitat suffered an estimated loss of 43 per cent with a decrease in the amount of accessible clams (above the minus three foot tide level) of 31 per cent (AK Dept. of Fish and Game, 1965, p. 2). Subsidence of clam beaches in the Cook Inlet area reduced the availability of clams to sport and commercial diggers but not as significantly as in the Prince William Sound area. Entire populations of some beaches were lost and re-establishment of clam populations will take many years (Gullard *et al.*, 1972, pp. 104-105).[2]

During the first few years of the Alaska clam industry plants were established principally for processing of clams. These plants later diversified into other fishery products as the clam fishery could not support independently the operation of the canneries (Wiese, 1973, Aug.). The number of plants processing clams has varied over the years, but as shown in Table 2, there were never many. Most of the plants processing clams were "kitchen sink" operations that never put out more than 400 pounds of clam products a year. At no time in clamming history in Alaska were there more than four "industrial" clam processors operating at one time; usually there were only two or three (Wiese, 1973, Nov.). Generally,

[2] Recovery of beaches is now taking place, but the dominant clams are now small hardshell clam species (*Protothaca staminea*), as opposed to the formerly dominant large butter clams (Feder and Paul, unpublished).

TABLE I

ALASKA COMMERCIAL CLAM HARVEST, 1957-1973

(thousand pounds shell weight)

1957	1,552.2
1958	664.2
1959	1,126.1
1960	1,351.4
1961	932.1
1962	687.2
1963	410.3
1964	99.6
1965	87.7
1966	44.1
1967	117.1
1968	79.3
1969	86.3
1970	160.2
1971	243.1
1972	213.8
1973	231.2

Source: Alaska Department of Fish and Game, Statistical Leaflets.

TABLE 2

NUMBER OF ALASKA CLAM OPERATING PLANTS AND LICENSED UNITS

1942-1972

Year	Operating Plants	Licensed Units
1942	6	166
1943	8	170
1944	16	168
1945	20	170
1946	20	274
1947	20	195
1948	14	271
1949	17	289
1950	19	396
1951	15	436
1952	14	248
1953	10	293
1954	14	264
1955	11	465
1956	6	450
1957	N/A	204
1958	N/A	426
1959	N/A	303
1960	N/A	434
1961	N/A	394
1962	8	319
1963	6	202
1964	7	131
1965	5	114
1966	5	102
1967	N/A	127
1968	4	148
1969	8	135
1970	10	149
1971	13	237
1972	17	336

Sources: U.S. Department of Interior, *Alaska Fisheries*, 1941-1959, and Alaska Department of Fish and Game, Statistical Leaflets, 1960-1972.

except in the early years, the plants were primarily processors of other finfish or shellfish. Clam processing usually occurred just prior to salmon season when plants were otherwise idle.

Almost all the razor clams produced in Alaska were shipped to Seattle for distribution to the West Coast states (Wiese, 1973, Aug.). During the late 1950's the volume of the canned product was not large enough to supply more than a limited market. Only a very small percentage of the razor clam pack was shipped east of the West Coast. The principal markets were San Francisco, Los Angeles, Portland, and Seattle (Brooke, 1950, p. 65).

Regulatory measures by the U.S. Government were established during the early years to conserve the clam resource. In 1924 a 4½ inch size limit was established for razor clams to prevent over harvest and depletion of the Cordova clam beds. The 4½ inch size limit would allow the razor clam to mature and spawn at least once (Pacific Fishermen Yearbook, 1925). Effective in 1933 the Government established pack limitations, digging seasons and restricted areas (Sweazey, 1944, p. 18). In the Prince William Sound-Copper River region, a quota of 1,100,000 pounds (shell weight) was set for the spring season of 5 April through 30 June and a 100,000 pound harvest allowed for the fall-winter season of 1 September through 28 February. The annual quota for this region was raised to 1,800,000 pounds in 1939. A 500,000 pound quota was established for the Kodiak area, and in 1935 a quota of 500,000 pounds was set for the west side of the Cook Inlet area (Pacific Fishermen Yearbook, 1936). The quotas were in effect until statehood.

Most of the razor clam diggers in the early years lived in Cordova, and the local economy depended heavily on the clam fishery. A clam digger had to be a member of the Prince William Sound Fishermen's Union, which also required him to be a resident of the Sound district. The rationale for this requirement was that there was only a specified pack each year and the resident diggers depended upon it for a large part of their livelihood. If outsiders were to come in for the season, compete for the fixed amount of money to be made and then leave at the end of the season with their earnings, the resident diggers and the local community would suffer economically (Sweazey, 1944, p. 18). Given the monopsony (buying) power facing harvesters and the harvesting quotas then in existence, the restrictions on the harvesting labor force were probably desirable. Without them, average returns to harvesters would have been less, monopsony profits would have been greater and excessive resources would have been used to harvest the quota.

Clam digging was considered a skilled job and it usually took years for a digger to achieve optimum efficiency. A highly skilled digger could, in normal years, bring in an average of five hundred pounds (shell weight) a tide. A normal digger averaged 200-400 pounds catch per tide (Sweazey, 1944, p. 18). Usually about 200 diggers were engaged and most of them had their favorite razor clam bars that they dug year after year. Tides and weather governed clam digging activities for the most part (Sweazey, 1944, p. 18). Once on a bar a digger had to stay there until the tide came back and floated his skiff. All digging was accomplished with a small steel shovel with a hardwood handle about three feet long. The blade was about six inches wide at the top and narrowed to about three inches at the knife-sharp end. It was slightly cupped and formed a slight angle with the handle. The average dig on a tide was only three to five hours. After the dig the boxes of clams were taken to the tally scow or buyer boat for weighing. They were then emptied into a series of inch square mesh platforms and carried along a moving belt with a stream of water sprayed on them to help remove the sand and other debris. The clams were then taken to the cannery. On occasion the tally scow stayed in the clam digging area for several tides (Sweazey, 1944, p. 22).

Canning was the principal means of processing the clams during the early years. The method of canning was as follows: the first operation was the removal of clam meat from the shells. This was done by immersing the clams in boiling water, either in vats designed to receive the wire baskets in which the clams were placed or the clams were passed through the boiling water on an endless belt. After remaining in the water approximately 30 seconds, the clams were thrown on a table and the shells fell away from the meat. The clam meats were then passed on to workers, who opened the stomachs and necks, removed the sand and sediment and severed the back part of the neck. The cleaning process was continued by placing the meats in a cylindrical perforated washing machine which revolved half a turn both ways in a tank filled with water. Any sand or sediment remaining in the clam meat was thus completely removed. The clam meats were then taken directly to the filling table if whole clams were to be packed or to the grinder if the minced variety was desired. The cans were filled by hand and then passed through the topping and sealing machines. The process was completed by cooking the canned product in retorts at a temperature of approximately 245°F. for one to one-and-a-half hours depending upon the size of the container used (U.S. Dept. of Interior, Fish and Wildlife Service, Statistical Digest, 1916).

The canning of razor clams in British Columbia began in 1923; practically the entire catch was canned and shipped to markets in the United States. In 1930 the United States placed a 35 per cent ad valorem tariff on imports of canned razor clams and by 1933 the Canadian canneries had ceased operation. In 1934 the tariff was reduced to 23 per cent, but canning did not resume until 1942. Since then production has been intermittent and generally small with the largest part of the catch frozen for sale to Washington crab fishermen for use as bait (Brooke, 1950, p. 51). In 1936 fresh razor clams were imported from Masset Beach (Canada) to Kasaan (Southeast Alaska) for processing. A total of 9,610 cases were produced (Pacific Fishermen Yearbook, 1938). This appeared to have been an isolated incident as it has not been noted since.

During 1944 there were some noteworthy advances in freezing clams, both razor and hardshell. In Alaska, limited quantities of minced butter clams were frozen for use by the military, mainly as clam chowder. In Washington State the practice of freezing razor clams in packages reached commercial stature in 1945. Most were frozen in packages, but some were minced and frozen in cups or boxes. They proved to be a seafood delicacy of attraction to the upper-class market (Pacific Fishermen Yearbook, 1945).

During and after WW II there was a rapid increase in the use of razor clams as dungeness crab bait, principally in Washington State. An increasing portion of the commercial catch of razor clams was frozen in the shell for this use. By 1949 competition among the crab bait buyers was heightened to the point that the price rose to as high as $0.30 a pound (shell weight) during the season. Large quantities of razor clams were shipped to Washington State from British Columbia and Alaska. The clam bait buyers were willing to pay more for razor clams to use as bait than canneries could afford to pay to process them for human consumption (Pacific Fishermen Yearbook, 1950). Alaska dungeness crab fishermen also have relied on razor clams as bait.

The razor clam is considered by the crab fishermen as the preferred bait even though experiments indicate that other kinds of bait could be used successfully. Squid, fish offal, other types of clams, various species of fish, and even salmon heads are all possible bait for dungeness crab (Brooke, 1950). The crab fishermen still prefer razor clams and, as indicated, in recent years they have been willing to pay high prices; they are utilizing nearly all of the razor clam catch each year.

CURRENT STATUS

The development of the Alaska clam resource for human consumption gained renewed interest by 1965 and led to a working conference on paralytic shellfish poisoning. The conference was jointly arranged by the Alaska Department of Health and Welfare and the U.S. Public Health Service for the purpose of reviewing and defining the specific problems associated with shellfish toxicity and establishing research and administrative program needs to permit the safe utilization of Alaska clam resources (Fehsing, 1965, p. 3). The conference was attended by representatives of health and fishery departments of the West Coast States, Federal agencies, Canada, educational institutions and the shellfish industry.

Another meeting sponsored by the Alaska Department of Health and Welfare was held in April, 1971. The purposes of that meeting were to present current requirements of the National Shellfish Sanitation Program, to ascertain potential involvement of each Alaska agency with regard to clam harvesting and processing, to isolate problems for the State associated with meeting the requirements of the National Shellfish Sanitation Program, and to decide on the courses of action necessary for the State to develop a viable clam industry (AK Dept. of Health and Welfare, 1971).

In February, 1973, a meeting was sponsored by the Alaska Department of Health and Social Services (formerly the Alaska Department of Health and Welfare) to discuss and finalize the program needs and the coordination necessary to secure Food and Drug Administration approval of the Alaska State Shellfish Plan. An "Interdepartmental Memorandum of Understanding" was signed by the Commissioners of the Alaska Department of Fish and Game, Alaska Department of Health and Social Services and Alaska Department of Public Safety in July, 1974 (Appendix II). This agreement formalized each agency's responsibilities in the State's shellfish program. Final approval of the State's program by FDA was accomplished in 1975 and removed an important obstacle to the renewed development of the Alaska clam industry. This will allow commercial harvest and interstate shipments of fresh and frozen razor clams under the NSSP.

Certain policy actions by the Alaska Department of Health and Social Services in recent years reflect the efforts made to organize and implement an Alaska Shellfish Program that would satisfy the stringent requirements of NSSP. In 1970 the Department approved

three beach areas - Polly Creek, on the west side of Cook Inlet; Cordova flats, adjacent to Prince William Sound; and Swikshak, on the Alaska Peninsula northwest of Kodiak Island[3] - for commercial harvest. These beaches had the required sanitary survey and have been continuously monitored as required by the NSSP. All other beach areas in the State were closed to commercial harvest. This regulation created resentment among bait harvesters who saw little logic in applying sanitary restrictions to clams headed for the bait market. Indeed, many people in the industry question the justification for applying any restrictions (related to the PSP problem) on the razor clam resource, even that which is to be sold for human consumption. Their view is based on the relative insusceptibility of the razor clam to PSP and on the fact that the toxin, when present, concentrates in the portions of the clam that are eviscerated. The Department, on the other hand, was faced with the need to demonstrate the State's ability to control source beaches for clams destined for the human-consumption market as required by NSSP. The position of the Department was that, given the limited resources available for enforcement, it was not possible to prevent clams from entering the human consumption market from unapproved beaches unless all commercial harvest was restricted to those beaches. However, an on-the-beach dyeing program was approved in 1973 for bait razor clams which allowed the opening of uncertified beaches to bait harvest.

Unfortunately, there appears to be little support for even this less stringent measure among harvesters and processors. It would seem that, in the future, self-interest would dictate support for and cooperation with the State's program in order that their product can gain and maintain access to an important new market. Violation by even a few harvesters and processors, with the accompanying possibility of a contaminated product reaching the human-consumption market, will jeopardize the State's participation in NSSP and adversely affect all members of the industry. A general awareness of this fact within the industry would add an important measure of self enforcement by those desiring continued access to the interstate human-consumption market and who, therefore, would not tolerate violations by others.

[3] A detailed description of these areas is provided in Chapter IV.

Even though the sanitary problems associated with shellfish toxicity, and the related regulations, are commonly given as the most pertinent reasons for the industry's decline over the past two decades, further mention must be made of the increasingly difficult competitive position in which the industry found itself beginning in the late 1950's. Total U.S. clam production increased by 44 per cent from 1955 to 1960 and by 43 per cent from 1960 to 1965, while Alaska's clam production declined by 36 and 93 per cent in the two periods respectively. Associated with the expanded U.S. production was the increasingly widespread use of clam dredges in the New England, Mid-Atlantic and Chesapeake harvesting areas. Alaska's less mechanized harvesting and processing techniques, along with a less reliable source of supply, resulted in a loss of the industry's position in the West Coast canned clam market to the East Coast producers. Given the exclusion of the State from the fresh and frozen human-consumption market due to nonmembership in NSSP, the bait market and a very limited intrastate human-consumption market have been the only commercial outlets for Alaska razor clams in recent years.

CHAPTER III

REGULATORY ENVIRONMENT

INTRODUCTION

This chapter will describe the sanitary regulations of the National Shellfish Sanitation Program, the State of Alaska Shellfish Program, the regulations of the Alaska Department of Fish and Game and the tax statutes applicable to the clam fishery. Because of their strategic importance to the future of the industry, the sanitary regulations applicable to the certification of source beaches by the State are described in detail. Those regulations applicable to harvesting, handling and processing of clams are discussed briefly and shown in Appendix I. There are no constraints imposed on the industry by stock-conservation measures as such; those that do exist can be attributed to the problem of limited certified beach area, rather than to the more basic problem of stock depletion. Accordingly, the description of these aspects of the regulatory environment is given less emphasis.

SANITARY REGULATIONS

National Shellfish Sanitation Program

The National Shellfish Sanitation Program (NSSP) was established by a conference of federal, state and municipal authorities and representatives of the shellfish industry in February, 1925, following a major outbreak of typhoid fever in the United States. A total of 1,500 cases with approximately 150 deaths were reported, all traced to the consumption of sewage-polluted oysters (Clem, 1969, p. 8). The program is a cooperative agreement administered jointly by the member shellfish producing states, the Food and Drug Administration (FDA) and the shellfish industry. The program applies to interstate shipment of fresh and frozen filter feeding molluscan shellfish - oysters, clams, cockles and mussels, but scallops, univalves and miscellaneous shellfish are presently not included. Crustaceans (crab, shrimp, lobster) are not filter feeders and are not included in the program. The problems of molluscan food sanitation and safety arise primarily as a result of their feeding method. Oysters, clams and mussels live in coastal waters and feed by pumping

water through their gills and filtering out organic particulate material, bacteria, diatoms and small zooplankters. The feeding activities tend to concentrate deleterious substances with little selectivity, and, as a result, the chemical content of the tissues directly reflects the quality of the waters inhabited (Clem, 1971, p. 15). Since these marine animals become contaminated in polluted waters, special health controls were established under the NSSP to provide satisfactory public-health protection to consumers of shellfish. In carrying out the cooperative control, the member states, the FDA, and the shellfish industry each accept responsibility for certain procedures.

All of the member shellfish-producing states participate in and subscribe to the procedures outlined in the NSSP's Manual of Operation. This Manual is published by the U.S. Public Health Service and addresses three topics: Part I covers the sanitation of shellfish growing areas; Part II, sanitation of the harvesting and processing of shellfish; and Part III, Public Health Service appraisal of state shellfish sanitation programs. Each member shellfish producing state must adopt adequate laws and regulations for sanitary control of the shellfish industry, make sanitary and water quality surveys of growing areas, classify and patrol closed shellfish waters, inspect harvesting methods and shellfish processing plants, make laboratory investigations and provide any additional control measures necessary to insure that the shellfish that reach the consumer have been grown, harvested, and processed in a sanitary manner. The state health department annually issues a numbered operating certificate to those shellfish shucking, packing, repacking, and shellstock plants whose equipment, method of operation, basic construction and product meet the cooperative program standards. Every package of fresh or frozen oysters, clams or mussels shipped in interstate commerce from a member state certified plant has a marked identification number preceded by an abbreviation of the state name (U.S. Dept. of HEW, Public Health Service, 1965, Part I, p. 7). These certified shellfish have been grown, processed and packaged under strict sanitary control.

The Food and Drug Administration conducts an annual evaluation of each member state's control program. Each appraisal includes an analysis of the legal and general administrative procedures, inspection of a representative number of shellfish processing plants, review of laboratory procedures, and effectiveness of closed area patrols. The

primary purpose of the program appraisal is to evaluate the degree of compliance with the provisions of the NSSP. On the basis of the information obtained, Federal endorsement of a member state's program is either given or withheld. Every two weeks the FDA publishes a national listing of some 1,500 valid state-certified interstate shellfish shippers for the information of health authorities and others concerned (U.S. Dept. of HEW, Public Health Service, 1965, Part I).

The shellfish industry cooperates by obtaining shellfish from safe approved sources, by providing plants which meet the agreed-upon sanitary standards, by maintaining sanitary plant conditions, by placing the proper certificate numbers on each package of shellfish, and by keeping and making available to the control authorities records that show the origin and disposition of all shellfish (U.S. Dept. of HEW, Public Health Service, 1965, Part I).

The NSSP was initially developed to meet the specific public health needs resulting from the 1924-25 typhoid epidemic. However, the national program has gone beyond the original objective of insuring that shellfish shipped interstate would not be the cause of communicable disease. In the 1940's paralytic shellfish poison (PSP) became a matter of public health concern and steps were taken under the program to protect the public against that hazard. Contamination by pesticides and industrial or radioactive wastes was recognized by 1957 and included in the program. The present NSSP is designed to assure that molluscan shellfish shipped in interstate commerce are free of hazards such as enteric pathogens, chemical pollutants, radionuclides and naturally occurring marine toxins (U.S. Dept. of HEW, Public Health Service, 1965, Part I, pp. 24-25).

In addition to the 22 member U.S. shellfish-producing states, agreements have been developed with Japan, Canada and Korea and they are also included under the provisions of the NSSP. They have subscribed to the uniform sanitation requirements of the program and certified plants of those countries can ship fresh and frozen oysters, clams and mussels to the United States and vice versa. As of 1 May 1973, a total of 54 plants in Canada, 1 in Japan and 3 in Korea were certified under the program by the respective governments (U.S. Dept. of HEW, Food and Drug Admin., 1973, pp. 15-16).

Most states have enacted laws that restrict the importation of fresh and frozen shellfish except from those shellfish producing states that are members of the NSSP and from certified interstate shippers from within those states. In other states numerous chain stores,

institutions and communities will not accept clams unless they were harvested and processed under the provisions of the NSSP (Clark, 1971, p. 8). Given these marketing restrictions, the importance of Alaska's acceptance into the NSSP is apparent.

The provisions of the NSSP do not apply to the canned, heat-retorted clam product. The U.S. Food, Drug and Cosmetic Act of 1938 is the basic law that governs the food quality standards required of processed canned clams. Plants in Alaska that process the canned, heat-retorted clam product must comply with the FDA's criteria that the raw product be pure, safe and wholesome and meet bacteriological and chemical standards as with any other food product (Torgerson, 1973, July). The source beach of the clams harvested for the canned product, as with the fresh and frozen clam product, must be certified by the Alaska Department of Health and Social Services. A marketing advantage at the present time of canned heat-retorted clam products is that they can be sold interstate; they are not limited to marketing within the state as is the case with fresh or frozen clams. The canned-clam products are inspected by the Alaska Department of Health and Social Services for intrastate sales and by the U.S. Food and Drug Administration for interstate shipment. Usually, samples are taken of the canned product and analyzed for adulteration by bacteria and PSP.

The FDA and the Department of Justice have three legal courses of action if the canned clam product is found to be adulterated under the provisions of the Food, Drug and Cosmetic Act of 1938. The first course is removal of the product from interstate commerce by seizure. The product is then either destroyed or brought into compliance, if practicable, with the 1938 Act. Second, the Department of Justice can bring criminal charges against the persons or firms responsible for having shipped or received adulterated products in interstate commerce. The third legal recourse is an injunction which in effect puts the enjoined firm out of the clam business (Morton, 1965, p. 14). The State of Alaska has similar legal seizure and penalty recourse.

Paralytic Shellfish Poison. There are four ways in which an individual can become ill from consuming clams, cockles, mussels or oysters. First, there can be infection from mollusks obtained from areas contaminated by bacteria and/or viruses. This form of contamination usually occurs as a result of raw, human sewage being dumped directly into receiving waters and eventually coming into contact with clam growing areas. Another

possible source of this form of contamination derives from the handling of clam products under unsanitary conditions. Second, poisoning can result from consuming clams that have been contaminated by pesticides and industrial or radioactive wastes. A third form of poisoning, known as erythematous shellfish poisoning, is thought to be an allergy, but the exact nature of the disorder is not understood. Inadequate preservation is assumed to be a factor in this type of poisoning, although fresh shellfish also have been involved. Characteristic symptoms, which begin a few hours after eating the clams, are abnormal redness of the skin and swelling and itching, particularly in the face and neck region. The symptoms may subsequently involve the whole body. Persons so affected usually recover within a few days, but occasionally die. Fourth, and perhaps foremost, is paralytic shellfish poisoning which is brought on by consuming shellfish that have ingested certain types of microscopic organisms known as dinoflagellates (Nickerson, 1973, March/April).

The most significant consideration with regard to harvesting of safe shellfish in Alaska is related to PSP. Outbreaks of PSP have occurred in widely scattered areas throughout the world (Fig. 2) with a significant number (greater than 600) along the Pacific Coast. Alaska has recorded a total of 222 cases with 107 deaths (Table 3). Paralytic shellfish poisoning has been recognized for over a century as a clinical entity and the prevention of human intoxication due to consumption of toxic shellfish has been a problem to public health and fishery officials in the United States and Canada for many years. From the viewpoint of the reported number of deaths each year, PSP does not appear to be a major public health problem. But, it is of significant concern because a fatal dose of the poison for humans is only a minute amount and there is no known antidote. Prevention depends primarily on identification of the toxic shellfish by laboratory assay methods before they reach the consumer. It is impossible to distinguish between toxic and nontoxic shellfish by sight, taste or smell (Prakash *et al.*, 1971, p. 5).

Gonyaulax is probably present in small numbers along the coast throughout the year. However, a rapid increase of the dinoflagellate occurs in the spring and summer when an optimal combination of light, temperature, salinity and nutrients is typically present. When *Gonyaulax* becomes numerous, the water is changed to a deep rust color and this condition is usually referred to as "red tide" or "red water". Although this condition is usually

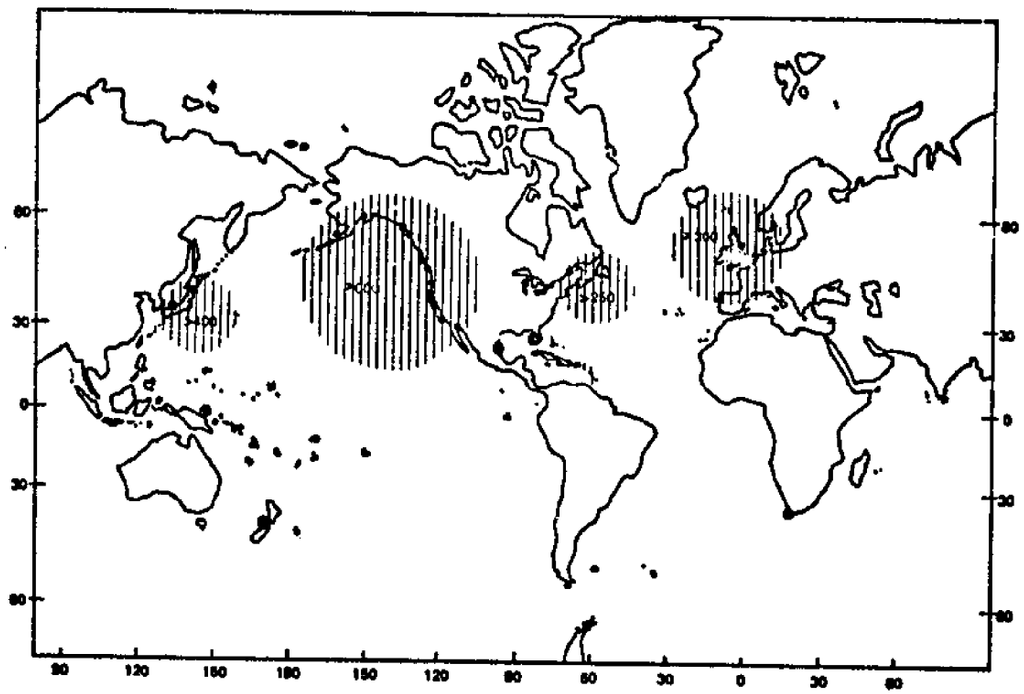

Figure 2. World distribution of paralytic shellfish poisoning, 1689-1970 (modified after Halstead, 1965). Numerals in hatched areas indicate approximate total numbers of human poisonings reported from the four major areas affected; solid circles, individual outbreaks.
Source: Prakash and Tennant (1971), Fisheries Research Board of Canada, Paralytic Shellfish Poisoning in Eastern Canada, Bulletin 177.

TABLE 3

INCIDENTS OF SHELLFISH POISONING IN ALASKA, 1799-1973

Date	Number of Cases	Number of Deaths	Comments
1799	150+	100+	Group of Aleut hunters under command of Baranof reportedly ate mussels from Peril Straits near Baranof Island. Baranof's Journal
1934	12	2	Douglas Island and Admiralty Island near Juneau, patients brought in small boat to hospital in Juneau. Sommers & Meyers, 1937
1944	4	1	Reported from a small community in Southeastern Alaska (perhaps Sitka report) Meyer & Foster, 1955 Alaska's Health, May, 1945
Unknown	3	1	Unconfirmed report of three persons becoming ill from eating butter clams taken near Peril Straits with one death Magnussen & Carlson 1951 Technical Report # 2
1954	8	1	False Pass, Alaska Peninsula cannery crew eating mussels. Meyer & Foster, 1955 Meyers & Hilliard, 1955
1962 (June 27)	25	0	Porpoise Island, Southeastern Alaska, reported that 25 members of four fishing boats collected and ate little neck clams from Porpoise Island. U.S. Public Health Service 1962, a,b
1962 (July 6)	1	1	Eating mussels, Hawk Inlet, Alaska

TABLE 3 (continued)

INCIDENTS OF SHELLFISH POISONING IN ALASKA, 1799-1973

Date	Number of Cases	Number of Deaths	Comments	
1962	1	0	Eating butter clams, Shelter Island, near Auke Bay, Alaska	Morley
1965 (June 12)	4	1	Hawk Inlet, Alaska, eating butter clams.	
1970 (July 18-20)	2	0	Butter clams from Funter Bay, Admiralty Island.	
1971 (April 1)	3	0	Douglas Island, North Beach, butter clams.	
1971 (June 27)	5	0	Butter clams at the Bay of Grand Island across from Taku harbor. Also steamer clams picked.	
1973 (May)	1	0	Razor clam, Kruzoff Islands, Sitka	
1973 (Sept. 25-26)	3	0	Butter clams, Tenakee Springs, 50 miles NE of Sitka	
	222+	107+		

Source: Files of Alaska Department of Health and Social Services (1973).

associated with PSP, the presence of red water does not necessarily mean that clams will become poisonous since other non-toxic dinoflagellates may multiply and cause similar red water conditions. Alternatively, PSP may occur when the blooms are not visible (Quayle, 1966, p. 3).

Plankton serve as food for filter-feeding shellfishes and the latter become toxic by extracting and accumulating the minute quantity of poison stored in each *Gonyaulax* cell (Quayle and Bourne, 1972, p. 15). The principal types of shellfish that appear to accumulate dangerous levels of toxicity are clams and mussels; oysters are affected to a lesser extent. Scallops may become highly toxic (Medcof *et al.*, 1947), but they have not been implicated in PSP because only the nontoxic adductor muscle is traditionally consumed. The shellfish are not harmed by the toxin that they accumulate since the poison is dangerous only to warm-blooded animals. The degree to which shellfish become toxic and the rate at which the toxin is eliminated varies among species. Generally, toxic shellfishes become nontoxic within three months except for the butter clam which retains some toxicity for up to two or more years after initial toxification (Quayle and Bourne, 1972, p. 15).

Butter clams concentrate up to 80 per cent of the toxin in the gills and siphons; the black tip of the siphon is the most poisonous part. By 1950 studies conducted by the U.S. Bureau of Commercial Fisheries led to the development of a procedure which could be utilized to bring about a safe toxicity level in the canned butter clam product. The process consists of removing the siphon from the shucked meat, steaming the cleaned meat for a 10 minute period, followed by retorting at 250°F. for 75 minutes. This process reduces the toxic content of the butter clams up to 93 per cent with no adverse effect on quality. However, no substantial use of the procedure was made by the shellfish industry in Alaska because clam processors felt that the removal of the siphon meant the loss of too much of the clam meat to make the process economical (Quayle and Bourne, 1972, p. 17).

Razor clams do not accumulate PSP as readily as the butter clam, and the natural cleansing process occurs more rapidly in the former species. The razor clam accumulates toxin in the digestive gland which is typically removed both in the domestic and commercial preparation of the clam for human consumption. Complete evisceration of the razor clam substantially reduces the risk in this species (Nickerson, 1973, August).

Symptoms of PSP usually occur within 30 minutes after eating toxic shellfish and consists of initial tingling and numbness in the lips, gums, tongue and face followed by similar sensations in the fingertips and toes. In moderate to severe cases a complete muscular paralysis of the extremities and neck occur, sometimes resulting in death due to respiratory failure within 3 to 12 hours after consuming toxic clams. Victims are usually calm and conscious of their condition throughout their illness. The effect of the toxin appears to be greatest when the shellfish are consumed on an empty stomach. If symptoms of PSP occur, treatment consists of emptying the stomach as soon as possible by induced vomiting and use of a rapid laxative. Artificial respiration should be applied and continued if breathing becomes difficult. There is no known antidote, but if the victim survives the first 12 hours the chances for recovery are good (Quayle, 1969, p. 4).

The minimum quantity of poison which will cause intoxification in a susceptible person cannot be precisely defined, as each person has a different tolerance level to the poison. Epidemiological investigations of paralytic shellfish poisoning in Canada have indicated that 200 to 600 micrograms of poison will produce symptoms in susceptible persons and a death has been attributed to the ingestion of approximately 480 micrograms of poison (U.S. Dept. of HEW, Public Health Service, 1965, Part I, pp. 19-20).

Presently, there are three testing methods to determine the existence and amount of toxin in a shellfish, all of which are fairly complex and require a well equipped laboratory and technical competence. The oldest and most commonly employed is the mouse bioassay. The standard procedure is to inject a prepared extract of clam meat into the body cavity of laboratory mice. From the time of death of several mice (usually three to six), the poison content of the shellfish meat can be calculated in terms of what are called mouse units (MU) of toxin. Approximately five mouse units are equivalent to one microgram of poison. In January, 1949, the Food and Drug Administration established allowable tolerance levels for the amount of toxin in whole and minced clams. As modified in February, 1951, the marketing of fresh or canned clams was permitted only when they had an average toxicity of less than 400 mouse units per 100 grams (3.5 ounces) of meat (Magnusson and Carlson, 1951, p. 7).

The second method is the chemical test in which the eluted poison is measured colorimetrically. It is a fairly complex procedure having a theoretical accuracy equal to or

better than the mouse bioassay. A serological test is the third method which can be ten times as sensitive as the mouse bioassay but complications with it tend to reduce levels (Quayle, 1969, pp. 5-8). The development of a rapid, reliable and improved chemical assay test or a physical method for estimating the toxin would be highly desirable, especially if it could be utilized on the beach for on-the-spot analysis in lieu of sending samples to a laboratory. Research efforts are continuing to this end at the University of Alaska and the University of California and hopefully results will lead to an acceptable, simpler testing method (Nevé, 1973).

Pollution and Waste. Pollution has been defined as "... altering of waters of the state in a manner which creates a nuisance or makes (them) ... unclean (or) ... harmful to public safety ... industrial or recreational use, ... or aquatic life." (State of AK, 1972, Title 46, p. 22). Pollution of shellfish growing areas can result from a number of sources: sewage, industrial waste, oil spills, pesticides, or radionuclides. The NSSP places primary emphasis on the source of the shellfish (the producing area) to assure that the growing areas are free of any contamination that would make the product unsafe as food. All shellfish producing states designate specific coastal waters where approved shellfish can be harvested by the industry. These states follow a uniform set of criteria for the water classification as outlined in the Manual of Operations of the NSSP. A comprehensive sanitary survey is conducted for each growing area prior to approval of the area by the state as a source for harvesting of shellfish for human consumption. The purpose of the sanitary survey is to identify and evaluate those factors influencing the sanitary quality of a growing area. These factors may include sources of pollution, potential or actual; the volume of dilution water; the effects of currents, winds and tides in disseminating pollution over the growing areas; the bacterial quality of water and bottom sediments; mortality rate of polluting bacteria; bottom configuration; and salinity and turbidity of the water (U.S. Dept. of HEW, Public Health Service, 1965, Part I, p. 11).

All actual and potential growing areas are classified by the state as to their public health suitability for harvesting of shellfish. Four classifications are used to designate growing areas: approved, conditionally approved; restricted; and prohibited (U.S. Dept. of HEW, Public Health Service, 1965, Part I, p. 12). All growing areas which have not been

subjected to sanitary surveys are automatically classified prohibited. In addition to the sanitary surveys the state must regularly collect and assay samples of shellfish from growing areas where PSP is likely to occur. If the PSP content reaches 80 micrograms per 100 grams of the edible portions of the raw shellfish meat, the area shall be closed to the taking of the species of shellfish in which the poison has been found (U.S. Dept. of HEW, Public Health Service, 1965, Part I, p. 19). A tolerance level of 160 micograms of PSP per 100 grams is allowed for harvesting of clams for canned heat-retorted products.

A joint study by the U.S. Public Health Service and the coastal states (exclusive of Hawaii and Alaska) in 1965 disclosed that two million acres of shellfish waters have been closed or restricted to the harvesting of shellfish due to pollution. A total of 8.2 million acres are approved (Houser and Silva, 1966, p. 6). The national trend is to close more estuarial waters where the shellfish grow, because they fail to meet the rigid water quality requirements of shellfish approved areas (Clem, 1969, p. 10). A national estuary study was conducted in 1969 for the U.S. Department of Interior in which findings indicate that factors such as filling and dredging, pollution, industrial development, and other competing uses of estuarine areas are reducing the shellfish growing area (U.S. Dept. of Interior, 1970, Fish and Wildlife Service, pp. 18-22).

In Alaska pollution has not become significant enough to affect the shellfish growing areas. Most clam beds are located in remote areas away from population centers and pollution sources. The Alaska Department of Environmental Conservation is responsible for the enforcement of water quality regulations. Alaska has established strict water quality standard regulations to prevent contamination so that it is unlikely that in the near future pollution will be a problem. An area of concern is the possibility of oil spills and the resultant effect of toxic hydrocarbons on the health hazard potential to consumers of shellfish. Plans are being made by the FDA to study the overall problem of oil pollution and its effect on shellfish quality (Clem, 1971, p. 17).

The problem of waste disposal by shellfish processors in Alaska is a notable one. In past years the untreated wastes were usually dumped into the bay or water next to the processing plant. This practice gradually created serious pollution problems where several canneries were located or where currents did not carry the wastes offshore. Kodiak

developed a significant waste pollution problem of this sort - in 1970 alone over 70 million pounds of shellfish waste were discharged into St. Paul harbor at Kodiak by 15 processing plants (U.S. EPA, 1971, p. 5). Measures were implemented to transport the wastes to a nearby by-product recovery plant to produce a dried meal product and other fisheries by-products (fertilizer material). This action has greatly alleviated the pollution problem in Kodiak.

Due to the strict Federal and State water quality standards, shellfish processors are required to find adequate means of disposing of their wastes. The Alaska Administrative Code states that primary treatment (removal of solids) must be performed on all wastes before discharging into natural waters. Secondary treatment is also required unless the processor can show that the natural receiving waters are within state standards while he is discharging wastes into the receiving waters (State of AK, 1966, Title 18, 70.080). The standards are written separately for seven categories of water, according to the use of the water (drinking, recreation, industry, etc.). Shellfish-growing coastal waters are Class E. Standards for this class include: dissolved oxygen greater than 6 mg/l, a temperature not over 5 per cent greater than the natural temperature, no floating or suspended solids visible or in a level dangerous to organisms, inorganic solutes (salts, acids, etc.) not higher than normal, and absence of offensive sight or smell (State of AK, 1966, Title 18, 70.020). Processors discharging wastes must, therefore, regulate the wastes according to their effect on the receiving waters. The laws that regulate waste disposal in natural waters are written to specify the quality of the natural waters which are receiving the waste. Waste treatment in Alaska shellfish processing plants at present consists of discharging treated wastes into the adjacent seawater. Any plants chopping the wastes, which is intended to make them more susceptible to decomposition, must pipe the waste out from shore which allows swift currents to disperse the waste and prevent bay or shoreline pollution (Mendenhall, 1971, p. 16).

Sanitary Standards for Harvesters and Processors. The sanitary standards required of certified processors of shellfish are delineated in Part II, NSSP Manual of Operations and by the Alaska Administrative Code under Shellfish Processing, Title 7, Chapter 15, Sections 310 through 370. The Code was revised in 1974 to obtain consistency with the provisions of the NSSP. The standards apply to shellfish growing areas and to the harvesting, handling and

processing of shellfish. The provisions of the code as revised are reproduced verbatim in Appendix I.

Given the importance of the bait market to the Alaska clam fishery, the differing treatment in these regulations of clams intended for human consumption and those intended for the bait market deserves special mention. Those clams harvested from unapproved areas must be dyed with an approved dye before being transferred from the beach or areas of harvest. Those clams harvested from approved beach areas may be transferred from the beach to a processing plant without prior dyeing as long as they are not transported along with clams taken from unapproved beach areas. These clams must be dyed at the processing plant to which they are delivered, if they are to be sold as bait. Clams taken from approved areas, but transported with clams from unapproved areas, must be dyed prior to transportation from the beach or area of harvest. While these regulations will impose moderate costs on harvesters and processors, they are necessary if clams from unapproved areas are going to be utilized for bait purposes concurrently with the use of clams from approved areas for human consumption purposes.

Unfortunately, these provisions requiring the dyeing of clams from unapproved beaches before they are transferred from the harvest area (as compared to the more favorable treatment, from the viewpoint of the harvester, of bait clams from approved beaches), may retard the development of unapproved stocks of bait clams. This situation may in turn jeopardize the ability of processors to obtain a continuous source of supply for developing human consumption product channels. Further the incentive not to use unapproved areas for bait harvest will make more difficult the identification of the most productive areas for the use of any newly appropriated beach survey and approval funds. Should sufficient demand appear to exist to utilize the entire production of the approved beach areas for human consumption channels, a requirement that bait clams be harvested from other areas would not appear to be unreasonable in view of the use of public resources to obtain approval of beach areas where production is marketable interstate for human consumption purposes. On the other hand, such a requirement might complicate the application of limited entry principles and have adverse implications for harvester's bargaining power over price, given the small number of human consumption processors who will initially be buying these clams.

State of Alaska Shellfish Program

Presently, the Alaska Departments of Fish and Game, Public Safety and Health and Social Services are jointly functioning as the shellfish control agencies for the State of Alaska. Table 4 depicts the various control agency responsibilities under the National Shellfish Sanitation Program. The State of Alaska has established legal authority under Alaska Administrative Code, Title 7, Chapter 15, Sections 310-370, Shellfish Processing, to regulate sanitary control of the shellfish industry. This regulation covers classification of growing areas; sanitary standards for harvesting, handling and processing; administrative procedures and penalties. The regulations incorporate and implement the provisions of the NSSP. The regulation states, "All shellfish growing areas of Alaska are closed to commercial shellfish harvesting for marketing for human consumption unless approved by the Commissioner as harvest areas", (State of AK, 1966, Title 7, 02.439). Three razor clam beaches were approved by the Commissioner of Health and Social Services, effective 27 April 1970, for commercial harvest. These beaches are located at Cordova, Swikshak, and Polly Creek. Sanitary surveys and toxicity studies had been completed on the three beaches prior to being approved. [The previous policy was that razor clams harvested for commercial purposes; whether for bait, for fresh or frozen markets or for heat-retorted, vacuum-packed canning; must be harvested solely from the three approved beaches (McCrary, 1973).]

As mentioned (p. 21), this regulation has been modified to allow the harvest of bait clams from unapproved beaches provided the clams are dyed before being transferred from the beach area. On 15 March 1973, the Alaska Department of Health and Social Services designated that all bait razor clams harvested must be treated with a yellow dye to prevent them from entering human consumption channels. In addition the containers of bait clams must be clearly marked, "Bait Razor Clams, Not for Human Consumption", and also have the processors name, address and Alaska certificate and permit number (Torgerson, 1973, March, pp. 1-2). The end result of the dyeing process is a distinct yellow coloring of the whole clam meat. The dye may also be used to distinguish other bait seafood products.

The state shellfish program consists of the following activities (Nickerson, 1971, pp. 12-28):

TABLE 4

NATIONAL SHELLFISH SANITATION PROGRAM:

CONTROL AGENCIES AND RESPONSIBILITIES

U.S. Food and Drug Administration

1. Conducts annual appraisal of State shellfish program.
2. Grants or withholds Federal indorsement of State program.
3. Publishes national listings of valid interstate shellfish shippers.

State of Alaska

Department of Health and Social Services

1. Coordinating agency for State shellfish program.
2. Classifies growing areas.
3. Establishes sanitary standards
4. Conducts sanitary surveys.
5. Conducts PSP testing.
6. Issues numbered certificates to approved clam processors.

Department of Fish and Game

1. Collects clam samples for PSP testing.
2. Issues licenses to commercial clam diggers.
3. Assists in sanitary surveys.

Department of Public Safety

1. Active patrolling of beach areas.
2. Enforcement of clam fishery laws.

Sources: U.S. Department of Health, Education and Welfare, Alaska Department of Health and Social Services.

1. Establishment of a surveillance system to assure that razor clams will not be commercially harvested from unapproved areas. Sufficient controls have been established to insure compliance with this aspect. Active patrolling of unapproved and approved razor clam beaches is being accomplished by protection officers of the Department of Public Safety. Passive patrolling is being done by the personnel of the Department of Fish and Game in line with their regular duties. Adequate licensing and inspection procedures have been established. Additionally, it can be anticipated that legal clam diggers and processors will contribute to the surveillance system.

2. Establishment of an effective monitoring program for early warning of the presence of paralytic shellfish poisoning. A bi-monthly testing program to determine the presence of PSP is carried out through a cooperative effort by the Departments of Fish and Game and Health and Social Services. Sampling stations have been established at the three approved beaches. Samples are collected by Fish and Game personnel and sent to the FDA certified Health and Social Services laboratory in Juneau for the mouse bioassay test. The Department of Health and Social Services is the coordinating and testing agency; the Department of Fish and Game is responsible for the actual collection of the clam samples.

3. Maintenance of laboratory capabilities that will enable rapid analysis of clam samples for PSP. The Food and Drug Administration has certified the Southcentral regional laboratory in Anchorage for bacteriological, water and seafood product examinations and the Southeast regional (Juneau) laboratory for conducting paralytic shellfish poisoning tests (Torgerson, 1973, March, p. 1). The Juneau lab has the physical capability to conduct in excess of 100 tests per month with a minimum two day turn-around time for routine bi-monthly samples (Nickerson, 1973).

4. Conduct sanitary surveys to evaluate growing areas with regard to domestic and industrial pollution. A comprehensive sanitary survey includes an evaluation of all sources of pollution; effectiveness and reliability of sewage treatment plants; presence of industrial waste, pesticides or radionuclides; effect of wind, stream flow, and tidal currents in distributing pollutants over the growing area; bacteriological quality of the growing waters and bottom sediments and identification of the presence and location of small sources of local pollution. Each approved growing area is reappraised every two years to determine if

there have been changes in stream flow, sewage treatment, population or other similar factors which might result in a change in the sanitary quality of the growing area. A complete resurvey is made at least once every ten years (U.S. Dept. of HEW, Public Health Service, 1965, Part I, pp. 10-12).

5. Development of an interdepartmental memorandum of understanding among the three state control agencies which specifies distinct responsibilities each agency is to carry out and enforce. This was accomplished in 1974. This memorandum is shown in Appendix II. Briefly the responsibilities are as follows: The Department of Health and Social Services serves as the central supervisory agency; establishing, coordinating, and enforcing all sanitary standards concerning shellfish harvesting and processing; the Department of Fish and Game collects razor clam samples for PSP testing, issues licenses for commercial harvesting of clams, and assists in sanitary surveys; the Department of Public Safety patrols beach areas and enforces regulations established with regard to commercial harvesting of clams.

The present Alaska Shellfish Program is of necessity limited to the three previously noted approved beaches. The state control agencies are constrained in their efforts by manpower and funding limitations. By keeping the program manageable with only three beaches, FDA approval of the state program has been easier to achieve. After FDA approval, expansion will be in priority of commercial importance as well as contingent upon increased manpower and funding for the state agencies involved. There are industry indications that commercial exploitation of oysters and geoducks in Southeastern Alaska are feasible and may be the next areas emphasized under the State shellfish program (Torgerson, 1973, July). It is expected that the State will continue to limit the program to the three approved razor clam beaches for at least two years so as not to exceed resource capabilities and to accumulate data and gather experience with the NSSP.

ALASKA CLAM FISHERY REGULATIONS

Prior to 1949, the regulation of Alaskan commercial fisheries was handled by the United States Fish and Wildlife Service of the Department of the Interior. On 21 March 1949, the Alaska Fisheries Board and the Alaska Department of Fisheries were created by the 19th Territorial Legislature of Alaska. In 1957, these agencies became known as the

Alaska Fish and Game Commission and the Alaska Department of Fish and Game respectively. The above departments were organized to supplement and compliment the regulatory program of the Federal government in effect at that time. When Alaska attained statehood in 1959, the regulation of commercial harvesting of clams became the function of the state through its Department of Fish and Game. Commercial fishing regulations are promulgated by the Alaska Board of Fish and Game. The Board consists of eleven members appointed by the Governor and acts on recommendations from area Fish and Game personnel and the testimony of citizens. The basic decision-making premise is that conservation and management programs must be guided by the maximum sustained yield principle. The board establishes seasons, quotas, legal gear, and issues emergency regulations to this end.

The State Department of Health and Social Services regulates the source beaches for commercial harvesting of clams. It does not approve nor regulate sport harvesting. The Department does provide warnings to the public that clams harvested by sport diggers may be hazardous to their health with the principal emphasis on PSP. A sport clam digger is required to have a sport fishing license issued by the Department of Fish and Game to sport dig clams in all areas of Alaska. Generally, there is no closed season or limit for sport digging of clams in Alaska with the exception of the Kenai Peninsula beaches from Kenai River to the tip of Homer Spit where there is a daily bag limit of the first 60 razor clams dug (AK Dept. of Fish and Game, 1973, Sport Fish Division, p. 14).

The State of Alaska requires that all commercial fishermen and their vessels and gear be licensed. The licenses expire at the close of 31 December following their issuance and are renewed annually upon application and payment of license fees (State of AK, 1972, Title 16, p. 18). The resident commercial clam digger must obtain a $10.00 commercial fishing license each year. The non-resident fee is $30.00. This license is required before any other licenses required of commercial fishermen may be obtained (State of AK, 1973, Title 16, p. 19).

A license is required for all vessels engaged in commercial fishing in the State of Alaska. This requirement applies to all vessels used in the commercial harvesting and/or transporting of clams in Alaska. The vessel license includes a permanent numbered plate to which is

affixed a tab designating the year. The numbered plate is not transferable and is considered a permanent fixture on the vessel to which it is orginally assigned. Residents pay a $10.00 fee, and a non-resident a $30.00 fee, for an annual vessel license (State of AK, 1972, Title 16, p. 20).

A fishing gear license is required of all commercial fishermen in Alaska. A clam digger's license is required of any person digging clams for commercial purposes from the waters or beaches of the state. The fee is $5.00 for residents and $15.00 for non-residents (State of AK, 1972, Title 16, p. 25).

In addition to a commercial fishing license, (possible) vessel license, and a clam digger's gear license, an interim-use permit is required for all licensed gear operators starting in 1974 under the State's limited entry program. The annual fee will be between $10.00 to $100.00 to cover the cost of administering the program with exact amount depending on the type of gear used. The temporary permit will be required for each fishery and will be renewed annually until permanent-entry permits are issued. A separate permit will be required for each type of gear in a particular area.

The basic objective of the limited-entry program is to stabilize the number of units of gear in those commercial fisheries characterized by excessive effort. This is designed to allow better management, more fishing time and an improved overall economic return to fishermen (Commercial Fisheries Entry Commission, 1973, pp. 1-4). Although the clam fishery is covered by the program it is not presently overcrowded with commercial harvesters and is not classified as a distressed fishery. Therefore, it is not expected that the limited-entry program will affect the clam industry for a number of years (Edfelt, 1973).

The management of commercial fisheries in Alaska is accomplished by areas. Twelve areas have been established with specific fishing regulations designated for each area. For the Alaska clam fishery there are no quotas established for any of the areas. The following are defined as legal types of gear allowed for harvesting of clams where permitted:

1. Shovel: A shovel (or fork) is a hand-operated implement for digging clams or cockles.

2. Mechanical Digger: A mechanical clam digger is a mechanical device used or capable of being used for the taking of clams.

3. Hydraulic Digger: A hydraulic clam digger is a device using water or a combination of air and water to remove clams from their environment (State of AK, 1966, Title 5, 39.105). Figure 3 shows those areas which are open to the use of hydraulic harvesters.

In the Kodiak area, where Swikshak is located, there is no closed season on the commercial harvesting of razor clams. Razor clams 4½ inches and over may be taken by hydraulic clam diggers west of Cape Chiniak on the Alaska peninsula, but they are not allowed on the currently approved beach of Swikshak proper, as this area lies between Cape Chiniak and Cape Douglas (Fig. 3). Razor clams may be dug by shovels or forks; there is no minimum legal size for hand-dug razor clams in this area (AK Dept. of Fish and Game, 1974 and Nickerson, 1975).

In the Cook Inlet area, where Polly Creek is located, razor clams may be harvested commercially throughout the year. Razor clams 4½ inches and over may be taken by hydraulic clam diggers (by permit from the Commissioner) on the west side of Cook Inlet between Cape Douglas and Spring Point. The Polly Creek approved beach area is north of, and excluded from, the area open to dredging (Fig. 3) except for a ½ mile section of beach from 1 to 1½ miles south of the mouth of Polly Creek (not shown in Fig. 3). Hand digging with shovels or forks is allowed throughout the Polly Creek area; there is no size limit on hand dug razor clams, although a size limit is under consideration by the Alaska Board of Fish and Game (AK Dept. of Fish and Game, 1974 and Nickerson, 1975).

In the Prince William Sound area, where the Cordova clam beds are located, there is no closed season on the commercial harvesting of razor clams. Razor clams may be taken only by shovels or forks. No hydraulic or mechanical diggers are permitted. The minimum legal size is 4½ inches in length of shell.

Hardshell clams may be taken by hydraulic or mechanical clam diggers in westward Alaska (Kodiak region) and in the Cook Inlet area by permit from the Commissioner. Shovels or forks for the taking of hardshell clams may be used in the Prince William Sound area (Cordova), Cook Inlet (Polly Creek) and westward area (Swikshak) (AK Dept. of Fish and Game, 1974 and Nickerson, 1975). The regulations are not clear as to the gear restrictions on Southeastern Alaska - Yakutat area, probably due to the absence of an active commercial clam fishery in that area.

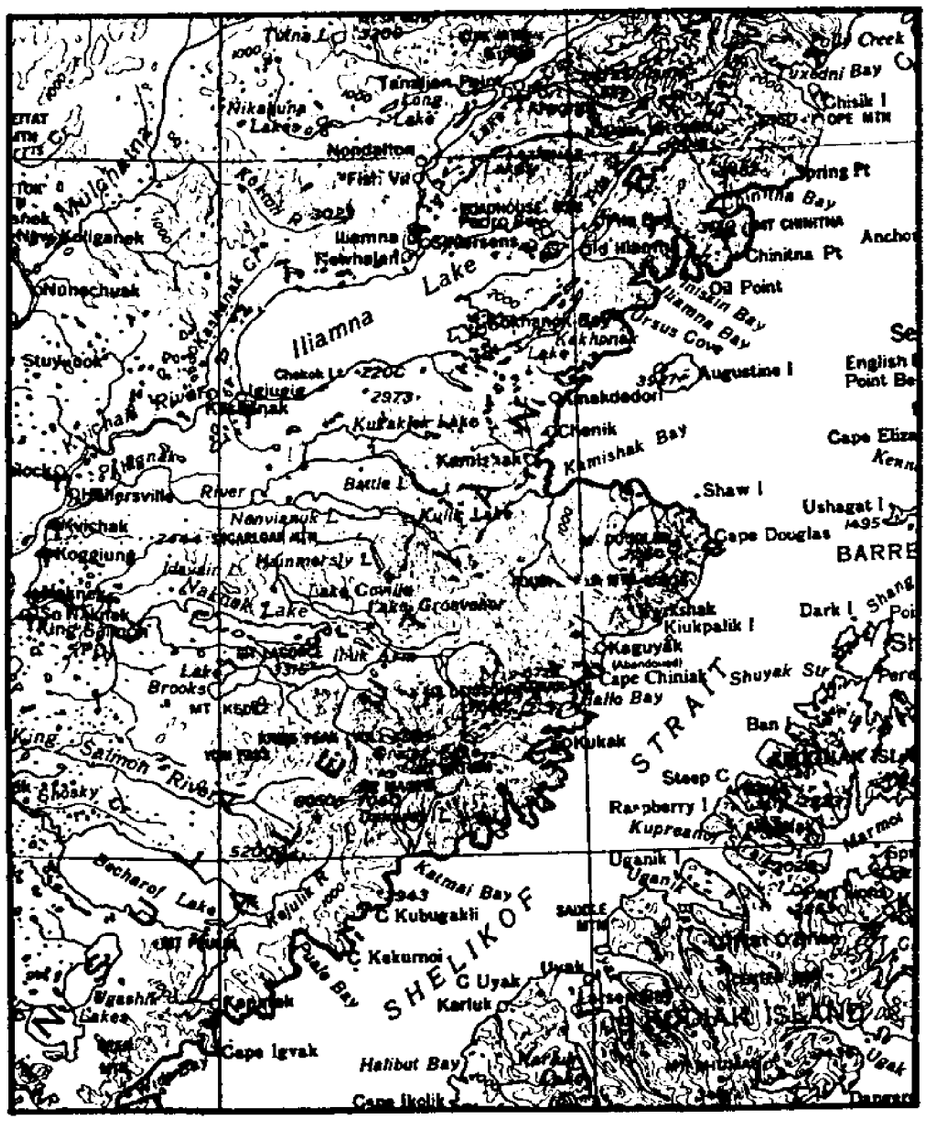

Figure 3. Map of area open to hydraulic dredges (bold line signifies areas open to dredging).
Source: U.S. Department of Interior, Geological Survey, Alaska Map B.
Scale: 1:1584000

The Department of Fish and Game requires certain reports to be submitted by processors, buyers and fishermen: Each person, company, firm, or other organization who purchases unprocessed fish or processes fish or by-products of fish is to furnish the Department of Fish and Game each calendar year, before operating, a written statement of intent to operate with a description of the nature, extent, and location of the operation. They are also to submit, on forms provided by Fish and Game, no later than 31 January, an accurate and complete summary of the previous year's operation. Each buyer of fish or shellfish is to keep a record of each purchase on fish tickets or other forms supplied by the Department of Fish and Game. Fish tickets are to be submitted to the local Department representative each week or as otherwise specified by the Department for each particular area and fishery. Each shellfish fisherman is to furnish in writing directly to the Department or through the buyer factual catch data necessary for completion of reports (State of AK, 1966, Title 5, 39.130).

Any person who violates any of the regulations pertaining to commercial fisheries in Alaska is guilty of a misdemeanor and upon conviction is punishable by a fine of not more than $5,000.00 or by imprisonment for not more than one year or by both (State of AK, 1972, Title 16, p. 28).

ALASKA CLAM FISHERY TAXES

All Alaska fish processors must apply for an annual fisheries business license from the Alaska Department of Revenue. A $25.00 fee is charged for this license and a separate fee is required for each plant specified in the application (State of AK, 1972, Title 43, p. 155). In addition, clam processors are to pay a fisheries tax equal to two per cent of the value of the raw razor clams. The value is determined by the actual price paid for the raw clam either by cash or its equivalent. Butter clams are taxed in the same manner at the rate of one per cent of the value of the raw clams (State of AK, 1972, Title 43, p. 154). The above tax applies to clams destined for a canned product and is referred to as a "cannery tax". For fresh or frozen clams a "cold storage tax" of one per cent applies unless the processing occurs on a freezer ship, in which case the tax rate is four per cent. A freezer ship moored for one year qualifies for the lower tax rate of one per cent.

CHAPTER IV

HARVESTING, PROCESSING AND MARKETING

HARVESTING

Approved Alaska Razor Clam Beaches

There are many known razor clam growing areas in Alaska which could possibly be exploited commercially.[1] Presently, however, only three razor clam beach areas are open to commercial harvest for human consumption. Historically these three beaches have been areas of high razor clam density and have supported commercial harvesting of razor clams for many years; therefore, these three beach areas had the most background data necessary to complete certification requirements (Torgerson, 1973, July). The three beach areas which were approved by the Alaska Commissioner of Health and Social Services effective 27 April 1970, are as follows (for a more detailed description see Appendix II):

Area 1. Prince William Sound beaches are those beach areas between 60° 33' North Latitude by 146° 20' West Longitude, this is near Hawkins Island, to a point 60° 00' North Latitude by 144° 19' 40" West Longitude, near Kanak Island. Presently, the Egg Islands and the area west of the Copper River are prohibited for human-consumption harvesting (Fig. 4).

Area 2. Swikshak beach which is located on the southeastern shore of the Alaska peninsula. The area presently approved for human-consumption harvesting is the beach area from Swiksnak Lagoon east for approximately four miles. This area is bounded by 58° 36' North Latitude by 153° 48' West Longitude and 58° 37' North Latitude by 153° 39' West Longitude (Fig. 5).

Area 3. Polly Creek beach on the west shore of Cook Inlet from Redoubt Point south approximately three miles, and four miles north of the Crescent River. This area contains approximately three miles of beach area approved for human-consumption harvesting. This area is bounded by 60° 17' 18" North Latitude by 152° 25' 12" West Longitude and 60° 16' 20" North Latitude by 152° 29' 40" West Longitude (Fig. 6).

The Cordova-Copper River Flats area covers approximately 94 miles of beach area, a section of which (as described above) is open for human-consumption harvesting. It was in

[1] An upcoming publication by Richard Nickerson of the Alaska Department of Fish and Game will contain more information on the location and density of stocks of razor clams in Alaska. This information has been compiled by Nickerson in his work with ADF&G.

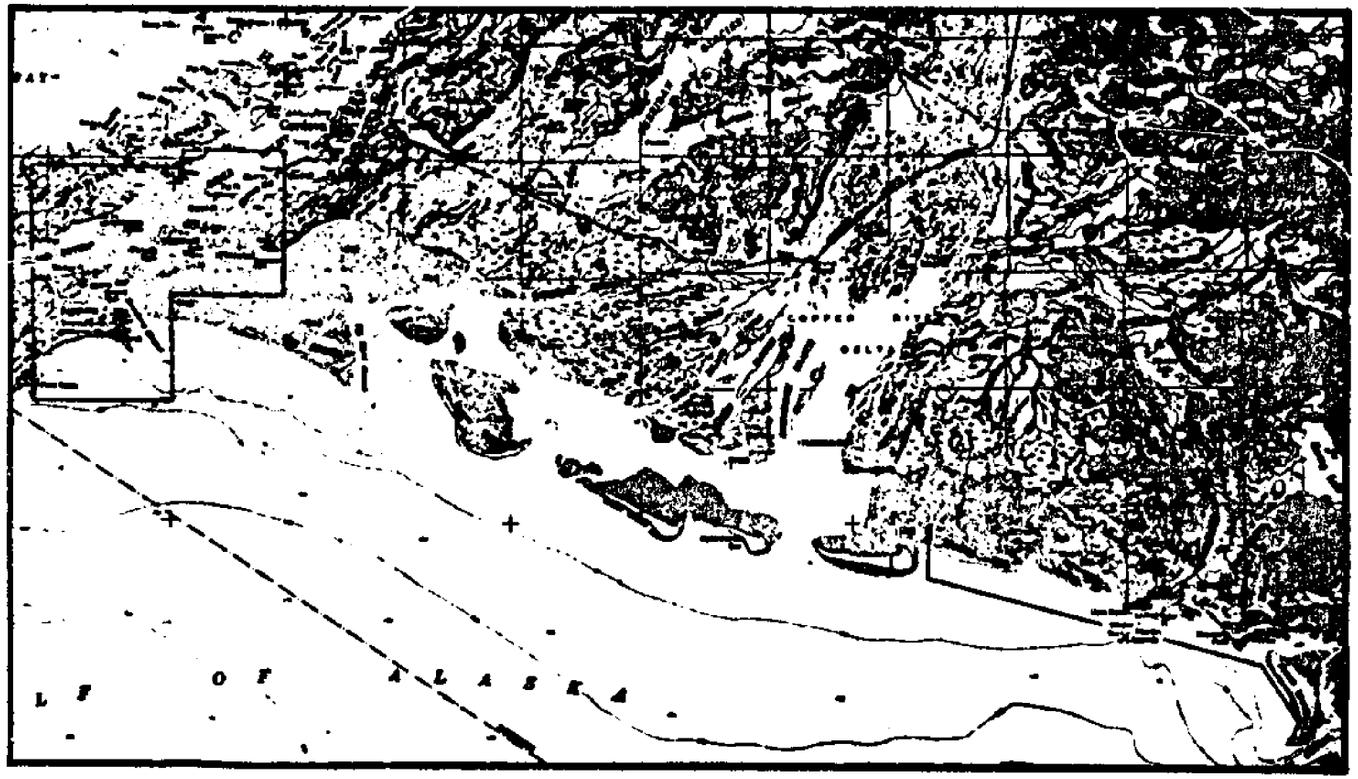

Figure 4. Map of Cordova area (marked areas signify approved beaches).
Source: U.S. Department of Interior, Geological Survey, Cordova, Alaska.
Scale: 1:250000

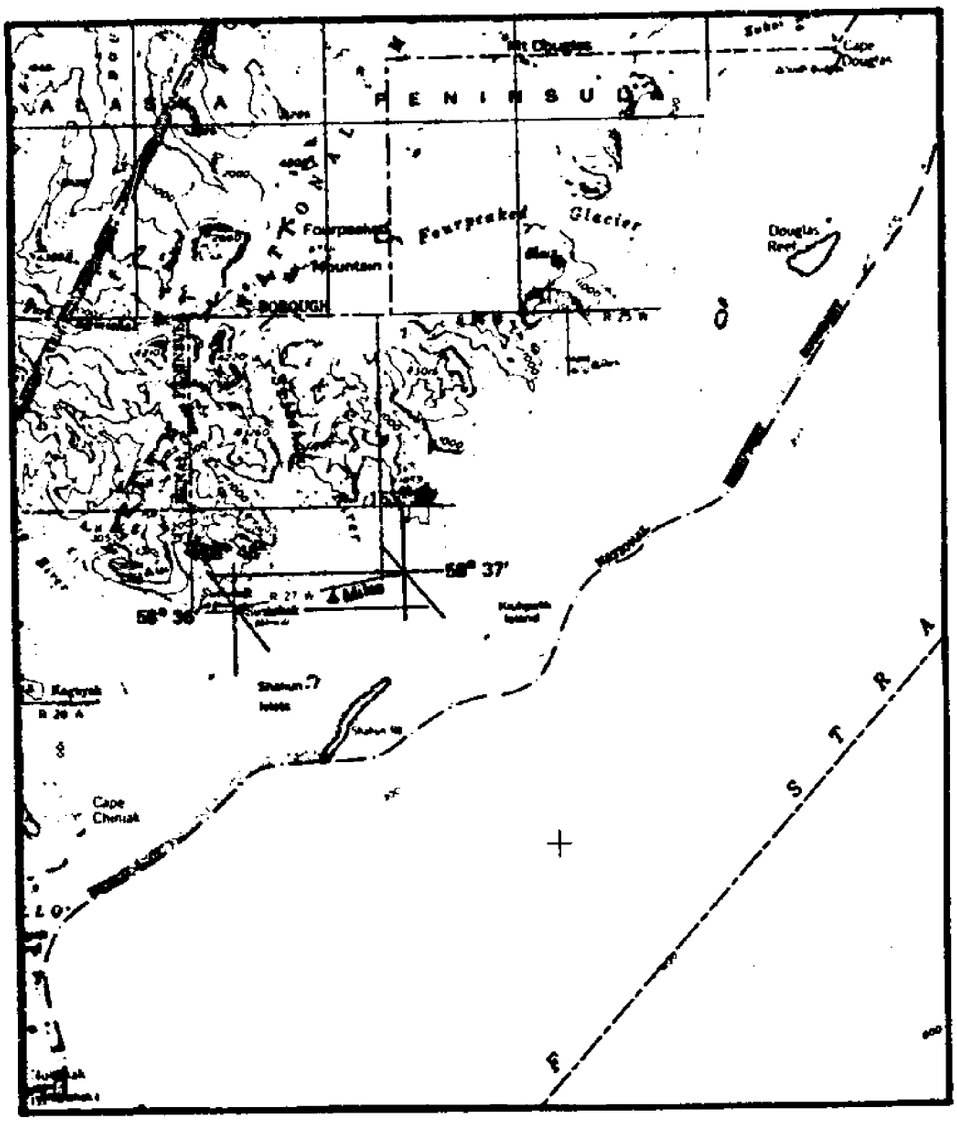

Figure 5. Map of Swikshak area (marked area signifies approved beach).
Source: U.S. Department of Interior, Geological Survey, Afognak, Alaska.
Scale: 1:250000

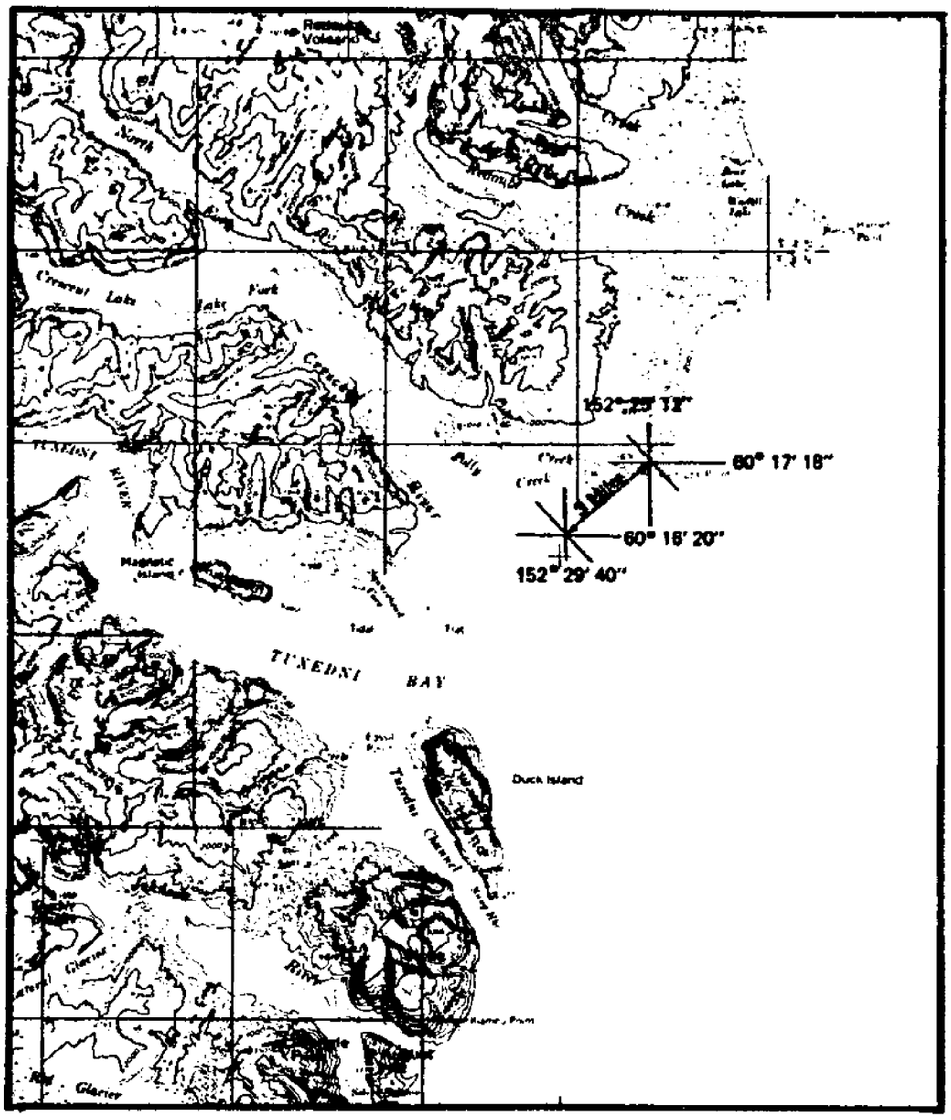

Figure 6. Map of Polly Creek area (marked area signifies approved beach).
Source: U.S. Department of Interior, Geological Survey, Kenai, Alaska.
Scale: 1:250000

this area that the razor clam industry had its start in 1916. Extensive tide flats occur with numerous exposed sand and mud bars at low tide. Variable habitat is contained within this area, much of which is poorly suited to razor clams because of excessive mud, clay and glacial silt (Tegelberg, 1961, p. 6). A significant part of this area does not contain the characteristic surf swept beaches that razor clams are known to require for their habitat (Nickerson, 1973, Aug.). Presently the clam beds in the Cordova area are not producing the large number of razor clams of the past (Nickerson, 1973, Aug.). Beach uplift which occurred in the 1964 earthquake has been a contributing factor. Some observers also blame the elimination of seals, who feed on clam predators, for the decline of the razor clam in the area.

The Swikshak Beach area is located approximately 75 miles northwest of Kodiak on the Alaska Peninsula and lies within the boundaries of the Katmai National Monument. The beach areas are exposed to the northern surf of the Shelikof Strait and contain approximately 25 miles of coastline, of which (as described above) four miles are approved for human-consumption harvesting. The beaches are of low gradient, exposing extensive intertidal zones at low tide. The beaches consist of fine, light sand mixed with volcanic ash, glacial silt, coarse sand, and some gravel. Razor clams in commercial quantities have been harvested from Swikshak beach since the early 1920's (Poulin and Gwartney, 1972, pp. 4-6).

In 1972 and 1973, the Kodiak area office of the Alaska Department of Fish and Game conducted razor clam studies on Swikshak Beach to provide current information on age and growth, length-weight relationships, population abundance and to monitor the level of commercial harvest. Since the mid-1960's the razor clams harvested from Swikshak have been used primarily for dungeness crab bait. The present status of the razor clam stocks with respect to a maximum sustained yield level of harvest is unknown. Between 1955 and 1963, Swikshak Beach and other beaches in the immediate area sustained an annual harvest of over 300,000 pounds without apparently reducing the abundance of razor clams (Gwartney, pp. 2-3).

Polly Creek contains approximately seven miles of beach area, of which (as described above) three miles are approved for human-consumption harvesting. Commercial harvest in this area started in the mid 1920's. Presently razor clams on Polly Creek beaches are abundant and capable of a significant sustained harvest. In 1973 the closed season of 15 July to 1 September was not put into effect; this closure period has since been reinstated.

Table 5 shows the comparative Alaska razor clam catch by area for the years 1965-1972. The Cordova area has become a less significant producer and the Kodiak area a more significant producer in recent years.

Harvesting Methods

Historically, the clam fishery of the United States has been a labor intensive industry with harvesting of clams accomplished by use of tongs, rakes, hoes, forks, picks, and shovels. In 1952 a hydraulic escalator dredge, the Maryland Dredge, was developed on the East Coast in the Chesapeake Bay area to harvest the vast subtidal soft-shell clams in that area (Hanks, 1966, p. 11). With the development of this dredge the Maryland soft-shell clam industry became the dominant soft-shell clam producer in the United States. The dredge is attached to a boat which slowly pushes it through the bottom sediments. Clams, loosened from their habitat by a high-pressure spray of water, are washed or scooped onto a chain-mesh conveyor belt. The pressured water is supplied by a high powered pump on the fishing vessel. The belt carries the clams to the crew where commercial size clams are removed by hand and all debris and small clams fall back into the water. This method takes most commercial clams and apparently does little damage to others (Hanks, 1966, p. 11). It has since been discovered that soft-shell clams multiply and grow more rapidly in bottoms cultivated by the clamming rigs. The loosened sediment constitutes a suitable base for the smaller clams, which are returned to the water, to grow to maturity and multiply. A single hydraulic escalator dredge is capable of harvesting 500,000 bushels of soft-shell clams annually (*Quick Frozen Foods Magazine*, 1970, p. 121). Most dredges are restricted by applicable state regulations to a daily quota of 40 bushels (Hanks, 1966, p. 11). The dredge can cover an area more than ten times as fast as a man using hand tools and populations of relatively low density can be exploited profitably. Studies indicate that the Maryland dredge

TABLE 5

COMPARATIVE ALASKA CLAM HARVEST BY AREA

(thousand pounds shell weight)

1965 - 1972

	Cordova	Cook Inlet	Kodiak	Aleutians East Unalaska	Total
1965	87.7	0	0	0	87.7
1966	28.6	0	15.5	0	44.1
1967	114.9	0	2.2	0	117.1
1968	72.9	0	6.4	0	79.3
1969	26.8	0	12.1	47.4	86.3
1970	27.9	0	132.3	.1	160.2
1971	38.0	14.8	190.4	0	243.1
1972	30.0	31.4	152.1	0	213.8

Source: Alaska Department of Fish and Game, Statistical Leaflets.

catches more than 95 per cent of the marketable clams in its path with less than one per cent breakage of the catch (Manning, 1959, p. 64). Favorable features of dredges are that harvesting can take place at times other than low tides, hand labor is reduced, and subtidal stocks can be harvested (Goodwin, 1971, p. 7).

Subsequent to the development of the Maryland dredge a deep-water hydraulic drag dredge was developed and used on the Atlantic Coast especially for the surf clam. The latter species has been the most important commercially in the U.S. since 1960 (U.S. Dept. of Commerce, Statistical Digest). This dredge operates in water depths to 20 fathoms and does not use a conveyor belt; rather the dredge with catch must be lifted to the vessel frequently to recover the clams. The dredge is towed by a host vessel. Figure 7 contains a schematic drawing of the soft-shell and surf clam dredges.

In 1969, dredges took 63.6 million pounds of clam meats representing 79 per cent of the total U.S. clam harvest; rakes and hoes took 5.3 million pounds each (seven per cent each), and tongs, 4.9 million pounds (six percent). The remainder of the catch was taken with forks, shovels, or gathered by hand (U.S. Dept. of Commerce, Statistical Digest, 1969).

As shown in Table 6, most clam dredges operate on the East Coast. The application of dredges to clam harvesting has been the most significant factor in the larger catches and the reduced cost of production of clams. Competition from machine-harvested East Coast clams was one of the reasons that Alaska clam production declined in the late 1950's (Wiese, 1968, p. 2).

Efforts to adapt a mechanical clam harvester from an East Coast model have been made in Alaska for the razor clam. An adapted hydraulic escalator dredge was "... boomed from a vessel working razor clam beds at high tide. But, among other problems, it could not be kept from reflecting the vessel's motions in the ocean surf and kept wrecking itself on the bottom" (Wiese, 1968, p. 10). The Alaska Packers Association conducted the above razor clam harvester experiment in 1963 on Swikshak beach. They concluded that steady production was not feasible as the waters fronting the major clam beaches appeared to be too rough for continued operation of a floating harvester. They noted that the harvester may be adaptable in the Cordova area where the majority of the razor clam beds are in sheltered waters protected by a chain of islands (AK Packers Association, 1963, pp. 1-9).

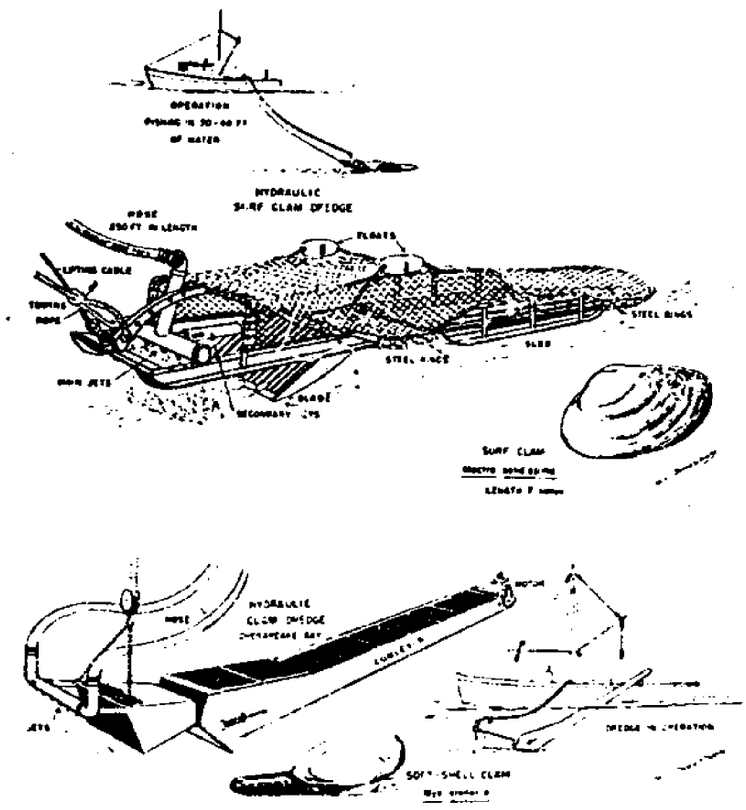

Figure 7. Hydraulic or jet dredges.
With this type of equipment, surf, soft, or hard clams are washed out of the bottom by action of jets of water from a pipe attached in front of the tooth bar. The pressured water is supplied by a high powered pump on the fishing vessel. The shellfish are then either washed on to, or collected by the tooth bar of the dredge. The Maryland type of hydraulic dredge utilizes a conveyer which brings the soft clams up to the vessel.
Sources: Sundstrom (1957), Bureau of Commercial Fisheries; Dumont and Sundstrom (1961), Bureau of Commercial Fisheries.

TABLE 6

LOCATION AND NUMBER OF CLAM DREDGES, SELECTED YEARS

Area	Number of Dredges				
	1950	1955	1960	1965	1970
New England	69	82	79	79	54
Middle Atlantic	176	192	214	127	130
Chesapeake	34	100	233	257	300
South Atlantic	61	17	19	21	22
Gulf	0	0	0	0	0
Pacific	0	0	3	3	6
Total Exclusive of Duplication	340	391	548	487	507

Source: U.S. Department of Commerce, National Marine Fisheries Service, *Fishery Statistics of the United States*, various years.

Efforts in Canada to develop a hydraulic-mechanical digger for razor clams were undertaken in British Columbia in 1972. A joint Canadian government and industry project produced an eight-wheeled, 46 ton, diesel-powered digger. Creeping over the sand at one-half mile per hour the device shoots two powerful jets of water into the sand ahead of it, then picks up the slurry of sand, water and clams with a scoop directly behind the water jets. A conveyor carries the slurry up to the vehicle's work area where a dewatering and desanding screen lets everything but the clams and an occasional rock drop back onto the beach below. The digger moves in a straight line and is able to dig 1,000 pounds per hour on the average. A particular problem noted was that if the heavy digger got into the same strip dug the day before, where the disturbed sand has not been firmed up by the surf, the device would get stuck and could not extricate itself (National Fisherman, 1973, pp. 12-13). Another problem was a high percentage of broken clams probably due to excessive water pressure (Nickerson, 1973, Aug.).

In recent years several manual hydraulic diggers of a type similar to that shown in Figure 8, have been used in Canada to harvest butter and horse clams. The digger weighs about 60 pounds and is a simple, easily constructed device. Water is supplied by a pump usually placed in a boat offshore. The digger may be operated in water of wading depth, but experience indicates it is more efficient and easier to manipulate on a dry beach. The digger is adjusted so the water jets penetrate 12 inches or so into the beach and is then manually pulled along slowly, the rate determined by experience. The usual practice is for one person to operate the digger while another person rakes the clams washed into the trench. Results of an experiment show that the hydraulic digger is about six times more productive than hand digging and breakage of all sizes of clams is only about five per cent. The manual hydraulic digger is inexpensive, about $500.00, portable and ideally suited for most small rocky clam beaches (Quayle and Bourne, 1972, pp. 65-66).[2]

A dredge experiment at the Polly Creek razor clam beach was conducted in 1973. The mechanical-hydraulic dredge operates by being towed by a "D-8 Cat" in about 2 to 3 feet of water. The towing action forces the dredge to mechanically bite into the substrate to a

[2] An intertidal hydraulic method has been tested on butter and little neck clams in Prince William Sound; up to 1,400 clams per hour were harvested on some beaches (Fagan and Paul, 1974).

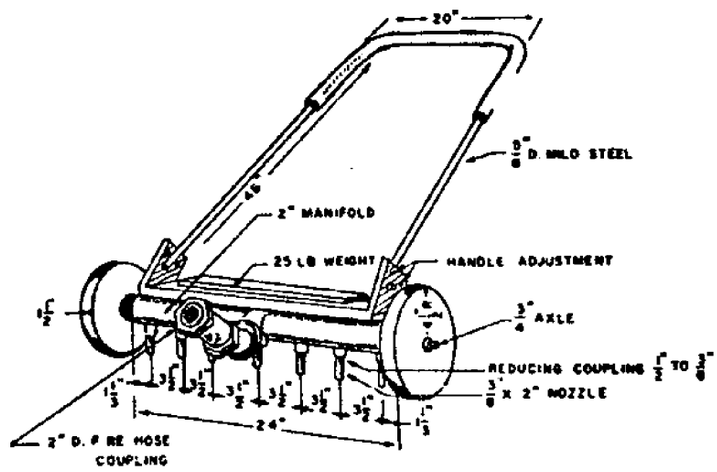

Figure 8. Perspective drawing of the manual hydraulic clam digger.
Source: D. B. Quayle and N. Bourne. The Clam Fisheries of British Columbia, Bulletin 179, reproduced by permission from the Fisheries Research Board of Canada.

depth of about 24 inches. Clams, sand and other debris are forced into the mouth of the dredge where an air and water mixture fluidizes the contents. After being fluidized the material passes over a length of 2 inch square steel mesh through which the sand, smaller clams, etc. are sifted back into the trench. The remainder of the clams are carried to and deposited in a net type sack attached to the back end of the dredge. Periodically the sack is brought to the surface and the contents dumped on a floating platform towed behind the dredge. Clams are then sorted by hand and the smaller ones are returned to the water. On one short test haul approximately 400 razor clams were harvested (Daisy, 1973, pp. 1-5). Excessive breakage of clams, as well as possible damage to small clams in the path of the heavy towing vehicle, are unresolved problems with this dredging device.

One of the most promising dredge experiments in Alaska, conducted during 1973 and 1974, is a drag dredge similar in some respects to the Eastern surf clam dredge. This dredge, drug along the bottom by a host vessel, releases a water and air mixture which has the effect of suspending the solids (clams, sand and other debris) in its path for a sufficient period of time to drag a large mesh collection bag beneath them. The bag is attached to the dredge frame behind the water and air injection devices. The dredge must be pulled to the surface to recover the collected clams. The early experiments with this dredge indicate a need for a wider "bite" in the bottom, so that its productivity can be increased. Thus, a larger model of the same dredge will need to be built; plans for its construction and testing during 1975 are being made (Young, 1974). Table 7 compares the dredges discussed above.

Historically, razor clams have been harvested from intertidal beaches during low tides by hand digging with a clam shovel. Razor clams are dug individually (pinpoint digging), not randomly, as are hardshell clams. The razor clams frequently produce a "show" or dimple on the surface of the sand. The number of shows produced depends on various factors such as weather, tide, surf, and is usually more numerous on hot, dry days than on cold, wet ones. Diggers sometimes try to make clams produce shows by stomping their feet on the beach. Trucks have been driven back and forth over the beach to stimulate the clams to show. The razor clam is dug with a clam shovel by removing a small wedge of sand seaward of a "show" and reaching down and grasping the clam siphon or shell. Care must be taken not to tilt the shovel too far or the shell may be broken. If the clam is not caught on the

TABLE 7

COMPARATIVE CHARACTERISTICS OF MECHANICAL AND HYDRAULIC CLAM DREDGES

	Maryland Escalator Dredge (soft clam)	Drag Dredge (surf clam)	(Experimental) Canadian Beach Dredge (razor clam)	Canadian Beach Dredge (hard clam)	(Experimental) Alaska Beach Dredge (razor clam)	(Experimental) Alaska Drag Dredge (razor clam)
Powered by Type action	Host Vessel Hydraulic	Host Vessel Hydraulic	Diesel engine Hydraulic	Hand Hydraulic	D-8 Caterpillar Mechanical and Hydraulic	Host Vessel Hydraulic
Area Covered	Subtidal	Subtidal (deep water)	Intertidal	Intertidal	Intertidal	Subtidal and Intertidal
Investment Cost	$15,000	$55,000	N/A	$500	N/A	$50,000 (est.)
Operational/ Maintenance Cost	$6/hour	$48,000/year	N/A	Minimal	N/A	N/A
Production Rate	500,000 Bushels/year	508,000 Pounds/year	1,000 pounds/ hour	300 pounds/ hour	N/A	N/A
Breakage Rate	1%	Minimal	High	5%	High	Minimal
Labor input required	2-4 persons	3-6 persons	N/A	2 persons	N/A	N/A

Sources: Manning, Commercial and Biological uses of the Maryland Soft-Clam Dredge, National Marine Fisheries Service, Marine Fisheries Review, National Fishermen Yearbook, Quayle and Bourne, Fisheries Research Board of Canada, The Clam Fisheries of British Columbia, Alaska Department of Fish and Game and Personal Interviews.

first attempt, commercial diggers move to another show as the clam rapidly burrows beyond reach. The number dug depends partly on skill and partly on whether the clams are "showing" well. An experienced digger can consistently dig 200-300 pounds of razor clams per four hour tide. The clams are put into boxes or sacks. If left exposed on the beach surface they will quickly reburrow (Quayle and Bourne, 1972, pp. 52-56).

The development of a suitable hydaulic harvester for razor clams appears imminent and is of concern to the management and conservation policies of the Alaska Department of Fish and Game. As mentioned, hydraulic dredges are allowed along certain parts of the west side of Cook Inlet and along certain parts of the Alaska Peninsula. Concern appears to center on the damage that may be inflicted on small clams. Another concern is the reduction of effort exerted by hand diggers that may accompany the widespread use of clam dredges. This concern is unsupportable on economic-efficiency grounds. Hand harvesters may be displaced by dredges from particular beaches but this is by no means certain. The effect on ex-vessel price of widespread use of dredges, however, might make other activities more economically rewarding. This price effect constitutes the real threat of dredges to hand harvesters but is necessary and desirable if Alaska clams are going to penetrate interstate human consumption markets. As emphasized above, the introduction of productive dredges is a precondition to the realization of the industry's potential.

Clam Work Force

In 1972 there were an estimated 14,900 full-time and 3,800 part-time fishermen in Alaska (U.S. Dept. of Commerce, National Marine Fisheries Service, *Current Fishery Statistics*, 1972). The number of commercially licensed clam diggers has varied over the years, but there were never a great number. An average of 259 commercial clam licenses have been issued annually over the past 30 years. In 1971 a total of 237 commercial clam digging licenses were issued by the Alaska Department of Fish and Game of which 188 were resident diggers and 49 were non-resident. Not all of the licensed clam diggers actively engage in the fishery however. In 1973 approximately 20 commercial diggers were engaged in razor clam digging at Polly Creek; 25 at Swikshak and 20 in the Cordova area. Except for the diggers with the small family operated canneries, all of the diggers are independent and

not connected or employed by the processors that purchase their razor clams. Most clam diggers in Alaska are engaged in various other forms of seasonal work including other fisheries; therefore, clamming is usually only a source of part-time employment and income. In past years clam digging was a significant factor in the livelihood of many commercial fishermen principally in the Cordova area where the clam fishery was centered. Clamming constituted an important source of income usually just prior to salmon season (Nickerson, 1973, Aug.). However, due to generally increasing affluence, economic and social changes, clam digging has lost its attraction as a source of employment. The present problem of securing experienced diggers is a significant one for the clam industry in Alaska. This fact, along with the relatively low productivity of hand harvesting, makes the introduction of dredges essential to the industry's growth.

During 1973, the Polly Creek commercial razor clam harvest was accomplished principally by an organized group of clam diggers from the Kenai Native Association. The harvest was transported by boat to a processor at Ninilchik which is located across from Polly Creek on the east shore of Cook Inlet. Delivered shell weight price paid was $0.30 per pound. The harvest was utilized entirely for crab bait. Boarding facilities were constructed at Polly Creek for use by the clam diggers. This group did not harvest at Polly Creek in 1974.

At Swikshak, there are two organized groups of commercial razor clam diggers. One group utilizes vessels to transport clams to Kodiak while the other group uses a chartered aircraft. An aircraft is used because the weather and sea conditions in Shelikof Strait are frequently too rough and dangerous for continued vessel use. The clams are sold to local processors at negotiated prices between $0.40 to $0.55 per pound. The individual digger received $0.24 per pound and some in-kind benefits in the form of shelter on the beach and transportation to Kodiak for those who work the entire season (Coma, 1973).

One particular consideration is that Swikshak razor clam beaches are located within the boundaries of the Katmai National Monument and certain park rules and regulations have to be observed by the clam harvesters. No firearms are allowed; this is sometimes of concern because of bears in the area. Construction of facilities is restricted to temporary shelters and garbage cannot be left in the area.

In the Cordova area a lack of experienced and willing clam diggers is a problem. Additionally, the clam beds in this area have not been producing at a very high level (Nickerson, 1973, Aug.). Small localized effort is accomplished by commercial diggers who use a boat to reach the clam beds which are generally sand and mud bars exposed at low tide. The price paid by local processors varies between $0.50 and $0.62 a pound. Clam harvesting in the Cordova area has declined to the point that the Cordova Aquatic Marketing Association no longer establishes marketing prices for razor clams. The small landings demand such a high price that negotiation is not considered necessary (Smith, 1973).

Seasonality of Clam Harvesting

Table 8 shows the harvesting of razor clams by month. While the razor clam fishery cannot claim the status of a winter fishery, it is somewhat counter-seasonal to salmon and shellfish production. Any perceptible benefit in this regard, however, awaits the expansion of the clam fishery to a more significant level of activity.

The seasonality of clam harvesting can be reduced still further with the introduction of dredges. Past seasonality can be explained by weather conditions in the winter months and the competing away of harvesters in the peak periods of the salmon and crab fisheries. The only regulatory closure occurs at Polly Creek from 15 July to 1 September. Dredge-based technology should be less sensitive to weather conditions, allowing perhaps some extension of the fishery into the fall months and earlier activity in the spring. Additionally, being capital intensive, dredges should be less affected by peak salmon and crab fishing activity.

PROCESSING

Location of Processors and Sources of Supply

Shellfish operators in Alaska are, for the greater part, corporations headquartered out of state and are often financially related to seafood brokerage or marketing firms. During the mid 1960's a trend toward consolidations of established fish packers and newer entrants into the field started. Foreign operators, notably Japanese firms, have entered the industry

TABLE 8

ALASKA CLAM HARVEST BY MONTH

(thousand pounds shell weight)

1965 - 1971

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1965	.2	.6	.3	19.3	24.4	12.8	14.9	10.1	4.9	.2	0	0	87.7
1966	.6	1.2	.4	4.2	19.5	12.3	5.6	.3	0	0	0	0	44.1
1967	0	0	14.2	47.7	26.6	12.0	12.3	3.8	.3	.2	0	0	117.1
1968	0	0	4.1	16.6	25.0	17.6	10.0	6.0	0	0	0	0	79.3
1969	0	0	.2	2.8	7.7	18.6	13.5	36.1	5.4	0	0	0	86.3
1970	0	0	1.2	3.8	56.6	74.4	22.0	1.9	0	.2	0	0	160.2
1971	0	.6	2.3	7.5	28.4	92.7	58.5	43.0	8.0	2.0	0	0	243.1
7 Year Average	.1	.3	3.3	14.6	26.9	34.3	19.5	14.7	2.7	.4	0	0	116.8

Source: Alaska Department of Fish and Game. Statistical Leaflets.

usually by joint-venturing with established domestic firms. The newer domestic entrants are generally entities of the larger national food processing and marketing firms (Wiese, 1968).

In 1972 a total of 51 Alaska shellfish processors were recorded with a total of 72 operating plant locations noted (AK Dept. of Fish and Game, 1972, pp. 9-13). A total of 15 plants processed clams as an additional product along with other shellfish species. Clam processing usually constituted a very small per cent of their total volume. All of the clam processors are located in the Southcentral region of Alaska due essentially to the fact that this region contains the most accessible stocks of razor clams and the only approved beaches. The Southeast and Western regions of Alaska do not contain any clam processors nor any certified beaches.

At present, a processing plant at Ninilchik absorbs the entire commercial harvest of razor clams from Polly Creek beaches. Recently several small processors in the Kasilof area have processed razor clams harvested from Polly Creek, principally for the human-consumption market. Part of the razor clams were canned (20 cases a year) as a gift pack and sold in Homer and the rest were sold as a fresh product in institutional markets principally in Anchorage. These processors are not presently processing razor clams.

A small, family operated, processing plant operates in the Homer area (Kasitsna Bay) canning butter clams harvested near the plant principally as a gift pack for sale in Homer; approximately 200 cases a year are prepared. The butter clams are hand shucked, cleaned, double washed; hand packed in cans in either whole or minced form, and then subjected to a heat-retort process. After cooling they are labeled and cased. Average wholesale price for a case of 24 ½ pound cans is $14.00. Retail value is $28.00 a case. The shucked shells are disposed of in a fill dirt area to build up a beach area. Butter clams are an additional product and their processing is accomplished during slack periods when salmon are not being processed. The harvesting of butter clams at this location is an exception to the state health regulations concerning approved beach area. Sufficient background data, toxicity tests and survey results are in existence to allow harvest of butter clams from this area. Periodic samples of the canned butter clam product are tested by the State to insure sanitary quality.

Razor clams harvested from Swikshak beaches are transported to eight processors in the Kodiak area. All of the processors are principally engaged in processing other shellfish

species with razor clams occupying usually less than one per cent by volume of their total product. They sell clams as bait to dungeness crab fishermen associated with the canneries at a small markup in price, usually $0.05 per pound. One processor provides a limited quantity (about 600 pounds a year) of fresh razor clams to local retail outlets for use in human consumption. There is no canning of razor clams in the Kodiak area at the present time, although one processor has canned a small amount for experimental purposes.

In the Cordova area 5 shellfish processors utilize the razor clam harvest in that area. Most of the harvest is used for crab bait with a small amount utilized fresh, frozen and in canned form for local human consumption. There are two processors that can razor clams in the Cordova area with a total volume of approximately 200 cases a year. Average retail price is $52.50 a case (48-½ pound). Several of the shellfish processors are under contract agreement with the local fishermen's union to provide crab bait to the fishermen. Recently they have had to procure other forms of bait in lieu of razor clams because of the short supply of clams. Squid has been imported at a high cost for use by the crab fishermen.

Most of the shellfish processors in Alaska do not establish the maximum number of razor clams that they will purchase from clam diggers. They generally purchase all razor clams offered for sale and have large standing orders for razor clams that they cannot fill.

Processing Methods

Razor clams that are processed for use as crab bait go through a generally simple process. The clams are first washed to get rid of sand and sediment and then are dyed to identify the clams as crab bait. The clams are then usually sacked into 25 to 50 pound sacks and frozen complete with shell. No special or significant additional plant equipment is required for this process. The frozen clams are stored at the canneries until sold to the crab fishermen. No waste is involved as the whole clam with shell is processed without shucking.

In the canning process speed is essential in handling razor clams. They must be alive and unbroken when started through the cannery, usually within 24 hours after being harvested from the beaches. This insures their freshness and high quality (Brooke, 1950, p. 61). The clams are washed free of sand and passed through a steam box having a reciprocating mesh-covered screen. The reciprocating motion of the screen keeps the clams

moving forward and in the process the clam meats are steamed loose from the shell. As the clams are discharged at the end of the steam box, a blast of air at right angles to the direction of travel of the conveyor blows the shells aside into a waste conveyor. Razor clam shells are much lighter in proportion to the total weight than other clam species and may be easily diverted by the air blast. The clam meats pass on to other workers who clip off the dark ends of the siphon, slit the siphons to wash out the sand and silt and separate the visceral parts. Meats go through a grinder to be minced and are filled mechanically into cans. If a whole clam product is desired, the mincing stage is bypassed. The cans are filled with brine or water and are then sealed under vacuum. They are then sent through a heat-retort process for cooking (Stansby, 1963, p. 189).

In a typical Alaskan cannery processing is accomplished primarily by hand. The clams are hand washed and shucked. They are cleaned by hand using scissors and separated into those to be canned for whole or minced clams. All clams are washed mechanically for 20 minutes in a rotating cylinder and drained in colanders. All equipment is stainless steel. The clams are handpacked into cans by weight, filled with water, sealed under vacuum and cooked in a heat-retort process.

The freezing of shucked clams for human consumption may be done by various methods including blast, multiple tunnel and other types of freezers. However, if clams are excessively frozen the meat becomes hard and difficult to chew (Nowak, 1970, pp. 167-171). An important quality consideration is the condition of the raw clam to be frozen. It has been established that decreases in the quality of raw material used for freezing results in a disproportional decrease in the storage life of the frozen product. If low quality clams are used for freezing, the initial quality of the frozen product will be similarly low, and further shelf life of the frozen product will be considerably reduced. In addition to the quality of the seafood product prior to freezing, the temperature and time of storage are the most important factors influencing shelf life and quality of frozen fish products. Table 9 shows the comparative shelf life of seafood products. An increase in storage temperature markedly reduces product shelf life. The storage life of frozen fish products can be increased significantly by controlling the microclimate surrounding the product to minimize dehydration (freezer burn) and oxidation (rancidity). Fish fillets, breaded convenience items

TABLE 9

STORAGE TIME OF ALASKA FISH PRODUCTS

(Held at 0°F. or less)

9-12 months	5-9 months	3-4 months
Halibut	King Salmon	Chum Salmon
Sole	Red Salmon	Pink Salmon
Flounder	Silver Salmon	Clams
King Crab	Rock Fish (Rock Cod)	Oysters
Dungeness Crab	Ocean Perch	Cooked Shrimp
Raw Shrimp	Large White Fishes	Trout
Cod	Sablefish (Black Cod)	Grayling
	Shee Fish	Lake Trout
		Dolly Varden and Char
		Small White Fish

Source. Doyle (1971). U. of A., Cooperative Extension Service, Freezing of Fish to Maintain Quality.

or steaks are usually packaged in waxed cartons overwrapped with combinations of waxed paper, polyethylene, aluminum foil, or cellophane. A recent trend is to use heavily waxed or polyethylene-coated cartons without overwrapping materials. Vacuum packaging in a moisture proof pouch considerably increases the shelf life of frozen fish but is not widely employed due to the higher cost. The tendency is toward an automated, containerization process using less protective coated cartons with a tear strip for convenience in opening rather then an overwrap or pouch (Slavin, 1968, pp. 190-196).

Although clam processing is largely labor intensive, several large East Coast firms have equipped their plants with modern, automated production machinery to process frozen clams. When clams are taken from the clamming rigs to the processing plant they are conveyed through a desanding operation. This gives the clams an opportunity to expel any sand particles prior to processing. The clams are then conveyorized through the hand shucking line before being routed to the conveyorized cooking process. The breading, cooking, freezing and packaging procedures are all automated. The cooking phase is performed by electronic control of the belt speed. After cooking, another conveyor belt routes the clams through a minus 30° F. freezing tunnel. The freezing belt leads directly to the packaging machine which automatically weighs and packages the frozen product. Finished sealed packages are then manually packed into shipping cases, ready for storage and distribution (*Quick Frozen Foods Magazine*, 1970, pp. 121-122).

Employment

In 1971 there were a total of 192 operating plants in Alaska processing various fishery products. In these fishery processing establishments average employment was 8,502 persons during the fishing season and 3,500 persons estimated on a year around basis (U.S. Dept. of Commerce, National Marine Fisheries Service, *Current Fishery Statistics*, 1972). No precise data are available on the number of persons utilized for clam processing; the shellfish plants are all diversified with clams representing a minuscule amount of their overall volume. The same personnel used for processing other shellfish also processed clams when available, therefore, very little incremental employment at the processing stage can be attributed to clam operations. Cannery workers average wage is between $3.50 and $4.00 per hour depending upon experience and function.

Final Products

Clams can be preserved in various ways - salting, drying, pickling, canning (whole, minced, chowder, juice), smoking, and in a frozen form. The preparation as clam chowder is the largest outlet nationally. One of the most recent methods of preparing frozen clam meats is in the breaded clam-stick form. These are similar in appearance to breaded shrimp and relatively easy to produce. The meat is minced and then frozen into blocks which are subsequently sliced into "sticks", dipped in breaded flour and packaged into various size cartons. Frozen clam products are also prepared for either steaming in the shell or frying. The fried-clam retail market is expanding rapidly and has been greatly helped by extensive publicity from large restaurant chains. Considerable quantities of smoked and dried clams are consumed in the United States principally by Orientals. Since few American processors preserve clams in these ways the consumers either prepare the clams themselves or obtain them from Japan (Nowak, 1970, pp. 167-171).

Most of the U.S. clam production is prepared in the canned form with the rest consumed in a fresh or frozen form. In 1972 the canned pack of clam products in the United States reached a record 2.9 million standard cases (48-½ pound) worth $27.3 million dollars wholesale. Additionally, 98,860 standard cases of clam specialties (dips, fritters, crisps, spreads, smoked, etc.) were prepared at a value of $2.4 million dollars. The final product composition of this pack is shown in Table 10.

In the past, Alaska production of razor clams was principally canned for human consumption. Beginning in the early 1960's the production shifted to frozen form, the final product being crab bait. The composition of Alaska production from 1942 to 1972 is shown in Table 11.

MARKETING

Processor Markets

Clam markets in the U.S. are highly concentrated in three geographic regions - New England, Middle Atlantic and Pacific. These three regions together account for 37 per cent

TABLE 10

U.S. CANNED CLAM PRODUCTION BY TYPE OF FINAL PRODUCT

1972

Production and Number of Plants	Standard Cases	% of Total	Pounds	% of Total	Dollars	% of Total
Whole (3)	3,731	-	55,965	-	$ 123,624	-
Minced (13)	700,088	24	10,501,320	13	9,150,463	31
Chowder (10)	1,953,214	66	58,596,420	73	17,161,756	58
Juice (9)	208,212	7	6,246,360	7	827,151	3
Specialties (12)	98,860	3	4,745,280	6	2,394,951	8
Total	2,964,105	100	80,145,345	100	$29,657,945	100

Source: U.S. Department of Commerce, National Marine Fisheries Service, Canned Fisheries Products, 1972. Annual Summary (revised 1973). *Current Fishery Statistics*, No. 6101.

TABLE 11

SOUTHCENTRAL ALASKA CLAM PRODUCTS AS PREPARED FOR MARKET, 1942-1972

Year	Fresh and Frozen Pounds	Wholesale Value	Canned Pounds	Canned Cases*	Wholesale Value
1942	-	-	558,816	37,254	$412,078
1943	-	-	589,200	39,280	435,668
1944	8,325	$ 2,411	568,902	37,927	428,597
1945	27,163	7,901	528,753	35,250	403,526
1946	31,196	18,558	654,816	43,654	739,753
1947	88	79	262,080	17,416	249,139
1948	17,557	4,203	413,085	27,539	494,402
1949	48,003	11,346	570,465	38,067	672,314
1950	103,219	34,339	702,057	46,804	835,480
1951	9,156	1,374	661,470	44,098	811,617
1952	2,574	260	391,845	26,123	502,078
1953	1,107	627	472,830	31,522	609,355
1954	21,859	2,629	397,155	26,477	498,018
1955	5,768	3,231	551,393	36,760	732,555
1956	278	201	411,210	27,414	545,009
1957	-	-	490,800	32,720	651,057
1958	1,005	525	173,100	11,540	230,493
1959	-	-	315,015	21,001	445,692
1960	333	250	344,535	22,969	459,295
1961	4,200	1,630	388,800	19,252	409,330
1962	-	-	153,800	10,256	245,530
1963	17,300	4,000	90,200	6,034	132,700
1964	36,600	22,620	4,300	290	7,370
1965	78,931	56,269	3,675	245	4,683
1966	3,612	3,055	2,025	135	3,220
1967	53,343	23,108	5,595	373	9,910
1968	3,040	1,083	5,430	362	7,827
1969	34,126	12,019	3,150	210	5,547
1970	233,174	73,618	2,160	144	4,496
1971	245,518	100,751	3,570	238	6,736
1972	139,596	10,926	1,695	113	4,300

*Standard cases (48-½ pounds)

Source: U.S. Department of Interior 1942-1959 and Alaska Department of Fish and Game 1960-1972.

of the U.S. population but consume about 85 per cent of the national clam production (Miller and Nash, 1971, pp. 4-5).

Consumption of clams in the New England region accounts for over 50 per cent of all clam products consumed in the U.S. New England, however, is no longer a leading clam-producing region and must depend on other regions for over 80 per cent of its supplies. Per capita consumption of clams in New England is close to nine times the national average and exemplifies the influence of tradition in fishery-product consumption (Miller and Nash, 1971, p. 5).

Outside of New England, clam products are consumed principally in the Mid-Atlantic and Pacific regions, which account respectively, for 19 and 16 per cent of the U.S. clam consumption. The per capita rate of consumption in both of these areas is close to the national average. In all other regions of the U.S. per capita consumption of clams is less than half the U.S. average. These consumption patterns are clearly associated with coastal and non-coastal environments and the consumption traditions found therein. Since most clams are frozen or canned and since large shipments east to west occur, product perishability does not create geographic barriers which could explain regional consumption patterns (Miller and Nash, 1971, p. 5).

As previously mentioned, in Alaska over 90 per cent of the razor clam harvest is utilized for crab bait. A limited market exists for fresh, frozen, and canned razor clam products for human consumption. This market is primarily restricted to the local markets in the areas of harvest, although some frozen product is occasionally shipped to institutional markets in Anchorage. The greatest potential market for Alaska razor clams is the Pacific Northwest and California. This market is familiar with the razor clam and it can be anticipated that a large institutional market for Alaska's fresh and frozen razor clams could be easily developed. Roughly half a dozen processors in Alaska are interested in this market once the State's membership in NSSP is assured; membership status will allow individual processors to be certified as interstate shippers of fresh and frozen clam products. When Alaska becomes a regular supplier of razor clams on the Pacific Coast, a significant intrastate institutional and retail grocery market will likely be developed. However, in the absence of the development of an external market, the size of the potential intrastate market is probably not sufficient to induce a significant intrastate processing and marketing effort.

The canned-clam product is packed for use as a gift pack. The higher cost of harvesting and processing in Alaska precludes significant competition with the lower cost, publicly accepted East Coast produced canned clams. The canned market is clearly not a potential market for Alaska produced clams as long as present supply constraints and harvesting techniques prevail.

Transportation and Distribution

Time, temperature and turnover work against frozen seafood quality at each level from harvest to ultimate consumption. The amount of deterioration, varying in practice from negligible to serious, depends on the control of each of these factors.

The transportation mode presently used most extensively for both canned and frozen seafood products in Alaska consists of the van-ship method. Loaded trailer vans are shipped by barge or ship to market areas. Freezer vans are, of course, used for the frozen products. Regular service is provided from all processing centers. Air transportation is available from all processing centers and is being utilized for shipment of fresh seafood products.

There are essentially two distribution channels available to clam processors in Alaska. One channel, available to vertically-integrated processing firms, is the firm's own sales force. The other involves the use of a broker. Seafood products may be consigned or sold to a seafood broker. The broker then places the product with wholesalers or directly with retail and institutional buyers. Generally the large and established firms use their own sales force while smaller firms use the services of a broker.

Merchandising, Packaging and Promotion

The greatest change within the food service industry in recent years has been the trend toward convenience foods, principally in a frozen form. The product must associate itself with new convenient methods of preparation, service and package disposal. It must be tasty, attractive and be able to compete with similar products created from a meat or poultry base (Grant, 1968, pp. 210-212). The problem of quality deterioration with frozen seafoods is a significant one. Packaging of seafood leaves a great deal to be desired from the standpoint of protection of quality through the distribution system. The obvious solution is an inner

wrap, either vacuum or shrink film, to protect the product from dehydration, but most seafoods are not packaged in this manner. Vacuum packaging would extend shelf life and protect the quality of frozen seafood products (Gruber, 1968, pp. 227-232).

The clam industry's promotion program is generally small, and regionally or locally directed. One large national producer promotes canned clams on the East and West Coasts. This particular firm sells through brokers and has three promotions a year: in the fall, at Christmas, and in the spring Lenten season. The advertising media are newspapers, regional editions of Good Housekeeping, and radio (*Business Week Magazine*, 1972, pp. 58-62).

Another large national producer directs its promotion to the New York middle-income group which is their biggest consumer. It uses TV in New York and radio and print elsewhere. Product promotion is increasing sales in the Midwest, but the firm's management contends that the potential sales volume there does not justify the advertising budget of the East and West Coasts. Another national firm stresses their frozen clam products using TV in localized areas such as Cleveland, Columbus and Detroit (*Sales Management Magazine*, 1971, p. 62).

One of the largest clam firms in the U.S. conducts an aggressive trade promotion program in major East and West Coast markets. It uses newspaper coupons and four-colored ads in Family Circle and Sunset magazines. A key part of the program is a tie-in promotion with branded and private label items for minced and chopped clams. One promotion is built around a $24.95 hot dip snack tray that is offered at $14.95 with two of their firms canned clam labels. The text of one of their ads is worded as follows: "Our fresh-tasting minced and chopped clams make the tastiest hot party dip you ever dipped into. And if you'll try our recipe, we'll pay you $0.50 for the crackers you'll need for dipping. Look for details on our display at your participating store" (*Advertising Age Magazine*, 1973, p. 31).

In Alaska, promotion of razor clam products is only accomplished by word of mouth in the limited markets that presently exist. TV, radio or newspapers are not utilized. Trade journals usually mention the clam product of Alaska processors along with their other seafood products.

An important marketing consideration is the adverse effect that paralytic shellfish poisoning (red tide) has had on the marketing of clams. When a ban on harvesting of

shellfish is put into effect by state health officials the public confidence in shellfish products is lost and sales drop significantly. The publicity given to a ban has the effect of dissuading shoppers from buying all kinds of seafoods in stores and restaurants. Even unaffected species such as lobster, fin fish and shrimp are spurned by shoppers. In 1972, the New England area suffered from an episode of shellfish toxicity; losses have been estimated to be as much as $200 million dollars (*Economist Magazine*, 1972, p. 92). Such losses imply the necessity for cooperation with, and self-enforcement in, the Alaska Shellfish Program. A PSP incident on the West Coast, associated with Alaska produced razor clams, would result in severe negative external effects on other uneffected fisheries, not to mention the effect on the clam fishery. Any existing animosity within the fishery toward the State's program should give way to a spirit of cooperation simply as a matter of self interest.

CHAPTER V

DEMAND, SUPPLY AND PRICES

INTRODUCTION

This report is concluded by drawing on the information presented in the preceeding chapters and other sources to analyze the economic environment in which the Alaska clam fishery must compete if it is to be successfully developed. The analysis consists of an examination of the past demand, supply and price trends and the changes that may be expected in these variables in the future.

DEMAND

A characteristic of all goods and services, including clams, is that the amount purchased is dependent upon price, buyer tastes, income, population and the price of related goods (substitutes and complements). This section develops what is known about the demand for clams in the United States. World demand is not considered here because the U.S. does not export clams to the rest of the world. Nor is it likely that the U.S. will become an exporter of clams in the future. World demand is only relevant, therefore, to the extent that it affects the price that must be paid for imported clams; this aspect is discussed below in the section dealing with clam prices.

Consumption Trends

The consumption of clams by U.S. consumers is part of the broader consumption pattern for food-fish products. U.S. consumption of food fish is forecast to increase by 33 per cent from 2.2 billion pounds in 1967 to 2.9 billion pounds by the year 2000. Per capita consumption, however, is expected to fall from 11.02 pounds to 9.38 pounds over the same period (Bell, *et al.*, 1970, p. 5); therefore, the growth in aggregate fish consumption will be derived primarily from growth in population. Per capita consumption since 1950 is shown in Table 12. It can be seen that the downward trend in per capita consumption expected by some has not yet begun. Indeed, an upward trend appears to be developing; it remains to be

TABLE 12

PER CAPITA CONSUMPTION OF COMMERCIALLY CAUGHT FISH AND SHELLFISH, 1950-1973

Year	Civilian Resident Population July 1	Per Capita Consumption			
		Fresh And Frozen	Canned	Cured	Total
	Million	Pounds, Edible Meat			
1950	150.8	6.3	4.9	0.6	11.8
1951	151.6	6.3	4.3	0.6	11.2
1952	153.9	6.2	4.3	0.7	11.2
1953	156.6	6.4	4.3	0.7	11.4
1954	159.7	6.2	4.3	0.7	11.2
1955	163.0	5.9	3.9	0.7	10.5
1956	166.1	5.7	4.0	0.7	10.4
1957	169.1	5.5	4.0	0.7	10.2
1958	172.2	5.7	4.3	0.6	10.6
1959	175.3	5.9	4.4	0.6	10.9
1960	178.1	5.7	4.0	0.6	10.3
1961	181.1	5.9	4.3	0.5	10.7
1962	183.7	5.8	4.3	0.5	10.6
1963	186.5	5.8	4.4	0.5	10.7
1964	189.1	5.9	4.1	0.5	10.5
1965	191.6	6.0	4.4	0.5	10.9
1966	193.4	6.1	4.3	0.5	10.9
1967	195.3	5.8	4.3	0.5	10.6
1968	197.1	6.2	4.3	0.5	11.0
1969	199.1	6.6	4.2	0.4	11.2
1970	201.7	6.9	4.5	0.4	11.8
1971	204.3	6.6	4.3	0.5	11.4
1972	206.5	7.0	4.9	0.4	12.2
1973*	208.1	7.2	5.0	0.4	12.6

*Preliminary.

Source: U.S. Department of Commerce, National Marine Fisheries Service, *Current Fishery Statistics*, 1973.

seen whether changes in per capita consumption occurring since 1967 are only temporary deviations from a downward trend or whether they actually represent a new upward trend or higher plateau.

Significant trends have been taking place in the composition of items that make up per capita consumption of fishery products. Tuna consumption increased from 1.9 pounds to 2.4 pounds per capita during the 1959-1968 period. Shrimp consumption increased from 1.1 pounds to 1.4 pounds per capita. Consumption of such bottom fish as ground fish and ocean perch fillets and blocks was 1.5 pounds per person in 1959, compared with 2.2 pounds in 1968. These three items together represent an increase in per capita consumption of 1.6 pounds. This increase has been offset by decreases in other products, e.g., canned salmon, canned sardines, and oysters (Shapiro, 1973, pp. 125-126).

Per capita consumption of clams has remained fairly stable over time although some recent increases are apparent. Table 13 shows actual and projected aggregate and per capita consumption of clams in the United States from 1947 to 2000.[1] The most recent projection by the National Marine Fishery Service suggests that one cannot expect significant additional changes in per capita consumption of clams (U.S. Dept. of Commerce, National Marine Fisheries Service, 1970, revised, p. 111; although, as discussed below, some increase is possible as a result of future changes in relative fish prices. Aggregate clam consumption will continue to experience growth as a result of an increase in the number of consuming units. A source of considerable uncertainty about the future is that the per capita consumption of clam products, and thus, the aggregate consumption associated with each year's population, can diverge significantly from past trends, in either direction. Per capita consumption is primarily determined by the relationship of consumption to income, by changes in relative prices, and by technical changes in product form. A change in each of these variables is possible, if not likely, and such changes can cause significant changes in per capita consumption.

[1]Actual apparent per capita consumption for 1971-1973 was .440, .463, and .532 pounds (meat weight) respectively. Apparent per capita consumption equals landings plus imports divided by resident population.

TABLE 13

UNITED STATES AGGREGATE AND PER CAPITA CLAM CONSUMPTION, 1947 - 2000

	Aggregate Consumption Million Pounds Meat Weight	Per Cent Change	Per Capita Consumption Pounds Meat Weight*	U.S. Resident Population Millions
1947	38.5	-	.267	144.0
1950	43.4	12.7	.286	151.9
1955	35.9	-17.3	.217	165.1
1960	51.0	42.1	.283	180.0
1965	72.3	41.8	.373	193.6
1970	105.5	46.1	.518	203.8
1975†	115.1	9.1	.530	217.1
1980	125.9	9.5	.541	232.7
1985	136.9	8.7	.547	250.2
1990	147.6	7.9	.551	267.9
2000	169.6	14.9	.557	304.5

*Figures after 1970 are projections based on the assumption of declining income elasticity through time.
†Projections based on Table 111-1; authors converted round weight to meat weight by applying per cent changes in Table 111-1 (round weight) to Table 11-1 (meat weight).

Sources: National Marine Fisheries Service. Basic Economic Indicators: Clams. Working Paper No. 55, April 1970. Tables 11-1 and 111-1, pp. 8, 16. 1970 estimate of actual apparent consumption obtained by adding U.S. landings and imports from U.S. Department of Commerce. National Marine Fisheries Service. *Fishery Statistics of the United States*, 1970. Population figures are revised to make actual 1970 a benchmark for projected population but the rate of population growth assumed in Basic Economic Indicators: Clams, is retained.

Consumer Income

The income elasticity of demand, which measures the degree of sensitivity of per capita consumption of clams to changes in real per capita income, is about unity: $E_I = 1.08$. This income elasticity coefficient means that a one per cent increase in real per capita income would cause per capita clam consumption to increase by about one and one-tenth per cent. This coefficient, as calculated from the data for the 1947-1973 period, is statistically different from zero at the five per cent level (U.S. Dept. of Commerce, National Marine Fisheries Service, 1975, p. 10, revised). The above coefficient is applicable to all clam product forms; a separate estimate of income elasticity of demand, applicable only to the fresh and frozen product form, is $E_I = 1.06$, but this estimate is not statistically different from zero at the five per cent level (Nash *et al.*, 1972, p. 150). This means that one cannot be confident that $E_I = 1.06$ is not in fact $E_I = 0$. $E_I = 1.06$ means that the per capita demand for fresh and frozen clam products can be expected to grow at about the same rate as per capita income. This growth performance could be somewhat enhanced, perhaps, by development of fresh and frozen product and packaging forms that are more appealing to potential buyers.

Relative Prices

There is no information available on the effects of changes in relative prices, particularly of changes in the prices of other food fish products, on the per capita consumption of clams. It is likely that a decrease in the price of clams relative to other food fish products (not necessarily an absolute decrease) will occur over the next several decades and that this decrease will tend to increase per capita consumption of clam products. The presumption of a fall in the relative price of clams is based on the trend growth in per capita demand and population, the relation of present world landings to the world MSY and the degree of dependency on imports. Information on these attributes for each of several selected species is shown in Table 14. Aside from scallops, clam landings have more room to expand than any other species (only about 12 per cent of the world MSY is being harvested) and clam imports in 1967 were only about three per cent of total U.S. supplies (about five per cent in 1973). Thus, it can be expected that growth in demand for clams in the U.S. can

TABLE 14

DEMAND AND SUPPLY GROWTH INDICATORS

Species	Average Annual Growth in U.S. PCC 1950-1967	World Landings as Per Cent of World MSY 1962-1967	U.S. Imports as Per Cent of Total U.S. Supplies 1950	1967
Selected Finfish				
Ground fish	2.0	68.78	24.9	68.6
Tuna	4.3	77.60	16.6	51.5
Salmon	-3.5	-	16.9	2.8
Halibut	0.8	107.61	30.6	44.4
Sardines	-3.3	46.78	9.3	64.2
Selected Shellfish				
Shrimp	3.0	42.70	26.1	51.6
Lobsters	2.3	71.32	48.7	36.8
Crabs	4.7	48.84	11.8	3.9
Clams	2.4	11.95	12.7	3.2
Scallops	1.9	11.16	3.3	56.8
Oysters	-2.8	-	0.6	22.8
All Other Fish and Shellfish	-4.2	45.01	-	-

Source: Bell, Frederick, *et al* 1970. National Marine Fisheries Service. The Future of the World's Fishery Resources: Forecasts of Demand, Supply and Prices of the Year 2000 with a Discussion of Implications for Public Policy. Draft manuscript, Working Paper No 71-1, December.

be supplied without large increases in the real price. This situation is in contrast with most other species of fish and shellfish for which potential supply growth is more limited. As a result, for these species, future demand increases will be accompanied by more significant real price increases. This prediction is supported by a Bureau of Commercial Fisheries statistical analysis of demand growth for the period 1967-2000, by species, and the combination of these estimates with information on available supplies (Bell, *et al*., 1970, p. 229). The result of their analysis is shown in Table 15 in the form of projected increases in the real price of each product on the world market. According to these estimates, there will be less upward pressure on the real price of clams than on any other species except scallops. These projections must, of course, be interpreted cautiously as they are based, of necessity, on a number of simplifying assumptions. Nevertheless, they are indicative, the authors believe, of the direction of the future pressures on relative prices.

In summary, the relative price of clams should fall over the next several decades in comparison with most fishery products and this fall in relative price should have a favorable, if yet undetermined, impact on per capita consumption. The amount of this impact will depend on the actual size of the change in relative price and on how closely consumers view clams and other food fishes as substitutes. Figure 9 shows that between 1967 and 1973 ex-vessel clam prices have risen more slowly than ex-vessel prices of all edible fish and shellfish; since 1971 the differential has widened dramatically. Thus the predicted trend change in relative price is already under way and is certainly one contributing factor toward the recent increases in per capita consumption.

SUPPLY

Domestic Sources

The majority of clams harvested in the United States come from the East Coast; the Middle Atlantic states are the largest suppliers. Table 16 shows the regional supply and distribution of clams harvested in the U.S. in 1969. Of the clams landed in the Mid-Atlantic states 75 per cent are shipped to other regions, chiefly for consumption in New England and on the West Coast. The South Atlantic area ranks behind the Mid-Atlantic in clam production, and exports over half of what it produces. Clam production in the South

TABLE 15

PROJECTED WORLD REAL PRICE INCREASES FOR SELECTED FISHERY PRODUCTS, 1965-2000

Cents per pound

Species	1965-7	1970	1980	1990	2000	Increase (1965-7-2000) Per cent
Groundfish	6	8.9	15	23	28	366.7
Tuna	16	16	20	25	30	87.5
Salmon	24	24	28	32	38	58.3
Halibut	25	28	36	45	52	108.0
Shrimp	37	42	52	67	94	154.0
Lobster	63	67	97	147	311	393.6
Crabs	12	12	21	80	114	850.0
Clams	3.5	3.5	3.7	4.2	4.8	37.1
Scallops	7.2	7.2	7.4	7.5	7.6	5.6
Fish meal	1.0	1.1	2.1	5.7	7.8	680.0

Source: Bell, Frederick *et al.* 1970. National Marine Fisheries Service: The Future of the World's Fisheries Resources: Forecasts of Demand, Supply and Prices to the Year 2000 with a Discussion of Implications for Public Policy. Draft manuscript, Working Paper No. 71-1, December.

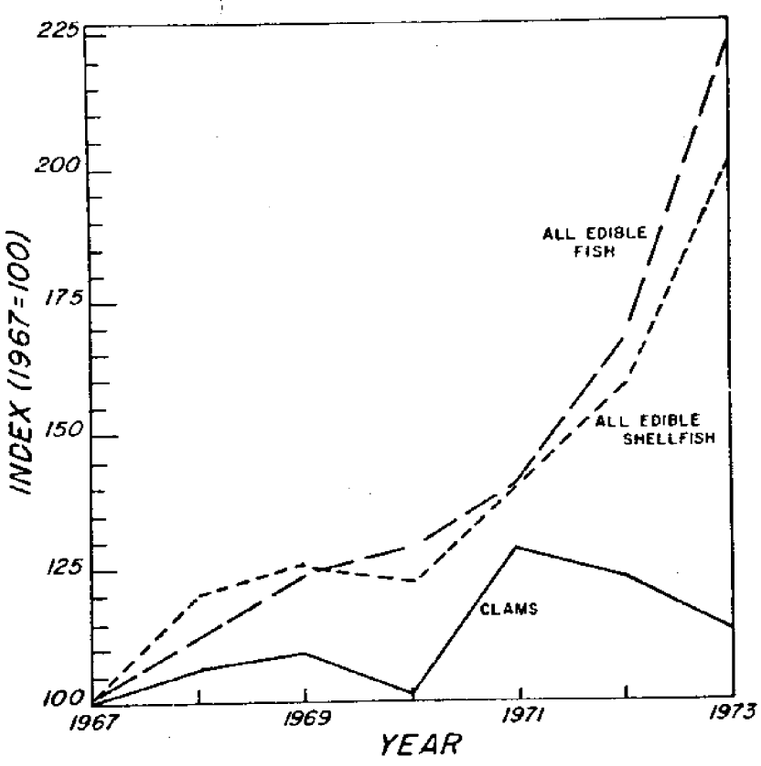

Figure 9. Ex-vessel price indexes: clams, edible shellfish and edible fish, 1967-1973 (1967 = 100).

Sources: U.S. Department of Commerce, National Marine Fisheries Service, *Current Fishery Statistics*, No. 6400, Average ex-vessel clam prices and index calculated from landings and value data from U.S. Department of Commerce, *Fishery Statistics of the U.S.*, 1967-1971, and U.S. Department of Commerce, *Current Fishery Statistics*, 1972-1973.

TABLE 16

REGIONAL SUPPLIES AND DISTRIBUTION OF CLAMS, 1969

(thousand pounds meat weight)

	Supplies		Distribution	
	Inshipment	Landings	Consumption	Outshipment
New England	31,423	6,392	37,815	-
Mid Atlantic	-	57,248	13,817	43,431
East North Central	4,242	-	4,242	-
West North Central	-	-	-	-
South Atlantic	-	11,860	5,362	6,498
East South Central	1,061	-	1,061	-
West South Central	298	-	298	-
Mountain	703	-	703	-
Pacific	12,202	-	12,202	-
TOTAL	49,929	75,500	75,500	49,929

Source: Miller and Nash, 1971. Regional and Other Related Aspects of Shellfish Consumption: Some Preliminary Findings from the 1969 Consumer Panel Survey National Marine Fisheries Service Circular 361.

Atlantic is concentrated heavily in the Chesapeake area (Miller and Nash, 1971, p. 5). These two areas are the only regional net exporters of clams in the U.S. All other regions, particularly the New England and Pacific regions, are net importers of clams. No area serves both as an importer and an exporter, which suggests, along with the highly perishable nature of the unprocessed product, that the value added from the processing stage is typically captured within each region of harvest.

Clams constituted 2 per cent of the total U.S. fishery landings and 12 per cent of shellfish landings in 1973 based on weight. Surf clams, landed principally in Virginia and New Jersey, accounted for 77 per cent of the U.S. clam harvest; hard clams (butter, littleneck, round) 14 per cent; and soft clams, 8 per cent. The rest consisted of ocean quahog, rangia, razor, sunray venus and mixed clams (U.S. Dept. of Commerce, National Marine Fisheries Service, *Current Fishery Statistics*, 1973). Table 17 presents U.S. clam landings by type for selected years. These figures show that over the past two decades the surf clam has replaced hardshell and, to a lesser extent, soft-shell clams as the most important species. Because the surf clam harvest is approaching MSY, its relative importance can be expected to decline in the future. The most likely replacement is the ocean quahog, which has an estimated MSY of around 150 million pounds (U.S. Dept. of Commerce, National Marine Fisheries Service, *Commercial Fisheries Review*, 1971, p. 17) and a 1971 harvest of 2.0 million pounds (U.S. Dept. of Commerce, National Marine Fisheries Service, Statistical Digest.)

In 1971 the middle Atlantic states led with 61 per cent of the clam landings, followed by the Chesapeake states with 24 per cent, New England 13 per cent and the Pacific Coast, Gulf and South Atlantic states with the remaining 2 per cent. The breakdown of 1971 landings by region, state and type is shown in Table 18.

Foreign Sources

Clam imports have generally been small in relation to total U.S. supplies. Table 19 shows U.S. clam landings and imports as a per cent of total U.S. supply. It is unlikely that significant increases in the proportion of U.S. supply made up of imports will occur in the near future. Both continuing changes in relative currency values (which have made imports

TABLE 17

U.S. CLAM LANDINGS BY TYPE, SELECTED YEARS

(thousand pounds meat weight)

	Surf		Hard		Soft		Other		Total
	Harvest	per cent	Harvest	per cent	Harvest	per cent	Harvest	per cent	
1950	7,742	19	21,049	51	9,390	23	2,875	7	41,056
1955	12,022	35	14,385	42	5,112	15	2,909	8	34,428
1960	25,071	51	14,877	30	8,579	17	1,045	2	49,572
1965	44,088	62	15,044	21	11,308	16	409	1	70,849
1970	61,200	62	15,500	16	12,500	13	10,002	10	99,202
1973	82,251	77	14,593	14	8,991	8	458	1	106,293

Sources: U.S. Department of Commerce, National Marine Fisheries Service, *Fishery Statistics of the United States, 1950 1970*, and U.S. Department of Commerce, *Current Fishery Statistics*, 1973.

TABLE 18

SUMMARY OF CLAM LANDINGS BY REGION, STATE AND TYPE, 1971

(thousand pounds meat weight)

	Surf	Hard	Soft	Other	Total
New England:					
Maine	-	6	5,250	-	5,256
Massachusetts	18	1,175	1,165	7	2,365
Rhode Island	155	1,068	49	1,495	2,767
Connecticut	-	276	-	532	808
Total	173	2,525	6,464	2,034	11,196
Middle Atlantic:					
New York	3,688	8,549	154	10	12,401
New Jersey	28,721	2,476	48	-	31,245
Delaware	7,694	113	-	-	7,807
Total	40,103	11,138	202	10	51,453
Chesapeake:					
Maryland	7,752	332	5,986	-	14,070
Virginia	4,507	1,837	-	-	6,344
Total	12,259	2,169	5,986	-	20,414
South Atlantic:					
North Carolina	-	253	-	47	300
South Carolina	-	18	-	-	18
Georgia	-	-	-	-	-
Florida (east)	-	95	-	-	95
Total	-	366	-	47	413
Gulf:					
Florida (west)	-	4	-	99	103
Pacific Coast:					
Alaska	-	-	-	102	102
Washington	-	464	-	324	788
Oregon	-	-	-	20	20
Total	-	464	-	446	910
Grand Total	52,535	16,666	12,652	2,636	84,489

Source: U.S. Department of Commerce, National Marine Fisheries Service, *Fishery Statistics of the United States*, 1971.

TABLE 19

U.S. CLAM LANDINGS AND IMPORTS, 1947 - 1973

(millions of pounds meat weight)

Year	Landings	Imports	Total	Imports as Per Cent of Total
1947	37.9	2.2	40.1	5.5
1948	39.6	3.6	43.2	8.3
1949	37.6	5.3	42.9	12.4
1950	41.1	5.8	46.9	12.4
1951	43.4	4.7	48.1	9.7
1952	39.8	5.3	45.1	11.8
1953	37.6	6.4	44.0	14.5
1954	32.3	3.4	35.7	9.5
1955	34.4	3.1	37.5	8.3
1956	38.2	3.1	41.3	7.5
1957	39.9	2.7	42.6	6.3
1958	36.4	2.7	39.1	6.9
1959	45.0	2.6	47.6	5.5
1960	49.6	2.1	51.7	4.1
1961	50.3	2.9	53.2	5.5
1962	54.2	2.1	56.3	3.7
1963	63.4	2.0	65.4	3.1
1964	64.5	1.8	66.3	2.7
1965	70.8	1.9	72.7	2.6
1966	72.8	2.6	75.4	3.4
1967	71.5	2.4	73.9	3.2
1968	67.2	2.6	69.8	3.7
1969	80.7	3.7	84.4	4.4
1970	99.2	6.3	105.5	6.0
1971	84.5	6.2	90.7	6.8
1972	89.1	7.2	96.3	7.5
1973	106.3	5.8	112.1	5.2

Sources: U.S. Department of Commerce, National Marine Fisheries Service, *Fishery Statistics of the United States*, 1947-1971, and U.S. Department of Commerce, *Current Fishery Statistics*, No. 6105, 1972.

relatively more expensive) and the sizable unexploited clam stocks in the U.S. make proportionally more imports unlikely.

Tariff levels for clams have been falling in recent years as shown in Tables 20 and 21. These reductions are partially responsible for the increase in imports as a per cent of total U.S. supplies occurring in recent years. The majority of clam imports are in a canned form. Table 22 reports clam imports by country of origin and type of product for 1972. Japan has historically provided the largest part of canned clams imported into the U.S. while Canada has provided most of the fresh and frozen clam imports. Presumably the Canadian preference for this product form for export is based in part on their tariff free status. There are no exports of clams from the U.S.

Alaska's Place in the National Supply System

Historically the U.S. clam harvest has consisted almost entirely of surf, hard and soft-shell clams from the East Coast of the United States. However, stock limitations, pollution and competition for estuarine resources can be expected to diminish the availability of these species of clams. Thus, the traditional sources of domestic supply will be dwindling at the same time that demand for clams will be increasing. This situation should not be interpreted, however, as necessarily creating an economic potential for Alaska produced clam products on the East Coast market. Ocean quahogs, also known as mahogany and black quahog, exist in abundant quantities on the Continental shelf off New England. Efforts to establish a fishery for these clams have been pursued intermittently (U.S. Dept. of Commerce, National Marine Fisheries Service, *Commercial Fisheries Review*, July/August 1971, pp. 20-21). Quantities, as estimated by National Marine Fisheries Service researchers, are so great that U.S. production could reach a sustained annual yield of about 150 million pounds of meats (U.S. Dept. of Commerce, National Marine Fisheries Service, *Commercial Fisheries Review*, April 1971, p. 17). This amount is almost 50 per cent greater than present U.S. aggregate clam consumption.

These abundant alternative sources of supply effectively foreclose Alaska from the East Coast market for the forseeable future. Consequently, Alaska's clam fishery should set its sights on the West Coast market. Table 23 shows Pacific Coast clam landings, all of which

TABLE 20

TARIFF SCHEDULE FOR IMPORTED CLAMS, 1972

Article	Quantity	Rate of Duty	
Clams:		Free World Countries	Communist Countries
Canned, Razor	Pound	3.5% Ad Valorem	23% Ad Valorem
Canned, Other	Pound	14.0% Ad Valorem	35% Ad Valorem
Canned, Clam Juice	Pound	8.5% Ad Valorem	35% Ad Valorem
Other (Fresh/Frozen)	Pound	Free	Free

Source: U.S. Tariff Commission, *Tariff Schedules of the U.S.*, 1972.

TABLE 21

TARIFF RATES FOR IMPORTED CLAMS, 1968-1971

Clams:	Prior	1968	1969	1970	1971
Canned, Razor	7.5%	6.5%	6.0%	5%	4%
Canned, Other	20.0%	18.5%	17.5%	16%	15%
Canned, Clam Juice	17.5%	15.5%	14.0%	12%	10%

Source: U.S. Tariff Commission, *Tariff Schedules of the U.S.*, 1968-1971.

TABLE 22

U.S. CLAM IMPORTS, BY COUNTRY OF ORIGIN, 1972

Commodity and Country of Origin	Net Quantity (Pound)	Wholesale Value (Dollars)
Razor Clams, canned		
Japan	2,344	$2,058
Spain	1,221	1,482
Other Countries	975	260
Total	4,540	$3,800
Other Clams, canned		
Japan	3,898,332	$2,797,429
Equador	98,054	55,305
Italy	77,311	37,788
Spain	69,540	62,470
Korea	31,394	20,151
Portugal	15,079	6,388
Taiwan	11,250	7,938
Philippines	5,003	1,353
Canada	4,044	5,680
Norway	3,921	1,845
United Kingdom	2,738	2,095
Other Countries	2,337	1,176
Total	4,219,003	$2,999,618
Clam Juice, Canned		
Canada	6,125	$2,388
Other Countries	900	924
Total	7,025	$3,312
Clams, Fresh/Frozen		
Canada	2,613,963	$1,213,868
Mexico	324,867	54,345
Japan	42,532	60,895
Korea	9,293	16,096
Spain	2,970	2,076
Other Countries	800	542
Total	2,994,425	$1,347,822
Grand Total	7,224,993	$4,354,552

Source: U.S. Department of Commerce, Bureau of the Census. *U.S. Foreign Trade: Imports*, 1972.

TABLE 23

PACIFIC COAST CLAM LANDINGS, 1962-1973

(thousand pounds meat weight)

Year	Alaska	British Columbia	Washington	Oregon	California
1962	240.5	1,035.2	640.1	38.3	1.0
1963	143.6	833.0	608.0	31.0	1.0
1964	34.7	427.5	518.0	26.0	1.0
1965	30.7	571.5	546.0	42.0	-
1966	15.4	642.2	507.0	45.0	1.0
1967	41.0	7.2.3	467.0	57.0	1.0
1968	22.7	379.7	457.0	45.0	-
1969	30.2	287.9	561.7	15.2	-
1970	56.1	585.0	793.4	11.2	-
1971	85.1	641.0	787.5	19.9	-
1972	74.8	NA	674.0	58.0	-
1973*	80.9	NA	1,295.0	9.0	-

*Preliminary

Sources: Alaska - Department of Fish and Game (converted to meat weight by assuming 35 per cent meats)
British Columbia - Department of Environment
Washington, Oregon, California - National Marine Fisheries Service

are sold in the West Coast market. Alaska is at present a relatively small producer even of this regional market. Given that the Pacific Coast is a substantial net importer (Table 16, p. 90), there is a market potential for Alaska in the human-consumption market. The established and growing institutional market and the market for razor clams for crab bait are the most obvious opportunities for expanded Alaska production. In addition, it is likely that Alaska produced fresh and frozen clams can partially displace imported canned clams from the East Coast and Japan on the Pacific Coast market (i.e., many Pacific Coast consumers might buy fresh or frozen clams in lieu of canned clams if the former were readily available). It is conceivable, but less likely, that Alaska processors will also be able to provide a canned product that can make inroads on the West Coast market. Such a development will have to await the widespread use of dredges and the certification of more beach area by the State.

A possible complication for Alaska's future on the West Coast market is the production of razor clams by British Columbia. British Columbia is supplying some of the West Coast market at present, principally the bait market insofar as the razor clam is concerned. British Columbia producers are experiencing difficulty with the introduction of dredges similar to those encountered in Alaska. In the future, if both Alaska and British Columbia become large producers, competition between the two areas on the West Coast market could become intense. Until the production increases significantly in both locations, however, the main factors that must be overcome are inertia and competition from East Coast producers.

CLAM PRICES

As discussed above, favorable changes in relative prices of food fishes, both those occurring in the recent past and those projected for the future, tend to have a favorable impact on clam consumption. This section seeks to analyze the effects of changes in clam prices on the consumption of clams independent of the effects of changes in the prices of other related food fishes. This distinction is necessary because a change in relative price can occur as a result of changes in other prices, the price of clams being unchanged, or solely as a result of a change in the price of clams. It is the latter cause of relative price change which is the concern of this section.

U.S. Clam Prices

U.S. clam prices have increased gradually since 1960. The 1973 average ex-vessel price was 35 per cent above the 1960 level (Table 24 and Fig. 10). Because the price of clams advanced less rapidly than the prices of goods and services generally, however, the real price of clams in 1973 was 10 per cent less than the 1960 level (Fig. 11), although the trend has been for a very slight increase over the entire period. This absence of significant change in the real price over time can occur only when demand and supply grow at about the same rate.

The effect of a variation in the real price is to cause a change in consumption which is independent of those changes which would have occurred as a result of variation in population, consumer real income and the real prices of other food fishes. Price elasticity of demand (a measure of the responsiveness of quantity demanded to changes in price) for clams has been measured at -0.16 for all clams[2] (U.S. Dept. of Commerce, National Marine Fisheries Service, 1970, p. 10, revised) and -1.0 for fresh and frozen clams (Nash *et al.* 1972, p. 150). E_p = -0.16 and -1.0 mean that a one per cent change in price will cause about a two-tenths of one per cent and a one per cent change in quantity, respectively, in the opposite direction. Alternatively, these elasticity coefficients imply that a one per cent increase in supply will cause the price of clams to fall by six per cent and one per cent respectively.[3] These elasticity values can be used to predict the actual effect on demand of changes in price or the effect on price of changes in supply, only if population, consumer

[2] E_p = -0.16 is not statistically different from zero at the 5 per cent level.

[3] Price elasticity is a measure of the responsiveness of demand to changes in price. The elasticity coefficient, the quantitative measure of elasticity, is the ratio $\%\Delta Q \div \%\Delta P$, where ΔQ is the change in quantity and ΔP is the change in price. The ratio can be approximated with the price-quantity data observable in the market:

$$E_p = \frac{\%\Delta Q}{\%\Delta P} = \frac{\frac{\Delta Q}{\bar{Q}}}{\frac{\Delta P}{\bar{P}}} ,$$

where $\bar{Q}$ and $\bar{P}$ represent the averages of the initial and ending quantities and prices respectively. Because price and quantity move inversely, E_p is always negative. If the absolute value of E_p < 1, demand is said to be relatively insensitive to price changes, or inelastic, and if $E_p > 1$ demand is relatively sensitive or elastic with respect to price changes. Income elasticity has an analogous meaning and is estimated by substituting income for price in the elasticity formula.

The price flexibility coefficient, which is a measure of the responsiveness of price to changes in supply, is derived from the price elasticity coefficient:

$$F = \frac{\%\Delta P}{\%\Delta Q} = \frac{1}{E_p} .$$

TABLE 24

U.S. CLAM LANDINGS, VALUE OF LANDINGS AND AVERAGE EX-VESSEL PRICES, 1960 - 1973

Year	Landings (000 Pounds Meat)	Value	Ave. Price (Cents Per Pound)	Clam Price Index*	Ave. Price / CPI* All Items (Cents Per Pound)	Ave. Price / CPI* MP&F (Cents Per Pound)
1960	49,572	12,049	24	84.7	27	27
1961	50,330	11,661	23	80.8	26	26
1962	54,169	11,762	22	75.6	24	24
1963	63,403	14,202	22	78.0	24	25
1964	64,464	14,890	23	80.5	25	26
1965	70,849	16,733	24	82.2	25	25
1966	72,751	18,551	26	88.9	26	25
1967	71,500	20,486	29	100.0	29	29
1968	67,246	20,728	31	107.3	30	30
1969	80,745	25,238	31	109.1	29	28
1970	99,202	28,789	29	101.0	25	25
1971	84,489	31,306	37	129.3	31	32
1972	89,100	31,859	36	124.7	29	28
1973	106,293	34,730	33	113.9	25	20
Per Cent Change 1960-1973	114	35	35	35	-10	-25

*Indexes are based on 1967 = 100.

Sources: U.S. Department of Commerce, National Marine Fisheries Service, *Fishery Statistics of the United States*, 1960-1971; U.S. Department of Commerce, *Current Fishery Statistics*, 1972-1973; U.S. Department of Labor, Bureau of Labor Statistics, *Handbook of Labor Statistics*, 1974.

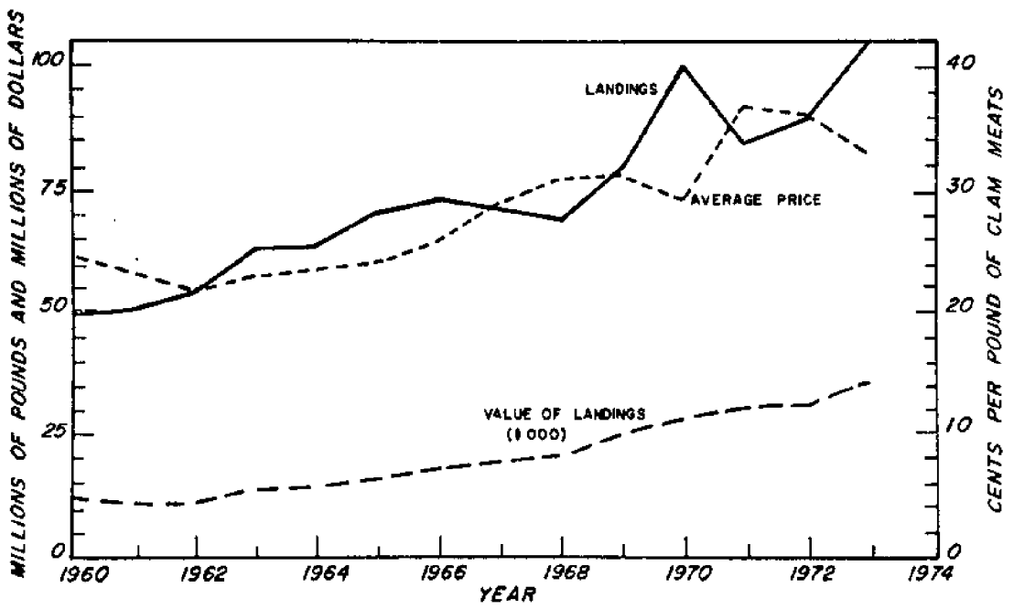

Figure 10. U.S. clam landings, value of landings and average prices, 1960-1973.
Sources: U.S. Department of Commerce, National Marine Fisheries Service, *Fishery Statistics of the U.S.*, 1960-1971; U.S. Department of Commerce, *Current Fishery Statistics*, 1972-1973.

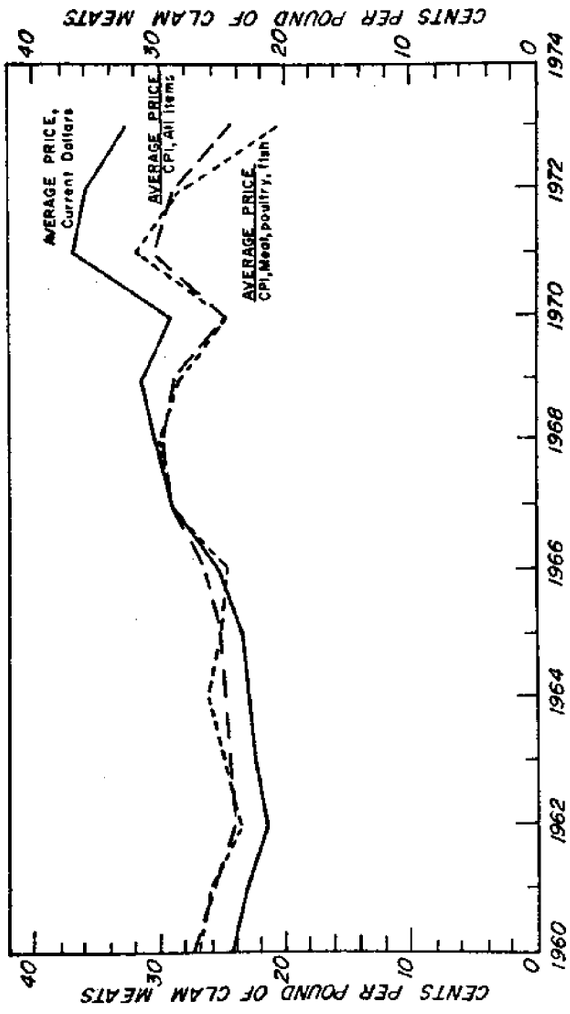

Figure 11. U.S. current dollar and constant dollar clam prices, 1960-1973.
Sources: U.S. Department of Commerce, National Marine Fisheries Service, *Fishery Statistics of the U.S.* 1960-1971; U.S. Department of Commerce, *Current Fishery Statistics*, 1972-1973; U.S. Department of Labor, Bureau of Labor Statistics, *Handbook of Labor Statistics*, 1974.

income and relative prices are constant. These variables, however, have not been constant; population and real incomes have been increasing and relative price changes have favored clams, with the result that the demand for clams has been increasing. Therefore, the quantity and price movements actually observed are the combined effect of the changes in population, income and prices of substitutes, as well as changes in supply, and cannot be easily and simply associated with elasticity coefficients.

Nevertheless, knowledge of these elasticity coefficients is useful for interpreting market price variations and for predicting future price-consumption movements. In the absence of an increase in demand, the price decline resulting from an increase in supply would be about proportional to slightly more than proportional to the increase in supply; an annual three per cent increase in supply would be accompanied by a three to five per cent fall in price, if income, population and related goods prices remain unchanged. Conservatively, however, an annual three to five per cent increase in demand is likely as a result of favorable changes in these variables. Therefore, it is reasonable to expect that annual demand growth will approximately match or slightly exceed supply growth at existing price levels and that as a result future real price increases will be moderate.

As discussed above, the world market demand and potential supply growth portend a similar absence of large world real price increases. It is expected that U.S. suppliers will, therefore, continue to face import competition at about past levels unless relative real harvesting and processing costs change significantly. Significant changes in relative costs (and therefore significant changes in the proportion of U.S. supply provided by imports) are not anticipated.

Alaska Clam Prices

Table 25 shows average ex-vessel price per pound (shell weight) between 1942 and 1973 for the Alaska clam fishery. Absolute clam prices have increased sixfold since 1942 and nearly threefold since 1960. Table 26 and Figure 12 show the price movements since 1960 on a meat weight basis to provide comparability with U.S. price data. The remarkable stability of price from 1960-1963 while landings were declining sharply can be explained either by commensurate reductions in demand over the period or, more likely, by the

TABLE 25

AVERAGE PRICE PER POUND (SHELL WEIGHT)
PAID TO ALASKA CLAM FISHERMEN

1942 - 1973

Year	Price	Year	Price
1942	$.06	1958	$.13
1943	.06	1959	.12
1944	.06	1960	.13
1945	.05	1961	.13
1946	.09	1962	.11
1947	.09	1963	.13
1948	.10	1964	.20
1949	.12	1965	.25
1950	.12	1966	.20
1951	.15	1967	.25
1952	.13	1968	.25
1953	.13	1969	.29
1954	.13	1970	.25
1955	.13	1971	.29
1956	.13	1972	.32
1957	.13	1973	.38

Sources: U.S. Department of Interior, Fish and Wildlife Service, *Alaska Fisheries*, 1942 - 1959. Alaska Department of Fish and Game Statistical Leaflets, 1960 - 1973.

TABLE 26

ALASKA CLAM LANDINGS, VALUE OF LANDINGS AND AVERAGE EXVESSEL PRICES, 1960-1973

Year	Landings (000 Pounds Meat)	Value	Ave. Price (Cents Per Pound)	Clam Price Index*	Ave. Price / CPI* All Items (Cents Per Pound)	Ave. Price / CPI* MP&F (Cents Per Pound)
1960	473	$175	37	51.4	42	42
1961	326	121	37	51.4	41	41
1962	241	79	33	45.8	36	36
1963	144	52	36	50.0	39	40
1964	35	19	55	76.4	59	62
1965	31	41	71	98.6	75	75
1966	15	9	59	81.9	61	58
1967	41	30	72	100.0	72	72
1968	28	20	71	98.6	68	69
1969	30	25	84	116.6	77	76
1970	56	40	71	98.6	61	61
1971	85	70	83	115.3	68	71
1972	75	69	91	126.4	73	71
1973	81	89	110	152.8	83	69

*Based on 1967 = 100.

Source: Landings (converted to meat weight assuming 35 per cent recovery) and value from Alaska Department of Fish and Game, Statistical Leaflets, 1960 - 1973.

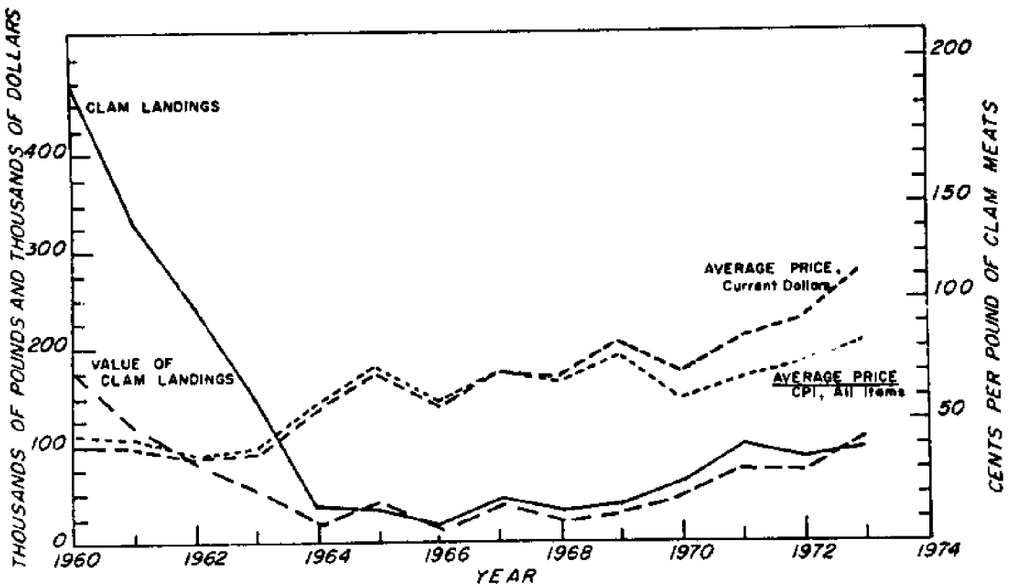

Figure 12. Alaska clam landings, value of landings, and average prices, 1960-1973.
Sources: Alaska Department of Fish and Game, Statistical Leaflets, 1960-1973; U.S. Department of Labor, Bureau of Labor Statistics, *Handbook of Labor Statistics*, 1974.

institutional nature of price determination in the bait market. The latter is the more likely cause because dungeness crab landings and value (from which the demand for bait clams is derived) increased by 155 per cent and 255 per cent respectively over this period. The demand for bait clams can be expected to have increased considerably under these conditions.

By convention processors provide razor clams to dungeness crab fishermen at cost so that the crab fishermen will return their crab harvest for processing to the cannery providing the bait. Under this system, there is no direct profit incentive for a processor to bid up the price when there is a shortage of bait clams; rather, the processor can provide alternative baits also at cost. Any excess demand for clams at existing prices will most likely be initially met by ordering other baits rather than bidding up the price of clams by whatever amount necessary to provide the quantity desired by crab fishermen (at the higher price). A substantial "shortage" of bait clams at existing prices (during 1973 and 1974, when record high clam prices were being established) was frequently alluded to by processors interviewed in the course of this research. These "shortages" appear to initially cause importation of other baits and to cause price of clams to be bid up only after a considerable lag. Were it not for the strong preference for razor clams and the higher price of the other preferred baits, this institutional price setting arrangement (affecting processors' profits only indirectly to the extent that it affects the ability to obtain crab to process) would likely cause prices to have been even less flexible. The effect of this barrier to upward price flexibility is to retard the expansion of effort and landings in the clam fishery in response to increases in demand.

Nominal and real prices have generally been increasing since 1963 with landings and prices increasing and decreasing together except in 1970 and 1972. This price trend is consistent with the growth in demand for bait clams in the dungeness crab fishery, which experienced rapid growth in landings from 1964 to 1970. From 1970 to 1973 crab landings and value were down, but clam landings and prices increased. Because the price changes occurring during the latter period are not explainable on the basis of supply variation (price changes were in the same direction as supply changes), changes in demand (from sources other than increases in crab landings and value) were apparently responsible for the price movements observed.

Outlook for Alaska Clam Prices

In the absence of the introduction of dredges into the Alaska clam fishery, the real price of clams harvested in Alaska can be expected to increase due to an increase in the cost of the labor input. The cost of labor to the clam fishery will be determined by the incomes available to potential clam harvesters in other endeavors. Given the rapid economic growth which will be experienced in the Southcentral region of the State, and given that this region is the primary producer of clams, it can be expected that the cost of labor to the clam fishery (the price of clams required to induce labor from alternative activities) will increase significantly for the remainder of this decade. Such price changes will mean the almost exclusive use of the resource as bait for the dungeness crab fishery. Whether landings increase significantly under these conditions will be determined by whether growth in the demand for clams is sufficient to support higher prices of bait. This, in turn, will be determined by the condition of the dungeness crab fishery, by changes in other bait prices and by the changing preferences of crab fishermen.

A quite different scenario is possible if dredges are introduced over the next several years. A much smaller labor input (at the harvesting level) would be required, labor productivity would be substantially increased and real price increases would be held in check if not reversed. Under these conditions it is much more likely that significant human-consumption processing would occur. Even though dredges are not at present allowed on the certified beaches, their widespread use would put downward pressure on the price of both the hand-harvested certified clams and the dredge-harvested bait clams.[4] Complete price equalization for bait and human-consumption clams under existing regulatory arrangements would be unlikely, however. A more direct and certain way to insure that Alaska's clam resources find their way into human-consumption channels would be to allow dredges on certified beaches. Under this management approach any price

[4] This follows because the predominant outlet for clams from the certified beaches is at present the bait market. If large dredge landings push the bait price down (or prevent it from rising more than it otherwise would) hand harvesters on certified beaches will be forced to meet the bait market price or attempt to stimulate human-consumption uses by establishing an intermediate price level (above the new bait price but lower than the old bait price). The same result could be obtained by tracing through the incentives to price determination on the buyers (processors) side of the market. In practice, of course, the interaction among harvester and processors would insure this outcome.

reductions resulting from dredge harvesting would be fully reflected in both the human-consumption and bait markets.

That past and present Alaska clam prices form a barrier to the human-consumption use of the razor clam resource is suggested by the comparison of Alaska and U.S. average meat weight prices. Table 27 shows the Alaska real price as a per cent of the U.S. real price for the period 1960 to 1973. Despite such drastic differences in price levels, it may be possible for Alaska razor clams to find a limited place in the institutional market on the Pacific Coast where the razor clam is known and desired. That this is only a possibility suggests the marginal nature of a human-consumption venture from the viewpoint of a processor; the high price level and uncertainty as to a reasonably continuous source of supply under present harvesting conditions suggest that a clam operation would be of very marginal profitability. On the other hand, given the depressed status of the other important fisheries in Alaska, operations that would not even have been considered several years ago might look more promising today. Such considerations have only short-run significance, however, as true economic feasibility rests on the development of a reliable market and the ability to serve that market competitively.

SUMMARY

In the U.S. as a whole and on the Pacific Coast, demand for clams should grow steadily over the next several decades. This growth in demand will result from increases in population and consumer real income and changes in the relative prices of fish and shellfish that are favorable to clams. Because there are large unexploited stocks of clams in both U.S. and foreign waters, supply will be relatively elastic. This means that the projected increases in demand will be supplied without large increases in the real price of clams.

Alaska's place in the national human-consumption supply system depends on the ability of Alaska harvesters and processors to compete with the East Coast producers. Price comparisons are not encouraging in this regard; however, product superiority and exploitation of the institutional market may partially overcome the adverse effects of the price differential. The most salient factors affecting the ability of Alaska to supply clams competitively are the ability of harvesters to introduce dredges and the certification of

TABLE 27

ALASKA REAL CLAM PRICE AS A PER CENT OF U.S. REAL CLAM PRICE

1960 - 1973

Year	Alaska Price[1] / U.S. Price	Year	Alaska Price / U.S. Price
1960	155.5	1967	248.3
1961	157.7	1968	226.7
1962	150.0	1969	265.5
1963	162.5	1970	244.0
1964	236.0	1971	219.4
1965	300.0	1972	251.7
1966	234.6	1973	332.0

[1] Alaska meat weight price based on 35 per cent recovery factor.

Source: Tables 24 and 26.

significantly greater amounts of beach area for human-consumption harvesting. In the absence of these changes, Alaska-produced clams will not be able to penetrate the Pacific Coast human-consumption market at significant levels.

With respect to the bait market in which the shell-weight price is relevant, the high prices will not necessarily prevent significant increases in landings. The use of dredges will greatly increase the likelihood of such increases along with a healthy and expanding dungeness crab fishery. Large increases in landings resulting from the use of dredges would put downward pressure on price; the latter, however, may be partially or fully offset by increases in the demand for bait clams.

When all the factors affecting economic potential are weighed - those factors which will determine the effective supply of and demand for Alaska clams - it is conceivable that the peak landings of the past of around five million pounds shell weight will be attainable within the next decade. For expansion beyond this level to occur, the meat weight price differential will have to be narrowed significantly in the future. Only then can the relatively great potential offered by the Pacific Coast human-consumption market be realized.

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APPENDIX I

SANITARY REGULATIONS: SHELLFISH
ALASKA ADMINISTRATION CODE 15.310-370
REGISTER , 1974 HEALTH AND SOCIAL SERVICES 7 AAC 15.310
ARTICLE 5. SHELLFISH PROCESSING.

APPENDIX I

SANITARY REGULATIONS: SHELLFISH

ALASKA ADMINISTRATION CODE 15.310-370

REGISTER . 1974 HEALTH AND SOCIAL SERVICES 7 AAC 15.310

ARTICLE 5. SHELLFISH PROCESSING.

Section
310 Definitions
315 Classes of shippers
320 Growing areas
330 Harvesting and handling
340 Preparing for market
350 Administrative procedures
360 Cold Process Packing Sanitation
370 Penalty

7 AAC 15.310. DEFINITIONS. In sections .310-.370 of this chapter, (1) "approved area" means an area in which pathogenic micro-organisms, radionuclides or harmful industrial waste do not reach dangerous concentration;

(2) "coliform organism" means members of a coliform bacteria group which includes all of the aerobic and facultative anaerobic, gram-negative, non-spore-forming bacilli which ferment lactose with gas formation within 48 hours at 35 degrees Centigrade; bacteria of this group which will produce gas for E.C. medium within 24 hours at 44.5 degrees Centigrade in a water bath will be referred to as fecal coliforms.

(3) "commissioner" means the commissioner of health and social services or his designated representative;

(4) "conditionally approved area" means an area of the same sanitary quality as an approved area, except that the sanitary quality varies seasonally or periodically due to manmade or naturally occurring bacterial or chemical pollutants;

(5) "controlled purification" means the process of removing contamination from whole, live shellfish acquired while growing in polluted areas;

(6) "dry storage" means the storage of shell-stock out of water;

(7) "floating" means holding shellfish on structures of wood or other material supported by pontoons or piling in bodies of water normally near shore;

(8) "growing area" means an area in which market shellfish or seed shellfish are growing;

(9) "market shellfish" means shellfish which are, may be, or have been harvested or prepared for sale for human consumption as a fresh or frozen product.

(10) "most probable number" (MPN) means the statistical estimate of the number of bacteria per unit volume and is determined from the number of positive results in a series of fermentation tubes;

(11) "National Shellfish Sanitation Program (N S S P)" means the cooperative state-PHS-industry program for the certification of interstate shellfish shippers;

(12) "paralytic shellfish poisoning (PSP)" means the potentially deadly poison that may be present in shellfish due to the filtering and concentrating by the shellfish of the dinoflagellate algae, Gonyaulax, the causitive agent of this poison;

(13) "person" means an individual, or a firm, corporation, partnership, company, trustee, association or any public or private entity;

(14) "prohibited area" means an area which has dangerous numbers of pathogenic microorganisms, radionuclides, or industrial wastes, or an area which has not had an adequate sanitary survey;

(15) "re-laying" means the transplanting of shellfish from one growing area to another;

(16) "repacking" means the packing of shucked shellfish in plants other than those in which they have been shucked;

(17) "sanitary survey" means the evaluation of all factors having a bearing on the quality of a shellfish growing area, including sources of pollution, the effects of wind, tides and currents and the distribution and dilution of polluting materials and the bacteriological quality of the water;

(18) "shellfish" means all species of oyster, clams or mussels, either shucked or in the shell, fresh or frozen;

(19) "shell-stock" means shellfish which remain in their shell;

(20) "shucked-shellfish" means shellfish or parts of them which have been removed from their shells;

(21) "state shellfish control agency" means the state agency having legal authority to classify shellfish growing areas or to issue permits for the interstate shipment of shellfish in accord with the provisions of sections .310-.370 of this chapter;

(22) "state shellfish patrol agency", is the state agency having responsibility for patrol of shellfish growing areas;

(23) "wet storage" means the temporary storage of shellfish from approved sources, intended for marketing, in tanks containing sea water or in natural bodies of water and including storage and floats;

7 AAC 15.315. CLASSES OF SHIPPERS. (a) reshippers are shippers who transship shucked stock in original containers of shell-stock from certified shellfish shippers to other dealers or to final consumers; reshippers may not shuck or repack shellfish;

(b) repackers are shippers other than the original shucker who pack shucked shellfish into containers for delivery to the consumer; shippers classified as repackers may shuck shellfish if they have the necessary facilities; a repacker may also act as a shell-stock shipper if he has the necessary facilities.

(c) shell-stock shippers are shippers who grow, harvest, and buy or sell shell-stock; they are not authorized to shuck shellfish or to repack shucked shellfish;

(d) shucker-packers are shippers who shuck and pack shellfish; a shucker-packer may act as a shell-stock dealer; shucker-packers are classified as repackers if shucked shellfish are regularly repacked. (in eff. before 7/28/59; am 74, Register)

Authority: AS 17.20.180
AS 18.05.040

7 AAC 15.320. GROWING AREAS. (a) all shellfish growing areas of Alaska are closed to commercial shellfish harvesting for marketing for human consumption unless approved by the commissioner as harvest areas.

(b) all approved shellfish growing areas in the State of Alaska shall be examined by sanitary and biological surveys before allowing harvest for human consumption. Prior to approval by the commissioner as a harvest area, the areas must have been

(1) examined by sanitary survey and verified by laboratory findings in appropriate cases, which indicates that pathogenic micro-organisms, radionuclides, pesticides, other harmful industrial wastes or sewage wastes do not reach the harvest area in dangerous concentration, and do not pollute the shellfish in the harvest areas; and

(2) sampled by the taking of shellfish from the area in order to establish that paralytic shellfish poison (PSP) content in the harvest areas is less than 80 micrograms per 100 grams of the whole raw shellfish meat as tested.

(c) the commissioner of health and social services will notify the public concerning growing areas approved as harvest areas by giving public notice published in at least three newspapers of general circulation in the state, one of which shall be nearest the approved area. The notice shall describe the boundaries of the approved area by one or both of the following:

(1) longitude and latitude to the nearest degree, minute and second as shown on the latest edition of the appropriate Coast and Geodetic Survey chart;

(2) fixed objects or landmarks as described in the United States Coast Pilot No. 8 (e.g. Pacific Coast of Alaska-Dixon Entrance to Cape Spencer) 12th Edition and United States Coast Pilot No. 9 (Pacific Coast of Alaska-Cape Spencer to Beaufort Sea) 8th Edition.

(d) because of differing levels in the various species of shellfish of paralytic shellfish poisoning (PSP), harvesting areas may be approved for harvest of selected species of shellfish for human consumption to the exclusion of all others. Specific processing techniques shall be prescribed by the commissioner to insure that species harvested are safe for public consumption;

(e) if any harvesting area approved for commercial harvesting of shellfish for human consumption is found upon reinspection to fail to meet the requirements of (b) of this section or to be otherwise hazardous to public health, emergency revocation of the approval will be made by the department with appropriate notice as described in (c) of this section.

(f) shellfish may be re-laid or transplanted from one approved growing area to another approved growing area only by written permission of the Alaska Department of Health and Social Services. Shellfish may not be re-laid from a prohibited area to an approved area. Notification of permission for re-laying will be given to all other interested agencies. Taking of shellfish from approved growing areas and re-laying them in other approved growing areas may only be done under the close supervision of the Department of Health and Social Services. Shellfish re-laid during the marketing season in approved growing areas from other approved growing areas may not be taken from the approved areas for marketing purposes until permission to do so has been received in writing from the Department of Health and Social Services. (eff. 8/30/70, Register 35, am ____/74, Register ___)

Authority: AS 18.05.040

7 AAC 15.330. HARVESTING AND HANDLING. (a) all boats used for tonging, dredging or transporting shellfish (including "bug" boats) shall be so constructed, operated, and maintained as to prevent contamination of the shellfish in the boat.

(b) during the marketing season no body excretions may be discharged overboard from a boat used in harvesting shellfish while it is in areas from which shellfish are being dredged, tonged, or otherwise gathered. As a minimum, such boats shall be provided with a water tight metal container having a close-fitting metal cover for reception of body excretions. The container shall be securely fastened to prevent spilling. The contents of the container shall be disposed of by discharging into suitable sewage disposal units on shore or by burying or by burning, after which the containers shall be thoroughly cleaned before being returned to the boat.

(c) procedures to be employed in the bacteriological examination of shellfish and shellfish waters are those established by the American Public Health Association, Inc. publication "Recommended Procedures for the Examination of Sea Water and Shellfish" 4th Edition 1970. recommended procedures for PSP determination will be from the "Official Methods of Analysis of the Association of Official Agricultural Chemists", 11th Edition, 1970.

(d) no shellfish may be sold or purchased unless they are of a good quality and are clean. No shellfish which are dead or which have broken shells may be sold or purchased for human consumption processing.

(e) whenever necessary to protect the public health from the danger of paralytic shellfish poisoning, or for other conditions detrimental to the public health by consumption of affected shellfish, the Department of Health and Social Services will designate special prohibited areas from which no commercial or sport harvesting for any purpose will be permitted, and will describe the particular circumstances concerning these areas.

(f) all bait shellstock harvested on beaches or from areas other than approved harvest areas must be identified with the approved dye before being transferred from the beach or area for any commercial use or purpose. A certificate must be secured for this practice from the Department of Health and Social Services.

(g) shell-stock or shucked shellfish from approved harvest areas may not be transferred, shipped or stored together with bait shellfish from unapproved or prohibited sources unless all are dyed with the approved dye for identification as bait. (in effect before 7/28/59; am 1/74, Register)

Authority: AS 18.05.040

7 AAC 15.340. PREPARING FOR MARKET. (a) conditioning of shellfish from approved growing areas is permitted only in watertight tanks, adequately protected against introduction of contamination from adjacent or connected spaces or surfaces. The water used shall have a salinity equal to that of the water from which the shellfish are taken and shall, after treatment, meet the bacteriological requirements of the Alaska Drinking Water Standards;

(b) shellfish for artificial cleansing shall be taken only from approved or conditionally approved growing areas. Artificial cleansing is permitted only in watertight tanks adequately protected against the introduction of contamination from adjacent or connected surfaces or spaces. The water used shall have a salinity equal to that of the water from which the shellfish are taken and shall otherwise meet the requirements of the Alaska Drinking Water Standards. Adequate precautions shall be taken to prevent shellfish intended for cleansing from reaching the market before cleansing has been completed. The facility must be certified for this type of operation and end product samples must be taken on routine basis to insure adequate cleaning;

(c) floating and wet storage, as defined in section .310 of this chapter, may not be practiced unless written approval is given each year by the Department of Health and Social Services; the request for departmental approval is to include, whenever floating is involved, a sketch drawn to scale, showing the fixed location of the float or structures and all the potential hazards to which shellfish floated in the designated area may be exposed. The approved request shall also describe the measures taken to protect the shellfish from the above potential hazards. Similar sketches and descriptions shall be provided by shippers marketing shellfish cultivated near shore. The presence of usable floats in the water is considered evidence that floating is being practiced;

(d) shell-stock in dry storage shall be adequately protected from contamination at all time;

(e) shellfish shall be processed for human consumption only in shellfish shucking and packing plants which are constructed and operated in accordance with section .310-.370 of this chapter, however, when written approval is secured from the Department of Health and Social Services, the freezing of previously shucked and packed shellfish may be done in a separate plant which meets sanitary requirements. Each specific case will receive special attention when freezing is done elsewhere than in the shucking and packing plant. Processing facilities shall conform with the following:

(1) the shucking and packing processes shall be done in separate rooms; there shall be installed in the partition between the two rooms a delivery window through which the shucked stock is passed to the packing room; and

(2) provision shall be made for storing the employees' outer garments, aprons, gloves, etc., in a separate room or in lockers;

(3) the floors shall be constructed of concrete or other impervious material, graded to drain quickly, free from cracks or uneven surfaces, and maintained in good condition;

(4) the walls shall be smooth, washable, light colored and shall be kept clean; the ceiling and roof shall be tight to prevent entrance of dirt or other foreign material;

(5) during seasons when insects, especially house flies, are on the wing, space used for washing and packing shucked shellfish shall have all openings effectively screened, including outward-opening, self-closing doors, unless other effective means are provided to prevent the entrance of flies;

(6) ample light to work by shall be provided in all working rooms; when necessary, natural light shall be supplemented with artificial light;

(7) working rooms shall be heated when necessary and ventilated so that workers may operate with safety and efficiency and without impairing their health;

(8) every shellfish shucking facility shall be provided with separate sanitary toilets for each sex, conveniently located but not opening directly into any processing room; toilets shall be constructed, operated and maintained so that the waste is inaccessible to flies and does not pollute the surface soil or contaminate any water supply. Separate toilet facilities for each sex are not required where family shucking is carried on and toilet facilities as above are available for family use in the home or conveniently located with respect to the shucking operation;

(9) lavatories with running hot and cold water shall be provided and preferably so located that their use by plant personnel can be readily checked; a supply of soap and individual towels shall be provided at all times and the facilities shall be maintained in proper operating conditions; signs shall be posted in the toilets and over the lavatory warning the employees to wash their hands thoroughly with hot water and soap and no employee may return from a toilet to work in the plant without first having washed his or her hands;

(10) the plant shall be provided with an abundant supply of water, under pressure, from a source approved by the Department of Health and Social Services; the supply shall be accessible to all parts of the plant, adequate in quantity, and of a safe, sanitary quality meeting the Alaska Drinking Water Standards; no cross connections with unapproved water supplies are permitted;

(11) at least one drinking fountain of a sanitary design shall be conveniently located for use of plant workers; no common drinking cups are allowed, but paper cups, in suitable dispensing containers, may be used;

(12) no person known to be affected with any disease in a communicable form, and no person known to be, or suspected of being a carrier of such a disease, or who has infected wounds or open lesions on the body may be employed in a shucking or packing plant; if the owner or manager has reason to suspect that any employee has contracted a communicable disease he shall immediately notify the local health officer or the Department of Health and Social Services for such action as may be indicated; pending action by the health officials or the recovery of the employee, the employee shall be excluded from the plant;

(13) the management shall designate an individual to be responsible for compliance with those provisions of sections .310-.370 of this chapter having to do with plant cleanliness, personnel and operation.

(f) plans for all newly proposed shellfish plants, and for existing shellfish plants in which major changes are contemplated, drawn to a reasonable scale and in such detail as will adequately show essential features of the plant and its immediate surroundings, shall be submitted to the Department of Health and Social Services before construction begins; no construction may begin until the plans are approved in writing by the Department of Health and Social Services;

(g) shucking room equipment and operation shall conform with the following:

(1) the tops of shucking benches and the sides above the bench top to a height of at least two feet, shall, when the benches are used to provide storage, be of smooth concrete, metal or other non-absorbent material, free from cracks or crevices and so constructed that drainage is complete and rapid; shucking blocks shall be removable unless they are an integral part of the bench and shall be of solid one-piece construction; the stands or stalls shall be of finished material and painted where hand contact occurs; there shall be no boxes, shelves, or nails above the benches where miscellaneous articles might accumulate; floor shucking is not permitted;

(2) all shucking pails or colanders shall be made of a not-readily corrodible, smooth, impervious material and shall be constructed in such a manner as to eliminate grooves, seams, and cracks, where foreign particles, dirt, and slime might collect; all seams and joints shall be well filled with solder and dressed to a smooth surface; the "nesting" of pails and similar containers is not allowed after they have been washed and sterilized;

(3) knives shall be made of not-readily corrodible, smooth, impervious material, and shall be constructed in such a manner as to eliminate grooves, joints and cracks where food particles and dirt might collect; the handles of opening knives and the breaking blocks shall be so constructed as not to have cracks or crevices which would retain food particles, dirt, and slime;

(4) every person who handles shucked shellfish shall wear a clean apron or coat of washable or waterproof material which shall be kept reasonably clean; if finger cots are worn they shall be of clean washable or waterproof material; similar shields for protecting the palm of the hand shall be of clean washable or waterproof material; preferably rubber;

(5) all utensils used in shucking, such as pails, knives, hammers, shucking blocks, and breaking irons, which come in contact with shucked shellfish, shall be thoroughly scoured until clean immediately following each day's operations; shucking pails shall be rinsed with running water before each filling; the practice of returning shucked shellfish to the shucker after delivery to the packing room is not permitted; floors, walls and benches shall be washed free of accumulations of mud, shells, and shell chips with water within two hours after shucking operations for the day have ceased;

(6) all utensils used in shucking such as pails, knives, hammers, breaking irons, etc., which come in contact with shucked shellfish shall be subjected to bactericidal treatment after thorough cleansing within three hours of the termination of each day's operations and shall be stored in a place where they are protected from contamination until

used. Equipment so treated shall be protected from recontamination in storage. This requirement will be satisfied if all utensils and equipment such as pails, knives, hammers, and breaking irons have been:

(A) exposed in a steam cabinet for at least 15 minutes, to a temperature of at least 170 degrees Fahrenheit or for at least five minutes to a temperature of at least 200 degrees Fahrenheit, the cabinet being equipped with an indicating thermometer located in the coldest zone; or

(B) immersed in hot water at a temperature of 170 degrees Fahrenheit or more for at least two minutes; or

(C) exposed to hot air at a temperature of at least 180 degrees Fahrenheit for at least 20 minutes in a properly designed oven or hot-air cabinet equipped with an indicating thermometer located in the coldest zone, or

(D) immersed in or exposed to a flow of chlorine solution prepared fresh each day for a period of at least two minutes; the initial strength of the solution shall be such that after use it will contain not less than 50 parts per million chlorine.

Amounts of Chlorine Compounds Required to Give
Approximately 100 Parts Per Million Chlorine
by Readily Available Measuring Devices

Volume of Water-Gallons	Dry Chlorine Compounds Available Chlorine			Liquid Hypochlorite Solutions Available Chlorine	
	15%	25%	70%	1%	5%
20	5-1/2 tbs.	3-1/2 tbs.	1-1/2 tbs.	3 cups	10 tbs.
40	11 tbs.	6-1/2 tbs.	2-1/2 tbs.	3 pts.	1-1/4 cups
60	1 cup	10 tbs.	3-1/2 tbs.	4-3/4 pts.	2 cups
80	1-2/5 cups	13-1/2 tbs.	4-1/2 tbs.	6-1/2 pts.	2-1/2 cups
100	1-4/5 cups	1 cup	6 tbs.	4 qts.	3 cups
150	2-3/4 cups	1-1/2 cups	9 tbs.	6 qts.	4-3/4 cups
200	3-3/5 cups	2 cups	12 tbs.	2 gal.	3 pts.

Note: Dry Measure
1 tablespoon (tbs.) - approx. 0.3 oz.
1 cup (1/2 pint) - approx. 5 oz.

Liquid Measure
1 tbs. - 3 tsp. - approx. 15 ml.
1 cup - 1/2 pint - approx. 16 tbs.

(7) the inspector may not approve the use of any other form of bactericide, or bactericidal treatment, until he has satisfied himself by his own or other official test that it is satisfactory for use in connection with shellfish sanitation, and that it is of adequate strength; under no circumstances may formaldehyde or other preservatives be used where such preservatives will come into contact with shellfish meats;

(8) all equipment used in the shucking process, including shucking pails, knives, breaking blocks, finger cots, etc., shall be left in a steam cabinet or stored in another suitable place in the plant after cleansing and bactericidal treatment;

(9) shells from which the meat has been removed shall be promptly removed from the shucking room and disposed of so that the shucked product can in no way become contaminated, and so that no nuisance is created.

(10) miscellaneous equipment not necessary to carry out the shucking processes shall be excluded from the shucking room; all unused or abandoned equipment or material foreign to this particular business shall be removed from the operating part of the the plant; all domestic animals and rodents shall be excluded from all parts of the plant; the shucking and packing portions of the plant, when in operation, shall be restricted to the handling of shellfish to prevent accumulation of material and articles which would hinder cleaning or might contribute to the contamination of the shellfish.

(h) packing and shipping rooms shall conform with the following:

(1) all packing equipment such as skimmers, tanks, tubs, measures, colanders, paddles, and so forth, shall be made of a not-readily corrodible, smooth, impervious material and constructed in such a manner as to eliminate grooves, seams and cracks where foreign material and slime might collect; all seams and joints shall be well filled with solder and dressed to a smooth finish; a stand or shelf shall be provided under all chutes from skimmers or blowers to support a measure or can; the surface of skimmers, blowers, tubs, tanks and other utensils with which shucked shellfish come in contact shall be free of paint and rust; the air pipes in the blower shall be removable or so located that cleaning is not difficult; the portion of the air pipes below the tank liquid level shall be of smooth, not-readily corrodible impervious material; there shall be a sterilization connection of adequate size to the air line of the blower above the tank liquid level by which steam or hot water may be forced through the line, in addition:

(A) perforations in the skimmers, colanders, and blower trays shall be smooth to facilitate cleaning; skimmers, ladles and colanders of wire mesh construction are not permitted; blowers having narrow and deep compartments along their sides or at corners, separated from the main part of the blower by a perforated plate, may not be used;

(B) pipes in blowers shall be supported at sufficient distance above the bottom of the tank to allow easy passage of a brush between the pipes and tank bottom;

(C) air pump intakes shall be protected against contamination;

(D) shallow tanks and tubs shall be elevated by legs, by a table, or by a bench to raise the top rim at least three feet above the floor;

(E) tables and shelves shall be made of materials that can be cleaned readily;

(F) the U.S. Department of Health, Education and Welfare, Public Health Service publication "Shellfish Industry Equipment Construction Guides", Public Health Service Publication No. 943, Printed April, 1962, shall be used as standards for satisfactory compliance with requirements of equipment construction in this section.

(2) shucked shellfish shall be packed and shipped within single-service containers made of clean, impervious materials positively sealed or in such containers so sealed that tampering can be detected; in addition:

(A) metal or paper shipping containers shall not be reused by the shellfish industry;

(B) the packers certificate number preceded by the state abbreviation shall be impressed, embossed, lithographed, or otherwise permanently recorded on the container or on the cover if the cover becomes an integral part of the container during the sealing process; the date of shucking either in code or non-code shall be impressed, embossed, or otherwise permanently recorded on the container; if a code system is used for dating the container, the code shall be filed with the Department of Health and Social Services.

(3) shucked shellfish shall be cooled to a temperature of 45 degrees Fahrenheit or less within two hours after the shellfish are shucked and shall be stored at or below 40 degrees Fahrenheit until delivered to the consumer, if shucked shellfish are frozen they shall be kept in a frozen condition until delivered to the consumer; where a refrigerator or icebox is used it shall have adequate capacity to store all shucked stock received by, or packed in, the plant during the day; the refrigerator or icebox shall be well insulated and have an impervious lining; the floor shall be graded to drain quickly; and a thermometer shall be kept in the refrigerator at a point predetermined to have approximately the highest temperature;

(4) ice used in cooling water for processing of shucked stock or for cooling shucked stock during processing shall be obtained from a source approved by the Department of Health and Social Services, and shall be stored and handled in a cleanly manner; no ice may be allowed to come in contact with shucked stock after processing has been completed;

(5) facilities for bactericidal treatment of packing equipment such as skimmers, tanks, tubs, measures, colanders, and paddles, which come in contact with shucked shellfish, shall be provided;

(6) persons working in the packing room shall wear clean outer garments protected with clean water-proof or washable aprons or coats; when manual handling of shucked shellfish which have received their final washing becomes necessary, clean rubber gloves shall be worn, or the hands shall be washed and sanitized before the manual handling;

(7) the floors, walls, and, if necessary, the ceiling, of the packing room shall be cleaned at the end of each day's operations and flushed with water meeting the Alaska Drinking Water Standards; windows and skylights shall be kept clean; refrigerators or ice boxes shall be washed out once a week or more often if necessary; all packing equipment, such as skimmers, tanks, tubs, measures, colanders and paddles, which come in contact with the shucked shellfish, shall be thoroughly scoured until clean at the end of each day's operation; air pipes in blowers shall be removed daily at the end of packing operations and their interior and exterior surfaces be thoroughly cleaned;

(8) all packing room equipment such as skimmers, tanks, tubs, measures, colanders, and paddles, which come in contact with shucked shellfish, shall be sterilized after cleansing; cleansing and sterilizing operations shall be carried on within three hours of the terminating of each day's operation and equipment shall be stored until used in a place where it will be protected from contamination; large equipment which cannot be stored in a protected place shall be cleaned at the end of each day's operation and be subjected to bactericidal treatment immediately before use;

(9) all equipment with which shucked shellfish in the packing room come in contact shall, after thorough bactericidal treatment, be stored in a manner that will protect it from contamination before it is again put to use;

(10) shucked shellfish shall be packed in container, dated and sealed, and, if they have not been subjected to a quick-freeze process, they shall be kept at a temperature between 32 degrees Fahrenheit and 40 degrees Fahrenheit; after tub washing or blowing, the washed shellfish may not be returned to the skimmer which is used for handling the freshly shucked stock;

(11) the packing of shucked shellfish preferably should take place only in the same plant as the one in which they are shucked; if repacking is practiced, it shall be done strictly in accordance with all the requirements stipulated for packing plants, the stock to be repacked must be received at the repacking plant in approved shipping containers; containers shall be coded to show the earliest date of shucking of stock packed in them, as well as the plant or plants in which the stock was shucked; this information shall be made a part of the plant record;

(12) the washing of shell-stock, when necessary, shall be done either with water obtained from sources approved by the Department of Health and Social Services or from approved shellfish areas; all shell-stock, except that consigned to a shucking plant, shall be packed and shipped in clean containers such as barrels, bags, crates, or boxes under conditions which will prevent spoilage or contamination; when consigned to shucking plants in bulk, shell-stock may be packed and shipped in such vehicles as clean trucks and boats, under conditions which will prevent spoilage and contamination; storage facilities shall be at least equal to the requirements of sections .310-.370 of this chapter, a dealer holding a certificate for shell-stock only, or as a reshipper, may not shuck any shellfish;

(13) shell-stock shall be identified by a tag or label securely fastened to the shipping container and bearing the certificate number of the shipper, his name and address, the name and address of the consignee, and the kind and quantity of shell-stock in the container;

(14) to permit tracing readily to the point of origin of any shellfish on the market, complete and accurate records shall be kept by every shellfish packer or shipper;

(15) the bacteriological standard for fresh and frozen shucked shellfish at the wholesale market level shall be a fecal coliform density of not more than 100 MPN per 100 grams and 35° Centigrade aerobic plate count of not more than 100,000 per gram; shellfish exceeding either or both of these levels constitute product unsuitable for human consumption. (in effect before 7/28/59; am / /74, Register)

Authority: AS 17.20.180
AS 18.05.040

7 AAC 15.350. ADMINISTRATIVE PROCEDURES. (a) every person operating a plant used for processing and packing, or repacking, shellfish, and every person selling, or having in his possession for sale, shell-stock shall have a certificate issued by the Department of Health and Social Services; such certificates will be numbered and will be renewed annually, but are subject to revocation at any time for violation of a provision of sections .310-.370 of this chapter;

(b) in setting standards for satisfactory compliance with sections .310-.370 of this chapter, the Department of Health and Social Services will apply the standards of the "National Shellfish Sanitation Program Manual of Operations, Parts I, II, and III", 1965 Revision, in all applicable cases, copies of which will be on file in the various offices of the Department of Health and Social Services and at other places convenient to those engaged in the shellfish industry;

(c) every operator of a shellfish plant, his superintendent, manager or agent, in Alaska shall afford to the commissioner of health and social services or his authorized agents, access to his grounds, plant and facilities, floating or otherwise, or any part of them, and extend every facility for inspection purposes in the premises. Any interference with, or obstruction of, such an officer in the performance of his duties is unlawful. (In effect before 7/28/59; am * /74, Register _)

Authority: AS 17.20.180
AS 18.05.040

7 AAC 25.360. COLD PROCESS PACKING SANITATION. Regulations providing for sanitary control of cold process shellfish packing as reflected in the official report, "National Shellfish Sanitation Program Manual of Operations, Parts I, II, and III" 1965 Revision, Public Health Service Publication No. 33, published by the U.S. Department of Health, Education and Welfare, Public Health Service, Washington, D.C., are hereby adopted by reference as regulations of the Department of Health and Social Services and constitute the official manual for determination of adequacy of facilities and services for cold processing of shellfish packing. (In effect before 7/28/59; am / /74, Register _)

Authority: AS 17.20.180
AS 18.05.040

7 AAC 15.370. PENALTY. A person who violates a provision of sections .310-.370 of this chapter is guilty of a misdemeanor and upon conviction is punishable by a fine of not more than $500.00 or imprisonment for not more than one year, or by both. Each day that a person continues any such violation is considered a separate offense. (In effect before 7/28/59; am / /74, Register _)

Authority: AS 17.20.180
AS 18.15.040

APPENDIX II

MEMORANDUM OF UNDERSTANDING

APPENDIX II

MEMORANDUM OF UNDERSTANDING

Approval of Razor Clam Growing Areas

Master State - State Interdepartmental Memorandum of Understanding
Alaska Department of Fish and Game,
Alaska Department of Health and Social Services
and the
Alaska Department of Public Safety

THIS MEMORANDUM OF UNDERSTANDING, made and entered into this 18th day of July, one thousand nine hundred and seventy four, by and between the Department of Fish and Game, State of Alaska, hereinafter referred to as the Department of Fish and Game, and the Department of Health and Social Services, State of Alaska, hereinafter referred to as the Department of Health and Social Services, and the Department of Public Safety, State of Alaska, hereinafter referred to as the Department of Public Safety, WITNESSETH:

WHEREAS, the Department of Fish and Game has been created under the laws of the State of Alaska to protect and manage fish and game resources of the State of Alaska, and

WHEREAS, the Department of Health and Social Services has been created under the laws of the State of Alaska to assure protection of the public health by provision of regulatory, advisory and educational services for seafood manufacturing, distribution and sales, and

WHEREAS, the Department of Public Safety has been created under the laws of the State of Alaska to enforce all criminal laws of the state and to assist other departments of the state, municipal and federal governments in the enforcement of criminal laws and regulations pertaining to those departments, and

WHEREAS, certain uses of the razor clam, a bivalve mollusc, taxonomically recognized as *Siliqua patula* (Dixon), notably for human consumption, require careful control and coordination with other uses to prevent illness to human beings, and

WHEREAS, it is the mutual desire of the Department of Fish and Game, the Department of Health and Social Services, and the Department of Public Safety to work in harmony for the common purpose of developing, maintaining, and managing all of the natural resources for the best interests of the people of Alaska and of the United States.

NOW THEREFORE, this memorandum WITNESSETH:

PART I. THE DEPARTMENT OF FISH AND GAME AGREES:

1. To procure a representative number of samples of the previously described razor clams for acceptable bio-assays to determine the levels of so-called "Paralytic Shellfish Poison" hereinafter referred to as P.S.P.

2. To initially prepare the razor clams in the manner prescribed by the Department of Health and Social Services and to package and ship the prepared samples to the nearest laboratory facility where the initially prepared samples will be further prepared for ultimate testing by qualified laboratory personnel.

3. To collect a representative number of sea water samples in sterile containers provided by the Department of Health and Social Services from razor clam growing areas and forward them to the nearest laboratory, when and as prescribed by the Department of Health and Social Services, for analysis to determine the most probable number (abbreviated MPN) of coliform bacteria per 100 milliliters of sea water, and for other tests as deemed necessary.

4. To pay the cost of collection and shipment of sea water samples to the nearest specified laboratory facility.

5. To assist personnel of the Department of Health and Social Services in carrying out sanitary surveys of razor clam growing areas.

6. To issue a commercial fishing license, a clam digger's license (and a vessel license if a floating craft is used to deliver, land or take razor clams within the jurisdiction of the State of Alaska) to all persons who are not under penalty of violation of Sections 440-720 of Alaska Statutes Title 16, Fish and Game, who will commercially dig or otherwise obtain for commercial purposes, razor clams for human consumption and/or bait.

7. To designate to commercial razor clam harvesters the razor clam growing areas in which a commercial razor clam harvester may obtain razor clams commercially for human consumption and/or bait, and to stipulate that no razor clams may be obtained commercially for human consumption and/or bait from any area not so designated.

8. To provide razor clam growing area delineations and Commercial Fisheries regulations to all persons receiving a clam digger's license.

9. To ensure that each fish ticket is completed accurately and entirely, promptly upon razor clam delivery.

10. To ensure that primary buyers so designated on each fish ticket whether the razor clams purchased shall be used for human consumption or for bait.

11. To ensure that only those razor clams that are dug or otherwise obtained commercially for human consumption and/or bait are dug or otherwise obtained solely by the holder(s) of a clam digger's license and obtained directly from approved growing areas by legal means and methods.

PART II. THE DEPARTMENT OF HEALTH AND SOCIAL SERVICES AGREES:

1. To ensure that laboratory analyses of razor clam samples for the determination of P.S.P. are carried out in a rapid, professional manner and that results of the analyses be made available to the Department of Fish and Game at the earliest possible time following submittal of samples.

2. To perform sanitary surveys of razor clam growing areas in satisfactory compliance to Section C of the National Shellfish Sanitation Program Manual of Operations, Part I, Sanitation of Shellfish Growing Areas.

3. To prosecute persons who have been apprehended for harvesting razor clams for commercial purposes for human consumption and/or bait from restricted, prohibited, or non-approved areas.

4. To regulate and supervise the shipment and storage of shellstock, and the shucking, packing, and repacking of razor clams.

5. To seize, condemn, or embargo razor clams when necessity demands.

6. To restrict the harvesting of razor clams from particular areas and to suspend intrastate and interstate shipper certificates, as deemed necessary.

7. To issue numbered certificates to reshippers, repackers, shellstock shippers, and shucker-packers, as each is defined on page 3 of Part II Sanitation of the Harvesting and Processing of Shellfish, National Shellfish Sanitation Program Manual of Operations, for intrastate and interstate shipping only when the shipper complies substantially with the construction requirements of Part II of the above mentioned Manual of Operations and maintains a sanitation rating of at least 80 percent during periods of operation. Only one classification will be used per certificate.

8. To provide the Department of Health and Social Services shellfish plant inspectors with: standardized inspection forms, thermometer, chlorine test kit, light meter and other equipment as is deemed necessary.

9. That Department of Health and Social Services plant inspectors will ensure that all sections and parts of the National Shellfish Sanitation Program Manual of Operations are satisfactorily complied with.

10. To suspend or revoke certificates if a plant sanitation rating drops below 80 percent or if any individual sanitation item is violated repeatedly.

11. To supervise the controlled purification of razor clams.

12. That the bacteriological standard for fresh and frozen shucked razor clams at the wholesale market level to be the following:

    Satisfactory: Fecal coliform density of not more than 100 MPN per 100 grams and 35° C. plate count of not more than 100,000 per gram will be acceptable without question. (Any changes in these standards adopted by the National Shellfish Sanitation Program will be implemented immediately upon notification to the Department of Health and Social Services.)

    Conditional: Fecal coliform density of more than 100 MPN per 100 grams and/or 35°C. plate count of more than 100,000 per gram will constitute a conditional sample and may be subject to rejection by the Department of Health and Social Services. (Any changes in these standards adopted by the National Shellfish Sanitation Program will be implemented immediately upon notification to the Department of Health and Social Services.)

PART III. THE DEPARTMENT OF PUBLIC SAFETY AGREES:

1. To enforce statutes requiring licensing of commercial fishermen, vessel and gear to ensure that only those razor clams that are dug or otherwise obtained commercially for human consumption and/or bait are dug or otherwise obtained solely by the holder(s) of a clam digger's license.

2. To enforce administrative regulations to ensure that each buyer of razor clams shall keep records of each purchase of razor clams on fish tickets or other forms supplied by the Department of Fish and Game providing such information as the Department of Fish and Game or the Department of Health and Social Services may require.

3. To enforce administrative regulations requiring that each shellfish fisherman furnish in writing to the Department of Fish and Game directly or through the buyer, data necessary for reports required by the Department of Fish and Game and or the Department of Health and Social Services.

4. To provide surveillance of coastal areas to ensure that only those razor clams that are dug or otherwise obtained commercially for human consumption are dug or otherwise obtained from approved growing areas by legal methods and means.

5. To apprehend and summon before the court any person engaged in the commercial harvest, transporation or handling of razor clams for human consumption in a manner that is in violation of the State of Alaska Statutes or Administrative Code.

PART IV. THE DEPARTMENT OF FISH AND GAME, THE DEPARTMENT OF HEALTH AND SOCIAL SERVICES AND THE DEPARTMENT OF PUBLIC SAFETY MUTUALLY AGREE

1. That each has a vitally important function as the shellfish control agencies of the State of Alaska.

2. That razor clam growing areas within the State of Alaska will be opened for the taking of razor clams commercially for human consumption after said growing areas are deemed safe and approved according to Class Area Interpretations as required in the appropriate sections of Title 7 Subchapter 3, Part 5, of the Alaska Administrative Code and when compliance to Parts I, II, and III of the National Shellfish Sanitation Program Manual of Operations are satisfied and approved.

3. That the edible portions of raw razor clam meat shall be defined as that part of the shucked body of the razor clam which is completely devoid of the dark tip of the siphon and all viscera and portions of the mantle.

4. Razor clams for bait purposes must be denatured with an approved dye for interstate or intrastate commerce.

5. Razor clams for human consumption shipped in interstate commerce must be shucked and eviscerated as defined in Item 3 above.

6. Razor clams for human consumption shipped in intrastate commerce may be shipped as live shellstock or shucked and eviscerated as defined in Item 3 above. But razor clams must be shucked and eviscerated only in approved facilities for sale as a retailable product, destined for human consumption.

7. That Class Area Interpretations be designated as follows:

(A) Class I areas are those classified as APPROVED

(1) In which P.S.P. toxicity in shellfish is consistently less than 80 micrograms/100 grams of the whole, raw shellfish meat
(2) In which the sea water of the growing area has a median coliform MPN not exceeding 70 per 100 ml, at all times
(3) In which the presence of radionuclides or industrial wastes are always in concentrations so low as to render shellfish harmless for human consumption.
-- Razor clams may be harvested for commercial purposes when the P.S.P. toxin levels are below 80 micrograms per 100 grams of the whole, raw razor clam meat.

(B) Class II areas are those classified as CONDITIONALLY APPROVED

(1) In which P.S.P. toxicity in shellfish is consistently at low levels for long periods of time each year
(2) In which the sea water of the growing area has a median coliform MPN not exceeding 70 per 100 ml, but that the sanitary quality of the area might undergo a significant adverse change within a short period of time due to mechanical failure of a sewage treatment plant or to sporadic fluctuations of human population or to other factors
(3) In which the presence of radionuclides or industrial wastes are in concentrations so low as to render shellfish harmless for human consumption.
-- Razor clams may be harvested for commercial purposes when P.S.P. toxin levels are below 80 micrograms per 100 grams of the whole, raw razor clam meat and when the median coliform MPN does not exceed 70 per 100 ml
-- These areas may be subject to seasonal closure.

(C) Class III areas are those classified as RESTRICTED AND OR PROHIBITED

(1) In which P.S.P. toxicity in shellfish is at dangerous levels or is potentially dangerous the year around and/or
(2) In which the sea water of the growing area has a median coliform MPN exceeding 70 per 100 ml and or
(3) In which the presence of radionuclides or industrial wastes are in concentrations high enough to cause shellfish to be harmful for human consumption.
-- Closed the year round to the taking of molluscan shellfish for shucking or for use as human food.
-- Potentially dangerous year round and casual diggers will be so advised.

8. To each budget for an amount sufficient to cover their cost of surveillance, razor clam and sea water sample collection, preparation, packaging, shipment and bioassays for the occurrence of P.S.P. in razor clams and other pertinent laboratory procedures to fully carry out the responsibilities as set forth for each Department in Parts I, II, and III respectively.

9. That routine samples of razor clams, each sample enough from which to obtain at least 200 grams of drained clam meat, will be collected twice each month on a bi-weekly basis throughout the harvest year, weather, tides and other circumstances permitting.

10. In the event that weather, tides or other circumstances prevent the collection of razor clam samples during scheduled sampling periods, lots of clams collected by the commercial fishery at the time in question will be held until bioassays of samples of these commercially dug clams can be completed. This will necessitate an individual lot coding system which is made known to the state shellfish authorities prior to granting a certificate and permit. Detailed records are to be maintained throughout the harvest year by the processor.

11. That specific razor clam growing areas will be closed or quarantined to all commercial harvesting for human consumption when bioassays reveal that P.S.P. levels are 80 micrograms or more per 100 grams of the whole portion of raw razor clam meat, but that such a closure or quarantine will be imposed only as long as toxic levels of P.S.P. remain at or above 80 micrograms.

12. That when P.S.P. levels from a razor clam growing area indicate 50 micrograms or more per 100 grams of the whole portion of raw razor clam meat, samples of razor clams will be collected twice-weekly or as frequently as deemed necessary, depending on weather and location of growing areas, until lower levels of P.S.P. occurrence are evidenced.

13. That harvestable razor clam growing areas in the State of Alaska will be classified by the Department of Health and Social Services according to the Class Area Interpretation, after examinations, as required in the appropriate Sections of the Alaska Administrative Code, are completed.

14. That the delineation of the three presently approved razor clam growing areas will be as follows.

A. Approved Cordova razor clams are designated as

<u>Sector I</u>
Is that part of Orca Inlet southwest of a line between U.S. Coast and Geodetic Survey Chart horizontal control stations "Travel" and "Treat" and includes the Department of Fish and Game Cordova shellfish statistical areas 203-98 Subsection 50, 203-99 Subsections 39-50, 20-106 Subsections 11-25 and Subsections 40, 45, 50, 20-107 Subsections 1-30 and Subsections 31, 32, 33, 36, 37, 38, 20-108 Subsections 1-25 inclusive.

<u>Sector IV</u>
Is that part of Controller Bay area lying within the Department of Fish and Game Cordova shellfish statistical areas 20-117 to 20-123 inclusive.

Sector II
(Subject to approval.)
Is that part of the Copper River Flat comprising the Egg Islands laying within the Department of Fish and Game Cordova shellfish statistical areas 20-108 Subsections 26-50; 20-109 and 20-110 inclusive.

Note:
20-111 to 20-116 inclusive is Section III (Prohibited Area).

These sectors lie within the U.S. Coast and Geodetic Survey Chart Number 8551 and conforming supplements of USC&G Survey Charts Number 8513 and 8500. These statistical areas lay within 60°00'00" North Latitude, by 144°19'40" West Longitude and 60°33'00" North Latitude, by 146°20'00" West Longitude.

B. Swikshak - Alaska Peninsula

East from mouth of Swikshak Lagoon, approximately four miles, between 58°36' North Latitude, 153°48' West Longitude and 58°37' North Latitude, 153°39' West Longitude. Locate on U.S. Geological Survey Chart "Afognak" (C-6) and (C-5).

Note:
Beach from mouth of Big River South and thence East to Village Rock, approximately three miles distance, will be considered after adequate background sampling and sanitary survey have been completed. This beach is located between 58°34'30" North Latitude, 153°52'30" West Longitude and 58°36'30" North Latitude, 153°54' West Longitude. Locate on U.S. Geological Survey Chart "Alognak" (C-6).

C. Polly Creek - Cook Inlet

Located between Redoubt Point on the North and a point approximately four miles North of the mouth of Cresent River (also shown as the Grecian River on older charts). This beach is approximately three miles long. Redoubt Point is located at 60°17'18" North Latitude, 152°25'12" West Longitude. A point four miles North of the mouth of Crescent River (three miles South of Redoubt Point) is located at 60°16'20" North Latitude, 152°29'40" West Longitude. Locate on U.S. Geological Survey Chart "Kenai" (B-7).

Note:
The beach from Redoubt Point to a point approximately two miles North of Redoubt Point will be considered for razor clam harvest after adequate background sampling has been completed. This beach is located between 60°17'18" North Latitude, 152°25'12" West Longitude and 60°18'40" North Latitude, 152°23'20" West Longitude. Locate on U.S. Geological Survey Chart "Kenai" (B-7).

15. That additional razor clam growing areas will be approved subject to sanitary surveys and that area classifications may be revised whenever warranted by survey data when in accordance with all departments.

16. Key sampling stations:

A. Cordova - Prince William Sound

(1) Sector I
Within Cordova Sector I, six samples:
At Inside Ocean Bar, statistical area 20-108, subsection 22; at Rockside Bar, statistical area 20-107, subsection 07; at Southwest Ocean Bar, statistical area 20-107, subsection 34; at Dave Bar, statistical area 20-106, subsection 15; at Big Point, statistical area 20-108, subsection 03; at Canoe Pass Trat Bar, statistical area 203-99, subsection 46. These six key stations will represent statistical areas 20-106, subsections 11-25, 40, 45, 50, 20-107, subsections 1-30 and 31, 32, 33, 36, 37, 38, 20-108, subsections 1-25, 203-98 subsection 50, 203-99, subsections 30-50. This combined group of statistical areas and subsections will be known as Cordova Sector Number One.

(2) Sector IV
Within Cordova Sector IV, four samples:
At Strawberry Reef, statistical area 20-117, subsection 31; at Softuk Bar, statistical area 20-117, subsection 35; at Katalla Beach, statistical area 20-119, subsection 41; at Kanak Island, statistical area 20-122, subsection 15. Statistical areas 20-117 to 20-123 inclusive will represent Cordova Sector Number Four.

(3) Sector II
Within Cordova Sector II (under study, and not approved), two samples:
Around the Egg Islands: Statistical area 20-108, subsection 40 and statistical area 20-109, subsection 30. Statistical areas 20-108, subsections 26-50; 20-109, subsections 1-50 and 20-110, subsections 1-50 inclusive make up Cordova Sector Number Two.

B. Swikshak Beach

(1) On Swikshak Beach, approximately four miles long, four samples, taken within the Alaska Department of Fish and Game clam population study sampling corridors A-B, B-C, C-D and D-E, which are approximately one mile wide each, from the mouth of Swikshak Lagoon and heading East.
A-B 58° 36' North Latitude, 153° 47' 30" West Longitude
B-C 58° 36' 10" North Latitude, 153° 45' 50" West Longitude
C-D 58° 36' 30" North Latitude, 153° 42' 40" West Longitude
D-E 58° 36' 40" North Latitude, 154° 40' West Longitude

(2) On Big River Beach, approximately three miles long, (area under study and not approved): Three samples:
One near the mouth of the River, to the South at 58° 36' 10" North Latitude, 153° 54' West Longitude; one near the middle of the beach, approximately one mile South of the sample near the mouth of the River at 58° 35' 50" North Latitude, 153° 54' West Longitude; one near Village Rock, approximately 300 yards West of the northern portion of Kaguyak Point at 58° 34' 30" North Latitude, 153° 52' 40" West Longitude.

C. Polly Creek

(1) On Polly Creek Beach, approximately three miles long, three samples: One just South of Redoubt Point at 60° 17' 30" North Latitude, 152° 25' West Longitude; one South of the mouth of Polly Creek at 60° 17' North Latitude, 152° 27' 20" West Longitude; one approximately one mile South of the mouth of Polly Creek at 60° 16' 20" North Latitude, 152° 28' 30" West Longitude.

(2) Polly Creek Beach, approximately two miles long, North of Redoubt Point (area under study and not approved), three samples: One just North of Redoubt Point at 60° 17' 20" North Latitude, 152° 24' 30" West Longitude; one approximately one mile North of first sample point at 60° 18' North Latitude, 152° 24' West Longitude; one approximately two miles North of first sample point at 60° 18' 40" North Latitude, 152° 23' 10" West Longitude.

17. That the location of any of the key sampling stations may be adjusted slightly in response to changes in terrain, razor clam abundance, or other factors, when razor clam samples are being obtained and that notification of the Department of Health and Social Services of location adjustment is not necessary prior to sampling.

18. That key sampling stations may be increased or reduced in number or changed as to location when and if it is deemed feasible or necessary to do so, when in accordance with all Departments.

19. That sanitary conditions of razor clam growing areas within Cordova Sectors Number One and Four, the Swikshak growing area, and the Polly Creek growing area as defined under item number fourteen of Part III of this Memorandum, do comply satisfactorily to U.S. Public Health standards and that each of these growing areas be designated as a Class I area according to Class Area Interpretations as defined under item number seven of Part IV of this Memorandum.

20. That all Departments will decide upon razor clam growing area reclassification and notify the Regional Public Health Service office of any reclassification.

21. That each Department will designate respective personnel to patrol the previously designated beach areas and enforce such State laws as each Department is empowered to enforce and satisfactorily comply with Section E, Part 1, Sanitation of Shellfish Growing Areas.

22. That relaying of shellfish cannot be performed without written permission of the Department of Health and Social Services.

23. To keep records which will facilitate Public Health Service review of the razor clam sanitation program and to assist the Service in making such reviews.

24. That amendments to this Memorandum of Understanding may be proposed by any or all parties and shall become effective upon approval by all parties.

25. That this Memorandum of Understanding shall become effective as soon as signed by all parties hereto and shall continue in force until terminated by any party after thirty (30) days' notice in writing to the others of their intention to do so.

26. No Member of, or Delegate to, Congress shall be admitted to any share or part of the Memorandum of Understanding or to any benefit that may arise here from, unless it is made for a corporation for its general benefit.

27. The Department of Health and Social Services shall serve as the liaison between Federal and State Agencies and shall act as the coordinator of the State of Alaska Shellfish Sanitation Program.

DEPARTMENT OF FISH GAME
State of Alaska

By _____
(Commissioner)

Date _____

DEPARTMENT OF PUBLIC SAFETY
State of Alaska

By _____
(Commissioner)

Date _____

DEPARTMENT OF HEALTH AND SOCIAL SERVICES
State of Alaska

By _____
(Commissioner)

Date _____