B

STATE OF ALASKA

DEPARTMENT OF FISH AND GAME

JAY S. HAMMOND, GOVERNOR

OFFICE OF THE COMMISSIONER

SUBPORT BUILDING
JUNEAU 99801

July 10, 1978

Mr. Mark Hutton
Executive Director
NPFMC
P.O. Box 3136 DT
Anchorage, Alaska 99510

Dear Mr. Hutton:

Enclosed please find the first quarterly report for Contract 78-4 between the Council and the Department of Fish and Game.

The report actually covers the four month period from March 1, 1978 through June 30, 1978. All subsequent reports will cover a three month period as outlined in Article II of the Contract.

Sincerely,

Donald Wanie

Donald Wanie
Computer Services
Division of Commercial Fisheries

Enclosure

QUARTERLY REPORT NUMBER 1

Project Title: The Development and Enhancement of a Computerized Fisheries Information System

Contract No: 78-4, North Pacific Fisheries Management Council

Report Period: March 1, 1978 through June 30, 1978

Prepared By: Donald L. Wanie

Alaska Department of Fish and Game
Cooperator

Subport Building, Juneau, Alaska 99801
Address

Abstract

This is the first in a series of quarterly reports prepared by the Department of Fish and Game as required under the terms of Contract number 78-4 between the Department and the North Pacific Fisheries Management Council. This report covers all activities relative to the Departments obligation under Phase I of the contract during the four month period from March 1, through June 30, 1978. During this period, the support staff funded under the contract was hired in the headquarters office in Juneau. The Department minicomputers were received and installed in Anchorage, Kodiak and Juneau and a major portion of the new catch data processing system was developed.

Introduction

Contract #78-4 between the Department of Fish and Game and The North Pacific Fisheries Management Council was entered into for the purpose of upgrading the Department's fisheries data collection system and assisting in the development of a fisheries information delivery system. The project is a joint effort of the Council and the Department, with the Council providing support funding and Department staff performing the duties outlined in the contract.

The contents of this initial report include a chronological narrative, a summary of all progress to date, a detailed report on status relative to the established timetable of events and a discussion of problem areas identified so far. Also included are several recommendations which will improve our performance during the remainder of the tasks in Phase I of the contract.

It should be noted the Project Schedule developed in Article II of the contract assumed a startup date of December 1, 1977. Because of legal problems and other delays, the contract was not actually approved until March 1, 1978. This three month lag must also be accompanied by a corresponding three month adjustment in the deliverable schedule listed in Article II of the contract.

Progress to Date:

Staffing: As of June 30, 1978 two new EDP Programmer positions had been established and filled by the Department. The first of these, a Systems Programmer II position, was filled by Bradley Wilmot on March 1, 1978. Brad was hired because of his specialized experience in computer operating systems and will be working as a System Software specialist for the duration of Phase I.

On May 1, 1978 Douglas Bolitho was hired as an EDP Programmer III.

The actual duties being performed under the terms of the contract are presently being carried out by Brad Wilmot and Bill McCauly who was our only existing EDP Programmer within the Department at the headquarters office. Bill was placed on the project because of his past experience in the Department and his familiarily with the existing fisheries systems. Doug is performing standard maintenance functions within the computer services section.

Hardware Installation:

All three of the Departments new minicomputers are in place and have been accepted. The Juneau-based machine was installed and accepted on April 6, 1978. The Anchorage and Kodiak machines were installed and accepted on June 14, 1978. While the machines are functional they will not be used on the project until the fish ticket processing system software is installed in each location.

Status of Project Relative to Established Timetable

The following is a summary of duties performed during the report period. The summary follows the outline of tasks listed in Component I and the timetable listed under Article II - Project Schedule and Deliverables.

Task I: After a careful evaluation of the new hardware, its associated software, capabilities and limitations it was decided that the catch information processing system should be developed in a modular fashion. The system will be implemented in three parts. Part 1 includes data entry, editing, file maintenance and error report generation capabilities. Part 2 provides file updating and correction and Part 3 will add informational report generation capability. During this report period virtually all of our effort has gone into the design and development of Part 1. Don Wanie and Bill McCauley travelled to Kodiak, Anchorage and Cordova in March to compile the background information needed to develop a complete and comprehensive set of editing requirements. In addition, documentation was compiled on internal processing procedures and reporting requirements. At this time a very detailed data entry, editing and file maintenance procedure has been developed and is scheduled for Regional implementation on July 17, 1978. Development and implementation of the system as designed is a somewhat more complicated task than was originally anticipated. As a result only Part 1 of the system will be available in July with Part 2 scheduled for late August and Part 3 for sometime in November. In that respect we are currently behind schedule in the implementation of the complete system.

Aside from an improvement in processing time requirements, Part 1 brings two other significant improvements to the present fish ticket system. The editing process is considerably more sophisticated and detailed than in past years and INPFC statistical area code have been made an integral part of every transaction on the catch data files.

Task 2: As stated earlier in the report, all hardware associated with work to be performed under the contract has been installed, checked out by the vendor and accepted by the Department.

Task 3: As stated under Task 1 above, Part 1 of the system will provide data capture, editing and file maintenance capability by July 17, 1978.

File maintenance will be limited to input of new data and will not initially permit either the addition of single transactions to existing batches of data or the correction of erroneous data on the file. These capabilities will be available when Part 2 is implemented.

Report generation under Part 1 will be limited to the printing of error reports associated with the data entry and editing. The remaining report generation capability will be developed as Part 3 of the system.

Task 4: System review cannot be accomplished until all parts of the system have been implemented.

Task 5: This procedure will be followed when Part 1 of the system is implemented in July and will have to be repeated as Parts 2 and 3 are completed.

The data entry support provided under the contract for the period from May 1 through June 30 was not used since the data entry system was not available.

Task 6: This task is not applicable at this time.

Summary: As of the end of the first quarter we are on schedule with regard to staff hiring, hardware installation and system design. Full implementation of the catch information processing system is progressing relatively well but Component I activities can be expected to overlap Component II activities through December of 1978.

Problems and Recommendations

As stated earlier, one of the two positions filled in accordance with the contract was a Systems Programmer II, with a salary two ranges higher than an EDP Programmer III. The budget statement includes a total of $51,500 for 21 months of personal services support from two EDP Programmer positions. Based on the salaries actually being paid, a total of $49,800 for 18 months of service will be paid by December 31, 1978. If there is no adjustment for a late start on the contract this will exhaust our personal services funds for Phase I of the contract.

The budget document included a total of two months of data entry support in each region from May 1 through June 30. This money was not used because the new system had not been completed. A mid-July system implementation data is somewhat later than we had anticipated and will result in significant processing backlogs. It is my recommendation that the additional data entry support be used in September for processing our catch data backlog after the new system becomes operational and initial problems have been resolved.

The 1978 legislature has approved a new Systems Analyst for the Department effective July 1. Since both positions funded by the Council will be working on Component I duties through November or December and not available to work on

Component II, it is my intention to use this new position to perform the tasks required by Component II. I further recommend that an additional temporary EDP Programmer be hired to provide programming support for the systems analyst. I also recommend that funding support for the EDP Programmer be transferred from contractual services monies since it now seems unlikely that any contractual support will be required under Phase I of the contract.

North Pacific Fishery Management Council

Harold E. Lokken, Chairman
Jim H. Branson, Executive Director

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C.

July 25, 1978

MEMORANDUM

To: Council, Scientific & Statistical Committee, and Advisory Panel Members

From: Jim H. Branson *Jim H Branson*
Executive Director

Subject: Interim Report of "A Study of the Social and Economic Impacts of a Commercial Herring Fishery on the Villages and Residents of the Arctic/Yukon/Kuskokwim (AYK) Area in Western Alaska," by Dames & Moore

Enclosed for your review and comment is the Interim Report from Dames and Moore.

THIS REPORT MAY NOT BE CITED, DUPLICATED, OR DISTRIBUTED WITHOUT ADVANCE WRITTEN PERMISSION FROM THE NORTH PACIFIC FISHERY MANAGEMENT COUNCIL. IT IS IN DRAFT FORM SUBJECT TO CHANGE. ALL COMMENTS MUST BE ADDRESSED TO THE COUNCIL AND RECEIVED BY AUGUST 11, 1978, TO BE CONSIDERED.

Enclosure

MIH

INTERIM REPORT

to the

NORTH PACIFIC FISHERY MANAGEMENT COUNCIL

THE SOCIAL AND ECONOMIC IMPACTS OF A COMMERCIAL HERRING FISHERY ON THE COASTAL VILLAGES OF THE ARCTIC/YUKON/KUSKOKWIM AREA

Prepared by

DAMES & MOORE
Anchorage, Alaska

July 1978

NOTE:

This is an Interim Report to the NPFMC intended for internal use only. This document represents a first draft of the presentation of information required by Tasks 1 through 8 of the contract between the NPFMC and the consultant. Information and analysis required by Tasks 9 through 11 (Sections VIII through XI of the report outline presented in the Table of Contents) will be presented in the Final Report only. Additional data and information is expected to be made available to the research team in the near future and will be incorporated in the Final Report. Some sections of this report are incomplete and all sections are subject to correction or changes.

TABLE OF CONTENTS

I. Introduction

A. Purpose and Objectives

This study is funded by the North Pacific Fishery Management Council (NPFMC), Anchorage, Alaska under contract #78-6. The purpose of this study is to assess the relationship between the coastal commercial herring fishery of the eastern Bering Sea and village communities in the area. Social and economic impacts of the commercial fishery on the villages are identified and analyzed in terms of the management of the fishery. The study provides the NPFMC with background information useful to the development of a management plan for the herring fishery in the eastern Bering Sea. The main objectives of the study are:

- to estimate the level of historic and present day subsistence use of herring in the study area;
- to access the nutritional, social and economic value of subsistence caught herring in the villages;
- to describe, analyze, and recommend to the NPFMC management alternatives for the domestic herring commercial fishery that minimize present and potential adverse impacts of the fishery on the rural villages.

B. Background

The Department of Commerce's Preliminary Management Plan (PMP) regulating herring fishing in the eastern Sea, dealt only with foreign fishing. In determining the total allowable foreign catch an estimate was made of the expected domestic catch. The estimation of the domestic catch was based on an indication that the traditional subsistence fishery would take one thousand tons of herring and the domestic commercial fishery would harvest approximately three times that amount.

This created two problems:

1) An unexpectedly high domestic harvest required a reduction in the foreign harvest of herring during 1978, and

2) The U.S. commercial harvest may have created unexpected short-term problems conflicting with the traditional subsistence fishery in the eastern Bristol Bay/eastern Bering Sea area and may create greater long-term adverse effects to this area.

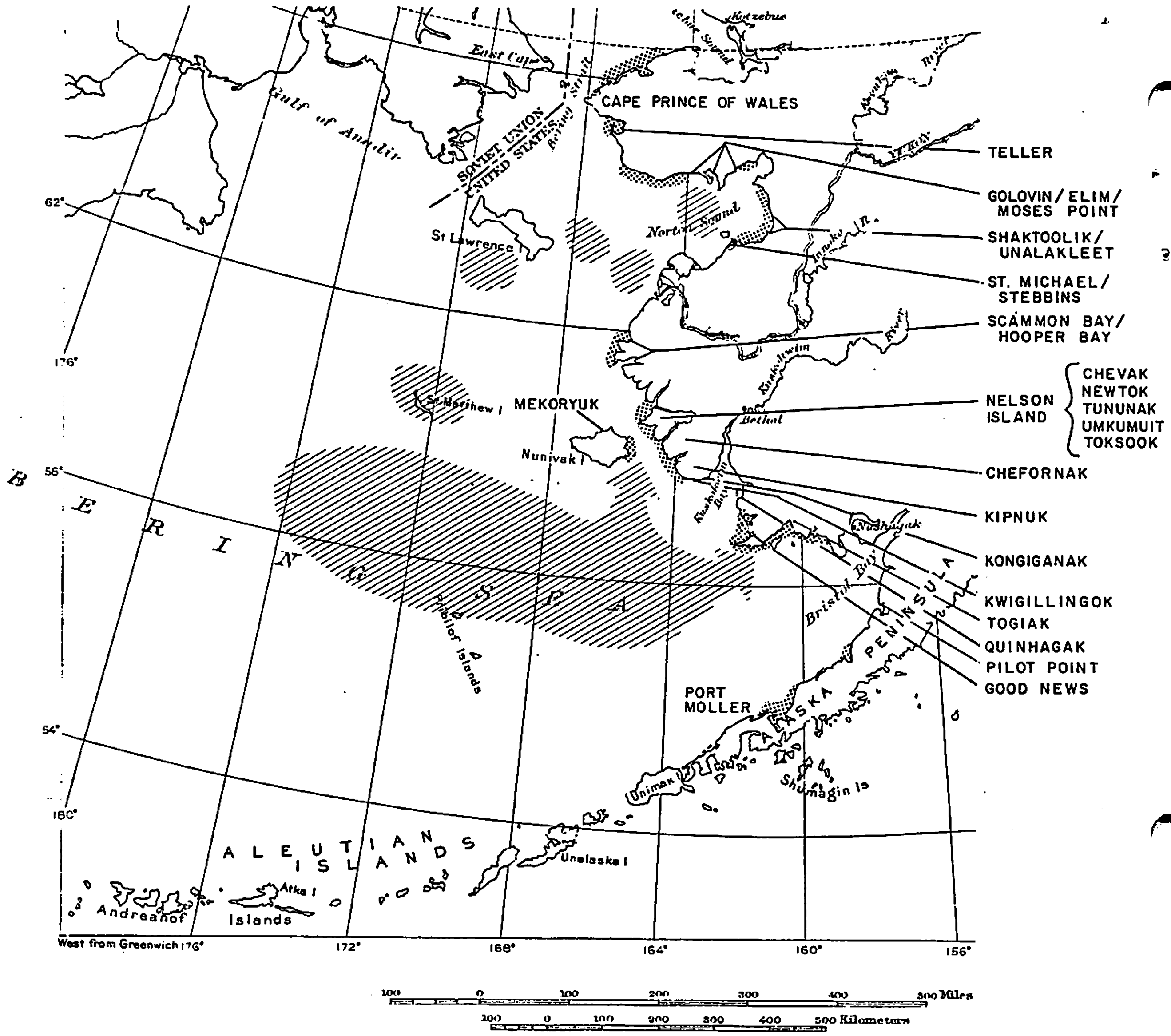
The North Pacific Fishery Management Council has received public input from people of the villages of this area indicating the potential conflicts between the increasing domestic commercial fishery and the traditional subsistence lifestyle of the residents of the area. The domestic commercial herring fishery is rapidly expanding because of increasing market demand and prices. It has been made possible, in part, through the use of export shipping; i.e. American catching and primary processing and foreign shipping and final processing. The success enjoyed in the herring fishery for 1977 have already led to increased inquiries regarding expansion of commercial herring fishing in the eastern Bering Sea/Bristol Bay area in 1978. The Alaskan native residents of that area have expressed concern regarding any increased commercial herring fishery. They feel it could be detrimental to the economy and the traditional lifestyles of the villagers.

C. Study Methods

The research team has gathered data and information from first-hand observation of commercial and subsistence fishing activity in the Togiak and Nelson Island areas, interviews and discussions with many village representatives and village fishermen throughout the study area; interviews with representatives of village and regional profit and non-profit corporations; household surveys of subsistence fishermen in several villages; discussions with commercial fishermen, processors, and equipment vendors; interviews with state and federal commercial fishery management and enforcement personnel; a review of historical, archeological, and ethnographic sources pertinent to the study area; a review of all relevant scientific literature about Pacific herring; a review of a large number of commercial management studies, reports, and memoranda made available by the NPFMC and by the Alaska Department of Fish and Game.

D. Organization of Report

The study is organized in eleven sections as shown in the Table of Contents. This organization of the report was prepared after the completion of field work and represents an attempt to present the information in the most logical and useful sequence. While it deviates from the organizational structure based on 11 tasks originally proposed by Dames & Moore and incorporated in the contract, it includes all of the information and data included in the original scheme.



KEY

LOCATION OF HERRING SPAWNING GROUNDS IN THE EASTERN BERING SEA

WINTER DISTRIBUTION OF HERRING

STUDY AREA
INCLUDING VILLAGES ENGAGED IN SUBSISTANCE FISHING FOR PACIFIC HERRING

(FROM BARTON ET AL. 1976, LIPANOV 1961, AND WESPESTAD 1977)

DAMES & MOORE

II. Background: Scientific Knowledge of Pacific Herring in Study Area

A. State of Knowledge

Comprehensive discussions of the biology of Bering Sea herring stocks and the status of current research have been described in detail by Wespestad (1977 and 1978) and will be only highlighted in this report.

Herring stocks have been identified along the Soviet coast in the western Bering Sea, west of the Alaska Peninsula, near Bristol Bay, and in Norton Sound (Wespestad 1977, Barton 1978). The movements and behavior of these herring are different from more southerly populations because they winter in deep water and migrate to shallow coastal waters in the spring for spawning and feeding and then return to deep water in the fall.

Due to more rapid growth among the older age classes in the Bering Sea herring are larger than in more southern stocks. There is also a range in size within the Bering Sea with the more northern stocks, such as those from Norton Sound, being significantly smaller.

Eggs are usually deposited on live plants such as eelgrass (*Zostera* sp.). Rockweed provides the most conspicuous spawning substrate and its distribution is limited to rocky intertidal habitat associated with capes and other cliff formations. Kelp species such as ribbon kelp (*Laminaria* sp.) are present as indicated by stems and leaves washed ashore by spring storms, but the distribution of this genus on the continental shelf is unknown.

Thus far spawning surveys have emphasized the intertidal zone leaving the subtidal area essentially unexplored. Study designs generally lack botanical emphasis and information about the natural dynamics of key spawning substrate plants is unknown. Growth rates of *Fucus* and other potentially important species for the roe-on-kelp industry must be examined more closely to determine recovery potential with intense harvest pressure.

Wespestad has developed the following conclusions regarding the status of herring in the Bering Sea:

> "Trends in the catch and CPUE data for the eastern Bering Sea herring stocks indicate that these stocks have decreased in abundance. Presently, stock abundance may have stabilized or increased over past low levels. Research in community relationships indicate that herring are heavily preyed upon and unless natural predation can be controlled, even a slight amount of overfishing could rapidly deplete stocks.
>
> As herring recruitment is variable, and largely dependent on conditions during the egg and larval stages, stock assessments must be made on an annual basis to account for the success of the recruiting year class. Several methods of stock assessment used in other fisheries could be applied in the Bering Sea. However, each method requires a major outlay of research effort. Ideally, estimates of year class strength should be obtained prior to its recruitment into the fishery so that long-range harvest strategies can be developed.
>
> Establishment of stock relationships within the eastern Bering Sea is an important management goal. Soviet research indicates that there are two stocks that winter on grounds northwest of the Pribilof Islands and surveys indicate the presence of at least one additional stock in the northern Bering Sea. Another goal is to develop methods of assessing herring abundance to allow for full utilization of the eastern Bering Sea herring without overexploitation."

To accomplish the goals stated above, the National Marine Fisheries Service and the Alaska Department of Fish and Game are developing a cooperative research program.

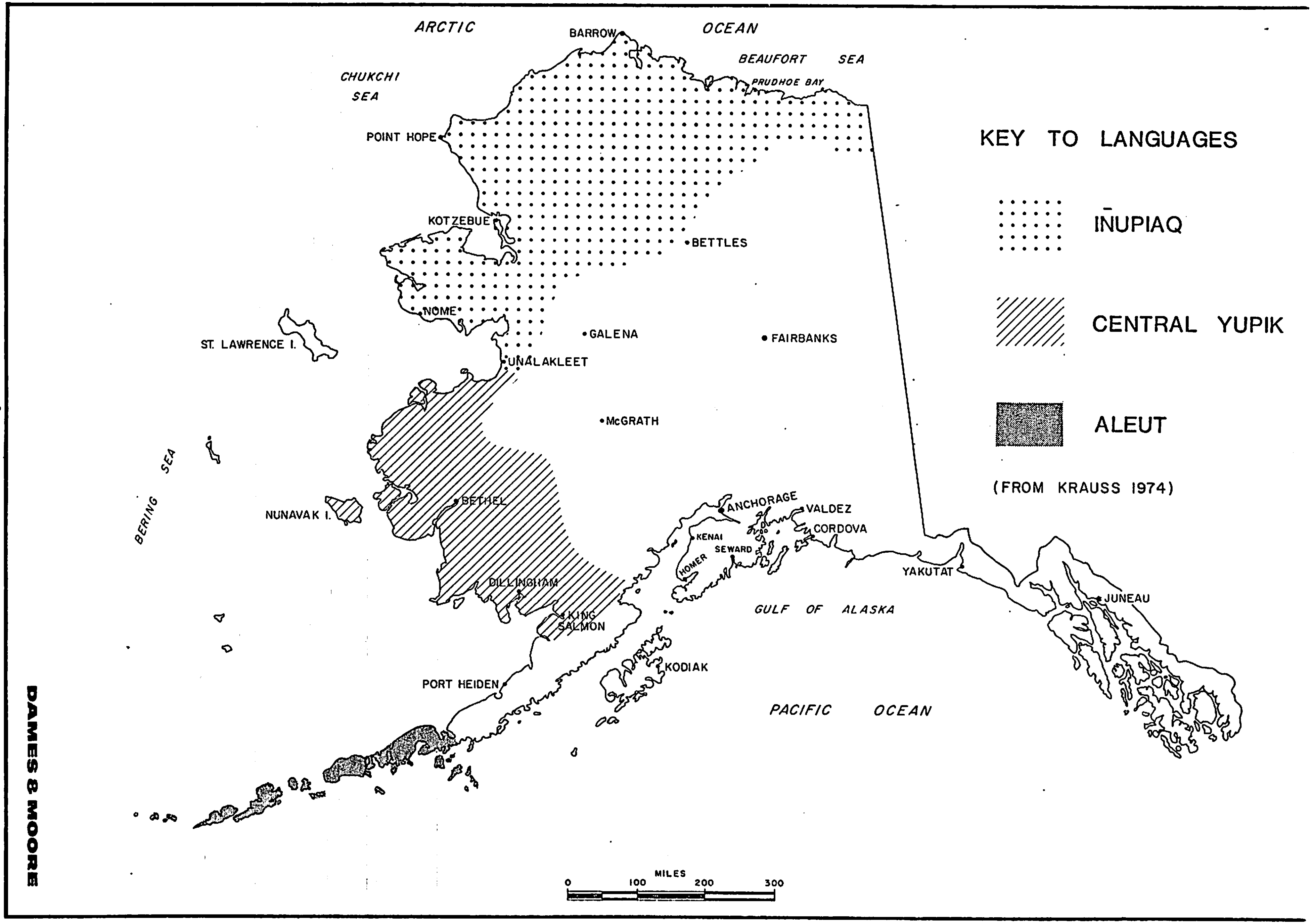
Biomass, distribution and age composition will be recorded by hydroacoustic techniques during winter and summer cruises. Basic information on lengths, weights, sex ratios and catch rates will be covered by observers on domestic and foreign commercial fishing vessels. Stock identification will be accomplished by scale analysis, meristic measurements, studies of juvenile abundance, and electrophoretic analysis (Wespestad 1978).

III. Background: A Socioeconomic Profile of the Study Area

A. Population and Economy

Inhabitants of the study area are predominately Eskimo, who in the Bristol Bay and Yukon-Kuskokwim regions speak Yupik, and in Norton Sound, Inupiq, two distinct Eskimo language dialects (Fig. III-1). The population is distributed among numerous villages of 100 to 500 inhabitants and a few regional centers of 1,500 to 3,000 residents. On the Bering Sea coast, Dillingham, Bethel, Nome and Kotzebue are regional centers which serve as transportation, communication, and administrative hubs of their geographical subregions. These regional centers have a sizeable non-native population in contrast to the rural villages, which typically have only a pair of white school teachers living year-round in the community.

Wage income is seasonal in rural Alaska, and opportunities for employment are few for villagers. Regular part-time wage income in the villages is earned by only a handful of residents who work as store-keeper, postmaster, health aid, teacher's aid, and school janitor. Cash income is earned intermittently from ivory carving, basket weaving, trapping, fire fighting, and construction work. Welfare payments from state and federal agencies is also a source of cash income. Most earned income in the villages is derived from the summer salmon fishery in which local people participate as fishermen and cannery workers. In the Bristol Bay area the red salmon fishery has recently become extremely lucrative because of rising prices, sizeable runs, and the state program of limited entry which has kept the amount of gear from rising with the rapid returns to fishermen. As a result, some village participants in the Bristol Bay salmon fishery have recently earned incomes comparable to that of urban professionals. In the Kuskokwim, lower Yukon, and Norton Sound areas, however, the commercial salmon fishery is neither as large nor as profitable as in Bristol Bay, and generally the villages



DAMES & MOORE

FIGURE III-1

throughout the study area are quite poor. A recent socioeconomic study of Bristol Bay reported the medium family income in that region was approximately $8,000 in 1970, in contrast to some $12,500 for the entire state (Kresge, et al., 1974). In the Kuskokwim-Lower Yukon region, median family income is about half that of Bristol Bay (Wolfe 1977, Yupiktak Bista 1974, Mason 1975).

Subsistence activities - that is, the hunting of large and small game animals, sea mammals, and birds; the catching of fish; and the gathering of wild berries, greens, and eggs - play an important role in the economies of all of the villages in the study area. In fact, the rural economy is best described as a mixed cash/subsistence economy (see Van Stone 1960). It is generally thought that as the cash income of a village or of an individual increases, subsistence hunting and fishing decreases. Certainly Natives employed full-time in the regional centers cannot put up sizeable subsistence harvests. Also, construction work, fire fighting, and the other seasonal wage employment opportunities usually conflict, to some degree, with summertime subsistence activity. Since earning cash limits opportunities to hunt and fish, participation in the cash economy tends to be self-perpetuating. Typically, Native communities with the greatest opportunity for cash incomes, such as those close to rich fisheries, participate more fully in the modern cash economy in all respects than do villages without such opportunities.

Nonetheless, the social, cultural, and economic importance of subsistence activities to rural Eskimos is still so profound (a subject discussed further below) that it continues to coexist and often thrives with the conventional cash economy. Indeed, most subsistence hunting, fishing, and gathering involves significant cash outlays - for boats, motors, nets, snowmobiles, rifles, ammunition, fuel and lubricants, and other supplies. A recent study of subsistence activity in the lower Yukon village of Kotlik, for example, has shown that households with the largest cash incomes harvest the greatest amount of traditional food (Wolfe 1977).

> "Almost paradoxically, low cash incomes may actually increase a family's dependence on store purchased food. In the sample the households with the lowest cash incomes received food stamp supplements for all or part of the year. The families least able to afford to pay for the higher priced imported protein products may rely to a greater extend upon them because of their need for food stamps." (Wolfe 1977)

Another recent study of subsistence patterns in an Eskimo village also points to the expense of subsistence activities as now practiced. It also emphasizes that an effort is made to engage in subsistence hunting and fishing despite demands of wage employment.

> "Two factors stand out in a general assessment of traditional subsistence activities on Nunivak Island. First, the per capita income of the inhabitants of Mekoryuk is high enough to allow them to spend a considerable amount of this income on the equipment required for the various aspects of hunting and fishing. Secondly, most individuals holding wage jobs are able to leave these for periods of time long enough for them to successfully undertake at least minimal hunting and fishing and so to enable their families to eat traditional foods for at least part of each meal." (Nowak 1975a)

While the attraction of lumber, plywood, and other building materials, household appliances, clothing, radios, and perhaps even frivolous products of the western economy, is a strong attraction of many rural people to acquire cash income, the high cost of fuel and equipment necessary to pursue traditional subsistence game may be an even more compelling force for many villagers to seek wage employment. It seems evident that subsistence pursuits on the part of rural Eskimos will continue as long as subsistence resources and access to the resources are available, even in the unlikely event that the opportunity for wage employment expands dramatically in the future.

B. The Cultural, Nutritional, and Economic Role of Subsistence Activities in the Study Area

Subsistence activity is at the very heart of traditional Eskimo culture. Continuation of these activities is considered by contemporary Eskimos to be vital to the perpetuation of their cultural identity. The preeminent cultural dimension of subsistence activities has become more apparent, and the problem of protecting subsistence resources and access to them has become an increasingly grievous political issue, as the competition for these fish and game resources has steadily increased from non-Native commercial fishermen, sport hunters, and most recently, environmentalists bent on preserving vast areas of wilderness and diminishing stocks of marine mammals. While commercial fishermen, sportsmen, and environmentalists all have legitimate interests in Alaska's natural resources, it also seems indisputable that Eskimo culture cannot survive apart from productive subsistence pursuits. Shared among the Alaska native community, Eskimo and Indian, urban and rural, is the strong belief that subsistence is the highest value of fish and wildlife resources, and that commercial enterprises or development projects, including those that are Native owned or generate wage employment for rural Natives, are not an acceptable activity if they threaten subsistence resources or the habitat that supports these resources.

Nutritionally, subsistence foods are very important to villagers. Of the many subsistence foods available, herring is among the richest in protein.

The most comprehensive and significant dietary work in rural Alaska was done by Heller and Scott (1967), which involved field surveys between 1956 and 1961 in nine Eskimo and two Indian villages. At that time the authors calculated that about half of the calories consumed by their sample of rural villagers came from local sources (Table III-1). In general, the shift from traditional to imported foods represents a shift from protein as a source of calories to carbohydrates as a caloric source.

TABLE III-1

SOURCE OF CALORIES: ADULT MALE AND FEMALE DIETS[1]

All Areas and Villages, All Seasons

Food Groups	All Foods		Local Foods		Imported Food		Mixed Food	
	M	F	M	F	M	F	M	F
Dairy	60	61	---	---	60	61	---	---
Egg	13	10	6	6	7	4	---	---
Meat	428	358	363	300	17	16	48	42
Fish	628	511	618	500	1	2	9	9
Fats	239	191	153	121	86	70	---	---
Fruits	96	91	8	7	34	34	54	50
Vegetables	28	28	12	11	16	17	---	---
Grains	868	739	---	---	868	739	---	---
Sugar	228	169	---	---	228	169	---	---
Miscellaneous	10	9	---	---	10	9	---	---
Mean Daily Intake	2,598	2,167	1,160	945	1,327	1,121	111	101

(1) 858 records for males, 1,067 for females.

Source: Heller and Scott (1967) the Alaska Dietary Survey 1956-1961.

The Heller and Scott survey focused primarily on nutrient sources and the adequacy of diet in terms of recommended dietary allowances established by the National Research Council. The researchers discovered nutrient shortages to be common among villagers, particularly among infants and pre-school children. The study did not directly address the question of the role of subsistence and imported foods in the health of villagers. Dietary research elsewhere, however, suggests that accompanying the trend to Western diet among Eskimos is a trend to Western diseases previously unknown in the Arctic. Schaeffer (1970) for example, speculates that the increased use of non-traditional food among Canadian Eskimos has significant effects on their sociological and individual development. He writes:

> "Changes that have taken place in their dietary habits and their way of living have occurred with frightening speed. The fact that they are now growing faster, reaching puberty earlier, suffering from diabetes, cardiovascular disease, just about every disease prevalent among people who have been civilized for centuries, suggests that the metabolic turbulence created by a shift in diet is largely responsible for the less than pleasant outlook. The Eskimos' experience presents further evidence that behind many medical phenomena with which every practioner in the Western world is now confronted lies a nutritional factor. How important we do not know. But important it certainly is."

Heller and Scott analyzed the nutritional value of some 50 traditional native subsistence foods and found that sun-dried herring is a rich source of protein: 100 grams were found to contain 46.7 grams of protein. This value compares, for example, with only 23.9 grams of protein in 100 grams of caribou meat. Superior to herring in protein content are dried beluga (71.0), flounder (67.8), mink (64.8), bearded seal (82.4), salmon (49.6), rainbow smelt (59.3), and walrus (57.0). (See Heller and Scott 1967, Table 87). Loss of herring to those who consume large quantities of it would represent a loss of significant nutritional value and, depending upon the caloric replacement, a potential long-term erosion of the community health as well.

In addition to its overriding cultural value and its nutritional worth, subsistence food has considerable economic importance to village residents. If locally harvested food became suddenly unavailable, an equivalent subsistitute would have to be imported. Several studies have been made to calculate the cash value of subsistence harvest by estimating the cost of their replacement with supermarket food. While these studies vary enormously in sophistication of their methods and reliability of their data base and results, together they point to a cash value of subsistence activities equal to a substantial proportion - from one-third to over twice - of median village family incomes.

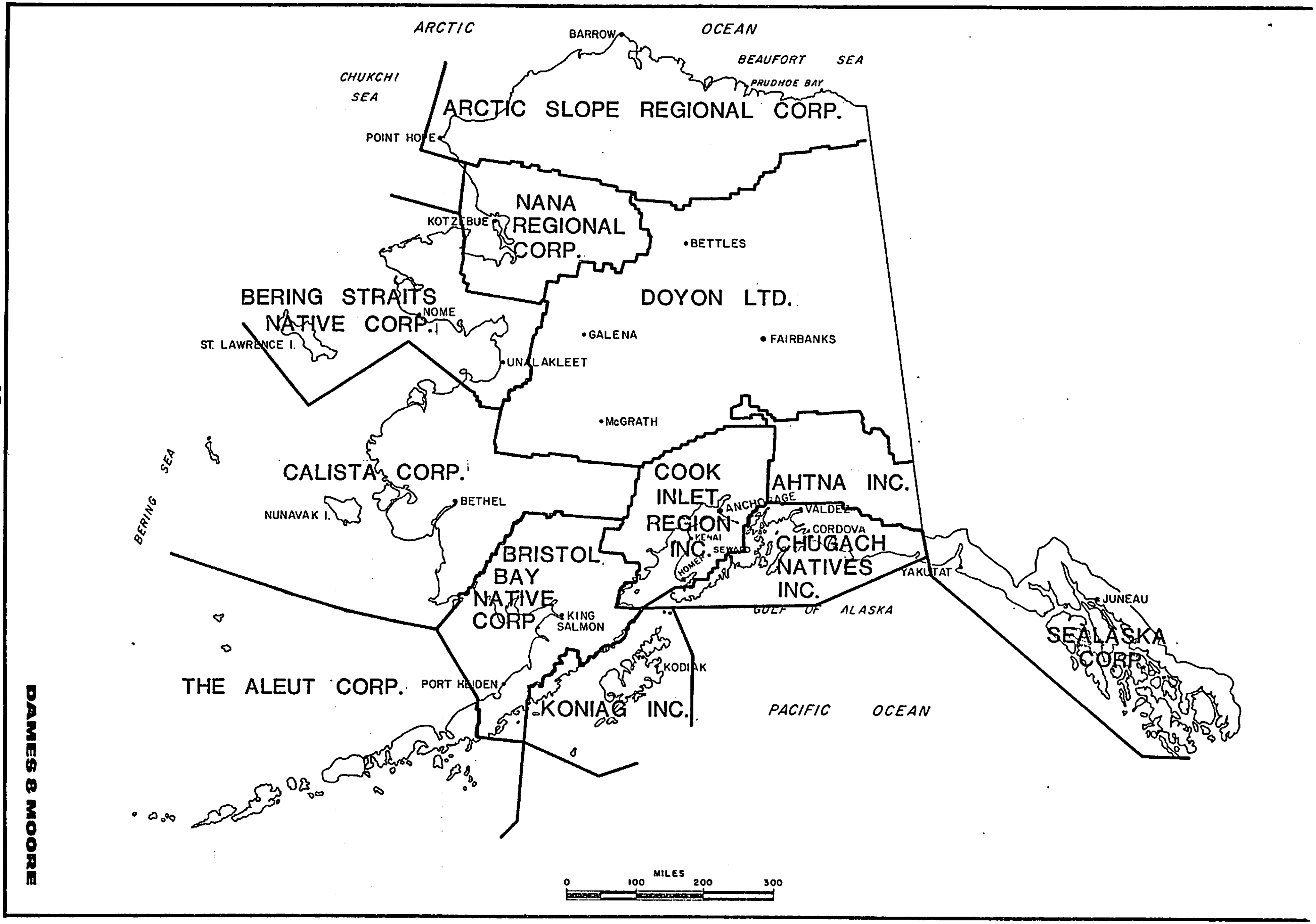
Discrepancies in results of a number of studies conducted in different communities should be expected because the size and species composition of subsistence harvests vary greatly in rural Alaska, not only from village-to-village and area-to-area, but from year-to-year in the same place. Some villages are within easy reach of a great deal more species than are other villages (this difference is reflected in the wide discrepancy of average cost of harvesting a pound of subsistence food at Mekoryuk and Kotlik, for example. See Wolfe, 1977 and Nowak, 1975a). Also, wildlife populations fluctuate radically, as can the movement and timing of movements of these populations. Bad weather, late or early ice movement, and other natural forces can result in a harvest of a particular species in one year that is but a fraction of the harvest in other years.

Calculations of the dollar value of subsistences catches must begin with an accurate estimation of the size of the catch, which should be expressed as "dressed weight" rather than as weight "in the round". The cost of harvesting resources must be calculated (Usher 1976). Then a replacement dollar value can be assigned to the harvest and its net value computed. Clearly the task of data collection is a very difficult one, and the larger the geographical scope of the study the less reliable the data is likely to be. Several studies have failed to include the cost of harvesting the resource. None of them have used an estimate of replacement cost that takes account of the economies of scale of food distribution that would be realized if, in fact, rural villages were totally dependent on imported foodstuffs. See Table III-2.

C. Socioeconomic Impacts of the Alaska Native Claims Settlement Act of 1971

Passage of the Alaska Native Claims Settlement Act of 1971 (ANCSA) has had many profound changes on the State. The settlement created 12 regional corporations in Alaska (Fig. III-2), and village corporations in all native communities, and it granted some $964.5 million to the natives and their corporations. The regional corporations and most of the village corporations are structured as profit-making entities. Consequently, the money that is distributed to the corporations will be used primarily as venture capital; it will not be used for welfare purposes or public works. Economic development opportunities must attract native investment on their own economic merits, just as they would attract investment funds from any private source. Only after investments are making profits will earnings reach individual stockholders via dividend payments.

While the effects of the settlement have been profound in certain spheres, and the long-term impacts are potentially profound in many other spheres, the settlement act is not likely to affect the economic development of the commercial herring fishery under examination in this study. Per capita income at the village level has not changed and will not change in the foreseeable future as a direct or indirect result of ANCSA, nor will native land selection under ANCSA affect subsistence activities. Investment in the commercial herring fishery will probably not be available from native corporations under terms more lenient than from any other private source. Indeed, the nearshore commercial herring fishery had been pioneered with private, non-native money.



DAMES & MOORE

FIGURE III-2

TABLE III-2

SUMMARY OF SUBSISTENCE HARVEST STUDIES

Author	Year(s) of Survey	Location	Estimated Lb/Capita[1]	Dollar Value of Harvest
Saarid and Kessel	1959-60	Kivalina	940[2] (in the round)	Not estimated
Nowak	1973-76	Mekoryuk	375 (dressed)	$1,780 net/family[3]
Wolfe	1976	Kotlik	775 (dressed)	$12,596 gross/family[4] $11,285 net/family
Yupiktak Bista	1973	Tuluksak	1,619 (in the round)	$2,146 gross/person
Nunam Kitlutsisti	1974	AVCP Region	1,000 approx. (in the round)	Not calculated
	1976		1,500 approx. (in the round)	
Bristol Bay Native Association	1974	Bristol Bay Region	259 (dressed)	$355 gross/person

[1]In several cases a per capita figure has been derived from per family harvest totals.

[2]Estimated from information provided by the study.

[3]The author calculated an average cost of harvest of $1.30/lb.; a net value of $.89/lb.

[4]The author calculated an average cost of harvest of $.26/lb.

IV. Subsistence Use of Herring in the Study Area

A. Historical Subsistence Use of Herring

Prehistory

Before discussing historical and contemporary subsistence utilization of herring, a few words about the prehistory of the study area are helpful. Though the traditions extend beyond the geographic scope of this report, these comments are limited to coastal archeological sites from Bering Strait to the northern side of the Alaska Peninsula. As the obvious remnants of herring fishing by the Bering Sea Eskimos (herring seines or nets) are organic and therefore long lost from the archeological record, the antiquity of this activity is difficult to determine. However, notched stone sinkers [Figure IV-1(A)] remain well preserved and a brief examination of their spatial and temporal distribution offers insights into the history of the use of fish nets along the Bering Sea coast. If we assume the technique of fishing with nets, implied by the presence of notched net sinkers, is required before a substantial subsistence herring fishery can exist, the problem is then to determine when net fishing emerged on the Bering Sea coast.

In Norton Sound, Cape Denbigh is not only a major herring spawning area, but also the site of a well known archeological excavation generally associated with the beginnings of Eskimo culture (Giddings 1964, p. 243). Three cultural layers were present and for simplicity these three traditions will be used to analyze the adaptation to the coast by the Bering Sea Eskimo. The bottom layer, named by Giddings (1964) the Denbigh Flint complex, is the type-site for the Arctic Small Tool tradition. Found under two later cultures (Norton and Nukleet), this culture dates from 2200 BC to 1000 BC (Dumond 1977, p. 86, 106). Giddings found no permanent houses, but only temporary camps which belonged to a nomadic people who primarily hunted tundra land mammals and seasonally traveled to the coast to hunt seals (Giddings 1964, p. 242; Dumond 1977, p. 92). The absence of notched stones led Giddings to conclude that these hunters did not fish extensively with nets (Giddings 1964, p. 239).

The middle layer of the Cape Denbigh excavations revealed the Norton tradition which appeared about 500 BC and lasted as late as AD 1000 in some areas (Dumond 1977, p. 106, 109). The abundance of notched stones lead Giddings to conclude that the Norton people had "a very strong reliance on fishing as a means of subsistence" (Giddings 1964, p. 186). For the first time permanent houses appeared on the coast, and Norton sites south of Bering Strait were rather large. The strong net fishing element of the Norton sites, as evidenced by the notched sinkers, evidently enabled the Norton people to successfully exploit a different food resource (fish) from that of the earlier Arctic Small Tool people. The success of these new Bering Sea coast fishermen is evidenced by their large sites with permanent houses. Known Norton sites with the net fishing element are located at Wales, Cape Nome (Bockstoce 1973b), Cape Denbigh (Giddings 1964), Unalakleet (Lutz 1970), Chagvan Bay near Platinum (Larsen 1950, Ackerman 1964), Nunivak Island (Nowak 1970), and the Alaska Peninsula (Dumond 1969, 1977). Thus, by the first millennium of the Christian era, the inhabitants of the Bering Sea coast had settled on the coast in permanent houses and had added net fishing to their previous pursuits of sea mammal and caribou hunting. In fact, it appears as though the net fishing element is possibly the very trait that enabled them to permenantly settle the coast south of Bering Strait.

The top level at Cape Denbigh dates from approximately the 12th to 18th century. Nukleet or modern Eskimo (pre-contact) was similar to Norton, except it had more specialized and refined tools which led to greater success in subsistence pursuits (Dumond 1977, p. 133). Giddings (1964, p. 53) said that "netting is particularly well documented in the relatively large numbers of floats, sinkers, and net making tools", and it was probably practiced during the large, predictable runs of salmon and herring.

Food varied according to locality. The resources available to residents of the Bering Sea coast are primarily seals, fish, beluga, and caribou (along with birds, small land mammals, eggs, greens and berries). Noteworthy, is the relative absence of the larger sea mammals, especially the large whales and walrus, which are found in the deeper waters of the Bering Sea. Though some walrus are hunted around Nunivak Island, the nearby mainland, and around Togiak, they are not nearly as important to the local economy as along the Arctic Coast and on St. Lawrence and Diomede Islands.

Inasmuch as fish was (and is) one of the principal food resources of the Bering Sea Eskimo, it is important to consider not only the type of gear used to fish, but also the people who did the fishing. A sketch by Nelson [Figure IV-1(D)] shows seven people operating a particularly large seine. However, fishing with a smaller seine only requires two people, and on Nunivak Island the husband and wife were the usual cooperating partners (Lantis 1946, p. 160 and 245). In the Kobuk region, the women and children seined (Townsend 1887, p. 86). Similarly, Lantis mentioned that on Nunivak Island the old men could handle the fish nets and traps. The point here is that while the hunting of large land and sea mammals (caribou, walrus, whales) is usually done by young men, the netting of fish was one method the women, children, and older men of a village can also provide food.

Literature Sources: General

The literature search for historic references to subsistence herring utilization indicates that: 1) herring abounded in Alaskan waters, and most early navigators made at least a passing reference to this fact, 2) most of the specific references to subsistence herring centered around southeastern Alaska, 3) whenever a traveler mentioned the great abundance of herring, he usually also added that the local residents made use of them for food, and 4) without the natural histories and ethnography of two individuals (Nelson and Turner), virtually no description of the 19th century subsistence herring use in the eastern Bering Sea would be available today.

The literature is full of early references to the immense quantities of herring found in Alaskan waters (Kotzebue 1830, p. 45; Bean 1880, p. 28; Dall 1870, p. 481; Burr 1919, p. 294, 301; Brooks 1953, p. 451; Andrews 1953, p. 232). One (Collinson 1889) even referred to the Bering Strait area (Port Clarence) when he said, "Herrings were abundant". Dall spoke of "incalculable numbers" of herring along the shores of the Bering Sea (Dall 1870, p. 484), but he, like so many others, provided no description of the local fishery. On the whole, the bulk of observations pertained to southeast Alaska. Methods of catching herring and harvesting roe-on-kelp by the local Indians were continuously described (Swineford 1898, p. 222-3; Moser 1899, p. 122-4; Elliot 1886, p. 56; Dall 1870, p. 484; Petrof 1884, p. 69; La Perouse 1799; Lisiansky 1814, p. 239). A good summary of Indian methods of harvesting herring is available in Stewart (1977).

Because many ships stopped at Unalaska, the herring fishery there also received some attention in the literature. Again, the voyages reported great quantities consumed by the locals (Elliot 1886, p. 168; Langsdorf 1817, p. 333; Petrof 1884; Nelson 1887). Turner reported that the

> "Aleuts of Unalaska catch thousands of these fish in seines. I knew one haul of a seine, about 75 feet long, to successfully land 3,600 of these fish. . ." (Turner 1886, p. 111).

Though an early navigator (Portlock 1789, p. 253) recorded that he believed the Chugach Eskimo of Prince William Sound caught herring with small nets, a later ethnographer (Birket-Smith 1953, p. 41) said they took the herring with rakes (a method similar to that used by Indians further south).

The following words from the census taker in Alaska in 1890 provide a good summary of much of the early literature:

> "Immense shoals of herring visit the bays and estuaries of Alaska at various seasons of the year, and they form an important item in the food supply of natives wherever this fish is found". (Porter 1893, p. 226)

Literature Sources: Eastern Bering Sea

Bering Sea Eskimos developed the technique of fishing with nets long before the arrival of the white man. In fact, prehistorically, fishing nets were apparently more common and used in more complex ways, such as seining, in Alaska than further east in Canada and Greenland (Birket-Smith 1959, p. 91). But the archeological record only demonstrates the presence of the net fishing element, as suggested by net-sinkers, and does not provide a description of how the local Eskimos made and used the nets to catch herring, or how they processed, preserved, and utilized the fish. The gap between the prehistory and the first good descriptions of the Bering Sea Eskimos is large indeed, and it wasn't until the late 19th century that detailed first-hand accounts of herring use by Alaskan Eskimos were available. U.S. Revenue Cutter reports (Hooper 1881, 1884; Healy 1887, 1889), publications by the U.S. Signal Service meteorological observers, who were also trained naturalists (Turner 1886, Nelson 1887, 1899), and accounts by members of the Western Union Telegraph Expedition (Dall 1870, Whymper 1868) provide the bulk of the following discussion. More recent articles and ethnographies about the Eskimos of the Bering Sea are also utilized (Muir 1917, Curtis 1930, Lantis 1946, Ray 1964, 1975, Ray ed. 1966, Oswalt 1967).

For the discussion of 19th century subsistence herring use in the eastern Bering Sea, the study area is divided into the following regions:

(1) Norton Sound, which includes the coastline from Cape Stephens (Stebbins/St. Michael) to Cape Nome;

(2) the area between the mouths of the Yukon and Kuskokwim Rivers, including Cape Romanzof, Cape Vancouver, and Nunivak Island,

(3) Bristol Bay, including the Goodnews Bay area.

By the late 19th century three methods were used to net fish along the Bering Sea - gill nets, beach seines, and dip nets. The method used to net herring varied in different localities with the small beach seine prominent in Norton Sound and points north (Nelson 1899, p. 183-90; Turner 1886, p. 111; Townsend 1887, p. 86). Within the second region, from Cape Romanzof to the Kuskokwim Bay, it is not clear from the literature which type of net prevailed for herring fishing (Nelson 1887, p. 321; 1899, p. 186; Curtis 1930, p. 52, 29; Lantis 1946, p. 160, 173, 178-9). Apparently, all three were used. No references to early herring use in Bristol Bay were found in the literature.

1. Norton Sound

Thanks to the U.S. Signal Service and the exceptional talents of two of their weather observers (L. M. Turner and E. W. Nelson), we have a good description of the St. Michael area for the years 1874-1881. Both Turner (1879-77) and Nelson (1877-81) reported that herring arrive at St. Michael between the 10th and 15th of June, but on the length of stay they disagreed - Turner reported 10 to 12 days and Nelson documented four days for the years 1877, 78, 79, and 81. Zagoskin, traveling in the area nearly 40 years earlier, reported that the herring appear at the end of April, and were "seldom caught as they swim under the ice" (Zagoskin 1967, p. 99). Some years this may be true, but from Nelson's and Turner's accounts there can be no doubt that the residents of St. Michael made extensive use of herring and roe in the 19th century. J. Muir, aboard the Corwin when it arrived at St. Michael on 20 June 1881, observed that the runs of herring were immense and provided the locals with an abundance of food (Muir 1917, p. 83).

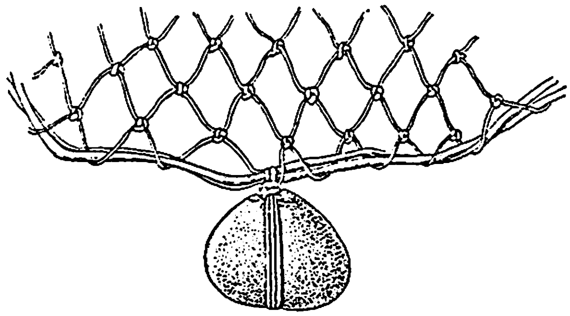
Turner made this observation about the local herring resource:

> "It is extremely abundant, swimming in large schools near the shore; seeking localities where seaweed abound on which to deposit its spawn. The natives use seines with meshes of two inches across for these fish and catch them by the ton. They are eviscerated and dried for food." (Turner 1886, p. 111).

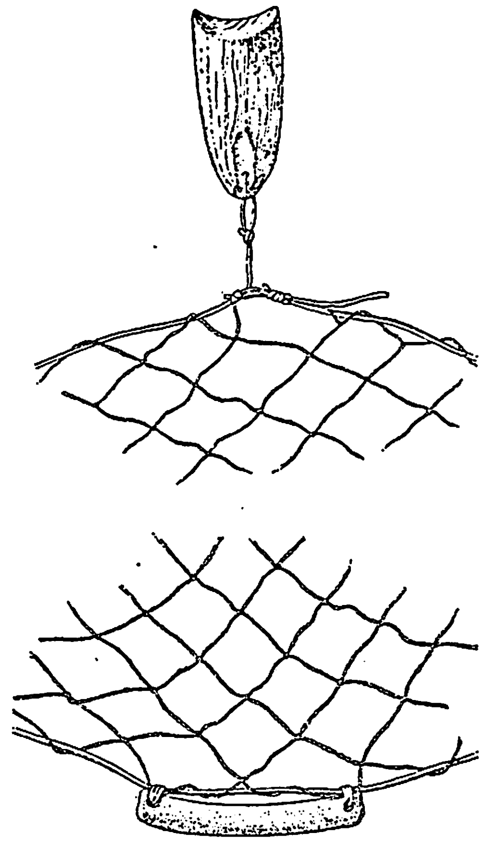
Nelson also reported the use of small seines at St. Michael made from rawhide or sinew cord (Nelson 1899, p. 183). The herring came so close to shore in such numbers that Nelson caught them in his bare hands. Putting his hand in the water for thirty seconds resulted in it being covered with roe (Nelson 1887, p. 321).

In addition to the use of sealskin rawhide and sinew for net material, baleen fibre was also worked into nets in the Bering Strait area and further north (Bockstoce 1977b, p. 52-3). The most common material for net floats was wood. Often these floats were carved into various shapes, including birds, animals or men. Less elaborate floats were simply rounded blocks of wood with holes to attach the net. Inflated bladders or stomachs from animals were also used as floats (Nelson 1899, p. 188). Net sinkers were most commonly made of notched stones, ivory, or antler. The size of beach seines seems to have been from three to five feet wide by 20 feet to a maximum of 60 feet long, with a average length of perhaps 20 to 30 feet. Nelson illustrated and described three herring seines from Norton Sound and Bering Strait:

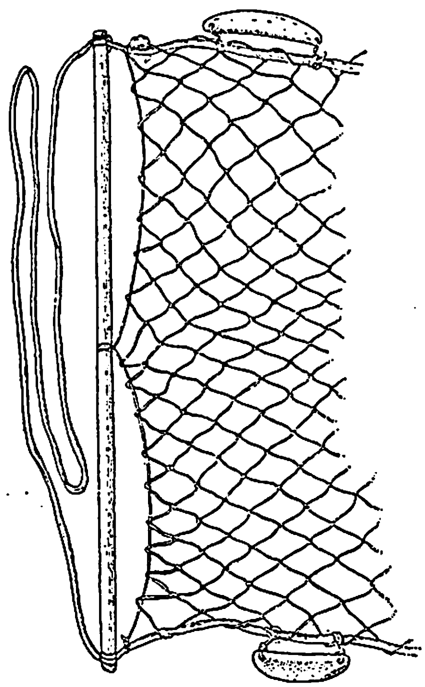
> "A herring seine of sinew cord, from St. Michael [Figure IV-1(B)], has a number of rounded, sub-triangular wooden floats pierced at their small end for attachment to a sealskin cord which runs



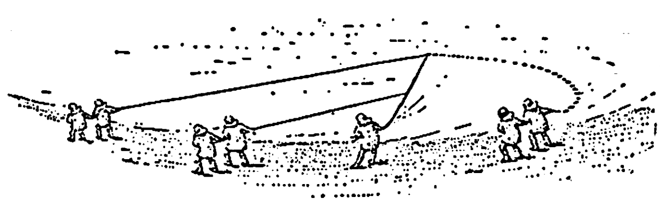
(A) SEALSKIN-CORD HERRING SEINE WITH STONE SINKER



(B) MESH, FLOAT, AND SINKER OF HERRING SEINE



(C) HERRING SEINE, WITH STRETCHER AT ONE END AND WITH FLOAT AND SINKER



(D) SEINING IN THE BERING SEA

FROM NELSON 1899

DAMES & MOORE

FIGURE IV-1

> along the lower border are lashed pieces of deerhorn four to five inches in length, which serve as weights and also as handles by which the net can be hauled to the shore.
>
> A small-mesh seine of sinew cord, used for herring and whitefish, obtained at Cape Prince of Wales, is shown in Figure IV-1(C). It is nearly thirty inches wide, and has wooden stretchers at each end, a series of rounded, tapering floats along the upper edge, and handle-like sinkers of ivory along the lower border. Another small-mesh herring seine, about five feet wide, obtained at St. Michael [Figure IV-1(A)], is made from fine seal-skin cord. Along the bottom is strung a series of small oval stone sinkers, notches above and below to secure the lashings. (Nelson 1899, p. 187-9).

Though the following description of the use of a particularly large beach seine is from Kotzebue Sound, the method for using the smaller herring seines are doubtless similar. See sketch in Figure IV-1(D).

> On Kotzebue Sound, I saw a party of Malemut catching whitefish with a seine. The net was fitted with wooden floats and stone sinkers in the usual manner, and was about 60 feet long (much larger than herring seines), the ends being spread by stout stakes secured by lashings of cord. The shore end of the net was held by two men standing at the water's edge; the other end was pushed out from the shore to its full extent by the aid of several long poles. A long, rawhide line was made fast to the outer end of the net and another to the middle of the string of poles, by which it is pulled along. One man carried the inner end of the pole along the beach between the two rear line men and the men holding the net. In this way the net was drawn along the beach for 100 or 200 yards, and when the fish were running large hauls were made (Nelson 1899, p. 186).

Thus the Eskimos of both St. Michael and Cape Prince of Wales used beach seines to catch herring in the 19th century. No first-hand descriptions of 19th century herring utilization for the area between these two points was located, but herring were reportedly netted in the spring at Teller and Unalakleet (Ray 1975, p. 115) and in the fall at Golovin Bay (Ray 1964, p. 67). Oswalt (1967, p. 168) stated that the Unaligmuit used seines to catch herring and also shows these people as occupying the entire coast of Norton Sound (Oswalt 1967, Map 2). It seems probable, therefore, to assume that the Eskimos from Cape Prince of Wales to St. Michael/Stebbins who were engaged in herring utilization in the 19th century caught them by means of a small beach seine. The abundance of this resource facilitated its capture. At St. Michael, Turner reported that the Eskimos caught herring "by the ton" (Turner 1886, p. 111).

After the fish were caught, they were cleaned and grass was braided around their gills forming long ropes of herring (Plate to be included in Final Report). These ropes, sometimes several yards long, were then hung on poles to dry (Turner 1886). Though in the following account Turner is describing boreal smelt, the methods most certainly apply to herring as well.

> The Eskimo catch great quantities of these fish and dry them in the air. The fish are generally obtained by means of a short seine about twice or three times as long as wide. The fish are then drawn on shore, where they remain in heaps until the women take the entrails out by a dextrous pinch of the thumb and forefinger, which tears apart the flesh between the gills and belly. The forefinger is then run inside the fish and the belly ripped open, which same movement takes out the offal. The women in the fall have prepared great quantities of grass blades, which are twisted into a thin rope, which is run through the gills and out the mouth of the fish, or else the strands of the rope are twisted around the fish's head as the rope is made. These strings of fish are then hung on poles in the open air. After having dried for a sufficient time the fish are then stored in the caches (Turner 1886, p. 102).

2. Yukon-Kuskokwim

While it is reasonably clear that the 19th century Eskimo of Norton Sound and more northerly coastal areas used a small beach seine to catch herring, the picture south of St. Michael is less clear because of the lack of ethnographic data for the area. The Yukon-Kuskokwim delta remained relatively isolated until the 20th century. Shallow and treacherous coastal waters, few minerals, frequent storms and few furs kept the traders, trappers, and miners out of the area during most of the 19th century. The hazards to navigation in this region were outlined early in the logs of Polar exploration.

In 1778 Cook sailed around the Alaska Peninsula, named Bristol Bay and Cape Newenham, and then encountered the dangerous shoals of the Kuskokwim Bay (Beaglehole 1967). Unable to find a channel, and in only five feet of water, Cook concluded that he must sail out the way he entered. Clerke, one of Cook's officers, provided the following description:

> "The land about here towards the Water Side is low; up the Country it rises in various Hillocks, but altogether has a wretched barren appearance; we can see no single article it produces, indeed this seems upon the whole a damnd unhappy part of the world, for the Country appears just as destitute as a Country can be, and the surrounding Seas are scarcely navigable for the numberless Shoals rising in different parts of them" (Beaglehole 1967, p. 401).

Although Cook traded with a few of the local Eskimos, he left no description of their activities. Cook sailed back out into the Bering Sea and later reported shallow water from Stuart Island to Cape Romanzof. Therefore, Cook did not sail near the coast from the Kuskokwim Bay to Stuart Island, and his journal, published six years later, reported the dangerously shallow water along this coast.

The Russians, in an attempt to expand their fur trade and influence, sent a number of expeditions north of the Alaska Peninsula between 1818 and 1822 (Van Stone ed. 1973). At Nunivak Island and other mainland coastal sites, the Russians met local Eskimos who claimed they had never seen a white man before. Unfortunately, ethnographic information from this period is very sketchy and contain no descriptions of the local herring fishery which we assume existed. The Russians established a trading post in Nushagak Bay in 1819, fourteen years before building their fort at St. Michael in 1833. But, by and large, the coast between Bristol Bay and Norton Sound remained relatively isolated, and, with the exception of Nelson in the 19th and Curtis and Lantis in the 20th century, virtually no accounts of Eskimo methods of herring use were found. Not even the rich ethnographic material collected by Zagoskin, who traveled extensively in the Ft. Yukon-Kuskokwim region in 1842-44, makes any references to local herring use (Zagoskin 1967). Unfortunately, most of Zagoskin's coastal routes were north of the Yukon delta.

A hundred years after Cook's voyage into the Bering Sea, E. W. Nelson made a sledge journey from St. Michael down the coast to Hooper Bay, Nelson Island, and around the north shore of the Kuskokwim Bay. He reported that Hooper Bay was "undoubtedly too shallow for vessels" and concluded that "along the entire coast from the Yukon mouth to that of the Kuskokwim the water is shallow and unfit for navigation except perhaps for small schooners at certain points" (Nelson 1882, p. 666 and 670). Nelson visited most of the villages on the coast and made the first map of the region. Apparently, in the 100 years since Nelson's journey, only Tununak has retained both its original name and location. Nelson described the Yukon-Kuskokwim delta as a "barren waste", and the 3,000 Eskimos who lived there as "among the most primitive people found in Alaska, and retain their ancient customs, and their character is but slightly modified by contact with whites (Nelson 1822, p. 670). Unfortunately, Nelson took this trip during the winter of 1778-9, and therefore he related no data on subsistence herring harvests.

Capt. C. L. Hooper, of the U.S. Revenue Cutter Corwin, reached similar conclusions when he visited the area 18 months later. Approaching Cape Romanzof in June of 1880, he saw many Eskimos sealing on the ice and observed, "On account of the shallow waters along this coast the traders avoid it, and in consequence the natives have seen very few white men. I think this is the first steamer they ever saw" (Hooper 1881, p. 6). Porter, enumerating the 11th census in 1890, echoed a now familiar theme that the shallow water at the mouth of the Yukon and Kuskokwim had retarded development in the area and kept white contact to a minimum. He reported that he was the first white man that thousands of the local Eskimos had ever seen (Porter 1893, p. 91, 99, 101).

A map published in 1900 (Jackson 1900) shows the sailing routes commonly used by voyagers going into the Bering Sea. Virtually all ships stopped at Unalaska on their way north. From Unalaska vessels most commonly sailed north or even northwest to St. Lawrence Island, Port Clarence, or Nome. Even ships going to St. Michael avoided venturing near the coast and usually passed Cape Romanzof fifty miles out to sea. They then sailed into Norton Sound and approached St. Michael from the north to avoid the shoals nearby (Swineford 1898, p. 172). If one's destination were Bristol Bay or Kuskokwim Bay, a shallow draft vessel would sail directly to that spot and then sail out again. It seems, therefore, that no commonly used sailing route existed along the southwest coast of Alaska. Without such a route contact remained at a minimum, and consequently ethnographic descriptions of the coastal Eskimos are few.

Now, with the foregoing in mind, let us review the brief data available related to historic herring use along the Yukon-Kuskokwim coast. During the herring run "near Cape Vancouver many are caught in gill nets and dip nets at this season" (Nelson 1887, p. 321). Elsewhere Nelson says

> "Between Cape Romanzof and the mouth of Kuskokwim River the greater part of the fishing is done by means of dip nets, but great quantities of stickleback and other small fish are taken in small nets or seines of fine rawhide cord. Large dip nets for

> whitefish are made of the same material, and among the people south of Cape Vancouver this style of net is used more than the gill net (Nelson 1899, p. 186).

Curtis visited Nunivak Island during the summer of 1927. He reported the use of both gill nets and seines (Curtis 1930, p. 29), but does not mention which method the Nuniwagmuit used for herring. In a narrative related to Curtis by an elderly woman recalling her childhood, she remembered carrying some food to her father in the middle of the night.

> There (on a point of land) I found nearly all the village netting a herring run. Even people who did not own nets were taking herring from them. The run lasted a long while, and we built shelters on the beach. We girls and women picked up seaweed with herring's eggs stuck to it. Those we dried on the rocks. We filled pokes with cooked herring strips and oil. (Curtis 1930, p. 52).

Twelve years later in 1939-40, M. Lantis spent one year's residence on Nunivak Island. She reported the use of a seine for catching herring (Lantis 1946, p. 160), along with dog salmon and other fish. The people had three sizes of seines and also used dip nets (Lantis 1946, p. 173). Since the Nunivak Islanders had many relatives on Nelson Island, Lantis was able to provide some information about the latter. She reported that "on May 4 Tununak had its first big herring run of the season," and on May 23 its second. "The staple of this village was herring, of which the people caught thousands every year" (Lantis 1946, p. 178-9).

Obviously, the Eskimos along the coast from Cape Romanzof to the Kuskokwim Bay used all three methods of netting fish (gill nets, seines, and dip nets). At one place or another, all three were reportedly used for herring. It became apparent that the literature would not provide a clear picture of exactly what methods prevailed in the Cape

Romanzof-Cape Vancouver area for catching herring. Nelson had mentioned a gill net at Cape Vancouver (Tununak) for herring fishing, but he also included dip nets. Then just a few miles away across Etolin Strait, the Nunivak Islanders reportedly used seines.

We have already examined how the beach seine operates in the 19th century, and a few words about the gill net are in order before we treat the contemporary methods of herring subsistence harvest. Hooper provided a general description of an Eskimo gill net in the early 1880's.

> The gill net is set from the shore in a very ingenious manner. It is made of seal skin thongs, is from 30 to 40 feet in length and about five feet in depth. It is held vertically in the water in the usual manner by means of floats and sinkers, wood and stone being used for the purpose. To the outer end is secured a flat stone, somewhat larger than the rest, which serves as an anchor. A number of short poles, about three inches in diameter are joined together by lashings to a length of 60 or 70 feet. This pole is used for pushing the net from shore into the desired depth of water, has its end attached to the stone anchor by a loop which allows it to be withdrawn when the net is set, the outer end of the net being held in place by the stone anchor while to the inner end is secured to a line of seal thong leading to the shore by which the net is drawn in (Hooper 1881, p. 59; 1884, p. 105).

Describing a Chukchi gill net, Hooper said

> They make nets of a thread of deer sinew, which is prepared by the women; the net is about 18 feet long by three wide, and the meshes are two inches in diameter. It is set from the shore by means of a long pole, and is held in a vertical position by the ordinary method of weights and floats. The net is very skillfully made and is the result of a vast amount of labor (Hooper 1884, p. 62).

At Cape Blossom, on Kotzebue Sound, Nelson witnessed the Eskimos using 25-foot gill nets. He explained

> A stout cord held one end fast to a stake on the shore, while the owner, by means of several slender poles lashed together, pushed the anchor stone on the outer end to its place, thus setting the net. When the floats gave indication that fish had been caught, the net was pulled in hand over hand, the fish removed, and the net reset (Nelson 1899, p. 185-6).

Nelson, observing the large number of fish drying on the racks, commented how well this method appeared to work. Neither Nelson nor Hooper mention the use of a boat or kayak to remove the fish from the gill net. Though boats are used today, evidently the 19th century Eskimo found their assistance unnecessary for both beach seining and gill netting. Possibly most of the hand-made nets were so short, and the runs of fish so heavy that the people found working directly off the beach a more than adequate method of securing plenty of fish.

3. Bristol Bay

This region, like the Yukon-Kuskokwim area, has many shoals and was consequently avoided by ships. Russian fur traders entered the area in the early 1800's and established a trading post in Nushagak Bay in 1819. Unfortunately, little ethnographic data for this period is available. Later ethnographic literature in the Bristol Bay region centers around the Nushagak area where extensive herring runs do not occur now. Therefore, it is not surprising that no references to early herring use were found in this literature. Because of this lack of data, there is no way to evaluate the aboriginal subsistence herring use in the Bristol Bay region.

B. Current Subsistence Herring Fishery(1)

1. Yukon-Kuskokwim

Nelson Island Ethnography

The Nelson Island region (Figure IV-2), which is one of the least known areas, both historically and ethnographically, is the area of the highest subsistence herring dependence in Alaska today. In a general book describing Alaskan Eskimos as they lived when first encountered by Europeans, Oswalt (1967, p. 127) states:

> Comparatively little is known about the economic pattern of those Yuit tribes living along the coast or on the inland tundra in the area between the Yukon River and Bristol Bay.

He mentions herring in relation to the Chugach Eskimo of Prince William Sound and the Unaligmuit of Norton Sound, but when discussing the subsistence patterns of the rest of his Bering Sea Hunters and Fishermen (non-riverine coast from Wales to Port Moller), he makes no reference to herring. This omission reflects the lack of 19th and 20th century sources to draw upon for information about the Bering Sea Eskimos.

The age of the herring fishery on Nelson Island is difficult to determine as no archeological sites have been excavated. Preliminary surveys have revealed a few sites, some of which are located on the coast near Cape Vancouver where fishing and sea mammal hunting could be practiced. Archeologically, a Norton-like people, with their strong net-fishing element, were living on Nunivak Island nearly 2000 years ago (Nowak 1970, p. 30), so it seems reasonable to assume that the area around Cape Vancouver less than 25 miles away was also populated at that time. Communication between the peoples of Nunivak Island and Nelson Island is documented in the literature (Porter 1893, p. 110).

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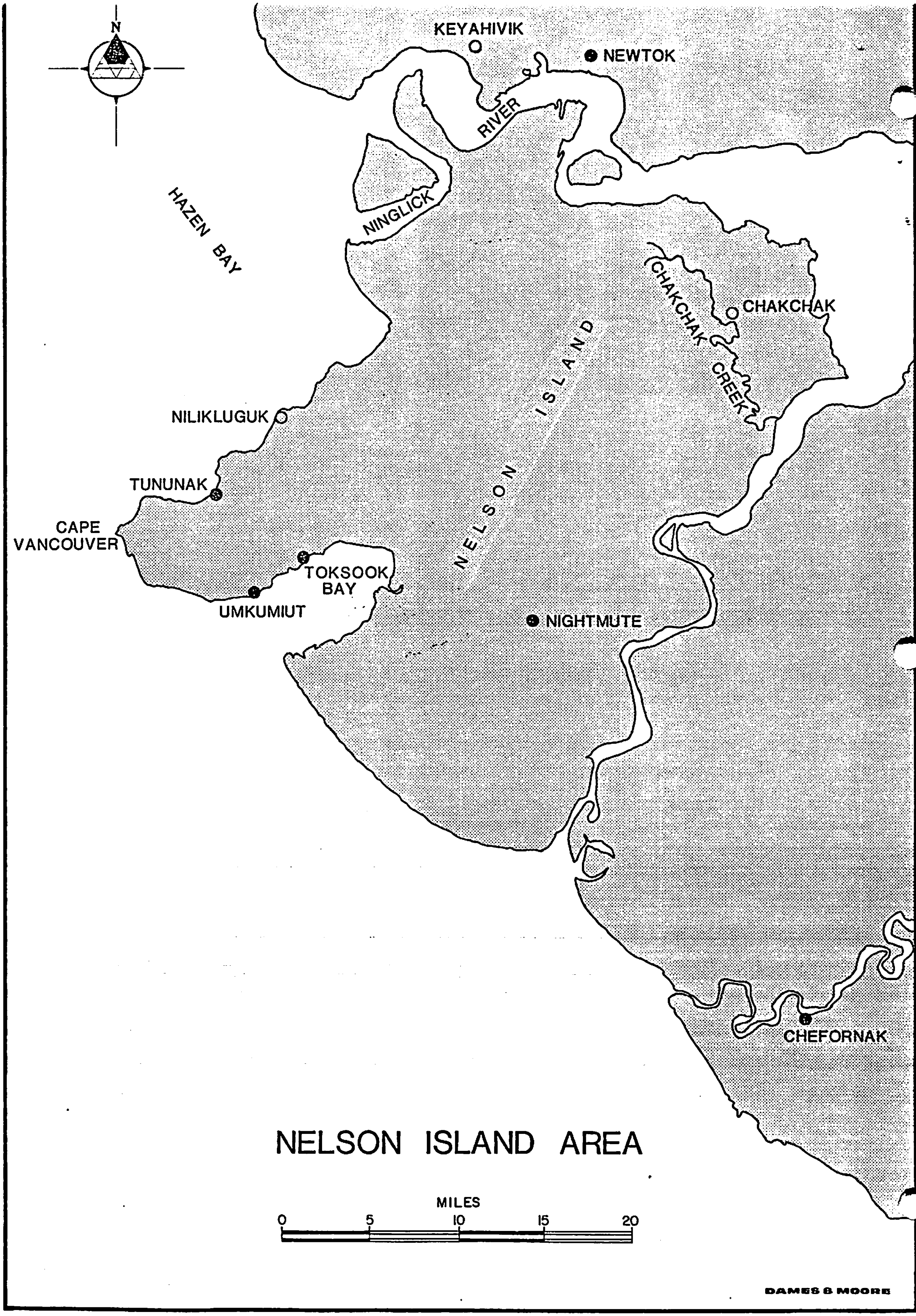
(1) Since data relating to subsistence methods and harvests for areas north and south of Nelson Island is still being received, these areas will be discussed in the Final Report.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KEYAHIVIK
NEWTOK
RIVER
NINGLICK
HAZEN BAY
CHAKCHAK
CHAKCHAK CREEK
NELSON ISLAND
NILIKLUGUK
TUNUNAK
CAPE VANCOUVER
TOKSOOK BAY
UMKUMIUT
NIGHTMUTE
CHEFORNAK
NELSON ISLAND AREA
MILES
0
5
10
15
20
DAMES & MOORE

FIGURE IV-2

Presently, only gill nets are used to catch herring on Nelson Island. The mesh ranges from 2-1/4 inches to 2-1/2 inches. The herring nets average six to eight feet deep and 18 to 60 feet in length (Table IV-1). In 1978, many people from Tununak set their nets near the point just north of the village. One end of the net is attached to the shore, and the other is anchored perpendicular to the land. When the fisherman empties his net, he positions his boat so he can work the net over the boat shaking the herring onto a piece of canvas or visqueen on the floor of the boat. During the short run, local people fish every high tide. If the run is heavy they can make two or three trips back to the village to unload their herring during one tide. Though there are a growing number of aluminum boats at Tununak (16 to 18 feet), most people seem to prefer the larger wood skiffs (16 to 20 feet).

Many residents of Nelson Island have complained that the herring have been too small for their nets for the past six to seven years. Most of them attributed this to the presence of Japanese commercial ships with their huge nets. Many people said that in the past a three inch mesh net was adequate for herring, but is too big since the Japanese ships. One informant explained that when the herring were small, he used a smaller-meshed whitefish seine to catch herring. He simply stretched his net out from the shore and used his boat to make a sweep back to the beach to trap the herring. Another informant said that he used his dip net on herring as they were simply too small for his regular gill net. Although many Nelson Islanders said that the herring are finally getting larger and more numerous since the Japanese ships have left, they generally agree that the fish are not as large nor the runs as big as they once were. It is also felt that the herring used to remain in the area longer than they presently do.

Most of the older people in Tununak remember when fishing nets were made out of sinew. Evidently, all kinds of sinew were used (ducks, geese, caribou or reindeer, walrus, seals). Women twisted the sinew

with their fingers to make nets. Needless to say, the nets were small and required a great deal of work. Later, nets were made out of twine. When picking the nets the fishermen used a kayak, and the herring were taken from the net one at a time. Grass mats, made by the women, were bent into a circle and positioned in both ends of the kayak. The fishermen would pick the herring from his gill net one at a time and fill up both ends of his craft. One elderly informant said his father had once considered 15 kayak loads adequate for the family for the winter. A kayak is approximately 15 feet long.

Once the herring fisherman returns home with his catch, the fish are put into herring pits (Plate to be included in Final Report). These pits are simply holes or small indentations in the ground where the fish are temporarily stored before the women clean them. Traditionally, the pits were lined with grass mats, but today a number of materials are used (grass mats, cardboard, plastic). Thirty-three such pits were counted at Tununak, or roughly one per family. A few families use the same herring pit. The fisherman dumps his herring into the pit, and, if the run is heavy, returns to the net. Thus, it is easy for the fish to pile up much faster than the women and girls can process them for drying or storing in pokes.

Most herring are dried. The women gut the herring (saving all roe for food) and separate those with high fat content from the others. Those containing more oil are recognized by a white coloring along the inside of the stomach cavity. These fish are split down the middle and laid out on rocks or other dry surface so the excess fat can ooze out before an attempt is made to dry the carcass. If too fatty, the fish will be soft and will not dry properly. Another method used to preserve these "fat herring" is to put them into a poke with sea oil. Many of the younger people do not care for the taste of "poke herring". Thus the Nelson Islanders do not prefer the "fat herring" as they require more work, do not dry as well, and taste inferior.

After the women clean the fish they braid grass around the herring's gills forming long strings of fish which are hung over poles to dry (Plate to be included in Final Report). This method is identical to that described by Turner above. The roe is also air dried by placing it on rocks, driftwood, or other dry surfaces. After it is dry it is stored in the fish houses in sacks. When the herring have dried properly (four to eight weeks depending on weather), they are removed from the racks and put into large grass baskets (Plate to be included in Final Report) and stored in the fish houses. These grass baskets are used because they allow air to circulate around the fish and therefore retard spoilage.

It takes the women about a week to process and hang the family's spring herring catch. During a heavy run of herring, the men can catch the fish in large quantities - faster than the women are able to clean and hang them. Therefore, the fisherman keeps this in mind and is careful to only catch what the women of his family are able to clean. The Nelson Islanders are waste conscious, and some people said they could have probably gotten more herring during the height of the run, but the women are limited in what they can clean. As the fish and roe are kept for food, waste from the Nelson Island subsistence herring fishery is apparently nonexistent.

The grass that is braided around the gills of the herring is the same grass used to make baskets. Preferably, the grass is gathered in the fall and stored over the winter, but it can also be collected in the spring. Sometimes the women form the grass into mats for storage, or it is simply kept in a dry place. Just before the women use the grass to braid the herring they soak it in the surf to make it easier to work. (See Plates to be included in Final Report).

Each family apparently has their own fish racks. The racks consist of posts with long logs across the top (Plate to be included in Final Report). A few people at Tununak still use the older teepee style fish rack (Plate to be included in Final Report) with the strings of herring strung around horizontally. One informant said he has used the same pole-type fish racks for 21 years. Most families have two to four of these large fish racks.

In addition to saving all of the roe from the herring, the Nelson Islanders gather herring roe-on-kelp, which seems to be relished by all. Both the roe and kelp are eaten. Many people complained that very few herring spawned this year, and consequently less roe-on-kelp was gathered this year than normal. The roe-on-kelp is often put into plastic bags and frozen in home freezers, but before freezers it was dried or stored in oil. Porter, while taking the 11th census in 1890 noted:

> The natives consume but a small fraction of the herring catch in fresh condition, most of it being dried for winter stores, while the spawn, which is gathered in great quantities, is either dried or preserved in oil (Porter 1893, p. 226).

Before the Eskimos eat the dried roe, they soak it in water to restore its freshness. According to Nelson:

> The roe of herring is gathered on seaweed during spawning time and some of this is dried and preserved for winter use, when it is boiled and eaten with great relish (Nelson 1899, p. 267).

One informant from Tununak gathered about 75 pounds of roe-on-kelp, but most people said there was very little spawning this year, even though there were apparently more herring this year than last.

Although dried herring provides the staple on Nelson Island, seals are also very important because they provide not only meat, but also oil, skins, rawhide lines, sinew, and stomach. Seal oil is stored in pokes and, though formerly also used for lamps, is now used for food. Without exception, nearly all dried fish or meat is dipped into seal oil

before it is eaten. Petrof (1884, p. 6) was not referring to petroleum when he said,

> Milk and honey can not be said to flow at anytime in this region, but oil does occasionally, lending a decided "luster" to the life of the Innuit and all his surroundings.

In general, the Nelson Island subsistence technique for harvesting herring is much the same as in the past. Some people reported that hand-made nets were used in the recent past by those who could not afford to buy one. But today most people buy their gear from the store. In Toksook Bay, 2-1/4 inch mesh net sells for $.85 per yard and lead line for $.17 per foot. The main change seems to be in boat use. The literature indicated that in the 19th century boats were not used to set, pick, or take in the net from the beach. According to older informants at Tununak, they remember when kayaks were used to work the gill nets and fish were removed one at a time. Presently, a wood skiff is used. (The open skin boat or "angyaq" was not used in this area for hunting or fishing.)

Weather often greatly affects the herring harvest. An onshore wind creates a rough sea, and the herring stay away from the beach. Therefore, the bad weather not only makes fishing difficult, but also, according to local informants, causes the herring to bypass the area without spawning. An offshore breeze or calm sea are good conditions for gillnetting these fish. If stormy weather persists during the very short run, the effects could cause a food shortage for the Nelson Islanders. Even in the years when the catch is good, excessive rain can interfere with drying. In 1958, bad weather caused the people of Newtok to lose "about 50 percent of their herring catch, which is usually one of their chief winter dietary items" (Heller and Scott 1967, p. 152). In the past, Eskimos used grass mats to cover the drying fish during inclement weather (see Curtis 1930, plate opposite p. 34). In June of 1978, a heavy storm passed through the Nelson Island area. At Toksook Bay, visqueen and tarps were seen temporarily covering the herring. Thus, the amount of time required for the fish to dry varies. Weather apparently also influences the date when the herring arrive. This spring the ice went out early and, consequently the herring arrived earlier than normal. Many people considered the early herring arrival fortunate as the lack of ice earlier in the spring had caused very poor seal hunting in the Nelson Island area. Thus, a subsistence economy based on hunting and fishing is at best unpredictable. Seasonal variation in resources, bad weather, and numerous unforeseen occurrences can cause food shortages and deviations in the normal subsistence pattern.

Traditionally, population shifts were primarily caused by the seasonal wanderings associated with the food quest. Typically, small groups of Bering Sea Eskimos would establish winter villages, wander from these during the summer months, returning to the same winter camp in the late fall. Usually the Kashgee or communal house was located in the winter village. In the 20th century, outside forces have affected the population movements in western Alaska, and have therefore altered the food quest.

Before the arrival of missionaries and teachers, the Eskimos in the study area were widely scattered in local food quest patterns. The establishment of schools and churches altered the traditional seasonal cycle and encouraged stabilized villages. Consequently, the trend has been for the smaller hamlets to come together into larger permanent villages, which often disrupts the aboriginal annual cycle. It seems that most often the settling occurred at the winter village site. Where this is true, the people still retain a semblance of their traditional settlement pattern by going to spring or summer or fall camp. Then in late fall they can return to their customary winter site and take advantage of their traditional food resources over the winter. Aside from modern hunting and fishing regulations, the most disruptive element in this phenomenon is that often school is still in session when the family wants to move to spring camp.

Preliminary investigation indicates that Tununak and possibly Toksook Bay, the two villages of highest herring dependence in the study area, have deviated from this typical pattern. Many residents of Tununak said they traditionally spent their winters inland on the eastern side of Nelson Island. By boat, the distance to this winter camp is probably over 75 miles. In the past, days were required to make this journey. In sloughs, lakes, and creeks of this lowland area, the people caught whitefish, needlefish, blackfish, pike, tomcod (Saffron cod), and lush (ling cod). The dietary importance of these fish is evidenced in the tundra villages of Kasigluk and Nunapitchuk (Heller and Scott 1967). In the spring, these Nelson Islanders would go to the coast for, among other things, seals and herring. They would remain at their summer camp (Tununak) long enough to enable the fish to dry and then pack up to begin the long journey inland. Consequently, they would return to their winter village with a new supply of seal oil and dried herring. Fresh whitefish, blackfish, and needlefish provided additional nutrients over the winter.

Inasmuch as geographic location determines the economic orientation of a village, Tununak and Toksook Bay have possibly entered into a specialized relationship with herring. The residents of Tununak, now stabilized in what was traditionally only a spring/summer camp, have lost the easy access they once had to their traditional winter resources. Therefore, they presently have an unusually high dependence on herring. It is now the staple that must carry them through the winter. With the rising cost of gasoline, Tununak residents claimed it now cost over $100 to make the trip to their traditional winter fishing grounds. Because of the limited number of other resources in the immediate Tununak area, the dependency on herring is even greater. Apparently, salmon are of minor importance to the residents. Most informants said there were very few salmon in the area. Thus, Tununak relies heavily for the bulk of its yearly protein on a resource that only comes once a year, often stays less than a week, and is subject to bad weather and other natural phenomena.

Economic Importance of Subsistence Catches

It should be evident that the subsistence harvest of herring in those villages heavily dependent upon the resource has major economic value. In the villages of Toksook, Tununak, and Nightmute, the harvest amounts to approximately 2,000 pounds per family. The dollar cost of providing an equivalent source of protein represents the cash value of the harvest. Salmon is the most comparable food source, and if the villagers were forced to purchase it from commercial fishermen in the lower Yukon or lower Kuskokwim areas, it is doubtful that they could have it delivered to the village for less than $2.00 per pound. Based on this conservative estimate of the replacement cost of protein, the herring catch is worth at least $4,000 to the average family in these three villages.(1) Annual median family income in these same villages is probably less than $4,000 per year at the present time. Access to subsistence herring for these people is clearly one of economic and social survival. Without the resource the residents would be forced to abandon the village sites for most of the year, if not permanently.

(1) The cost of harvesting herring is not high for the villagers. Nets, with useful life of several years, cost about $200 (100 feet) in the spring of 1978 in the village store at Toksook (villagers hang their own nets from components that are available by the foot). Boats and motors are required, but the fishery lasts only a week or two. 16-foot aluminum skiffs at Toksook were $1,200 in the spring of 1978; 18-foot skiffs were $1,600. The total expense of harvesting herring, including prorated depreciation of equipment, is probably not more than $.01 per pound.

C. Contemporary Subsistence Surveys[1]

1. Yukon-Kuskokwim

Nelson Island

The first subsistence herring harvest surveys in the Nelson Island area were conducted from 1975 through 1977 by the Alaska Department of Fish and Game for the Department of Commerce and the Department of Interior as part of an environmental assessment of the Alaska Continental Shelf (Table IV-2).

A resident of Tununak was hired by Dames & Moore to conduct house-to-house surveys in the villages of Nelson Island and adjacent areas in 1978. The survey included a series of standard questions designed to provide quantitative information on herring harvest, roe-on-kelp harvest, relative effort and success compared with previous years and the amount of time required for fishing activities. Information was also gathered on the types and dimensions of fishing gear currently in use for subsistence activities (Tables IV-1 and IV-3).

To aid in communication and reduce bias in data gathering, letters describing the survey were sent to village council presidents and local members of Fish and Game Advisory Boards in advance of the survey. As soon as the study team arrived in a village the mayor or village council president was located and requests were made to schedule a public meeting for all interested residents.

At the public meetings the study area, purpose, and objectives were described through a local interpreter (all public participation was in Yupik), including a lengthy question and answer period for study team

(1) Since data from house-to-house surveys is still being gathered, Nelson Island will serve as an example of data collection for this study. Villages north and south of Nelson Island will be discussed in the Final Report.

TABLE IV-1

TIME SPENT IN SUBSISTENCE HERRING FISHERY AND TYPES OF GEAR FOR THE NELSON ISLAND AREA, 1978[1]

Village	Fishing Time (days)				Boat Length (ft.)		Gill Net Specifications			
	Herring		Eggs on Kelp				Length (ft.)		Mesh (inch stretch)	
	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average
Tununak	1 - 7	3.3	1 - 2	1.1	14 - 20	17	18 - 50	38	2.25 - 2.5	2.3
Toksook Bay	2 - 24	9.8	1 - 1.5	1.1	12 - 20	17	20 - 55	37	2.25 - 2.5	2.4
Nightmute/Umkumiut	2 - 17	10.1	1	1	14 - 19	17	18 - 60	40	2.25 - 2.5	2.4
Newtok	1 - 5	2.3	0	0	14 - 18	16	28 - 75	44	2.25 - 2.5	2.4
Chefornak	1 - 3	1.6	0	0	16 - 18	17	90 - 150	117	2.5	2.5

(1) Based on interviews of 126 heads of families.

TABLE IV-2

HERRING SUBSISTENCE CATCHES IN POUNDS BY RESIDENTS OF NELSON ISLAND 1975-1977[1]

Village	1975	1976	1977
Tunanak	43,565	30,593	114,425
Umkumiut	65,898	18,660	6,075
Toksook Bay	68,405	85,675	42,600
TOTALS	177,868 (109)	134,928 (42)	163,100 (90)

(1) From Alaska Department of Fish and Game, 1977.

TABLE IV-3

SUBSISTENCE HERRING HARVEST FOR NELSON ISLAND AREA, 1978[1]

Village	Number of Herring	Pounds of Herring	Pounds of Eggs on Kelp
Tununak	203,842	76,400	810
Toksook Bay	197,194	73,908	450
Nightmute/ Umkumiut	61,273	22,965	90

(1) Harvests based on interviews with 86 families.

members and the public. These meetings were usually followed by selected interviews with older fishermen in the community.

House-to-house surveys were completed at the discretion of the local investigator when he determined that all herring fishing had been completed. Survey forms were then forwarded by mail to Dames & Moore in Anchorage.

In order to provide guidelines for data interpretation the study team made direct counts of all herring on drying racks at selected locations, including number of drying racks, number of strings and number of herring per string. Later in the summer such tallies would not be possible because herring would be in storage in seal oil-filled pokes, baskets and sacks.

As discussed earlier, local residents expressed strong concern about the affect of Japanese high seas fishing in the 1960's and 1970's on herring size and abundance. Randall (1975) reported that 1974 commercial harvests showed a significant drop in older age classes that were prevalent in 1968 through 1969. He further suggests that such changes were influenced by foreign fishing just outside the 12-mile limit. According to subsistence fishermen 1978 herring abundance is now approaching historical levels, but returning spawners are still "smaller than normal".

Preliminary analysis based on all subsistence harvest data for the eastern Bering Sea since 1975 indicated a total annual harvest of about 92.8 metric tons (Table IV-4).

Village residents could give us no solid estimates of historical harvest levels and such information does not exist in the literature, therefore, it is impossible to compare present harvest levels with traditional requirements except in a very general way.

TABLE IV-4

ESTIMATED HERRING HARVEST BY SUBSISTENCE FISHERMEN IN THE EASTERN BERING SEA

Village	Herring per Fishing Family (Pounds)	Annual Harvest (Pounds)	Source
Ugashik/Pilot Point		<100	Alex Greichen, Personal Communication
Egegik		250	Ed Clark, Personal Communication
Dillingham		<100	Truman Emberg, Personal Communication
Manokotak	100	4,000	Joe Bacon, Personal Communication
Togiak			(1)
Twin Hills			(1)
Platinum		<100	Harry Bavilla, Personal Communication
Goodnews		<100	Christian Small, Personal Communication Ken Middleton, Personal Communication
Kongiganak		650	ADF&G 1978
Kwigillingok	2,669	11,700	ADF&G 1978, (1)
Kipnuk	500	1,500	ADF&G 1978, (1)
Mekoryuk		1,200	ADF&G 1978, Village Council 1978
Chefornak	328	6,600	ADF&G 1978, This Study
Nightmute/Umkumiut	2,320	28,000	ADF&G 1978, This Study
Toksook Bay	3,067	67,600	ADF&G 1978, This Study
Tununak	2,125	66,200	ADF&G 1978, This Study
Newtok	290	2,500	This Study
Chevak	156	1,400	ADF&G 1978, (1)
Hooper Bay	215	5,400	ADF&G 1978, (1)
Scammon Bay	348	1,400	ADF&G 1978, (1)
Stebbins		2,400	Barton 1977
St. Michael		2,700	Barton 1977
Unalakleet/Shaktolik		300	Barton 1977
Moses Pt./Elim		150	Barton 1977
	TOTAL	204,600	

(1) Survey data pending for 1978.

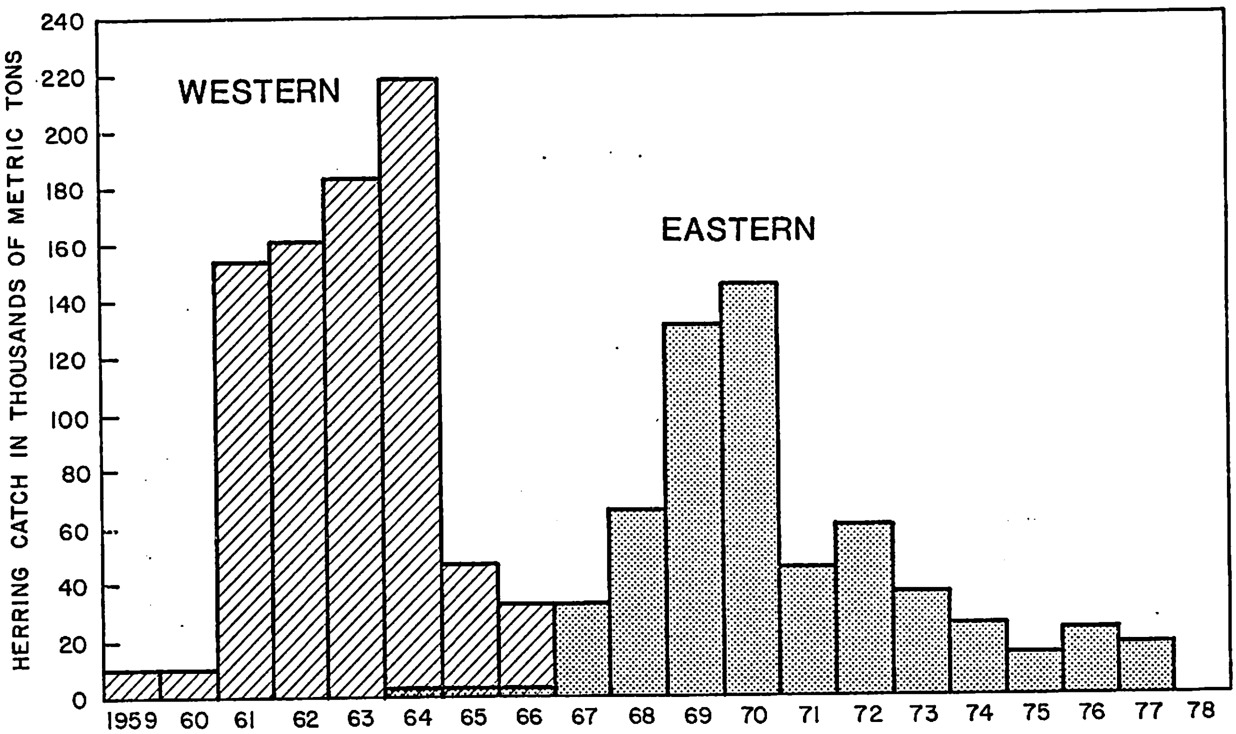
V. Commercial Herring Fishery in Study Area

The American commercial herring fishery in the Bering Sea began around 1909 at Golovin Bay (Rounsefell 1930). Initially, herring harvested in the fall were salted and pickled using Norwegian techniques. Later, in an attempt to improve product quality, Scotch-cured methods were employed (Bower 1917-1938). Approximately 3,000 metric tons of herring were processed before the industry collapsed in 1941 due to poor market conditions. A similar pickled herring industry operated at Dutch Harbor on Unalaska Island from 1928-1946 (Bower 1917-1938, Fish and Wildlife Service 1939-1946). The Ness Kaug saltery at Unalaska was the last to operate in the Bering Sea.

Herring operations resumed in 1959 when Russian fishermen initiated a fishery in the western Bering Sea. They were joined by the Japanese in 1961. Herring stocks could not stand the intensive fishing pressure applied by the two nations and the resource deteriorated as indicated by declining catches (Figure V-1). The Western Bering Sea herring fishery was subsequently closed by mutual agreement of Japan and the U.S.S.R. in 1970. However, even before the international agreement was prepared Japanese and Russian fleets had moved eastward in search of more herring (Lipanov and Shestopalov 1961, Dudnik and Usol'tsev 1964, Rumantsev and Darda 1970).

Large concentrations of herring were discovered in the St. George Basin lying roughly between Unimak and St. Mathew Islands (Berg 1977). Three principal fisheries developed in the area: a Japanese trawl fishery, a Soviet trawl fishery, and a Japanese gill net fishery (Mason 1976). Peak catches of up to 145,000 metric tons of herring were taken between 1968 and 1974 followed by a sharp drop in harvest and catch per unit effort (Preuter 1973, Mason 1976, NMFS 1977).

Passage of the Fishery Conservation and Management Act of 1976 resulted in the establishment of a 200-mile limit which allowed the Department of Commerce to limit foreign entry into the eastern Bering



HERRING CATCHES
IN THE EASTERN AND WESTERN BERING SEA 1959-77

(MODIFIED FROM NATIONAL MARINE FISHERIES SERVICE 1977 AND WESPESTAD 1978)

DAMES & MOORE

FIGURE V-1

Sea herring fishery. The International North Pacific Fisheries Commission recommended harvest quotas of 21,000 metric tons and called for intensified biological data collection. Boundaries were established that excluded all foreign herring fishing from north of 58° N. Latitude and east of 168° W. Longitude to protect coastal subsistence fisheries. The stimulus for the closure was a recommendation from the Alaska Department of Fish and Game to the North Pacific Fishery Management Council (Appendix 1).

The most recent American herring fishery began in 1963 when 1.6 metric tons of herring were taken for salt curing at Golovin by local fishermen. This market did not prove viable, but due to the high demand for sac roe in Japan an experimental gill net fishery started the following year and operated sporadically after that time (Barton 1977). This spring fishery has taken a total of 112 metric tons of herring since 1964 (ADF&G 1977).

In 1977 the first roe-on-kelp harvest were reported in Norton Sound and in 1978 approximately 3.6 metric tons were gathered (Ken Middleton, personal communication).

A herring gill net fishery began in Bristol Bay near Togiak in 1967. This fishery harvested sac roe and roe-on-kelp. Until 1977 operations were relatively small due to variable herring abundance, limited fishing and processing efforts, and weather. Average annual production was only 69 metric tons of herring and 47 metric tons of roe-on-kelp (ADF&G 1977).

In 1977 six processors, including two large factory ships accompanied by purse seine and gill net fleets, took a total of 2,540 metric tons of herring "a 40 fold increase" over previous averages (ADF&G 1977). The fish were gutted, salted, and boxed before loading on Korean vessels for shipment to the Orient. In 1978 sixteen processors took 7,014 metric tons of herring with seine fishermen accounting for over 90 percent of the harvest (Skrade 1978). A maximum of 12 foreign transport vessels were involved in the operation. In addition, processors purchased 136 metric tons of herring roe-on-kelp in 1977 and over 149 metric tons in 1978 (Skrade 1978).

stripped and carcasses reduced to meal. Vessels used for tenders in 1978 were of all description, typically over 80 feet in length. Several 85 foot-class crabbers were among the vessels used for tenders.

Freezing herring on the grounds is a method that is much slower and requires more handling than salting. But frozen herring are more versatile, and more valuable product. One processor mounted a substantial freezing operation in 1977 but processed with salt in 1978. This was reportedly because the high prices received for frozen crab made the opportunity cost of utilizing his equipment in the herring fishery too high. There were several small-scale freezing operations in 1978. One of these utilized a brine freeze method which froze the fish individually, in contrast to the usual method of freezing the fish in blocs in small containers. The individually frozen fish were reportedly received very well in the Japanese food fish market and resulted in a very valuable product.

Stripping roe from female herring -- "popping" as the process is often called -- is done by hand. As the roe is stripped it is graded and put in five gallon plastic buckets with saturated brine. Japanese technicians representing the purchaser usually oversee the stripping and grading process. Sac roe is typically graded in five categories:

No. 1	3" and larger, unbroken skein
No. 2	3" and larger, broken skein or 2" to 3" unbroken skein
No. 3	1/2" to 2" unbroken skein
No. 4	immature roe
No. 5	"punk" roe (pieces and loose roe)

A good stripping operation will yield about 75 percent No. 1 roe; 20 percent No. 2; four percent No. 3; 0.5 percent No. 4; and 0.5 percent No. 5.

Roe-on-kelp is processed on the grounds with salt and brine. The kelp is received from the pickers on a barge or suitable vessel and held in large containers where it is layered generously with salt. It is then packed in five gallon plastic buckets and saturated brine poured in to fill the container. No further processing is required prior to export. Processing roe-on-kelp is not complicated and it may be undertaken at any scale. Several families or small groups of kelp pickers were their own processors in 1978. They brought salt and buckets to the grounds with them and took the product to Dillingham or Naknek and sold it there. One man reported an investment of $1,200 in 500 plastic buckets and the required salt, and he expected to receive at Naknek twice the going price on the grounds. A potential pitfall in the roe-on-kelp business -- for the volume buyer as well as the family operation -- is contaminating the product with sand or other impurities, or buying a contaminated product. At the time it is deposited on kelp, the roe is extremely sticky. A storm that stirs up sand, for example, can ruin the roe.

4. Harvesting Techniques and Gear Cost

a) Purse Seines

Harvesting nearshore herring with purse seines is extremely effective. In fact, herring purse seines are so effective that a very few units of gear are able to harvest the allowable quota. In the 1977 season, six seine boats caught 85 percent of the herring harvest, or approximately 2,190 metric tons, which amounts to an average of 365 tons per boat. In 1978, an estimated 25 seine boats caught 92 percent of the herring harvest or approximately 6,453 metric tons, which amounts to 258 tons per vessel. Processing capacity, not acquisition of fish, has limited the size of individual processing operations. During the 1978 season, most of the seine boats were restricted to one or two deliveries per day by processors. Half of the seine fleet -- about 12 boats -- could probably have harvested the total number of herring required by all the processors on the grounds.

Prior to the large expansion of the fishery in 1977, seines did not play a major role in the harvests. Rather, gill nets predominated and because of the low average roe recovery by gill nets (discussed below), the profitability of early commercial ventures were severely penalized. Thus, the major expansion that occurred in 1977 is attributable to the aggressive use of seining gear by processors who were equipped to handle the volume of fish this gear could produce when fished skillfully.

Hauls of 100 tons of fish are common from a single purse seine set, and even larger hauls are possible. Herring seiners make "round hauls" on the fish in open water; they do not "hold a hook" from shore or from a net fastened to shore as salmon seiners typically do. Because the men on the boat cannot see the fish they use spotters in aircraft who guide them over the school of herring and tell them exactly when to make their set. A spotter can work for at least two boats at a time, and he shares in a percentage of the value of the catch (typically 10 percent).

Seining is a particularly desirable method of fishing for herring because it allows only properly mature fish to be harvested. Processors are only interested in fish with a high roe content -- 10 percent of total weight or more. Because herring will not die immediately when caught in a seine, they are sampled for their roe content and released if found to be immature. The ability to select high yield fish is a major factor in the economic viability of the expanded Togiak fishery.

A typical herring seine used in the Togiak area fishery is 150 fathoms long and four strips deep. Because the water is shallow and the bottom rocky, some fishermen prefer seines of only two strips or three strips. Since seines are new to the area fishermen will doubtless experiment with different combinations of seine length, depth, and leadline weight for several years until the "ideal" net is designed. The common mesh size is 1-1/4 inches, compared to four inch mesh used in salmon seines. Boats normally have a crew of four.

Herring pursue seines can be operated effectively from relatively small boats. Although very skillfully fished and sturdily built of welded aluminum, the two boats which landed some of the largest catches in both 1977 and 1978 were 30 feet in length. (In contrast, salmon seine boats in the Kodiak area are typically 34 feet to 38 feet, and in southeastern they are up to 52 feet long). Properly rigged small crafts can be used because the fishing boat does not take the catch aboard and deliver it to a tender as is the common practice in a salmon fishery. Rather, the fishing boat merely catches and holds the herring in the pursed seine until a tender comes alongside and pumps the fish directly from the net into the tender.

Seining operations require relatively calm weather - less than 15 to 20 knot winds. Aerial spotters cannot see herring schools through a choppy water surface and tenders cannot safely pull alongside seiners in high wind or rough water. Neither can crews safely set and purse the seine from a small boat in bad weather.

Of the 25 seine boats that fished in the 1978 season, six were converted 32-foot Bristol Bay gillnet boats; the remainder were from Kodiak Island or Cook Inlet. The Kodiak boats ran from there to the grounds; the Cook Inlet boats were brought by barge from there to Naknek where they were unloaded for the run to Togiak.

Seining requires three main gear components: 1) a shallow draft seine boat, 2) a herring seine, and 3) a heavy-duty skiff (inboard or outboard). The seine boat is the most expensive item. New 36 to 38-foot seiners of the type used around Kodiak Island and in Prince William Sound now cost upwards of $150,000 new. A new 32 foot inboard fiberglass gill netter designed for Bristol Bay that can be adopted for seining costs about $60,000. New welded aluminum seiners in the 30-foot class cost around $40,000.

A new herring seine of 150 fathoms and four strips cost approximately $8,500 in 1978. Smaller seines (shorter in length or shallower) cost somewhat less. A fisherman from Dillingham reported that in May 1978 he purchased a new seine in Seattle of 120 fathoms and four strips for $6,500 F.O.B. Seattle. Actual cost of a particular seine depends upon size of twine, type of floats, the weights of the lead line, and other variables. It is useful to note that the cost of a herring seine suitable for the Bering Sea is much less than the cost of one required for the comparatively deep waters of southeastern Alaska. There, a seine costs in the neighborhood of $30,000.

Heavy-duty wood or fiberglass skiffs vary greatly in price. There are many available second-hand, and wood skiffs can be made at home from marine plywood for a modest price. Outboard motors are a different matter, however. A new 50 horsepower outboard.costs some $1,900, and a 75 horsepower outboard about $2,500. New inboard fiberglass skiffs used by salmon seiners may cost well over $5,000.

Entry into the fishery is not particularly expensive for owners of seine boats. They may have to purchase a herring seine if they do not already own one that is suitable. Beyond this expense, cash outlay consists of gas, oil and food, and perhaps supplemental insurance, and amounts to only a few hundred dollars. The fishermens' time has a low opportunity cost because there is no open salmon fishery during May. Boat and seine depreciation is an additional expense.

Because Bristol Bay fishermen do not typically own seine boats (the use of seines is prohibited in the Bristol Bay salmon fishery), entry into herring fishery is an expensive proposition. Most conventional 32-foot inboard Bristol Bay gill netters can be converted to use a seine. Not all Bristol Bay fishermen own these boats, however (many fish from large skiffs), so outfitting for the herring fishery may have to begin with the acquisition of a new boat properly equipped or a boat suitable for conversion.

Conversion costs will depend greatly upon the characteristics of the particular boat to be converted. It will also depend upon the amount of rigging and installation the owner can do himself and how ingenious he is in acquiring and adapting used and cast-off parts and equipment. Conversion involves installing a mast and boom, a hydraulic system (a power take-off, pump, fluid reservoir, valves, and hoses), a power bloc, a winch and davit. The cost of necessary parts and equipment may cost from $8,000 to $10,000. A seine is an additional $8,500, and a used skiff and new outboard (50 hp) may cost another $3,000. Thus, the owner of a boat that is suitable for conversion may expect to pay over $20,000 to enter the fishery if he must convert his boat and also acquire a skiff and outboard. At the other end of the range is a mechanic-fisherman who installs the mast and boom and basic hydraulic system himself, borrows a seine and power bloc from a friend who, say, seines in Cook Inlet but wants to try his luck in Bristol Bay, and owns his own skiff and outboard. This man's investment may be less than $4,000. The owner of one converted 32 foot fiberglass power boat reported that he spent $12,000 preparing his boat to seine, and that he did the work himself.

It must be pointed out that knowledge of seining operations is essential to the successful rigging of a boat. The mast, boom, and other rigging must be installed to handle the stresses, strains, twists, and pulls exerted on the bobbing boat during each maneuver of the seining operation.

b) Gill Nets

Gillnetters have played a minor role in the rapidly expanding commercial herring fishery near Togiak. In 1977, some 15 percent of the harvest was taken by gillnet fishermen; in 1978, 8 percent. There are two reasons for this peripheral participation by gillnetters in recent years. One is the fact that the few processors who account for the bulk of the harvest are equipped for a very high volume of production that must occur in a short period. While many local people own gillnets or have access to them, there is not a sufficiently large and reliable gillnet fishing fleet to even begin to deliver the quantity of fish that are required by the major operators. The second reason for the gillnetters small role in the new fishery is the fact that gill nets do not discriminate between spawned-out fish and mature ones, and consequently the average yield - that is, the roe content - of the gillnet harvest is lower than that of seine-caught fish, which can be sampled while still alive.

Indeed, it was this inadequacy of gill net fishing in the Togiak area that accounted in substantial measure for the slow development of the fishery. Randall's evaluation of the commercial fishery in 1975 contained the following observation:

> "Limited to the use of inefficient and non-selective gill nets... local operations have only a marginal chance of success. More complete utilization of the resource and development of more efficient and economical harvest methods will be required for a profitable exploitation of the herring...stocks of the Togiak district." (Randall 1975, p. 6).

Gill nets are the traditional device for harvesting herring in the Togiak area. Gill nets of both the set and drift type are used close to the shore near the spawning grounds. Gillnetters are not as hampered by bad weather as seiners because they can usually find a place to work along a shore in the lee of the wind. Commercial gill net fishermen use nets of about 50 fathoms in length with a 2-1/2 inch stretch mesh. Stout skiffs of 16 to 20 feet are adequate, although larger boats including 32-foot power boats are commonly used by gill net fishermen. Gill net fishermen are mostly Natives from nearby villages of Togiak, Twin Hills, and Manakotak who camp on the fishing grounds with their families. They will typically pick kelp as well as fish for herring, a portion of both of which may be intended for subsistence use. The State Department of Fish & Game estimated that in 1978 between 24 and 36 gillnet boats were active at some time during the fishery.

A gill net crew of two people can harvest up to 10 tons of fish per day, although they will have worked very hard to have done it. Shaking the net will dislodge only part of the fish, and the rest have to be picked out one at a time. Gillnetters work mainly on high tides when the herring move into the rocky coast to spawn. It is reasonable to assume that during the season a serious, experienced gillnetting crew might be able to average two tons of fish per day. There appears to be great variation in the quantity of fish actually sold by individual gillnetters. This depends upon the amount of time and energy devoted to fishing, the availability of a market, and luck at catching mature fish.

In southeastern Alaska and British Columbia, gillnet-caught fish frequently have a higher roe content than the seine-caught fish and command higher prices from buyers. The combination of fish size and mesh size there tend to be selective for mature females.

It may be that local gillnet fishermen with the proper gear and more experience, may be able to recover consistently higher than average percentages of roe. In his observations on the 1978 season, Skrade (1978) notes: "Later in the season some experienced gillnetters from outside Bristol Bay, mainly from Southeastern, did very well. The roe percentage of their deliveries was one to two percent higher per delivery than the purse seine fleet."

To say that the gill net fishermen account for a minor portion of the total harvest does not mean that they account for an unimportant share. Several processors were on the grounds in 1977 and 1978 with a low volume operation, typically a freezing operation aimed at a high value, quality product, who utilized fish deliveries predominately from gillnetters. Because of the problem of frequent low yields of gillnet harvests, however, many fish were refused by these and other buyers or were discarded immediately when the roe content was checked by the fishermen. This resulted in frustration to the fishermen as well as a waste of the resource. One small-scale operator who reported good luck with gillnet fish caught mainly by Togiak villagers used a spotting plane to direct the fishermen to grounds where fish were seen moving to spawn. Also, he concentrated his efforts in an area where he reasoned the mixing of mature and immature fish was less likely to occur.

The gill net fishery was also important economically to gill net fishermen who participate earnestly in it. It is a relatively low investment fishery since the fishermen already own suitable boats and motors. A full-length commercial gill net costs approximately $1,100. A fisherman who does not own a gill net could probably arrange to borrow or buy one from a processor.

c) Roe-on-Kelp

Roe-on-kelp is harvested along the rocky shoreline at low tide when it is exposed and easily accessible. It is mainly picked by hand, although the use of a few garden rakes was discussed. In 1978 three men with diving equipment harvested kelp, although they reported that the water was too murky to gather kelp efficiently in the subtidal zone. However, their diving suits allowed them to operate in the intertidal area for longer periods of time than the hand-pickers or rakers and thereby more effectively pick the kelp.

Picking kelp tends to be a family affair in which all participate. The Department of Fish and Game estimated that some 70 pickers were active in the 1977 season. Individual pickers fill plastic containers -- a bucket or slotted clothes basket -- and empty it into their nearby skiff. When the skiff is loaded, or the tide has risen too high, or the pickers are exhausted, the load is taken to a processor and sold.

Amounts of roe-on-kelp harvested, like the quantity of gill net fish caught, seems to vary greatly among individuals and family units. Skiff loads of kelp delivered at the end of the day could weigh as much as 3,000 lb. or as little as 200. As the season progresses the pickers must travel further from the processors to find good kelp beds since the closer ones are harvested.

5. Uncertainties of the Fishery

Considerable risk and uncertainty distinguish the Togiak commercial herring fishery. There are several elements of this fishery that expose the investor to loss. These are:

1) there is a general lack of scientific knowledge about and practical experience with the herring resource in this area;

2) the duration of runs is extremely short;

3) the weather tends to be bad much of the time;

4) the region is isolated in terms of transporation and communications;

5) the region is a long distance from processing centers and sources of supply.

Bad weather, presence of ice, unexpectedly small runs, an early run, a late run, or other erratic behavior of the fish, an accident, or a mechanical breakdown during the critical two-week period when the bulk of herring are mature can spell financial disaster for an operator. Summarizing the commercial situation in 1975, Richard Randall, a fishery biologist for the Alaska Department of Fish and Game, wrote:

> "During its short 9-year history Bristol Bay's commercial fishery on Pacific herring has failed to develop into anything more than a small-scale operation. Annual variations in the abundance of fish along with adverse weather conditions and the general logistical difficulties of operating in the area have discouraged any large-scale exploitation of herring in Bristol Bay." (Randall 1975, p. 2).

It is only in the light of these substantial uncertainties that one can fully appreciate the accomplishment of two companies, Icicyle Seafoods and all Alaskan Seafoods, which in 1977 transformed the fishery into one of the major herring producers in the entire state.

An illustration of the potential problems of operating in an area as remote as Togiak was the mid-air crash of two spotter planes during the peak of the harvest in 1978. The crash was a terrible personal tragedy for the family and friends of the three men who perished. It also idled the seine boats of two processors at a time when the fish were at the height of their abundance and maturity. At least two valuable days of fishing were lost before new spotting aircraft could resume work.

Logistically, the area presents unusual problems because of its isolation and distance from sources of supply. The fishing grounds are over 24 hours away by boat from Dillingham. Air support is limited to amphibious aircraft such as Gruman Goose or to single engine planes no larger than a Cessna 180. A minor mechanical failure could close down an operation for several days if a new part was required from Seattle or Anchorage.

6. Value of Harvest to Processors and Fishermen

a) Herring

The success of commercial herring harvests in the Togiak area in 1977 and 1978 have been built on relatively high prices commanded by sac roe in the Japanese market.

In 1978 the price of brine-cured No. 1 sac roe was reportedly in the neighborhood of $8.00 per pound F.O.B. in Alaska.(1) We see that

(1) Canadian processors were receiving $10.00 (Canadian) -- or $8.80 (U.S. at 11 percent discount) -- for No. 1 roe by the end of the 1978 season.

the price of roe establishes a ceiling on the market value of herring used exclusively for roe: one short ton of herring that yielded 10 percent roe by weight could be worth no more than $1,600 (2,000 lb. x .10 percent x $8.00/pound = $1,600.) However, only about 75 percent of sac roe will be graded No. 1, and less is paid for the lower grades. Thus, the ceiling market value of a ton of herring used exclusively for sac roe is closer to $1,500 at a price of $8.00 per pound for No. 1 sac roe. Commercial utilization of the carcass adds more value to the herring. Reduction of the carcasses to meal adds the least value. Bio-Dry, Inc. in Kodiak paid about $5.00 per ton for carcasses that were processed into meal. Drying and smoking the flesh of cured or frozen fish for table consumption adds greater value, but no dollar figures are available. Filleting the flesh of frozen fish results in the greatest value for the carcass. No dollar figures are available, but this value could approach that of the roe itself.

All of the factors engaged in the production of the 200 pounds of finished sac roe from a ton of herring -- the boats and equipment, fishermen, hired labor, supplies such as salt and containers, capital, and entrepreneurial skill -- divide the $1,500 (plus carcass value) in some fashion. The prices paid to the various factors of production depends upon the role of these factors of production in the various harvesting, transporting and marketing schemes. An expensive item in the production of herring in the Togiak area, one that is not as large in other parts of the state or in British Columbia, is tendering. This expense has the effect of reducing prices paid to other productive factors, especially fishermen. Transportation of salted herring from the fishing grounds in chartered freighters added extraordinary costs to the two operations that used this method. In general, the distance of the fishery from processing centers from conventional transportation networks combines to reduce the returns to the fishermen.[1]

The relative significance of the cost of labor to strip the roe in the total cost of production is not known. It is generally assumed that foreign, low cost labor helps to keep the return to other factors of production high. It is interesting that in 1978 the processor who paid the most for herring to fishermen and tenders were those who stripped the roe in Kodiak with American labor.

Prices paid for herring -- that is, prices paid by the buyer to the processor, and by the processor to the fishermen -- are based on the percentage of roe recovery. The base price is established on a 10 percent recovery, and a premium is paid for fish with a higher roe content and a discount is made for fish with less roe. Since the weight of the roe will shrink up to 2 percent with salting and handling, the actual roe recovery is not known until after the fish have been delivered to the buyer.

We know that the processors who produced sac roe as an end product received the equivalent of approximately $1,500 per ton for 10 percent fish (plus the nominal value of the carcasses as reduction feedstock). It is not known what most processors active in the 1978 fishery were actually paid for their product by buyers because they produced only a primary processed product and the end use of the carcass varied. The price depended largely upon the point of delivery and upon

(1) Many fishermen were perplexed by the low prices paid for herring on the grounds near Togiak compared to those paid for herring in Southeastern Alaska, Prince William Sound, and British Columbia. The reasons for this discrepancy are the same ones that explain the differential between the price paid to fishermen for king salmon in, say, Emmonak and in Puget Sound. Also, potential returns to an entrepreneur should increase as the risks of a venture increases. The Togiak herring fishery is an extremely risky one, or at least it has been for the past two years when experience with it was minimal. Therefore, the profit margin for processors is properly larger there than in an area where they are not as vulnerable to large losses. None of these observations, however, are intended as commentary on the "equity" of any particular pricing system used during the fishery.

the form of the primary processing. Bloc freezing, for example, resulted in a product that was worth at least $200 per ton more than salted fish in 1977. One operator who was freezing fish individually in 1978 hoped for a price about twice that received for salted fish. It is known that one processor received a guaranteed price of some $800 per ton for 10 percent salt-cured fish delivered on the grounds, and this is probably a representative figure of other processors who primary processed with salt in a comparable fashion.

Prices to fishermen varied considerably on the grounds for 10 percent herring -- from $100 per ton to over $300 per ton (with the possibility of a post season bonus based upon the overall profitability of the processor's particular venture). Most processors were paying in the neighborhood of $240 per ton for 10 percent fish.

Prices paid to tenders also varied considerably. Some tenders were chartered by processors and paid a fixed daily rate (also with the possibility of a bonus at the end of the season); others were paid a price per delivered ton. Charter rates depend upon vessel capacity, but are confidential in any case. It is known that one processor who paid tenders on a per ton basis paid approximately $540 per ton, and another paid $360 per ton for 10 percent herring.(1)

A very critical element of the pricing system used during the 1977 and 1978 season, and one that explains the remarkable spread between prices received among fishermen and tender operators, was the existence of exclusive arrangements between processors and seiners. A system of open competition among processors did not exist whereby fishermen delivered to the highest bidder. Seine boats were committed to fish for certain processors at prices agreed upon prior to the season. In one case, a small number of seine crews received substantially less per ton than crews delivering to other processors, but in exchange, they were assured an exclusive market for a very high volume of fish which, under reasonable conditions, would be easy to capture.

(1) These tendering costs contrast with tendering expense in Prince William Sound of about $150 per ton and in British Columbia of about $110 per ton in 1978.

These exclusive agreements had the effect of limiting entry into the fishery by independent fishermen, and thereby of keeping the returns to participating fishermen higher than they otherwise would have been.(1) That is, a private system of limiting entry was applied to the fishery by processors that had the same effect on returns to fishermen that governmental limited entry schemes are intended to have.

It is not known how most processors structured their operations financially. However, two distinct patterns were in evidence among the largest processors. One approach was for the operator to pay the cost of transportation for the seiners to the fishing grounds, and to charter tenders and hire a spotter aircraft, and assume all of the costs of processing. In this situation, he shouldered the entire risk of defeat by weather, accident, or breakdown. On the other hand, he stood to reap the benefits of a bumper harvest. The second approach was to pay tenders, fishermen, and a spotter aircraft a percentage of the value of the catch. Under this arrangement, the processor paid only for the processing costs and shared the risk of a poor season and the chance of an exceptional season with the other participants. This arrangement is typical in the industry because it reduces the amount of "front end" money required to launch an operation and reduces the losses in the case of financial disaster.

It is clear that the potential financial rewards of the Togiak fishery are certainly commensurate with its risks. No information is available about the profitability of the fishery for individual processors. However, the rapid growth of the herring fishery from 1977, when five processors and a half dozen seiners were involved, to 1978, when 16

(1) During the 1978 season two 32-foot boats converted for seining arrived on the grounds without a committed market for their catch. One of these boats managed to sell its fish to two different processors, but it is doubtful that it would have been so fortunate had it not been owned by the council president of a nearby Eskimo village and crewed by, among others, a member of the Alaska Board of Fisheries. The crew of the other converted 32-foot boat from the Bristol Bay gill net fleet did not manage to acquire a market for its fish until the closing days of the season. They departed the scene bitter and resentful of the situation there for independent fishermen.

processors and some two dozen seiners were active, is indicative of its financial attractiveness. The preparation of even more processors to become involved in 1979 is further evidence of its potential lucrativeness.

The gross income of the seine boats varied. Boats with experienced crews from Cook Inlet and Kodiak grossed in excess of $68,000 each. Some boats are reported to have grossed over $100,000 in the 1977 season and in the 1978 season. The average catch per seine boat in 1978 was 250 tons. The average roe recovery was in the neighborhood of 8 percent, which translated into a price of roughly $200 per ton for most fishermen. These figures suggest an average gross income of $51,600 per seine boat. However, it is known that the crews of the six converted Bristol Bay boats did not land as many fish as the highly experienced crews of the non-local boats.

The gross income of a seine boat is typically divided on the basis of a 40 percent share to the boat and a 60 percent share for the crew. Food is usually subtracted from the crews' gross earning prior to a division.

If the seine is owned by someone other than the boat owner, it would receive a share of perhaps 10 or 15 percent and the boat owner would receive 25-30 percent instead of a full 40 percent. Therefore, the earnings of a boat crewed by four men that grossed $70,000 would be split as follows:

Boat (including seine)	-	$28,000
Crew members	-	$10,500 (less prorated food expenses)

Thus, if the boat owner was also a crew member, he would receive $38,500.

Gross earnings of individual tenders are not known. Those that shared in the value of the catch probably earned between $50,000 and $100,000, depending upon their capacity and the operator they worked with.

It is difficult to generalize about the average earnings of gill net fishermen because the level of fishing effort varied greatly and the number of gill net fishermen is not known precisely. Many gill net fishermen had trouble obtaining a market for their catch, a situation which discouraged many from making a substantial effort.

The Department of Fish and Game reported that between 24 and 36 gill net boats harvested approximately 619 short tons of herring. Roe content of gill net fish averaged less than 10 percent. If we assume that gill netters received an average of $200 per ton, then the gross value of the gill net catch was $123,600. Divided among 24 boats, this amounts to $5,150 per boat; divided among 36 boats, it amounts to $3,433 per boat. It is doubtful that single boats grossed over $8,000.

b) Roe-on-Kelp

In the 1978 season, some 300,000 lbs (165 short tons, 150 metric tons) of roe-on-kelp was harvested. The average price paid was about $.35 per pound. Therefore, the gross value of the harvest was approximately $115,500. It is not known how many pickers participated, so an average yield to the harvesters is not possible. As in the case of gillnetting, however, the range of earnings was apparently quite wide. Generally, pickers worked sporadically at kelping and gillnetting and only a few made a sustained, concentrated effort. Those who did pick aggressively could have earned $4,000 or more. A household of kelp pickers serious about their business might have earned twice that.

7. Wage Employment

Very little wage employment is created by the Togiak herring fishery. Roe-on-kelp processors may hire up to 10 employees to salt and pack the harvest (see photograph). Many of these employees will be from the surrounding towns and villages. Alfred Ivanoff, a longtime kelp buyer in the area reported 10 employees, eight of whom were from Manokotak.

Several girls from Togiak were working aboard the M/V Bering, operated by Togiak Fisheries, but the manager reported that he could not recruit a full crew from the village. This is because gillnetting herring and picking kelp is considered more fun and can be more profitable as well.

Crews on tenders and processing barges were usually from the home port of the vessel or from Seattle.

A processor in Kodiak who stripped roe reported about two weeks work for some 150 women at a base pay of $4.50/hour. Bio-Dry, Inc. employs a half dozen people, who worked with the Togiak herring carcasses for about two weeks.

B. Norton Sound

The following summary of the Norton Sound commercial fishery is intended only as an introduction to the subject, which will be covered in more detail in the Final Report. The study team is awaiting statistical information from governmental agencies.

Commercial fishing in Norton Sound resumed in 1964, many years after the collapse of a small hand-pack industry that existed in the early part of the century. Sac roe and roe-on-kelp are the current products of interest. However, the fishery has been sporadic since 1964 and is extremely small in comparison with that which is developing at Togiak.

Gill nets (20 to 50 fathoms) are used exclusively in the Norton Sound herring fishery. Local fishermen use skiffs from 14 to 18 feet in length.

In 1978 commercial operations centered around the Norton Sound Fisherman's Cooperative, Inc. at Unalakleet. The cooperative purchased 29,300 pounds (13.3 metric tons) of herring from some 14 fishermen at $.20 per pound. This is an average return to fishermen of $419 per boat. Roe recovery was reportedly a low 6.75 percent, which means that Norton Sound fishermen received a good price for their catch. The herring were air freighted from Unalakleet to Anchorage without any primary processing. The cooperative received approximately $670 per short ton for the product. Gill nets were provided to the fishermen by the cooperative.

It was generally felt that fewer fish were harvested in Norton Sound this year than would have been possible if organizational problems had not existed and if the season opening had been earlier. One processor arrived too late to begin an operation he had planned in the Elim area. The Alaska Department of Fish and Game estimated a spring run of greater abundance than observed in recent years (Barton, personal communication).

VII. Future Growth of the Commercial Fishery

Table VII-1 shows the explosive growth of the Togiak commercial herring fishery in recent years.

TABLE VII-1

Year	Harvest (metric tons)	Number of Processors	Number of Seine Boats
1967-75[1] (average)	69	2	1
1977	2,586	5	6
1978	7,014	16	25

[1] There were no commercial herring operations in 1971 and 1976.

The harvest grew by 171 percent from 1977 to 1978; the number of operators by 220 percent; and the units of seine gear 317 percent. All indications are that the number of operators and units of gear will increase as much or more than they did last year. This fishing is Alaska's latest "gold rush"; the waterfronts in Dillingham, Kodiak, and Homer are rife with rumors of quick fortunes made at Togiak in the last two years. Many fishermen are known to be preparing to enter the fishery next year. One processor who operated in 1978 reported that his phone is "ringing off the hook" with fishermen who want to get into the fishery in 1979. A group of Bristol Bay gillnetters are currently promoting a large volume operation for next year.

There is considerable freezing capacity at King Cove, Dutch Harbor and Nunivak Island that could be utilized by processors entering the fishery. Peter Pan Seafood, owned by the Bristol Bay Native Corporation, has freezing and cold storage capacity at Dillingham. The lack of reduction plants in Alaska will impose limits to the growth of sac roe production within the state. However, Bio-Dry, Inc. of Kodiak, which processed about 2,000 tons of herring in 1978, reports that there is room for some expansion in their herring reduction operation next year.

In 1977 they were unprepared for the salt content in the herring which makes the flesh difficult to reduce.(1) As a consequence, they experienced production problems in 1978, which they plan to have solved for the 1979 season. In summary, there are a number of processors and facilities available to substantially expand the scope of activities at Togiak in 1979.

No joint ventures between foreign processors and domestic fishermen have been publically proposed to exploit the nearshore herring fishery.

A factor that will affect the dimensions and nature of growth in the fishery in 1979 is the size of the commercial quotas established by the Council and the State of Alaska. The recent success of the fishery, the strong interest of prospective entrants, and the rich abundance of fish observed during the 1978 season will combine to generate tremendous pressure to expand the domestic commercial allocation in the next few years. Processors who operated in 1978 will want to maintain or increase their share of the upcoming harvests. New entrants will cause sharp competition if the quotas are not relaxed.

An important question, one with political implications, is whether opportunities for significantly high levels of participation in the fishery by seine boats (local as well as non-local) not now in the fishery will be created by both the expansion of harvests and the enhanced competition which will be an inevitable by-product of the appearance of new processors. The answer to this question probably depends on whether enhanced competition undermines the system of exclusive marketing agreements that have dominated the seine fishery. Substantial increases in participation would result from a very large expansion in the number of operators working the area. Even greater participation would be achieved -- if this is a desirable objective of policy -- if independent fishermen could freely enter the fishery without a prior marketing commitment from a processor.

(1) It also produces a meal with a high salt content which reduces the palatability of the meal.

Unfettered entry by new fishermen may not be desirable because it could quickly produce a situation similar to that of the herring fisheries in Prince William Sound and southeast Alaska, where the amount of gear far exceeds the physical requirements of harvesting the quotas as well as the requirements for a reasonably equitable division of the wealth that the fishery is capable of producing. In these two areas the situation appears to be nothing short of ridiculous: the entire season lasts for one day or less and over a hundred boats scramble for a share of very tiny pie. As it is, only a few boats are lucky enough to profit from the season.

There is no reason to expect the large volume processors, including the newcomers, to abandon the use of exclusive market agreements with fishermen. These agreements are useful to the processor because they allow him to rely on a volume of deliveries tailored to his operation. Also, the processor may want to channel money to boats which he has financed. If the use of exclusive market agreements persists, so will the disparity of prices paid to seine boat crews for their catch.

Exclusive market agreements were not used in the gill net fishery. Therefore, we can assume that an increase in the number of small-scale operations that rely on gillnet fishermen will increase the opportunity for local participation by gillnetters. More operators dependent upon gillnet fish would create competitive pressure that might result in higher prices to gillnet fishermen for fish with satisfactory roe recovery.

IX. Attitudes of Local Residents Toward Commercial Fishery

Appendix 2 - contains information about the attitudes toward and interest in a commercial herring fishery by residents of the Bristol Bay, lower Kuskokwim, and Norton Sound areas as expressed in letters, resolutions, and hearing testimony. So far public meetings have been held in 10 primary subsistence herring villages on the Yukon-Kuskokwim Delta, plus meetings with local and regional native organizations, individual fishermen and various state and federal management agencies.

The Final Report will discuss this subject in more detail, and it will include information obtained from field interviews.

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APPENDIX 1

Management of Current Nearshore Fishery

Division of Commercial Fisheries

November 22, 1976

H. A. Larkins
National Marine Fisheries Service
Northwest & Alaska Fisheries Center
2725 Montlake Blvd. East
Seattle, Wash 98112

Dear Burt:

Attached is a report that you requested describing domestic herring stocks and fisheries along Alaska's Bering Sea coast. It is hoped that this information can be utilized by your agency in the preparation of the Bering Sea trawl fishery management plan.

I wish to elaborate on the reasons for proposing further restrictions on herring fisheries by foreign nations in the eastern Bering Sea. They are as follows:

1. The Japanese herring gillnet fishery is targetting on Alaskan stocks which are considerably below former levels of abundance in many areas.

2. Native residents in several Alaskan coastal communities are greatly dependant on herring as a source of food.

3. Development of the domestic fishery will be fostered by rebuilding the stocks to former levels of abundance. Also the Japanese are believed to sell high quality sac roe from maturing herring taken in their gillnet fishery which is in direct competition with the same markets that must be utilized for domestic fishery products. Finally, commercial salmon fishing is prohibited in several coastal areas for conservation reasons and, in many of these areas, herring represent the only resource having commercial fishing potential.

4. The Japanese herring gillnet fleet has a history of fishing violations within U.S. contiguous fishing zone waters. This is based on both written NMFS reports and from statements made by local residents. I gave you a handwritten summary of these reported violations while in Seattle.

5. Based on the relatively small catches (compared to groundfish catches) made by the gillnet fleet, it is obvious that they are conducting this fishery primarily for sale of the valuable sac roe extracted from maturing Alaskan herring. As marketed, herring roe as a luxury item and elimination of this fishery cannot be viewed as affecting the staple protein diet of the Japanese people.

For the aforementioned reasons, I propose that the following recommendations be incorporated into the plan being prepared for review by the North Pacific Council:

1. Eliminate the foreign nation gillnet allocation of 1,000 m.t and decrease the TAC for foreign nations by this amount.

2. An area in the eastern Bering Sea adjacent to Alaskan spawning areas should be closed to herring fishing by foreign nations. This area should in general represent areas presently fished by the Japanese gillnet fleet to preclude future development of a new foreign nation fishery in this area targetting on herring (use of pelagic trawls?). The boundaries of this closed area must be structured to give reasonable protection to Alaskan herring stocks without seriously affecting harvests of other target species allowed under the plan. I have no firm recommendation regarding exact boundaries at this time.

The subject herring stocks are dependant on the integrity of spawning and rearing habitats within State waters and represent a greater potential for enriching the quality of life in several Alaskan coastal communities. It is understandable that the State has a strong proprietary interest in these stocks throughout their entire range in the Bering Sea.

If there is additional information that you may require, please don't hesitate to contact me by phone.

Sincerely,

Ronald I. Regnart
Regional Supervisor
AYK Region
Anchorage

APPENDIX 2

Attitudes of Local Residents Toward Commercial Fishery

COASTAL VILLAGES OF THE ASSOCIAITION OF VILLAGE COUNCIL PRESIDENTS, INCLUDING THE CENTRAL BERING SEA FISH AND GAME ADVISORY BOARD ON THE EASTERN BERING SEA HERRING

The priority utilization of herring in the Eastern Bering Sea must be for subsistence purposes. In many villages, herring is the traditional food source. It is an important food source for many people of the coastal villages of the Association of Village Council Presidents' region. The herring is abundant only in a small area and it is only abundant in these areas for a few days. Therefore, the village subsistence fisherman has only three to four days to catch his subsistence requirement for herring before the herring leave the area. The coastal villages of the Association of Village Council Presidents do not want commercial fishing of herring in the Eastern Bering Sea.

The State of Alaska and the United States Government must do a complete biological study on herring for no less than ten years to record all important information on the Eastern Bering Sea herring population. All the data that is produced from these studies on herring must be made available to the coastal communities, and to the annual meetings of these communities, or as important issues create the need for joint communication between the State of Alaska and the Federal Government.

If it becomes evident to all parties concerned that commercial fishing of herring will be detrimental to the villages that depend on the herring as a result of the biological studies, then the commercial herring fishery's closure will be extended to the agreed upon date.

MOTIONED AND PASSED THIS 3rd DAY OF SEPTEMBER, 1977 at Kipnuq, Alaska.

[signature]
Jack Williams, Acting Chairman,
Central Bering Sea Fish and Game Advisory Board

1. [signature] Jack Williams Sr., Mekoryuk, C.B.S. FGAB
2. [signature] John Jones, Quinhagak , C.B.S. FGAB
3. [signature] Paul Aquimuk. Toksook Bay, C.B.S. FGAB
4. [signature] Mark Tom, Newtok, C.B.S. FGAB
5. [signature] Henry Albert, Tununaq, C.B.S.FGAB
6. [signature] Christian Small, Goodnews Bay, C.B.S. FGAB
7. [signature] Oscar Snyder, Platinum, C.B.S. FGAB
8. [signature] George Usugan, Sr, Representative, Tununaq
9. [signature] Peter Lupie, Rep., Tuntatuliak
10. [signature] Henry K. Evon, Kwigillingok, C.B.S. FGAB
11. [signature] David Friday, Rep., Chevak
12. [signature] Stanley Beans, Rep., South Naknak
13. [signature] Paul R. Kiunya, Rep., Kipnuq
14. [signature] George Carl, Rep., Kipnuq
15. [signature] Issac Hawk, Rep., Eek
16. [signature] Paul Guy, Rep., Napaskiak
17. [signature] Stanley Paulkin, Rep., St. Mary's
18. [signature] James Afcan., Rep., Sheldon's Point
19. [signature] Jimmy Anaver, Kipnuq, C.B.S. FGAB

20. Joseph Mike, Rep., Kotlik

21. Patrick Kelly, Rep., Emmonak

22. Peter P. Seton, Sr., Rep., Hooper Bay

23. Mike J. Utereyuk, Rep., Scammon Bay

24. Janet Napoleon, Rep., Paimute

25. Luke Amik, Rep., Kipnuq

26. Ray Ulkakuak, Rep., Kipnuq

27. James Sanson, Rep., Kipnuq

28. Issac B. Amik, Rep., Kipnuq

29. Teddy Kuytsan, Rep., Kipnuq

30. David O. David, Rep., Kwigillingok

31. David Martin, Rep., Kipnuq

32. Mary Gunlik, Rep., Kipnuq

33. Nellie Evon, Rep., Kwigillingok

34. Charlie Kairaiuak, Chefornak, C.B.S. F

35. Ralph Kiunya, Kongiganak, C.B.S. FGAB

T

RESOLUTION OF CENTRAL BERING SEA FISH AND GAME ADVISORY BOARD

WHEREAS THE REPRESENTATIVES FROM TOGIAK attended the proposal making meeting of the Central Bering Sea Fish and Game Asvisory Board, and participated with us on our deliberations on the subject of herring in the Eastern Bering Sea; and

WHEREAS the representatives from Togiak explained that their way of life was being threatened by the open, and unregulated fishery for herring in the Togiak basin, and feared for the continuation of their lifestyle unless biological and socio-economic studies to determine the effects of the herring fishery were begun immediately, and that the commercial harvest of herring be closed until these studies were completed;

THEREFORE BE IT RESOLVED BY THE CENTRAL BERING SEA FISH AND GAME ADVISORY BOARD that commercial fishing for herring in the Togiak Basin be closed in 1978, and for the years thereafter until complete biological and social-econimic studies are completed by the State of Alaska, North Pacific Fisheries Management Council, and the National Marine Fisheries Service; and

BE IT FURTHER RESOLVED that if commercial fishing for herring is re-introduced in the Togiak Basin that rules applicable to the commercial fishing of salmon in Bristol Bay be be applicable to the commercial fishing of herring, with the full and complete cooperation of the village of Togiak in the process of making up the rules for this fishery.

MOTIONED AND PASSED THIS 4 DAY OF SEPTEMBER, 1977 at Kipnuq, Alaska.

Jack W Williams Sr
Jack Williams, Sr, Acting Chairman

1977

MINUTES, CENTRAL BERING SEA FISH AND GAME ADVISORY BOARD, kipnuq, Alaska

7:00 P.M., September 2, B.I.A. School
Meeting called to order by Jack Williams
Introduction of three of four designated members of C.B.S. FGAB, Jack Williams, Mekoryuk, Mark Tom, Newtok, and Henry K. Evon, Kwigillingok. Andrew Beaver of Goodnews Bay resigned. Three members appointed following members to complete Board

Newtok, Mark Tom
Nightmute, Peter Dull
Tununak Henry Albert
Toksook Bay Paul Aquimaq
Mekoryuk, Jack Williams
Chefornak Charlie "airaiuak
Kipnuq Jimmy Anaver
Kwigillingok Henry K. Evon
Kongiganak Ralph Kivnya
Quinhagak John Jones
Goodnews Bay Christian Small
Paltinum Oscar Snyder

The Board decided to leave the remaing three seats on the open for later discussion
Nomination for Chairman

Jack Williams
Henry K. Evon
Henry Albert

Vote taken by secret ballot:Williams 6, Evon, 4, Albert 1; Jack Williams elected Chairman
Introduction of guests were made:
Harold sparck, chuck hunt, paul guy from Nunam Kitlutsisti
David Nanalook, Dan Nanalook, Henry Tuckak, Togiak
Stanely Beans, South Naknak
Issac Hawk, Eek, Peter Lupie, Tuntatuliak, Steven Maxie, Napaskiak; Peter Seton, Hooper Bay, Janet Napoleon, Paimute, Mike Utereyuk, Scammon Bay, David Friday, Chevak James Afcan, Sheldon's Point, Pat Kelly, Emmonak, Joseph Mike, Kotlik, and 30 people from Kipnuq in attendance
Floor moved that agenda should be adopted as presented
Discussion of herring

1. Board wondered why North Pacific Fisheries Managem nt Counci, Arctic Environmental Information and Data Center, and Department of Fish and Game did not attend meeting when specifically invited to do so, and recommended that strong letters of protest be sent to these organization. If villages disrupt their lives to attend meeting, these people should respect villages by following up their committments.
2. Sparck and "airaiuak, Nanalook, and Guy made presentations to board on herring fishery. Current regulations of State of Alaska in Bristol Bay and A-Y-K were read, hisotry of herring investigations with OCS funds discussed, position of N.P.F.M.C. and 200 Mile legislation discussed also. People were concerned that subsistence not mentioned in plans to increase fishery to 10,000 M.T.
3. Board discussed management options left open to them to submit to Ak. Board of Fish by October 4, and to NPFMC by November 15. Board requested that NPFMC attend next meeting of CBS FGAB to discuss federal herring position.

Meeting adjourned at 11 P.M.

9:00 A.M. September 3, Kipnuq B.I.A. school
Meeting called to order by Chairman Jack Williams
1. Herring

A. Board reconvened discussion on herring, and concentrated on affect of commercial fishing on subsistence lifestyle, lack of any biological data to support growth in commercial fishing, possible management rules if commercial fishing were to start, and how villages could protect themselves and their subsistence lifestyle.
B. Board appointed six man sub-committee to draft resolutions on herring fishery, and outlined four major positions. Each village representative was asked to give his opinion of herring fishery after lunch break, and their answers were recorded and four major topics were outlined. Subcommittee moved to another room to deliberate.

1. No commercial fishing, only subsistence fishing
2. Biological studies to determine amount, conc. movement of herring
3. socio-economic studies
4. regulations in case commercial fishing was to be established

2. State of Alaska Interim Committee on Subsistence

2. (cont.)

Representative Nels Anderson and Billy Akers discussed issues of walrus, birds, d-2 musk-oxen, subsistence in general, and the funding of the Department of Fish and Game directly from the general fund. The meeting lasted for three hours on all of these subjects. The advisory stated that it would make resolutions to invite the Commissioner of Fish and Game to come to its next meeting, that it would support an elimination of the fee for the harvest of a musk-oxen for residents of the State who are subsistence hunters, and do not have cash income, that it would recommend the stop of selling Alaska's wildlife to support the Department of Fish and Game, that it would recommend that the Department be funded out of general fund revenues of the State, and that it would support the Interim Subcommittee on Subsistence to have the State pay more attention to rural Alaskans who depend on subsistence for their lifestyle

3. Subcommittee of Board returned with position paper, which included opposition to start up of commercial herring fishing in area of Central Bering Sea, support for biological studies. The Board did not want to suppot socio-economic studies becuase Board members stated he ring harvest was low compared to the past, and herring was just as important as food source, and that if villages stated what they caught this year for subsistence, when runs are small, they would be restricted in the future to that number, even if other gildlife resources diminished, and the people depended on herring more for subsistence food. The subcommittee made mention of possible commercial fishing restrictions that would apply to the Central bering Sea coast if the Board rejected the Advisory Boards recommendations, but the full committee and the other village representatives from the floor voted to reject all commercial fishing regulations becuase the villages did not want to support any commercial fishing. They wanted the entire area left close to commercial herring fishing, with no compromise. Motion made by Evon, seconded by Kiunya and Albert. Vote unanimous and all Association of Village Council President coastal village representatives, and members of Central Bering Sea Coast village FGAB signed resolution

4. Glen Akins, Eric Ekvall, Judith Andregg, and George Kinesok made presentation on Coastal Zone Management. Ekvall consultant to CZM program, Akins and Andregg from Office of Governor, CZM, and Kinesok from Dept. Comm and Regional Affairs discussed legislation, showed slide show, introduced Stanley Paulkin as Governor nomination for AVCP/Bristol Bay area on Alaska Coastal Policy Council. Slide show on CZM shown, bill was outlined and discussed, funding procedures, election procedures, and staffing procedures were discussed. Issue would be brought up at AVCP ...

Meeting adjourned 12 A.M.

9:00 A.M., September 4, Kipnuq B.I.A. school

1. Discussion of resoltuion to support Togiak. Motion read, Motion Evon, Sec/Anavaer Question by Evon; Vote, Unanimous

2. Discussion of resolution for invitation to Skoog; Motion read; Motion Tom, Sec/Evon Question, Evon; Vote unanimous

3. Discussion of replacement for Charlie Nairaiuak; Nomination of Owen Beaver, Nick Phillip; Sparck will write to each council and KYUK job announcement; advertise for three weeks

4. Further CZM discussion to fill out questionairres
5. Resolution of Fisheries Development Corporation
6. Walrus Concern
   A, Dead walrus washing up on beaches are not from this region
   B. Walrus here only for few weeks in spring; meat is so valuable that headhunting is food-wise prohibited
   C. Some times, when walrus is shot on ice floe, walrus drops off and sinks, later to wash up. If carcass when found is bloated, hunter will harvest what is valuable or edible
   D. People are not sure of cause of dead mammals, but do not want blame or restrictionsplaced against villages for these carcasses
   E. People want Division of Game people at next meeting to discuss this situation. Councils will discuss issue in each village

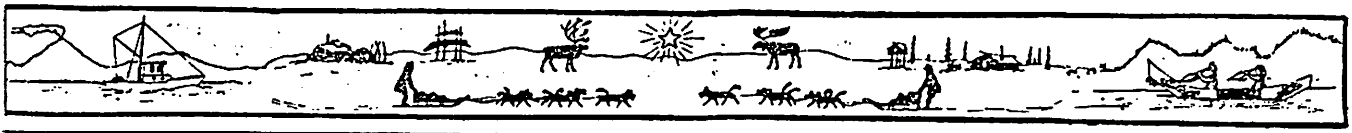
MEETING ADJOURNED BY CHAIRMAN JACK WILLIAMS 1:30 P.M., B.I.A. School, Kipnuq

25c

Tundra Times

Alaska's Oldest Statewide Newspaper

Inupiat Paitot People's Heritage — Den Nena Henash Our Land Speaks — Unanguq Tunuktaug The Aleuts Speak — Ut Kah neek Informing and Reporting — Yupit Kanlautciat The Way Eskimos Talk



Volume 14, No. 48 | Wednesday, November 30, 1977 | FAIRBANKS, ALASKA

ndustry eyes subsistence herring

By JEFFREY R. RICHARDSON

The Board of Fisheries has a long agenda when it meets Decem- r 4 in Anchorage. One of the most important items on that agen- is the up and coming herring fishery in southwestern Alaska.

At least 20 villages between Bristol Bay and Norton Sound, and few in Bristol Bay rely on the spring spawning runs of herring to pplement food supplies which are scarce in that season. Last ring, subsistence gillnetters took about 130 metric tons of herring.

It is, as one Bethel resident put it, a classic situation. The villa- rs of Bristol Bay and Norton Sound want to catch the herring to t; commercial operators want to harvest the herring not only as a od fish, but also process the herring roe that clings to kelp. What villagers fear is that a commercial fishery is too early, that not ough is yet known to adequately manage the fishery.

Lending support to these fears, commercial operators last spring ceeded the catch of herring deemed safe by biologists by more an 2,000 metric tons.

The Alaska Department of Fish and Game disagrees. Regional pervisor Ron Regnart maintains that the department has sufficient owledge to manage the herring, although he admits that popula- n figures and other data could be more complete. The depart- nt feels it is important to establish an American herring fishery the area in order to protect the resource for all American users. der the federal 200-mile limit law, the United States must allocate y surplus fish to foreign nations. The department feels the herring uld best be protected and utilized and managed with a predomi- ntly American fishery.

"We feel that the whole crux of this thing is that if the domestic hery is closed, it allows the foreign fishermen to make that much re catch," Regnart said.

Although there was a herring fishery in Golovin Bay during the enties and Thirties, the market for herring as a food fish declined d it has only been in the last five years that there has been re- wed American interest in Bering Sea herring stocks. Until last ring, very modest, almost insignificant, operations were carried by local commercial operators in the sac roe and spawn on-kelp heries. A near-shore Japanese herring fishery, which had been tive since 1968, catching an average of 1,000 metric tons, was minated by the North Pacific Fishery Management Council, which s jurisdiction over foreign fishing off Alaska outside of three les.

What frustrated the subsistence fishermen of the coastal villages that the very year the Japanese were cut out, two major American ocessors, one from Kodiak and one from Petersburg, dipped their ts into the near-shore waters and sailed away with 3,200 metric ns of herring.

Although Fish and Game asserts that any danger to Bering Sea rring now comes from a destructive Japanese offshore trawl fish- y, the Eskimos of Bristol Bay and Norton Sound are most fearful commercial operations wreaking havoc with spawning stocks und close to shore in the spring. The commercial catch of spawn- stock increased 220 percent this year and observers have pre- ted a catch in the neighborhood of 10,000 metric tons for 1978.

Although people in Bristol Bay are interested in entering the mmercial herring fishery themselves and do not rely heavily on rring as food fish, they are sympathetic to conflicts with subsis- nce users in their region and further north. The Bethel-based en- onmental group, Nunam Kitlutsisti, wants the whole coastline m the north end of Bristol Bay to the southern end of Norton und closed to commercial herring fishing. The group also advo- tes that the Total Allowable Catch of herring for the whole eas- n Bering Sea be reduced from 21,000 metric tons to 12,000 me- c tons until studies are completed to determine what the distribution of spawning stocks in the area actually is.

Only part of the subsistence battle has been won, according to Harold Sparck of Nunam Kitlutsisti:

"One of the benefits we've gotten is that a tremendous amount of money is going to be spent in the next three years (for herring research). We've won that issue."

But issues and questions remain unresolved. Sparck said Native subsistence fishermen do not buy Fish and Game's urgent insistence that American commercial fishermen must assert their right to harvest the resource; Sparck sees protection of the resource from domestic and foreign exploitation to insure village food supplies as more important. And there just is not enough information in yet to provide that protection.

Although the Department of Fish and Game will offer a proposed regulation to the Board of Fisheries that would close down part of the coastline between Bristol Bay and Norton Sound, it is a substantially smaller area than the Natives are asking for.

And the North Pacific Fishery Management Council, which has responded to the subsistence fishermen's pleas for more research, has set the Total Allowable Catch of herring in the Bering Sea at 18,000 metric tons, much higher than requested by the villagers.

And although the Department of Fish and Game has drafted regulations that would support the desire of Bristol Bay commercial fishermen to get into herring, there is no guarantee that the Board of Fisheries will buy the proposals. In order to compete with better organized and equipped operators from outside the region, Bristol Bay fishermen want purse seiners to be eliminated in favor of gillnetters, a ban on the use of spotter aircraft and several days of commercial closure to allow subsistence fishermen to take a portion of the quota.

There is evidence that fishing industry politics and pressures will play a significant role in herring decisions that will be made by the fisheries board next week. Subsistence fishermen are attempting to organize well enough to hold their own against outside entrepreneurs who may, in the rush for profit, make it impossible for the villagers to maintain their relatively tiny catch.

ALASKA BOARD OF FISHERIES

COMMERCIAL AND SUBSISTENCE FISHING REGULATORY CHANGES

TO BE CONSIDERED AT THE BOARD OF FISHERIES MEETING

IN ANCHORAGE, ALASKA FROM DECEMBER 4, 1977

TO APPROXIMATELY DECEMBER 16, 1977

32. 5 AAC 03.610. FISHING SEASON. (Regulation page 13). Prohibit commercial herring fishing in the Toksook Bay-Nelson Island region of the Arctic-Yukon-Kuskokwim area.

The proposed regulation reads as follows:

5 AAC 03.610. FISHING SEASON. There is no closed season on herring except in the Toksook Bay - Nelson Island region.

Justification: We have depended on subsistence herring fishing for survival for many generations. We know the herring which we heavily depend on will disappear, when the herring fishery is open commercially. Ever since the commercial herring fishery operate in our area in four years, the herring catch and the size of fish has decreased. We don't want any commercial fishing for herring except for subsistence only.

Proposed by: Willie Chase of City of Toksook Bay

COMMERCIAL AND SUBSISTENCE FISHING REGULATORY CHANGES

TO BE CONSIDERED AT THE BOARD OF FISHERIES MEETING

IN ANCHORAGE, ALASKA FROM DECEMBER 4, 1977

TO APPROXIMATELY DECEMBER 16, 1977

ARCTIC-YUKON-KUSKOKWIM AREA

3. 5 AAC 03.610. FISHING SEASON. (Regulation page 13). Prohibit commercial herring fishing in the Central Bering Sea region of the Arctic-Yukon-Kuskokwim area;

The proposed regulation reads as follows:

5 AAC 03.610. FISHING SEASON. There is no closed season on herring except in the Central Bering Sea region where the commercial fishery shall remain closed until such time as biological and socio-economic studies are completed, and the conclusion drawn by the villages of the region and the Alaska Board of Fish that a commercial herring fishery is possible based on the completed studies. Herring fishing for subsistence shall be given preference in the future over all competing uses of Eastern Bering Sea herring stocks.

Justification: The priority utilization of herring in the Eastern Bering Sea must be for subsistence purposes. In many villages, herring is the traditional food source. It is an important food source for many people of the coastal villages of the Association of Village Council President's region.

herring is abundant only in a small area and it is only abundant in these areas for a few days. Therefore, the village subsistence fisherman has only three to four days to catch his subsistence requirement for herring before the herring leave the area. The coastal villages of the Association of Village Council Presidents do not want commercial fishing of herring in the Eastern Bering Sea.

Proposed by: Jack Williams of Central Bering Sea Fish and Game Advisory Committee

ALASKA BOARD OF FISHERIES

COMMERCIAL AND SUBSISTENCE FISHING REGULATORY CHANGES

TO BE CONSIDERED AT THE BOARD OF FISHERIES MEETING

IN ANCHORAGE, ALASKA FROM DECEMBER 4, 1977

TO APPROXIMATELY DECEMBER 16, 1977

5 AAC 03.610. FISHING SEASON. (Regulation page 13). Prohibit commercial herring fishing in the area from Cape Newenham to Kotlik.

The proposed regulation reads as follows:

5 AAC 03.610. FISHING SEASON. There is no closed season on herring except in the area from Cape Newenham to Kotlik.

Justification: The commercial herring fishery in the Central Bering Sea should be closed until biological and socio-economic studies are completed where appropriate; and with the consent of the involved villages have taken place; and that no decision on the start-up of commercial fishing for herring shall take place until all parties agree that the herring resource can withstand commercial exploitation while protecting our coastal subsistence fisheries.

Proposed by: Harry Wilde of Lower Yukon Fish and Game Advisory Committee

ALASKA BOARD OF FISHERIES

COMMERCIAL AND SUBSISTENCE FISHING REGULATORY CHANGES AND PROPOSED PRIVATE NONPROFIT SALMON HATCHERY REGULATIONS TO BE CONSIDERED AT THE BOARD OF FISHERIES MEETING IN ANCHORAGE, ALASKA FROM APRIL 3, 1978 TO APPROXIMATELY APRIL 11, 1978

BRISTOL BAY AREA

130. 5 AAC 06.641. VESSEL SPECIFICATIONS AND OPERATION. (new section) Restrict the size of vessels that can be used to fish herring.

The proposed regulation reads as follows:

5 AAC 06.641. VESSEL SPECIFICATIONS AND OPERATION. No vessel used in the taking of herring may be more than 32 feet in overall length. For the purposes of this regulation, overall length means the straight line measurement between the extremities of the vessel hull proper.

Justification: Sending in a fleet of large vessels ranging anywhere from 75' to over 100' in length could potentially deplete the herring resource, thus having an adverse impact on the industry and subsistence usage of the herring resource.

No comprehensive study has been completed by the Alaska Department of Fish and Game on the herring industry near Togiak. If the herring industry shows indication of over exploitation in the future years, then surely the action of the Board of Fisheries will be at fault.

One must take the salmon industry of Bristol Bay into consideration when considering the harvest industry of Togiak's herring.

Proposed by: Frank G. Woods, Jr.
William Gumlickpuk

BRISTOL BAY NATIVE ASSOCIATION
P.O. BOX 179
DILLINGHAM, ALASKA 99576

FOREIGN PROCESSORS IN HERRING FISHERIES

RESOLUTION NO. 78-3

WHEREAS, the Alaska Board of Fisheries has regulated the exclusion of the foreign processors to participate in the herring fishery activity taking place in the Kulukak/Togiak area of Bristol Bay, and

WHEREAS, such a decision will more than likely affect the ability of the herring fisherman to market herring at a reasonable price, and

WHEREAS, such a decision is in complete favor of the participating domestic processors to reap extremely high profits off the fishery, and

WHEREAS, the most numerous and typical businessmen presently participating in the herring fishery are herring fisherman, and not processors;

NOW THEREFORE BE IT RESOLVED by the Board of Directors of the Bristol Bay Native Association, Inc., gathered in Dillingham, Alaska on this 11 day of May, 1978 that the Board of Fisheries considers the position of the Bristol Bay herring fishermen in their next meeting and plan to include the foreign vessels in processing of herring in years to come.

SIGNED: [signature] V.P
President

ATTEST:

[signature]
Secretary

CERTIFICATION:

I hereby certify that the foregoing resolution was duly passed by the Full Board of Directors of the Bristol Bay Native Association, Inc., at a meeting in Dillingham, Alaska this 11 day of May, 1978.

[signature]
Secretary

BRISTOL BAY NATIVE ASSOCIATION
P.O. BOX 179
DILLINGHAM, ALASKA 99576

SOCIOECONOMIC STUDY OF HERRING

RESOLUTION NO. 78-4

WHEREAS, the North Pacific Fisheries Management Council has set aside funds to complete a socio-economic study of the herring fishery development occuring at the Togiak/Kulukak Bay area of Bristol Bay, and

WHEREAS, the Alaska Board of Fisheries has decided to exclude the participation of the foreign processors in the local herring fishery, and

WHEREAS, such a decision may have an adverse impact on the income and participation of the herring sac roe and roe-on-kelp fishermen of Bristol Bay;

NOW THEREFORE BE IT RESOLVED, by the Board of Directors of the Bristol Bay Native Association, Inc., gathered in Dillingham, Alaska this 11 day of May, 1978 that the North Pacific Fisheries Management Council includes in their socioeconomic study the affects of the decision of the Alaska Board of Fisheries to exclude the foreign processors on the income of the local herring sac roe and roe-on-kelp fishermen of Bristol Bay.

BE IT FURTHER RESOLVED, that the study includes how much income, the local Bristol Bay herring fisherman has made, as compared to the domestic processors participating in the herring fishery.

BE IT FURTHER RESOLVED, that the study reveals the marketing outlets of the local Bristol Bay herring fishermen in the 1978 herring season with the exclusion of the foreign processors.

BE IT FURTHER RESOLVED, that the study reveals the average price per ton received by the local Bristol Bay fisherman, as well as, determines it's benefit to the local economy.

SIGNED: [signature] V.P.
President

ATTEST: [signature]
Secretary

CERTIFICATION:

I hereby certify that the foregoing resolution was duly passed by the Full Board of Directors of the Bristol Bay Native Association, Inc., at a meeting in Dillingham, Alaska this 11 day of May, 1978.

[signature]
Secretary

Nunam Kitlutsisti
Box 267
Bethel, Alaska 99559
May 20, 1978

Juanita Krebs
Secretary of Commerce
Department of Commerce
Washington, D.C.

Dear Secretary Krebs,

Nunam Kitlutsisti is the environmental arm of the 57 native villages of the Yukon-Kuskokwim Delta in Southwestern Alaska. As the only rural group with technical knowledge of the herring fishery, we have been asked to assist the formation of the Western Alaska Resource Commission, which is composed of the Bristol Bay, Yukon, Kuskokwim, Norton Sound, and Kotzebue Sound subsistence and commercial fisheries. The statement of concern over Department of Commerce management of the OSY for Eastern Bering Sea Herring is sponsored by the WARC.

The villages of Western Alaska depend on herring for the mainstay of their summer subsistence fishery, and in localized area, for the major portion of their cash supplement to their subsistence economy. Beginning in the late 60's, a severe problem of economic dislocation involving herring has occured. Our villages were faced with a crisis in conservation, for they recognized with no support from either the State or Federal government that their herring stocks were depleted. Villages that had formally participated in the herring subsistence fishery away from major spawning areas no longer had herring, and villages located close to the major centers of spawn were forced to concentrate their fisheries to days rather then weeks. Western Alaskans finally discovered in 1976 that the Soviets and Japanese had pulse fished the Eastern Bering Sea herring in both directed and non-directed trawl fisheries beginning in 1968-69, and that by 1974, the foreign CPUE had dropped 84%. The villages, which had never had a consistent fisheries policy joined forces, and found a sympathetic body in the North Pacific Fisheries Management Council. The NPFMC and its staff welcomed Western Alaskan participation. Learning of the plight of our villages, the NPFMC acted to reduce the 1977 T.A.C. to 12,000 M.T., with domestic subsistence having the highest priority, and to eliminate the Japanese spring gill net sac-roe fishery as being wasteful and a hinderance to successful subsistence fishing by remote native villages. Due to international pressure, NMFS reversed the Council, establishing a 21,000 M.T. T.A.C. for 1977, 1,000 M.T. being reserved for native subsistence, 1,000 M.T. for an experimental domestic fishery, and the remainder as TALFF. The domestic subsistence allocation was a result of rural native spokesmen informing the NPFMC that subsistence harvest were down due to depressed populations and the forced change-over by entire villages to alternate fish resources once the herring population dropped in Western Alaska.

MAY

In 1977, the domestic harvest far exceeded the allocation, and our problems with both State and Federal management of this resource for commercial purposes intensified.

Based on industry success with a domestic sac roe fishery for herring, the very fishery that had been expelled from the F.M.Z. for being wasteful when practiced by foreigners, saber rattling in government fisheries managment offices developed, fueled by out of the region commercial interests that sought an even larger share of the TAC. Village Alaska acted with restraint however. Realizing that commercial pressure would be intense to increase the domestic fishery, the villages of Western Alaska met in Kipnuq Alaska, September 1-3, 1977 to discuss their concerns. The results of that meeting were support for a complete moratorium on the commercial fishing of herring until the off-shore NMFS, near-shore, ADF&G, and on-shore socio-economic study by the NPFMC were completed. The villages reasoned that without an adaquate data base that the studies would contribute to, any harvest of herring was risky.

At the same time, officials of the Hammond Administration under intense commercial fisheries pressure, were seeking a 1978 domestic allocation of 10,000 M.T. Recognizing that the State had allowed the industry to exceed its 1,000 M.T. allocation by 2200 M.T. in 1977, the villages feared that if the herring showed up in abundance in 1978, the State would again allow the fishery to go past the allocation level. Already, the villagers have witnessed the decimation of their salmon stocks by Japanese high-seas interception and their herring by the mid-water foreign trawl fleet. With no knowledge on the migratory routes of the herring, the villages believed that interception near-shore of their stocks could occur in Bristol Bay, again a subject covered in the proposed NMFS off-shore research program. To this end, the villages further petitioned that all herring fishing be restricted near shore, within the three miles controlled by the Alaska Board of Fish, and adaquately supervised by the Department's Division of Commercial Fisheries.

In regard to allocation, there was a mixture in the native community. The villages north of Bristol Bay have had little experience with commercial fisheries, and wanted no commercial fisheries. The villages in Bristol Bay, witnessing the success and affluence of the domestic purse seine fleet, wanted a more equitable and biologically sound managment program. These villages had contacted other herring fishing areas of the world, and had reviewed the history of purse seine/trawl versus gill nets, and deduced that gill-nets allowed for better management of a food fishery. With the world food crisis, the villages stated that fishing herring for food was more important then appealing to the Japanese sac roe market, and the wasteing of the herring carcasses for meal. A second issue in this remote part of Alaska was that salmon fishing was their only cash income. Increases in CPUE and the quality of gear had caused the Alaska Board of Fish to restrict vessel size to 32 feet. These boats are too small for power seine gear, and with little capitol, no market information, and facing an influential lobby in State politics, the

Bristol Bay fishermen asked the Board of Fish to restrict all boat size to 32 feet, and to eliminate purse seines, thereby making participation in the food herring fishery equal, and beneficial to the people of Western Alaska. The Board of Fish rejected all proposals by Bristol Bay, and even went to the extreme to open up a trawl fishery within State waters in September in order to insure the domestic fleet caught its allocation. Given this unusual support by the Board, the herring fleet began to float ideas of a trawl fishery in the F.M.Z. in September 1978 to cut into the foreign allocation remaining after the 1978 mid-winter foreign harvest. Both in 1977 and again in 1978, the out-of-region commercial fisheries have excluded the native villagers from participating in the fishery. To make matters worse, the FMP for Eastern Bering Sea herring that the coastal villages had expected to be in effect by January, 1979 was now delayed until September, 1979. To the villager, this meant that the unrestricted, State promoted commercial sac roe fishery would have three full seasons of existence, along with a potential for the development of a domestic trawl fishery, and the entire T.A.C. being allocated domestically before the three phases of the herring research effort were completed. The villagers fully expected their concern for the conservation of the resource, a dampening of the commercial fires, and a demonstrated sympathy for subsistence under the FMP would drown by September, 1979. In our own region, the Board of Fish also overruled our villages, and opened up our bays to commercial quotas and purse seines. Our fish and game advisory boards are now preparing to issue closures by emergency orders if the large scale purse seine operators come into our bays. We fully expect to be overruled by the State which has a proclivity toward commercial exploitation without adequate data, but feel that the issue is sensitive enough to warrant Federal intervention if necessary to conserve our herring resources.

The NPFMC undertook an unusual study asked by our villages, and that was a socio-economic study of our subsistence villages toward their personal food harvest, and their ability to enter the commercial fishery in the future if research proved that a surplus above subsistence needs was available. The staff of the Council, the SAC and the AP all promised Western Alaskan representatives that meaningful involvement by Western Alaska would be guaranteed in the study. As we waited for the 1978 commercial season to explode in Bristol Bay, we suffered another disappointment. The Council selected an engineering firm that does environmental work as a sideline, and one whose dearth of subsistence knowledge lead our coastal villages to reject their RFP application, specifically because they was no involvement by knowledgable members of the subsistence community to keep them on the right tract. When we requested that the village designated representatives on the Western Alaska Resource Commission formally assist in the study, we were denied access by both the contractor and the Council. Our villages realise that they are dammed if they participate, and dammed if they don't participate, for the Council and the contractor fully intend to go ahead with the study to comply with their preparation of the FMP, even if the information is inadaquate. In this regard, the soul of the subsistence concern by our villages, we have been tread on. Our villages are not happy with the arrogent manner in which their input on this issue little understood by Western observers has been handled, and many villages have stated that they will not participate unless there is native oversight on the contractors report to insure proper evaluation of the subsistence issue. We fear now with the bulky attitude of the contractorand the staff, that a serious problem resulting in conflicting information and an alternate report by the native community in order to insure proper NPFMC examination of the subsistence issue and village economies will result. Our request for the WARC to meet with the contractor in July and August prior to the preliminary and final reports being turned in by the contractor to the Council have been turned down a second time.

In regard to the 1978 T.A.C., we have learned that the foreign fleet has already exceeded its TALFF in a non-directed herring fishery, catching more than its allocation in the pollack mid-water trawl fishery. The number of domestic processors in Bristol Bay has swelled to five major processors, and numerous small processors, all fishing purse seines. Native villagers sit inside bays close to the summer camps, and hope for subsistence success, or a small part of the commercial quota through use of gill nets, for once again, the commercial purse operations are interested in sac roe and are refusing to buy from native gill net fishermen, who do not have the money, knowledge or interest to participate in this luxury fishery.

While in Washington, a delegation of Western Alaskan fishing leaders met with Terry Leitzle, Director of the NMFS, and Dr. Roland Smith. We discussed our concerns with them, but felt that a follow up letter giving our perspective to youroffice was in order, for from our conversation with these representatives of the DoC, incorrect reports on our position by State and Federal officials were being forwarded to D.C.

In summary, we would like to petition your office for support on the following issues:

1. For the Yukon-Kuskokwim villages, we would request your support of our emergency closures of our bays in the event the large commercial operators go north of Cape Newenham and the Stateof Alaska overrurles our closure, due to inadaquate data base and interference with our subsistence.

2. For an emergency FMP to stop all domestic off-shore fishing by trawl in September, 1978, similar to the plan being proposed by the Northeast Management Council on the purse seining of blue fish off the New Jersey coast in the F.M.Z.

3. For your support of the involvement of the Western Alaska Resource Commission in a formal way in the development of the contractors preliminary and final report to the NPFMC. on the Herring Socio-Economic report.

4. A reduction of the 1979 T.A.C. under an FMP to 112,000 M.T. in order to insure that stock depletion will not occur until the joint Federal/state biological research program has satisfactorily progressed to assure an adaquate data base for a fisheries management decision.

5. Development of time-area closures and gear restrictions on the foreign pollack fishery under the 1979 PMP to lessened the incidental catch of Eastern Bering Sea herring

6. To develop a management plan to insure a food herring industry without use of purse seines/trawls in Western Alaska in the event biological research proves a harvestable surplus above subsistence and stock conservation exists, so as to maximize western Alaskan food production and real economic growth to participating native fisheries.

7. To continue deployment of NMFS manpower and funding to insure that continuing monitoring of the Eastern Bering Sea herring occurs in order to protect our subsistence lifestyles. The only native corporation financially capable of participating in a commercial fishery currently operating is the Bristol Bay Native Corporation, owners of Peter Pan Seafoods. Officials of Peter Pan have stated that they will not participate in any herring operations, pending proper analysis of the food web of the North Pacific and the Bering Sea. Herring is an important link in the food chain of the salmon harvested by our villages for both subsistence and commercial. Commercial fishing of salmon is the major way villagers of Western Alaska have of raising funds to purchase their life necessities.

8. That a revised FMP schedule for the NPFMC be approved for January, 1979 to bring the State of Alaska, and the domestic commercial herring fishery under OSY. As you well know, the domestic fishery can operate without federal sanction in the F.M.Z., which must be corrected immediately.to insure conservation of the resource and protection of our subsistence fisheries.

The villages of Western Alaska feel that until the biological research is completed, the proof that commercial exploitation of the herring stocks will not result in resource depletion rests with the industry and the government agencies promoting their cause. Western Alaska does not believe that other western U.S. regions should dictate fishery policy to the Federal government in the Bering Sea, and we ask your support of the eight steps suggested by Western Alaska to insure proper management of the Eastern Bering Sea herring.

in peace,

Harold Sparck, for the
Western Alaska Resource Commssion

ADDRESS TO THE NORTH PACIFIC FISHERIES MANAGEMENT COUNCIL BY HAROLD SPARCK REPRESENTING THE WESTERN ALASKA RESOURCE COMMISSION BRISTOL BAY, YUKON, KUWKOKWIM, NORTON SOUND, KOTZEBUE SOUND ON THE 1978 COMMERCIAL HERRING FISHERY.

Gentlemen, I want to thank you for this opportunity to discuss the concerns of the four fishing districts of Western Alaska with the Eastern Bering Sea herring.

I have spoken with this Council and its members before, and I feel that given your past actions, I can dispense with a history of our concerns, and speak bluntly and to the point by making specific requests of this Council at this meeting to satisfy the concerns of the people of Western Alaska that I am representi

1. The villages ofWestern Alaska are displeased with the current socio-economic impact study as funded by this Council. Although the Western Alaskan representatives on the Advisory Panel and myself werepromised meaningful participation in this study, western Alaskans knowledgable ofthe subsistence fishery are not involved with this study. On the contrary, requests by the village appointed Western Alaska Resource Commission to meet formally with the contractor and the staff have been rebuffed. I point this out in a critical way for the current contractor's proposal had been rejected by the villages he must work with in advance of his selection due to the glaring deficiency that western Alaskans familiar with subsistence were missing from the proposal. I am asking this Council for its financial support in having the Western Alaska Resource Commission meet with the contractor in late July and August prior to the contract submitting his interim and final report to the NPFMC. We disag with the staff of the Council that the contractors has the capable of adaquately doing this study, and call upon the Council to solve this glaring breech in the controls on the stud This is our subsistence the Council is dealing with, this is the guts of the herring issue from our perspective, and we are not being treated fairly at this time by the contract or contracto
2. We can expect several of the larger processors to come around Cape Newenham into the Yukon-Kuskokwim delta to fish commercially for herring. We did not sanction this move. Our villages have uniformly opposed commercial fishing in lieu of an adaquate resource base. Yet the Board of Fish of theState ofAlaska distinquished itself by opening up our region. I have word from the majorities of both the Central Bering Sea Fish and Game Advisory Board and the Lower Yukon Fish and Game Advisory Boards that if the big boats come, they will close their areas to commercial herring fishing by emergency order. Given the intense political pressure Commissioner Skoog would face from the commercial fishing people, we expect to be overruled. Can we expect assistance from this Council to sustain our closure on the federal level if we appeal directly to the Secretary of Commerce.
3. We seek this Council's support for some consistency in management, and therefore beseech this Council to shuffle its FMP schedule to allow for a January 1979 FMP. We ask for this for it was only two years ago when this Council took the historic step

of eliminating the Japanese sac roe fishery off our coastline, only to have the Stateof Alaska and its Board of Fish re-open a domestic sac-roe fishery six times the reported size of the Japanese effort, again with little or no data. We are also pressed by industry statements that a domestic trawl fishery will be begun in the federal management zone in September, 1978. The industry was encouraged that the Board of Fish for some unknown reason opened up trawl fishing within the shallow Bristol Bay to assure Americans ?? grubbing up every gram of the domestic allocation, so given that surprise, the industry looked further off-shore. NMFS informs us that under a PMP it cannot restrain a domestic fishery in the federal zone, and we cannotcount on the Stateto impose its landing laws on its own commercial people who have proven themselves timeandagain in harmony with the Board of Fish. We ask that this Council ask the Secretaryof Commeroe to institute an emergency FMP to prevent any domestic trawl fishery, and to institute a FMP in January, 1979 that will be honestly based on the best available biological and socio-economic data, and featuring a reduced TAC to 12,000 M.T. as a conservation step to insure no serious stock depletion until the three biological/socio-economic studies required for a adaquate OSY occurs, the establishment of subsistence as the first priority of domestic allocation, a local fish and game advisory board option to participate in domestic commercial herring activities within its sphere of influence, and an even handed analyses of the food herring industry in Bristol Bay versus the sac-roe purse seine effort so that economic activity can be broadened to include participation by native people once they are assured that their herring have a harvestable surplus.

I have taken the liberty of speaking bluntly about our disappointment with the State mechanism controlling herring. It is not the State people, involved, but the process and the tremendous advantage the commercial people have over we Western Alaskans who wish to conserve our resources rather then exploit them.

This Council has been outstanding in listening to us. Your decisions have been fair up to this time. The majorityof you have commercial fishing backgrounds, and it has been surprising how even handed you have treated this issue. But events are rushing fast, witness the tremendous increase in harvest capacity in Bristol Bay, the discovery of the foreign incidental catch ofherring in a legal fishery which will creat awful problems for many years under a reduced TALFF, ?? the actions of this Council to set back the FMP for herring, and the Board of Fish's devotion to a dubious luxury fishery that imperils our resources, and does nothing for stable economic development in western Alaska.

Gentlemen, we do not believe that Prince William Sound, Kodiak Southeastern Alaska or Seattle should dominate this Council or the Stateof Alaska's decision making on the conservation of marine resources in the Bering Sea. If they ruin own fishery while making their money, we have to pay the expenses. We want conservation, not exploitation, by forcing the industry to prove that its fishery will not harm the resource. As it is now, both the State and Federal government are demanding that we prove it will. I request Council resolutions at this time on the three issues so that thepeople of Western Alaska will know where their interests stand with this Council.

STATE OF ALASKA

DEPARTMENT OF FISH AND GAME

JAY S. HAMMOND, GOVERNOR

OFFICE OF THE COMMISSIONER / SUBPORT BUILDING
JUNEAU 99801

June 15, 1978

Mr. Harold Sparck, Director
NUNAM Kitlutsisti
Box 267
Bethel, Alaska 99559

Dear Mr. Sparck:

Governor Hammond has requested that my staff respond to the concern you have expressed to Mr. Jerry Gilliland, Assistant to the Secretary to the Department of Interior, regarding allocation of fishery resources in the Bering Sea, and particularly the management of Western Alaska herring stocks. Your testimony in Anchorage before the North Pacific Fishery Management Council recently further emphasized to me the need to strengthen lines of communication between the Alaska Department of Fish and Game, your office, and the people you represent. I know that my staff and the Board of Fisheries have discussed the herring fishery with you in the past, but perhaps some confusion still exists regarding our research and management program. My staff has prepared the following information for you.

Bering Sea herring congregate during the winter months in the area of the Pribilof Islands in the east Central Bering Sea. This wintering population is an aggregate of an unknown number and proportion of spawning stocks from various areas of Western Alaska and Siberia. These populations were harvested by Russia and Japan under limited regulation until the enactment of the Fishery Management and Conservation Act of 1976. The foreign harvest is taken from all contributing stocks with no consideration for individual stock strength use by other user groups such as your village association, and with no regard to the annual spawning success of the various stocks.

Attached is a table showing the foreign harvest of Bering Sea herring from 1959 to 1976. You will note that the bulk of the harvest has been taken by Russia and Japan and in some years has totaled over 200,000 metric tons. The table also illustrates the decline in foreign harvest to only 23,000 metric tons in 1976. This decline occurred for unknown reasons, but certainly the magnitude of foreign harvest and the lack of meaningful regulations based on annual spawning success were a major contributor.

The Fisheries Conservation and Management Act provides for reduction in foreign quotas based on increasing utilization by domestic fisheries. As the domestic fishery increases its capacity and desire to utilize the resource, the foreign harvest will be decreased to provide for this. Based on projected expansion of domestic commercial harvest in 1978, the foreign catch allocation has been reduced to 8,670 metric tons from their 1977 level of 20,000 metric tons. I might add that based on concern for certain spawning stock segments, particularly those in the Nelson Island area, the Japanese gillnet fishery on Western Alaska herring was all but eliminated in 1977 and with the closure of the Bering Sea east of 168° the gillnet herring fishery will not be conducted in 1978.

The inshore harvest is managed by the State of Alaska on a stock specific basis. When stocks are found to be numerically in excess of spawning requirements a harvest can be allowed. When a stock is being used primarily for subsistence purposes other uses can be reduced or prohibited. It seems in the best interest of your association and their concern for the status of various stocks up and down the coast, to support reduction of the foreign harvest, as rapidly as possible and promote stock regulation by the State of Alaska in the Territorial Sea.

The North Pacific Fisheries Management Council is in the process of developing a fisheries management plan for Bering Sea herring stocks. An integral part of this plan will be the State's management outlook for the inshore commercial and subsistence fisheries of Western Alaska. The first draft of this plan is due in November of this year and will be the subject of public hearings as well as discussion at the Council meetings which are open to the public. I would suggest that you interact with the Council in these hearings on the development of the plans. Additionally, the regulation within the Territorial Sea will be accomplished through the State Board of Fisheries. Again, this process will be the subject of extensive hearings by the Board and there will be ample opportunity for the Western Alaska coastal communities to review this years management and research results and make their views known.

As part of the Outer Continental Shelf resource assessment program the Alaska Department of Fish and Game conducted spawning surveys of herring stocks in Western Alaska both in 1976 and 1977. This base line data will be used for comparison purposes in managing these fisheries in 1978/79. The North Pacific Fisheries Management Council through contract with the Department of Fish and Game has provided for a continuation of these surveys, expanded research on spawning success and size and age composition of Western Alaska stocks. I have attached a copy of the contract outlining the research plan. Also attached is a copy of our management operational plan for the Togiak district commercial herring fishery and pertinent Board of Fisheries regulations for herring fishing in Western Alaska.

I understand that on May 3 our A-Y-K staff transmitted a letter regarding the herring fishery which outlined for the 1978 season, commercial and subsistence fishing regulations, permit and licensing requirements and research plans to all coastal communities and advisory committees from Cape Newenham to Teller. Areas closed by the Board of Fisheries to commercial fishing to protect stocks being heavily utilized by the subsistence fishery were indicated on maps.

I hope that these documents demonstrate to you that the herring fishery as conducted by the domestic fleet this year is the subject of a specific management and research program and is being closely monitored. There is an obvious advantage of this approach over the stock indiscriminate harvest conducted by foreigners on the high seas.

I read with interest your plans to form a Western Alaska Resource Commission and would like to offer the services of my staff to provide you with biological information on the fish and game resources of your area as may be required by the Commission. Thank you for your continuing interest and innovative thoughts on fisheries matters in the A-Y-K region.

Sincerely,

Carl L. Rosier

for Ronald O. Skoog
Commissioner

Enclosures

Table . Herring catches by foreign nations from the Bering sea and Aleutian Islands.

Year	USSR	Japan	South Korea	Total
	in thousands of MT			
1959	10	--	--	10
60	10	--	--	10
61	80	74	--	154
62	150	10	--	160
63	150	32	--	182
64	176	43	--	219
65	10	36	--	46
66	5	28	--	33
67	--	33	--	33
68	22	45	--	67
69	94	36	--	130
70	117	28	--	145
71	23	23	--	46
72	54	6	--	60
73	34	2	tr.	36
74	20	6	tr.	26
75 1/	14	1	tr.	15
76 1/	17	6	tr.	23

1/ Personal communication, Naab, R.C., Law Enforcement Div., NMFS, Juneau

Source: National Marine Fisheries Service, 1977. Environmental impact statement/preliminary fishery management plan - Trawl and herring gillnet fishery of the Bering Sea and Aleutian Islands, Juneau.

Kipnuk Village Council

GEN. DELIVERY • KIPNUK, ALASKA 99614 • 598-8001

PRESIDENT: ISAAC B. AMIK
VICE PRES.: PETER WHITE, SR.
SECRETARY: Billy W. Anaver
TREASURER: HENRY DOCK

MEMBERS
1. Luke Amik Sr.
2. Paul Kiunya Sr.
3. Teddy Kugtsun

June 20, 1978

Mr. Jim Branson
North Pacific Fishery Management Council
P.O. Box 3136 DT.
Anchorage, Alaska 99510

Dear Sir;

We, the Kipnuk Village Council on behalf of the community of Kipnuk, would like to express our thought concerning the fishing of Herring Commercially on the waters of the Southwestern Coast of Alaska from the point off Stebbins to the point off the Kuskokwim Bay.

On the mentioned area above we'd like it known that we do not, repeat do not, want any kind of Commercial Fishing done for Herring.

We feel that we have enough problems of our own now concerning subsistance without more, which we know will arise, if Commercial Fishing should be allowed in the waters of the area mentioned above. As far back as we can remember we have depended quite heavily on Herring, besides some other game we can get in our area, to help us through the winter here in Kipnuk.

Just recently we had a visit by a gentlemen from Dames and Moore, who was conducting a survey regarding the total amount of Herring caught in this area. That let us to believe that, the results of that survey will help to determine whether or not Commercial Fishing will be allowed in this area.

If there is to be a decision made on this matter we'd like it known that we will do anything in our power to conflict against Commercial Fishing in our area.

Cont'd.

p k Village Council

LIVERY • KIPNUK, ALASKA 99614 • 598-8001

NT: ISAAC B. AMIK
ES.: PETER WHITE, SR.
RY: JOSEPH DOCK Billy W. Anaver
ER: HENRY DOCK

S

1. Luke Amik Sr.
2. Paul Kiunya Sr.
3. Teddy Kugtsun

We have expressed our feelings to that gentlemen who conducted that survey and we have come up with some reasonable results on the conversation with him which we feel should be enough to prove that no Commercial Fishing should be allowed in our area.. These reasons below are only a few we can think of now, but we hope they will help you to realize why we don't want Commercial Fishing.

(1). If Commercial Fishing should be allowed, we feel that it will bring negative results on our subsistance way of life.

( ). We have heard some talks which lead us to believe the preservation of wildlife, both on land and water, was important. What do you think will result if too much fish is taken, if Commercial Fishing was allowed?

(3). The existance of Herring seems to have decreased recently and we feel that if Commercial Fishing should be allowed the Herring will be subject to extinction in our area, because at times we have caught nothing, repeat nothing, when fishing for them.

The above are only a few of the many reasons we can come up with which can, not only bring us problems but can hurt the existance of Herring in this region. Like we said, we have depended heavily on Herring as one of our main source of food in the past and we know that we will always depend on them in the years to come.

Any help you can render to us to help prove that <u>NO</u> Commercial Fishing should be done in this area will be of great help to <u>not</u> only the people of this community <u>but</u> to the other communities along the Southwestern and Western Coastal areas of Alaska.

Cont'd.

Kipnuk Village Council

GEN. DELIVERY • KIPNUK, ALASKA 99614 • 598-8001

PRESIDENT: ISAAC B. AMIK
VICE PRES.: PETER WHITE, SR.
SECRETARY: ~~JOSEPH XXXX~~ Billy W. Anaver
TREASURER: HENRY DOCK

MEMBERS
~~XXXXXXXXX~~ 1. Luke Amik Sr.
~~XXXXXXXXX~~ 2. Paul Kiunya Sr.
~~XXXXXXXXX~~ 3. Teddy Kugtsun

We will be looking forward to a reply of notification of NO Commercial Fishing to be done in this area.

Sincerely,

Isaac B. Amik
President
Kipnuk Village Council

xc: Governor Jay S. Hammond
Senator George Hohman
Representative Nels Anderson Jr.
U.S. Senator Ted Stevens
U.S. Senator Mike Gravel
U.S. Congressman Don Young
Dames & Moore ✓
Carl Jack, President A.V.C.P.
Files

IBA:ead

Norton Sound Fishermen's Co-Operative
P. O. Box 10
UNALAKLEET, ALASKA 99684

Steve Braund
c/o Dames & Moore
510 L Street Suite 310
Anchorage, Alaska 99501

Steve:

Being that we did not get to see each other, I felt it important that I contact you concerning the matter of herring fishing in the Unalakleet area. I talked to a few people and the concensus was that they would like to keep it local. They also felt that commercial fishing for herring would not interfere with subsistence fishing to any substantial degree.

However, the local native corporation has voiced interest about using their 60 foot vessel (the 50 ton net capacity "Muktuk") for purse seining herring. Being that the Unalakleet Native Corporation is, to a great extent, locally owned there is a conflict of interests. On one hand, the village people would like the herring fishing to be local yet, as you mentioned, one way the Management Council could keep it local was by regulating the size of the gear.

If something could be worked out to the advantage of the local people who are using their own equipment, I am sure the people of Unalakleet would appreciate having a local type of industry. However, if the only way to keep the fishing local would be to have some limitations on gear size, then I'm certain the corporation could find alternate means of using their vessel.

Thank you for your concern on our behalf and I hope we can keep in touch.

Sincerely,

Isaiah Towarak
Business Manager

IT/je

Phone 624-3722

D

PRELIMINARY REPORT ON BLOCK 60, OUTER BRISTOL BAY, SURF CLAMS, AND HYDRAULIC DREDGING

Prepared for:
North Pacific Fishery Management Council

Chief Biologist:
Gerald J. Bakus, Ph.D.

Tetra Tech Report No. TC 3224

June 1978

Tetra Tech, Inc.
630 North Rosemead Boulevard
Pasadena, California 91107
(213) 449-6400

TETRA TECH, INC.
630 NORTH ROSEMEAD BLVD.
PASADENA, CALIFORNIA 91107
TELEPHONE (213) 449-6400
TELEX NO. 67-6345
TETRATECH PSD

June 22, 1978

Mr. Mark I. Hutton
Assistant Executive Director
North Pacific Fishery Management
Council
333 W. 4th
Anchorage, AK 99510

Dear Mr. Hutton:

This report entitled "Preliminary Report on Block 60, Outer Bristol Bay, Surf Clams, and Hydraulic Dredging" is submitted in compliance with Contract No. TC 3224.

The report includes detailed information on the climatology, oceanography, geology, and marine biology of Block 60. It reviews the biology of the Atlantic surf clam and that of the Alaskan and Atlantic pinkneck clam. A review of the effects of sediment dredging and disposal, a history of hydraulic dredging, and the effects of hydraulic shellfish harvesting on the marine ecosystem is also included.

We are awaiting further data from some of the numerous individuals that have been contacted on the east coast of the United States and in Alaska. Your comments on the present preliminary report would be greatly appreciated.

Sincerely yours,

TETRA TECH, INC.

Gerald J. Bakus

Gerald J. Bakus, Ph.D.
Chief Biologist

GJB:ts

EFFECTS OF HYDRAULIC CLAM HARVESTING ON THE BERING SEA ECOSYSTEM

1.0 BERING SEA ECOSYSTEM

1.1 Introduction

A large-scale investigation of clam resources in the Bering Sea was conducted in 1977 (Hughes et al., 1978). The surf clam (pinkneck clam), *Spisula polynyma*, was identified as an abundant potential commercial species in the study area. A site was selected to study the effects of hydraulic clam harvesting on the marine ecosystem in 1978, prior to the initiation of commercial clam harvesting. This study site is a square 10 miles on a side, located at 56° 30'N. latitude and 160° W. longitude (Figure 1). This portion of our report provides baseline information on the study site, surf clam biology, and the effects of hydraulic clam harvesting on the marine ecosystem.

1.2 Climatology and Oceanography

The air temperature, precipitation, surface wind, and tides at Port Moller and Port Heiden (two bays adjacent to the study area--see Figure 1) are summarized in Table 1. Snowfall is maximum in December for Port Heiden and March for Port Moller. Port Heiden is located in a rain shadow. Although Table 1 would suggest moderate winds, other sources report strong to extreme winds (23 knots, south by southeast) as a normal summer phenomenon in the coastal study area (Alaska Department of Fish and Game, 1977). The tide changes from a duirnal to a semiduirnal mode thus occasionally producing a vanishing tide, that is, periods of no tidal flux.

FIGURE 1. Location of the Intensive Research Study Region (Block 60).

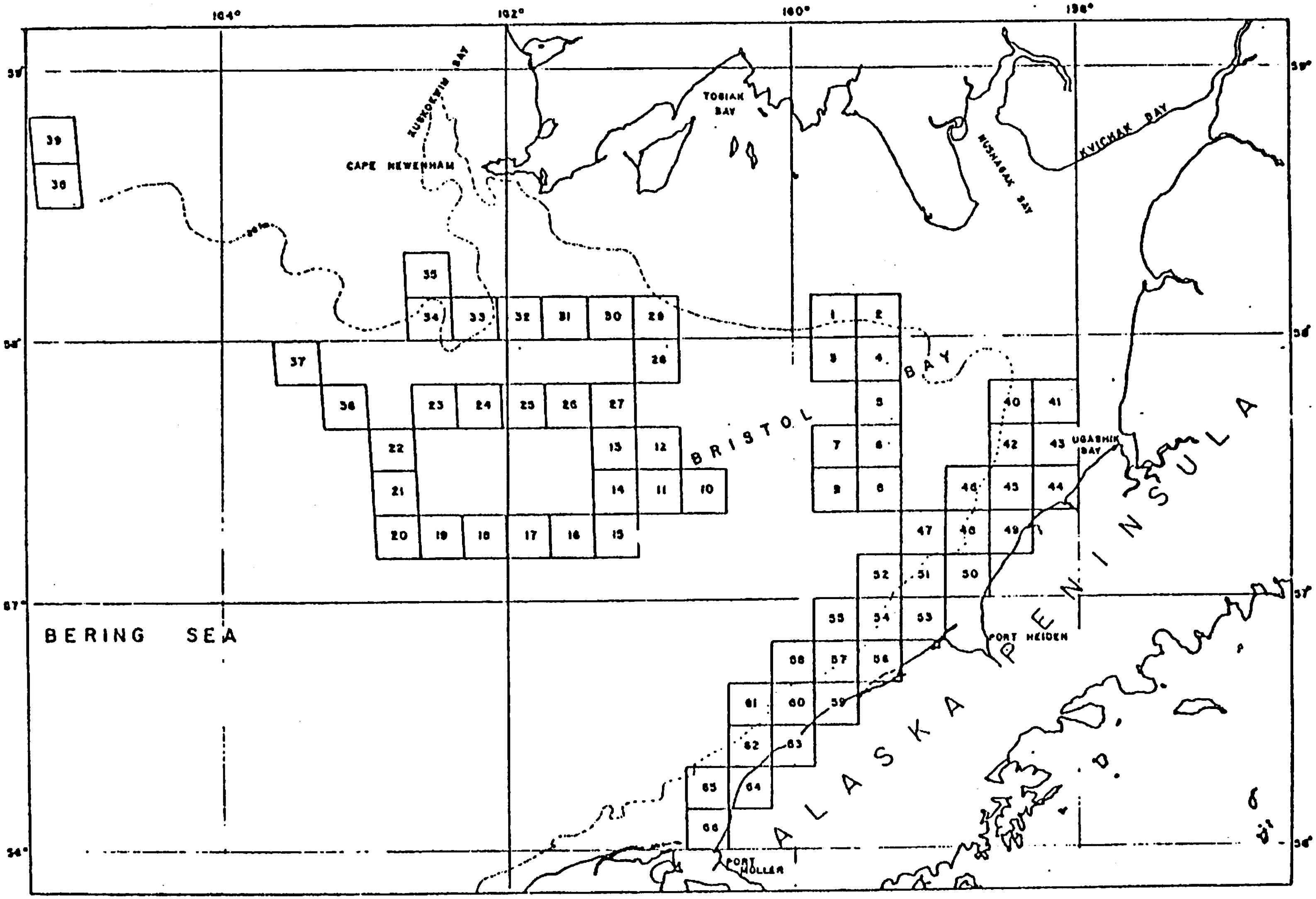


Table 1. COASTAL CLIMATOLOGY AND TIDES OF THE STUDY REGION, OUTER BRISTOL BAY[1]

	Port Moller	Port Heiden
Air temperature - Highest	23.3°C	30.6°C
Air temperature - Mean Maximum	5.5°C	5.5°C
Air temperature - Lowest	-22.8°C	-31.7°C
Air temperature - Mean Minimum	-2.9°C	-1.7°C
Precipitation - Mean Annual	111 cm	37 cm
Snowfall - Fraction of Annual Precipitation	~39%	~18%
Surface Wind - Direction and Mean	S 8.7 kn	ESE 12.9 kn
Surface Wind - Maximum	S 55 kn	E 65 kn
Tide - Minimum	-3.9 ft	-4.3 ft
Tide - Maximum	12.9 ft	14.3 ft
Tide - Mean Daily Range	10.8 ft	12.3 ft

[1]Source: Bower *et al*. (1977).

The climatology and oceanography of inshore and offshore waters in Block 60 is summarized in Table 2. The general ocean circulation in Bristol Bay consists of a cyclonic gyre (counterclockwise). Pacific water enters the Bering Sea near Unimak Island then flows northward, and also eastward along the north side of the Alaska Peninsula towards Bristol Bay (Sharma, 1974; Environmental Research Laboratories, 1976). The surface current velocity in the general region around the study area is about 5 cm/sec in summer and <10 cm/sec in winter (Natarov, 1968; Takenouti and Ohtani (1974). The major source of freshwater into Bristol Bay is the Kuskokwim River. Many smaller rivers near Block 60 supply water and sediments to the coastal study area. The salinity of the shallow shelf water in the Bering Sea averages between 31.5 and 32.3‰ (Takenouti and Ohtani, 1974), although local streams may reduce these values even further during summer along the coast. The study area can have ocean ice between about December 16 and April 30. The sea first freezes in the north (Ugashik Bay) then ice continues to form southward into Block 60. Seawater temperatures and wave heights are indicated in Table 2. Oxygen in the general region around the study area measures about 105% of saturation on the surface and approximately 70% of saturation at the bottom in summer. Nutrient values in seawater in the same general region in summer are as follows: phosphates-surface ~20 mg P/m^3, bottom ~70 mg P/m^3; nitrates-surface ~0 mg N/m^3, bottom ~1 mg N/m^3; silicon-surface ~100 mg Si/m^3 (Davidovich, 1968). Alexander (1977) presents numerous data on concentrations of these nutrients in March and April in an area about 125 miles west of Block 60. She states that nutrient values over the continental shelf in the euphotic zone of the Bering Sea are relatively constant just prior to the spring bloom (nitrate ~17.5 μg-at/l, phosphate ~1.5 μg-at/l and silicate ~34 μg-at/l). The concentrations of suspended matter, derived largely from

Table 2. CLIMATOLOGY AND OCEANOGRAPHY OF BLOCK 60, OUTER BRISTOL BAY[1]

	Month[2]											
	J	F	M	A	M	J	J	A	S	O	N	D
Air temperature(°C) - Mean	-4	-4	-2	1	4	7	10	10	10	5	2	-2
Sea surface temperature(°C)												
Maximum	4	2	5	5	8	10	14	14	13	13	8	6
Mean	0	0	0	1	4	6	9	10	10	9	6	4
Minimum	-1	-1	-1	-1	-1	0	3	6	7	3	1	-1
Sea level pressure (millibars)	1006	1003	1009	1010	1010	1012	1015	1012	1007	1002	1001	1003
Wind speed												
(%≤ 10 kn)	45	35	43	45	53	62	70	47	33	20	44	35
(%≥ 34 kn)	<5	5	<5	<5	<5	<5	<5	<5	<5	5	5	8
Cloud cover - low clouds												
(%≥ 5/8 of the area)	55	68	55	67	67	71	78	78	66	65	66	60
Fog (% occurrence)	10	<10	10	13	16	20	20	22	17	8	<10	<10
Visibility												
(%< 2 naut. mi)	12	<10	<10	13	17	5-20	20	<10	7	5	8	8
Waves												
(%< 2.5 m)	92	76	90	86	93	92	>95	87	86	73	80	55
(%< 1.5 m)	60	60	75	53	65	63	65	65	43	52	55	88

[1] Source: Bower *et al.* (1977).

[2] Mean values for each month.

coastal streams and lagoons, decrease rapidly away from the coast, due to the rapid mixing of highly turbid shelf water with relatively clear Pacific Ocean water (Feely and Cline, 1977). Total suspended matter (mg/l) in surface waters is 1.52 (September-October) and 1.92 (June-July); at 5 m above the seafloor it is 4.95 (September-October) and 2.12 (June-July). Neiman (1968) reports that suspended solids in bottom water near Block 60 measure ~8 mg/l. Sharma (1974) gives a value of 10 mg/l at a depth of 15 m in the study area. The high values for bottom waters suggest possible resuspension of bottom sediments. This may be particularly true during stormy weather or when swell with long wave lengths pass through the area. Feely and Cline (1977) found particulate matter depletion in Mg, Al, Si, K, Ca, Ti, Mn, and Fe and enrichment in Ni, Cu, and Zn. Hydrocarbon levels in Bering Sea waters indicate no petroleum pollution. Surface concentrations (nl/l) were 150 for methane and 60 for ethane; 5 m above the seafloor they were <100 for methane and 50 for ethane.

1.3 Geology

The region surrounding Block 60 is seismically active, due to the thrusting of the nearby Pacific tectonic plate under the American plate. The largest seismic ocean waves recorded at Port Heiden were 2 m (Alaska Department of Fish and Game, 1977). Sediments are derived from land drainage to the east and north of Block 60, and contemporary vulcanism along the Alaska Peninsula in the south (Sharma, 1974). Some of the sediments are transported northeastward both by littoral drift and by offshore general cyclonic circulation; fine sediments tend to be transported offshore by long waves generated by frequent storms in the Bering Sea. Considerable sediment is transported by winter ice, the amount varying regionally and temporally. Beach sediments between Port Moller and Port Heiden are sand and gravel, apparently without rocky areas (Alaska Department of Fish and Game, 1977). Nearshore sediments in the s.e. Bering Sea are gravel and coarse sand, extremely poorly sorted, and strongly coarse skewed. Offshore sediments are fine to medium sands, moderately well sorted, with a more symmetrical size distribution. Most sediments are leptokurtic to extremely leptokurtic. Sediments near the study area are moderately poorly sorted with a mean sediment size of $<1.5\phi$ ($<350\mu m$) and an organic carbon content (wt %) of 0.05. Sediment samples taken from the study site were not yet analyzed in 1976 (Hoskin, 1976; station 2). Neiman (1968) records an organic carbon content of <0.5% for an area near Block 60.

Sediment minerals in the southeastern Bering Sea include smectitic material (20-40%), illitic material (20-50%), chlorite (30-40%), and kaolinite ($\overline{<}$10%). Smectitic material is presumably derived from volcanic ash and kaolinite presumably introduced by the Kuskokwim-Nushagak River systems (Naidu, 1976). Volcanic glass comprises >1% of the sediment in Bristol Bay. Detailed mineral composition of Bering Sea sediments is given in Gershanovich (1968; Figure 8, p. 51). Sediment mineral values located closest to Block 60 (weighted peak area %) are illite (61), chlorite (22) and kaolinite (15) (Burrell, 1977; station 2). The total trace metal contents (ppm) of surface sediments (0-2 cm deep) nearest Block 60 are Mn (573), Va (118), Ba (650), and As (4.3) (Burrell, 1977, station 12). Petroleum hydrocarbons, organic carbon, and acid ratios in sediments of the same locality are given in Table 3.

1.4 Coastal Characteristics

Wet tundra covers all of the coastal lowlands between Port Moller and Port Heiden. Beach rye grass, beach pea, seabeach

Table 3. PETROLEUM HYDROCARBONS IN SEDIMENTS NEAR BLOCK 60, OUTER BRISTOL BAY[1]

Fraction	Values
Nonsaponifiable[2]	43.9
Hexane[2]	3.4
Benzene[2]	1.4
Methanol[2]	32.9
Total Hydrocarbons[2]	4.8
Organic Carbon (%)	0.14
Total n-alkanes[2]	0.331
HC/OC ($x10^{-4}$)[3]	34.3
ALK/OC ($x10^{-4}$)[3]	2.3
FA/HA	1.59

[1]Source: Kaplan et al. (1977). FA/HA ratio from Station 45B, all others from Station 12.

[2]µgm/gm dry sediment.

[3]HC = hydrocarbons

OC = organic carbon

ALK = alkanes

FA = fulvic acid

HA = humic acid

sandwort, and common oysterleaf (all halophytic plants) fringe the coastline (Alaska Department of Fish and Game, 1977). Bank swallows feed on insects in beach drift algae and magpies and ravens are coastal scavengers. The red fox, two species of weasels, mink, wolverine, and the land otter feed on carrion and marine organisms washed ashore. Porcupines consume tundra vegetation and algae washed ashore. Bears (represented by the densest concentration on the Alaska Peninsula) travel along the beaches from mid-June through July and scavenge for food. Because of coarse sediment (sand and gravel), freezing temperatures, and ice scouring, the intertidal supports a low diversity and abundance of marine invertebrates. Polychaete worms are most diverse and abundant although apparently no intertidal collections have been made in Block 60 (Environmental Research Laboratories, 1976). Capelin, boreal smelt, and eulachon (anadromous) spawn in or near Block 60, capelin on sandy beaches in large numbers. Villagers catch boreal smelt and capelin with cast nets, dip nets, buckets, and by hand (Scientific Applications, 1977).

1.5 Primary Production

There are no records of benthic algae growing in the intertidal or subtidal regions of Block 60, so far as is known. Drift algae washed ashore is probably derived from lagoons such as Port Moller or even Izembek Lagoon (containing the largest eelgrass beds in the world). There is often a rich growth of under-ice algae and its primary production is 44-95 mg C/m^3/day (McRoy and Goering, 1974). Diatoms dominate the phytoplankton in and near Block 60, especially *Chaetocerus* and *Phaeoceros*. Densities of 10^5 cells/m^3 are reported (Environmental Research Laboratories, 1976). A detailed list of phytoplankton species, total densities, chlorophyll, and carbon fixation rates with depth are given by Alexander (1977) for a site about 125 miles west of Block 60. A summary of primary production is given in Table 4. The spring phytoplankton bloom is intense, severly reducing light penetration. After surface water primary production has somewhat subsided, the process continues at depth. Summer and fall waters have a low nutrient concentration and relatively little production as a result (Alexander, 1977).

1.6 Zooplankton

The dominant zooplankton in the southern Bering Sea Shelf waters are copepods and amphipods. The dominant summer copepods in and near Bock 60 are the Arctic *Calanus glacialis* and the Arctic-Boreal *Acartia longiremis*. Other dominant zooplankton in Bering Sea waters include *Parathemisto libellula* (amphipod) and *Thysanöessa rachii* (euphausiid) (Motoda and Minoda, 1974). Near Block 60 there is a coastal community of neritic copepods and two cladocerans (*Podon, Evadne*), as well as abundant meroplankton (Cooney, 1977). Zooplankton biomass in surface waters north of the Alaska Peninsula in June and July was 0.21-7.48 ($\bar{x}$ = 1.54) g wet wt/m^3; in the upper 80 m it was 13.1-627.9 ($\bar{x}$ = 114.7) g wet wt/m^2 (Minoda and Marumo, 1974). Population fluctuations produce large biomass peaks of zooplankton about every three years (Motoda and Minoda, 1974).

1.7 Benthic Biota

The benthic biota comprises the under-ice algae and invertebrates (often amphipods) as well as numerous seafloor invertebrates and demersal fish. Polychaete worms dominate the infauna of the southern Bering Shelf, and molluscs, crustaceans, and flounders the epifauna (Experimental Research Laboratories, 1976). Most benthic species exhibit a markedly patchy distribution. The biomass of benthic animals in the

Table 4. PRIMARY PRODUCTION OF PHYTOPLANKTON IN THE BERING SEA

Region	Production (mg/C)	Time	Source
Bering Sea Shelf	500/m^2/day	summer	McRoy & Goering, 1974
Bering Sea Shelf (under an ice cover)	15-20/m^2/day	winter	McRoy & Goering, 1974
Bering Sea, Southern Shelf	0.3/m^3/hr 1.2/mg chl. a/hr		Environmental Research Laboratories, 1976
Bering Sea, Eastern	21/m^2/day	winter (Feb.)	McAlister and Perez, 1977
Bering Sea, Southeastern, and the Aleutian Islands	243/m^2/day	summer	McRoy & Goering, 1974
Offshore, near Block 60	3600/m^2/day 200/m^3/day 100/m^3/day	fall fall summer	Azova, 1968

eastern Bering Sea, poorest region in the Bering Sea, averages 55 g/m^2 live weight (Alton, 1974). The rank order of abundance of animals in a portion of Bristol Bay (Group 1 Pereyra et al., 1976) is given in Table 5 and the total catch of animals taken near Block 60 in Table 6. Red king crabs occur in very low numbers. Both species of snails (*Neptunea lyrata*, the commonest gastropod, and *Fusitriton oregonensis*, taken from about 33% of the stations) are eaten by the Japanese. A recurrent species group analysis in the study area provided only one group of limited diversity (a red king crab--Pacific sandfish group), suggesting a high degree of patchiness in the distribution of benthic organisms. Feder (1977) reported poor penetration of a 0.1 m^2 van Veen grab in sand or gravel bottoms in his Bering Sea studies. He found considerable patchiness in the infauna and recommended 5 or 6 samples (replicates) as a minimum number to take per station. Commercial fish and invertebrates taken in or near Block 60 by the NMFS exploratory trawls (1948-1975) are presented in Table 7. Neiman (1968) produced data on the *Spisula polynyma* biocoenosis (Table 8) and Hughes et al. (1977) on 4 species of clams in Block 60 (Table 9).

1.8 Fish

At least 96 species of fish, representing 29 families, are recorded from Bristol Bay (Environmental Research Laboratories, 1976). The dominant families are Cottidae, Liparidae, Stichaeidae, Pleuronectidae, Zoarcidae, Agonidae, Scorpaenidae and Salmonidae, representing 73% of the species. Bristol Bay contains an unusually high proportion of cottids and liparids. It has the world's largest sockeye salmon runs.

Table 5. RANK ORDER OF ABUNDANCE OF ANIMALS IN GROUP 1 (including Block 60), BRISTOL BAY[1]

Species	Percent Occurrence	Biomass (CPUE kg/km)[2]
Yellowfin sole	100	103.6
Rock Sole	93	12.9
Pollock	88	10.7
Sturgeon Poacher	84	-
Great Sculpin	74	3.4
Alaska Plaice	-	3.7

[1]Source: Pereyra *et al*. (1976).

[2]CPUE = catch per unit effort.

Table 6. TOTAL CATCH OF MARINE ANIMALS NEAR BLOCK 60, OUTER BRISTOL BAY[1]

Animal Group	Biomass (CPUE kg/km)[2]
All Animals	141
All Fish	105
All Invertebrates	36
Flounders	100
Yellowfin Sole	62
Rock Sole	19
Pacific Halibut	16
Longhead Dab	<0.5
Sculpins	2
Poachers	1
Gastropods	<0.5
Fusitriton oregonensis	< 2,000 NM^2
Neptunea lyrata	< 2,000 NM^2
Red King Crab	< 0.5 < 1,000 NM^2
Tanner Crabs	
Chionoecetes opilio	0
C. bairdi	0

[1]Pereyra et al. (1976).

[2]CPUE = catch per unit effort.

Table 7. NATIONAL MARINE FISHERIES SERVICE EXPLORATORY TRAWLS IN OR NEAR BLOCK 60, OUTER BRISTOL BAY[1]

Cruise	Depth (fms)	Trawl and Trawling Time (hr)	Dominant Species	CPUE (lb)[2]
Sunny Bay 66-5, Station 9	14	OTE[3] (1)	Yellowfin Sole	432
			Pollock	70
			Sandfish	35
			Sculpins	20
			Total	658
Oregon 73-4, Station 79	17-18	OTE (1)	Yellowfin Sole	5,312
			Starfish	420
			King Crab	326
			Longhead Dab	83
			Total	6,173
Oregon 75-2, Station 18	30-33	OTE (1)	Yellowfin Sole	827
			King Crab	594
			Tunicates	450
			Rock Sole	203
			Total	1,685

continued next page

Table 7 (Cont'd.) NATIONAL MARINE FISHERIES SERVICE EXPLORATORY TRAWLS IN OR NEAR BLOCK 60, OUTER BRISTOL BAY[1]

Cruise	Depth (fms)	Trawl and Trawling Time (hr)	Dominant Species	CPUE (lb)[2]
Miller Freeman 75-1, Station				
212	28-32	MOTE[4] (0.5)	Yellowfin Sole	243
			Rock Sole	120
			Halibut	84
			Tunicates	80
			Total	780
213	19-22	MOTE (0.5)	Yellowfin Sole	456
			Rock Sole	137
			Halibut	117
			Shells	53
			Total	1,129

[1]Source: National Marine Fisheries Service (1948-1975).

[2]CPUE = catch per unit effort.

[3]OTE = 94 ft eastern otter trawl

[4]MOTE = modified 94 ft eastern otter trawl.

Table 8. THE *SPISULA POLYNYMA* BIOCOENOSIS[1]

Species	Mean Biomass g/m^2	Percentage of Total Biomass	Average Number of Individuals per m^2	Frequency, % of Stations	Characteristics of the Animals	
					Zoo-geographic	Trophic
Spisula polynyma voyi	7.0	50	360	100	L	F
Venericardia crebricostata	2.8	20	70	100	L	F
Nucula tenuis	1.2	10	20	40	P	B
Scoloplos armiger	1.1	9	100	100	O	C
Solariella obscura	0.3	3	1	60	A	B
Echinarachnius parma	0.2	3	4	20	L	F
Tellina lutea	0.1	1	1	40	L	B
Pontarpinia longirostris	0.1	1	5	40	L	F
Spiophanes bombyx	0.1	1	3	40	L	B

[1]Source: Neiman (1968). Total of 6 stations, depth 35-60 m, mean biomass of biocoenosis = 14 g/m^2.

Note: P=8.5%; A=3.0%; L=75.0%; O=7.5%; F=74.0%; B=13.5%; C=7.5%.

Table 9. DOMINANT CLAMS IN BLOCK 60, OUTER BRISTOL BAY[1]

Species	Mean Catch (lb/hr)	Biomass (MT)[2]
Spisula polynyma	350	31,194
Tellina lutea	12	1,025
Serripes laperousii	17	1,540
Serripes groenlandicus	0.1	13

[1]Source: Hughes et al. (1977). Data based on 21 tows. Biomass is estimated for the entire Block 60.

[2]MT = metric tons.

The biomass of all demersal fish in the southeastern Bering Sea is 3.7 mt/km^2; for flatfish it is 0.58 mt/km^2 (Alton, 1974). Yellowfin sole comprise 13% and rock sole and flathead sole 3% of demersal fish in the region. The spawning areas of most demersal fish in the eastern Bering Sea are not known or only poorly known. The nursey areas for juveniles are virtually unknown (Scientific Applications, 1977). Waldron et al. (1977) record ichthyoplankton, *Ammodytes hexapterus* (68), *Theragra chalcogramma* (1), and unidentified fish (1) near Block 60. Pereyra et al. (1976) summarize the dominant fish for the study area (Table 10). The onshore and offshore fish populations between Port Heiden and Port Moller are summarized in Table 11. Capelin are known to spawn from the beach to a depth of 60 m. Although they are not commercially exploited (villagers catch them), they are considered to be a potential commercial fisheries (Barton et al., 1977). The total adult salmon run during a peak period of about three weeks in the study area is estimated at 1.1 million fish, of which 60% are sockeye and 30% chum salmon. Pink and chum salmon arrive first, beginning in mid-June, followed by sockeye and chinook, and finally coho salmon in early August. The seaward migration route of sockeye salmon is largely coastal. A catch per unit effort value for sockeye salmon just northeast of the study area was 11-100 per hour. Juvenile sockeyes depart from numerous rivers and streams and enter the sea between mid-May and mid-July. The major population of juvenile migrants is found in outer Bristol Bay after mid-August, reaching the study area from the middle to the end of August (Straty, 1974). Juvenile salmon are then most abundant 18-55 km offshore (Scientific Applications, 1977). Steelhead trout and char have been reported in the Bear River, near Block 60 (Alaska Department of Fish and Game, 1977). A station just northeast of the study area records no Pacific cod captured that had pseudobranchial tumors (McCain et al., 1977).

Table 10. BIOMASS OF DOMINANT FISH IN BLOCK 60, OUTER BRISTOL BAY[1]

Species	Biomass (kg/km)	Relative Abundance[2]	
		June	July-August
Pollock	≤ 100	no catch to moderate	no catch to low catch
Pacific Cod	≤ 100, once >100	no catch to low	no catch to moderately high
Yellowfin Sole	≤ 100, once 125-250	moderate catch	moderately high to high catch
Pacific Halibut	up to >10	moderately high to high catch	low catch
Other Flounders:			
(Rock Sole Flathead Sole, etc.)	≤ 100	moderately high to high catch	low catch

[1]Source: Pereyra et al. (1976).

[2]Based on a series of relative abundances, different for each species.

Table 11. ONSHORE AND OFFSHORE FISH BETWEEN PORT HEIDEN AND PORT MOLLER, OUTER BRISTOL BAY[1]

Area	Herring	Capelin	Boreal Smelt	Eulachon	Misc.	Total
Port Heiden Spring	205	608	804	30	197	1,844
Port Heiden Fall	1		62		32	95
Port Moller		28	1			29
Herendeen Bay	235	5	11		84	353
Seal Islands		2			85	87
Totals	459	643	878	30	398	2,408
Offshore Station 1	139					139
Offshore Station 2	421					421
Offshore Station 3	89					89
Offshore Station 4	286					286
Offshore Station 5	255					255
Offshore Station 6		102				102
Totals	1,190	102				1,292
Grand Totals	1,649	745	878	30	398	3,700

[1]Source: Barton et al. (1977). The data are based on catches from May through October 1976.

1.9 Birds

There are about 132 species of marine birds representing 28 families in the eastern Bering Sea (Sanger and Baird, 1977). The most abundant species are indicated in Table 12. Arneson (1977) recorded 41 species and 415,701 individual birds in October and 18 species and 72,604 individuals in July along the north coast of the Alaska Peninsula. The dominant birds were geese, shorebirds, ocean ducks, dabbling ducks and gulls. Between June and November the most abundant offshore birds in Bristol Bay are reported to be shearwaters, kittiwakes, murres, and tufted puffins (Environmental Research Laboratories, 1976). Some 82 species of seabirds, shorebirds, and waterfowl are recorded for the Nelson Lagoon--Port Moller--Herendeen Bay region. Estuaries and lagoons near the study area serve as important staging sites for migratory birds (October birds include the American emperor goose, black brant, cackling and lesser Canada geese, and snow geese, among others. King eider, scoters, emperor geese and other waterfowl are known to overwinter in the region. Among the common migrants are the least sandpiper, common snipe, greater and lesser yellowlegs, dunlins, short-billed dowitchers, ruddy and black turnstoves, and northern phalaropes. However, the coastal region of the study area is limited for birds (Alaska Department of Fish and Game, 1977). Birds are particularly sparse where ice covers the nearshore area.

A list of seabirds and their densities in and near Block 60 is given in Table 13. The slender-billed shearwater is reported to be the most abundant offshore seabird between Port Moller and Pt. Heiden. Bartonek et al. (1977) record 6 bird colonies (~16,000 individuals) in this same region.

Table 12. ABUNDANCE OF SELECTED MARINE BIRDS IN THE EASTERN BERING SEA[1]

Species	Estimated Number of Birds[2]
Northern Fulmar	5,000,000
Shearwaters (both species)	10,000,000
Glaucous-winged Gull	170,000
Black-legged Kittiwake	750,000
Murres (both species)	5,000,000
Least Auklet	2,000,000
Crested Auklet	1,500,000
Parakeet Auklet	500,000

[1]Bartonek et al. (1977).

[2]Based on an area of 1 million km^2.

Table 13. SEABIRDS IN AND NEAR BLOCK 60, OUTER BERING SEA[1]

Seabird	Month	Density (No./km^2)
Loons	June	3-10
Shearwaters	July October[2]	< 1 30-100
Fork-tailed Petrels	October	< 1
Cormorants	June	1-3
Oldsquaw	February	present
Scoters	October	3-10
Jaegers	July[2] October	3-10 < 1
Glaucous Gulls	June	1-3
Glaucous-winged Gulls	June July	30-100 >100
Mew Gulls	June	1-3
Black-legged Kittiwake	July October	3-10 1-3
Murres	June	3-10
Tufted Puffins	June	1-3

[1]Source: Bartonek *et al.* (1977)

[2]Sightings made just northeast of Block 60.

Black-legged Kittiwake colonies occur in the Pt. Moller and Cape Seniavin (adjacent to Block 60) regions (Sanger and Baird, 1977). About 6,000 cormorants, black-legged kittiwakes, and common murres nest in the Cape Seniavin colony.

1.10 Mammals

McAlister and Perez (1977) give winter and summer population estimates for seals and sea lions along the eastern Bering Sea shelf, including the northern fur seal, northern sea lion, two subspecies (*richardi* and *largha*) of harbor seal, ringed seal, ribbon seal, and bearded seal. Harbor seals appear to be the most common marine mammal in and near Block 60. They are concentrated in the Seal Islands and at Cinder River, Port Heiden, and Pt. Moller. Up to 1137 harbor seals were counted in June in the Seal Islands and even more occur at Port Heiden and Port Moller. A seal hauling out area is located at Cape Seniavin. Relatively few northern sea lions occur in Block 60. Both harbor seals and northern sea lions move out of the region in winter when sea ice formation occurs. Bearded seals have been reported just offshore of Block 60 (Braham et al., 1977). The Alaska walrus population is 135,000 ± 30% (Fay, 1974). They spend 6 months in the Bering Sea (mainly north of the ice front) and have been reported from the study area (Braham et al., 1977), although they are concentrated between Nunivak Island and Bristol Bay (primarily males). Their distribution is believed to be related to the occurrence of sea ice rather than benthic food resources (Fay, 1974). Several thousand males remain in Bristol Bay during the summer (Burns, 1977). Between 9 and 215 walrus were sighted between Nushagak Bay and Cape Leontovich (including Block 60) in April 1976. The estimated walrus population for that area is 134 to 1633 (Burns, 1977). They are believed to plow up several million tons of bottom sediment ($\leq$ 20 cm) each year while feeding, possibly releasing large quantities of nutrients. They may ingest and redistribute in their feces at least several thousand tons of bottom sediment annually.

About 10,000 sea otters live in Bristol Bay. Sea otters are abundant on the southeastern Bering Sea shelf and throughout the Aleutian Islands (Fay, 1974). They haul out to as far as 100 m inland for rest during storms. Their distribution is restricted by ice. Sea otters can feed to a depth of 80 m. Breeding and pupping occur throughout the year but less frequently in winter. The dall porpoise and minke whale are the commonest cetaceans in Bristol Bay. Other less common species include the grey, humpback, fin, and sperm whales, and the harbor porpoise. The gray whale moves through Block 60 from April to June and is reported to be the most abundant whale along the Alaska Peninsula north coast (Environmental Research Laboratories, 1976; Scientific Applications, 1977).

1.11 Feeding Dynamics

Feeding in coastal animals has been discussed in section 1.4. The feeding habits of selected Bering Sea invertebrates are presented in Table 14 and fish in Table 15. The heavy metal contents (ppm) of Tanner crab at a site closest to Block 60 were: Cd (<1.3), Cu (27.7), Ni (<1.3), and Zn (157) (Burrell, 1977; station 3). Predators of selected Bering Sea animals are listed in Table 16. Favorite and McAlister (1976) report that marine birds and mammals consume about 17% of the finfish stock in the eastern Bering Sea. The feeding habits of murres and short-tailed shearwaters

Table 14. FEFDING HABITS OF MARINE INVERTEBRATES IN THE BERING SEA

Animal	Feeding Habits	Source
Spisula polynyma (clam)	filter feeder	Vinogradov, 1968
Tellina lutea (clam)	epibenthic deposit feeder	Vinogradov, 1968
Serripes laperousii (clam)	filter feeder	Vinogradov, 1968
Serripes groenlandicus (clam)	filter feeder	Vinogradov, 1968
Siliqua alta (clam)	filter feeder	Barnes, 1974
Mya elegans (clam)	filter feeder	Barnes, 1974
Macoma calcarea (clam)	epibenthic deposit feeder	Vinogradov, 1968
Macoma middendorfi (clam)	epibenthic deposit feeder	Barnes, 1974
Gastropods (snails)	probably polychaetes, clams, etc.	Pereyra et. al., 1976
Lepasterias polaris (starfish)	amphipods, fish	Feder, 1977
Pandalid Shrimp	small molluscs, worms, crustaceans	Pereyra et al., 1976
Tanner Crab	octopus, Pacific cod, snail fish	Pereyra et al., 1976
	polychaetes, ophiuroids	Scientific Applications, 1977
King Crab	plankton (as larvae), benthic diatoms, misc. small invertebrates. Juveniles and adults are omnivores, consuming small molluscs (*Nucula quirica, Yoldia*), sea urchins, *Pycnopodia*, sea cucumbers, larger molluscs (*Clinocardium, Macoma, Saxidomus*) sand-dollars, bryozoans, cockles, *Pandalus goniurus*	Feder, 1977
	small snails, ophiuroids	Scientific Applications, 1977

Table 15. FEEDING HABITS OF FISH IN THE BERING SEA

Animal	Feeding Habits	Source
Yellowfin Sole	14 species of molluscs (size 9-60 mm). Maximum frequency of occurrence = 3-8%, including *Serripes groenlandicus* fragments, *Tellina lutea* (16-38 mm), *Macoma calcarea* (11-20 mm), and *Siliqua* (45 mm).	Skalkin, 1968
	Feeds on ~50 species, including clams (29% of the food of 20-30 cm juvenile and 37% of >30 cm juvenile yellowfin sole are clams), polychaetes, zooplankton, capelin, and smelt.	Pereyra et al., 1976
Rock Sole	13 species of molluscs (size 2-21 mm). Maximum frequency of occurrence = 3-100%, including *Serripes groenlandicus* fragments, *Tellina lutea* (17 mm), *Macoma calcarea* (21 mm), and *Siliqua* fragments.	Skalkin, 1968
	Frequency of consuming molluscs = 43-64%. Eats polychates and crustaceans.	Pereyra et al., 1976
Alaska Plaice	9 species of molluscs (size 2-17 mm). Maximum frequency of occurrence = 3-60%, including *Serripes groenlandicus* fragments and *Macoma calcarea* (8-12 mm).	Skalkin, 1968
	Benthic molluscs, crustaceans, and polychaetes, including predominantly *Serripes groenlandicus* but also *Yoldia hyperborea* and *Yoldia johanni*.	Pereyra et al., 1976
	Fish	Feder, 1977
Pollock	Euphausiids, copepods, amphipods; small pollock.	Pereyra et al., 1976

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Table 15 (Cont'd.). FEEDING HABITS OF FISH IN THE BERING SEA

Animal	Feeding Habits	Source
Flathead Sole	Zooplankton in shallow waters; shrimp, brittlestars.	Pereyra, *et al.*, 1976
	Molluscs rank fifth in feeding preference in the southeast Bering Sea.	Environmental Research Laboratories, 1976
Pacific Cod	Crabs	Feder, 1977
Pacific Halibut	More than 20 species. Juveniles eat shrimp and other crustaceans, adults consume flatfish, especially yellowfin sole in the southeast Bering Sea.	Pereyra *et al.*, 1976
Greenland Halibut	Zooplankton, squid, fish (mostly pollock; also flatfish and sculpins).	Pereyra *et al.*, 1976
Arrowtooth Flounder	Principally pollock, also zooplankton and small crabs.	Pereyra *et al.*, 1976

Table 16. PREDATORS OF BERING SEA ANIMALS[1]

Animal	Predators
Gastropods (snails)	Probably crabs
Pandalid Shrimp	Many organisms including birds and mammals
Tanner Crab	Eggs eaten by nemerteans and amphipods. Juveniles consumed by fish.
King Crab	River otters in seashore habitats, hair crabs (*Erimacrus isenbeckii*), sculpins, greenling fish. Molted crabs are eaten by halibut, cod, and sculpins.
Yellowfin Sole	Halibut are principal predators (33-73% incidence and 30-55% of weight of consumed food). Probably beluga whales and pelagic fur seals.
Rock Sole	Probably beluga whales and fur seals
Alaska Plaice	Probably eaten by halibut, fur seals, and beluga whales
Pollock	Fur seals, Pacific cod, large fish
Flathead Sole	Probably halibut, fur seals, and beluga whales
Pacific Halibut	Predators on juveniles little known. Adults unimmune to predation except from marine mammals.
Pacific Cod	Halibut (small amount), fur seals, sperm whales
Greenland Halibut	Halibut, fur seals, and beluga whales
Arrowtooth Flounder	Halibut and probably fur seals and beluga whales

[1]Source: Pereyra et al., (1976).

are presented in Table 17 and for northern fulmars, glaucous-winged gulls and black-legged kittiwakes in Table 18. Murres in the Bering Sea eat a variety of commercial fish including sockeye salmon and pollock, as well as zooplankton and shellfish (Nishiyama, 1974), Guillemots also consume sockeye salmon (Straty, 1974).

The annual food consumtpion of finfish by pinnipeds in the eastern Bering Sea is shown in Table 19. Bearded seals eat mostly benthic invertebrates (Johnson, in McAlister and Perez, 1977). Fur seals consume pollock, gonatid squid, Atka mackerel, capelin, and salmon from May to August and also Greenland turbot and bathypelagic smelt from July to September (McAlister and Perez (1977). Harbor seals feed on crustaceans and fish, to a depth of 60 m (Alaska Department of Fish and Game, 1977). Walrus consume $\geq$ 1 million tons of Bering Sea benthos annually. They utilize >60 species of invertebrates, half of which are molluscs. The biomass of molluscs destroyed is believed to greatly exceed the amount consumed because walrus eat only fleshy parts (Fay, 1974). Walrus eat a wide variety of infauna, mainly *Mya, Spisula, Serripes, Clinocardium,* and *Hiatella.* They consume smaller amounts of *Neptunea, Buccinum, Polinices,* crabs, shrimp, and tunicates (Burns, 1977). Sea otters feed on clams, octopus and fish, to a depth of 80 m in the study area (Alaska Department of Fish and Game, 1977). Beluga whales commonly eat sockeye salmon in the study area (Straty, 1974). A food web, based on benthic invertebrates of the southeastern Bering Sea, is presented in Figure 2 and a schematic summer food chain is shown in Figure 3. Laevastu and Favorite (1977) present a summary review of their numerical marine ecosystem model (DYNUMES).

Table 17. FEEDING HABITS OF MURRES AND SHORT-TAILED SHEARWATERS IN THE EASTERN BERING SEA[1]

Prey Item	Prey Lengths (cm)	% Composition (weight)	Equivalent DYNUMES Trophic Component
	Murres (*Uria* spp.), N = 163		
FISH		72	Pollock I
Pollock	10-24		
Sandlance	5-20		
Capelin	11-12		
EUPHAUSIIDS		15	Euphausiids
SQUID		8	Euphausiids
OTHER		5	Euphausiids
	Short-tailed Shearwaters, N = 29		
FISH			
Sandlance		tr	---
EUPHAUSIIDS		100	Euphausiids

[1]Source: Sanger and Baird (1977), adopted from Ogi and Tsujita (1973).

Table 18. FREQUENCY OF OCCURRENCE OF PREY ITEMS IN NORTHERN FULMARS, GLAUCOUS-WINGED GULLS AND BLACK-LEGGED KITTIWAKES[1]

Prey Item	Northern Fulmar	Glaucous-Winged Gull	Black-Legged Kittiwake
MOLLUSCA			
Cephalopoda	$Moderate_{A}$ 100.0_{H}	$Minor_{A}$	$Minor_{A}$ 9.0_{H}
Shellfish		$Major_{PM}$	$Trace_{PM}$
CRUSTACEAN	$Major_{A}$		$Moderate_{A}$
Barnacle		$Moderate_{A}$	$Minor_{PM}$
Copepod (*Calanus*)			
Amphipod			$Trace_{Z}$ 14.0_{H}
Euphausiacea			4.0_{H}
Mysid			
Decapoda		$Major_{PM}$	17.0_{H}
POLYCHAETA			$Minor_{Z}$
ECHINODERMATA		$Major_{PM}$	
OTHER INVERTEBRATES	$Minor_{A}$	$Moderate_{A}$	$Minor_{A}$
FISH	$Minor_{A}$	$Moderate_{A}$	62.0_{H} $Major_{A, Z}$
Ammodytes			100.0_{D} $Major_{Z}$
Boreogadus			$Major_{Z}$
CARRION etc.	$Minor_{A}$	$Moderate_{A}$ $Major_{PM}$	$Minor_{A, PM}$

continued next page

Table 18 (Cont'd.). FREQUENCY OF OCCURRENCE OF PREY ITEMS IN NORTHERN FULMARS, GLAUCOUS-WINGED GULLS AND BLACK-LEGGED KITTIWAKES[1]

Prey Item	Northern Fulmar	Glaucous-Winged Gull	Black-Legged Kittiwakes
DEBRIS			6.0_H
PLASTIC PARTICLES			3.0_H.

1

Note: A=Ashmole 1971; H=Hunt 1975; D=Drury 1975; S-Stejneger 1885; PM=Preble & McAtee 1923; Z=Swartz 1966.

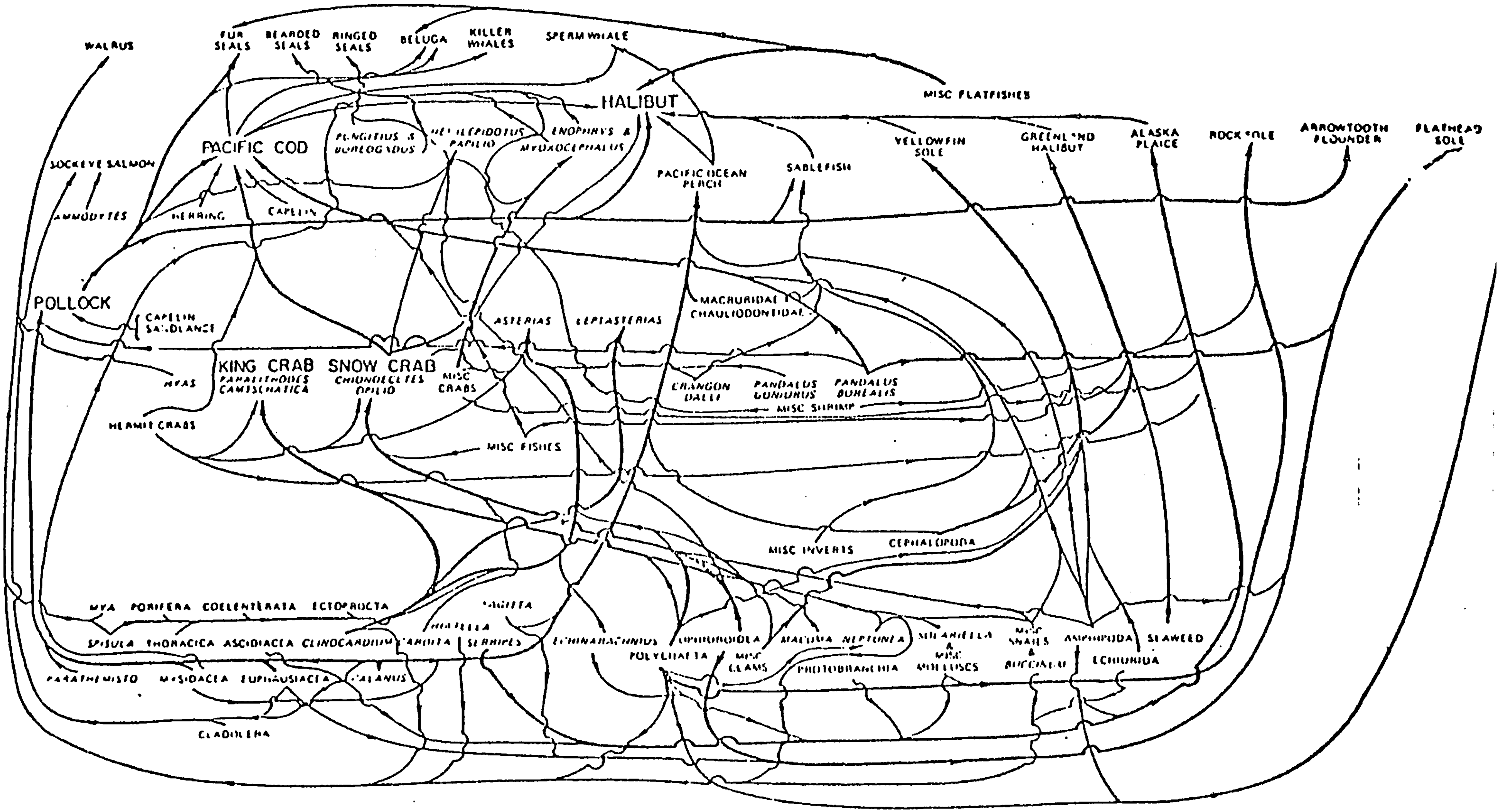
[1]Source: Sanger and Baird (1977).

Table 19. ANNUAL FOOD CONSUMPTION OF FINFISH BY PINNIPEDS IN THE EASTERN BERING SEA[1]

Species	Food (thousands of metric tons)	Percent Finfish (w = winter s = summer)	Finfish Consumption (thousands of metric tons)
Northern fur seal *(Callorhinus ursinus)*	447	84	375
Northern sea lion *(Eumetopias jubatus)*	824	90	742
Harbor seal *(Phoca* sp.*)*	970	50	485
Ringed seal *(Pusa hispida)*	122s/223w	90w/40s	246
Ribbon seal *(Histriophoca fasciata)*	55s/110w	90w/40s	121
Bearded seal *(Erignathus barbatus)*	1,482	10	148
SUBTOTALS	4,223		2,117

[1]Source: McAlister and Perez (1977).

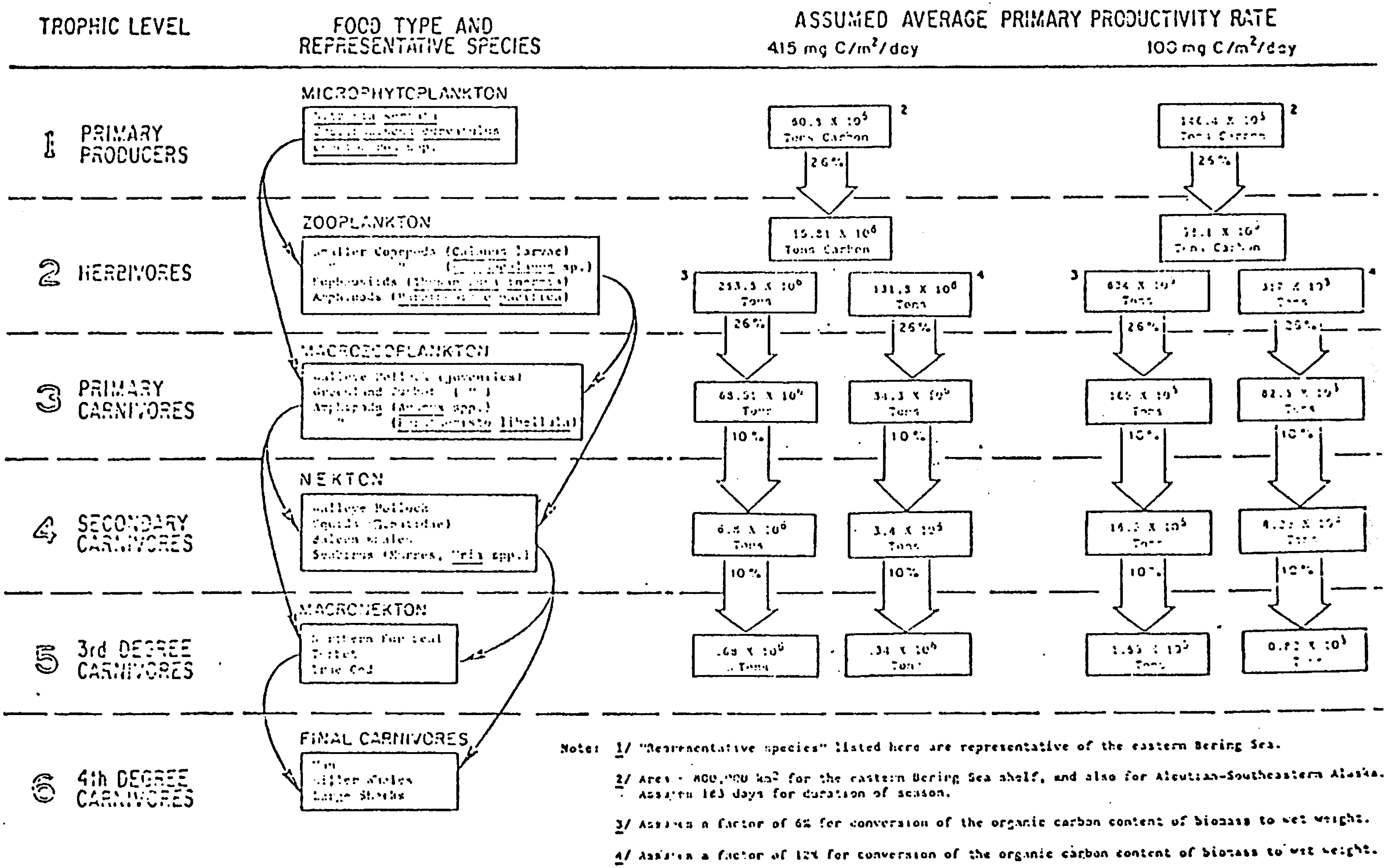
FIGURE 2. The Southeast Bering Sea Food Web



Source: Feder (1977).

Note: A food web based on the benthic invertebrates of the southeastern Bering Sea. Carbon flow generally in the direction of the arrows. Bold lines indicate major food sources based on frequency of occurrence.

FIGURE 3. Schematic - Simplified Summer (June-November) Food Chain in the Eastern Bering Sea



Source: McAlister and Perez (1977).

Note: Our printed source for this figure was of poor quality. A clean copy of the manuscript figure will be obtained for the final report.

2.0 BIOLOGY OF SURF CLAMS

2.1 *Spisula solidissima*

A preliminary summary of information on the biology of the surf clam *Spisula solidissima* is given in Table 20.

2.2 *Spisula polynyma*

The surf clam or pinkneck clam (*Spisula polynyma*) probably originated in the Pacific Ocean, dispersed through the Bering Strait and along the Arctic coast (when sea surface temperatures were warmer than at present) then south into the Atlantic Ocean (Chamberlain and Stearns, 1963). The pinkneck clam is recorded from the west Pacific in the Miocene, the east Pacific in the Pliocene, and the west Atlantic in the Pleistocene. No fossils are known from the European side of the Atlantic Ocean. The pinkneck clam has undergone a series of nomenclatural changes. Some of the older publications placed the pinkneck clam in the genus *Mactra* or in the species *Spisula ovalis*. It was also recorded as *S. polynyma alaskana* (Dall), *S. alaskana* (Dall), *S. polynyma voyi* (Gabb), and today is recognized as *S. polynyma* (Stimpson), a species separate from *S. solidissima*.

The present distribution of *S. polynyma* is from off mid-Long Island, New York (40° 10'N., 72° 25'W., depth 68 m) to Île de la Demoiselle, N.E. Quebec (51° 30'W., 57° 40'W.) on the Atlantic coast of North America and from Juan de Fuca Strait, Washington (48° 30'N., 156° 30'W.) to Pt. Barrow, Alaska (71° 30'N., 156° 30'W.). It is also recorded from nothern Sakhalin Island, U.S.S.R. (52° 40'N., 143° 30'E). Salinity is believed to be relatively unimportant in regard to its distribution. It tolerates coastal salinities

Table 20. BIOLOGY OF THE SURF CLAM (*SPISULA SOLIDISSIMA*) IN THE NORTHEASTERN UNITED STATES

POPULATION INFORMATION

Numbers. The Atlantic surf clam fisheries declined from 96 million lb of meat in 1974 to about 50 million lb of meat each in 1976 and 1977.

Size Distribution. Specimens with shells 6 in. are common.

Age Distribution. No specific information was found concerning this topic.

Growth Rates of Individuals. The normal early development of the surf clam has been described by Allen (1953) and Schecter (1941), while Westman and Bidwell (1946) have discussed its life history.

As with most other aquatic organisms, the growth rate of these individuals varies with the temperature (Loosanoff and Davis, 1963). At 14°C these organisms take 112 hours to reach a length of 85 μ, and 35 days to reach a size where setting and metamorphosis will occur. If the temperature is 22°C it takes 68 hours to reach 85 μ and 19 days pass before setting occurs.

Growth Rates of Biomass. No specific information was found concerning this topic.

Population Trends. There are seasonal fluctuations in the population because of a biannual reproductive cycle (Ropes, 1966, 1968) in the surf clam. There is a major mid-year and minor late-year spawning. The Atlantic coast mortality coefficient for surf clams (M) is 0.25 (Hughes et al., 1978).

EFFECTS OF ENVIRONMENTAL CHANGES

Natural Influences.

Temperature. Temperature can be used to delay or hasten the gametogenic cycle in the surf clam, and increased temperature will induce spawning in ripe clams (Ropes, 1968; Walne, 1964). Gonadal development occurs as the temperature increases to 12°C, after spawning occurs. Although adults will grow in the lab at 14°C (Allen, 1951, 1953) growth and development of the larvae is optimal at 21°C. Temperatures over 30°C are very unfavorable for this clam and have been found to injure the egg (Loosanoff and Davis, 1963).

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Dissolved Oxygen. These organisms require a high concentration of dissolved oxygen.

Salinity. The surf clam prefers oceanic salinity of about 35°/oo (Allen, 1953; Loosanoff and Davis, 1963).

Nutrients. When clam eggs are fertilized they have been shown to take up nutrients (Monroy and Tolis, 1964). Adult surf clams have been reared in the laboratory on phytoplankton (Loosanoff and Davis, 1963).

Turbidity. As with other filter feeders, an increase in the turbidity is likely to clog the filters and cause a decrease in the feeding rate.

pH. Allen (1953) found that if you decrease the pH of the environment the excitability of this clam decreases.

Other. Calcium ions are believed to have some function in the stimulation of surf clam egg maturation (Raven, 1964).

Toxic Influences

Saxitoxin. East coast surf clams have saxitoxin for considerable periods of time (Hughes et al., 1977).

Pesticides. No specific information concerning this topic was found, but consult Butler (1966), Butler and Springer (1963), Modin (1969), and Tarzwell (1963) for a general discussion of pesticide effects.

Radionuclides. No specific information concerning this topic was found, but consult Bryan, Preston, and Templeton (1966), National Academy of Sciences (1957), and Polikarpov (1964) for a general discussion of this topic.

Heavy Metals. No specific information was found concerning this topic.

Oil. No specific information was found concerning this topic, but the effects of oil pollution and its removal have been discussed by Smith (1968).

X-Rays. Rugh (1953) has investigated the effects of x-rays on the sperm and eggs of the surf clam.

continued next page

Table 20 (Cont'd.). BIOLOGY OF THE SURF CLAM (*SPISULA SOLIDISSIMA*) IN THE NORTHEASTERN UNITED STATES

HABITAT REQUIREMENTS

Water Circulation. This organism requires water movement and currents for feeding.

Water Depth. This is a benthic organism normally found in the intertidal zone; offshore to at least 68 m.

Benthic Composition. Surf clams are usually found on sandy beaches (Loosanoff and Davis, 1963).

Benthic Physiography. These clams live on flat or slightly sloping bottoms.

OTHER FACTORS

Competition. Surf clams would compete with other benthic filter feeders of the intertidal zone. They can live in loose sand or ocean beaches where the surf is unfavorable for other clams.

Predation. Fish and man are the major predators of this organism.

Production. No specific information was found concerning this topic.

Energy Transfer. No specific information was found conerning this topic.

Population Growth and Control. No specific information was found concerning this topic.

Diversity of Surf Clams. Loosanoff and Davis (1963) mention several other species of surf clams.

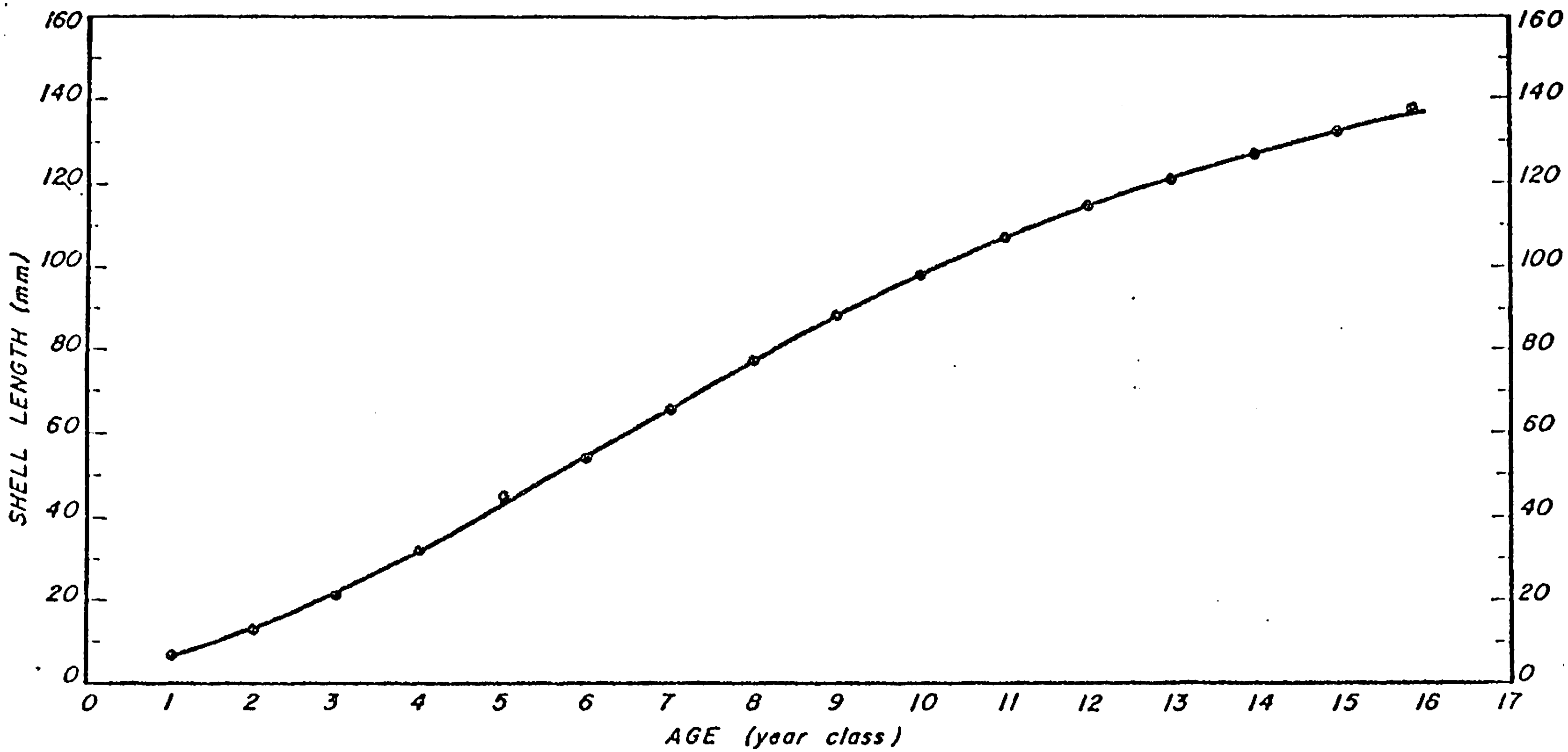
Source: New York Ocean Science Laboratory (1970), and others.

(< 30 ppt) as well as open ocean salinities (34 ppt). Minimum water temperatures do not control its distribution. The maximum temperature for survival is ~13°C (55°F). The limiting maximum temperature for reproduction is ~5.5°C (42°F). *Spisula polynyma* is strongly associated with "medium" sediments such as sand, gravel and sand-gravel admixtures. It is weakly associated with fine-medium and medium-coarse (admixtures of mud with other sediment types) sediments. It is not associated with solely fine or coarse sediments and at best only weakly associated with fine-medium-coarse sediments (those with admixtures of mud). The species, in strong contrast to *S. solidissima*, is slow-growing and long-lived. Two inch-long shells are estimated to be 6 years old and four-inch long shells $\geq$ 14 years old.

The growth rate of *S. polynyma* from Hartney Bay, Prince William Sound, Alaska is estimated by Feder et al. (1976) (see Figure 4). It requires about 10 years to reach a harvestable size of 4 in. Preliminary age estimates for the Alaska Peninsula are presented in Table 21. The largest specimens of *S. polynyma* from the Atlantic measure 5 3/4 in., and 7 in. from the Pacific. A few clams may live past 40 years. Because of such slow growth, the pinkneck clam has been considered, until recently, unacceptable for commercial exploitation.

Pinkneck clams are filter feeders and strong burrowers, but may emerge from the sediment and move about on the seafloor. Their predators have been discussed in sections 1.7 to 1.10. In addition, Chamberlain and Stearns (1963) record naticid snails (e.g., *Polinices*, *Natica*). The biology of the pinkneck clam is not well understood on either coast. In Alaska *Spisula* is found both in the intertidal and subtidally. There are no statewide Alaska abundance estimations for this clam. Hughes

FIGURE 4. Growth of *Spisula polynyma* from Hartney Bay, Prince William Sound, Alaska



Source: Feder et al., (1976).

Table 21. PRELIMINARY RANGES OF LENGTH AT AGE FOR THE ALASKA SURF CLAM *SPISULA POLYNYMA*, OBTAINED IN THE ALASKA PENINSULA REGION, JULY - AUGUST 1977[1]

Age (yrs)	Range of Lengths at Age (mm)
2	11 - 14
3	16 - 34
4	24 - 46
5	37 - 59
6	49 - 67
7	59 - 80
8	73 - 94
9	70 - 103
10	80 - 121
11	84 - 118
12	98 - 128
13	107 - 130
14	113 - 135
15[2]	119
16[2]	127

[1]Source: Hughes et al., (1978)

[2]One individual.

et al. (1977) studied a 1,600 mi^2 subtidal area in the Bering Sea between Ugashik Bay and Port Moller. The Alaska surf clam was abundant at depths of 13 to 18 fathoms. Two additional *Spisula*-rich communities were reported by Semenov (1968), one northeast of Port Moller and the other south of Togiak Bay. Hughes et al. (1977) report 3-4 age classes of harvestable clams; these had a mean shell length of 110 mm (age about 11 years). The total exploitable biomass for *S. polynyma* was estimated to be 286,184 metric tons (mean catch = 0.3-634.2 lb/hr) and the annual yield of clams about 25,000-32,000 metric tons (19-25 million lb of meat). The 35 percent meat yield of Alaska surf clams is higher than that for the Atlantic surf clam (21%) and the potential for commercial development of the Alaskan resource was judged to be excellent. No saxitoxin was found in edible portions of the clams tested.

3.0 EFFECTS OF HYDRAULIC CLAM HARVESTING ON MARINE ECOSYSTEMS

3.1 Dredging and Disposal of Sediments

A survey of the effects of dredging and disposal of sediments on marine organisms is included in this study because much of the activity of hydraulic clam harvesters moves, suspends, and redistributes bottom sediments. The environmental impact of dredging and the disposal of dredged materials has been studied mainly in bays, estuaries and in the vicinity of eroded beaches used for swimming and other water contact recreation. The most economically important areas affected by these operations are shellfish beds and spawning grounds. Reviews on the environmental effects of spoil disposal are presented by Sherk (1971) and O'Connor et al. (1977) for estuarine organisms, Thompson (1973) for offshore dredge spoil to replace eroded beach sand, Interstate Electronics Corporation (1973) and Bernard (1976) for ocean waste disposal and Yamamoto and Alcouskas (U.S. Army Corps of Engineers, 1975) and the U.S. Army Corps of Engineers (1977) for general coverage. A multi-million dollar research program for studing the effects of dredging and disposal of sediments is currently being conducted by the U.S. Army Corps of Engineers, Waterways Experiment Station, in Vicksburg, Mississippi.

Spoil disposal may result in several types of environmental impacts, such as: (1) bottom disturbance, (2) dissolved oxygen reductions, (3) increased suspended solids loading, (4) accumulation and uptake of toxicants, (5) biostimulation, and (6) public health concerns from pathogenic bacteria and viruses.

Bottom disturbance is one of the most significant adverse biological consequences of dredging and disposal opeations. Changes in bottom topography can lead to changes in circulation patterns (e.g., inducing shoaling, altering flushing rates), but the biological impacts of these small-scale alterations are little known. Moldan (1978) found that changes in circulation patterns resulting from dredging in Saldanha Bay, South Africa, caused significant alterations in the distribution of marine organisms. The disposal of spoil often buries benthic marine organisms. Those most susceptible to burial by dredged sediments are sessile organisms, slow-moving epibenthic species and weak burrowers. Animals such as flounders, rays and skates, and nektobenthic shrimp are frequently capable of swimming away from the spoil being deposited. Benthic animals adapted to unstable bottom sediment show relatively little effect from burial by spoil (U.S. Army Corps of Engineers, 1975; Oliver and Slattery, 1976). About half of the *Mercenaria mercenaria* (East coast hard clam) buried under as much as 30 cm of coarse grain sediments were capable of moving to the sediment surface (Mr. Richard Peddicord, personal communication, June 20, 1978). Spoil disposal usually results in a temporary reduction in numerical abundance, biomass and species diversity. Oliver and Slattery (1976) found a positive correlation between community resilience, environmental stress and decreasing community complexity in Monterey Bay. Disposal of dredged material near the Monterey Canyon head at Moss Landing, California, removed 60% of the individuals. After 1.5 years, the number of individuals remained low but the species diversity and evenness indices were higher than before disposal. Recovery from spoil deposition in Chesapeake Bay took 1.5 years (Cronin et al., 1970). The recovery of the numerical abundance of benthic organisms in Mare Island Strait near San Francisco was only about 3% in 4 months, based on a comparison with a previous population high at the same station. Recovery rates would be predicted to be highly variable, depending largely on the differences between characteristics of natural and spoil sediments (e.g., sand versus mud), species composition (e.g., rapid burrowers versus sessile animals), season (e.g., reproductive or recruitment versus non-reproductive periods--see Oliver and Slattery, 1976), and habitat type (e.g., soft bottom versus coral reef; siltation can be very detrimental to coral reefs--see Bakus, 1968, 1969b, and Smith et al., 1973).

Reduction in dissolved oxygen levels by resuspension of anoxic or low-level oxygenated sediments may affect marine organisms. Although short term (2 minute) reductions of up to 2 ppm O_2 in surface waters of San Francisco Bay have been recorded during both dredging and disposal operations, these changes probably are not producing lethal effects. Invertebrates such as bivalve molluscs may close their valves (e.g., *Mytilus* can survive a lack of oxygen for weeks--see Vernberg and Vernberg, 1972) and fish swim away to areas of higher oxygen concentration. Fish are often not seriously affected by oxygen levels until they reach a low value of about 3 ppm (Prager, 1974). Numerous marine invertebrates can respire anaerobically during periods of stress (Moore, 1962). The effects of oxygen levels on the mortality of eggs and larvae are little known. Young animals require more oxygen per unit weight than adults and thus may be more severely affected by low oxygen levels (Nicol, 1968).

Increased suspended solids loading may affect phytoplankton by decreasing the light available for photosynthesis. This effect would be less in areas of turbulence where phytoplankton are carried into surface waters (Bakus, 1973). Decreased water clarity may also affect sport fishing success (Bakus, 1976). Suspended sediments can scour the substrate with the aid of surge, currents or waves (Thompson, 1973). Suspended solids most frequently interefere with respiration in marine organisms by the clogging of gills. They may also interfere with feeding in filter feeders (Rice and Smith, 1958; Loosanoff, 1962; Maurer, 1967; Wakeman _et al._, 1975). Extensive laboratory experiments on animals from San Francisco Bay suggest that tolerance to suspended bentonite is correlated with the normal habitat of the organisms, for example, animals living on mud bottoms were generally tolerant of suspended solids loading (U.S. Army Corps of Engineers, 1977). However, the combination of suspended solids loading, low oxygen levels, and elevated summer temperatures can produce stress and even mortality.

The occurrence of toxicants in spoil constitutes one of the more serious environmental problems. The remobilization of contaminants is dependent on clay fraction, organic content, redox potential, pH, bacteria, the sulfur cycle, and the iron cycle (Morton, 1977). The production of H_2S by bacteria can result in a highly toxic and anoxic sediment, one that may be dredged from harbors and deposited in more oxygen rich areas. Approximately 80% by weight of all ocean dumping consists of dredged spoil, of which about 34% is considered to be polluted (Boyd _et al._, 1972). Trace metals, chlorinated hydrocarbons and polychlorinated biphenyls may occur in considerable quantities in dredge spoil and may produce long term sublethal effects. This is particularly true if spoil sediments are associated with major sewage outfalls, such as the White's Point outfall in southern California (Schaefer, 1976). Although San Francisco Bay dredging and disposal activities were found to redistribute contaminated sediments without resulting in increased contaminant availability (U.S. Army Corps of Engineers, 1977), deposit feeders can readily accumulate toxic substances from such sediments. This is particularly true of heavily contaminated sediments (Young, and McDermott *et al.*, 1976). These sediments could provide long-term sublethal effects (*e.g.*, histological changes, fin erosion--see Sherwood and McCain, 1976) in certain benthic marine organisms and enhance the probability of transfer of toxic substances (*e.g.*, DDT) to piscivorous organisms such as pelicans (Jehl, 1973).

Biostimulation results principally from the occurrence of nitrogen in marine waters (Goldman *et al.*, 1973). This takes place during upwelling, the redistribution of sediments by natural turbulence or by spoil dredging and disposal, nitrogen fixation by blue-green algae (Carpenter and Price, 1976), Potts and Whitton, 1977), and by normal *in situ* nitrogen turnover. Nitrogen in the form of ammonia can be toxic to some marine organisms. However, ammonia levels frequently return to normal concentrations within 1½ hours due to nitrification and dilution (U.S. Army Corps of Engineers, 1977).

Pathogenic bacteria and viruses may be transferred from one region to another during spoil disposal. Their concentrations become diluted in the process. The effects of dredging and disposal operations on these organisms is little studied. There probably are few such detrimental effects on marine organisms except with highly contaminated sediments (*e.g.*, fresh sewage sludge--see Bott, 1973 and Dewling and Anderson, 1976).

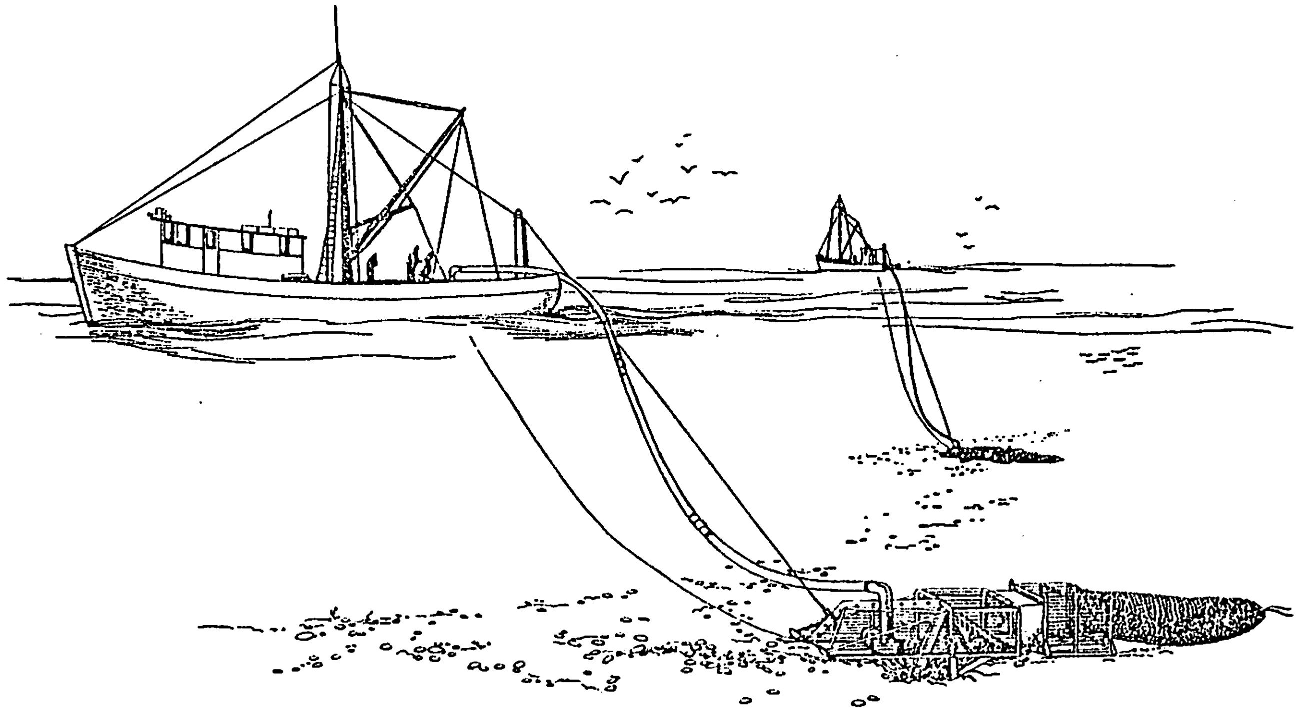
The benefits of spoil disposal include the fact that dredging and disposal activities contribute importantly to the more than $12 billion total commerce in the United States each year. Dredge spoil is used to create new salt marsh habitat, to form higher upland habitat including nesting areas for birds and turtles, and to increase recreational use of waterways (Psuty et al., 1974). Spoil can be used in improving substrates to create new habitats for shellfish, in providing beach fill, and in creating islands for nesting seabirds (Boyd et al., 1972).

3.2 Effects of Hydraulic Clam Harvesting

3.2.1 History

Early clamming for *Spisula solidissima* took place with rakes and tongs (Parker, 1971). The development of clam harvesting gear was limited prior to World War II. The demand for high protein sources by government and industry spurred the development of a market for surf clams. Many models of dredges were devised and different types of hauling gear and ship sizes were used experimentally prior to the development of the hydraulic jet dredge. Scraper-type dredges appeared in the 1920's. They possessed a front knife blade and were towed, collecting organisms to a depth of 9 in., but they accumulated sand too rapidly. The hydraulic jet dredge consisted of jetting water directly into a conventional "dry" dredge (Figure 5). A series of models were developed. The classic 40 in. dredge was used in New Jersey and Maryland during the 1950's and up to the present. It consisted of a straight edge knife and a chain bag. Other models used a V-shaped knife. The largest current hydraulic jet dredge is an 84 in. dredge requiring two 6 in. I.D.

FIGURE 5. Hydraulic Clam Dredging on the East Coast of the United States



Source: Parker (1971).

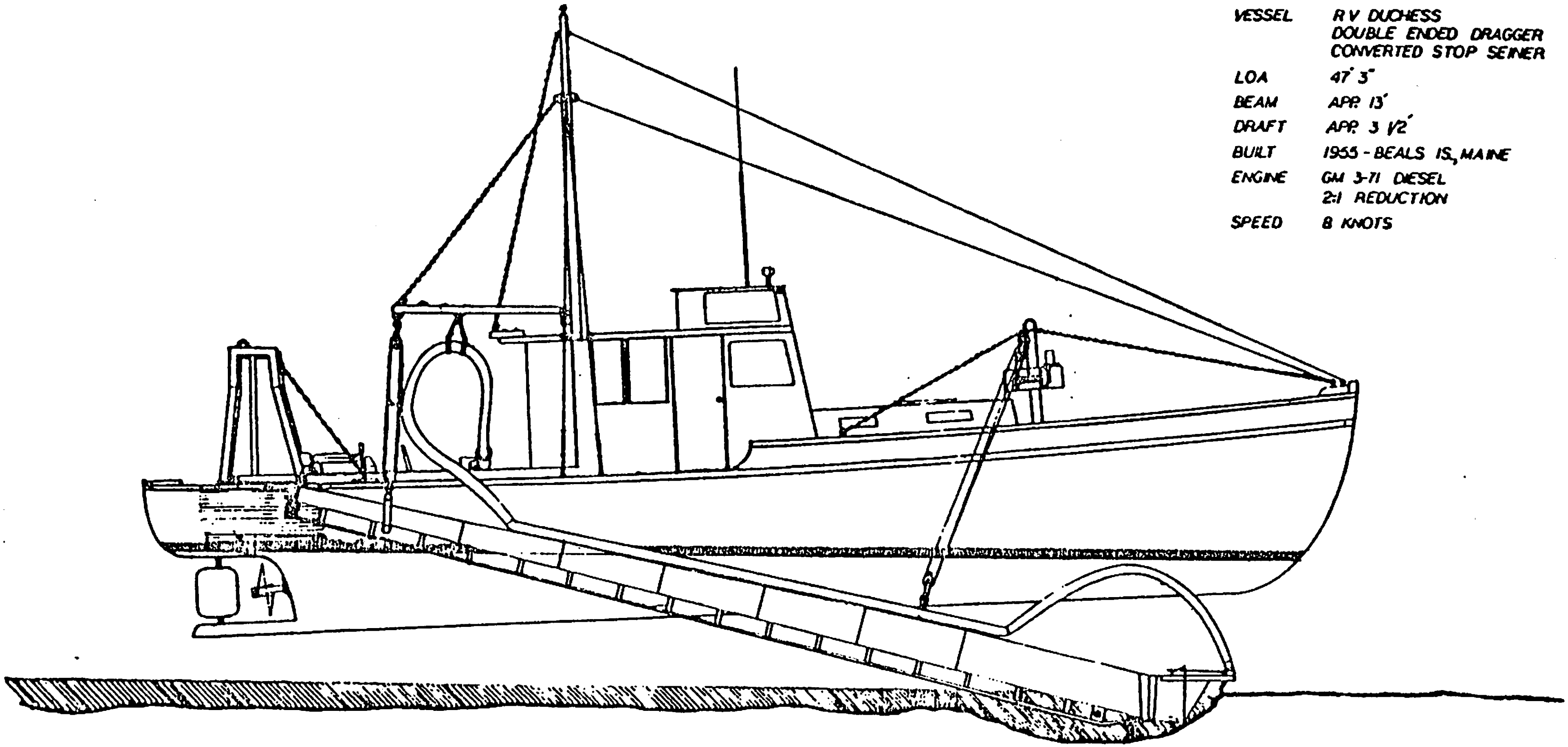
supply hoses. Today shrimp boats and other vessels are converted into clam dredge harvesters. These diesel-powered ships range from 31 to 136 ft long and displace 14 to 160 gross tons. An innovation in clam harvesting was the development of an escalator dredge (Figure 6), first developed by Manning and used in Maryland for soft-shell clams, then in eastern Canada (Hodges, 1971; Kyte and Chew, 1975). The dredgehead is not forced through the sediment, but sediment containing clams are washed in a jet stream and the bivalves are carried to the ship on a conveyor belt. Unretrieved material remains on the belt and is returned to the water. The escalator shellfish harvester is limited to shallow waters. The efficiency of this harvester in highly compact sediment is ~11%, in firm sand it is 95-100% (Kyte and Chew, 1975).

3.2.2 Hydraulic Clam Harvesting

3.2.2.1 Water Column Effects

Little is known concerning the effects of hydraulic clam harvesting on water quality and the marine biota of the water column (but see section 3.1). Westley et al. (1973) found no significant change in water quality except for a minor decrease in O_2 and a minor increase in BOD in Puget Sound, Washington. Kyte et al. (1965) recorded total particulate suspension in Maine at a maximum of 854 mg/l at the conveyor belt and 89 mg/l some 61 m downstream, at which point the turbidity plume was readily visible. Tarr (1975) reported a decrease in light transmission values of 4 to 80% in the vicinity of a harvester in Washington. There was an increase in inorganic phosphate of $\leq$ 40% near the seafloor by the harvester. Either no change or only a slight change occurred

FIGURE 6. A Hydraulic Escalator Shellfish Harvester



Source: Kyte and Chew (1975).

in DO, BOD, most inorganic and organic nutrients, salinity, phytoplankton production, or chlorophyll a. Kyte and Chew (1975) concluded that there is no direct evidence of the effects of harvester-induced changes in turbidity, pH, DO, or H_2S on organisms in the water column.

3.2.2.2 Benthic Effects

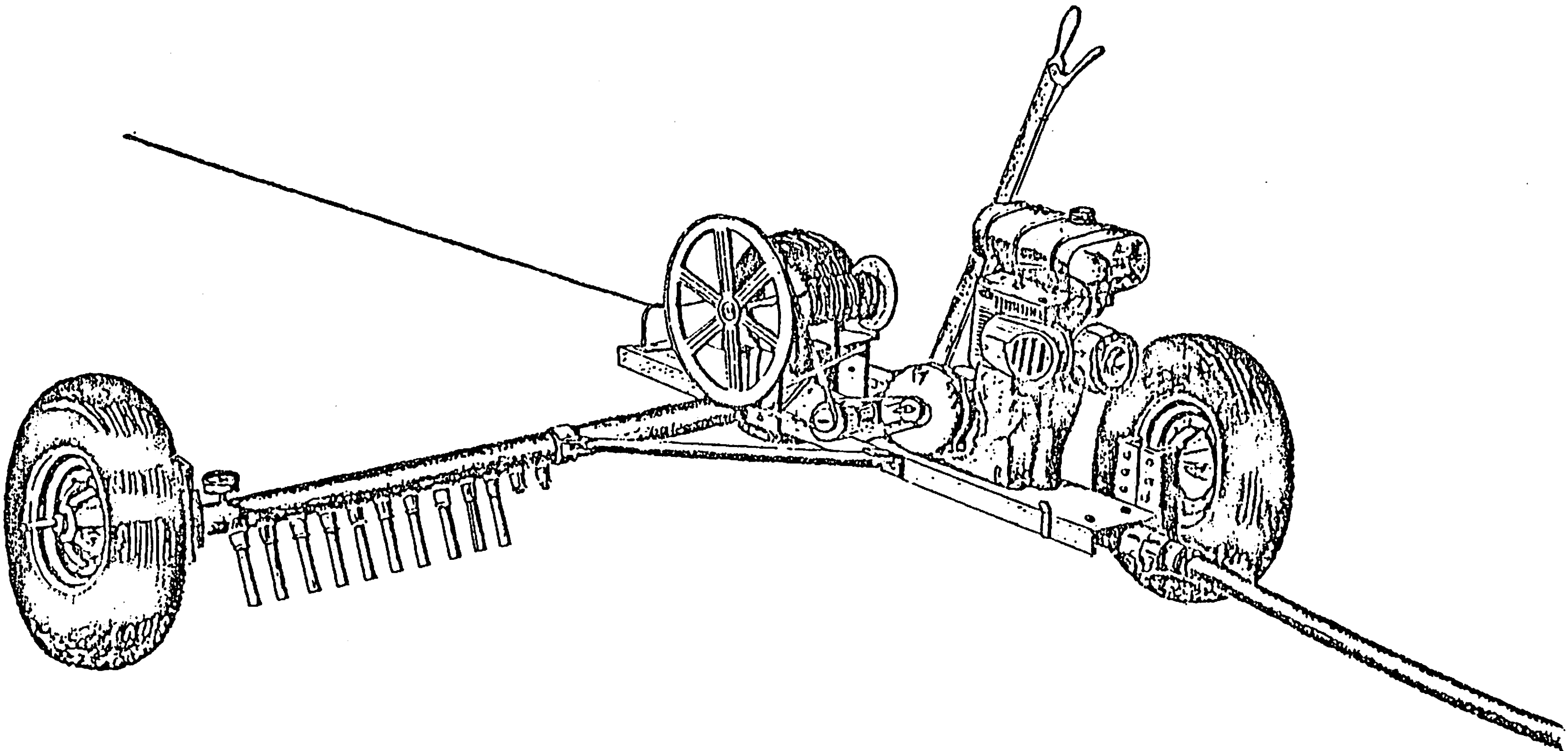
Kyte and Chew (1975) summarized the effects of hydraulic escalation shellfish harvesting on the soft-shell clam, *Mya arenaria*. Many of these effects are applicable in part to those for *Spisula*. There occurs a winnowing of suspended sediments in which the coarse particles fall first, followed by the fines. The differences between sediment in the harvester trench and outside of it depends on the sediment composition and structure. For example, the grain size in the trench and the adjoining flats of an intertidal estuarine mud flat ($\geq$90% silt and clay) in Maine was the same (Kyte et al., 1975). However, on sand flats there is a quantitative and qualitative change. Loss of fines are documented in subtidal studies of Chesapeake Bay, Florida and the intertidal zone in Washington. In Washington there was a marked reduction in fines (<63μ) and volatile solids, and these differences persisted for at least several months. There are very few data on the compactness and water content of dredge scars and the redeposition of sediment outside the track. Little is known about changes in organic carbon (one study reported no marked change). The tracks or scars are usually softer, their sediments contain more water, and they are lower than the adjacent flats. Scars have lasted up to 3 years in Washington, 2 years in Florida, and at least 1½ years in Maine. Tracks in Florida (e.g., Tampa Bay) were visible longest in seagrass (*Thalassia*) beds, pure sandy areas filling in almost immediately (Hodges, 1971). It is not known what effect bioturbation has on the tracks. However, Hughes *et al.* (1978) report that dredge tracks in the s.e. Bering Sea filled in after only 24-36 hours. This rapid filling was undoubtedly due in part to large scale bioturbation (*i.e.*, feeding activities) by yellowfin sole, starfish, and crabs (based on observations on NMFS videotapes of the seafloor by G. Bakus). Manning (1957) and Haven (1970) concluded that deposition of suspended sediments is negligible 75 ft downcurrent from a working dredge. However, Manning (1957) observed that oysters show a significant mortality within 25 ft of a hydraulic escalator dredge, and suggested the possibility that oyster spat may suffer mortaility from dredge sediments as far away as 75 ft.

Breakage of soft-shell clams by hydraulic escalator dredging in Maine was often $\leq$ 5%, the highest value being 14% with inexperienced operators. Kyte *et al.* (1975) indicate that total mortalities probably were much higher than indicated by clam breakage due to predation by herring gulls. This appears also to be true for clams in the s.e. Bering Sea (based on videotapes), which after dredging were soon being encountered by numerous starfish, crabs and flatfish (see Hughes *et al.*, 1978). Haven (1970) concluded that hydraulic dredging did not significantly increase or decrease recruitment of soft or hard-shell clams. Chesapeake Bay studies also showed little changed in recruitment, but in Maine there were significant increases in clam spat and juvenile clams during the season following harvesting (Kyte and Chew, 1975). The differences may have been associated in part with varying sediment characteristics. No recolonization of sea grasses (*Thalassia testudinum* and *Syringodium filaforme*) occurred in any dredged areas in Florida (Hodges, 1971). In contrast, Burrell and Gracy (in Kyte and Chew, 1975) concluded that there was no significant effect of hydraulic dredging on animals in South Carolina and Kyte et al. (1975) found no definite long-lasting effects on the infauna in Maine, populations returning to normal levels within 10 months.

Mya arenaria has suffered a 70% juvenile mortality as the result of hand digging (caused by breakage, exposure, or smothering caused by burial), a major factor in the decline of clam production in New England and eastern Canada. Hydraulic dredging is a more efficient operation than collecting by hand or other methods. Little breakage of captured organisms occurs and far less mortality. Hydraulic dredging is an efficient sampler for molluscs and polychaete worms but active swimmers (e.g., decapod crustaceans and flatfish) are not readily captured. Kyte and Chew (1975) recommended a hydraulic clam rake for intertidal clam harvesting (Figure 7). The rake is less expensive than the hydraulic clam harvester, easier to operate, and has a 95% efficiency with less than 3% breakage.

In conclusion, it appears that the nature of the sediment plays an important role in the effects of hydraulic clam harvesting. Sea grasses are especially sensitive to harvesting. Kyte and Chew (1975) conclude that the results of hydraulic dredging in Chesapeake Bay cannot be applied to other regions for *Mya* due to different sediments and growth rates. No studies of any kind on the effects of dredging on marine organisims have been conducted or supported in Alaska by the U.S. Army Corps of Engineers Waterways Experiment Station in Vicksburg, Mississippi (Mr. Richard Peddicord, personal communication, June 20, 1978). There are no studies on the effects of hydraulic

FIGURE 7. Hydraulic Clam Digger for Operation on Dry, Sandy Intertidal Clam Flats



Source: Kyte and Chew (1975).

dredging in Alaskan waters, so far as is known. Extrapolations of the biology of *Mya* or even *Spisula solidissima* to that of *Spisula polymyma* in predicting the impacts of hydraulic dredge harvesting on the pinkneck clam is precarious at best. Even closely related species may differ markedly in their life histories and their ability to tolerate changes in sediments and exposure to potential predators. Consequently, the effects of hydraulic harvesting on surfclams in Block 60 cannot be predicted. Any tentative conclusions must be based on site specific, ground truth studies.