ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF ENFORCEMENT

A SUMMARY OF WASTE SOURCE AND WATER QUALITY INFORMATION ON THE ALASKA SEAFOOD INDUSTRY

Review and Evaluation Branch
National Field Investigations Center-Denver
Denver, Colorado

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I. INTRODUCTION

Seafood processing is a major industry in Alaska. Owing to substantial variations in commercial catches from year to year, the number of processing plants in operation in any given year varies but has ranged between 100 and 200 in recent years. Plant sizes range from large salmon canneries processing as much as 18 million lb of salmon per season down to small family operations providing various seafoods for the fresh food markets. At least 35 plants can be considered major industrial operations.

Salmon, crab and shrimp are the major species of fish and shellfish processed. A substantial portion of fish and shellfish is waste material, ranging from one-third of the whole salmon to as high as 75 to 85 percent for crab and shrimp. In some areas part of the waste materials are recovered for by-products but in most cases all waste materials are discharged directly to adjacent waters. A majority of the plants grind their wastes before discharge but some dump whole wastes near shore and others barge whole wastes some distance offshore. Tidal currents and scavengers rapidly disperse or consume most wastes. This fact coupled with the remote locations of many plants has minimized water quality problems associated with seafood waste disposal. As a result, waste treatment as commonly defined is absent from the industry.

Water quality problems of varying degrees of severity do exist, however, and additional pollution abatement measures are needed. An EPA reconnaissance survey of selected seafood processing plants in 1971 found esthetic problems such as foam, floating waste solids and bloody water common to most locations.[1/] In some locations, waste materials such as fish heads and crab shells had accumulated in the vicinity of waste outfalls. Water quality standards were violated at a number of locations.

The Federal Water Pollution Control act Amendments of 1972 require that effluent limitations be established for all sources of industrial wastes discharged to navigable waters. Current information on Alaska seafood processing plants is inadequate to develop effluent limitations for this industry.

On 2 February 1973 the Director of the Surveillance and Analysis Division, Region X, EPA, Seattle, Washington, requested the assistance of the National Field Investigations Center-Denver in conducting a study of the Alaska seafood industry during the 1973 processing season. The scope of the Regional request was defined in a 2 March 1973 memorandum from Mr. Craig Vogt of the Surveillance and Analysis Division. Objectives of the requested study would be to determine water quality at areas previously identified as having possible water quality problems and to investigate specific types of waste disposal methods relative to their impact on water quality. A total of 33 processing plants were proposed for study. Field investigations would include documentation of waste disposal methods at each plant and receiving water studies with primary emphasis on esthetic problems, sludge deposits and dissolved oxygen concentrations.

A meeting between Alaska Operations Office and NFIC-D personnel was held in Anchorage 13 March 1973 to discuss study objectives. As a result of this meeting, a third objective was added, the development of acceptable waste abatement procedures for inclusion in effluent limitations.

On 1 May 1973 Mr. Vogt revised his list of priority processing plants to include a total of 30 plants. This revision was based on the release by the National Canners Association of a list of salmon canneries expected to operate in 1973. Three plants on the 2 March 1973 list will not operate in 1973.

This report is a compilation and summarization of available recent information on the Alaska seafood industry. Chapter IV discusses applicable water quality regulations. Characteristics of the salmon, crab, and shrimp processing industries are discussed in Chapter V including a history of the fishery, processing procedures, waste disposal methods, and waste characteristics. Operational data, production data, waste loads, waste disposal practices, and receiving water characteristics for plants operating in 1971 are summarized in Chapter VI.

Pertinent details and results of a number of recent studies of Alaskan seafood plants, selected water quality studies, waste treatment investigations, and a by-products plant development report are discussed in Chapter VII.

Information and data summarized in this report were compiled from a number of sources. The assistance of Mr. Craig Vogt, Region X and Mr. Steve Provant, Alaska Operations Office, in collecting and assembling information is gratefully acknowledged. The National Canners Association and Alaska Fish and Game Department also furnished information.

II. SUMMARY AND CONCLUSIONS

1. Seafood processing is the third largest industry in Alaska. In recent years the number of operating seafood processing plants has ranged between 100 and 200 with 116 known commercial operators in 1971. An average of about 9,000 workers are employed by the industry, many on a seasonal basis. At least 35 plants can be considered major industrial operations.

2. The size and value of the seafood catch processed vary widely from year to year. Between 1960 and 1969 the annual catch of fin fish ranged from 355 to 580 million lb with a value of 40 to 84 million dollars. The majority of this catch was salmon (160 to 330 million lb per year) with an annual value ranging from 25 to 54 million dollars. This finfish catch was converted into products with an annual value ranging from 95 to 195 million dollars. Shellfish catches (king, tanner, and dungeness crab and shrimp) increased rapidly from minor amounts prior to 1957 to reach a peak of 190 million lb in 1966. An accompanying rise in the value of the shellfish catch peaked in 1967 at 28 million dollars. The growth of the shellfish industry was based on development of the king crab fishery which has substantially declined since 1966. This decline has been partially offset by an increase in the tanner crab catch and a major increase in the shrimp catch.

3. Available information is not adequate to fully assess the impact of waste discharges from seafood processing plants on the

quality of Alaskan waters. Within the past four years several studies of processing plants, waste discharges, and/or receiving waters were conducted, primarily for or by the EPA and the National Canners Association. These studies varied widely in scope, ranging from a reconnaissance survey of 29 plants to detailed biological and chemical studies of the receiving waters at Naknek on Bristol Bay, Kodiak Harbor, several remote Kodiak Island canneries and Petersburg. Water quality problems ranging from gross pollution at Kodiak Harbor to minor esthetic problems were observed. The reconnaissance survey coupled with waste discharge permit applications submitted in 1971 under the Refuse Act Permit Program provided information on waste disposal practices at most major processing plants. This information is incomplete on a number of plants, however, and no information is available on many of the small operators. The characteristics of salmon processing wastes have been relatively well defined but data on crab and shrimp processing wastes are sparse. A wide variation in waste characteristics, waste disposal practices, and receiving water conditions exists among plants making it impossible to readily extrapolate data from one plant to another.

4. Seafood processing wastes consist almost entirely of discarded inedible portions of the fish or shellfish. Depending upon the waste disposal methods used, waste constituents may range from whole sections such as salmon heads and crab bodies to finely

ground solids and strong organic waste solutions. The fraction of the raw seafood wasted is high, ranging from about one-third of the whole salmon to as high as 75 to 88 percent of the green crab and raw shrimp. Some salmon processors recover waste solids for by-products such as pet food and fish bait. Waste load reductions as high as 70 percent have been achieved in this manner. With the exception of Kodiak, where a by-products plant is scheduled to begin operation in 1973, no shellfish processors recover by-products. With the exception of crab shells, seafood wastes are readily degradable, breaking down rapidly in the marine environment. Birds and aquatic scavengers consume large amounts of waste solids.

5. Three basic types of waste disposal methods are used by Alaskan seafood plants. The most primitive is the "hole-in-the-floor" method where all wastes are discharged from the processing machines directly through the floor into the receiving water. The second method is to collect wastes in a central system for discharge at the dock face or through an offshore outfall on the surface or at depth. The third method combines the central waste collection system with a "gurry scow" for offshore disposal of waste solids. Where an outfall is used, part (usually fish heads) or all of the waste solids might be ground before discharge. Grinders might also be used for off-the-dock discharges and, in a few cases, for through-the-floor discharges. Waste treatment as commonly defined is entirely absent from the industry.

6. Esthetic problems such as bloody water, foam and floating waste solids are common to many waste discharges. In areas where tidal currents are not swift enough to rapidly disperse the solid wastes, bottom accumulations and sludge deposits may form. Such deposits are a major problem in Kodiak Harbor but significant problems have also been observed in Naknek, Dutch Harbor, Orca and Petersburg. The use of a deep-water outfall minimizes water quality problems relative to a near-shore surface discharge point.

7. Alaska is currently revising the state's water quality standards to meet the requirements of the Federal Water Pollution Control Act Amendments of 1972. The present standards require all waste sources to provide secondary treatment unless it can be demonstrated that primary treatment will meet water quality standards. The proposed revisions require secondary treatment for domestic wastes and best practicable control technology currently available as shall be defined for industrial wastes. None of the seafood processors, with the exception of one plant connected to a municipal system, provide even primary treatment of industrial wastes. Few provide secondary treatment of domestic wastes and many provide no treatment. Many waste discharges are in violation of present or proposed water quality criteria for coliform bacteria, floating solids, sludge deposits, esthetics and turbidity. Some dissolved oxygen violations also occur.

8. A permit from EPA is required to dump any materials except dredged spoil and fish wastes in the ocean under the provisions

of the Marine Protection, Research, and Sanctuaries Act of 1972. A permit may be required for fish wastes if they are dumped in harbors or enclosed bays or any location where EPA finds that this dumping could endanger health, the environment, or ecological systems in a specific location. "Gurry scows" might require such a permit in some locations.

9. Alaska has indicated to EPA that the state will not operate an effluent permit system. Region X, Seattle, Washington, and the Alaska Operations Office, Anchorage, expect to begin issuing permits to seafood processors in late 1973. It is evident that additional waste abatement measures must be placed in operation by most seafood processing plants. Adequate information is not available on most individual plants to provide the basis for development of effluent limitations that will meet water quality standards, adequately protect beneficial water uses, and at the same time minimize the economic impact of pollution abatement actions on the industry. As a minimum, a field reconnaissance of each plant to collect information on seafood production, waste loads and characteristics, waste disposal methods, and receiving water characteristics coupled with water quality and biological investigations of selected locations is needed to develop a rational basis for establishing effluent limitations for the industry.

III. DESCRIPTION OF AREA

A. GEOGRAPHY

Alaska is a land of geographical extremes. With a land area of about 586,400 square miles, the State is about one-fifth the size of the conterminous United States and two and one-half times the size of Texas. The northernmost, easternmost and westernmost points in the United States are located in Alaska. By superimposing a map of Alaska over the conterminous 48 states, these extremes become readily apparent [Figure III-1].

With many coastal inlets and islands, Alaska has 32,000 miles of coastland (54 percent of the U. S. total). The area of interest in the Alaska seafood industry study is the southern coastal area extending from British Columbia, Canada, westward to the Aleutian Islands chain. This area, extending for about 2,000 air miles, contains a major portion of the Alaska coastline.

A number of geographical features of interest define characteristics of the coastal area [Figure III-2]. Southeastern Alaska or the Panhandle is a long narrow coastal strip isolated from inland British Columbia by a mountain range averaging more than 9,000 feet in elevation. Numerous waterways divide much of the area into the islands of the Alexander Archipelago. Except for the high mountain areas covered with ice fields and glaciers, most of Southeastern Alaska is heavily wooded with hemlock and spruce. Land slopes are steep with the result that little land area is available for building towns and cities. Most communities are strung out along shorelines. Roads are practically non-existent outside developed

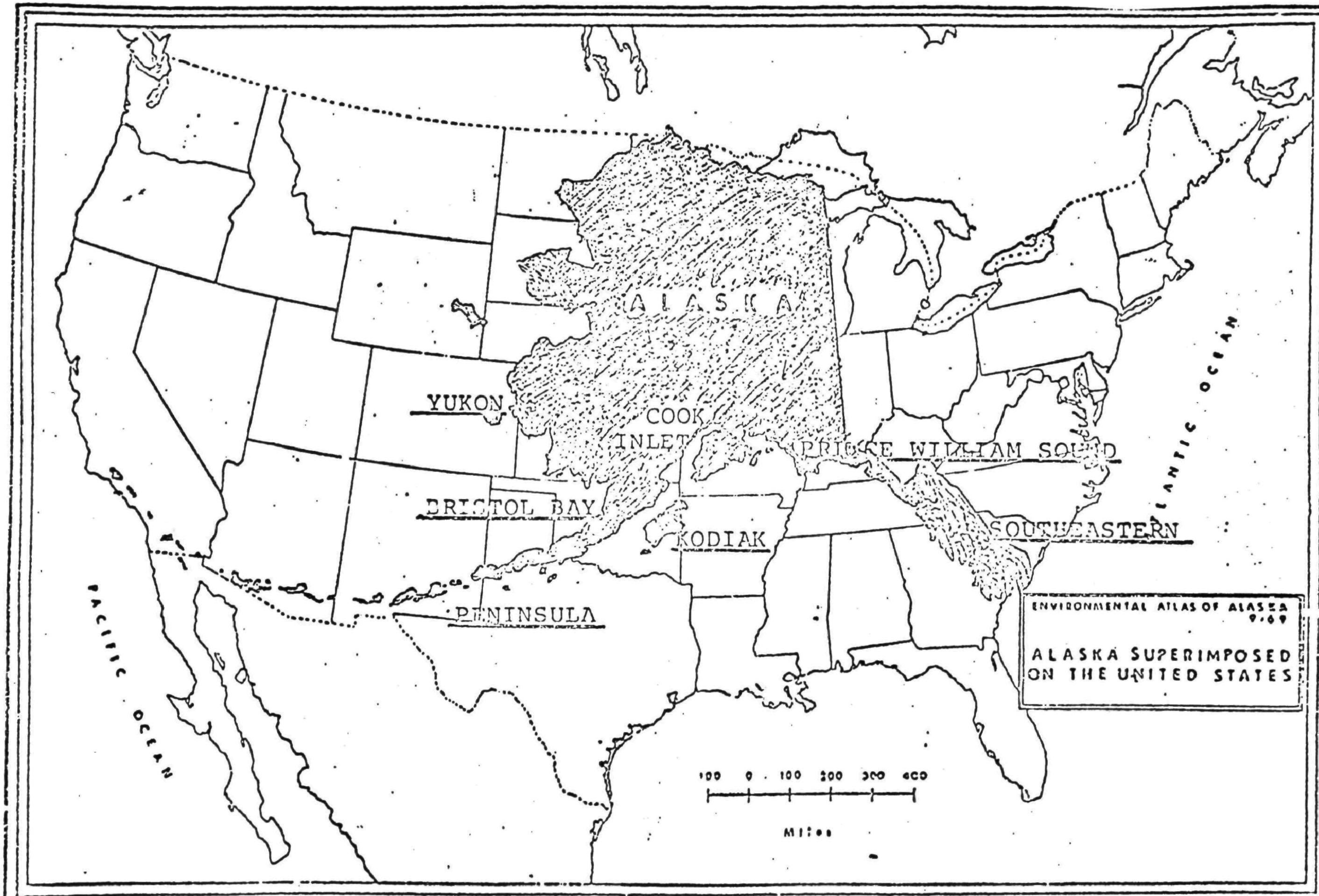

Figure III-1 Map of Alaska Overlying United States

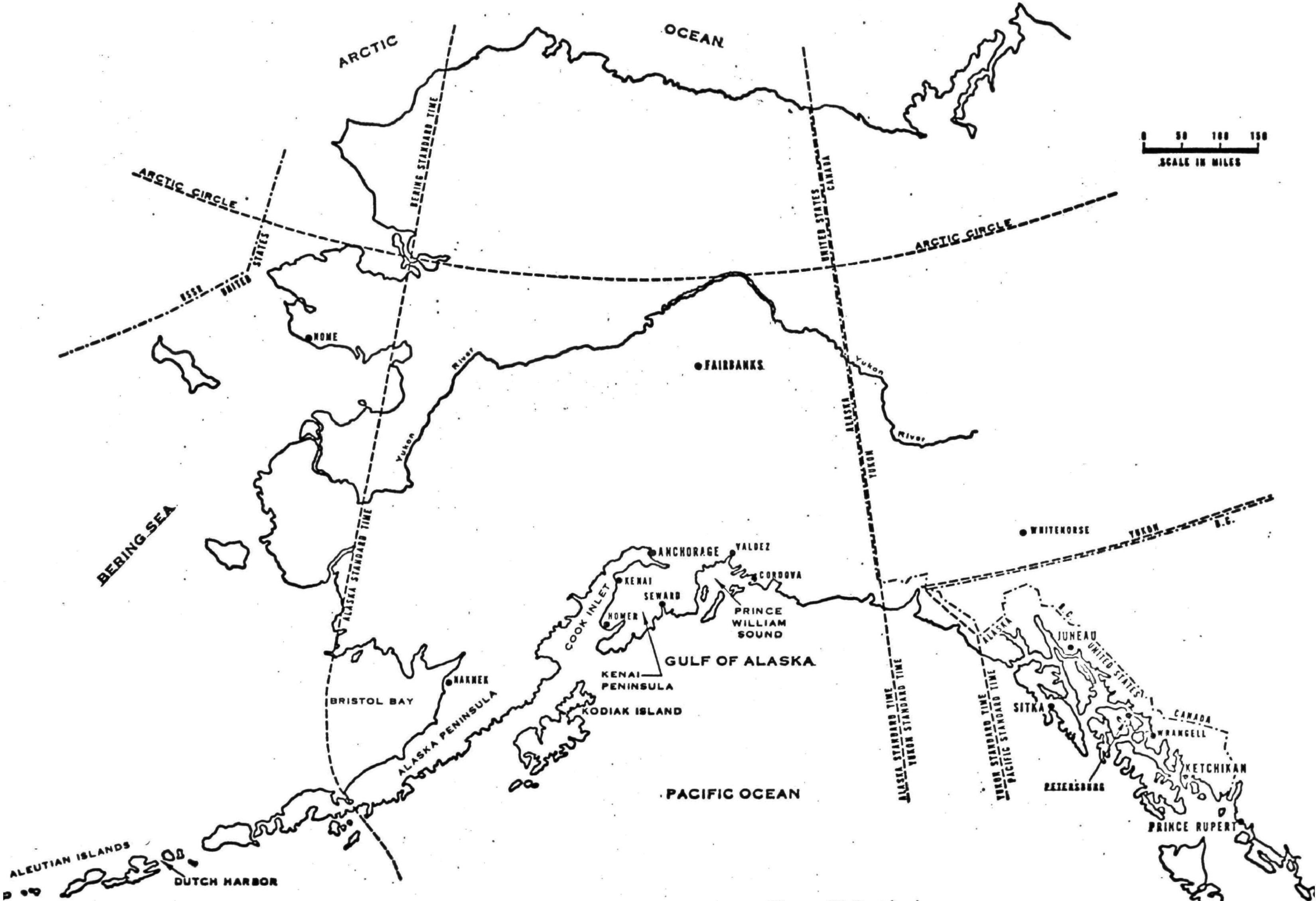

Figure III-2. Alaska

communities. Principal cities are Juneau (the State capitol), Ketchikan, Sitka, Petersburg and Wrangell.

Prince William Sound is located southeast of Anchorage in south-central Alaska. The Sound is surrounded by mountains and numerous narrow inlets. A number of islands partially protect the Sound from the Gulf of Alaska. Hemlock and spruce forests are located adjacent to the Sound while higher elevations are primarily mountain tundra and barrens. Cordova and Valdez are the principal cities.

The Kenai Peninsula extends southward from Anchorage separating Cook Inlet from the Gulf of Alaska. Mountainous terrain, the Peninsula is predominately mountain tundra on the eastern slopes and spruce-birch forests on the western slopes. The Peninsula is the most accessible coastal area with highways connecting most communities to Anchorage. Principal communities are Seward, Kenai and Homer.

Kodiak Island, a large mountainous island, is located south of the Kenai Peninsula. Much of the island is mountain tundra with the north end supporting spruce-hemlock forests. Kodiak is the only sizeable community on the island.

The Alaska Peninsula juts westward from the mainland, separating the Bering Sea from the Pacific Ocean. Bristol Bay, a large shallow bay, is located on the north side of the peninsula. Bristol Bay is bordered by low elevation tundras while part of the peninsula is mountainous and covered mainly by mountain tundra. The Alaska Peninsula is quite remote supporting only small fishing communities of which Naknek is of the most interest.

Extending westward from the Alaska Peninsula for about 1,000 miles is the chain of islands known as the Aleutian Islands. Largely uninhabited except for a few Aleut Indian villages and naval installations, the islands are barren and windswept.

B. CLIMATE

Temperatures in coastal Alaska are moderated by the influence of the sea and differ markedly from the extremes that occur in interior areas. Southeastern Alaska experiences mild weather year around comparable to western Washington. The warm waters of the Japan Current are responsible for this moderation. The warm current also has a beneficial effect on marine life and commercial fishing fluorishes.

In the Aleutian Islands temperatures rarely fall below zero although fog and severe winds are common. South-central Alaska including the Prince William Sound area and the Kenai Peninsula experience weather similar to upper New York State. Valdez is an ice-free port while Anchorage is land-locked by ice in winter. Average temperature ranges for the summer months are shown for several locations in Table III-1.

TABLE III-1

AVERAGE SUMMER TEMPERATURES

	May		June		July		August	
City	Ave. Max.	Ave. Min.	Ave. Max.	Ave. Min.	Ave. Max.	Ave. Min.	Ave. Max.	Ave. Min.
Anchorage	54	38	63	43	65	50	63	48
Cordova	52	36	58	42	60	46	61	44
Juneau	54	38	61	44	63	48	62	47

Owing to its proximity to the sea, coastal Alaska receives heavy precipitation. Cloudy weather is the rule with rain two days out of three common in many areas. Southeastern Alaska receives the most rain with annual precipitation ranging from 95 inches at Juneau to more than 150 inches at Ketchikan. Other coastal areas receive lesser amounts although 60 inches is common. Fog occurs about 20 to 30 days per year.

The far north latitude contributes long days in Summer and long nights in Winter. During mid-summer in Anchorage, nights may be as short as four hours.

C. POPULATION AND ECONOMY

With a population of slightly more than 300,000, Alaska ranks last of the 50 states. About 70 percent of the population lives in the coastal area which is sparsely populated. Sizeable communities are widely scattered with most areas supporting only small Indian, fishing or mining villages. Many communities are populated only seasonally.

Anchorage with a metropolitan area population of about 125,000 has more than one-third of the state's population. All other coastal communities have less than 15,000 population. Cities of interest and their approximate area populations are: Ketchikan, 7,000; Petersburg, 3,000; Juneau, 14,000; Sitka, 7,000; Cordova, 2,000; Seward, 2,500; Kenai, 3,500; Homer, 3,000; and Kodiak, 9,000.

The economy of Southeastern Alaska is predominately dependent upon tourism and the lumber, pulp and paper, and fishing industries. Until recently the south-central area economy rested upon fishing, mining, and tourism. Discoveries of oil in Cook Inlet have developed a petroleum industry which centers on petrochemical plants at Kenai. Valdez is the southern terminus of the proposed Alaska pipeline to transport oil from the new North Slope oilfields. The Alaska Peninsula and Aleutian Islands depend heavily upon fishing and tourism.

D. TRANSPORTATION AND LODGING

The remoteness of many fishing communities coupled with the lack of roads makes travel in coastal Alaska substantially different than in the "other 48." Most travel is by plane or boat.

Roads are almost non-existent in Southeast Alaska. The Alaska Marine Highway system operates passenger and vehicle ferries along the Inner Passage between Prince Rupert, British Columbia, and Skagway, Alaska. Essentially daily service is provided to the intermediate points of Ketchikan, Wrangell, Petersburg, Juneau and Haines with several stops a week at Sitka. Winter service is on a reduced schedule.

Alaska Airlines provides scheduled jet service to Juneau, Petersburg and Ketchikan with scheduled small plane service to other points in Southeastern Alaska. Air taxis provide service to remote locations.

Lodging is available in motels and hotels in most sizeable communities in the Southeast. During the tourist season, however, this space is regularly filled. Little lodging is available at remote locations.

Another segment of the Alaska ferry system serves the south central area connecting the communities of Anchorage (summer only), Kenai, Homer, Kodiak, Seward, Whittier, Valdez, and Cordova. All of these except Kodiak and Cordova are accessible by road from Anchorage. Rental cars are available in Anchorage.

Cordova receives once-a-day jet service from Juneau and Anchorage.

Kodiak is served by scheduled small plane flights (Reeve Aleutian Airways, Inc.) with other communities reached by air taxi.

Outside the Anchorage area lodging is more limited than in the Southeast although motels are available in some communities.

Travel is difficult in the Bristol Bay, Alaska Peninsula, and Aleutian Island areas. Wein Consolidated provides jet service daily to King Salmon and Kodiak from Anchorage. Reeve Aleutian provides scheduled small plane service to King Salmon (Naknek - no traffic from Anchorage), Sand Point, Cold Bay, and Dutch Harbor. As few as one or two flights a week serve some points and weather is a major problem. No scheduled ferry service is available.

Most travel in this area is by air taxi. Typical planes used will carry five passengers and a moderate amount of gear. Charter fees run about $80 to 100 per hour flight time with an extra charge for waiting time. For remote pickups, flight time is charged both ways. The Bureau of Land Management has a small fleet of planes in Anchorage. The Regional Office chartered a Grumman Goose and pilot for the 1971 reconnaisance survey for $135 per hour flight time with no waiting time charge.

In the Bristol Bay and Aleutian Island areas no normal lodging is available. The canneries will usually accomodate lodgers at a reasonable fee with adequate advance notice.

E. OCEANOGRAPHY

Tides in Alaska are markedly different than in typical southern United States waters. The tides are semi-diurnal with two highs and two lows daily. Tide ranges of 12 to 20 feet are common. This high tidal range produces strong tidal currents (two to nine knots) in many of the narrower tidal channels. In areas of interconnected tidal channels such as in the Southeast, tide stages strongly influence the direction of freshwater flow in such channels. In areas with large freshwater inflows, salinities may vary sharply with the tides. Water temperatures are also affected. Typical water temperatures and salinities at key locations are summarized in Appendix A. Tide tables for the 1973 summer season are presented in Appendix B.

IV. APPLICABLE WATER QUALITY REGULATIONS

All seafood processing plants in Alaska are located on coastal waters. The quality of these waters and tributary waste sources are subject to regulations established pursuant to the Federal Water Pollution Control Act, the Refuse Act of 1899, and the Marine Protection, Research and Sanctuaries Act of 1972. These regulations include water quality standards, waste discharge permits, and ocean dumping criteria. All of these regulations are currently in the process of revision and/or formulation. The following discussion is based on the status of regulations in April 1973. As substantial changes may occur in the next few months, the reader should verify if the regulations contained herein have been revised prior to application to specific cases.

A. WATER QUALITY STANDARDS

Present Standards

The State of Alaska established water quality standards in 1967 for all waters of the State, including coastal waters, under the provisions of the Federal Water Pollution Control Act as amended by the Water Quality Act of 1965. These standards subsequently received partial Federal approval in 1968. Revisions were submitted in 1971 and the standards received full Federal approval on 4 October 1971. The approved standards are being revised as discussed below.

Proposed Standards

The Alaska standards are currently being revised to meet the requirements of the Federal Water Pollution Control Act Amendments of 1972.

These revisions include changes in water quality criteria, revised classifications of various waters, and upgraded waste treatment requirements. [Proposed standards are contained in Appendix C.]

On 23 March 1973 the Department of Environmental Conservation announced public hearings to be held on the revised standards during late April. It is anticipated that revisions will be finalized during May and the new standards submitted for Federal approval by June 1973.

Pertinent Criteria

All marine and coastal waters of Alaska are classified for water contact recreation (Class C), growth and propagation of fish and other aquatic life, including waterfowl and furbearers (Class D), shellfish growth and propagation, including natural and commercial growing areas (Class E), and industrial water supply (Class G). Water quality criteria have been established for each of these water use classifications. The most stringent criterion for each water quality parameter of interest is listed in Table IV-1 (excerpted from the proposed revised standards).

Of special interest are the criteria for total coliform organisms, dissolved oxygen, sludge deposits, suspended and settleable solids, and aesthetic considerations. One or more of these criteria are being violated by most seafood processing plants.

The water quality criteria apply outside of mixing zones defined by waste discharge permits. The mixing zone will be limited to a volume of the receiving water that will not interfere with biological communities or populations of important species to a degree which is damaging to the ecosystem and that will not diminish other beneficial uses disproportionately. No waste discharge permits have been issued.

TABLE IV-1

APPLICABLE WATER QUALITY CRITERIA

Water Quality Parameter	Applicable Criterion
Total Coliform Organisms	Not to exceed limits specified in National Shellfish Sanitation Program, Manual of Operations, Part 1, USPHS.[2]
Dissolved Oxygen	Greater than 6 mg/l in salt water and greater than 7 mg/l in fresh water
pH	Between 7.5 and 8.5 for salt water. Between 6.5 and 8.5 for fresh water.
Residues Including Oils, Floating Solids, Sludge Deposits and Other Wastes	Residues may not make the receiving water unfit or unsafe for the uses of this classification; nor cause a film or sheen upon, or discoloration of, the surface of the water or adjoining shoreline; nor cause a sludge or emulsion to be deposited beneath or upon the surface of the water, within the water column, on the bottom, or upon adjoining shorelines. Residues shall be less than those levels which cause tainting of fish or other organisms and less than acute or chronic problem levels as determined by bioassay.
Settleable Solids and Suspended Solids	No visible concentrations of sediment. No deposition which adversely affects fish and other aquatic life reproduction and habitat or adversely affects growth and propagation of shellfish.
Toxic or Other Deleterious Substances, Pesticides, and Related Organic and Inorganic Materials	Below concentrations found to be of public health significance. Concentrations shall be less than those levels which cause tainting of fish, less than acute or chronic problem levels as revealed by bioassay or other appropriate methods and below concentrations affecting the ecological balance.
Turbidity	Below 25 JTU except when natural conditions exceed this figure effluents may not increase the turbidity.

TABLE IV-1 (Cont.)

APPLICABLE WATER QUALITY CRITERIA

Water Quality Parameter	Applicable Criterion
Temperature	May not exceed natural temperature by more than 2°F for salt water. May not exceed natural temperature by more than 4°F for fresh water. No change shall be permitted for temperature over 60°F. Maximum rate of change permitted is 0.5°F per hr.
Dissolved Inorganic Substances	Within ranges to avoid chronic toxicity or significant ecological change.
Aesthetic Considerations	May not be impaired by the presence of materials or their effects which are offensive to the sight, smell, taste or touch.

Waste Treatment Requirements

The present water quality standards call for all waste sources to provide a minimum of secondary treatment unless it can be demonstrated that primary treatment will meet water quality standards. The implementation schedule established a 1972 completion date for all seafood processing facilities. Essentially all facilities did not meet this deadline.

The proposed standards call for a minimum of secondary treatment for all domestic wastes. All industrial waste discharges are required to have treatment equivalent to best practicable control technology currently available as shall be defined for each industrial waste. Higher levels of treatment will be required where necessary to meet water quality criteria. New waste discharges must provide such treatment at the time of construction. Existing discharges must provide such treatment as soon as possible but not later than July 1977.

The standards provide for the issuance of waste discharge permits by the State and by the Federal government with State certification. Alaska has indicated that it wants EPA to administer the permit program.

B. REFUSE ACT PERMIT PROGRAM

The Refuse Act of 1899 prohibited the discharge of industrial wastes to navigable waters without a permit from the Corps of Engineers. Executive Order No. 11574 tightened enforcement of this Act in December 1970 by requiring all sources of industrial waste discharging to navigable waters to apply for a discharge permit by 1 July 1971.

A total of 73 seafood processing plants in Alaska subsequently submitted Refuse Act permit applications. The Federal Water Pollution Control Act Amendments of 1972 abolished the Refuse Act Permit Program and established a new permit program discussed below. Discharge applications submitted under the Refuse Act serve as applications under the new program. No waste discharge permits were issued to seafood processors under the Refuse Act Permit Program.

C. NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

The Federal Water Pollution Control Act Amendments of 1972 require that a waste discharge permit system known as the National Pollutant Discharge Elimination System (NPDES) be established to regulate all point sources of municipal, industrial and other wastes. If the States meet certain requirements they can administer the NPDES permit program subject to EPA review. Otherwise, EPA will administer the program. Alaska has indicated it wants EPA to issue all permits in that State.

Responsibility for issuing permits has been delegated to the EPA Regional offices. Region X, Seattle, Washington and the Anchorage Operations Office will issue permits for Alaska waste sources.

Waste discharge permits will contain effluent limitations based on secondary treatment for publicly owned treatment facilities and best practicable control technology currently available for industrial sources. Guidelines to define these levels of treatment on control are currently under development by EPA. For the seafood processing industry, the current schedule calls for development of effluent guidelines for crab and shrimp processors by about October 1973 with guidelines for salmon processors to be developed at a later date.

The Region has indicated that it will issue interim permits to processors located on Kodiak Harbor in the near future. Public hearings on permits for the other seafood processors in Alaska may be held in late 1973.

D. MARINE PROTECTION, RESEARCH, AND SANCTUARIES ACT OF 1972

This Act, which became effective 23 April 1973, requires EPA to promulgate regulations to control the dumping of wastes into ocean waters. In March 1973 EPA announced an interim permit program to be in effect until final regulations are developed. A permit to dump materials in the ocean can be obtained by submitting a letter to the appropriate EPA Regional Administrator with details of the dumping location, means of transport, waste materials, and alternate means of disposal that were not considered practical.

All materials dumped in the ocean must be covered by such a permit with the exception of dredged spoil and fish wastes. A permit is not required for dumping of fish wastes unless these wastes are dumped in harbors or enclosed bays or any location where EPA finds that this dumping could endanger health, the environment, or ecological systems in a specific location.

V. INDUSTRY CHARACTERISTICS

Alaskan coastal waters support a major seafood industry. Most of the commercial fishery is located in the Southeastern, Prince William Sound, Kenai Peninsula, Kodiak Island, Bristol Bay, Alaska Peninsula, and Aleutian Islands areas. Seafood processing plants are located close to the fishing areas. With few exceptions the plants are remotely located with only one or two processors in one location. Communities with more than three processors in the vicinity include Kodiak (14), Naknek (11), Cordova (8), Petersburg (5), and Ketchikan (4).

Salmon, crab, and shrimp are the main species processed with minor amounts of halibut, herring, scallops, and clams also harvested. Salmon are the most important seafood in Alaska. The commercial catch has ranged from 21 million to 68 million salmon during the past 20 years. The principal salmon processing areas are Southeast Alaska, Prince William Sound, Kodiak Island, Alaska Peninsula, and Bristol Bay. The Alaska crab industry is primarily based on the king crab although recent declines in the king crab catch have resulted in increased importance of the tanner and dungeness crab fisheries. Principal crab processing areas include the Aleutian Islands, Kodiak Island, Prince William Sound, and Southeast Alaska. Substantial growth has occurred in the shrimp fishery in recent years. The majority of the shrimp are processed on Kodiak Island.

Seafood processing in Alaska is highly seasonal with much of the

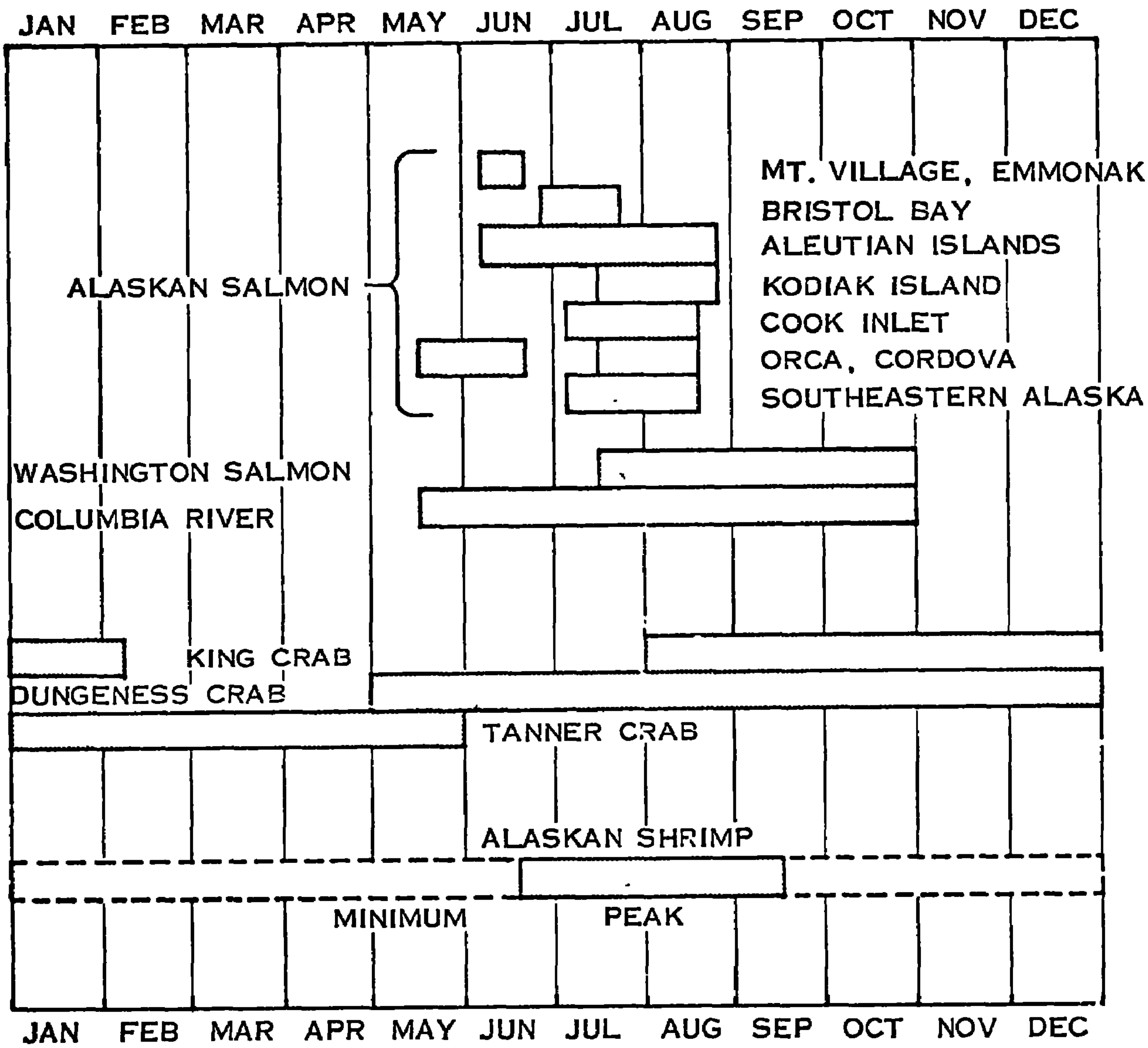

Figure V-1. Typical Seafood Processing Seasons[3/]

commercial fishing conducted in July and August. Typical seafood processing seasons are shown in Figure V-1.

Fishing catches are highly variable from year to year. As a result some processing plants do not operate every year and the number of plants operating in a given year is quite variable. In recent years the number of operating plants have declined. A peak of 225 plants were in operation in 1965. Operating plants declined to 165 in 1969 and 116 in 1971.[4/] A below average salmon run in 1973 will probably result in a further reduction in operating plants this year.

The highly seasonal operations, remote locations, and fluctuating catches are factors that directly affect waste disposal practices prevailing in the Alaska seafood industry. Current processing practices, waste characteristics, and waste disposal practices for the salmon, crab, and shrimp industries are discussed below.

A. SALMON INDUSTRY

The Salmon Fishery

Salmon are an anadromous fish which spend part of their life cycle in both fresh and salt water. They spawn in freshwater streams and lakes connected to the ocean. The young or smolts migrate to salt water while small and live their adult lives there, returning to the area where they were hatched to spawn and die. The Alaska commercial fishery concentrates on catching the salmon as they school in nearshore waters at the beginning of the spawning runs. The spawning runs occur during a short time span accounting for the highly seasonal nature of the commercial fishery.

Different species of salmon have different life spans. The size of spawning runs in a given area fluctuate substantially from year to year with both the time span between peak runs and the degree of fluctuation dependent primarily upon the dominant species of salmon. Severe weather conditions during the hatching period and initial migration of the smolt affect survival rates and may decrease the salmon runs several years later as that year class matures.

The commercial fishery is operated on an escapement basis. Counting stations are located on major spawning streams. If the number of spawners escaping the fishing and passing up the streams falls below projected levels needed to assure maintenance of the fishery, commercial fishing is temporarily suspended. In some cases projected salmon runs may be inadequate to allow a commercial harvest and no commercial fishing will be permitted that season in that area.

Five species of salmon occur in Alaskan waters. Chinook salmon (*Oncorhynchus tschawytscha*), also known as king or spring salmon, is the largest, averaging 20 lb in weight. Sockeye salmon (*O. nerka*), also known as red, blueback and quinalt salmon, averages about 6.5 lb. Silver salmon (*O. kisutch*) average 8 lb and are also known as coho or medium red salmon. Pink salmon (*O. gorbuscha*), also known as humpback salmon averages only 4 lb. Chum salmon (*O. keta*) is sometimes called dog salmon and averages about 8 lb.

The salmon fishery is divided into seven districts. The Yukon River district is the most northerly and is primarily a chinook fishery. Gill netting is the primary fishing method with the catch taking place close to the processing plants.

Bristol Bay produces a major portion of the U.S. pack of canned red or sockeye salmon. Small catches of the other four species are also made. Bristol Bay is a very large, shallow and open fishing area with characteristically turbid water. Gill nets are the primary fishing method. The catch is transferred from the fishing boats to the canneries by cannery tenders and power scows. When a large spawning run enters the Bay, the catch may be large, overloading the canneries. At such times fishing may be suspended for several days while the canneries process stored fish.

The fishery in the Alaska Peninsula area is mixed with the predominant runs being sockeye, chum and pink salmon. Purse seines are the predominant fishing method. Cannery tenders and power scows transfer the catch to the canneries as the fishing grounds are some distance from the canneries.

All five species are caught in the Kodiak Island area using purse seines. The major catch is pink salmon with chum and sockeye also significant.

A widely scattered fishery is operated in Cook Inlet with all five species caught with gill nets and purse seines.

Two distinct fishing seasons occur in the Prince William Sound and Copper River area. A run of chinook and sockeye salmon occurs in the Copper river in late May and early June. The catch is taken by gill nets close to the canneries. During July a run of pink and chum salmon occurs. The catch is widespread in the Sound with both purse seines and gill nets used. Cannery tenders transport the catch.

The last district is Southeastern Alaska where again all five species are caught. Pink salmon are the most important with chum salmon also taken in significant numbers. Purse seines are the primary fishing method. Transportation is a problem as the catch is widespread.

Sockeye and pink salmon are the most important species in terms of total catch. Sockeye salmon account for most of the catch in the western (Bristol Bay and Yukon areas) statistical region [Figure V-2].[5/] Sockeye salmon mature in four to six years. Peak runs in this area exhibit a five-year cycle with recent peaks in 1965 and 1970. The western region has the most extreme variations in annual catches. A combination of the normal mid-cycle low returns and adverse survival of smolts that mature this year is expected to result in the lowest sockeye harvest of the century this year in Bristol Bay [Figure V-2].

In contrast to the western region, pink salmon account for a major portion of the catch in the central statistical region (southern side of Alaska Peninsula, Kodiak Island, Cook Inlet, and Prince William Sound) [Figure V-3]. Pink salmon have a two-year life cycle. Peak runs in this region occur in even-numbered years with lower runs in odd years. Projections for 1973 estimate that the pink salmon harvest will be slightly below average for an odd year [Figure V-3].

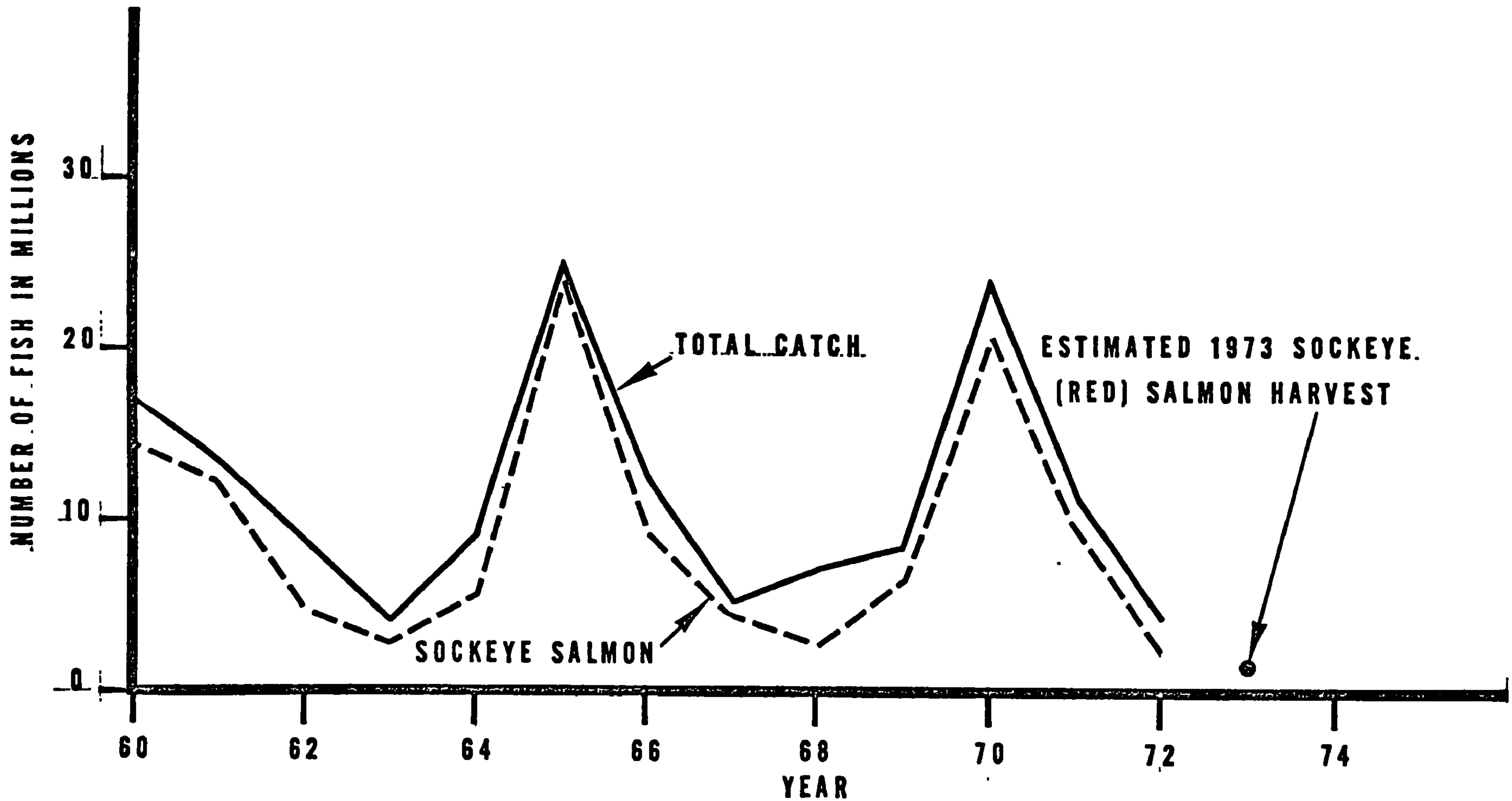

Figure V-2. Annual Commercial Salmon Harvest, Western Region

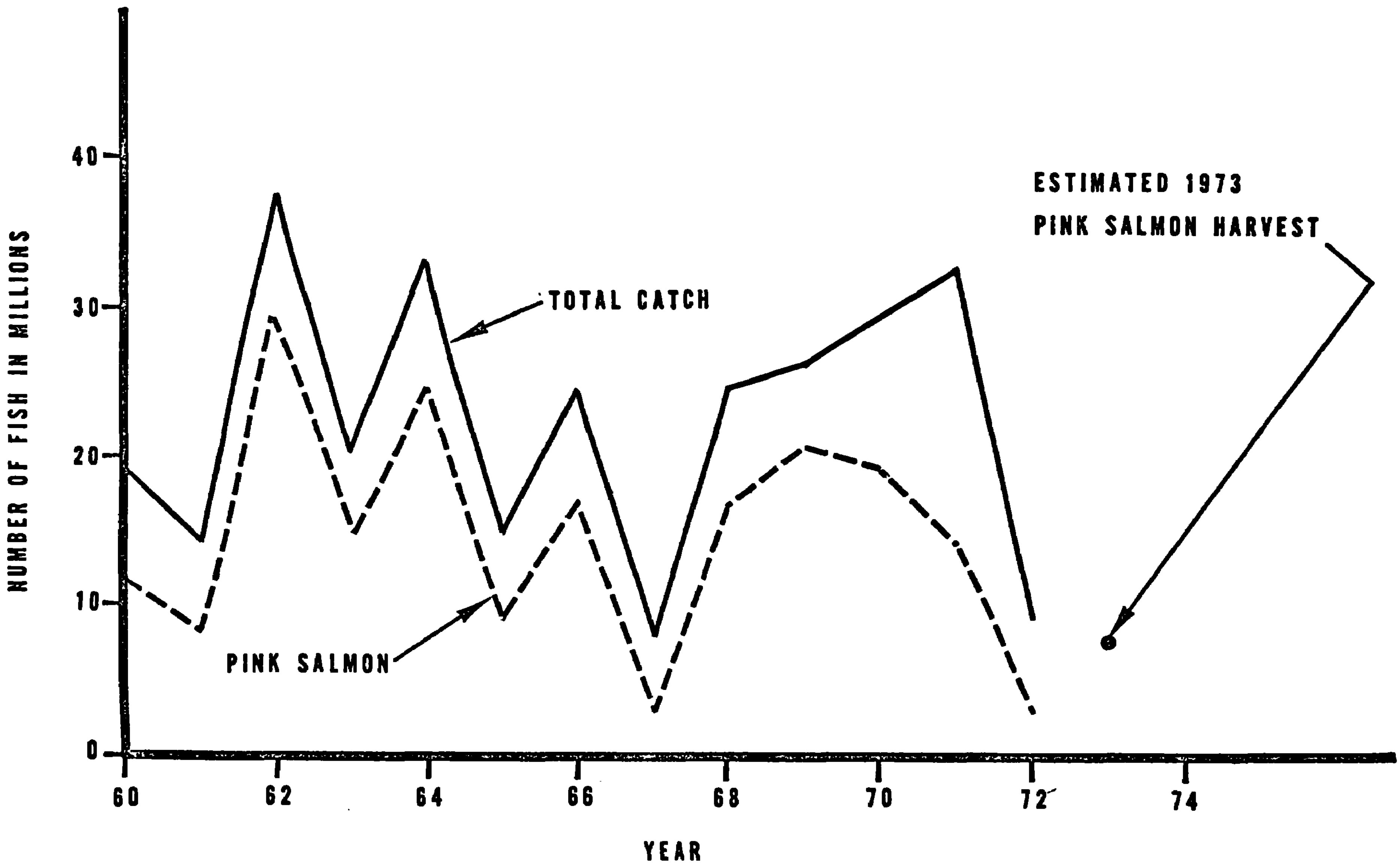

Figure V-3. Annual Commercial Salmon Harvest, Central Region.

Pink salmon also dominate the Southeast Alaska harvest [Figure V-4]. In recent years major fluctuations between even and odd year catches have occurred. The estimated 1973 pink salmon harvest is near average for odd years.

A comparison of the regional commercial catches indicates that, in terms of the number of fish processed, the western region accounts for a substantial portion of the total Alaska catch only during peaks every five years [Figure V-5]. The central region accounts for the largest number of fish caught most years but this catch is spread among several fishing areas. The Southeast Alaska area has the largest catch of a single fishing region most years.

Process Details And Waste Sources

A majority of Alaska salmon are canned for marketing. Distance from markets and the large volumes of fish handled during peak fishing periods preclude, marketing the salmon fresh or frozen except in Southeast Alaska. This discussion will be limited to canning processes.

Depending upon the distance from fishing areas, the salmon may be delivered directly to the canneries by fishing boats or by cannery tenders and power scows. At the cannery the fish holds are filled with salt water to enable the salmon to be pushed out of the boat onto an elevator. This elevator dewaters the fish and delivers them to a conveyor on the cannery dock that carries the salmon to the fish house. Blood and slime from the fish hold are discharged overboard.

In the fish house the salmon either go directly to the butchering

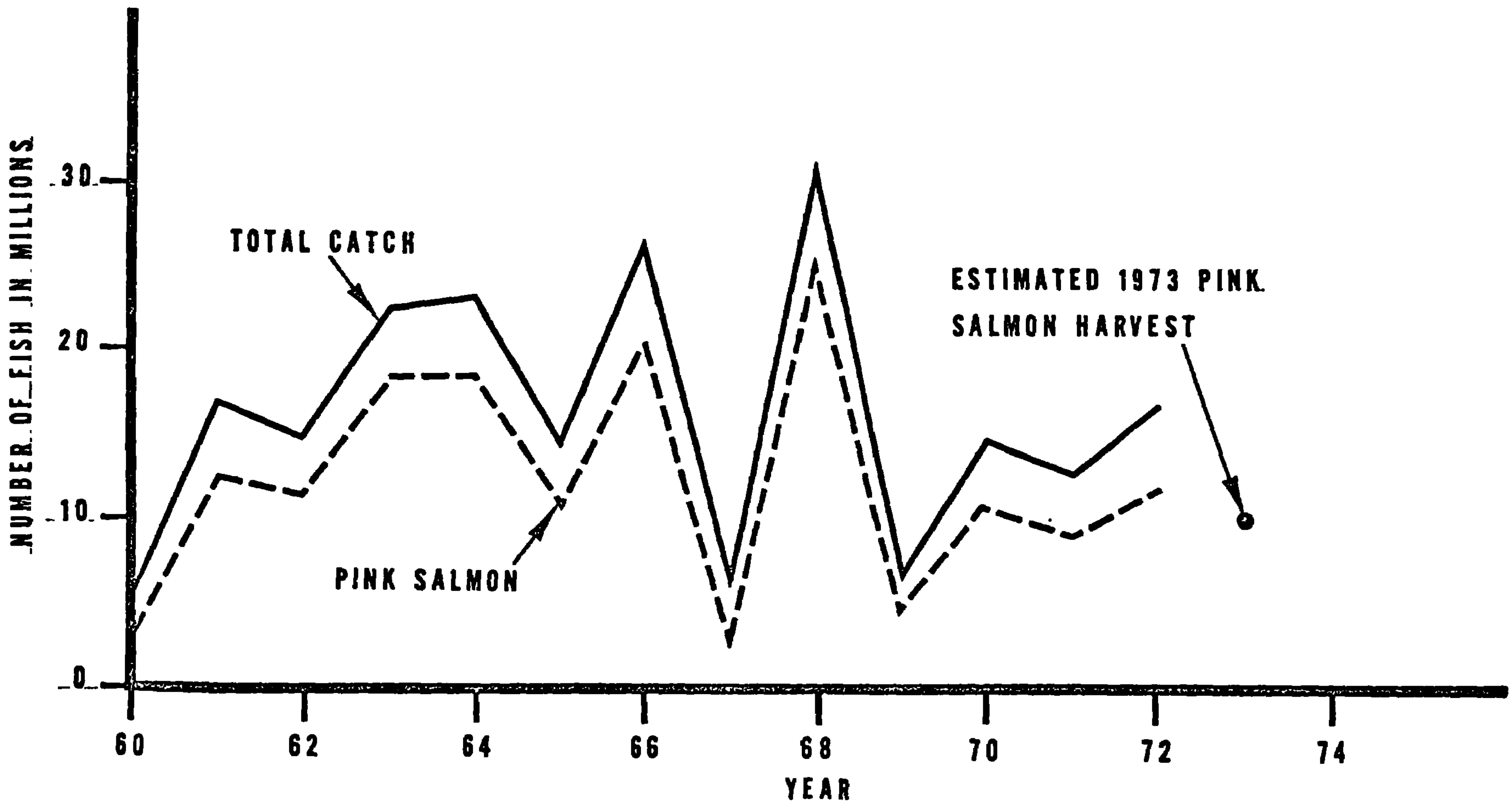

Figure V-4. Annual Commercial Salmon Harvest, Southeastern Region

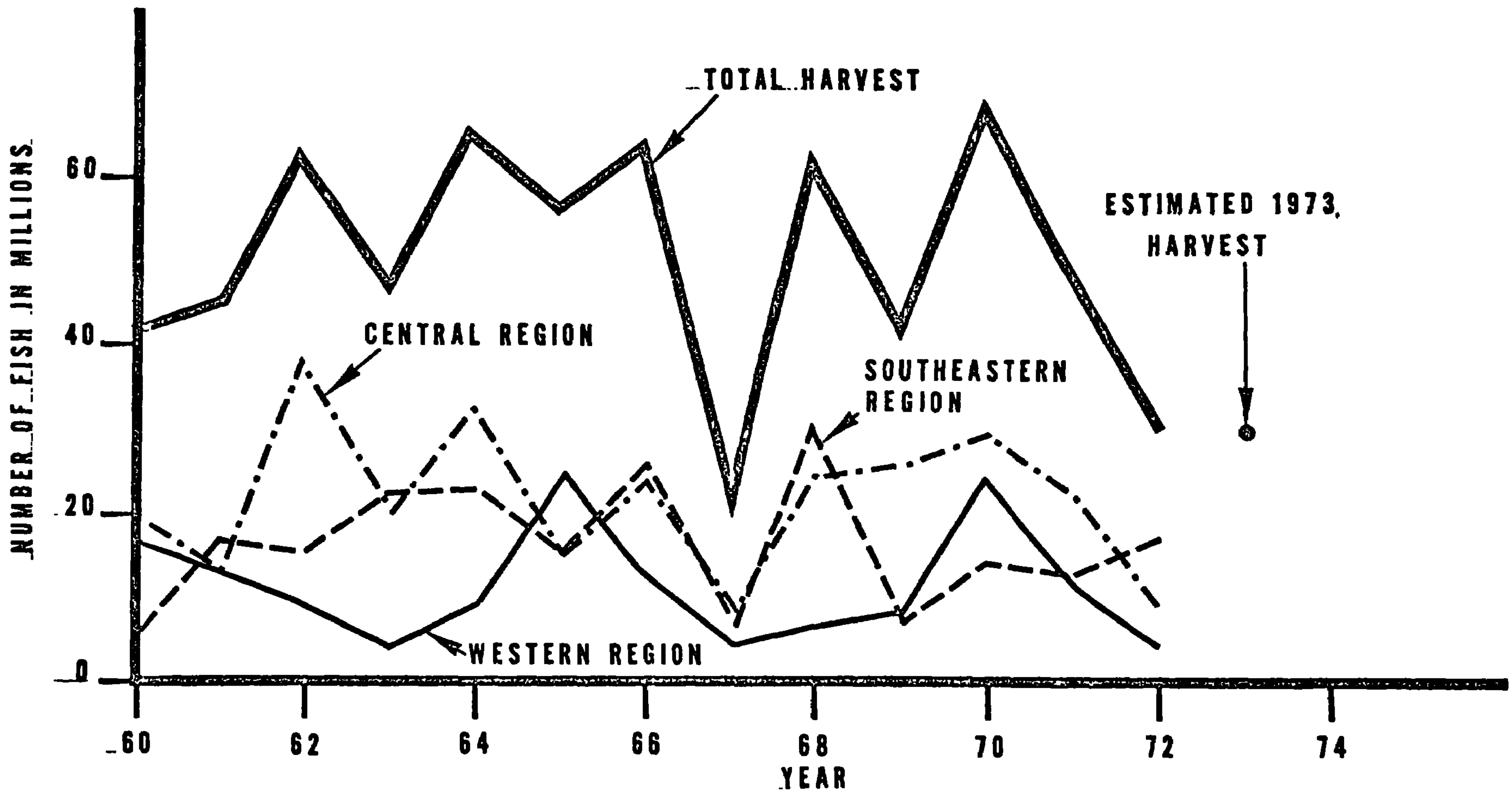

Figure V-5. Annual Commercial Salmon Harvest, Regional Distribution

area or to storage bins where they are chilled with ice or refrigerated brine for later processing [Figure V-6]. During peak catch periods fish may be kept in storage for several days. Blood, slime and brines may be discharged from the storage bins.

The next step in the processing is the butchering, the major source of waste materials. Fish are transported from storage to the butchering area by conveyor belt or by sluicing with salt water. Most of the butchering is done by machines with manual assistance to remove inedible parts missed by the machines.

The salmon are aligned by hand on a conveyor belt feeding an indexer which beheads the fish. Further processing of the heads varies widely among Alaskan processors. In many cases, the heads are not used and become waste material. Disposal of waste materials is discussed in a later section. Some plants freeze the heads whole and ship them to a by-products plant. Others grind the heads before freezing and shipment. In a number of plants part of the heads may be ground and rendered in pressure cookers. Fish oil recovered in this process goes to the cannery for addition to the canned meat. Rendering wastes, a thick viscous red fluid, are discharged to waste.

Following the indexer, the belly of the fish is cut open by hand and the roe removed and sluiced to the egg house. Some plants also recover milt as a by-product. In the egg house any viscera clinging to the eggs is removed by hand and sluiced to waste. The eggs are placed in brine vats and later packed as caviar for shipment to Japan. Brine

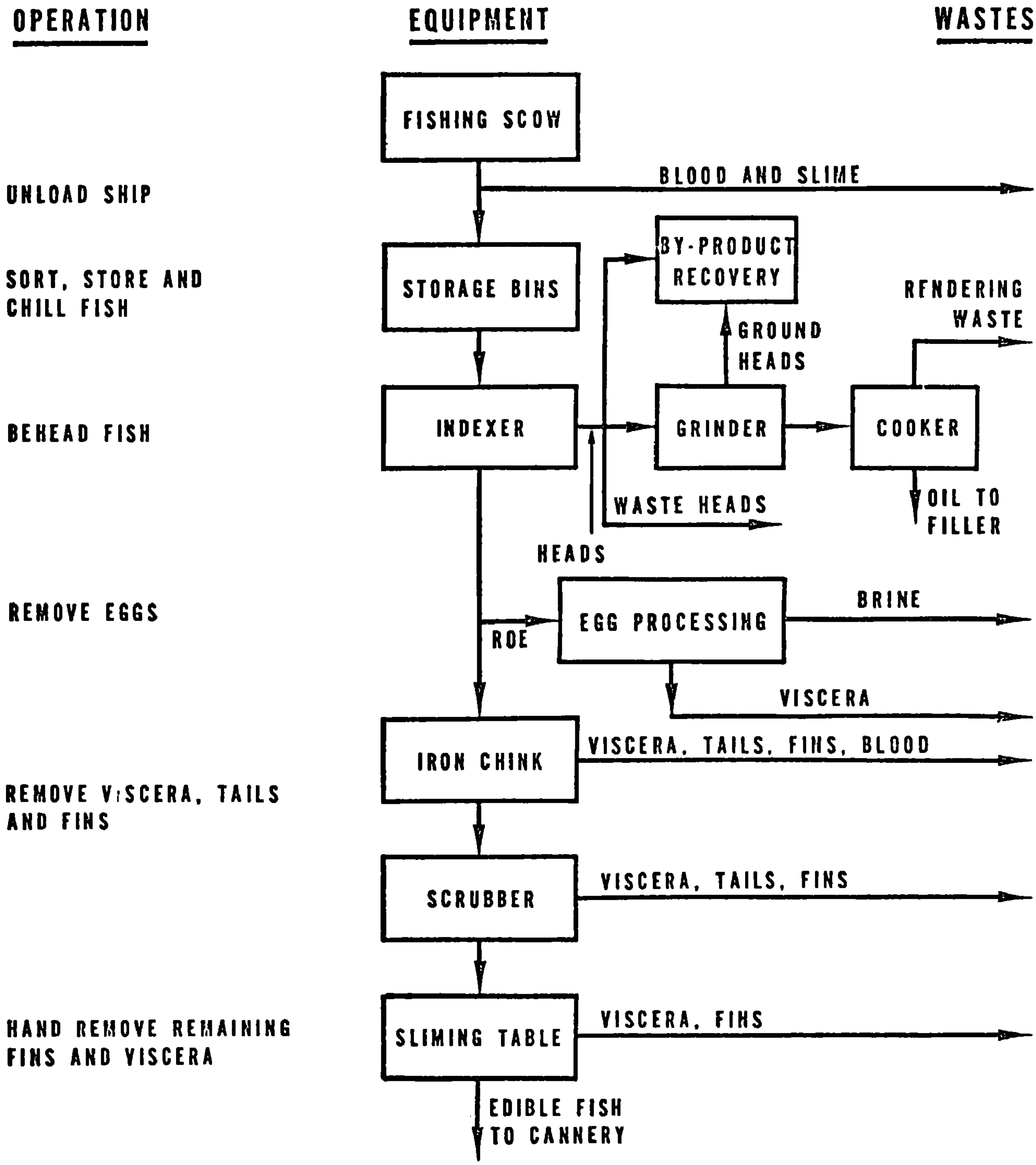

Figure V-6. Salmon Fish House Process Details from the vats is periodically drained to waste. The entire egg processing operation is handled by Japanese in most plants.

The fish now move to the main butchering machine known as an "iron chink". This machine removes the viscera, tails and fins at a rate of about 120 fish per minute. Large volumes of water are sprayed on the machine to remove blood and waste fish parts which are sluiced to waste. Some plants have a mechanical scrubber following the "iron chink" to achieve greater effectiveness in removing waste parts.

Butchered fish are conveyed to the sliming table where any remaining blood, viscera and fins are removed by hand and the meat inspected for bruises and damage. Waste materials are sluiced to waste. Edible fish portions are conveyed to the canning area known as the cannery. The fish house and cannery may be two separate buildings or may be the same building.

Salmon are usually canned in 1/4, 1/2, or 1 lb cans. These size cans are filled by machine with a canning line handling one size of a can only. A cannery may have as many as four or more canning lines. One "iron chink" and butchering line can supply several canning lines. A small amount of salmon is hand packed in 4 lb institutional packs.

In the cannery the edible fish from the fish house are temporarily stored in filler bins [Figure V-7]. The filler machine cuts the fish into size controlled portions and forces them into the cans. Salt is also added. In some canneries, fish oil derived by rendering heads is added to the cans. Meat fragments from the filling operation fall to the floor and are wasted.

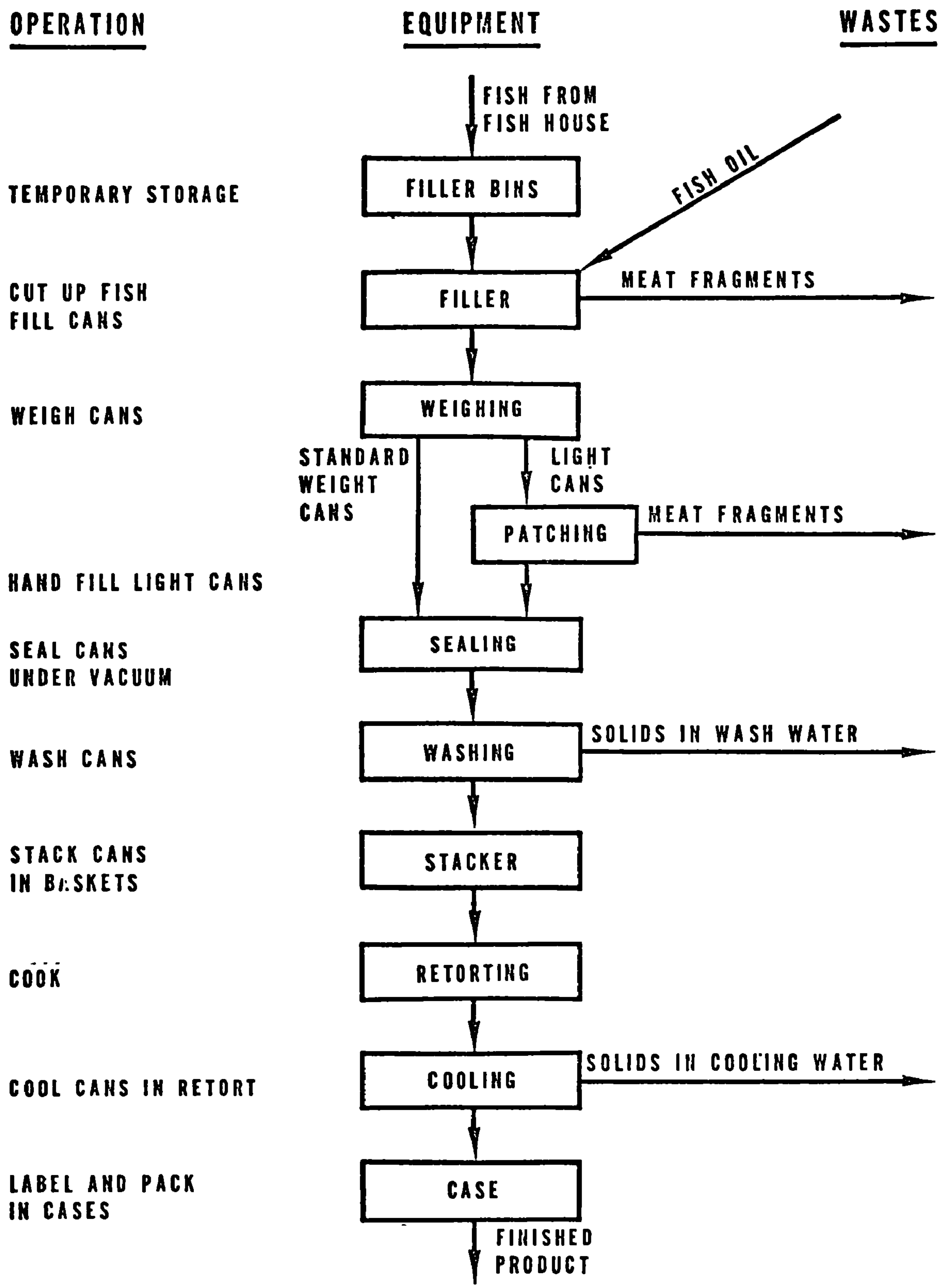

Figure V-7. Salmon Cannery Process Details

Filled cans are automatically weighed and light cans diverted to the patching area. These cans are brought up to weight by adding meat pieces by hand. Meat fragments are wasted by this operation.

Cans are sealed in two steps. One machine loosely crimps the lid while the second machine pulls a partial vacuum in the can and seals the lid. The cans are then washed to remove exterior meat particles with wash water and solids sluiced to waste.

Washed cans are stacked by machine in metal baskets about four ft. on a side and then rolled into the retorts. The retorts are large tubular cookers about five ft. in diameter and 30 ft. long with doors on both ends. The meat is cooked by filling the retorts with steam. After cooking, the cans are cooled by flooding the retorts with cold water. Cooling water containing minor amounts of organics is discharged to waste.

Cooled cans are cased by machines for shipment to distributors. The cans may be cased bright and shipped to another location for labeling or labeled before casing.

Waste Characteristics

Essentially all wastes from salmon processing are inedible parts of the fish. the portion of the whole fish that is wasted varies slightly by species but averages about 33 percent. As shown in Table V-1, a major portion of the waste is the head and collar. Recovery of this waste section of the fish alone would reduce the waste load by about 50 to 60 percent. The other solid waste portions of the fish (tails, fins, viscera) can also be utilized for by-products. Where such recovery is practiced, the waste stream from the plant contains low solids but strong organic wastes because of leaching of solubles and blood wastes.

TABLE VI-1. CONSTITUENTS OF SALMON WASTE SOLIDS[6/]

	Percent of Total Salmon Cannery Waste by Species				
Portion	Pink	Red	Chum	King	Coho
Head and collar	57	61	54	50	60
Tail and fins	16	14	11	11	11
Liver	5	5	5	3	4
Roe	8	9	16	15	8
Milt	5	5	6	4	6
Digestive tract	9	6	8	18	11
Heart	0.8	0.8	0.7	0.7	0.7

As discussed in the following section on waste disposal practices, the waste solids may be discharged whole or ground. Grinding greatly increases the amount of waste materials that go into solution with resultant increases in BOD and COD. Another practice that increases the soluble organics load is the rendering of fish heads for oil.

Both waste loads and waste characteristics are thus dependent upon the degree of by-product recovery practiced by the plant and whether or not solids are ground. Waste concentrations are partly the function of the amount of water used by a plant, a value that varies widely between plants. Water use records are scarce and most available flow records are subject to question.

Several recent studies discussed in Chapter VII have defined the characteristics of salmon wastes. Wide variations in characteristics were observed as a result of the factors discussed above. One study evaluated available data on waste characteristics and presented a summary [Table V-2] of the range of values observed in the composite waste stream from a number of plants.

TABLE V-2. TYPICAL SALMON WASTE CHARACTERISTICS[3/]

Waste Parameter*	Range
Flow	0.5 - 1.75 gal/lb output
BOD	900 - 5400
COD	200 - 9600
Suspended Solids	500 - 4800
Volatile Solids	1000 - 7300
Total Solids	1100 - 8400
Oil	60 - 350
Turbidity	180 - 1500 JTU
pH	6.1 - 7.0 SU

The above study was directed at the objective of defining waste treatment alternatives for a typical salmon cannery. The values shown in Table V-2 thus include plants with differing degrees of by-product recovery and represent combined dilute and concentrated wastes from the various in-plant sources. A much greater range in concentrations of various constituents has been observed when evaluating different types of waste streams such as sliming table wastes, "iron chink" flume contents, head cooker wastes, etc. A study of various waste streams in

* All units are mg/l unless otherwise stated.

four Alaska canneries using different waste disposal methods was conducted by the National Canners Association in 1970.[7/] Detailed data on waste characteristics developed by this study are presented in Appendix D, Tables D-1 through D-4. The much broader range in parameter values observed by this study is shown in Table V-3.

TABLE V-3. RANGE OF WASTE CHARACTERISTICS OBSERVED AT FOUR ALASKA SALMON CANNERIES[7/]

Waste Parameter*	Range
BOD	60 - 236,000
COD	190 - 188,000
Suspended Solids	0 - 325,000
Dissolved Solids	155 - 65,400
Total Solids	310 - 338,000
Oil	10 - 132,000
Protein	<50 - 171,000
Ash	870 - 57,600
NaCl	50 - 26,000
Turbidity, JTU	<25 - >5,000
pH, SU	6.2 - 7.6

The most important values defining waste characteristics are the total loads of each pollutant. By eliminating the variability of water use, waste loads per unit of production (standard case of 48 - one lb cans) were computed for a cannery discharging all waste solids and a cannery recovering heads, tails, milt and eggs for by-products. Wet fish waste solids averaged 26.4 lb/case (28 percent waste whole fish) for the cannery discharging all wastes while by-product recovery reduced the waste load to 7.8 lb/case at the other cannery, a 70 percent reduction

* All units are mg/l unless otherwise stated.

[Appendix D, Table D-5]. Wastes at the cannery discharging all solids had BOD, COD, suspended solids, and oil loads of 6.2, 8.1, 5.8, and 1.2 lb per case respectively. By-product recovery at the other cannery reduced the BOD 77 percent (6.2 lb/case), the COD 78 percent (1.8 lb/case), the suspended solids 85 percent (0.9 lb/case), and the oil 92 percent (0.1 lb/case).

Waste Disposal Methods

In comparison to accepted waste disposal practices in the conterminous United States, waste disposal practices in the Alaska seafood industry are primitive. Waste treatment is practically non-existent. In most cases all waste materials are discharged directly to the receiving waters with no treatment. In a few cases large solids such as fish heads are hauled some distance out into open water and dumped.

The type of waste disposal utilized by a particular salmon processing plant is primarily a function of the construction of the plant buildings and the receiving water characteristics. The old salmon canneries were usually constructed on piles over the water surface at high tide and had wooden floors. The floors had numerous cracks, slots, and holes that allowed all waste materials to fall directly through the floor to the water below. In some locations the area below the plant was exposed at low tide and fish wastes accumulated on the bottom between high tides.

Some plants still practice the "hole-in-the-floor" method of waste disposal. These plants are most commonly located in areas with deep water under the docks and strong tidal currents to rapidly disperse waste materials. Most fish houses now have concrete floors to facilitate wash-down and fluming of wastes to a central disposal point. Many canneries, however, still have wooden floors and disposal of cannery wastes through the floor is common at plants providing more effective means of disposing of fish house wastes. Conversion of the "hole-in-the-floor" fish houses and the wooden floor canneries to centralized waste disposal systems would require construction of concrete floors with flumes or substantial plumbing installations.

Where a central waste system has been constructed, the wastes may be discharged to the receiving water at one of four typical locations. A typical discharge point where deep water and strong tidal currents are present is off the face of the dock above the water surface. Foam and floating solids as well as a visible waste plume are problems associated with this method. If currents are not strong enough, waste solids may accumulate on the bottom.

Where the water near the dock is too shallow or currents too weak, an outfall may be used to transport the wastes into an area with better dispersal characteristics. This outfall may discharge near the bottom or near the surface. Outfall lengths ranging from less than 100 ft to 800 ft have been used in Alaska. Surface discharge of the wastes results in similar problems with floating solids and esthetics similar to the off-the-dock discharge. Bottom discharge may also have the same problems if the water is shallow (less than 30 ft deep) as the fresh-water waste discharge tends to surface rapidly in the more dense salt water. Problems with floating solids and esthetics have been minimal for the few deep-water outfalls currently in operation.

The fourth location for waste disposal is the deeper waters of the larger bays and inlets. Wastes are discharged to a "gurry scow" which is a barge with either a net bottom or slotted wood sides that allow liquid wastes to escape and that retain the coarser solids. Waste solids are hauled out to open water and dumped. This disposal method is used in locations where the receiving water has limited ability to disperse solid wastes. The liquid wastes passing through the "gurry scow" are high in suspended solids and organics and may cause esthetic problems as well as water quality problems in the vicinity of the discharge point.

The waste solids disposed of by one of the above methods may be whole as removed from the fish or some or all of the solids may be ground. Grinding the solids facilitates the rapid dispersal of the wastes in the receiving water and makes the wastes easier for scavengers to consume. Grinding also increases the amount of waste materials in solution with the result that BOD and COD are higher than for whole waste discharges. Fish heads are the waste solids most commonly ground. A number of plants grind only the heads and discharge other solids whole. Other plants grind all solids.

Most plants that grind solids discharge the entire waste stream through an outfall. A few plants dewater the waste solids before grinding and discharge only the ground wastes through an outfall with liquid wastes discharged near the grinder. This practice results in conditions similar to the use of a "gurry scow."

Waste solids are recovered for by-products at some plants, primarily in the Southeast. Heads are the most common portion recovered and are used for pet or mink food as well as rendering for oil. Eggs or roe are processed for caviar, primarily for Japanese markets. Tails are used for halibut bait. Milt is also recovered in some cases. Various solids may be used for crab bait.

B. CRAB INDUSTRY

The Crab Fishery

In contrast to the salmon industry the major development of the crab industry in Alaska has occurred within the past 25 years.[8/] Most of the growth has occurred since 1960. King crab is the major species processed with significant catches of Dungeness and, more recently, tanner or snow crab also processed.

The king crab fishery was not commercially exploited until after 1945. By 1960 the commercial catch had increased to 29 million lb [Figure V-8]. A major expansion of the fishery occurred in the following six years with the catch increasing rapidly to a peak of 159 million lb in 1966. Just as rapidly, the catch declined to about 59 million lb in 1969.

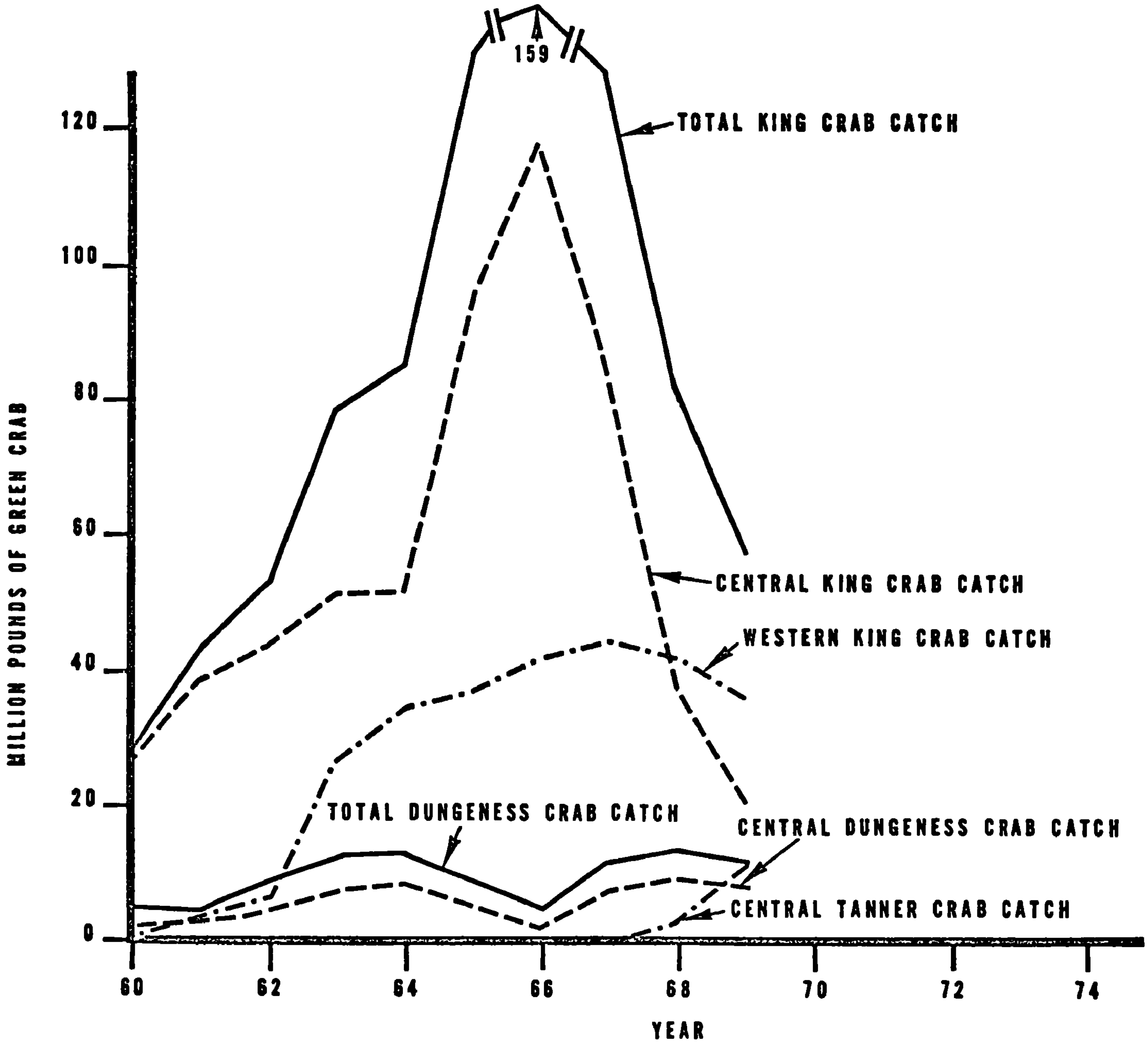

Figure V-8. Distribution of Crab Catch

This decline was largely blamed on overfishing with the result that more restrictive fishing regulations such as shorter seasons were imposed.

Prior to 1960 the king crab fishery was primarily confined to the central region. Since that time a major fishery has been developed in the western region centered on the Aleutian Islands. The western fishery peaked in 1967 with a catch of about 44 million lb and has declined gradually since that time. Crab processing is conducted at Adak, Akutan, Dutch Harbor and Unalaska. Much of the processing is done on ships that process at two or more locations during the season. Development of the king crab fishery in the central region between 1960 and 1966 accounted for the major portion of the increase in the total catch. This fishery also experienced a sharp decline since 1966. A major portion of the central region catch is processed at Kodiak with significant quantities also processed at Cordova, Port Lyons, and Sand Point.

King crab processing in Southeast Alaska is minimal, ranging between one and two million lb annually. Plants are small and scattered.

The Dungeness crab fishery remained relatively stable during the 1962-1969 period. Dungeness crab catches in Southeast Alaska ranged between two and four million lb annually. Catches in the central region were higher, ranging between three and nine million lb. Dungeness crab catches in the western region are minimal.

The decline in the king crab fishery has resulted in commercial exploitation of the tanner (snow) crab resources. Between 1967 and 1969 the catches of tanner crab increased from minor to about 12 million lb with most of the catch landed in the central region.

Process Details and Waste Sources

All species of crab are caught in pots on the bottom and kept alive in holding tanks or storage nets on the fishing boats until they reach the processing plant. At the plant they are placed in live storage facilities until processed as crab meat deteriorates rapidly after death. The process used and end product are primarily determined by the species of crab handled.

The Dungeness crab (Cancer magister) weighs about two to three lb and has a carapace width of from eight to nine inches. The crab has a substantial amount of edible meat in the body, and both body and leg meat are used. Dungeness crab are frequently cooked and frozen whole. This process is relatively simple [Figure V-9]. The crabs are taken from live storage and cooked whole. The cooking water containing organic solids is periodically discharged to waste.

The whole crabs are then cooled, packaged and frozen. Cooling water containing solids is discharged to waste. This completes the processing. Waste quantities at the plant are minimal as essentially the whole crab is packaged. Waste is disposed of by the consumer.

Dungeness crab may also be butchered, the meat separated from the shell, and then either frozen or canned. In the butchering process the

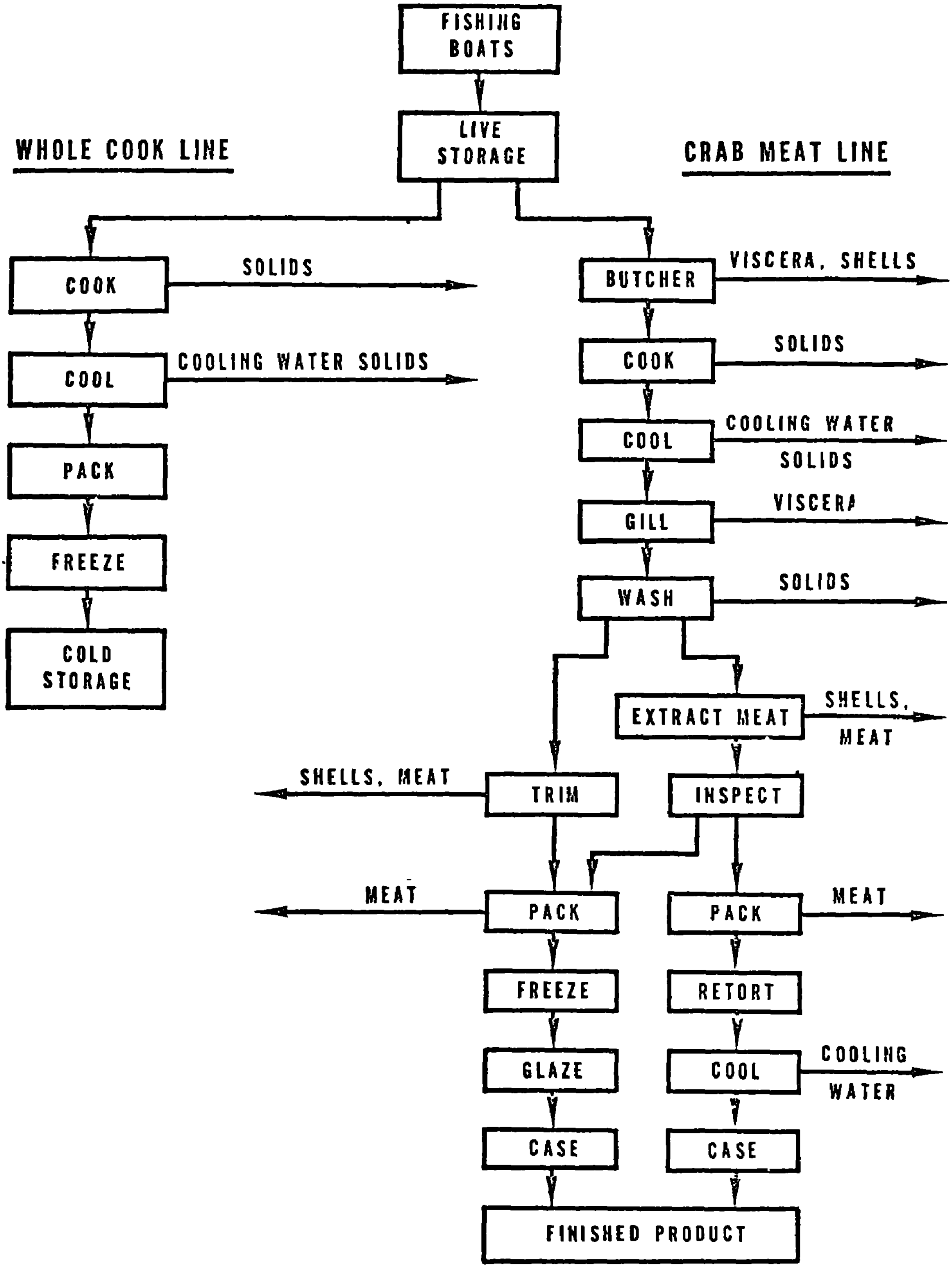

Figure V-9. Crab Processing Details

carapace is removed by a fixed blade and then the crab broken in half. The gills and viscera are then removed. Wastes from this operation include blood, shell and viscera.

The cleaned crab halves are cooked in boiling water and then cooled. Both the cooking and cooling waters containing solids and soluble organics are discharged to waste.

Cooked meat is extracted by breaking away parts of the shell and shaking out the meat. The meat segments are then dumped in strong brine to aid in removal of shell fragments. Following a fresh-water rinse, the meat is inspected to remove any remaining shell fragments. Wastes from these operations are shell and meat fragments.

Inspected meat is then either frozen or canned. Frozen meat is packaged and frozen followed by glazing with a water spray. Some meat is wasted in packing.

Canning proceeds in much the same manner as for salmon. The meat is packed and sealed in cans with some wastage. The cans are then retorted, cooled and cased.

King crab (<u>Paralithodes</u> <u>camschatica</u>) are giants, weighing as much as 24 lb and spanning up to five ft from tip to tip of outstretched legs. Only leg and shoulder meat is utilized and most meat is frozen for the market.

The live crabs are butchered by using a fixed blade to remove legs and shoulders. The bodies are discarded to waste along with blood and shell fragments. The leg sections are then cooked and cooled and processed in much the same manner as Dungeness crab sections.

Some king crab meat is frozen and marketed in the shell. Leg sections are hand trimmed and inspected, packed, frozen, glazed and cased. Waste from these operations includes shell and meat fragments. A substantial amount of shell is shipped with this product reducing the waste load at the plant.

Most king crab meat is extracted from the shell and frozen in large blocks for marketing. Processing is identical to frozen Dungeness crab meat except that the meat is extracted from the shell by blowing or by squeezing between rollers. Some extracted meat is canned in the same manner as Dungeness crab.

Tanner crabs are smaller than king crabs. Only the leg meats are used and processing is essentially the same as king crab.

Waste Characteristics

As in the case of salmon, crab processing wastes consist of inedible portions of the crab including shell, viscera, gills and some meat. The shell is primarily composed of chitin (a protein substance) and calcium carbonate.

By weight, a large portion of the green or raw crab is wasted when meat is extracted from the shell for freezing or canning. Waste quantities are minimal for whole crab cooking. Most processors recover shoulder meats for king crab. Waste quantities for these plants are about 70 to 75 percent of green crab weight.[1/] If shoulder meat is not recovered, waste may run as high as 88 percent.

Little information on the characteristics of Alaska crab wastes has been developed. Waste characteristics were evaluated by laboratory simulation for the Kodiak by-products plant study.[9/] Waste characteristics as determined by this study are presented in Appendix D, tables D-6 and D-7.

One study estimated waste loads as 0.10 lb of COD and 0.14 lb of titak dat solids per lb of green crab.[1/]

Physically the wastes may range from small sections of shell combined with other waste solids to whole crab bodies and shells depending upon the waste disposal method used.

Water use records are practically non-existent in this industry.

Waste Disposal Methods

Basically, two disposal methods are used for crab wastes in Alaska. The shells may be ground and discharged with other wastes under the dock or off the dock face. In the other case the wastes are discharged whole at either location. At a few plants the wastes may be discharged underwater or through a short outfall at depth. Grinding wastes and discharging at the dock face is the most common method for land-based plants. Floating processors located on ships operating in the Aleutian Islands commonly grind wastes and discharge below the ship at depths ranging from 42 to 60 feet.

Problems associated with above water discharge points include foam and floating solids. Crab shells break down slowly. Shells may accumulate in piles on the bottom below discharge points and remain for several months before waves and tides wash them away. The shells may also accumulate on beaches. Fine grinding shells reduces the probability of waste accumulations.

C. SHRIMP INDUSTRY

The Shrimp Fishery

The Alaska shrimp fishery has experienced rapid growth in the past 15 years. the introduction of mechanical peeling machines combined with the decline of the king crab fishery are the factors primarily influencing this growth. Alaska shrimp are small and hand-picking a costly method of processing. The mechanical peeling machines made it possible to process much larger quantities of shrimp economically.

Three species of shrimp are caught in Alaska waters: the pink shrimp, *Pandalus borealis*; the side-stripe, *Pandalopsis dispar*; and the coon-stripe shrimp, *Pandalus hypsinotus*. The shrimp are fished with either beam trawls or other trawls. Fishing is conducted most of the year but the peak processing season is from mid-June to mid-September.

The major portion of the shrimp catch is landed in the central region, primarily at Kodiak with significant landings also at Squaw Harbor [Figure V-10]. The shrimp catch in the central region increased rapidly from about 5 million lb in 1964 to 46 million lb in 1969 at the same time the crab catch processed was declining rapidly. The shrimp catch in the southeast region has remained relatively stable, ranging between two and four million lb annually. The catch is processed at several small, widely scattered plants.

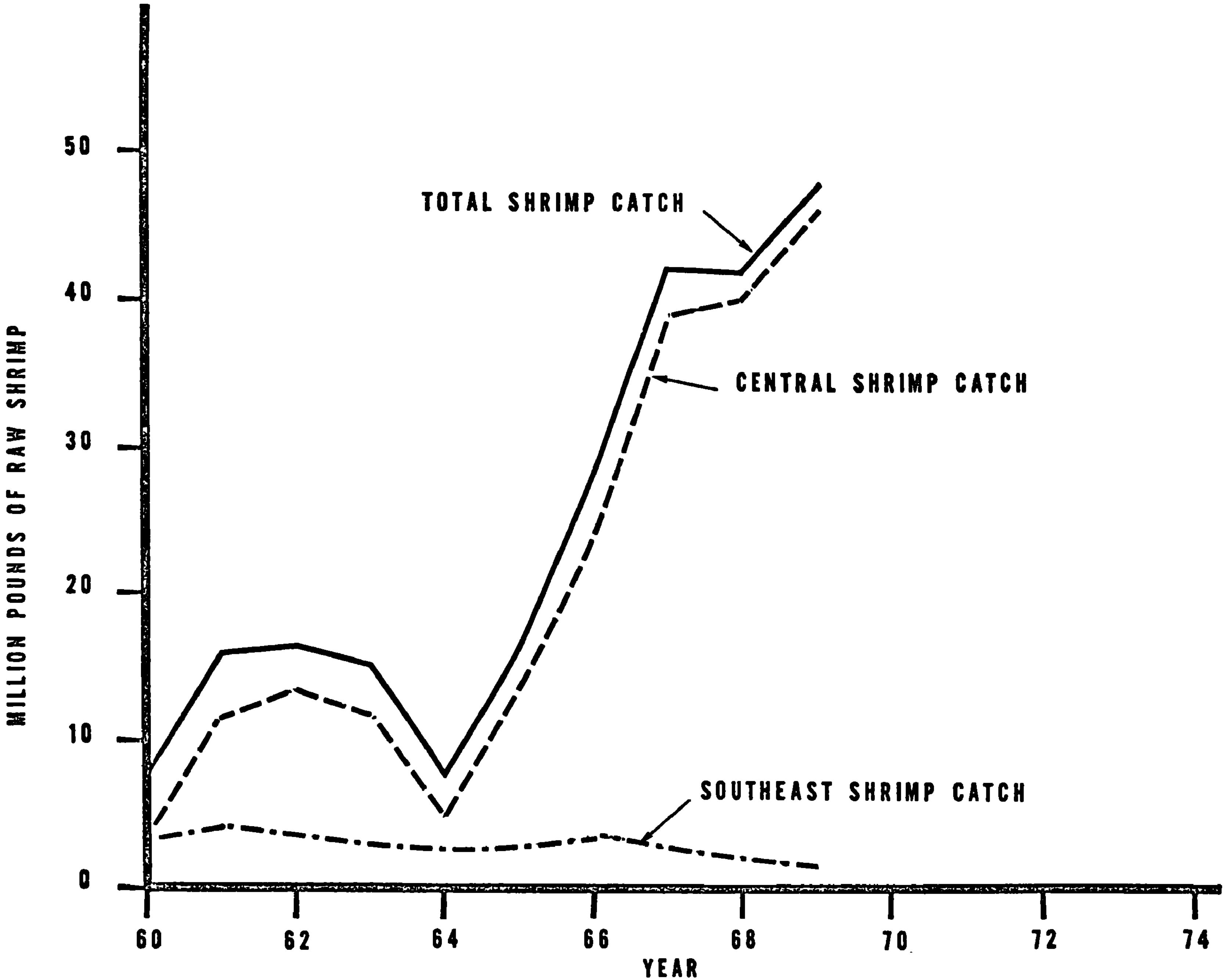

Figure V-10. Distribution of Shrimp Catch.

Process Details and Waste Sources

Shrimp are processed by either hand picking or mechanical peeling with the majority handled mechanically. The hand-picked shrimp may be marketed either frozen or canned while most of the mechanically peeled shrimp are canned. A hand-pick operation will process about 100 to 400 lb of raw shrimp per day per picker while a mechanical peeler can handle 4,000 to 12,000 lb per day per machine.

In the hand-picking operation, shrimp are taken from cold storage and cooked [Figure V-11]. Cooking water containing some solids and soluble organics is discharged to waste. The shrimp are then cooled with cooling water discharged to waste. Cooled shrimp are hand picked to remove the heads and shells, leaving only edible tail meat. Shells and offal are discharge to waste. The edible meat is passed through a brine solution. The meat is now packed and frozen or canned in the same manner as crab meat.

Shrimp for mechanical peeling are first washed followed by blanching [Figure V-11]. Waste waters generated contain solids and soluble organics. The blanched shrimp are mechanically peeled with head and shells discarded to waste. Peeled meats are washed and passed through a separator to remove offal and shell fragments. The meat is again blanched and passed under a blower to remove remaining shell fragments. Shell and some meat fragments pass to waste. The meat is now inspected, graded for size, packed in cans with small amounts of citric acid added, and canned. Some meat fragments are wasted in packing.

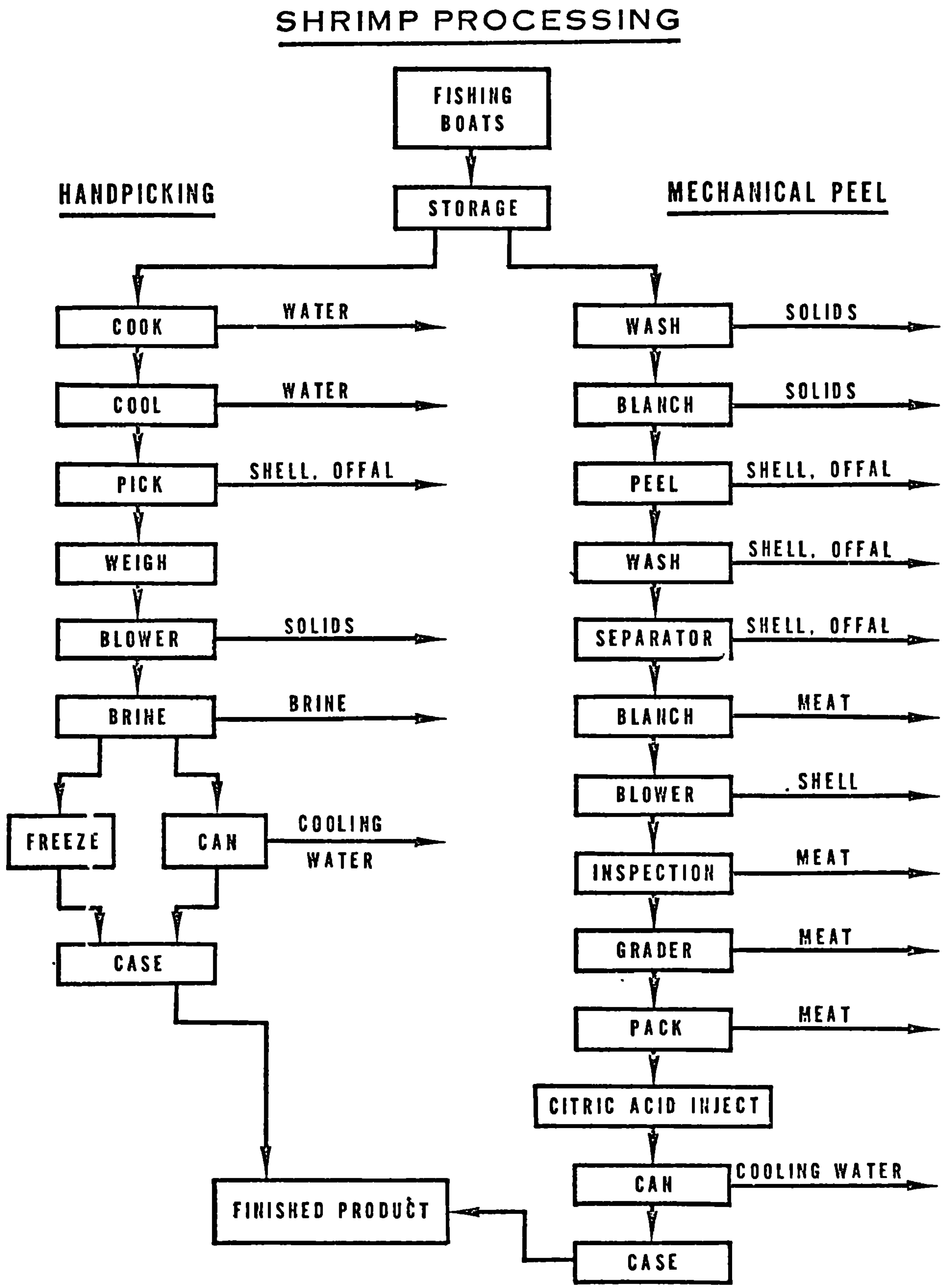

Figure V-11. Shrimp Processing Details

Waste Characteristics

Only limited information is available on the characteristics of Alaska shrimp wastes. The 1971 EPA reconnaissance survey placed the amount of shrimp waste at about 80 to 85 percent of raw shrimp weight.[1/] The machine-peeling operations produce slightly more waste than hand picking. Chemical oxygen demand and total dry solids were estimated at 0.31 and 0.30 lb per lb of raw shrimp, respectively.

Waste characteristics as evaluated in a laboratory simulation of raw peeling and peeling after steaming operations at Kodiak are summarized in Appendix D, Tables D-8 and D-9.

Waste Disposal Methods

Waste solids from shrimp operations are small in size and are usually discharged whole. The discharge may be at the dock face either above or below the water surface or may be through an outfall. Discharge at the dock face is the most common.

At remote locations, esthetic problems such as foam and floating solids occur. At Kodiak Harbor, accumulations of waste solids are present in addition to the esthetic problems.

VI. SUMMARY OF SEAFOOD PROCESSING PLANT DATA

A. GENERAL

In 1971 a total of 116 commercial fisheries processors were in operation in the State of Alaska.[4/] This number is substantially below the recent peak number of 225 operating in 1965 and 165 in 1969. A further decline is anticipated in 1973 as a small salmon catch is predicted in several areas.

Salmon is the most common seafood processed with 84 plant processing canned, fresh, frozen or cured salmon. Forty nine plants process only salmon while the remaining plants also process shellfish or other fish. Many of the salmon processing plants are large canneries. A total of 38 salmon canneries are expected to operate in 1973.[10/]

Fifty one plants process shellfish in fresh, frozen and canned forms. Crab is processed at 34 plants and shrimp at 12. Other shellfish processed include clams and scallops.

Twenty two plants process miscellaneous fish with halibut and herring the most common. Other fish include sablefish, cod, trout, red snapper, char, whitefish and smelt.

Southeast Alaska has the largest number of seafood processors (33) [Figure VI-1]. All but six of the plants process salmon. One-fourth of the plants process miscellaneous fish. Crab and shrimp processing is conducted at another fourth of the plants. Many of the processors are relatively small although about 10 of the plants are medium to large salmon canneries. Available operating and waste disposal data for the numerous small operators is rather limited.

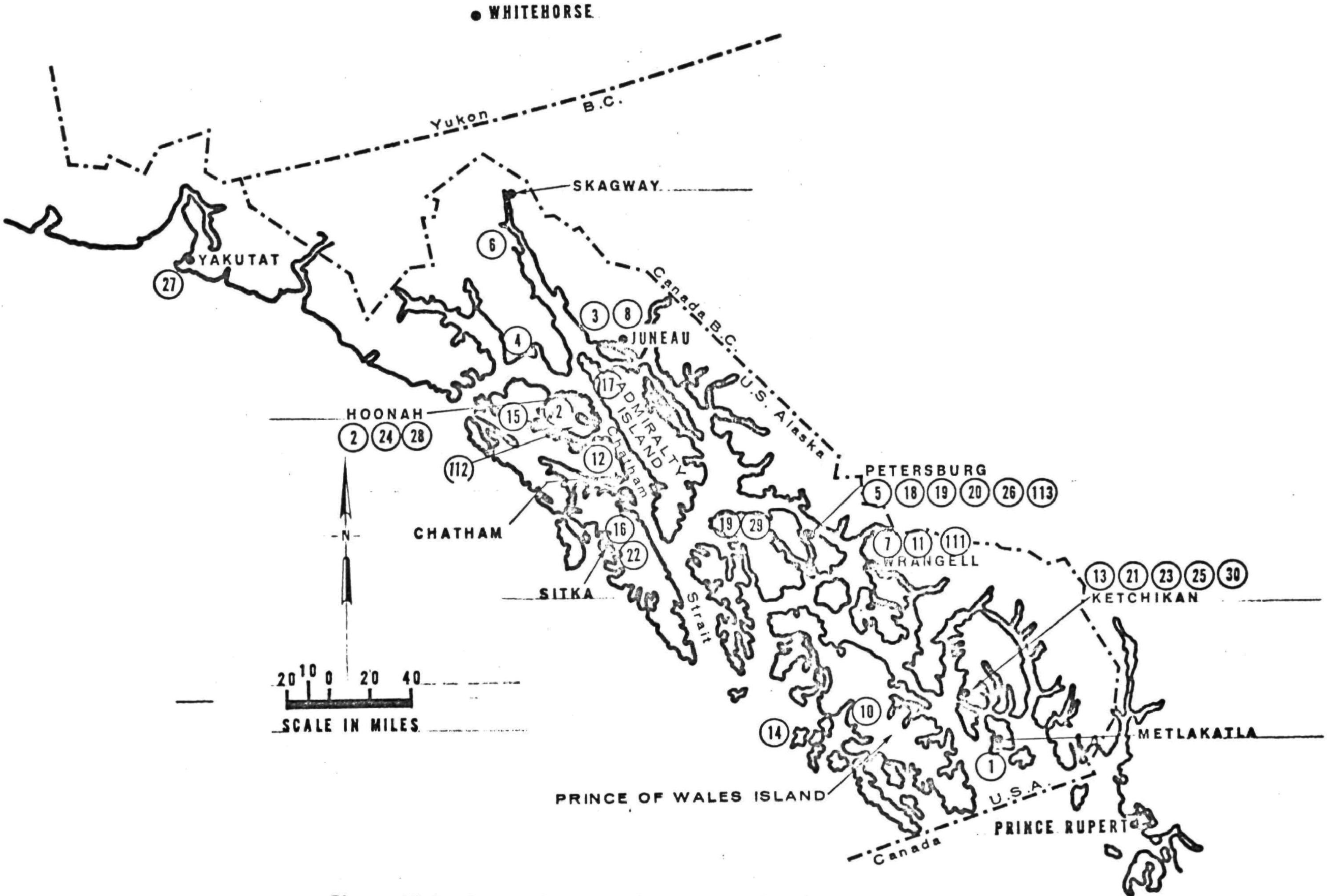

Figure VI-1. Seafood Processing Plants, Southeast Alaska

Prince William Sound supports 10 seafood processors [Figure VI-2]. Most process salmon while half also process shellfish, primarily crab. Basic data is available for the major operators.

The second largest number of plants (21) is located on the Kenai Peninsula, primarily on the Cook Inlet side. The types of processors are similar to those in Southeast Alaska. All but four plants process salmon. Nine plants process miscellaneous fish and seven process shellfish. Most of the plants are small operations. Operating and waste disposal data is very limited.

A total of 19 seafood processing plants are located on Kodiak Island with 14 of these plants concentrated in the Kodiak Harbor vicinity. The remote plants are large salmon canneries while the Kodiak Harbor plants are primarily sizeable shrimp and crab processors. A large salmon catch is also processed at Kodiak Harbor. Basic data on this area is good.

Salmon canning is conducted by 14 plants in the Bristol Bay area [Figure VI-3]. Most plants are major operators. Basic data is available for the major plants.

The Alaska Peninsula has only six plants which include three large salmon canneries, two crab operations and a shrimp processor. Basic data is adequate.

Crab is the only seafood processed in the Aleutian Islands with the exception of one small salmon operation. Four processors operate ships that process in two locations each year. Three plants are shoreside facilities. Basic data is available on most operations.

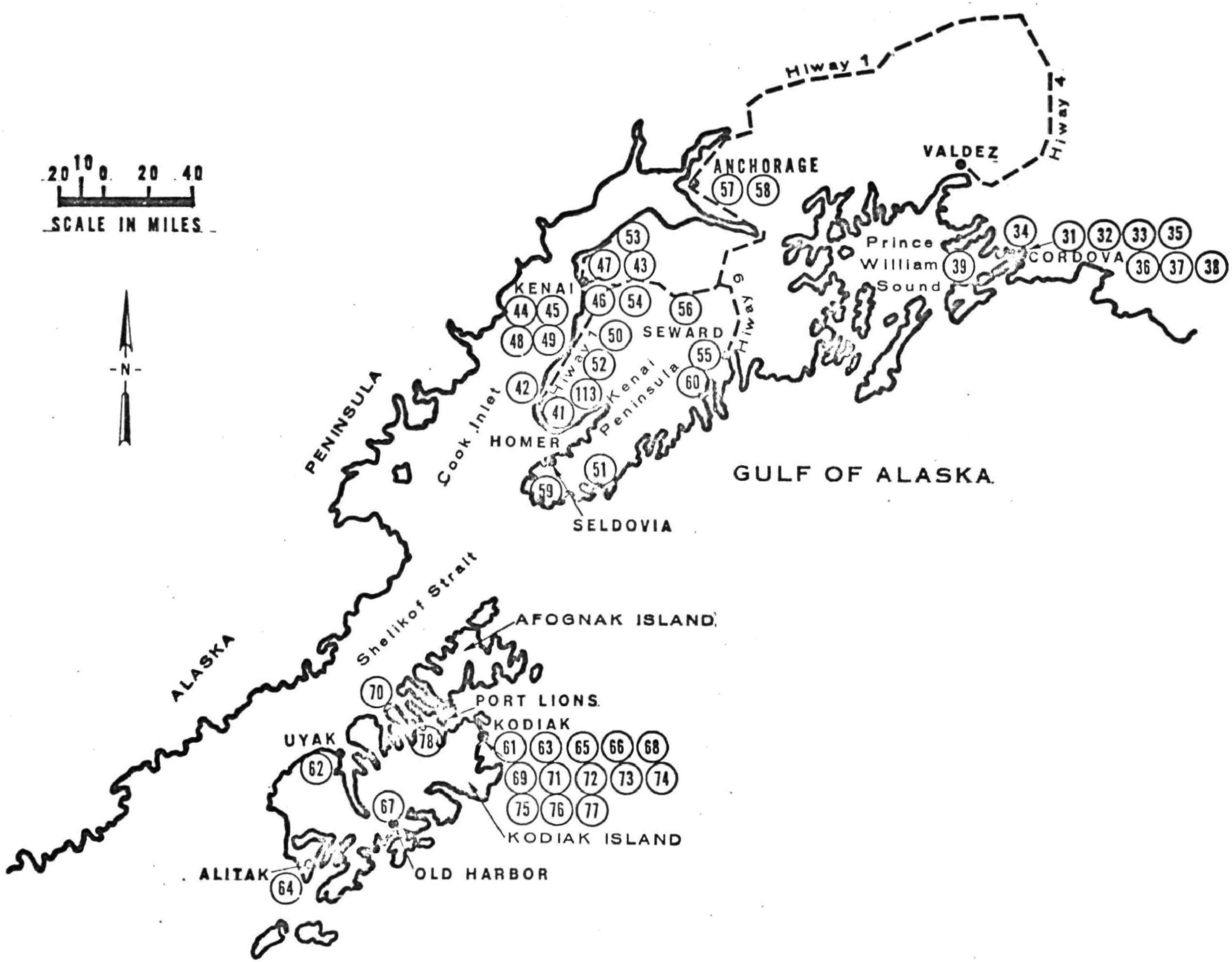

Figure VI-2. Seafood Processing Plants, Central Alaska

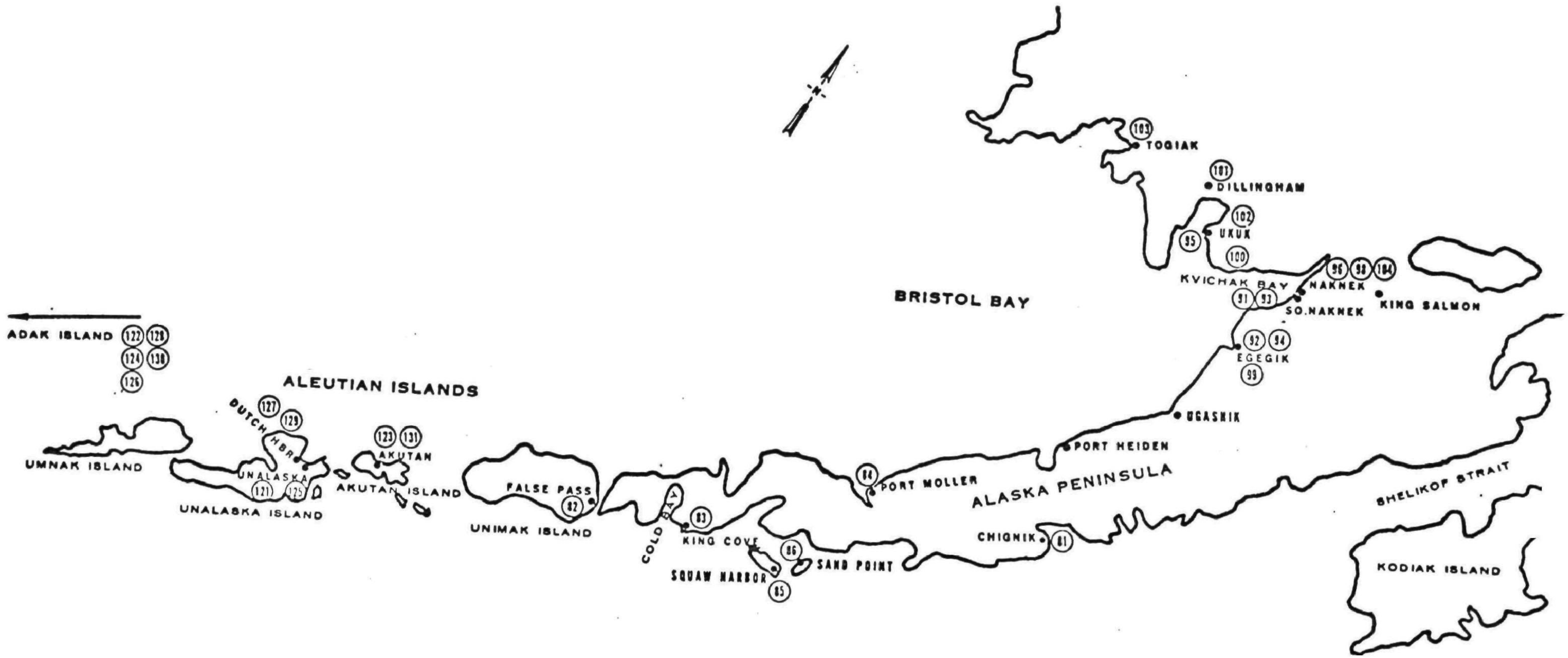

Figure VI-3. Seafood Processing Plants, Southwest Alaska

In the following sections available basic data on plant operations and waste disposal practices for salmon and shellfish processors is summarized and discussed by fishing area. Major plants are identified. Miscellaneous fish processors are also listed.

Processors listed in the following sections were identified by the Alaska Department of Fish and Game as operating in 1971.[4/] Products processed were taken from this source. At the time of report preparation the 1972 operators list was being printed and not available.

The remaining basic data was compiled primarily from three sources. Working papers prepared by Mr. Craig Vogt, Surveillance and Analysis Division, Region X, EPA, summarizing a reconnaissance survey of 29 operating plants in 1971, provided production and waste disposal data.[1,11/] Additional basic data was obtained from Refuse Act Permit Program (RAPP) applications for 32 major plants. Additional production data for salmon canneries was obtained from a report prepared for the National Canners Association.[3/]

RAPP applications for a total of 75 seafood processors have been placed in the computerized RAPP data system by Region X. Some of these are only partially complete. Review of the 32 applications for major plants (xerox copies of originals) indicated important data are missing on a substantial number. More importantly, the data reported differed significantly from data obtained during the 1971 EPA survey although the permit applications were filed in mid-1971. It is evident that not all processors have filed applications and that additional information is needed to complete present applications.

B. SALMON PROCESSING PLANTS

Southeast Alaska

Salmon by far account for the largest amount of seafood processed in this area. In most years the southeast region salmon pack is the largest of the three Alaska statistical regions. Most salmon is canned although a substantial amount is also frozen or sold fresh as a result of the proximity to the conterminous United States markets. The amount of salmon canned is relatively well defined but the fresh and frozen pack is unknown.

The largest catch is landed in Petersburg and Ketchikan with several processors at each location [Table VI-1]. Other plants are widely scattered. Major plants in Petersburg are Petersburg Cold Storage Co., Petersburg Fisheries, Petersburg Processors, Inc., and Whitney-Fidalgo Seafoods, Inc. Ketchikan processors include Nefco-Fidalgo Seafoods, E. C. Phillips and Sons, Inc., Southeast Fisheries, Inc., and Wards Cove Packing Co. Major processors in remote locations include Annette Island Canning Co., Metlakatla; Excursion Inlet Packing Co., Excursion Inlet; Keku Canning Co., Kake; Klawock Oceanside Packing Co., Klawock; New England Fish Co., Chatham; and Peter Pan Seafoods, Inc., Hawk Inlet.

Owing to its proximity to economically favorable markets, salmon processing plants in Southeast Alaska commonly practice recovery of heads and other waste materials for pet food and other by-products [Table VI-2]. At least seven major processors reduce their waste loads by recovery of by-products.

TABLE VI-1

SUMMARY OF OPERATING DATA, SALMON PROCESSING PLANTS, SOUTHEAST ALASKA

Map Key[a]	Company and Location	Typical Processing Season	No. of Processing Days	No. of Employees	Products	Production: RAPP Data	Production: Annual (Cases) 1966-1970
1	Annette Island Canning Co. Metlakatla	June-Sept.[b]		140	Canned and Frozen Salmon, Salmon Eggs, Misc. Fish[c]	100,000 cases/yr.	57,500 avg. 128,400 max.
2	Dignon Co., Inc. Hoonah				Frozen Salmon		
3	Engstrom Brothers Co. Juneau				Frozen Salmon		
4	Excursion Inlet Packing Co. Excursion Inlet	July-Sept.[b]	35	110	Canned Salmon Salmon Eggs		112,700 avg. 167,000 max.
5	Fairweather Supply Co. Petersburg				Frozen and Cured Salmon Misc. Fish[c]		
6	Haines Packing Co. Haines				Canned Salmon Salmon Eggs		21,300 avg. 30,600 max.
7	Harbor Seafoods Co., Inc. Wrangell	May-Febr.[b]		40	Canned and Frozen Salmon, Salmon Eggs, Misc. Fish[c]		17,900 avg. 33,700 max.
8	Juneau Cold Storage Juneau	Year-Round[b,d]		111	Canned and Frozen Salmon Crab and Shrimp[e]	400 cases/day	7,900 avg. 14,900 max.
9	Keku Canning Co. Kake	[b]		50	Canned Salmon		40,800 avg. 99,700 max.
10	Klawock Oceanside Packing Co. Klawock	July-Sept.[b]		70	Canned Salmon Salmon Eggs		52,000 avg. 99,700 max.
11	Michelson's Smoked Salmon Cannery Wrangell	May-Sept.			Canned Smoked Salmon		
12	New England Fish Co. Chatham	July-Aug.[b,d]	40	130	Canned Salmon	100,000 cases/yr	101,400 avg. 139,300 max.
13	Nefco-Fidalgo Seafoods Ketchikan	July-Sept.[b,d]		120	Fresh and Frozen Salmon	21,000 lb/day	97,000 avg. 213,500 max.
14	New England Fish Co. Noyes Island	July-Sept.		140	Fresh Salmon		
15	Pelican Cold Storage Pelican	April-Oct.		30-40	Fresh, Frozen and Cured Salmon, Salmon Eggs, Misc. Fish[c]		
16	Pelican Cold Storage Sitka				Fresh, Frozen and Cured Salmon, Salmon Eggs, Misc.		

TABLE VI-1 (Cont.)

SUMMARY OF OPERATING DATA, SALMON PROCESSING PLANTS, SOUTHEAST ALASKA

Map Key a/	Company and Location	Typical Processing Season	No. of Processing Days	No. of Employees	Products	Production: RAPP Data	Production: Annual (Cases) 1966-1970
17	Peter Pan Seafoods, Inc. Hawk Inlet	July-Sept.	36	125	Canned Salmon	45,000 cases/yr	62,900 avg. 107,900 max.
18	Petersburg Cold Storage Co. Petersburg	Year-Round d/		25-50	Fresh, Frozen and Cured Salmon, Misc. Fish c/	150,000 lb/day capacity	
19	Petersburg Fisheries Petersburg	June-Oct. b,d/	96	140	Canned Salmon	60,000 cases/yr	68,200 avg. 107,200 max.
20	Petersburg Processers, Inc. Petersburg	May-Sept. b/		50-70	Canned Salmon	50,000 cases/yr	23,800 avg. 39,000 max.
21	E.C. Phillips and Sons, Inc. Ketchikan	Year-Round d/		10-63	Fresh and Frozen Salmon Misc. Fish c/	28,000 lb/day	
22	Sitka Sound Seafoods Sitka				Fresh and Frozen Salmon Salmon Eggs, Crab c/		
23	Southeast Fisheries, Inc. Ketchikan				Canned, Fresh, Frozen and Smoked Salmon, Salmon Eggs, Crab and Shrimp e/ Misc. Fish c/		
24	Thompson Fish Co. Hoonah	Year-Round		8	Fish and Frozen Salmon Misc. Fish c/		
25	Wards Cove Packing Co. Ketchikan	July-Aug. b,d/		125	Canned Salmon	2,200 cases/day	44,900 avg. 99,100 max.
26	Whitney-Fidalgo Seafoods, Inc. Petersburg	April-Oct. b,d/	104	80	Fresh and Canned Salmon Salmon Eggs	50,000 cases/yr	29,900 avg. 69,000 max.
27	Whitney-Fidalgo Seafoods, Inc. Yakutat				Frozen Salmon, Salmon Eggs, Crab e/		

a/ See Figure VI-1 for plant locations.
b/ Operating salmon cannery in 1973.
c/ See Table VI-25 for miscellaneous fish data.
d/ Processor on Regional priority list.
e/ See Table VI-13 for shellfish data.

TABLE VI-2

SUMMARY OF WASTE DISPOSAL PRACTICES, SALMON PROCESSING PLANTS, SOUTHEAST ALASKA

Map Key[a]	Company and Location	Waste Flow (mgd)	Estimated Solid Waste Load: RAPP Data	Estimated Solid Waste Load: 1967-1971 Maximum	Waste Disposal Practices: Domestic	Waste Disposal Practices: Industrial	Receiving Water Characteristics: Name	Receiving Water Characteristics: Type	Receiving Water Characteristics: Tidal Range (ft)	Receiving Water Characteristics: Tidal Current (mph)
1	Annette Island Canning Co. Metlakatla[b]	0.64			City Sewer	Outfall				
2	Dignon Co., Inc. Hoonah									
3	Engstrom Brothers Co. Juneau									
4	Excursion Inlet Packing Co. Excursion Inlet[b]	0.64		5,220,000 lb	Untreated to inlet 1,500 ft cannery	Freeze heads for by-product. Outfall 80 ft out.	Excursion Inlet	Large Inlet		
5	Fairweather Supply Co. Petersburg									
6	Haines Packing Co. Haines									
7	Harbor Seafoods Co., Inc. Wrangell[b]				City Sewer	Gurry Scow				
8	Juneau Cold Storage Juneau[b,c]	0.25			Unknown	Heads recovered for pet food. Eggs and milt recovered. Floor drains below building.	Gastineau Channel	Large Channel	15	
9	Keku Canning Co. Kake[b]	0.29								
10	Klawock Oceanside Packing Co. Klawock[b]				Gurry Scow	Gurry Scow				
11	Mickelson's Smoked Salmon Cannery Wrangell				Unknown	Dumped in deep water.				
12	New England Fish Co. Chatham[b,c]	0.38	80,000 lb/day	4,900,000 lb	Partial Secondary most untreated	Recover salmon eggs Grind solids discharge at depth at dock face	Sitkoh Bay	Small Bay	15	

TABLE VI-2 (Cont.)

SUMMARY OF WASTE DISPOSAL PRACTICES, SALMON PROCESSING PLANTS, SOUTHEAST ALASKA

Map Key[a]	Company and Location	Waste Flow (mgd)	Estimated Solid Waste Load: RAPP Data	Estimated Solid Waste Load: 1967-1971 Maximum	Waste Disposal Practices: Domestic	Waste Disposal Practices: Industrial	Receiving Water Characteristics: Name	Receiving Water Characteristics: Type	Receiving Water Characteristics: Tidal Range (ft)	Receiving Water Characteristics: Tidal Current (mph)
13	Nefco-Fidalgo Seafoods Ketchikan[b,c]				Unknown	Heads recovered for pet food. Solids ground and discharged through floor	Tongass Narrows	Large Channel	16	
14	New England Fish Co. Noyes Island				Unknown	Gurry Scow				
15	Pelican Cold Storage Pelican									
16	Pelican Cold Storage Sitka									
·17	Peter Pan Seafoods, Inc. Hawk Inlet			3,400,000 lb	Partial Secondary	Gurry Scow 2 1/2 in. mesh net	Hawk Inlet	Inlet		
18	Petersburg Cold Storage Co. Petersburg[c]	0.60				Heads recovered for pet food. Other solids discharged through floor or at dock face	Wrangell Narrows	Narrow Channel		5
19	Petersburg Fisheries Petersburg[b,c]	0.55	650,000 lb/yr		City Sewer	Heads, tails and eggs recovered. Grinder and flume to dock face	Wrangell Narrows	Narrow Channel		5
20	Petersburg Processors, Inc. Petersburg[b]									
21	E. C. Phillips and Sons, Inc. Ketchikan[c]	0.04	10-20,000 lb/day			Discharge through hole in floor under dock	Tongass Narrows	Large Channel	16	

TABLE VI-2 (Cont.)

SUMMARY OF WASTE DISPOSAL PRACTICES, SALMON PROCESSING PLANTS, SOUTHEAST ALASKA

			Estimated Solid Waste Load		Waste Disposal Practices		Receiving Water Characteristics			
Map Key[a/]	Company and Location	Waste Flow (mgd)	RAPP Data	1967-1971 Maximum	Domestic	Industrial	Name	Type	Tidal Range (ft)	Tidal Current (mph)
22	Sitka Sound Seafoods Sitka									
23	Southeast Fisheries, Inc. Ketchikan									
24	Thompson Fish Co. Hoonah									
25	Wards Cove Packing Co. Ketchikan	0.10	2,000,000 lb/yr			Eggs recovered. Solids discharged at dock face. No grinding.	Wards Cove	Small Bay	15	
26	Whitney-Fidalgo Seafoods, Inc. Petersburg	0.4	6,000 lb/day	2,000,000 lb/yr	Untreated to harbor	Salmon heads recovered for pet food. Solids ground and discharged 100 ft off dock	Wrangell Narrows	Narrow Channel		5
27	Whitney-Fidalgo Seafoods, Inc. Yakutat									

a/ See Figure VI-1 for plant locations.
b/ Operating salmon cannery in 1973.
c/ Processor on Regional priority list.

Waste disposal practices are mixed. At least four major plants haul solid wastes to deeper water by the use of gurry scows. About half of the plants for which waste disposal data is available grind solids before discharge while the remainder discharge solids without grinding. In many cases the latter plants recover heads for by-products.

Prince William Sound

Seafood processing in this area is centered on Cordova where seven processors are located [Table VI-3]. Crab as well as salmon is processed by most plants. North Pacific Processors and St. Elias Ocean Products, Inc. are the major processors. At nearby Orca, New England Fish Company operates one of the largest salmon canneries in Alaska. One major processor recovers fish heads and the other two grind solids before discharge [Table VI-4].

Kenai Peninsula

With the exception of four plants in Kenai, processors in this area are widely scattered with most being small operations [Table VI-5]. Most of the catch is canned but fresh and frozen packs are also significant owing to the proximity to Anchorage.

Major processors in Kenai include Columbia Wards Fisheries, Kenai Packers and Kenai Salmon Packing Co. Other major processors are the Whitney-Fidalgo Seafoods, Inc. plants at Anchorage and Port Graham.

Waste disposal data is limited. Some by-product recovery is practiced. One plant (Seward Fisheries) is connected to the municipal sewer system.

TABLE VI-3

SUMMARY OF OPERATING DATA, SALMON PROCESSING PLANTS, PRINCE WILLIAM SOUND

Map Key[a]	Company and Location	Typical Processing Season	No. of Processing Days	No. of Employees	Products	Production: RAPP Data	Production: Annual (Cases) 1966-1970
31	Blake Packing[b] Cordova				Canned Salmon		Small
32	Glacier Packing Co. Cordova				Canned Salmon, Clams		
33	Morpac, Inc. Cordova			20	Canned, Fresh and Frozen Salmon, Salmon Eggs, Crab[c]		
34	New England Fish Co. Orca	May-Aug.[b,d]	44	125	Canned and Frozen Salmon Salmon Eggs	4,000 cases/day	168,500 avg. 208,500 max.
35	North Pacific Processors (Pt. Chehalis Packers, Inc.) Cordova	May-Oct.[b,d]	76	40-85	Canned and Frozen Salmon Salmon Eggs, Crab[c] Misc. Fish[e]	50,000 cases/yr	46,000 avg. 70,800 max.
36	Ocean Beauty Seafoods, Inc. Cordova				Canned, Fresh and Frozen Salmon, Salmon Eggs Crab,[c] Misc. Fish[e]		
37	Polar Pacific Ltd. Prince William Sound				Frozen Salmon, Salmon Eggs		
38	St. Elias Ocean Products, Inc. Cordova (Floater)	May-Aug.[b,d]	54	50	Canned, Fresh and Frozen Salmon, Salmon Eggs, Crab,[c] Clams		

a/ See Figure VI-2 for plant locations.
b/ Processor on Regional priority list.
c/ See Table VI-15 for shellfish processing details.
d/ Operating salmon cannery in 1973.
e/ See Table VI-25 for miscellaneous fish processing data.

TABLE VI-4

SUMMARY OF WASTE DISPOSAL PRACTICES, SALMON PROCESSING PLANTS, PRINCE WILLIAM SOUND

Map Key[a/]	Company and Location	Waste Flow (mgd)	Estimated Solid Waste Load: RAPP Data	Estimated Solid Waste Load: 1967-1971 Maximum	Waste Disposal Practices: Domestic	Waste Disposal Practices: Industrial	Receiving Water Characteristics: Name	Receiving Water Characteristics: Type	Tidal Range (ft)	Tidal Current (mph)
31	Blake Packing[b/] Cordova									
32	Glacier Packing Co. Cordova									
33	Morpac, Inc. Cordova	2.15								
34	New England Fish Co.[b,c/] Orca	1.5	156,000 lb/day	7,000,000 lb/yr	Untreated to bay	Eggs recovered Solids ground and discharged 450 ft offshore on surface	Orca Inlet	Large Inlet	12	
35	North Pacific (Pt. Chehalis Packers, Inc.) Cordova			2,400,000 lb/yr	Untreated to Bay	Fish heads recovered for pet food. Other wastes through floor to water	Orca Inlet	Large Inlet	12	
36	Ocean Beauty Seafoods, Inc. Cordova									
37	Polar Pacific Ltd. Prince William Sound									
38	St. Elias Ocean Products, Inc. Cordova (Floater)[b,c/]	0.02	30,000 lb/day	1,200,000 lb/yr	Untreated overboard	Solids ground and discharged overboard	Orca Inlet	Large Inlet	12	

a/ See Figure VI-2 for plant locations.
b/ Processor on Regional priority list.
c/ Operating salmon cannery in 1973.

TABLE VI-5

SUMMARY OF OPERATING DATA, SALMON PROCESSING PLANTS, KENAI PENINSULA

Map Key[a]	Company and Location	Typical Processing Season	No. of Processing Days	No. of Employees	Products	Production: RAPP Data	Production: Annual (Cases) 1966-1970
41	Alaskan Seafoods, Inc. Homer Spit				Fresh and Frozen Salmon, Salmon Eggs, Crab[b] Shrimp and Misc. Fish[c]		
42	American Freezerships Ninilchik				Canned and Frozen Salmon, Salmon Eggs		
43	Brinkley's Sterling			75	Canned and Frozen Salmon		22,000 avg. 37,800 max.
44	Columbia Wards Fisheries[d] Kenai				Canned Salmon		40,100 avg. 68,500 max.
45	Huhndorf Cold Storage Kenai				Fresh, Frozen, Smoked and Cured Salmon, Salmon Eggs		
46	Kachemak Seafoods Kasilof				Fresh, Frozen and Cured Salmon, Crab[b], Shrimp, Clams, Misc, Fish[c]		
47	Keener Packing Co. Soldotna				Canned, Fresh, Frozen and Smoked Salmon, Clams[c]		
48	Kenai Packers[d,e] Kenai				Canned and Frozen Salmon, Salmon Eggs	240,000 lb/day round fish	84,700 avg. 114,700 max.
49	Kenai Salmon Packing Co. Kenai			125	Canned and Frozen Salmon, Salmon Eggs	6,000 cases/day	
50	Luba Moser Clam Gulch				Smoked Salmon		
51	Ocean Beauty Seafoods, Inc. Port Williams				Frozen Salmon, Salmon Eggs, Misc. Fish[c]		
52	Osmar's Ocean Specialties Clam Gulch				Frozen Salmon, Misc. Fish[c]		

TABLE VI-5 (Cont.)

SUMMARY OF OPERATING DATA, SALMON PROCESSING PLANTS, KENAI PENINSULA

Map Key[a]	Company and Location	Typical Processing Season	No. of Processing Days	No. of Employees	Products	Production: RAPP Data	Production: Annual (Cases) 1966-1970
53	R-Lee Seafoods, Inc. Soldotna				Fresh and Frozen Salmon Salmon Eggs, Clams,[b] Misc. Fish[c]		
54	Charles L. Simon Seafoods Kasilof				Canned, Fresh, Frozen, and Smoked Salmon, Clams[b]		
55	Seward Fisheries[d,e] Seward			40	Canned and Frozen Salmon Misc. Fish[c]	360,000 lb/day round fish	
56	Sportsman's Lodge Cooper Landing				Canned and Smoked Salmon		
57	Tidewater Packing Co.[d] Anchorage				Canned Salmon, Salmon Eggs		800 avg. 1,100 max.
58	Whitney-Fidalgo Seafood, Inc.[d] Anchorage				Canned Salmon, Salmon Eggs		59,200 avg. 92,500 max.
59	Whitney-Fidalgo Seafood, Inc.[d] Port Graham				Canned Salmon, Salmon Eggs, Misc. Fish[c]		57,600 avg. 109,200 max.

a/ See Figure VI-2 for plant locations.
b/ See Table VI-17 for shellfish processing details.
c/ See Table VI-25 for miscellaneous fish processing details.
d/ Operating salmon cannery in 1973.
e/ Processor on Regional priority list.

TABLE VI-6

SUMMARY OF WASTE DISPOSAL PRACTICES, SALMON PROCESSING PLANTS, KENAI PENINSULA

Map Key[a/]	Company and Location	Waste Flow (mgd)	Estimated Solid Waste Load: RAPP Data	Estimated Solid Waste Load: 1967-1971 Maximum	Waste Disposal Practices: Domestic	Waste Disposal Practices: Industrial	Receiving Water Characteristics: Name	Receiving Water Characteristics: Type	Receiving Water Characteristics: Tidal Range (ft)	Receiving Water Characteristics: Tidal Current (mph)
41	Alaskan Seafoods, Inc. Homer Spit									
42	American Freezerships Ninilchik	0.10								
43	Brinkley's Sterling									
44	Columbia Ward[b/] Kenai									
45	Huhndorf Cold Storage Kenai									
46	Kachemak Seafoods Kasilof									
47	Keener Packing Co. Soldotna									
48	Kenai Packers[b,c/] Kenai					Solids discharged through floor unground				
49	Kenai Salmon Packing Co. Kenai	0.36	600,000 lb/yr			80 to 90 percent of solids ground, cooked and oil rendered. All wastes discharged through outfall to river bottom	Kenai River			
50	Luba Moser Clam Gulch									
51	Ocean Beauty Seafoods, Inc. Port Williams									

TABLE VI-6 (Cont.)

SUMMARY OF WASTE DISPOSAL PRACTICES, SALMON PROCESSING PLANTS, KENAI PENINSULA

Map Key[a]	Company and Location	Waste Flow (mgd)	Estimated Solid Waste Load: RAPP Data	Estimated Solid Waste Load: 1967-1971 Maximum	Waste Disposal Practices: Domestic	Waste Disposal Practices: Industrial	Receiving Water Characteristics: Name	Receiving Water Characteristics: Type	Receiving Water Characteristics: Tidal Range (ft)	Receiving Water Characteristics: Tidal Current (mph)
52	Osmar's Ocean Specialties Clam Gulch									
53	R-Lee Seafoods, Inc. Soldotna									
54	Charles L. Simon Seafoods Kasilof									
55	Seward Fisheries[b,c] Seward	0.13			City Sewer	Salmon eggs recovered Heads ground for pet food. Tails sold for halibut bait. Some milt frozen for by-product. Process wastes to city sewer.				
56	Sportsman's Lodge Cooper Landing									
57	Tidewater Packing Co.[b] Anchorage									
58	Whitney-Fidalgo Seafood, Inc.[b] Anchorage									
59	Whitney-Fidalgo Seafood, Inc.[b] Port Graham									

a/ See Figure VI-2 for plant locations.
b/ Operating salmon cannery in 1973.
c/ Processor on Regional priority list.

Kodiak Island

Eight of the 11 salmon processors on Kodiak Island are located in the vicinity of Kodiak Harbor [Table VI-7]. The three remote plants (Alaska Packers Assoc., Inc., Larsen Bay; Columbia Wards Fisheries, Alitak; and New England Fish Company, Uganik) are large canneries. The Kodiak Harbor facilities process canned and frozen salmon as well as a large pack of crab and shrimp.

The large concentration of processors in Kodiak Harbor has resulted in a serious water quality problem that has been the subject of several detailed studies. A by-products plant has been placed in operation to reduce the pollution problem. Region X excluded the Kodiak Harbor processors from their request to NFIC for the seafood investigations as substantial data was already available. Waste disposal practices for these processors are not summarized in this report. Two of the remote canneries grind solids before discharge and the third employs a gurry scow [Table VI-8].

Alaska Peninsula

Three large salmon canneries are remotely located on this peninsula [Table VI-9]. One of these also processes crab. Two plants render fish heads for oil with one plant discharging waste solids without grinding and the other using a gurry scow [Table VI-10]. The third cannery uses a gurry scow for all wastes.

Bristol Bay

A total of 14 salmon canneries, most of them large, were in operation

TABLE VI-7

SUMMARY OF OPERATING DATA, SALMON PROCESSING PLANTS, KODIAK ISLAND

Map Key[a]	Company and Location	Typical Processing Season	No. of Processing Days	No. of Employees	Products	Production	
						RAPP Data	Annual (Cases) 1966-1970
61	Alaska Ice and Storage, Inc. Kodiak				Frozen and Fresh Salmon Salmon Eggs, Crab[b]		
62	Alaska Packers Assoc., Inc. Larsen Bay	June to Aug.	45	98	Canned Salmon, Salmon Eggs		93,900 avg. 110,400 max.
63	B and B Fisheries, Inc. Kodiak				Frozen Salmon, Salmon Eggs Crab,[b] Shrimp		
64	Columbia Wards Fisheries[c,d] Alitak	June to Aug.		110	Canned Salmon, Salmon Eggs	2,250 cases/day	109,300 avg. 195,000 max.
65	Columbia Wards Fisheries[c] Icy Cape (Kodiak)	June to Aug.		50	Canned Salmon, Salmon Eggs	550 cases/day	21,200 avg. 27,100 max.
66	Roy Furfiord (M/V Aleutian Fjord) Kodiak)				Frozen Salmon, Salmon Eggs, Crab[b]		
67	Roy Furfiord (M/V Sonya) Old Harbor				Frozen Salmon, Salmon Eggs, Crab[b]		
68	King Crab, Inc.[c] Kodiak				Canned Salmon, Crab[b]		67,400 avg. 118,300 max.
69	Ocean Beauty Seafoods, Inc. Kodiak				Canned Salmon, Crab[b] Shrimp, Clams		
70	New England Fish Co.[c,d] Uganik	July-Aug.	35	110	Canned Salmon, Salmon Eggs	6,000 cases/day	97,300 avg. 156,700 max.
71	Whitney-Fidalgo Seafoods, Inc.[c] Kodiak				Canned Salmon, Salmon Eggs Crab[b]		22,900 avg. 30,600 max.

a/ See Figure VI-2 for plant locations.
b/ See Table VI-19 for shellfish processing data.
c/ Operating salmon cannery in 1973.
d/ Processor on Regional priority list.

TABLE VI-8

SUMMARY OF WASTE DISPOSAL PRACTICES, SALMON PROCESSING PLANTS, KODIAK ISLAND

Map Key[a]	Company and Location	Waste Flow (mgd)	Estimated Solid Waste Load: RAPP Data	Estimated Solid Waste Load: 1967-1971 Maximum	Waste Disposal Practices: Domestic	Waste Disposal Practices: Industrial	Receiving Water Characteristics: Name	Receiving Water Characteristics: Type	Tidal Range (ft)	Tidal Current (mph)
61	Alaska Ice and Storage, Inc. Kodiak									
62	Alaska Packers Assoc., Inc. Larsen Bay	0.4		4,500,000 lb/yr	Septic Tanks and outfall	Unground solids transported by gurry barge to Uyak Bay liquids discharge to Larsen Bay	Larsen Bay Uyak Bay	Small Bays	16	
63	B and B Fisheries, Inc. Kodiak									
64	Columbai Wards Fisheries[b,c] Alitak	0.25	3,000,000 lb/yr			Solids ground before discharge 500 ft offshore on bottom	Lazy Bay	Small Bay		
65	Columbia Wards Fisheries[b] Icy Cape (Kodiak)	0.21	720,000 lb/yr			Solids ground and discharged on bottom 40 ft offshore	Kodiak Harbor	Small Channel	12	
66	Roy Furfiord (M/V Aleutian Fjord) Kodiak									
67	Roy Furfiord (M/V Sonya) Old Harbor									

TABLE VI-8 (Cont.)

SUMMARY OF WASTE DISPOSAL PRACTICES, SALMON PROCESSING PLANTS, KODIAK ISLAND

Map Key[a]	Company and Location	Waste Flow (mgd)	Estimated Solid Waste Load: RAPP Data	Estimated Solid Waste Load: 1967-1971 Maximum	Waste Disposal Practices: Domestic	Waste Disposal Practices: Industrial	Receiving Water Characteristics: Name	Receiving Water Characteristics: Type	Receiving Water Characteristics: Tidal Range (ft)	Receiving Water Characteristics: Tidal Current (mph)
68	King Crab, Inc.[b] Kodiak									
69	Ocean Beauty Seafoods, Inc. Kodiak									
70	New England Fish Co.[b,c] Uganik	Unknown	157,000 lb/day	5,523,000 lb/yr	Package Plant	Eggs recovered Solids ground and discharged through 300 ft outfall to bottom of Bay	Northeast Arm of Uganik Bay	Channel	15	
71	Whitney-Fidalgo Seafoods, Inc.[b] Kodiak									

a/ See Figure VI-2 for plant locations.
b/ Operating salmon cannery in 1973.
c/ Processor on Regional priority list.

TABLE VI-9

SUMMARY OF OPERATING DATA, SALMON PROCESSING PLANTS, ALASKA PENINSULA

Map Key[a/]	Company and Location	Typical Processing Season	No. of Processing Days	No. of Employees	Products	Production: RAPP Data	Production: Annual (Cases) 1966-1970
81	Alaska Packers Assn., Inc.[b,c/] Chignik	June to Aug.	50	100-150	Canned Salmon, Salmon Eggs		106,000 avg. 169,500 max.
82	Peter Pan Seafoods, Inc.[b,c/] False Pass	June to Aug.	60	125	Canned Salmon		105,700 avg. 159,400 max.
83	Peter Pan Seafoods, Inc.[b,c/] King Cove	June to Aug.	60	105	Canned, Fresh, Frozen, and Salted Salmon, Crab[d/]	400,000 lb/day	126,200 avg. 229,100 max.
84	Peter Pan Seafoods, Inc. Port Moller				Fresh, Frozen, Cured and Salted Salmon		

a/ See Figure VI-3 for plant locations.
b/ Operating salmon cannery in 1973.
c/ Processor on Regional priority list.
d/ See Table VI-21 for crab processing data.

TABLE VI-10

SUMMARY OF WASTE DISPOSAL PRACTICES, SALMON PROCESSING PLANTS, ALASKA PENINSULA

Map Key[a/]	Company and Location	Waste Flow (mgd)	Estimated Solid Waste Load: RAPP Data	Estimated Solid Waste Load: 1967-1971 Maximum	Waste Disposal Practices: Domestic	Waste Disposal Practices: Industrial	Receiving Water Characteristics: Name	Receiving Water Characteristics: Type	Receiving Water Characteristics: Tidal Range (ft)	Receiving Water Characteristics: Tidal Current (mph)
81	Alaska Packers Assn., Inc.[b,c/] Chignik	0.40	4,750,000 lb/yr	5,274,000 lb/yr	Some septic tanks. Rest untreated	All solids flumed to net bottom gurry scow and transported to 7 fathoms deep for dumping	Chignik Bay	Large Bay		
82	Peter Pan Seafoods, Inc.[b,c/] False Pass	0.32	3,200,000 lb/yr	4,176,000 lb/yr	Septic tanks	Fish heads rendered Other solids discharged through hole in floor of dock	Isanotski Strait	Large Channel		
83	Peter Pan Seafoods, Inc.[b,c/] King Cove	0.12		7,300,000 lb/yr	Part of waste to city plant	Fish heads rendered Salmon eggs recovered Other solids to gurry scow discharged one mile offshore in Deer Passage	King Cove	Narrow Inlet		
84	Peter Pan Seafoods, Inc. Port Moller									

a/ See Figure VI-3 for plant locations.
b/ Operating salmon cannery in 1973.
c/ Processor on Regional priority list.

on the northern and eastern shores of Bristol Bay in 1971 [Table VI-11]. No other seafood is processed in this area. The sockeye salmon catch (the major species processed) peaks every five years with the most recent peak occurring in 1970. There are additional canneries in this area which operate in years when large catches are anticipated. In 1973 the sockeye salmon run is predicted to be the smallest this century. As a result, only seven canneries in the Bristol Bay area are expected to operate.

The most canneries are concentrated in the Naknek-South Naknek vicinity. Five plants in this area operated in 1971. There are 11 operable canneries at this location. Only three will process in 1973. All but two of the Bristol Bay plants are considered major processors.

Most plants grind waste solids before discharge [Table VI-12]. Three plants have outfalls while the remainder discharge at the cannery dock. Four plants render part of their fish heads for oil.

C. SHELLFISH PROCESSING PLANTS

King crab is the most important shellfish processed in Alaska. The largest King crab catches are landed in the Aleutian Islands and Kodiak Island with significant catches also landed in Southeastern Alaska, Prince William Sound and the Kenai Peninsula. King crab catches have declined in recent years with the result that tanner (snow) crab have received more attention and catches are increasing. Tanner crab are processed at the same locations as King crab. Dungeness crab are primarily processed in the Southeast Alaska, Prince William Sound and Kodiak Island areas.

TABLE VI-11

SUMMARY OF OPERATING DATA, SALMON PROCESSING PLANTS, BRISTOL BAY

Map Key[a/]	Company and Location	Typical Processing Season	No. of Processing Days	No. of Employees	Products	Production: RAPP Data	Production: Annual (Cases) 1966-1970
91	Alaska Packers Assn., Inc. South Naknek	June-July	24	200-400	Canned Salmon, Salmon Eggs		109,100 avg. 174,700 max.
92	Alaska Packers Assn., Inc. Egegik			75	Canned Salmon		84,000 avg. 84,700 max.
93	Bumble Bee Seafoods[b,c/] South Naknek	June-July	18	275	Canned Salmon, Salmon Eggs	3,000 cases/day	82,400 avg. 135,500 max.
94	Clark Fishing and Packing Egegik				Salt Salmon		
95	Columbia Wards Fisheries[b,c/] Ekuk	June-Aug.	35	250-300	Canned and Frozen Salmon, Salmon Eggs		83,000 avg. 134,800 max.
96	Columbia Wards Fisheries (Red Salmon Cannery) Naknek	June-July	24	600	Canned Salmon		91,500 avg. 147,900 max.
97	Kayak Packing Co.[b/] Big Creek (Floater)				Canned Salmon		8,900 avg. 12,600 max.
98	Nelbro Packing Co.[b,c/] Naknek	June-July	20	400	Canned Salmon, Salmon Eggs	8,000 cases/day	60,000 avg. 111,900 max.
99	New England Fish Co. Egegik				Canned Salmon, Salmon Eggs		41,100 avg. 44,000 max.
100	New England Fish Co. Pederson Point			250	Canned and Frozen Salmon Salmon Eggs		90,400 avg. 160,300 max.
101	Peter Pan Seafoods, Inc.[b/] Dillingham	June-July	35	160	Canned, Fresh and Frozen Salmon		68,200 avg. 108,100 max.
102	Queen Fisheries[b/] Nushagak				Canned Salmon		38,200 avg. 63,300 max.
103	Togiak Fisheries, Inc.[b/] Togiak				Canned and Cured Salmon		19,800 avg. 28,700 max.
104	Whitney-Fidalgo Seafoods, Inc. Naknek			86	Canned Salmon, Salmon Eggs	450,000 lb/day round fish	65,300 avg.

a/ See Figure VI-3 for plant locations.
b/ Operating salmon cannery in 1973.
c/ Processor on Regional priority list.

TABLE VI-12

SUMMARY OF WASTE DISPOSAL PRACTICES, SALMON PROCESSING PLANTS, BRISTOL BAY

Map Key[a]	Company and Location	Waste Flow (mgd)	Estimated Solid Waste Load: RAPP Data	Estimated Solid Waste Load: 1967-1971 Maximum	Waste Disposal Practices: Domestic	Waste Disposal Practices: Industrial	Receiving Water Characteristics: Name	Receiving Water Characteristics: Type	Receiving Water Characteristics: Tidal Range (ft)	Receiving Water Characteristics: Tidal Current (mph)
91	Alaska Packers Assn., Inc. South Naknek	1.2	5,200,000 lb/yr	4,900,000 lb/yr	Septic Tanks and drain fields	Solids ground and discharged at dock face	Naknek River	Narrow Estuary	20	9
92	Alaska Packers Assn., Inc. Egegik									
93	Bumble Bee Seafoods[b,c] South Naknek	0.44	1,000,000 lb/yr	3,300,000 lb/yr	Package treatment Plant scheduled in 1972	Part of heads are rendered. Remaining heads ground. Other solids unground discharge through floor	Naknek River	Narrow Estuary	20	9
94	Clark Fishing and Packing Egegik									
95	Columbia Wards Fisheries[b,c] Ekuk	Unknown		2,700,000 lb/yr	Septic tanks	Part of heads rendered. Solids ground and discharged under dock	Nushagak Bay	Large Estuary	20	
96	Columbia Wards Fisheries (Red Salmon Cannery) Naknek	0.36	N.A.	N.A.	N.A.	Heads ground. Other solids unground Discharged below dock	Naknek River	Narrow Estuary	20	9
97	Kayak Packing Co.[b] Big Creek (Floater)									
98	Nelbro Packing Co.[b,c] Naknek	0.50	1,400,000 lb/yr	2,600,000 lb/yr	N.A.	Heads ground and part are rendered All solids ground and pumped through outfall 150 ft off dock face above low water	Naknek River	Narrow Estuary	20	9

TABLE VI-12 (Cont.)

SUMMARY OF WASTE DISPOSAL PRACTICES, SALMON PROCESSING PLANTS, BRISTOL BAY

Map Key[a]	Company and Location	Waste Flow (mgd)	Estimated Solid Waste Load: RAPP Data	Estimated Solid Waste Load: 1967-1971 Maximum	Waste Disposal Practices: Domestic	Waste Disposal Practices: Industrial	Receiving Water Characteristics: Name	Receiving Water Characteristics: Type	Tidal Range (ft)	Tidal Current (mph)
99	New England Fish Co. Egegik									
100	New England Fish Co. Pederson Point									
101	Peter Pan Seafoods, Inc.[b] Dillingham	0.5		2,400,000 lb/yr	Septic tanks scheduled in 1972	Heads ground and parts are rendered All solids to disintegrator and 200 ft outfall on bottom	Nushagak River Estuary	Large Estuary		
102	Queen Fisheries[b] Nushagak									
103	Togiak Fisheries, Inc.[b] Togiak									
104	Whitney-Fidalgo Seafoods, Inc. Naknek	0.31	930,000 lb/yr			Eggs recovered Heads ground. All solids discharged through 200 ft outfall on bottom	Naknek River	Narrow Estuary	20	9

a/ See Figure VI-3 for plant locations.
b/ Operating salmon cannery in 1973.
c/ Processor on Regional priority list.

Alaskan shrimp are very small. The introduction of mechanical peelers has allowed this fishery to expand in recent years. The major shrimp catch is processed at Kodiak Harbor with significant processing activity also occurring at Squaw Harbor and in Southeast Alaska.

Other shellfish processed include clams and scallops.

Southeast Alaska

Of the 10 shellfish plants in this area, most process dungeness crab [Table VI-13]. Some process king and tanner crab and four process shrimp. Most operations are relatively small and widely scattered.

Data on waste disposal practices is limited [Table VI-14]. A common waste disposal method in other areas is to grind shells and offal and discharge at the dock face.

Prince William Sound

Five crab and clam processors are located in Cordova [Table VI-15]. North Pacific Processors is a major plant.

Two processors discharge unground shells and waste solids at near-shore locations resulting in solids accomulations and water quality problems [Table VI-16].

Kenai Peninsula

A total of seven small shellfish processors operate on the Kenai Peninsula [Table VI-17]. Shellfish processed include all three species of crabs, shrimp, clams, and scallops.

Waste disposal data is limited [Table VI-18]. Additional information is needed to identify potential water quality problems.

TABLE VI-13

SUMMARY OF OPERATING DATA, SHELL FISH PROCESSORS, SOUTHEAST ALASKA

Map Key[a]	Company and Location	Typical Processing Season	No. of Processing Days	No. of Employees	Products	Production: RAPP Data	Production: Maximum Annual 1967-1971
113	Alaskan Glacier Seafood Co. Petersburg	May-Febr.		40	Canned and Frozen Shrimp and Dungeness and Tanner Crab		
28	Coastal Glacier Sea Foods Hoonah	May-Nov.			Canned, Fresh and Frozen King Crab, Tanner Crab and Dungeness Crab		
8	Juneau Cold Storage[b,c] Juneau	Year-Round		111 max.	Canned and Frozen King Crab, Salmon[d]	400 cases/day	
29	Kupreanof Packing Inc. Kake				Canned Dungeness Crab		
30	Jesse H. Petrich (M/V Hoquiam) Ketchikan				Fresh and Frozen Shrimp		
111	Reliance Shrimp Co. Wrangell	May-Febr.		20-40	Frozen and Canned Shrimp and Crab		
22	Sitka Sound Seafoods Sitka				Fresh and Frozen King, Tanner and Dungeness Crab, Salmon[d]		
23	Southeast Fisheries, Inc. Ketchikan				Frozen Dungeness Crab and Shrimp, Salmon,[d] Misc. Fish[e]		
112	Totem Seafoods Tenakee	June-Nov.		15	Canned Dungeness Crab		
27	Whitney-Fidalgo Seafoods, Inc. Yakutat				Canned Dungeness Crab, Salmon[d]		

a/ See Figure VI-1 for plant locations.
b/ Operating salmon cannery in 1973.
c/ Processor on Regional priority list.
d/ See Table VI-1 for salmon processing data.
e/ See Table VI-25 for miscellaneous fish processing data.

TABLE VI-14

SUMMARY OF WASTE DISPOSAL PRACTICES, SHELLFISH PROCESSORS, SOUTHEAST ALASKA

Map Key[a/]	Company and Location	Waste Flow (mgd)	Estimated Solid Waste Load: RAPP Data	Estimated Solid Waste Load: 1967-1971 Maximum	Waste Disposal Practices: Domestic	Waste Disposal Practices: Industrial	Receiving Water Characteristics: Name	Receiving Water Characteristics: Type	Receiving Water Characteristics: Tidal Range (ft)	Receiving Water Characteristics: Tidal Current (mph)
113	Alaskan Glacier Seafoods Co. Petersburg					Solids ground and discharged at dock face	Wrangell Narrows	Narrow Channel		
28	Coastal Glacier Sea Foods Hoonah									
8	Juneau Cold Storage[b,c/] Juneau	0.25			Unknown	Discharge unground through floor drains	Gastineau Channel	Large Channel		
29	Kupreanof Packing Inc. Kake									
30	Jesse H. Petrich (M/V Hoquiam) Ketchikan									
111	Reliance Shrimp Co. Wrangell									
22	Sitka Sound Seafoods Sitka									
23	Southeast Fisheries, Inc. Ketchikan									
112	Totem Seafoods Tenakee									
27	Whitney-Fidalgo Seafoods, Inc. Yakutat									

a/ See Figure VI-1 for plant locations.
b/ Operating salmon cannery in 1973.
c/ Processor is on Regional priority list.

TABLE VI-15

SUMMARY OF OPERATING DATA, SHELLFISH PROCESSORS, PRINCE WILLIAM SOUND

Map Key[a/]	Company and Location	Typical Processing Season	No. of Processing Days	No. of Employees	Products	Production: RAPP Data	Production: Maximum Annual 1967-1971
39	Fairmount Island Sea Foods Fairmount Island				Fresh and Frozen King Crab, Dungeness Crab, and Shrimp		
32	Glacier Packing Co. Cordova				Canned Clams, Salmon[b/]		
33	Morpac, Inc. Cordova			20	Fresh and Frozen Dungeness Crab, Salmon[b/]		
35	North Pacific Processors[c/] (Pt. Chehalis Packers, Inc.) Cordova	Jan.-Nov.	238	40-55	Canned and Frozen King, Tanner and Dungeness Crab, Salmon,[b/] Misc. Fish[d/]	60,000 lb green crab/day max.	4,500,000 lb green crab
36	Ocean Beauty Seafoods, Inc. Cordova				Canned, Fresh and Frozen King and Dungeness Crab, Salmon[b/]		
38	St. Elias Ocean Products[c,e/] Cordova (Floater)	Sept.-Oct.	35	50	Canned, Fresh and Frozen Dungeness Crab, Frozen Clams, Salmon[b/]		300,000 lb green crab

a/ See Figure VI-2 for plant locations.
b/ See Table VI-3 for salmon processing data.
c/ Processor on Regional priority list.
d/ See Table VI-25 for miscellaneous fish processing data.
e/ Operating salmon cannery in 1973.

TABLE VI-16

SUMMARY OF WASTE DISPOSAL PRACTICES, SHELLFISH PROCESSORS, PRINCE WILLIAM SOUND

Map Key[a/]	Company and Location	Waste Flow (mgd)	Estimated Solid Waste Load: RAPP Data	Estimated Solid Waste Load: 1967-1971 Maximum	Waste Disposal Practices: Domestic	Waste Disposal Practices: Industrial	Receiving Water Characteristics: Name	Receiving Water Characteristics: Type	Receiving Water Characteristics: Tidal Range (ft)	Receiving Water Characteristics: Tidal Current (mph)
40	Fairmount Island Sea Foods Fairmount Island									
32	Glacier Packing Co. Cordova									
33	Morpac, Inc. Cordova									
35	North Pacific Processors (Pt. Chehalis Packers, Inc.)[b/] Cordova	0.01	25,000 lb/day	3,950,000 lb/yr	Untreated to Bay	Unground solids discharged under dock	Orca Inlet	Large Inlet	12	Low
36	Ocean Beauty Seafoods, Inc. Cordova									
38	St. Elias Ocean Products[b/]	0.02		230,000 lb/yr	Untreated overboard	Unground solids discharged overboard	Orca Inlet	Large Inlet	12	Low

a/ See Figure VI-2 for plant locations.
b/ Processor on Regional Priority list.

TABLE VI-17

SUMMARY OF OPERATING DATA, SHELLFISH PROCESSORS, KENAI PENINSULA

Map Key[a]	Company and Location	Typical Processing Season	No. of Processing Days	No. of Employees	Products	Production: RAPP Data	Production: Maximum Annual 1967-1971
60	Alaskan Scallop Processors, Inc. Seward				Fresh and Frozen Scallops		
41	Alaskan Seafoods, Inc. Homer				Fresh and Frozen King, Tanner and Dungeness Crab and Shrimp, Salmon,[b] Misc. Fish[c]		
46	Kachemak Seafoods Kasilof				Fresh and Frozen King, Tanner and Dungeness Crab and Shrimp, Frozen Clams, Salmon,[b] and Misc. Fish[c]		
47	Keener Packing Co. Soldotna				Canned Clams, Salmon[b]		
53	R-Lee Seafoods, Inc. Soldotna				Canned, Fresh and Frozen Clams, Salmon,[b] Misc. Fish[c]		
113	Michael Rearden (M/V Eider) Homer				Fresh Shrimp		
54	Charles L. Simon Seafoods Kasilof				Canned Clams, Salmon[b]		

a/ See Figure VI-2 for plant locations.
b/ See Table VI-5 for salmon processing data.
c/ See Table VI-25 for miscellaneous fish processing data.

TABLE VI-18

SUMMARY OF WASTE DISPOSAL PRACTICES, SHELLFISH PROCESSORS, KENAI PENINSULA

Map Key[a]	Company and Location	Waste Flow (mgd)	Estimated Solid Waste Load: RAPP Data	Estimated Solid Waste Load: 1967-1971 Maximum	Waste Disposal Practices: Domestic	Waste Disposal Practices: Industrial	Receiving Water Characteristics: Name	Receiving Water Characteristics: Type	Receiving Water Characteristics: Tidal Range (ft)	Receiving Water Characteristics: Tidal Current (mph)
60	Alaskan Scallop Processors, Inc. Seward									
41	Alaskan Seafoods, Inc. Homer									
46	Kachemak Seafoods Kasilof									
47	Keener Packing Co. Soldotna									
53	R-Lee Seafoods, Inc. Soldotna									
113	Michael Rearden (M/V Eider) Homer									
54	Charles L. Simon Seafoods Kasilof									

a/ See Figure VI-2 for plant locations.

Kodiak Island

Shellfish processing is a major industry on Kodiak Island with 14 plants in operation, 12 of which are located near Kodiak Harbor [Table VI-19]. Large catches of both crab and shrimp are processed. Most plants are major operators. The Wakefield Seafoods, Inc. plant at Port Lyons is a major operation at a remote location.

Waste disposal practices at the Kodiak Harbor plants were not summarized as these plants will not be included in the NFIC study. A by-products plant is scheduled to be in operation at this location during the 1973 season. Recovery of waste materials is necessary to abate a serious water quality problem. The Port Lyons plant grinds solids and discharges at the dock face [Table VI-20].

Alaska Peninsula

Only three shellfish processors are located on the Alaska Peninsula [Table VI-21]. Two are major crab operations and the third a major shrimp processor. The crab processors grind waste solids and discharge at the dock face while the shrimp processor discharges solids unground through a 100 ft outfall [Table VI-22].

Aleutian Islands

With the exception of some salmon and halibut processing at Unalaska, shellfish processing is the only seafood activity in the Aleutian Islands. A major portion of the Alaska King crab catch is landed in this area. In 1971 four floating processors were operating in the Islands [Table VI-23]. These plants operated at Adak part of

TABLE VI-19

SUMMARY OF OPERATING DATA, SHELLFISH PROCESSORS, KODIAK ISLAND

Map Key[a/]	Company and Location	Typical Processing Season	No. of Processing Days	No. of Employees	Products	Production: RAPP Data	Production: Maximum Annual 1967-1971
61	Alaska Ice and Storage, Inc. Kodiak				Fresh and Frozen King, Tanner, and Dungeness Crabs, Scallops and Clams, Salmon,[b/] Misc. Fish[c/]		
72	Alaska Packers Assn., Inc. Kodiak				Canned and Frozen King Crab		
73	Alaska-Shell, Inc. Jap Bay				Canned and Frozen Shrimp		
74	American Freezerships Kodiak				Frozen King and Dungeness Crab, Shrimp		
63	B and B Fisheries, Inc. Kodiak				Fresh and Frozen King Crab and Shrimp, canned Shrimp, Salmon,[b/] Misc. Fish[c/]		
66	Roy Furfiord (M/V Aleutian Fjord) Kodiak				Frozen King, Tanner and Dungeness Crab, Salmon[b/]		
67	Roy Furfiord (M/V Sonya) Old Harbor				Frozen king, Tanner and Dungeness Crab, Salmon[b/]		
68	King Crab, Inc. Kodiak				Crab, Salmon[b/]		
75	Northern Processors, Inc. Kodiak				Frozen King, Tanner, and Dungeness Crab		
69	Ocean Beauty Seafoods, Inc. Kodiak				Canned and Frozen King, Tanner and Dungeness Crab and Shrimp, Frozen Clams and Scallops, Salmon[b/]		
76	Pan-Alaska Fisheries, Inc. Kodiak				Frozen King and Tanner Crab and Shrimp		
77	Pt. Chehalis Packers, Inc. Kodiak				Canned and Frozen King, Tanner and Dungeness Crab		
78	Wakefield Seafoods, Inc.[d/] Port Wakefield (Port Lyons)	Aug.-June	100	60	Frozen King and Tanner Crab	37,000 lb green crab/day	
71	Whitney-Fidalgo Seafoods, Inc. Kodiak				Canned King and Tanner Crab, Salmon[b/]		

a/ See Figure VI-2 for plant locations.
b/ See Table VI-7 for salmon processing details.
c/ See Table VI-25 for miscellaneous fish processing details.
d/ Processor is on Regional priority list.

TABLE VI-20

SUMMARY OF WASTE DISPOSAL PRACTICES, SHELLFISH PROCESSORS, KODIAK ISLAND

Map Key[a/]	Company and Location	Waste Flow (mgd)	Estimated Solid Waste Load: RAPP Data	Estimated Solid Waste Load: 1967-1971 Maximum	Waste Disposal Practices: Domestic	Waste Disposal Practices: Industrial	Receiving Water Characteristics: Name	Receiving Water Characteristics: Type	Receiving Water Characteristics: Tidal Range (ft)	Receiving Water Characteristics: Tidal Current (mph)
61	Alaska Ice and Storage, Inc. Kodiak									
72	Alaska Packers Assn., Inc. Kodiak									
73	Alaska-Shell Inc. Jap Bay									
74	American Freezerships Kodiak									
63	B and B Fisheries, Inc. Kodiak									
66	Roy Furfiord (M/V Aleutian Fjord) Kodiak									
67	Roy Furfiord (M/V Sonya) Old Harbor									
68	King Crab, Inc. Kodiak									

TABLE VI-20 (Cont.)

SUMMARY OF WASTE DISPOSAL PRACTICES, SHELLFISH PROCESSORS, KODIAK ISLAND

Map Key[a/]	Company and Location	Waste Flow (mgd)	Estimated Solid Waste Load: RAPP Data	Estimated Solid Waste Load: 1967-1971 Maximum	Waste Disposal Practices: Domestic	Waste Disposal Practices: Industrial	Receiving Water Characteristics: Name	Receiving Water Characteristics: Type	Tidal Range (ft)	Tidal Current (mph)
75	Northern Processors, Inc. Kodiak									
69	Ocean Beauty Seafoods, Inc. Kodiak									
76	Pan-Alaska Fisheries, Inc. Kodiak									
77	Pt. Chehalis Packers, Inc. Kodiak									
78	Wakefield Seafoods, Inc.[b/] Port Wakefield (Port Lyons)	0.82	2,500,000 lb/yr		Septic tank and outfall	Grind Solids and flume to dock face	Kizhuyak Bay	Large Bay	10	
71	Whitney-Fidalgo Seafoods, Inc. Kodiak									

a/ See Figure VI-2 for plant locations.
b/ Processor on Regional priority list.

TABLE VI-21

SUMMARY OF OPERATING DATA, SHELLFISH PROCESSORS, ALASKA PENINSULA

Map Key[a/]	Company and Location	Typical Processing Season	No. of Processing Days	No. of Employees	Products	Production: RAPP Data	Production: Maximum Annual 1967-1971
83	Peter Pan Seafoods, Inc.[b/] King Cove	Sept.-Jan.	89	105	Canned King and Tanner Crab, Salmon[c/]	60,000 lb green crab/day max.	6,000,000 lb green crab
85	Peter Pan Seafoods, Inc.[b/] Squaw Harbor	July-April	195	40	Canned Shrimp	70,000 lb round shrimp/day max.	7,800,000 lb round shrimp (150,000 cases 24-4 1/2 oz cans)
86	Wakefield Seafoods, Inc.[b/] Sand Point	Year-Round	182	64-100	Frozen King and Tanner Crab, Halibut[d/]	42,000 lb green crab/day	7,000,000 lb green crab

a/ See Figure VI-3 for plant locations.
b/ Processor is on Regional priority list.
c/ See Table VI-9 for salmon processing data.
d/ See Table VI-25 for miscellaneous fish processing data.

TABLE VI-22

SUMMARY OF WASTE DISPOSAL PRACTICES, SHELLFISH PROCESSORS, ALASKA PENINSULA

Map Key a/	Company and Location	Waste Flow (mgd)	Estimated Solid Waste Load: RAPP Data	Estimated Solid Waste Load: 1967-1971 Maximum	Waste Disposal Practices: Domestic	Waste Disposal Practices: Industrial	Receiving Water Characteristics: Name	Receiving Water Characteristics: Type	Tidal Range (ft)	Tidal Current (mph)
83	Peter Pan Seafoods, Inc. b/ King Cove	0.38	3,600,000 lb/yr	4,800,000 lb/yr	Part of waste to city plant rest untreated	Shells and solids ground and discharged at dock face in 30 ft of water	King Cove	Narrow Inlet		
85	Peter Pan Seafoods, Inc. b/ Squaw Harbor	0.34	4,000,000 lb/yr	6,300,000 lb/yr	Some septic tanks. Rest untreated	Solids discharged unground through 100 ft outfall 5 ft off bottom	Baralof Bay	Small Bay		
86	Wakefield Fisheries Sand Point	9.0		5,250,000 lb/yr	Some septic tanks and a package plant. Most waste untreated	All solids ground and discharged at dock face about 25 ft below water surface	Humboldt Harbor	Small Cove	12	Small

a/ See Figure VI-3 for plant locations.
b/ Processor is on Regional priority list.

TABLE VI-23

SUMMARY OF OPERATING DATA, SHELLFISH PROCESSORS, ALEUTIAN ISLANDS

Map Key a/	Company and Location	Typical Processing Season	No. of Processing Days	No. of Employees	Products	Production: RAPP Data	Production: Maximum Annual 1967-1971
121	Aleutian Development Co. Unalaska				Canned, Fresh and Frozen King, Dungeness and Tanner Crab		
122	American Freezerships (M/V Theresa Lee) Adak	Nov.-Febr.	69	30	Frozen King Crab	N.A.	N.A.
123	American Freezerships (M/V Theresa Lee) Akutan b/	July-Oct.	64	35	Frozen King Crab	N.A.	N.A.
124	Pan Alaska Fisheries, Inc. Adak				Frozen King Crab		
125	Pan Alaska Fisheries, Inc. Unalaska b/	Year-Round	150	40-50	Frozen King, Tanner and Dungeness Crab, Salmon	100,000 lb green crab/day	12,500,000 lb green crab
126	Point Adams Packing Co. (M/V Northgate) Adak	Nov.-March	105	61	Frozen King Crab	N.A.	5,600,000 lb green crab
127	Point Adams Packing Co. (M/V Northgate) Dutch Harbor b/	July-Sept.	105	61	Frozen King Crab	N.A.	5,600,000 lb green crab
128	Vita Food Products, Inc. (M/V Viceroy) Adak	Nov.-March	105	52	Frozen King Crab	27,000 lb green crab/day	3,400,000 lb green crab
129	Vita Food Products, Inc. (M/V Viceroy) Dutch Harbor b/	July-Oct.	70	52	Frozen King Crab	27,000 lb green crab/day	4,900,000 lb green crab
130	Wakefield Seafoods, Inc. (M/V Akutan) Adak	Nov.-March	90	54	Frozen King and Tanner Crab	42,000 lb green crab/day	4,000,000 lb green crab/yr
131	Wakefield Seafoods, Inc. (M/V Akutan) Akutan b/	July-Oct.	64	54	Frozen King and Tanner Crab	42,000 lb green crab/day	1,300,000 lb green crab/yr

a/ See Figure VI-3 for plant locations.
b/ Processor is on Regional priority list.

the year and at either Akutan or Dutch Harbor the remainder of the year. Three shore plants, two at Unalaska and the other at Adak, were also in operation. Pan Alaska Fisheries, Inc. at Unalaska is the largest crab processor in Alaska.

All of the processors grind waste solids and discharge overboard or at the dock face in deep water [Table VI-24]. The U.S. Navy requires the floaters at Adak to discharge at least 42 ft deep.

D. MISCELLANEOUS FISH PROCESSORS

A total of 31 plants in 1971 processed miscellaneous fish products [Table VI-25]. Most of these plants are either small operations or primarily process salmon or shellfish. In addition to miscellaneous fish, 14 plants process salmon, one plant processes shellfish and 9 plants process both salmon and shellfish. Two-thrids of the plant are located in Southeast Alaska, Kenai Peninsula and Kodiak Island.

The most common species processed are halibut and herring. Other fish include sablefish, cod, trout, red snapper, char, octopus, whitefish, and smelt.

Little data is available on the amount of fish processed and on waste disposal practices.

E. SUMMARY OF MAJOR PROCESSING PLANTS

The Surveillence and Analysis Division, Region X, EPA, has identified 30 major seafood processors in Alaska (excluding Kodiak Harbor) which they have requested NFIC-Denver to give priority to in investigations prepatory to development of waste discharge effluent limitations.[12/] These major processors are listed in Table VI-26.

TABLE VI-24

SUMMARY OF WASTE DISPOSAL PRACTICES, SHELLFISH PROCESSORS, ALEUTIAN ISLANDS

Map Key[a/]	Company and Location	Waste Flow (mgd)	Estimated Solid Waste Load: RAPP Data	Estimated Solid Waste Load: 1967-1971 Maximum	Waste Disposal Practices: Domestic	Waste Disposal Practices: Industrial	Receiving Water Characteristics: Name	Receiving Water Characteristics: Type	Tidal Range (ft)	Tidal Current (mph)
121	Aleutian Development Co. Unalaska									
122	American Freezerships (M/V Theresa Lee) Adak	0.10	2-4,000 lb/hr	N.A.	Unknown	Solids ground and discharged at 42 ft depth	Finger Bay	Narrow Inlet		
123	American Freezerships[b/] (M/V Theresa Lee) Akutan	0.10	2-4,000 lb/hr	N.A.	Unknown	Same as Adak	Akutan Harbor	Small Bay		
124	Pan Alaska Fisheries, Inc. Adak									
125	Pan Alaska Fisheries, Inc.[b/] Unalaska	0.20	9,300,000 lb/yr	9,300,000 lb/yr	Unknown	Solids ground and discharged offshore at 27 ft depth	Iliuliuk Harbor	Narrow Channel		5
126	Point Adams Packing Co. (M/V Northgate) Adak	0.01	N.A.	4,500,000 lb/yr	Untreated	Solids ground and discharged at 42 ft depth	Finger Bay	Narrow Inlet		
127	Point Adams Packing Co.[b/] (M/V Northgate) Dutch Harbor	0.01	N.A.	4,500,000 lb/yr	Untreated	Same as Adak	Dutch Harbor	Medium Bay		

TABLE VI-24 (Cont.)

SUMMARY OF WASTE DISPOSAL PRACTICES, SHELLFISH PROCESSORS, ALEUTIAN ISLANDS

Map Key a/	Company and Location	Waste Flow (mgd)	Estimated Solid Waste Load		Waste Disposal Practices		Receiving Water Characteristics			
			RAPP Data	1967-1971 Maximum	Domestic	Industrial	Name	Type	Tidal Range (ft)	Tidal Current (mph)
128	Vita Food Products, Inc. (M/V Viceroy) Adak	0.36	27,000 lb/day	2,600,000 lb/yr	Chlorinated and mixed with process wastes	Solids ground and discharged at 42 ft depth	Finger Bay	Narrow Inlet		
129	Vita Food Products, Inc. b/ (M/V Viceroy) Dutch Harbor	0.36	27,000 lb/day	3,800,000 lb/yr	Same as Adak	Same as Adak	Iliuliuk Harbor	Small Bay		
130	Wakefield Seafoods, Inc. (M/V Akutan) Adak	0.57	2,500,000 lb/yr	3,200,000 lb/yr	Septic tanks	Solids ground and discharged at 42 ft depth	Finger Bay	Narrow Inlet		
131	Wakefield Seafoods, Inc. b/ (M/V Akutan) Akutan	0.57	2,500,000 lb/yr	1,000,000 lb/yr	Septic tanks	Same as Adak or may be overboard	Akutan Harbor	Narrow Bay		

a/ See Figure VI-3 for plant locations.
b/ Processor is on Regional priority list.

TABLE VI-25

MISCELLANEOUS FISH PROCESSORS[4/]

Company	Plant Location	Products[a,b/]
Alaska Ice & Storage, Inc.	Kodiak	Herring: Frozen Halibut: Fresh, Frozen Sablefish: Fresh, Frozen Cod: Fresh, Frozen Salmon, Shellfish
Alaskan Seafoods, Inc.	Homer Split	Herring: Frozen, Eggs, Bait Halibut: Fresh, Frozen Trout: Fresh, Frozen Salmon, Shellfish
Annette Islands Canning Co.	Metlakatla	Halibut: Frozen Cod: Frozen Red Snapper: Frozen Salmon
B & B Fisheries, Inc.	Kodiak	Herring: Frozen, Eggs, Bait, Eggs on Kelp Salmon, Shellfish
Fairmount Island Sea Foods	Fairmount Island	Halibut: Fresh, Frozen Shellfish
Fairweather Supply Co.	Petersburg	Halibut: Frozen Salmon
Roy Furfiord	M/V Aleutian Fjord Old Harbor M/V Sonya	Herring: Frozen Herring: Frozen Salmon, Shellfish
Harbor Seafoods, Co., Inc.	Wrangell	Herring: Bait Halibut: Fresh Salmon
Kachemak Seafoods	Kasilof	Herring: Frozen, Salted, Eggs, Bait, Eggs on Kelp Halibut: Fresh Char: Fresh, Frozen Octopus: Fresh, Frozen Salmon, Shellfish
Kodiak Bait Co.	Larsen Bay	Herring: Fresh, Salted, Eggs, Bait, Eggs on Kelp
Peter E. Merry	Fairbanks	Whitefish: Fresh, Frozen
New England Fish Co.	Ketchikan	Herring: Frozen, Bait Halibut: Frozen Salmon
Ocean Beauty Seafoods, Inc.	Zachar Bay Port Williams	Herring: Eggs, Meal Herring: Frozen Halibut: Frozen Salmon
Osmar's Ocean Specialties	Clam Gulch	Halibut: Frozen Salmon

TABLE VI-25 (Cont.)

MISCELLANEOUS FISH PROCESSORS[a/]

Company	Plant Location	Products[a,b/]
Pan-Alaska Fisheries	Unalaska	Halibut: Frozen Salmon, Shellfish
Pelican Cold Storage Co.	Pelican	Herring: Frozen, Bait Halibut: Fresh, Frozen Sablefish: Frozen Cod: Fresh, Frozen Red Snapper: Fresh, Frozen Salmon
	Sitka	Herring: Frozen, Bait Halibut: Fresh, Frozen Sablefish: Fresh, Frozen Cod: Fresh, Frozen Red Snapper: Fresh, Frozen Salmon
Petersburg Cold Storage Co.	Petersburg	Herring: Frozen, Salted, Bait, Eggs on Kelp Halibut: Frozen Sablefish: Frozen, Salted Steelhead: Frozen Trout: Frozen Smelt: Frozen Salmon
E. C. Phillips & Sons, Inc.	Ketchikan	Herring: Frozen Halibut: Fresh, Frozen Sablefish: Frozen Steelhead: Frozen Cod: Frozen Red Snapper: Fresh, Frozen Salmon
Pt. Chehalis Packers, Inc.	Cordova	Halibut: Frozen Salmon, Shellfish
Polar Pacific Ltd.	Pr. William Sound	Herring: Fresh, Frozen, Salted, Eggs, Eggs on Kelp Salmon
R-Lee Seafoods, Inc.	Soldotna	Herring: Fresh, Frozen, Bait Halibut: Fresh, Frozen Salmon, Shellfish
Seward Marine Services, Inc.	Seward	Herring: Eggs, Eggs on Kelp
Southeast Fisheries, Inc.	Ketchikan	Herring: Frozen Halibut: Frozen Sablefish: Frozen, Smoked Cod: Frozen Red Snapper: Frozen Salmon, Shellfish
Thompson Fish Co.	Hoonah	Halibut: Fresh, Frozen Salmon
Whitney-Fidalgo Seafoods, Inc.	Anchorage	Herring: Eggs Salmon
	Valdez	Herring: Eggs, Eggs on Kelp
	Port Graham	Herring: Fresh, Eggs Salmon
	Seward	Herring: Eggs
Zachar Bay Fisheries, Inc.	Zachar Bay	Herring: Salted, Eggs, Meal

a/ See Tables VI-1 through VI-12 for data on salmon processing operations.
b/ See Tables VI-13 through VI-24 for data on shellfish processing operations.

TABLE VI-26

MAJOR ALASKA SEAFOOD PROCESSORS

Company	Location	Seafood Processed
	Southeast Alaska	
Juneau Cold Storage	Juneau	Salmon, Crab, Shrimp
Nefco-Fidalgo	Ketchikan	Salmon
New England Fish Co.	Chatham	Salmon
Petersburg Cold Storage Co.	Petersburg	Salmon, Misc. Fish
Petersburg Fisheries	Petersburg	Salmon
E. C. Phillips & Sons, Inc.	Ketchikan	Salmon, Misc. Fish
Wards Cove Packing Co.	Ketchikan	Salmon
Whitney-Fidalgo Seafoods, Inc.	Petersburg	Salmon
	Prince William Sound	
Blake Packing	Cordova	Salmon
New England Fish Co.	Orca	Salmon
North Pacific Processors (Pt. Chehalis Packers, Inc.)	Cordova	Salmon, Crab, Misc. Fish
St. Elias Ocean Products, Inc.	Cordova	Salmon, Crab, Clams
	Kenai Peninsula	
Kenai Packers	Kenai	Salmon
Seward Fisheries	Seward	Salmon, Misc. Fish
	Kodiak Island	
Columbia Wards Fisheries	Alitak	Salmon
New England Fish Co.	Uganik	Salmon
Wakefield Seafoods, Inc.	Port Lyons	Crab
	Alaska Peninsula	
Alaska Packers Assn., Inc.	Chignik	Salmon
Peter Pan Seafoods	King Cove	Salmon, Crab
Peter Pan Seafoods	Squaw Harbor	Shrimp
Wakefield Fisheries	Sand Point	Crab, Misc. Fish
	Bristol Bay	
Bumble Bee Seafoods	South Naknek	Salmon
Columbia Wards Fisheries	Ekuk	Salmon
Nelbro Packing Co.	Naknek	Salmon
	Aleutian Islands	
New England Fish Co. (M/V Theresa Lee)	Akutan	Crab
Pan Alaska Fisheries, Inc.	Unalaska	Salmon, Crab
Peter Pan Seafoods	False Pass	Salmon
Point Adams Packing Co. (M/V Northgate)	Dutch Harbor	Crab
Vita Food Products, Inc. (M/V Viceroy)	Dutch Harbor	Crab
Wakefield Seafoods, Inc. (M/V Akutan)	Akutan	Crab

TABLE VI-27

OPERATING SALMON CANNERIES, 1973[10/]

Company	Location
Yukon River	
Mt. Village Fish Co.	Mt. Village
Bearing Sea Fisheries	Floater
Bristol Bay	
Bumble Bee Seafoods	Naknek
Columbia Wards Fisheries	Ekuk
Kayak Packing Co.	Big Creek (floater)
Nelbro Packing Co.	Naknek
Peter Pan Seafoods	Dillingham
Queen Fisheries	Nushigak
Togiak Fisheries	Togiak
Alaska Chain	
Alaska Packers Association	Chignik
Peter Pan Seafoods	False Pass
Peter Pan Seafoods	King Cove
Kodiak Island	
Columbia Wards Fisheries	Alitak
Columbia Wards Fisheries	Icy Cape
King Crab, Inc.	Kodiak
New England Fish Co.	Uganik
Whitney-Fidalgo Seafoods	Kodiak

TABLE VI-27 (Cont.)

OPERATING SALMON CANNERIES, 1973[10/]

Company	Location
Cook Inlet Area	
Columbia Wards Fisheries	Kenai
Kenai Packers	Kenai
Tidewater Packing Co.	Anchorage
Whitney-Fidalgo Seafoods	Anchorage
Whitney-Fidalgo Seafoods	Port Graham
Prince William Sound	
New England Fish Co.	Orca
North Pacific Processors	Cordova
St. Elias Ocean Products	Cordova
Seward Fisheries	Seward
Southeastern	
Annette Island Packing Co.	Metlakatla
Excursion Inlet Packing Co.	Excursion Inlet
Harbor Seafoods	Wrangell
Juneau Cold Storage	Juneau
Keku Canning Co.	Kake
Klawock Oceanside Packing Co.	Klawock
New England Fish Co.	Chatham
Nefco-Fidalgo Seafoods	Ketchikan
Petersburg Fisheries	Petersburg
Petersburg Processors	Petersburg
Whitney-Fidalgo Seafoods	Petersburg
Wards Cove Packing Co.	Ketchikan

VII. SUMMARY OF PREVIOUS STUDIES

A. GENERAL

Until recently little effort had been expended in defining waste disposal practices and associated water quality problems for the Alaska seafood industry. Establishment of water quality standards and waste treatment requirements provided the catalyst to generate a number of studies during the past three years. Several of these studies were conducted by EPA or with EPA funding, and were designed to identify water quality problems and possible solutions. The National Canners Association also funded various studies to evaluate the effects of cannery waste discharges on receiving water quality and to develop alternative means of waste treatment and disposal. Various research efforts underway or completed at other locations deal with treatment of seafood wastes and recovery of by-products and have some application to the Alaska seafood industry.[6/] Pertinent studies are summarized in the following section.

B. EPA RECONNAISSANCE SURVEY OF SELECTED SEAFOOD PROCESSORS, 1971

At the request of the State of Alaska, EPA Region X and Anchorage Operations Office personnel conducted a reconnaissance survey of selected seafood processing plants during the summer of 1971. A total of 29 plants were visited and information on existing waste disposal practices and any attendant environmental problems was obtained. The investigation consisted primarily of interviews with plant personnel to obtain production, water use, waste quantity, and waste disposal data and visual observations of waste disposal practices and receiving water conditions.

Results of this survey have not been published. Data summaries on each plant visited and a working paper summarizing the results of the survey have been prepared by Mr. Craig Vogt (a survey participant), Surveillance and Analysis Division, Region X.[11,1] Plant operating data and waste disposal information abstracted from these documents are included in the data summaries contained in Chapter VI. Primary findings of the survey are discussed below.

Three basic methods of waste disposal were observed during the survey:

1. Discharging wastes whole either through holes in the plant floor or by fluming to the dock face.

2. Grinding wastes and discharging at the dock face or at depth through an outfall.

3. Barging whole wastes to deeper water for dumping.

A majority of the plants visited grind their wastes.

The principal environmental problems observed were the accumulation of seafood wastes on the bottoms of receiving waters with associated sludge beds and various esthetic problems such as bloody water, accumulation of waste solids on beaches, and foam and floating seafood wastes on the water surface. Esthetic problems existed at most locations. Observed environmental problems are summarized in

Table VII-1 along with the types of seafood being processed at each plant and waste disposal practices.

The most significant water quality problems were observed at Cordova, Dutch Harbor, Orca and Naknek River. With the exception of Orca, several processors are located at each of these locations.

C. EPA KODIAK STUDIES, 1971

An investigation of waste sources and receiving water conditions in the Kodiak Harbor vicinity was conducted by the Anchorage Operations Office during May and August, 1971.[13/] Fifteen plants processing salmon, crab and shrimp are located in close proximity in this area. These plants processed more than 100 million pounds of fishery products in 1970 and discharged more than 72 million pounds of waste solids.

Shrimp wastes are discharged unground. Salmon and crab wastes are usually ground although whole waste solids are frequently observed. Some plants discharge on the surface while others have outfalls at depth.

Both inplant studies and receiving water investigations were conducted. Plant operational information and production were obtained. Waste samples were taken from the seven plants in operation in May and analyses performed to determine selected physical, chemical and bacteriological characteristics. Both water and benthic sampling were conducted for the receiving water studies. Water quality observations included dissolved oxygen, temperature, salinity, transmissivity, total organic carbon, total volatile solids, suspended solids, and volatile suspended solids. Bottom samples were analyzed for general characteristics,

TABLE VII-1

SUMMARY OF ENVIRONMENTAL PROBLEMS AT SELECTED ALASKA SEAFOOD PROCESSING PLANTS[a]

Company and Location	Seafood Processed	Waste Disposal Practices	Environmental Problems
		SOUTHEAST ALASKA	
Alaska Glacier Seafood Co. Petersburg	Shrimp, Crab	Grind all solids and discharge at dock face below tide. Domestic wastes discharged untreated.	No sludge buildup observed. Wastes not being discharged at time of visit.
Petersburg Cold Storage Petersburg	Salmon, Misc. Fish	Heads recovered for by-product. Solids discharged through floor or at dock face.	
Petersburg Fisheries, Inc. Petersburg	Salmon	Some heads recovered for by-product. Other heads ground. Waste solids flumed to dock face. Domestic waste to city sewers which discharge untreated.	Some solids accumulation.[b] Esthetic problems: floating solids and foam.
Whitney-Fidalgo Seafoods Petersburg	Salmon, Crab, Shrimp, Misc. Fish	About 15 percent of salmon heads ground for pet food. Rest ground and discharged off dock. Other salmon wastes discharged unground through holes in floor. Crab wastes discharged unground off dock. Domestic wastes untreated. Central fluming system, grinder and outfall to be installed in 1971.	Some solids accumulation.[b]
New England Fish Co. Chatham	Salmon	All wastes ground and pumped through 450 ft outfall to discharge point 100 ft deep. Part of domestic wastes treated in package plant. Rest untreated.	Beaches clean. No floating solids observed.
Peter Pan Seafoods Excursion Inlet	Salmon	About 35 percent of fish heads recovered for by-product. Remainder of heads and other solids discharged unground through outfall 80 ft offshore and 10 ft deep in 50 ft deep water. Central domestic sewer system discharges untreated wastes 1500 ft from cannery.	Beaches clean. Esthetic problems: foam and floating solids.
Peter Pan Seafoods Hawk Inlet	Salmon	All wastes flumed to a gurry scow with 2 1/2 in. mesh bottom. Domestic wastes from cannery to package plant. Village wastes untreated.	Beaches clean. Bloody water at scow loading point.
		PRINCE WILLIAM SOUND	
Orca Pacific Packing Co. Orca	Salmon	Fish house wastes ground and discharged on the surface 600 ft offshore in 20 ft of water at low tide. Domestic wastes untreated.	Fish wastes floating on the water over a large area. Fish wastes observed on beaches 1/2 mile from cannery. Some sludge deposits at discharge points.
Point Chehalis Packers, Inc. Cordova	Salmon, Crab	About 95 percent of fish heads recovered for by-product. All other salmon wastes are discharged unground below the dock above the water surface. Crab wastes are discharged unground near the salmon wastes. Domestic wastes untreated.	Floating solids, bloody water and foam were observed. Sludge deposits near the outfall. Crab shells pile up under dock for three to four months. Crab shells and fish fins accumulated on beaches.

TABLE VII-1 (Cont.)

SUMMARY OF ENVIRONMENTAL PROBLEMS AT SELECTED ALASKA SEAFOOD PROCESSING PLANTS[a/]

Company and Location	Seafood Processed	Waste Disposal Practices	Environmental Problems
St. Elias Ocean Products, Inc. Cordova (Floater)	Salmon, Crab	Fish heads ground and discharged above water directly under the boat. Other salmon wastes discharged overboard without grinding. Crab wastes discharged without grinding. Domestic wastes untreated.	Floating fish wastes observed. Accumulations of fresh fish wastes and sludge deposits noted on bottom. Small accumulations of crab shells and fish fins on beaches.
		KODIAK ISLAND	
Alaska Packers Association Larsen Bay	Salmon	Fish wastes from the indexer and iron chinks are dewatered and conveyed a barge underground for disposal four miles out in Uyak Bay. Sliming table and filler machine wastes drop through the floor. Septic tanks and outfalls handle domestic wastes.	Beaches were clean. Some fish wasted noted on bottom at cannery.
New England Fish Co. Uganik Bay	Salmon	Fish house wastes ground and pumped 300 ft offshore and about 15 ft off the bottom in 180 ft of water. Domestic waste untreated. Package plant scheduled for 1972.	No wastes observed floating or on beaches but plant not processing at time of visit.
Alaska Packers Association Chignik	Salmon	Fish house solids flumed to gurry scow with 2 1/2 in. mesh bottom and dumped 1/2 mile offshore. Some septic tanks but most domestic wastes untreated.	Bloody water at scow. Beaches were clean but a few fish heads observed floating near cannery.
Peter Pan Seafoods False Pass	Salmon	Heads, tails, and belly fins rendered for oil. Cooker waste discharged below dock. Other wastes discharged unground above water at dock face. Domestic wastes handled by septic tanks or gas toilets.	Floating solids observed.
Peter Pan Seafoods King Cove	Salmon, Crab	Salmon heads rendered for oil. Cooker wastes and other wastes flumed to wood barge with large cracks between boards. Barge is dumped in the middle of the cove. Part of domestic wastes connected to municipal plant. Crab wastes are ground and dumped at dock face in 35 ft of water.	Beaches clean. Some fish wastes on bottom below barge.
Peter Pan Seafoods Squaw Harbor	Shrimp	All wastes flumed to discharge point at dock face. Installation of pump and 100 ft outfall at depth scheduled for mid-1971. Some septic tanks. Most domestic waste untreated.	Beaches clean. Floating solids near discharge point.
Wakefield Fisheries Sand Point	Crab	All wastes ground to minus 1/4 inch and discharged at dock face in 30 ft of water. Part of domestic wastes treated in package plant or septic tanks.	Beaches clean. Foaming and floating solids observed off dock.

TABLE VII-1 (Cont.)

SUMMARY OF ENVIRONMENTAL PROBLEMS AT SELECTED ALASKA SEAFOOD PROCESSING PLANTS[a/]

Company and Location	Seafood Processed	Waste Disposal Practices	Environmental Problems
		BRISTOL BAY	
Alaska Packers Association South Naknek	Salmon	Waste solids ground and discharged under dock. Domestic wastes to septic tanks and drain fields.	No sludge buildup on solids accumulation apparent.
Bumble Bee Seafoods South Naknek	Salmon	Fish heads rendered for oil. All other wastes drop through holes in floor unground. Domestic wastes untreated. Package plant scheduled for 1972.	No sludge buildup or solids accumulation observed under dock. Floating solids observed.
Columbia Wards Fisheries (Red Salmon Cannery) Naknek	Salmon	Fish heads are ground and discharged below the dock. Other wastes discharged through floor unground.	No sludge buildup but waste solids accumulated under the dock between high tides. Some floating solids observed.
Nelbro Packing Co. Naknek	Salmon	Fish heads are rendered for oil. Cooker wastes discharged below dock. All other wastes ground and discharged through a 150 ft outfall on the bottom above low tide.	Some heads and tails were observed on the beaches at low tide along with some fish skeletons.
Whitney-Fidalgo Seafoods Naknek	Salmon	Grind all wastes most of the time and discharge at the dock face. A 150 ft outfall was installed but has broken apart.	No apparent sludge bed but a large area under cannery covered with fish wastes at low tide. Bones and fins noted on beaches.
Columbia Wards Fisheries Ekuk	Salmon	Most fish heads rendered for oil with cooker waste discharged directly to bay. All other wastes flumed to grinder and discharged under dock. Domestic wastes to septic tanks.	No accumulated sludge around cannery. Some fish wastes on beach.
Peter Pan Seafoods Dillingham	Salmon	Fish heads ground and part rendered for oil. All waste solids go to a disintegrator and are pumped 200 ft offshore on the bottom above low tide.	No waste accumulations on beaches noted.
		ALEUTIAN ISLANDS	
American Freezerships, Inc. (M/V Theresa Lee) Akutan	Crab	All wastes ground and discharged 60 ft deep.	No processing during plant visit.
Wakefield Fisheries (M/V Akutan) Akutan	Crab	All wastes ground and discharged 42 ft deep. Wastes discharged overboard at time of visit. Domestic wastes untreated.	Foam and floating wastes observed.

TABLE VII-1 (Cont.)

SUMMARY OF ENVIRONMENTAL PROBLEMS AT SELECTED ALASKA SEAFOOD PROCESSING PLANTS[a/]

Company and Location	Seafood Processed	Waste Disposal Practices	Environmental Problems
Point Adams Packing Co. (M/V Northgate) Dutch Harbor	Crab	All wastes ground and discharged over the side above water. Domestic wastes untreated.	Floating wastes observed.
Vita Food Products, Inc. (M/V Viceroy) Dutch Harbor	Crab	All wastes ground to about one inch maximum and discharged overboard above water.	Grinder passing large shell chunks. Crab shell accumulated above water. Foam observed.
Pan Alaska Fisheries Unalaska	Salmon, Crab	Salmon hand cleaned. Heads recovered for bait. Other salmon wastes ground and discharged at dock face over 42 ft of water. Crab wastes ground and discharged to same outfall.	Solids accumulations were noted on the bottom. Floating solids and foam were observed in the vicinity of the outfall

a/ See Appendix F for maps of plant locations and receiving water characteristics.
b/ Observations from 1971 study by Fisheries Research Institute.[14/]

macroscopic biological organisms, total solids, total volatile solids, organic carbon, and organic nitrogen.

Waste load data was compiled based on production figures and waste characteristics obtained by this survey and a 1968 waste characterization study. The 72 million lb of waste solids discharged in 1970 contained an estimated 22 million lb of chemical oxygen demand and 23 million lb of total solids. About 85 percent of this waste was from shrimp operations.

Dissolved oxygen levels as low as 1.3 mg/l were observed in the vicinity of operating plants. The lowest DO levels occurred in surface waters. Significant decreases in transmissivity and increases in suspended solids concentrations were observed in the vicinity of waste discharges. The most serious problems centered on extensive sludge deposits. At least 51 acres of the harbor bottom were severly polluted. Floating sludge mats and gas bubbles were observed over much of the area. Bottom deposits were black and foul-smelling. No normal marine life existed in the area.

D. NCA NAKNEK RIVER (BRISTOL BAY) STUDY, 1970

The Fisheries Research Institute of the University of Washington conducted a study of the Naknek River Estuary in the vicinity of operating salmon canneries during the 1970 season.[15] The study was financed by the National Canners Association.

There are ten salmon canneries located on the lower four miles of the Naknek River Estuary at Naknek on Kvichak Bay, the northeast extremity of Bristol Bay. Six of the canneries operated in 1970. The major portion of the Bristol Bay sockeye salmon catch is processed at this location. The 1970 catch of 18 million fish in the Naknek area was the third largest of record, exceeded only by the 1922 catch (22 million fish) and the 1965 catch (19 million fish). The average area catch is about 5 million fish. In contrast, the predicted 1973 commercial harvest from the entire Bristol Bay is only 1.5 million fish. The 1970 study was thus very valuable in assessing environmental effects during a peak season with waste loads at least one order of magnitude greater than the present season. Two waste disposal methods were in use by the canneries. Several canneries discharged all wastes, without grinding, directly under the cannery docks. The other canneries ground the solids before discharge, again under the docks except for one plant with an outfall some distance off the dock but above low tide.

Water quality measurements included dissolved oxygen, temperature, salinity, Secchi disc, turbidity, and settleable solids (Imhoff cone). A few zooplankton samples were taken. Core samples of the top layers of bottom sediments were analyzed for solids, fixed solids, and total organic nitrogen. Benthic communities were sampled in the intertidal zone. Observations were begun before the canning season and continued until well past peak canning activity covering a total study period of about six weeks.

Dissolved oxygen observations at each station were made at several tidal stages and several depths at weekly intervals. Dissolved oxygen levels showed little variation as a result of the waste discharges. Only two samples taken on the surface at low tide during the peak canning period showed low readings (6.7 and 7.3 mg/l). It should be noted that these samples were taken in the river away from the dock while the waste discharge was under the dock.

Turbidity was highly variable and was affected by tides, wind direction, and wind velocity. The high variability and high background turbidity prevented any evaluation of waste discharge effects.

Organic material in the core samples was low and did not increase as the season progressed. One set of core samples was taken under the dock of an operating cannery.

Natural conditions result in a sparse invertebrate fauna in the intertidal zone. The resident fish population is also low owing to the large freshwater discharges from oligotrophic lakes.

Wastes from the canneries were observed to accumulate in large piles on the bottom under the docks at low tide during the peak canning period. Most of these wastes were flushed away on the next high tide. Some wastes remained under docks during a two-week period when waste discharges were the largest. Very little waste material accumulated under the dock of the cannery with the grinder and outfall.

E. NCA KODIAK ISLAND CANNERY STUDIES, 1970

The Fisheries Research Institute also conducted studies of the receiving waters at three salmon canneries at remote locations on Kodiak Island during the 1970 season.[16/] The studies were financed by the National Canners Association.

The 1970 run of pink salmon, the principal species processed, was large (15.2 million fish) relative to average catches (1952 to 1969 average, 6.9 million fish). Thus, the studies were conducted while the canneries were discharging large waste loads.

Alitak Cannery

Alitak Cannery, operated by the Columbia Wards Fisheries, is located on Lazy Bay, an arm of Alitak Bay, on the south end of Kodiak Island. Lazy Bay is a small partially enclosed bay of moderate to strong tidal currents.

Solid wastes at the cannery are passed through a grinder (one in. maximum size pieces) and discharged 100 ft off the dock 35 ft deep. The wastes are dewatered before grinding and liquid wastes containing small solids enter the water under the cannery.

Biological observations were made on benthic and intertidal fauna, fish indigenous to the area and their food habits, and scavenging of salmon waste tissue by benthic animals. Physical and chemical observations were limited to dissolved oxygen, salinity and current pattern. The study was begun before the start of canning operations and extended until the canning load dropped off.

Benthic and intertidal fauna were found not to vary significantly between stations near the cannery and control locations. No significant changes occurred after canning began. During the canning period, about 70 percent of the fish caught in the cannery vicinity were feeding on salmon waste.

Low DO values (3.2 - 7.3 mg/l) were observed in the vicinity of the waste discharge during flood tides. This low DO was confined to a thin surface lens of less than 75 yd radius. Recovery to normal DO values occurred rapidly with a change in tides.

Some "slime" and "gurry" were observed floating near the cannery dock indicating a possible esthetics problem. No examination for possible sludge deposits was made. A depressed DO level (5.6 mg/l) in one bottom sample at the waste discharge location indicated a possible waste accumulation although normal DO levels were observed on three other days.

Larsen Bay Cannery

The Larsen Bay Cannery, operated by Alaska Packers Assoc., Inc., is located on a spit separating the small Larsen Bay from Uyak Bay on the west side of Kodiak Island, The waters at the cannery are relatively shallow but tidal currents range from medium to strong.

Unground wastes from the fish house are flumed to a gurry barge. Drainage from the barge and wastes from the cannery enter Larsen Bay directly. The gurry scow is dumped over a large area of Uyak Bay.

Results of the study were similar to those for Alitak. During normal wind conditions, the minimum DO observed was 6.4 mg/l on the surface near the gurry barge. A lower reading of 3.6 mg/l was observed in a surface sample near shore on a day when high winds had piled surface waters containing organic wastes against the shore. Small DO depressions (less than one mg/l) were observed near the bottom at the gurry barge on two occasions.

Biological results were similar to the Alitak study.

Port Bailey Cannery

This cannery is located on an open bay with deep water and moderate to strong currents at the north end of Kodiak Island. Solid wastes are flumed from the cannery to a wire basket for dewatering before grinding. Ground solids are discharged through an outfall 240 ft offshore in 65 ft of water. Liquid wastes enter the bay at the grinder basket.

Benthic and intertidal fauna observations were inconclusive as to effects of the cannery discharge. About 79 percent of fish caught were feeding on salmon waste. Various sea birds, primarily gulls and terns, were observed feeding on floating solids.

Low DO values (1.5 - 3.8 mg/l) were observed near the surface on incoming tides in the vicinity of the grinder. Some small DO depressions near the bottom in the vicinity of the waste discharge at the grinder were also observed.

F. NCA PETERSBURG STUDY, 1971

The Fisheries Research Institute conducted an extensive and comprehensive survey at Petersburg during the 1971 salmon canning season.14/ This survey expanded upon the approach used at Naknek and Kodiak Island in 1970. The study was again financed by the National Canners Association.

Five seafood processors are located in close proximity on the Petersburg waterfront [Figure VII-1]. During the survey, three salmon processors and a hand-picked shrimp processor were operating while one plant was idle. During the eight-week survey, two plants processed more than 1.1 million lb of salmon, and about 140,000 lb of shrimp were processed. Salmon processed at the third plant were not tabulated.

Wrangell Narrows is a long (25 miles), narrow (1/4 to 1/2 mile), and deep (30 to 50 ft) channel. Strong tidal currents (3 to 5 knots) and high tidal fluctuations (up to 20 ft) result in excellent flushing action at Petersburg.

Petersburg Fisheries, Inc. is primarily a salmon cannery but also packs crab after the salmon season. In certain seasons, salmon heads are ground for mink or pet food and tails are saved for halibut bait. Eggs are utilized. Unutilized heads are ground and discharged with other wastes through a flume to the dock face.

Petersburg Cold Storage processes salmon, halibut, and miscellaneous fish for the fresh frozen market. Heads and tails are saved for

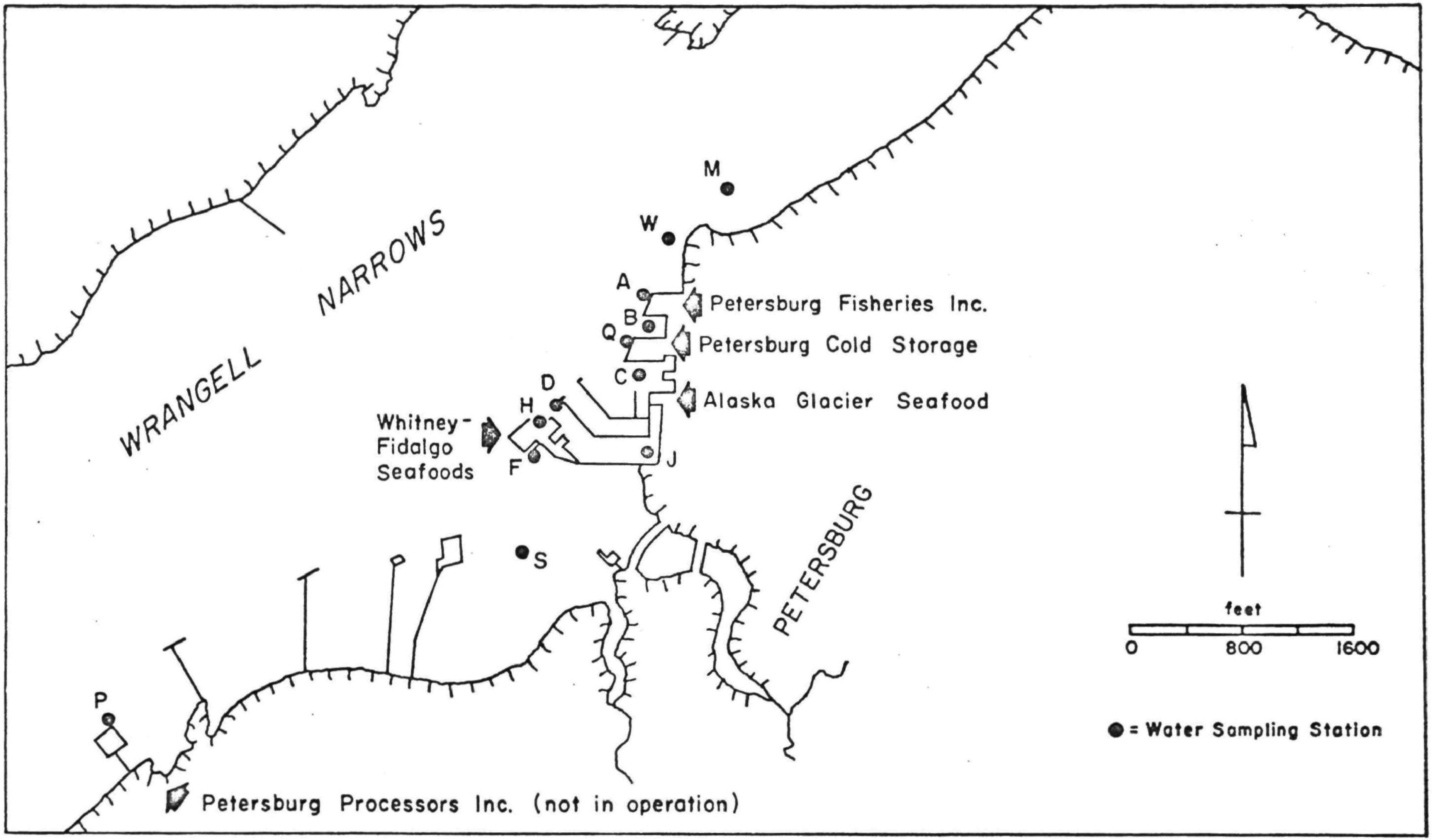

Figure VII-1. Locations of Petersburg Seafood Processing Plants[14] halibut bait. Unutilized heads and tails along with viscera and other wastes are discharged directly to the Narrows through holes in the floor. Halibut wastes are similarly disposed of.

Whitney-Fidalgo Seafoods processes both halibut and salmon. Tails, fins, and viscera are discharged directly to the Narrows through floor drains, During some seasons heads are saved, but during the survey they were mainly discharged as either ground or whole wastes.

Alaskan Glacier Seafood is a hand-picked shrimp and crab processor. Solid wastes are primarily heads and shells. All wastes are discharged through one pipe at the dock face.

Municipal wastes from a population of about 2,200 were discharged untreated through three outfalls in the vicinity of the seafood plants.

Water quality observations included dissolved oxygen, temperature, salinity, turbidity and pH. Some BOD measurements in the waste dispersal area were also made. Macrofauna were sampled along beach transects near the canneries. Dye studies were made to trace waste dispersal patterns. The fate of salmon wastes was evaluated. Intertidal fauna and phytoplankton were also sampled.

Dissolved oxygen values were observed to decrease from about 13 mg/l before the salmon season to about 7.5 mg/l during the peak of the canning season. This decline occurred at both stations near waste discharges and at control stations, and was attributed to natural factors including a decrease in light intensity due to rainy weather and a decrease in phytoplankton abundance. Some small DO depressions occurred on the surface and near the bottom in the vicinity of waste discharges. At no time did DO levels fall below 6 mg/l nor did DO depressions near waste discharges exceed 1.5 mg/l in comparison to control stations.

Turbidity readings were usually very low (less than 10 J.T.U.) except during rainy weather and the surface waters near waste discharges. A high turbidity of 58 J.T.U. was obtained near the Petersburg Fisheries, Inc. outfall (violation of water quality standards). Secchi disk readings were low (0 - 1/2 m) in the vicinity of waste discharges but high elsewhere.

Large waste materials such as salmon heads were found to be consumed primarily by bacterial decomposition in the vicinity of waste discharges where scavengers fed primarily on the smaller waste fragments.

Scavengers were numerous in the area and were determined to be feeding on salmon wastes either by direct observation or by examination of stomach contents.

Benthic sampling found small areas near waste discharges where waste solids were always present and larger areas where wastes were occasionally found [Figure VII-2]. These waste accumulations were primarily heavier solids such as heads and fins.

Diversity of benthic animals tended to be lower in the immediate area of waste accumulations and higher adjacent to the accumulations. Variations in substrate between the various sampling locations had a major effect on organism density and masked any effects of proximity to waste discharges.

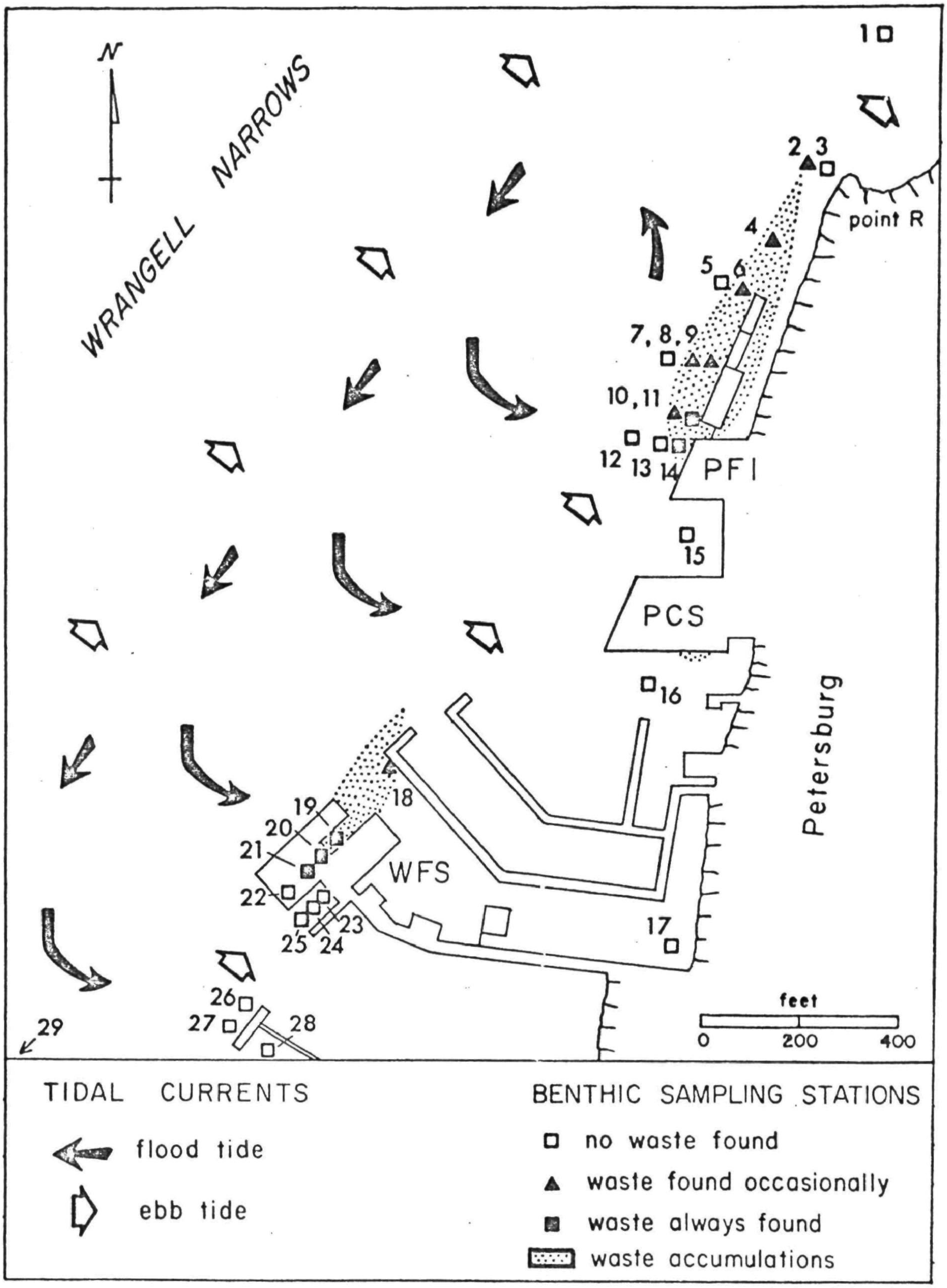

Figure VII-2. Observed Waste Accumulations.[14/]

Measurements of chlorophyll a showed a decline in phytoplankton as light intensity decreased during the study.

Outside of the cannery area, no esthetic effects were noticeable. Around the docks, foam and the waste plumes were visible but were quickly dispersed in the current. All signs of seafood processing disappeared within a few hours after activity ceased for the day.

Biochemical oxygen demand was observed by sampling while floating in a dispersing waste flume. The BOD was found to decrease to background levels in a distance of about 1000 ft (10 minutes flow time). The BOD also decreased rapidly with depth indicating the liquid wastes were primarily contained in the surface waters.

G. NCA SALMON CANNERY WASTE SURVEY, 1970

The National Canners Association conducted a survey of four salmon canneries in Alaska during the 1970 salmon season.[17/] Cannery locations were Bristol Bay, Kodiak Island, and Southeast Alaska (2). Specific caneries were not identified. The purpose of the survey was to characterize salmon cannery waste as to strength and volume and to relate waste loads to production.

A total of 11 waste characteristics were measured on a number of grab and composite samples taken at various points in each cannery. The sampling was designed to characterize each of the principal types of waste streams near their source. The sampling points varied between canneries because of different waste handling systems at each location.

Cannery "A" on Bristol Bay rendered heads for oil. Fish house wastes were ground. All wastes were flumed to a central offshore discharge. Production was 750 cases per hour from 58,000 lb of red salmon. Cannery "B" on Kodiak Island did not utilize any waste materials for by-products. Fish house wastes were flumed to a grinder. Cannery wastes, at the filler machines, were discharged through the floor. Production was 436 cases per hour from 31,000 lb of pink salmon. Cannery "C" in Southeast Alaska flumed fish house wastes to a net-bottomed gurry scow. Production was about 650 cases per hour from pink salmon. Cannery "D" in Southeast Alaska recovered heads, tails, eggs and milt for by-products. Fish house wastes were flumed to the dock face and discharged without grinding. Production was 300 cases per hour packing pink salmon.

Data on waste characteristics as determined by the survey are presented in Appendix D. Comparison of the data showed substantial differences between canneries. Part of these differences can be attributed to variations in waste handling procedures and water use. The degree of utilization of waste materials for by-products strongly influenced waste characteristics. A comparison of waste loads for Cannery "B" (no by-product recovery) and Cannery "D" (heads, tails, eggs and milt recovered) showed a waste load reduction (unit production basis) of 70 percent was achieved by recovery of waste materials for by-products. At Cannery "C", the net-bottom gurry scow retained about 70 to 80 percent of waste solids for dumping remote from the cannery.

H. NCA SEAFOOD CANNERY WASTE STUDY, 1971

In 1971 the firm of Cornell, Howland, Hayes and Merryfield, Inc. (CH_2M) conducted a reconnaissance study of waste treatment systems to serve seafood processing plants in Alaska, Washington, and Oregon.[3/] The study, the first phase of a five-year program progressing through pilot plants and full-scale demonstration projects, was funded by the National Canners Association.

The scope of the 1971 initial phase of the study included defining the location and magnitude of waste sources, summarizing available information on waste characteristics, investigating current waste treatment and disposal practices, suggesting potential systems for solids processing, waste treatment and by-product recovery, and preparing reconnaissance-grade capital and operating cost estimates for these potential systems.

The report primarily deals with alternative waste disposal and treatment systems and associated costs. Data on waste sources and waste characteristics is limited. A total of 73 seafood canneries in Alaska are identified. Data on the average, maximum and minimum cannery pack at each location for the 1966 to 1970 period is presented.

Treatment alternatives evaluated for liquid wastes include grinding, screening, clarification, flotation. anaerobic filters, spray irrigation, spray drying, evaporation, chemical treatment, activated sludge, activated biofilter, and deep-well injection. Solid waste disposal alternatives, included sanitary landfill, ocean disposal and by-product manufacture. Joint municipal-industrial treatment was recommended where possible. Grinding, chemical treatment and deep-well injection were not recommended. Evaporation and spray irrigation were considered infeasible while spray drying was too expensive. By-product manufacture was considered presently unacceptable. All other methods were considered acceptable for further study.

Reconnaissance-grade cost estimates were prepared for various possible combinations of acceptable treatment methods. The minimum cost system provided screening only with ocean disposal of solid wastes. No net waste load reduction would be achieved as all waste materials are discharged to the receiving water with the bulk of the waste load discharged to the ocean. The highest cost system combined screening, air flotation and biological secondary treatment with sanitary landfill disposal of solid wastes. Such a system would achieve about a 90 percent reduction in the waste load discharged.

The cost estimates were prepared for cannery sizes of 20,000, 70,000, 125,000 and 200,000 cases per year production. Estimated capital and operating costs were $92,500 and $32,300 per year, respectively, for the minimum system and smallest cannery. Comparable costs for the maximum system for this cannery were $216,000 and $15,300 per year. For the largest cannery, the estimated capital and operating costs for the minimum system were $132,000 and $40,800 per year respectively. Comparable costs for the maximum system increased to $611,000 and $67,150 per year. These costs are in 1971 dollars for western Washington locations. For Alaska locations these costs were estimated to increase by a factor ranging from 1.5 to 3.2 depending upon the remoteness of the location.

Costs would be about doubled at Bristol Bay. A typical cannery in this area would be in the range of a 70,000 cases per year plant. Screening plus ocean disposal of solids for such a cannery would have estimated capital and operating costs of $200,000 and $85,000 per year respectively (1971 dollars). A system providing screening, clarification, biological secondary treatment and sanitary landfill disposal of solid wastes would have estimated capital and operating costs of $600,000 and $55,000 per year, respectively (1971 dollars).

I. KODIAK BY-PRODUCT RECOVERY PLANT STUDY, 1971

An engineering study of a potential by-product recovery plant at Kodiak Harbor was completed in 1971 by CRESA, a joint venture of Food, Chemical and Research Laboratories, Inc. and Engineering-Science of Alaska. The study was funded by an EPA grant to the city of Kodiak.

As described previously in the summary of the 1971 EPA Kodiak study, water quality problems are severe in the Kodiak Harbor area owing to the discharge of large volumes of crab and shrimp processing wastes from 15 plants. This concentration of processing plants makes Kodiak potentially the most feasible location in Alaska for a shellfish waste by-product plant. This study was undertaken to assess the engineering and economic feasibility of such a plant.

An engineering survey was conducted at Kodiak to determine the character, extent, and distribution of pollution loads, and to obtain all basic data needed for preliminary design of a waste collection and recovery facility. Operating practices and facilities at individual processing plants were reviewed to determine possibilities for in-house improvements. Pilot plant and chemical studies were conducted at Seattle to obtain design parameters for the recovery facility and to characterize wastes and possible products. A pre-construction report was prepared summarizing the results of the study including a preliminary design of the by-products plant, waste characteristics, waste handling procedures, potential by-products, and estimated plant costs and revenues.[9/]

Waste characteristics were obtained for four types of processing: shrimp raw peeling, shrimp peeling after steaming, whole cooked crab, and crab live butchered [Appendix D, tables D-6 through D-9]. Pilot plant studies indicated that alkali extraction of shellfish wastes would yield a high quality protein and a chitin - $CaCO_3$ residue as products. The protein would be marketable as a pet food additive for industrial application. The chitin - $CaCO_3$ residue could be exported for conversation to chitin and derived products or could be used in Alaska as a soil liming and fertilizer material. Alkali extraction of of fish wastes would yield a concentrated protein product similar to fish solubles, oil, and bone meal.

A preliminary plan was developed for a by-products plant to be located on Near Island a short distance from most plants. Dewatered wastes would be collected at each processing plant on barges and transported to the by-products plant. This system would reduce the COD load to the harbor area by about 70 percent. All solid waste discharges to the harbor area would be abated. The study did not evaluate systems or costs for treatment and disposal of liquid waste factions.

Economic studies showed estimated revenues from sale of by-products as $1,223,000 (1971 dollars) and from disposal fees of $225,000. The estimated plant cost was $1,592,000. Estimated direct operating costs were $692,000 per year and indirect operating costs were $531,000 per year. With an annual profit of $219,700 before taxes, the plant was considered economically feasible. This profit would be derived entirely from the waste disposal fees.

J. EPA WASTE TREATMENT STUDY, 1971

A limited laboratory investigation of the effects of screening on shrimp and crab wastes was conducted in 1971 by the EPA Alaska Operations Office.[17/] The wastes evaluated were shrimp peeler effluents from both raw and pre-cook type peelers from two different plants and a ground, tanner crab butchering-room waste. The plants providing the waste samples were located in Kodiak.

The wastes were batch screened through four graduated size soil screens. Mesh sizes were U.S. Standard Series numbers 4, 10, 40, and 80. Some problems with blinding occurred with the No. 80 screen. Average results of four runs of shrimp waste using the No. 40 screen showed 39 percent removal of total solids, 41 percent removal of suspended solids, and 34 percent removal of COD. Removal efficiencies were slightly higher for the single run on crab wastes with 35 percent removal of total solids, 53 percent removal of suspended solids, 75 percent removal of settleable solids and 43 percent removal of COD. For these wastes, screening thus produced a lower removal efficiency than efficient primary clarification.

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APPENDIX A

TYPICAL WATER TEMPERATURE AND SALINITY DATA

SELECTED ALASKA LOCATIONS

Table 1. - Surface Water Temperatures and Densities

Means and Extremes

Years	January		February		March		April		May		June		July		August		September		October		November		December		Means		Maximum		Minimum	
	Temp °C	Dens. σ_{15}	Temp °C	Dens. σ_{15}	Temp °C	Dens. σ_{15}	Temp °C	Dens. σ_{15}	Temp °C	Dens. σ_{15}	Temp °C	Dens. σ_{15}	Temp °C	Dens. σ_{15}	Temp °C	Dens. σ_{15}	Temp °C	Dens. σ_{15}	Temp °C	Dens. σ_{15}	Temp °C	Dens. σ_{15}	Temp °C	Dens. σ_{15}	Temp °C	Dens. σ_{15}	Temp °C	Dens. σ_{15}	Temp °C	Dens. σ_{15}
ANACORTES, WASH -continued																														
Mean	6.9	22.0	6.8	21.8	7.2	22.0	8.1	22.2	9.5	22.3	10.9	22.1	11.9	21.6	11.9	22.1	11.6	22.0	10.6	22.4	9.0	22.4	7.9	22.3	9.4	22.1				
Maximum	8	23.2	8	22.4	8	23.0	10	23.2	12	24.0	15	23.3	16	23.3	14	23.9	15	22.9	14	23.2	10	23.0	9	23.2			16	24.0		
Mean Max.	7.5	22.6	7.4	22.1	7.9	22.6	9.1	22.8	10.9	23.2	13.5	23.0	14.8	23.1	13.8	23.2	14.3	22.8	12.8	23.0	9.8	22.8	8.8	22.6						
Mean Min.	5.5	21.4	5.8	21.1	6.4	21.6	7.2	21.6	8.4	20.8	9.7	20.6	10.3	19.8	10.7	20.4	10.3	19.6	9.2	21.8	7.8	21.8	5.8	21.8						
Minimum	5	20.9	4	20.0	6	21.0	6	20.2	8	19.7	9	20.4	10	19.0	10	19.4	10	19.2	9.	21.5	7	21.5	6	21.2					4	19.0
FRIDAY HARBOR, SAN JUAN ISLAND, WASH																														
1935-1939	7.4	22.3	6.9	22.5	7.1	22.6	7.8	22.6	8.9	22.4	9.8	22.3	10.7	21.8	10.9	22.1	10.3	22.3	9.6	22.8	8.7	22.8	8.2	22.5	8.9	22.4	14	23.6	6	17.6
1940-1944	8.2	22.3	8.1	22.2	8.3	22.4	9.1	22.5	10.0	22.3	10.8	22.3	11.5	22.3	11.4	22.5	11.0	22.6	10.2	22.6	9.6	22.6	8.7	22.5	9.7	22.4	15	24.7	7	18.9
1945-1949	7.3	22.3	6.9	22.4	7.2	22.5	8.1	22.5	9.3	22.4	10.4	21.9	11.1	22.1	11.1	22.4	10.6	22.6	9.7	22.7	8.8	22.7	8.0	22.6	9.0	22.4	16	23.9	6	14.1
1950-1952	6.8	22.6	6.4	22.5	6.7	22.5	7.5	22.6	8.4	22.7	9.3	22.5	10.3	22.1	10.8	22.4	10.6	22.6	9.5	23.0	8.7	22.9	8.1	22.6	8.6	22.6	13	23.7	5	19.4
Mean	7.4	22.4	7.1	22.4	7.3	22.5	8.1	22.5	9.2	22.4	10.2	22.2	10.9	22.0	11.1	22.3	10.6	22.5	9.8	22.8	8.9	22.7	8.3	22.5	9.1	22.4				
Maximum	9	23.2	8	23.2	9	23.2	10	23.2	13	23.3	13	23.6	16	24.7	15	23.7	13	23.5	11	23.7	11	23.5	9	23.4			16	24.7		
Mean Max.	7.8	22.7	7.4	22.7	7.7	22.7	8.6	22.8	10.0	23.0	11.3	22.9	13.1	23.1	12.9	23.0	11.7	23.1	10.4	23.2	9.4	23.1	8.6	22.9						
Mean Min.	6.9	21.9	6.7	22.1	7.0	22.2	7.6	22.2	8.6	21.4	9.6	20.2	10.1	19.7	10.2	20.2	10.1	21.4	9.3	22.0	8.5	22.3	7.7	22.0						
Minimum	5	19.3	5	21.2	6	21.5	7	21.6	8	18.9	9	16.4	9	14.1	9	18.5	9	19.4	9	20.0	8	21.8	7	19.8					5	14.1
BLAINE,* WASH.																														
1934-1935	4.8	--	6.4	--	6.6	--	8.7	--	12.1	--	14.9	--	16.2	--	16.2	--	13.8	--	10.7	--	9.1	--	6.9	--	10.5	--	18	--	0	--
KETCHIKAN, ALASKA																														
1922-1924	5.4	21.5	5.1	21.6	5.3	21.9	6.1	21.9	8.2	20.1	12.3	18.4	13.6	19.0	14.1	19.3	11.5	17.8	9.4	18.3	7.3	17.7	5.3	20.4	8.6	19.8	17	23.8	3	8.0
1925-1929	5.6	20.5	5.6	21.8	5.9	21.4	6.8	21.6	9.4	20.5	12.9	18.9	14.2	18.3	14.5	18.6	12.2	20.1	9.3	19.5	7.3	19.4	5.9	20.1	9.1	20.1	18	24.2	2	10.1
1930-1934	5.1	20.6	5.1	21.1	5.4	21.4	6.9	21.6	9.6	20.2	11.9	18.7	13.5	18.1	14.5	18.0	11.9	18.6	9.2	18.3	7.1	18.0	5.7	19.7	8.8	19.5	17	25.4	2	10.2
1935-1939	4.7	20.5	3.9	20.5	5.0	20.9	5.9	20.8	8.6	20.4	12.6	20.2	13.8	19.0	13.2	18.4	12.1	18.5	9.7	18.2	7.2	17.2	5.2	17.4	8.5	19.3	20	25.7	1	10.1
1940-1944	5.4	20.2	5.5	21.4	5.7	22.0	7.4	22.0	9.4	21.8	12.6	21.7	14.3	20.6	13.9	19.3	12.7	19.4	9.9	18.9	7.1	18.4	6.2	19.3	9.2	20.4	20	24.4	0	12.4
1945-1949	5.1	21.4	4.7	22.2	5.3	22.0	6.2	21.8	9.4	20.5	12.6	18.0	13.7	17.6	13.9	18.3	12.1	18.4	9.2	18.0	6.9	18.5	5.4	20.8	8.7	19.8	17	24.6	0	11.2
1950-1954	5.1	22.1	4.9	21.9	4.9	22.3	5.7	22.0	8.4	19.9	12.1	17.7	13.7	17.8	14.2	18.1	12.2	18.7	9.5	18.5	7.4	19.1	6.2	20.3	8.7	19.9	17	23.8	2	10.7
1955-1959	5.3	21.2	5.2	21.9	5.4	22.2	6.4	21.9	8.7	20.8	12.2	18.9	13.9	18.4	13.8	17.9	12.3	18.6	9.2	18.8	6.8	19.1	5.7	20.2	8.7	20.0	18	24.3	0	10.0
1960	5.3	21.7	5.8	21.7	5.6	21.6	6.4	19.9	9.6	20.3	11.1	20.0	13.5	17.0	14.2	17.8	12.2	18.4	9.8	17.7	7.4	17.6	6.6	20.1	9.0	19.5	16	23.4	4	14.8
1961	5.8	19.8	5.7	20.7	6.1	21.6	7.1	20.8	10.1	20.2	12.2	18.3	14.7	18.5	15.1	19.3	12.4	18.4	9.2	17.0	6.5	18.0	5.6	21.6	9.2	19.5	17	22.4	4	13.6
1962	4.9	20.1	4.8	21.1	5.3	22.6	6.2	22.1	8.2	21.5	11.2	19.3	13.9	17.9	13.8	18.0	11.8	19.2	9.7	19.2	8.1	18.6	6.7	18.2	8.7	19.8	16	23.4	3	14.4
1963	5.8	20.1	6.2	20.6	6.4	20.9	7.3	21.7	9.3	21.5	11.5	20.1	14.3	19.3	15.0	19.0	13.3	18.1	10.6	17.4	7.6	18.9	6.9	20.7	9.5	19.9	16	22.8	4	14.2
1964	5.7	19.6	6.1	20.4	5.9	21.0	6.8	21.2	8.4	21.2	13.1	17.5	13.4	16.2	13.3	17.0	12.2	18.5	9.9	18.4	7.3	18.6	5.7	21.1	9.0	19.2	14	22.5	4	14.6
Mean	5.2	20.9	5.1	21.5	5.4	21.7	6.5	21.6	9.1	20.6	12.3	19.1	13.8	18.5	14.1	18.4	12.2	18.8	9.4	18.5	7.2	18.5	5.8	19.8	8.8	19.8				
Maximum	8	24.4	9	24.4	8	25.0	11	26.7	15	24.0	20	24.4	20	24.2	18	22.8	19	22.8	15	22.9	16	22.6	10	23.3			20	26.7		
Mean Max.	6.3	21.8	6.1	22.6	6.3	22.8	8.1	22.9	11.6	22.4	14.6	21.0	15.8	20.3	15.9	20.3	14.1	20.8	11.1	20.7	8.7	20.5	7.2	21.9						
Mean Min.	3.7	17.8	3.6	18.7	4.2	19.1	5.4	19.3	6.9	17.8	10.2	16.5	11.9	16.5	12.4	16.4	10.4	16.2	7.8	15.0	5.4	15.3	4.1	16.9						
Minimum	1	10.7	0	10.1	0	10.7	3	11.0	4	11.1	7	10.7	8	11.4	[illegible]	11.3	8	9.7	4	10.1	2	8.0	1	10.1					0	8.0
SITKA, ALASKA																														
1924-1925	3.0	21.1	3.4	22.8	3.7	21.3	5.2	21.1	8.3	15.9	10.4	16.4	12.0	13.6	13.4	15.1	11.4	15.7	9.7	17.2	6.4	18.7	5.4	18.6	7.7	18.1	18	23.3	-1	8.2
1943-1944	6.0	21.8	5.6	22.1	5.4	22.0	6.7	21.6	9.4	19.4	11.7	17.4	13.4	17.8	14.2	17.8	12.4	17.4	9.8	19.1	7.3	20.8	6.1	20.4	9.0	19.8	17	24.0	4	10.2
1945-1949	4.5	21.8	4.5	22.9	4.7	22.0	6.0	22.0	9.3	19.5	11.2	18.4	13.2	18.3	13.7	19.1	11.9	18.3	9.2	19.9	6.9	20.9	5.2	22.4	8.4	20.5	17	23.9	1	10.5
1950-1954	4.6	23.2	3.8	22.8	3.9	23.0	5.2	22.4	7.9	20.1	11.2	18.3	13.5	18.6	14.2	18.9	12.1	19.2	9.4	20.6	7.3	21.4	5.9	22.0	8.2	20.9	18	24.2	2	10.7
1955-1959	4.8	22.5	4.3	22.5	4.4	22.4	6.1	21.8	8.6	19.8	11.4	18.7	13.7	18.6	14.1	18.5	12.2	17.9	8.9	20.5	6.9	20.6	5.7	21.8	8.4	20.6	17	23.8	2	11.1
1960	5.3	21.9	5.7	22.6	5.2	22.5	6.7	22.0	10.5	20.4	11.9	20.1	13.2	19.7	13.4	19.3	12.0	18.9	9.6	19.2	7.3	21.0	6.4	20.9	8.9	20.7	16	23.2	4	14.7
1961	5.5	21.1	5.5	22.1	5.9	22.2	6.9	20.6	10.4	21.4	11.8	20.2	14.4	19.0	14.9	18.1	12.7	18.3	9.1	19.2	6.9	21.3	5.2	21.9	9.1	20.4	18	25.3	4	11.5
1962	4.5	21.2	4.2	21.5	4.5	21.2	6.1	21.5	9.3	20.8	11.5	18.7	13.4	18.1	13.9	18.7	12.2	18.4	9.8	20.5	8.1	20.8	6.6	20.8	8.7	20.2	17	23.0	2	14.4
1963	5.1	19.6	6.0	21.4	5.9	21.2	7.1	21.8	10.7	20.8	11.7	19.7	14.5	19.1	15.4	20.0	13.8	20.1	10.7	19.4	7.9	21.7	6.1	21.2	9.6	20.5	18	23.3	3	15.1
1964	5.7	21.5	5.1	20.6	5.2	21.5	6.4	20.2	9.0	19.9	12.6	18.5	13.6	18.4	14.0	18.4	12.4	20.6	9.8	19.7	7.4	20.7	4.8	21.9	8.8	20.2	17	23.3	3	13.0

*Observations for the year are incomplete, extremes are for the months shown.

Table 1.–Surface Water Temperatures and Densities

Means and Extremes

Years	January Temp. °C	January Dens. σ_{15}	February Temp °C	February Dens. σ_{15}	March Temp °C	March Dens. σ_{15}	April Temp °C	April Dens. σ_{15}	May Temp °C	May Dens. σ_{15}	June Temp °C	June Dens. σ_{15}	July Temp °C	July Dens. σ_{15}
SITKA,														
Mean	4.8	22.1	4.4	22.5	4.6	22.2	6.0	21.8	8.9	19.8	11.4	18.5	13.5	18.3
Maximum	8	24.2	7	24.2	7	24.2	11	24.2	15	23.5	18	22.5	17	26.3
Mean Max.	5.9	23.3	5.2	23.4	5.4	23.3	7.9	23.0	12.7	22.4	13.4	21.3	15.6	21.4
Mean Min.	3.3	19.8	3.4	20.5	3.6	20.0	4.6	19.9	6.9	16.0	9.6	14.7	11.7	14.8
Minimum	-1	15.1	2	15.9	2	14.1	3	16.9	5	10.2	7	10.5	10	9.3
JUNEAU,														
1937-1939	3.0	21.1	1.9	21.5	3.4	21.8	5.1	21.1	8.2	14.9	10.8	10.9	11.5	9.4
1940-1944	3.2	20.4	3.2	21.1	3.4	21.5	5.2	18.8	8.4	13.8	11.1	10.0	10.9	7.9
1945-1949	2.3	20.2	1.9	22.0	2.8	21.2	4.1	20.3	7.5	13.3	10.2	9.1	10.6	8.8
1950-1954	1.4	21.9	1.3	22.0	2.2	22.4	3.9	21.0	7.1	13.7	10.2	11.2	10.9	9.9
1955-1959	2.0	21.1	2.0	21.2	2.5	22.1	4.3	21.0	6.9	14.5	10.3	9.7	10.9	8.0
1960	3.3	20.9	3.8	21.2	3.8	21.7	5.8	20.6	9.5	13.7	9.7	9.7	10.2	7.9
1961	3.9	20.1	3.6	21.3	3.7	21.4	5.4	19.1	7.7	13.7	10.3	9.4	10.6	6.9
1962	2.1	20.0	2.2	21.6	2.3	22.2	4.5	21.4	7.6	16.8	9.1	8.9	11.8	8.0
1963	3.0	20.7	3.6	20.3	3.7	19.5	4.9	21.5	9.3	15.9	9.9	11.1	11.8	7.8
1964	3.7	21.2	3.7	20.8	3.3	21.7	4.9	21.0	7.3	19.3	11.3	9.4	11.1	9.5
Mean	2.4	20.9	2.3	21.5	2.9	21.7	4.6	20.5	7.7	14.3	10.4	10.1	10.9	8.7
Maximum	6	25.9	5	24.4	5	27.7	10	24.5	15	24.5	15	20.6	16	19.4
Mean Max.	3.7	23.0	3.4	23.1	3.9	23.6	6.6	23.0	11.0	21.2	13.6	16.2	13.6	13.8
Mean Min.	0.6	15.3	0.8	15.9	1.6	16.9	3.1	14.3	5.3	6.2	7.4	4.3	8.6	3.7
Minimum	-2	5.4	-1	9.5	-1	5.0	1	5.8	4	-0.9	4	-0.1	6	1.1
HAINES,														
1949-1950	1.4	22.7	-0.9	22.8	2.9	23.2	4.3	22.4	8.8	19.9	12.6	13.3	12.8	6.4
SKAGWAY,														
1944	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1945-1949	2.8	23.0	2.4	23.5	2.8	22.8	3.7	23.0	7.4	14.7	10.2	5.6	10.5	3.6
1950-1954	2.3	23.3	1.9	23.5	2.1	23.4	3.1	22.9	7.2	16.4	10.4	6.0	10.9	1.8
1955-1959	2.6	22.6	2.2	22.8	2.3	23.2	3.1	22.9	6.8	17.6	10.4	7.2	10.8	3.5
1960	2.3	22.4	3.2	23.0	3.3	24.1	4.4	23.6	7.7	17.7	10.2	12.2	8.8	8.9
1961	3.0	21.5	3.3	22.4	3.6	22.6	4.3	23.0	5.6	23.0	8.0	15.1	9.4	4.4
1962	2.4	23.4	1.7	23.1	1.7	23.0	2.6	22.6	3.9	21.9	7.0	11.2	10.1	1.8
1963	2.6	23.7	1.8	22.8	3.5	22.8	3.6	24.0	7.4	19.1	10.4	8.3	10.7	6.3
1964	3.7	22.8	3.3	22.8	--	--	3.9	23.0	4.4	22.1	7.9	7.6	9.7	4.0
Mean	2.6	22.9	2.3	23.1	2.5	23.2	3.4	23.0	6.8	17.5	9.9	7.6	10.5	3.5
Maximum	5	24.8	4	25.2	4	24.9	7	25.1	14	24.2	14	23.4	15	18.2
Mean Max.	3.4	23.6	2.9	23.7	3.0	23.8	4.9	24.0	9.5	22.7	11.8	16.1	12.2	7.8
Mean Min.	1.7	22.1	1.6	22.4	2.0	21.9	2.4	20.3	4.6	9.5	8.0	2.1	9.0	3.5
Minimum	-1	20.2	0	20.6	0	13.5	1	9.5	3	1.3	4	-0.6	7	-1.3
YAKUTAT,														
1941-1944	5.1	22.0	5.0	22.1	5.4	21.7	6.4	21.6	8.9	20.9	11.5	19.0	13.4	17.0
1945-1949	4.2	22.1	3.5	22.6	4.0	22.2	5.2	22.1	8.1	20.5	10.9	19.3	12.7	18.0
1950-1954	3.2	22.5	3.0	22.8	3.3	22.8	4.9	22.2	7.1	21.2	10.3	19.3	12.7	17.1
1955-1959	3.2	21.7	2.8	21.7	3.3	21.8	5.4	21.2	7.9	20.1	11.3	19.0	13.4	17.0
1960	3.3	21.6	4.3	21.8	3.9	22.1	5.6	21.4	9.7	20.9	11.6	20.0	12.9	17.0
1961	4.6	21.8	3.4	22.0	4.1	22.2	6.1	21.1	9.6	20.4	11.0	19.4	12.1	16.9
1962	2.9	22.0	2.4	22.4	2.8	22.7	4.3	22.0	7.7	21.1	10.1	20.0	13.2	17.4
1963	4.7	22.2	4.9	22.3	5.1	22.3	5.6	22.7	8.3	22.3	10.2	21.0	13.4	19.2
1964	5.2	22.1	4.4	21.9	4.3	22.2	5.1	21.8	7.1	21.6	11.8	19.7	12.6	19.6

Years	August Temp °C	August Dens. σ_{15}	September Temp °C	September Dens. σ_{15}	October Temp °C	October Dens. σ_{15}	November Temp. °C	November Dens. σ_{15}	December Temp °C	December Dens. σ_{15}	Means Temp °C	Means Dens. σ_{15}	Maximum Temp. °C	Maximum Dens. σ_{15}	Minimum Temp °C	Minimum Dens. σ_{15}
ALASKA-continued																
Mean	14.1	18.7	12.2	18.9	9.4	19.9	7.1	20.8	5.7	21.5	8.5	20.4				
Maximum	18	23.2	16	22.8	13	23.3	10	24.2	8	24.2			18	26.3		
Mean Max.	15.7	21.4	13.8	21.7	11.2	22.2	8.6	22.8	6.9	22.9						
Mean Min.	12.7	14.5	10.4	14.8	7.6	15.3	5.4	16.8	4.1	17.9						
Minimum	11	9.1	8	9.5	6	11.1	3	8.2	0	8.9					-1	8.2
ALASKA																
1937-1939	11.1	9.4	9.6	11.0	7.2	13.6	5.1	18.6	3.7	19.8	6.7	16.1	14	24.3	-2	0.5
1940-1944	10.6	9.2	9.3	11.0	6.8	13.2	4.9	17.4	3.5	20.6	6.7	15.4	15	23.5	-1	0.8
1945-1949	10.4	9.8	8.9	11.0	6.4	13.1	4.2	15.9	2.6	20.6	6.0	15.4	16	27.5	-2	-1.4
1950-1954	11.1	10.9	9.3	10.8	6.6	14.3	4.5	17.3	3.2	19.4	6.0	16.2	16	27.7	-1	1.4
1955-1959	10.0	8.8	9.0	12.0	6.2	15.0	4.5	17.7	3.3	19.6	6.0	15.9	15	24.5	-1	-0.9
1960	10.5	8.5	8.9	9.7	6.9	11.6	4.9	16.7	4.2	17.6	6.8	15.0	13	22.7	2	1.9
1961	10.7	6.7	9.3	9.7	6.2	11.8	4.0	17.7	2.7	21.7	6.5	15.0	14	22.7	1	1.1
1962	11.7	9.4	9.0	10.5	7.2	14.0	5.8	16.8	4.1	18.1	6.4	15.6	16	23.3	-1	2.0
1963	12.1	9.7	10.0	10.4	7.6	14.2	5.1	20.4	4.5	20.8	7.1	16.0	15	22.8	1	4.9
1964	10.4	10.0	9.7	14.7	7.2	16.0	4.9	19.3	2.2	21.7	6.6	17.0	14	23.6	-1	5.7
Mean	10.7	9.6	9.2	11.1	6.7	13.8	4.7	17.4	3.3	20.0	6.3	15.8				
Maximum	16	23.5	14	20.1	9	22.2	8	23.7	6	24.9			16	27.7		
Mean Max.	13.1	15.3	11.2	16.8	8.4	18.9	6.0	21.4	4.4	22.8						
Mean Min.	8.9	4.3	7.6	4.5	4.9	6.8	2.8	10.1	1.5	13.2						
Minimum	8	0.5	6	-0.3	2	-1.4	0	2.8	-2	5.8					-2	-1.4
ALASKA																
1949-1950	12.7	5.3	10.6	7.3	6.8	17.5	3.4	20.8	1.8	22.2	6.4	17.0	18	26.1*	-2	0.9*
ALASKA																
1944	9.4	3.6	8.2	7.1	6.2	10.2	4.5	21.4	3.6	20.5	--	--	12*	25.0*	2*	-0.3*
1945-1949	10.1	3.0	9.0	7.2	6.6	13.7	4.7	19.4	3.6	22.2	6.2	15.1	14	25.0	-1	-0.5
1950-1954	10.4	2.5	8.5	8.0	6.3	16.4	4.5	20.0	3.3	22.2	5.9	15.5	15	25.2	0	-1.2
1955-1959	9.8	3.5	9.2	7.7	6.4	18.4	3.8	21.4	2.9	22.1	5.9	16.1	15	25.4	1	-0.4
1960	9.5	1.2	9.3	10.2	8.1	10.9	5.1	20.6	2.7	20.8	6.2	16.3	11	24.9	1	-0.3
1961	8.9	-0.7	9.2	7.4	6.9	17.4	3.9	15.1	3.1	23.4	5.8	16.2	10	23.9	2	-1.5
1962	10.3	1.8	9.6	10.2	7.2	14.7	5.7	20.3	3.9	23.6	5.5	16.5	11	24.1	2	-1.0
1963	10.7	2.8	8.6	12.4	7.2	13.2	5.1	13.5	4.3	21.8	6.3	15.9	11	25.1	1	-0.6
1964	10.7	3.9	9.1	9.8	7.6	16.9	4.8	21.0	3.3	24.0	--	--	13*	25.2*	2*	-0.1*
Mean	10.1	2.7	8.9	8.3	6.7	15.6	4.4	19.8	3.3	22.2	6.0	15.8				
Maximum	13	17.3	13	22.4	9	25.4	7	25.9	6	25.2			15	25.9		
Mean Max.	11.4	7.6	10.2	16.5	8.1	20.8	5.6	22.5	4.1	23.4						
Mean Min.	8.8	2.9	7.4	2.6	5.1	7.2	3.2	13.9	2.4	19.6						
Minimum	7	-1.5	5	-0.3	2	0.0	1	0.9	1	10.8					-2	-1.5
ALASKA																
1941-1944	13.7	16.9	11.8	19.2	9.2	19.8	7.6	21.5	5.5	21.8	8.6	20.3	17	26.5	2	10.5
1945-1949	12.6	17.8	11.2	18.9	8.9	20.6	6.8	21.7	4.7	22.3	7.7	20.7	18	24.2	1	10.3
1950-1954	12.8	17.0	11.3	18.0	8.9	20.4	6.6	21.3	4.9	22.0	7.4	20.6	17	24.0	1	10.1
1955-1959	13.1	17.0	11.2	18.6	8.2	20.0	5.7	20.5	4.1	21.5	7.5	20.0	18	25.1	-1	5.4
1960	13.0	16.9	10.8	17.8	8.8	19.7	6.1	21.1	5.2	21.0	7.9	20.1	15	23.0	2	10.0
1961	12.8	16.0	11.6	19.1	8.3	20.4	5.9	22.1	2.9	22.2	7.7	20.3	15	23.3	2	13.8
1962	13.4	18.2	11.6	19.3	9.2	20.8	7.9	21.5	6.0	22.1	7.6	20.8	16	23.1	2	15.1
1963	13.5	18.0	12.6	18.8	10.4	20.9	7.1	22.2	5.8	21.8	8.5	21.1	16	23.5	3	14.4
1964	12.7	[illegible]	11.5	20.4	9.7	20.7	7.4	21.7	4.2	22.0	8.0	21.1	14	23.6	3	16.2

*Observations for the year are incomplete, extremes are for the months shown

Table 1. - Surface Water Temperatures and Densities

Means and Extremes

Years	January Temp. °C	January Dens. σ_{15}	February Temp. °C	February Dens. σ_{15}	March Temp. °C	March Dens. σ_{15}	April Temp. °C	April Dens. σ_{15}	May Temp. °C	May Dens. σ_{15}	June Temp. °C	June Dens. σ_{15}	July Temp. °C	July Dens. σ_{15}	August Temp. °C	August Dens. σ_{15}	September Temp. °C	September Dens. σ_{15}	October Temp. °C	October Dens. σ_{15}	November Temp. °C	November Dens. σ_{15}	December Temp. °C	December Dens. σ_{15}	Means Temp. °C	Means Dens. σ_{15}	Maximum Temp. °C	Maximum Dens. σ_{15}	Minimum Temp. °C	Minimum Dens. σ_{15}
YAKUTAT, ALASKA-continued																														
Mean	3.9	22.0	3.6	22.3	3.9	22.2	5.4	21.8	8.1	20.8	10.9	19.4	13.0	17.4	13.1	17.3	11.4	18.7	8.9	20.3	6.7	21.3	4.8	21.9	7.8	20.4				
Maximum	7	25.1	8	24.2	8	25.1	9	24.9	15	23.9	16	23.3	18	23.3	18	23.1	15	22.8	12	23.4	10	23.8	8	26.5			18	26.5		
Mean Max.	5.1	23.2	4.7	23.2	5.0	23.2	7.6	23.0	10.7	22.9	13.8	22.1	15.2	21.1	14.9	20.9	12.9	21.5	10.6	22.0	8.3	22.5	6.4	23.0						
Mean Min.	2.3	20.2	2.6	20.5	2.7	20.5	3.8	19.6	5.7	17.7	8.7	15.4	10.9	13.0	11.6	13.4	9.8	15.4	7.2	17.1	4.7	19.2	3.2	20.3						
Minimum	-1	16.8	1	17.8	-1	17.7	2	14.6	4	10.0	7	10.1	9	5.4	10	10.0	8	11.1	5	10.4	2	14.4	0	17.4					-1	5.4
CORDOVA, ALASKA																														
1949-1953	3.2	22.9	2.1	22.8	2.1	23.0	3.5	22.7	5.3	22.5	7.8	21.4	9.8	20.2	11.3	18.5	10.0	18.6	7.5	20.2	5.3	21.7	4.6	22.5	6.0	21.4	14	23.8	-1	13.5
--																														
1956	--	--	--	--	--	--	--	--	4.1	--	6.1	--	9.5	--	10.8	--	--	--	--	--	--	--	--	--	--	--	12*	--	--	--
1957	--	--	--	--	--	--	--	--	--	--	9.7	22.3	10.9	21.1	11.9	19.9	--	--	--	--	--	--	--	--	--	--	14*	23.8*	--	12.7*
--																														
1959	--	--	--	--	--	--	--	--	6.9	22.9	10.6	22.3	10.4	20.7	11.7	20.4	--	--	--	--	--	--	--	--	--	--	14*	23.7*	--	16.3*
--																														
1961	--	--	--	--	--	--	--	--	7.8	21.6	10.1	20.5	--	--	12.0	--	--	--	--	--	--	--	--	--	--	--	13*	23.3*	--	18.0*
Mean	3.2	22.9	2.1	22.8	2.1	23.0	3.5	22.7	5.8	22.4	8.6	21.6	10.0	20.5	11.4	19.2	10.0	18.6	7.5	20.2	5.3	21.7	4.6	22.5	6.2	21.5	14	23.8	-1	13.5
Maximum	8	23.4	4	23.6	4	23.8	7	23.4	10	23.6	14	23.8	13	22.9	14	21.9	13	22.5	9	22.3	7	23.1	7	23.2			14	23.8		
Mean Max.	5.0	23.3	3.3	23.3	2.9	23.4	5.0	23.3	7.6	23.3	10.9	22.8	12.4	21.8	13.0	20.4	11.7	21.1	8.6	21.8	6.1	22.7	5.6	23.0						
Mean Min.	1.5	22.5	1.0	21.5	0.6	22.5	2.6	21.7	4.6	20.6	6.7	20.2	8.4	18.2	10.0	16.0	7.8	15.1	6.2	17.7	3.7	20.5	2.3	21.8						
Minimum	0	22.3	1	18.7	-1	22.4	1	20.3	3	18.0	5	19.2	8	16.3	9	12.7	7	13.5	5	16.1	1	20.2	-1	21.3					-1	13.5
SEWARD, ALASKA																														
1926-1929	4.1	20.8	3.7	21.4	3.3	21.4	4.8	20.3	7.6	16.5	11.3	9.4	12.3	4.4	12.4	6.9	11.5	10.7	7.8	18.1	4.4	17.6	4.7	21.6	7.3	15.8	18	27.4	0	-0.2
1930-1934	3.6	23.0	2.9	22.0	3.5	21.3	4.7	21.1	7.5	16.8	10.9	11.0	12.2	7.9	12.0	7.3	10.5	14.0	7.8	17.6	5.8	20.3	4.7	21.4	7.2	17.0	18	29.2	1	-0.2
1935-1939	3.7	21.3	3.8	21.6	3.8	22.4	5.3	21.9	7.8	17.3	11.9	8.5	13.1	6.6	13.0	9.3	11.0	13.1	8.2	14.9	6.1	18.4	4.8	20.0	7.7	16.3	18	26.5	0	-0.4
--																														
1945-1949	3.2	21.2	3.1	21.2	3.3	20.8	4.2	21.4	6.8	15.5	9.4	7.8	10.9	5.8	11.1	8.8	9.6	10.6	7.5	15.1	5.8	19.5	4.6	21.7	6.6	15.8	14	23.6	-2	-0.5
1950-1954	3.5	22.0	2.6	21.9	2.8	22.2	4.1	20.4	7.2	15.3	9.3	10.7	11.8	7.1	11.8	8.5	10.1	12.4	7.9	15.7	6.1	18.8	4.5	21.4	6.8	16.4	15	26.0	-1	-1.3
1955-1959	3.0	22.2	3.3	22.7	3.3	22.8	4.1	22.1	7.1	17.5	10.2	10.0	11.5	3.8	12.3	10.1	10.7	13.7	7.9	19.3	5.9	20.2	4.1	22.1	7.0	17.2	16	26.4	1	-2.0
1960	--	--	3.6	22.4	3.7	22.9	4.5	21.8	7.9	10.3	10.8	8.4	12.9	7.8	12.6	11.1	11.2	16.0	8.7	19.0	6.7	21.0	5.2	21.6	--	--	16	23.5*	1	-2.2*
1961	4.4	21.1	--	--	3.3	23.3	4.9	22.5	8.4	18.0	11.3	9.4	--	--	--	--	11.2	14.8	--	--	--	--	--	--	--	--	--	23.7*	2*	0.9*
1962	1.9	23.4	2.3	23.2	2.2	23.4	3.6	23.0	6.6	19.2	10.7	11.8	12.8	6.8	12.9	12.4	9.9	18.9	8.4	19.8	6.3	21.7	3.9	22.3	6.8	18.8	15	24.1	0	-1.1
1963	3.1	21.7	3.4	22.5	3.6	22.4	4.6	22.5	7.2	18.8	10.9	10.6	13.2	9.9	13.7	11.9	12.2	14.6	9.2	18.2	6.7	21.8	4.6	20.7	7.7	18.0	16	23.8	1	1.6
1964	4.6	22.4	3.1	22.6	--	--	--	--	--	--	11.6	14.1	13.7	12.8	12.4	16.3	11.9	15.9	9.4	19.4	6.4	20.6	4.8	--	--	--	15	23.2*	2*	5.0*
Mean	3.5	22.0	3.2	22.0	3.3	22.0	4.6	21.4	7.3	16.5	10.6	9.8	12.1	6.5	12.2	9.0	10.6	13.1	8.0	17.0	5.8	19.5	4.6	21.3	7.2	16.7				
Maximum	7	29.2	6	25.5	7	25.5	8	27.4	12	23.9	16	24.4	18	24.3	18	22.8	15	23.6	13	26.9	9	26.6	8	27.4			18	29.2		
Mean Max.	4.9	23.6	4.3	23.6	4.4	23.8	6.4	23.8	10.0	22.6	13.4	20.2	14.8	17.1	14.8	19.2	12.9	21.0	10.2	22.0	7.7	22.9	6.1	23.5						
Mean Min.	1.9	17.6	1.6	18.3	2.2	18.6	3.1	15.7	4.8	6.8	7.8	1.5	9.1	0.7	9.4	1.5	8.1	3.4	5.6	7.6	3.6	10.8	2.6	16.0						
Minimum	0	6.4	-2	7.9	0	9.8	1	6.2	0	-2.2	6	-1.6	6	-1.5	7	-0.5	6	-0.7	2	-0.4	0	0.6	0	4.5					-2	-2.2
KODIAK, KODIAK ISLAND, ALASKA																														
1889-1890	3.3	--	2.8	--	3.2	--	2.7	--	6.1	--	7.8	--	9.4	--	10.5	--	9.7	--	7.6	--	5.7	--	3.5	--	6.0	--	14	--	0	--
--																														
1935-1936	3.9	22.7	3.9	23.2	3.1	23.7	4.3	24.1	6.3	22.3	8.6	22.8	9.8	23.2	10.4	23.8	9.9	22.6	7.3	22.8	5.4	23.1	3.5	23.1	6.4	23.1	12	25.1	2	16.2
Mean	3.5	--	3.2	--	3.2	--	3.4	--	6.2	--	8.2	--	9.6	--	10.4	--	9.8	--	7.5	--	5.6	--	3.5	--	6.2					
Maximum	5	--	5	--	5	--	6	--	9	--	12	--	14	--	12	--	12	--	9	--	7	--	6	--			14	--		
Mean Max.	4.6	--	4.0	--	3.8	--	4.6	--	7.9	--	10.7	--	12.0	--	11.6	--	11.1	--	9.0	--	6.7	--	4.7	--						
Mean Min.	2.3	--	0.9	--	1.9	--	2.1	--	5.2	--	6.5	--	8.0	--	9.8	--	8.8	--	6.0	--	4.1	--	2.2	--						
Minimum	2	--	0	--	1	--	1	--	4	--	6	--	7	--	9	--	8	--	3	--	3	--	1	--					0	--
WOMENS BAY, KODIAK ISLAND, ALASKA																														
1950-1954	0.4	22.0	0.2	22.4	1.2	23.0	3.7	21.7	6.4	17.2	8.8	13.3	11.9	15.3	11.8	17.5	10.4	18.6	7.2	19.4	3.9	19.7	1.5	21.8	5.6	19.3	17	28.5	-2	-0.1
1955-1959	-0.2	21.2	0.6	19.9	1.2	21.7	3.8	21.6	6.5	16.0	9.0	12.4	11.4	14.1	12.2	19.0	9.7	19.6	6.1	20.2	3.1	18.6	0.8	21.2	5.4	18.8	17	27.8	-3	-1.2

*Observations for the year are incomplete, extremes are for the months shown.

Table 1.–Surface Water Temperatures and Densities

Means and Extremes

Years	January Temp °C	January Dens. σ_{15}	February Temp °C	February Dens. σ_{15}	March Temp °C	March Dens. σ_{15}	April Temp °C	April Dens. σ_{15}	May Temp °C	May Dens. σ_{15}	June Temp °C	June Dens. σ_{15}	July Temp °C	July Dens. σ_{15}
WOMENS BAY, KODIAK ISLAND,														
1960	1.0	17.6	1.7	20.9	1.1	22.8	3.2	22.5	6.6	--	8.4	--	11.1	13.2
1961	2.1	17.1	1.9	22.1	0.1	23.3	3.4	23.1	7.8	17.7	9.8	16.9	11.3	19.1
1962	-0.8	18.8	-0.1	19.8	1.4	23.1	3.8	21.7	6.4	19.4	9.2	18.4	12.8	20.0
1963	1.8	17.6	1.8	19.3	2.6	19.4	3.6	23.3	7.7	20.3	10.3	18.5	13.4	20.2
1964	1.9	19.7	1.1	21.8	1.3	22.7	3.4	22.8	5.8	21.4	9.3	10.4	11 2	14.6
Mean	0.5	20.4	0.7	20.9	1.2	22.2	3.7	22.0	6.6	17.5	9.1	13.8	11.8	15.6
Maximum	4	25.8	4	25.1	6	25.0	8	27.8	11	27.6	16	23.8	17	23.7
Mean Max.	2.6	23.9	2.8	23.5	3.4	23.8	5.9	24.4	8.9	23.7	12.3	21.3	14.9	21.8
Mean Min.	-1.7	12.6	-1.5	14.4	-0.6	18.8	1.3	16.9	4.7	4.3	5.8	2.7	9.2	4.3
Minimum	-3	-0.1	-3	3.2	-3	1.3	-1	13.7	4	-1.2	4	-1.2	6	-1.0
DUTCH HARBOR, AMAKNAK														
1946-1949	2.2	23.8	2.3	23.6	2.4	23.7	4.2	23.6	5.0	23.9	6.9	23.0	9.0	23.6
1950-1954	2.9	23.7	2.2	23.7	3.0	23.8	3.9	23.6	5.7	23.4	7.2	23.1	9.3	23.4
1955	3.3	23.4	3.2	23.9	3.7	24.0	3.8	24.1	4.7	23.5	--	--	7.6	23.5
Mean	2.7	23.7	2.3	23.7	2.9	23.8	4.1	23.7	5.3	23.6	7.1	23.1	8.9	23.5
Maximum	4	24.6	4	24.6	4	24.8	7	25.2	9	25.2	11	25.2	12	24.8
Mean Max.	3.8	24.3	2.9	24.2	3.8	24.2	5.6	24.5	6.8	24.6	9.0	24.6	10.6	24.4
Mean Min.	1.7	22.6	1.4	23.0	1.8	23.0	2.6	21.7	4.0	22.0	5.5	21.2	6.9	21.7
Minimum	1	18.8	0	21.4	1	22.0	1	18.1	3	17.9	4	16.5	6	19.7
UNALASKA, UNALASKA														
1955-1959	2.0	19.4	1.5	17.0	1.5	20.6	3.8	18.9	5.3	16.2	7.7	15.8	9.8	18.0
1960	2.7	18.3	1.8	21.6	--	--	--	--	5.3	19.2	7.8	17.7	10.3	20.7
1961	2.0	19.8	1.4	19.3	2.0	17.6	4.4	--	6.8	14.3	8.8	18.4	9.8	20.9
1962	1.2	20.7	2.3	20.4	3.1	21.0	3.6	20.2	5.0	21.5	9.3	21.1	9.1	22.3
1963	3.1	20.2	2.0	22.0	3.7	22.7	4.4	22.6	5.6	22.4	6.5	22.2	9.6	22.7
1964	3.1	23.0	2.9	22.8	2.9	23.1	3.7	22.4	5.2	22.1	7.6	20.8	8.3	22.4
Mean	2.3	20.1	1.9	20.0	2.4	21.0	3.9	20.3	5.4	18.3	7.9	18.1	9.6	20.1
Maximum	4	23.9	4	25.2	4	22.8	7	24.3	9	24.2	13	23.8	15	25.1
Mean Max.	3.5	23.3	3.4	23.6	3.6	23.5	5.4	23.7	6.9	23.0	10.0	22.3	13.9	23.1
Mean Min.	0.3	13.5	-0.1	12.4	1.2	14.6	2.6	13.8	4.1	11.9	6.1	12.8	7.4	15.0
Minimum	-2	7.9	-1	-0.2	-1	4.2	1	5.8	3	7.4	4	5.9	4	7.2
SWEEPER COVE, ADAK														
1944	1.7	23.8	2.2	22.5	2.6	21.0	3.5	20.3	4.8	22.3	6.4	23.7	--	--
1945-1947	2.4	20.6	2.7	20.7	3.0	19.7	3.9	17.4	5.3	17.9	6.8	20.5	8.2	20.7
1950-1954	2.7	23.2	2.4	23.2	3.3	22.4	3.7	21.1	5.1	21.1	6.6	22.6	7.3	23.8
1955-1959	2.9	24.1	3.1	23.7	3.1	23.8	4.1	23.7	4.8	24.0	6.4	24.0	7.6	24.3
1960	3.2	24.0	2.6	24.4	3.5	22.9	3.4	24.5	4.7	24.1	6.6	24.2	7.9	24.2
1961	--	--	--	--	--	--	--	--	4.8	24.3	6.6	--	--	--
1962	--	--	--	--	--	--	3.8	24.5	4.6	24.3	7.3	24.3	7.6	23.8
1963	3.1	21.9	1.4	21.2	3.4	20.0	4.2	--	5.1	23.6	6.6	23.4	8.4	22.9
1964	--	--	--	--	--	--	1.1	24.1	3.3	24.4	5.4	24.5	5.6	24.6
Mean	2.7	22.7	2.6	22.4	3.2	21.7	3.7	21.0	4.9	21.6	6.6	22.8	7.6	23.1
Maximum	5	25.2	6	27.0	7	26.2	7	26.4	8	25.9	12	26.1	14	26.8
Mean Max.	4.0	24.8	4.1	24.8	4.8	24.8	5.3	24.9	6.8	25.0	9.1	25.0	10.9	25.2
Mean Min.	0.6	18.4	0.7	16.9	15	14.0	1.9	14.3	3.4	14.7	4.6	17.3	5.3	18.4
Minimum	-2	8.5	-1	8.9	-1	3.8	-2	0.5	1	-1.2	3	3.5	2	3.4

Years	August Temp °C	August Dens. σ_{15}	September Temp °C	September Dens. σ_{15}	October Temp °C	October Dens. σ_{15}	November Temp °C	November Dens. σ_{15}	December Temp °C	December Dens. σ_{15}	Means Temp °C	Means Dens. σ_{15}	Maximum Temp °C	Maximum Dens. σ_{15}	Minimum Temp °C	Minimum Dens. σ_{15}
ALASKA-continued																
1960	--	--	9.5	18.9	--	--	3.6	21.5	2.7	20.4	--	--	14	25.2*	-2	0.9*
1961	11.8	21.4	--	--	5.6	22.3	2.1	--	-0.1	--	--	--	14	25.8*	-1	-1.2*
1962	12.4	21.5	9.9	21.3	7.0	21.6	4.4	17.1	2.2	18.2	5.7	20.1	16	26.1	-3	-0.3
1963	14.4	21.9	11.4	14.9	7.2	21.0	3.0	22.6	2.9	16.4	6.7	19.6	17	26.0	-2	-1.5
1964	11.3	18.0	10.1	17.6	6.7	19.3	3.1	21.1	-0.2	--	5.4	--	15	24.1*	-2	0.9*
Mean	12.1	18.9	10.1	18.8	6.6	20.1	3.4	19.6	1.3	20.8	5.6	19.2				
Maximum	17	26.8	14	27.3	11	27.7	7	28.5	6	25.3			17	28.5		
Mean Max.	14.7	23.1	12.2	23.4	9.2	24.6	5.7	23.8	3.5	23.7						
Mean Min.	10.[illegible]	8.7	7.4	9.2	3.6	10.7	0.5	10.8	-1.2	12.2						
Minimum	6	-0.1	4	0.0	2	0.6	-2	-0.4	-3	-1.5					-3	-1.5
ISLAND, ALASKA																
1946-1949	9.4	23.9	8.2	23.6	6.2	23.9	4.6	23.6	3.3	23.8	5.3	23.7	12	27.5	1	16.5
1950-1954	10.1	23.8	8.4	23.8	6.7	23.7	5.0	23.8	3.7	23.7	5.7	23.6	18	25.4	0	17.9
1955	--	--	--	--	--	--	--	--	--	--	--	--	--	24.7*	2*	21.5*
Mean	9.8	23.8	8.3	23.7	6.5	23.8	4.8	23.7	3.6	23.8	5.5	23.7				
Maximum	18	27.5	12	24.9	9	25.4	7	24.9	5	25.4			18	27.5		
Mean Max.	12.2	24.9	10.0	24.4	7.7	24.4	5.8	24.4	4.6	24.4						
Mean Min.	7.9	22.7	7.3	23.0	5.4	23.1	3.4	22.7	2.4	23.1						
Minimum	6	22.0	7	22.3	4	22.1	2	19.1	1	22.8					0	16.5
ISLAND, ALASKA																
1955-1959	10.4	20.0	8.7	17.4	5.8	16.4	4.2	18.8	2.3	18.1	5.2	18.0	15	25.2	-1	-0.2
1960	10.4	--	9.2	--	6.9	--	3.6	--	2.4	--	--	--	13	23.0*	0*	13.2*
1961	10.1	21.2	9.4	20.9	6.1	21.4	--	--	2.1	21.1	--	--	14	21.5*	-1*	4.2*
1962	9.7	23.4	8.6	22.4	6.4	22.0	4.7	21.7	2.9	22.6	5.5	21.5	13	24.1	-2	5.4
1963	10.0	22.7	8.8	22.0	6.7	21.6	4.6	22.7	3.3	22.3	5.7	22.2	12	24.6	0	14.8
1964	8.3	23.0	7.8	22.1	5.6	21.9	4.1	22.6	3.0	22.9	5.2	22.4	11	24.6	2	15.2
Mean	10.0	21.3	8.7	19.6	6.1	19.1	4.2	20.3	2.6	20.5	5.4	19.9				
Maximum	13	24.6	14	23.9	9	24.3	6	24.6	7	23.9			15	25.2		
Mean Max.	12.1	23.7	10.1	23.4	7.9	23.1	5.3	23.7	4.2	23.3						
Mean Min.	8.4	15.2	7.2	11.2	4.1	13.2	2.8	13.9	0.4	14.4						
Minimum	7	8.1	6	4.2	0	2.3	2	6.7	-1	4.9					-2	-0.2
ISLAND, ALASKA																
1944	--	--	--	--	6.6	18.3	5.1	18.2	3.2	18.5	--	--	--	25.8*	0	6.6*
1945-1947	8.1	21.0	8.0	20.3	6.1	20.2	4.3	20.8	3.3	21.5	5.2	20.1	14	27.6	-2	0.5
1950-1954	8.3	23.9	7.9	24.2	6.1	23.9	4.6	23.7	3.2	23.6	5.1	23.1	13	27.0	-2	-1.2
1955-1959	8.6	24.5	7.7	24.0	6.3	24.1	4.6	24.1	3.3	23.9	5.2	24.0	13	25.2	-2	13.2
1960	6.9	24.7	7.6	24.4	6.7	24.5	4.4	24.3	3.1	24.4	5.0	24.2	12	25.3	-1	19.2
1961	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1962	6.9	24.9	7.3	24.0	6.3	23.6	4.3	24.2	3.2	22.8	--	--	12	25.4*	--	14.6*
1963	--	--	--	--	5.7	24.6	4.3	24.4	1.8	24.8	--	--	12	25.5*	-1*	13.0*
1964	5.7	24.6	--	--	1.6	24.3	--	--	--	--	--	--	9*	25.1*	-2	22.6*
Mean	8.0	23.4	7.8	23.0	5.9	23.1	4.5	23.1	3.2	23.0	5.1	22.6				
Maximum	14	27.6	11	26.3	9	25.8	8	25.3	8	25.6			14	27.6		
Mean Max.	10.9	25.2	9.5	25.1	7.7	25.0	5.9	24.6	4.9	24.8						
Mean Min.	6.1	19.0	6.6	17.1	4.4	19.2	2.6	19.1	0.9	18.8						
Minimum	4	3.8	4	9.1	0	8.4	1	6.6	-1	9.2					-2	-1.2

*Observations for the year are incomplete, extremes are for the months shown

Table 1. - Surface Water Temperatures and Densities

Means and Extremes

Years	January Temp °C	January Dens. σ_{15}	February Temp °C	February Dens. σ_{15}	March Temp °C	March Dens. σ_{15}	April Temp °C	April Dens. σ_{15}	May Temp °C	May Dens. σ_{15}	June Temp °C	June Dens. σ_{15}	July Temp °C	July Dens. σ_{15}	August Temp °C	August Dens. σ_{15}	September Temp °C	September Dens. σ_{15}	October Temp °C	October Dens. σ_{15}	November Temp °C	November Dens. σ_{15}	December Temp °C	December Dens. σ_{15}	Means Temp °C	Means Dens. σ_{15}	Maximum Temp °C	Maximum Dens. σ_{15}	Minimum Temp °C	Minimum Dens. σ_{15}
CONSTANTINE HARBOR, AMCHITKA ISLAND, ALASKA																														
1944-1948	3.1	24.4	2.8	25.0	3.1	24.8	4.5	24.5	--	--	5.5	24.7	6.3	24.6	7.0	24.6	6.9	24.3	5.8	24.5	4.7	24.3	3.7	24.2	--	--	11	27.8	2	19.7
Mean	3.1	24.4	2.8	25.0	3.1	24.8	4.5	24.5	--	--	5.5	24.7	6.3	24.6	7.0	24.6	6.9	24.3	5.8	24.5	4.7	24.3	3.7	24.2	--	--				
Maximum	4	25.9	3	27.8	3	25.2	6	25.0	--	--	8	26.7	11	26.6	9	25.6	10	25.6	8	25.8	6	24.8	4	25.0			11	27.8		
Mean Max.	3.6	25.2	33	26.4	--	--	--	--	--	--	6.9	25.4	8.4	25.4	9.0	25.1	8.6	24.9	6.8	24.9	5.3	24.7	4.4	24.8						
Mean Min.	2.2	22.9	22	23.5	--	--	--	--	--	--	4.8	24.2	4.9	23.2	5.8	23.2	5.8	22.8	4.8	23.6	3.7	23.5	2.9	22.7						
Minimum	2	19.7	2	22.1	2	23.7	3	22.9	--	--	4	23.9	4	22.1	6	21.6	6	20.2	4	22.3	3	22.9	2	21.0					2	19.7
MASSACRE BAY (Pyramid Cove), ATTU ISLAND, ALASKA																														
1946-1949	2.1	24.4	2.0	24.2	2.7	24.7	3.5	24.2	4.9	23.8	6.7	23.0	7.7	23.8	9.1	24.0	9.0	24.1	6.6	24.4	4.4	24.2	2.6	24.4	5.1	24.1	15	26.1	-1	17.9
1951-1954	2.4	24.2	1.8	24.5	1.8	24.6	3.1	24.4	4.5	24.0	6.6	23.6	8.7	23.2	9.5	23.9	8.8	24.3	6.8	24.3	4.6	24.2	2.9	24.2	5.1	24.1	14	26.1	-2	17.7
1955-1958	2.2	24.4	2.3	24.4	2.6	24.4	3.3	24.3	4.7	24.1	6.4	23.5	8.8	23.1	10.1	23.4	8.9	24.2	7.2	24.4	5.0	24.3	3.2	24.4	5.4	24.1	14	26.0	0	19.2
1960	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.1	23.8	2.3	23.7	0.6	24.3	--	--	--	--	--	--
1961	--	--	--	--	--	--	2.7	--	4.1	19.5	5.6	19.2	7.6	17.6	8.7	18.7	8.5	19.1	7.2	18.9	4.4	19.2	--	--	--	--	11*	19.9*	2*	15.1*
1962	--	--	--	--	2.6	19.4	3.8	23.9	5.0	23.7	6.6	23.2	8.1	23.5	8.6	23.5	8.4	24.0	7.1	24.0	4.9	--	3.6	24.4	--	--	11*	25.3*	2*	18.4*
1963	3.2	24.5	2.8	24.5	2.9	24.7	3.7	24.7	4.9	24.4	6.8	23.9	8.4	22.5	9.4	23.5	8.6	23.9	7.4	24.1	5.2	24.3	3.5	24.3	5.6	24.1	12	26.0	2*	18.2
1964	2.6	24.3	1.3	24.4	1.7	24.7	2.2	24.6	4.9	23.9	6.1	24.1	6.6	24.0	7.8	24.1	7.7	24.0	6.4	24.1	2.6	23.8	2.7	24.1	4.4	24.2	11	25.6	-3	19.6
Mean	2.3	24.3	2.1	24.4	2.3	24.2	3.2	24.3	4.7	23.6	6.5	23.2	8.2	22.9	9.3	23.3	8.7	23.8	6.8	23.9	4.4	23.8	2.8	24.3	5.1	23.8				
Maximum	4	25.4	6	25.1	4	26.1	6	25.5	9	25.4	11	25.5	13	25.3	15	25.9	11	25.5	10	26.0	7	25.5	5	25.3			15	26.1		
Mean Max.	3.2	24.9	3.1	25.1	3.4	24.7	4.4	25.0	6.2	24.5	8.8	24.5	11.1	24.3	11.8	24.5	10.1	24.6	8.3	24.7	5.8	24.4	4.2	24.8						
Mean Min.	1.1	23.5	0.5	23.3	1.0	23.4	2.0	23.1	3.4	21.4	4.7	20.5	6.2	20.3	7.6	21.2	7.3	22.0	5.1	22.4	2.5	22.5	1.3	23.4						
Minimum	-2	20.7	-2	19.6	-1	18.4	1	21.2	2	17.9	3	17.0	5	15.1	6	17.7	5	18.5	3	18.4	-3	18.3	-2	22.2					-3	15.1
MASSACRE BAY (Murder Point), ATTU ISLAND, ALASKA																														
1958	--	--	--	--	--	--	--	--	--	--	7.8	22.7	8.5	23.3	10.1	24.0	9.9	24.2	6.8	24.5	--	--	2.0	--	--	--	13	25.8*	1*	19.1*
1959	2.4	23.8	1.6	23.6	2.1	23.9	3.9	23.3	5.6	23.8	6.5	23.3	9.8	23.9	11.3	22.9	9.7	22.9	6.3	23.3	4.6	23.7	1.2	24.3	5.4	23.6	14	25.5	0	18.6
1960	0.9	24.2	0.6	24.3	2.2	24.2	3.2	23.7	4.9	23.2	6.5	23.3	8.2	23.3	9.1	23.9	--	--	--	--	--	--	--	--	--	--	11	25.1	-1*	18.2*
PORT MOLLER, ALASKA																														
1948	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10.9	22.3	6.1	22.2	2.2	22.3	(ice)	(ice)	--	--	--	22.8*	(ice)	21.4*
1949	(ice)	(ice)	(ice)	(ice)	0.4	22.2	0.9	22.5	4.8	22.7	10.4	22.7	11.8	23.0	13.0	22.8	11.8	22.8	7.4	21.9	4.4	21.8	0.7	21.6	--	--	14	23.4*	(ice)	21.1*
1950	-0.1	21.6	(ice)	(ice)	-0.6	22.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	22.7*	(ice)	21.1*
1955	--	--	--	--	--	--	--	--	--	--	7.5	21.5	10.6	21.5	11.6	21.2	--	--	--	--	--	--	--	--	--	--	13	21.9*	--	20.0*
1957	--	--	--	--	--	--	--	--	--	--	10.9	21.8	12.1	22.0	13.6	22.2	--	--	--	--	--	--	--	--	--	--	15	22.4*	--	21.3*
1958	--	--	--	--	--	--	--	--	--	--	--	--	10.8	21.9	11.1	21.9	--	--	--	--	--	--	--	--	--	--	12*	22.4*	--	21.2*
1959	--	--	--	--	--	--	--	--	--	--	--	--	9.0	21.9	8.9	22.0	--	--	--	--	--	--	--	--	--	--	11*	22.4*	--	21.6*
1960	--	--	--	--	--	--	--	--	--	--	--	--	11.9	22.6	11.4	22.3	--	--	--	--	--	--	--	--	--	--	13*	22.8*	--	21.8*
PEARD BAY, ALASKA																														
1947	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.3	21.0	--	--	--	--	--	--	--	--	--	21.7*	--	18.4*
POINT BARROW (ocean), ALASKA																														
1945	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-0.3	19.8	--	--	--	--	--	--	--	--	--	21.7*	--	15.3*
1951	--	--	--	--	--	--	--	--	--	--	--	--	6.8	21.4	--	--	--	--	--	--	--	--	--	--	--	--	--	24.1*	--	10.0*
POINT BARROW (Elson Lagoon), ALASKA																														
1945	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	20.5*	--	11.1*
1951	--	--	--	--	--	--	--	--	--	--	--	--	7.5	18.6	--	--	--	--	--	--	--	--	--	--	--	--	--	21.6*	--	12.2*

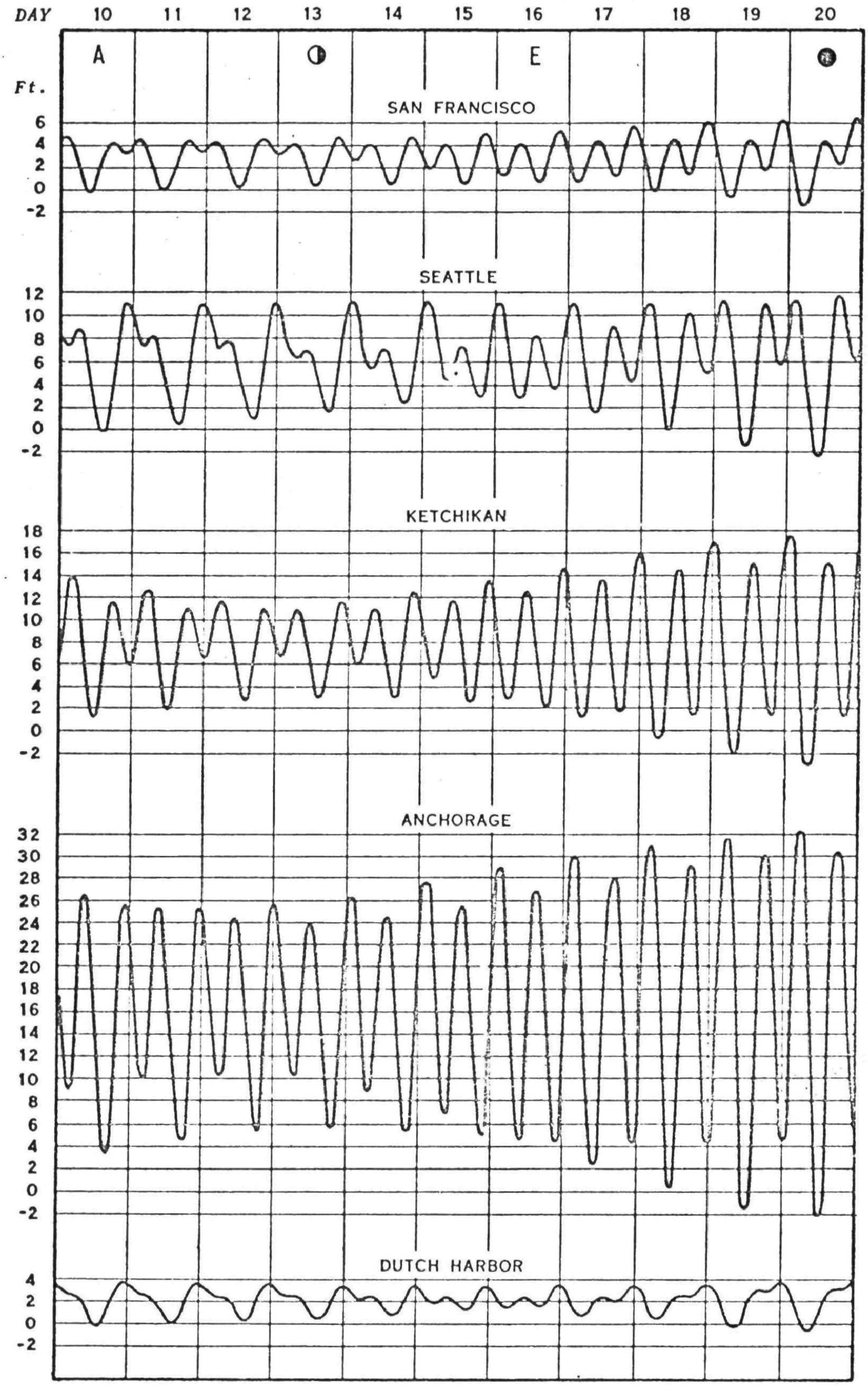
*Observations for the year are incomplete, extremes are for the months shown.

APPENDIX B

TIDAL DATA

SELECTED ALASKA STATIONS

TYPICAL TIDE CURVES FOR UNITED STATES PORTS



A discussion of these curves is given on the preceding page.

Lunar data: A - moon in apogee
◐ - last quarter
E - moon on equator
● - new moon

ANCHORAGE, ALASKA, 1973

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

APRIL

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0450	28.9	16	0526	30.1
SU	1125	1.4	M	1217	-1.3
	1700	29.0		1752	29.6
	2344	1.3			
2	0523	30.1	17	0029	2.6
M	1208	-0.3	TU	0551	30.3
	1741	30.2		1255	-1.1
				1827	29.8
3	0022	1.1	18	0100	3.5
TU	0555	31.3	W	0617	30.6
	1253	-1.8		1328	-0.9
	1824	30.9		1903	29.8
4	0100	1.2	19	0125	4.1
W	0628	32.2	TH	0646	30.5
	1334	-2.8		1358	-0.6
	1907	31.1		1937	29.6
5	0139	1.5	20	0152	4.5
TH	0703	32.7	F	0715	30.0
	1417	-3.3		1428	-0.4
	1951	30.8		2015	29.0
6	0218	2.3	21	0224	5.1
F	0742	32.6	SA	0745	29.1
	1459	-3.1		1500	-0.1
	2037	30.1		2053	28.2
7	0259	3.4	22	0259	6.0
SA	0821	31.9	SU	0816	27.8
	1542	-2.3		1535	0.5
	2125	29.2		2135	27.2
8	0342	4.9	23	0338	7.1
SU	0909	30.5	M	0857	26.3
	1630	-1.1		1613	1.4
	2223	28.0		2223	26.1
9	0433	6.6	24	0423	8.2
M	1004	28.5	TU	0948	24.5
	1724	0.5		1655	2.7
	2340	27.2		2321	25.3
10	0547	7.8	25	0517	9.1
TU	1121	26.5	W	1053	23.0
	1835	1.8		1750	4.2
11	0100	27.1	26	0029	25.1
W	0717	7.3	TH	0632	9.2
	1257	25.8		1217	22.5
	1953	2.3		1903	5.2
12	0214	27.8	27	0136	25.5
TH	0841	5.1	F	0809	7.3
	1419	26.5		1338	23.3
	2116	1.8		2030	5.0
13	0321	28.9	28	0239	26.5
F	0952	2.5	SA	0910	4.8
	1526	27.6		1449	24.9
	2218	1.1		2127	4.4
14	0412	29.6	29	0324	27.8
SA	1049	0.3	SU	1003	2.4
	1622	28.6		1545	26.6
	2309	1.0		2217	3.9
15	0451	29.9	30	0405	29.0
SU	1136	-0.9	M	1054	0.3
	1709	29.2		1635	28.2
	2352	1.7		2303	3.5

MAY

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0444	30.3	16	0000	5.4
TU	1143	-1.4	W	0519	29.0
	1722	29.4		1232	-0.9
	2349	3.2		1817	29.4
2	0519	31.5	17	0033	5.7
W	1229	-2.9	TH	0547	29.3
	1808	30.2		1305	-0.6
				1849	28.6
3	0034	3.0	18	0100	5.8
TH	0555	32.4	F	0618	29.5
	1316	-3.8		1336	-0.5
	1854	30.5		1923	28.8
4	0118	3.0	19	0131	5.6
F	0635	32.8	SA	0649	29.1
	1401	-4.2		1407	-0.5
	1940	30.5		1958	28.7
5	0202	3.3	20	0205	5.7
SA	0720	32.5	SU	0722	28.4
	1446	-3.9		1440	-0.3
	2027	30.3		2034	28.3
6	0250	3.9	21	0243	6.0
SU	0807	31.6	M	0759	27.4
	1531	-3.1		1512	0.1
	2119	29.9		2115	27.7
7	0338	4.7	22	0322	6.3
M	0900	30.1	TU	0840	26.2
	1618	-1.9		1551	0.8
	2216	29.3		2157	27.1
8	0436	5.5	23	0405	6.7
TU	0957	28.3	W	0931	25.0
	1711	-0.3		1629	1.8
	2321	28.9		2245	26.5
9	0543	5.7	24	0454	6.9
W	1115	26.5	TH	1027	23.9
	1812	1.4		1714	3.1
				2337	26.2
10	0028	28.6	25	0553	6.7
TH	0659	5.0	F	1130	23.3
	1239	25.6		1809	4.5
	1921	2.7			
11	0135	28.6	26	0036	26.2
F	0814	3.3	SA	0705	5.7
	1359	25.6		1241	23.4
	2034	3.6		1912	5.6
12	0238	28.8	27	0135	26.8
SA	0927	1.4	SU	0823	3.7
	1510	26.3		1357	24.2
	2143	3.9		2026	5.9
13	0330	28.9	28	0228	27.7
SU	1023	-0.2	M	0923	1.5
	1609	27.1		1511	25.6
	2240	4.2		2124	5.6
14	0415	29.9	29	0318	28.9
M	1112	-1.1	TU	1019	-0.4
	1700	27.7		1615	27.1
	2325	4.7		2221	5.2
15	0450	28.8	30	0403	30.2
TU	1155	-1.2	W	1117	-2.0
	1742	28.1		1707	28.3
				2315	4.8
			31	0448	31.3
			TH	1210	-3.3
				1757	29.2

JUNE

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0011	4.3	16	0042	6.2
F	0531	32.1	SA	0601	28.6
	1259	-4.2		1318	-0.8
	1944	29.8		1904	28.2
2	0102	3.8	17	0115	5.6
SA	0618	32.4	SU	0638	28.6
	1348	-4.7		1351	-0.8
	1931	30.2		1939	28.5
3	0152	3.3	18	0152	5.2
SU	0709	32.2	M	0714	28.3
	1434	-4.6		1424	-0.7
	2017	30.4		2014	28.5
4	0241	3.1	19	0223	5.0
M	0800	31.5	TU	0749	27.7
	1519	-3.9		1454	-0.3
	2104	30.6		2050	28.3
5	0332	3.0	20	0307	4.8
TU	0852	30.2	W	0830	26.9
	1602	-2.7		1528	0.2
	2157	30.5		2126	28.0
6	0426	3.2	21	0348	4.7
W	0951	28.6	TH	0913	26.0
	1649	-0.9		1602	1.1
	2249	30.1		2201	27.7
7	0524	3.3	22	0434	4.4
TH	1055	26.7	F	1002	25.1
	1738	1.3		1643	2.3
	2348	29.4		2242	27.4
8	0628	3.1	23	0524	4.1
F	1209	25.2	SA	1057	24.3
	1835	3.6		1730	3.9
				2329	27.2
9	0046	28.6	24	0623	3.6
SA	0737	2.6	SU	1159	23.8
	1330	24.5		1825	5.7
	1941	5.6			
10	0148	27.9	25	0028	27.2
SU	0849	1.7	M	0735	2.5
	1451	24.8		1316	23.8
	2054	6.8		1935	6.8
11	0245	27.4	26	0131	27.7
M	0952	0.6	TU	0844	0.9
	1555	25.7		1449	24.8
	2206	7.1		2045	6.9
12	0336	27.2	27	0233	28.5
TU	1045	-0.3	W	0950	-0.5
	1648	26.5		1603	26.3
	2255	7.0		2149	6.4
13	0419	27.3	28	0330	29.7
W	1128	-0.7	TH	1054	-1.9
	1729	27.0		1659	27.8
	2336	6.9		2254	5.6
14	0454	27.6	29	0427	30.8
TH	1209	-0.8	F	1154	-3.2
	1802	27.4		1749	28.8
				2355	4.6
15	0009	6.6	30	0520	31.7
F	0527	28.2	SA	1247	-4.3
	1245	-0.8		1835	29.6
	1833	27.6			

TIME MERIDIAN 150° W. 0000 IS MIDNIGHT. 1200 IS NOON.
HEIGHTS ARE RECKONED FROM THE DATUM OF SOUNDINGS ON CHARTS OF THE LOCALITY WHICH IS MEAN LOWER LOW WATER.

ANCHORAGE, ALASKA, 1973

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

JULY

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0052	3.4	16	0101	4.6
SU	0610	32.2	M	0627	29.0
	1334	-4.9		1332	-1.3
	1917	30.2		1916	28.8
2	0143	2.2	17	0136	3.8
M	0701	32.3	TU	0703	29.1
	1417	-4.9		1405	-1.0
	2000	30.8		1949	29.1
3	0231	1.3	18	0214	3.3
TU	0750	31.8	W	0738	2[illegible].8
	1500	-4.2		1434	-0.6
	2043	31.2		2022	29.2
4	0318	0.9	19	0251	2.8
W	0839	30.7	TH	0817	28.2
	1541	-2.8		1504	0.1
	2125	31.2		2053	29.1
5	0405	1.0	20	0332	2.5
TH	0932	29.0	F	0856	27.4
	1620	-0.7		1537	1.0
	2213	30.6		2122	29.0
6	0454	1.5	21	0413	2.2
F	1027	27.0	SA	0939	26.4
	1701	1.9		1614	2.3
	2301	29.4		2159	28.7
7	0547	2.2	22	0458	2.0
SA	1130	25.0	SU	1029	25.3
	1746	4.8		1658	4.1
	2356	27.9		2242	28.3
8	0647	2.7	23	0551	2.0
SU	1245	23.5	M	1130	24.2
	1845	7.5		1751	6.2
				2341	27.7
9	0053	26.5	24	0655	1.8
M	0754	2.8	TU	1251	23.7
	1425	23.5		1858	7.8
	2001	9.1			
10	0154	25.6	25	0049	27.4
TU	0911	2.2	W	0810	1.1
	1536	24.6		1436	24.6
	2121	9.2		2018	8.0
11	0255	25.4	26	0206	27.9
W	1013	1.1	TH	0924	0.0
	1631	25.8		1550	26.3
	2226	8.2		2129	7.1
12	0349	25.9	27	0318	29.0
TH	1102	0.0	F	1040	-1.4
	1713	26.7		1647	28.0
	2309	7.2		2243	5.7
13	0434	26.7	28	0419	30.4
F	1145	-0.7	SA	1141	-3.0
	1746	27.2		1738	29.2
	2350	6.2		2349	3.8
14	0513	27.6	29	0513	31.6
SA	1224	-1.2	SU	1232	-4.2
	1811	27.7		1819	30.1
15	0027	5.4	30	0042	2.0
SU	0549	28.4	M	0601	32.3
	1259	-1.4		1317	-4.6
	1841	28.3		1858	30.8
			31	0131	0.5
			TU	0650	32.5
				1358	-4.2
				1935	31.4

AUGUST

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0214	-0.4	16	0156	1.3
W	0736	32.1	TH	0722	30.0
	1438	-3.2		1409	0.0
	2012	31.7		1947	30.4
2	0257	-0.7	17	0233	0.7
TH	0821	31.1	F	0759	29.5
	1512	-1.5		1438	0.7
	2050	31.6		2016	30.4
3	0340	-0.3	18	0312	0.5
F	0906	29.4	SA	0838	28.6
	1547	0.7		1513	1.7
	2128	30.6		2046	30.2
4	0420	0.6	19	0351	0.4
SA	0954	27.3	SU	0919	27.5
	1621	3.3		1548	3.2
	2207	29.1		2122	29.8
5	0505	1.8	20	0436	0.7
SU	1050	25.2	M	1010	26.2
	1657	6.1		1631	5.1
	2252	27.1		2208	28.9
6	0553	3.0	21	0525	1.2
M	1159	23.4	TU	1111	24.8
	1746	8.9		1724	7.3
	2355	25.1		2305	27.6
7	0654	3.8	22	0629	1.8
TU	1334	22.8	W	1241	24.2
	1909	10.8		1836	8.9
8	0105	23.9	23	0022	26.8
W	0808	3.8	TH	0747	1.7
	1508	23.9		1422	25.3
	2042	10.3		2004	8.6
9	0220	23.9	24	0157	27.2
TH	0930	2.6	F	0910	0.8
	1603	25.5		1535	27.2
	2154	8.5		2127	6.8
10	0326	25.0	25	0316	28.7
F	1029	0.9	SA	1027	-0.5
	1648	26.7		1630	29.0
	2245	6.6		2243	4.4
11	0415	26.4	26	0415	30.4
SA	1116	-0.4	SU	1125	-2.5
	1719	27.5		1719	30.2
	2326	5.1		2342	2.0
12	0456	27.7	27	0507	31.6
SU	1157	-1.1	M	1214	-3.2
	1746	28.2		1758	30.9
13	0005	3.9	28	0031	0.2
M	0531	28.9	TU	0552	32.3
	1233	-1.3		1257	-3.0
	1815	28.9		1831	31.5
14	0040	2.9	29	0114	-0.9
TU	0608	29.7	W	0637	32.4
	1308	-1.2		1335	-2.2
	1846	29.7		1905	31.9
15	0119	2.0	30	0156	-1.4
W	0644	30.1	TH	0718	32.1
	1341	-0.7		1410	-0.8
	1917	30.2		1936	32.1
			31	0233	-1.2
			F	0801	31.1
				1440	0.9
				2011	31.6

SEPTEMBER

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0310	-0.6	16	0253	-1.1
SA	0843	29.7	SU	0823	29.5
	1511	2.8		1449	3.1
	2043	30.4		2017	31.2
2	0347	0.4	17	0333	-0.7
SU	0925	27.8	M	0905	28.4
	1542	4.9		1527	4.5
	2112	28.7		2056	30.4
3	0423	1.6	18	0416	0.0
M	1010	25.9	TU	1000	27.0
	1618	7.2		1613	6.3
	2147	26.6		2145	29.0
4	0503	2.9	19	0505	1.1
TU	1112	24.3	W	1105	25.9
	1701	9.6		1708	8.2
	2236	24.4		2246	27.3
5	0557	4.1	20	0609	2.1
W	1227	23.3	TH	1237	25.6
	1913	11.5		1829	9.2
6	0015	22.8	21	0012	26.2
TH	0714	4.8	F	0732	2.3
	1409	23.7		1403	26.7
	2010	10.8		2006	7.8
7	0144	22.9	22	0154	26.9
F	0839	3.8	SA	0855	1.5
	1524	25.4		1514	28.4
	2121	8.3		2127	5.2
8	0301	24.4	23	0303	28.5
SA	0946	2.1	SU	1009	0.1
	1609	26.9		1606	30.0
	2212	5.9		2234	2.3
9	0349	26.2	24	0405	30.1
SU	1040	0.6	M	1104	-0.9
	1644	28.0		1653	31.0
	2257	4.0		2328	0.1
10	0431	27.8	25	0456	31.1
M	1123	-0.1	TU	1151	-1.0
	1713	28.9		1732	31.4
	2338	2.5			
11	0510	29.2	26	0015	-1.2
TU	1202	-0.2	W	0541	31.6
	1742	29.8		1232	-0.3
				1801	31.7
12	0017	1.3	27	0056	-1.6
W	0547	30.2	TH	0624	31.6
	1237	0.1		1309	0.9
	1811	30.7		1831	32.0
13	0057	0.2	28	0135	-1.5
TH	0623	30.8	F	0702	31.4
	1310	0.6		1341	2.2
	1842	31.3		1900	31.9
14	0134	-0.6	29	0210	-1.0
F	0701	30.8	SA	0742	30.7
	1343	1.3		1410	3.5
	1911	31.6		1932	31.3
15	0215	-1.1	30	0243	-0.3
SA	0742	30.4	SU	0621	29.7
	1414	2.0		1437	4.7
	1942	31.6		2002	30.0

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CORDOVA, ALASKA, 1973

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

APRIL

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0446	1.2	16	0530	-0.5
SU	1058	11.8	M	1154	11.5
	1701	0.4		1731	1.1
	2318	12.6		2349	13.2
2	0524	-0.1	17	0606	-1.0
M	1139	12.3	TU	1231	11.4
	1736	0.2		1806	1.5
	2349	13.5			
3	0605	-1.2	18	0020	13.3
TU	1221	12.5	W	0641	-1.2
	1811	0.4		1306	11.2
				1839	2.0
4	0022	14.2	19	0048	13.1
W	0646	-2.0	TH	0716	-1.1
	1303	12.4		1341	10.7
	1848	0.6		1910	2.5
5	0057	14.5	20	0115	12.8
TH	0730	-2.3	F	0754	-0.8
	1346	12.0		1415	10.2
	1929	1.4		1945	3.1
6	0132	14.5	21	0144	12.3
F	0815	-2.2	SA	0833	-0.3
	1430	11.3		1451	9.5
	2010	2.2		2022	3.8
7	0213	14.1	22	0215	11.8
SA	0907	-1.6	SU	0915	0.3
	1523	10.3		1533	8.9
	2059	3.1		2104	4.4
8	0258	13.2	23	0248	11.1
SU	1003	-0.9	M	1005	0.9
	1629	9.5		1630	8.3
	2159	3.9		2155	4.9
9	0355	12.1	24	0329	10.3
M	1107	0.0	TU	1055	1.5
	1757	9.1		1745	8.1
	2310	4.5		2258	5.3
10	0515	11.0	25	0431	9.5
TU	1216	0.7	W	1154	2.0
	1926	9.4		1902	8.4
11	0038	4.6	26	0013	5.2
W	0653	10.5	TH	0606	9.0
	1333	1.0		1257	2.2
	2031	10.1		1958	9.1
12	0208	3.9	27	0135	4.5
TH	0817	10.5	F	0733	9.1
	1442	1.0		1358	2.1
	2125	11.0		2040	9.9
13	0319	2.7	28	0243	3.3
F	0924	10.8	SA	0839	9.5
	1535	0.8		1450	1.9
	2206	11.9		2115	10.9
14	0412	1.4	29	0332	1.7
SA	1023	11.2	SU	0938	10.1
	1620	0.8		1538	1.6
	2245	12.5		2151	11.9
15	0454	0.3	30	0416	0.2
SU	1110	11.4	M	1031	10.7
	1657	0.9		1620	1.4
	2318	13.0		2229	12.9

MAY

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0458	-1.3	16	0547	-1.2
TU	1120	11.2	W	1222	10.3
	1701	1.3		1739	2.7
	2308	13.8		2349	12.7
2	0543	-2.4	17	0622	-1.4
W	1208	11.6	TH	1257	10.3
	1740	1.4		1814	2.9
	2349	14.4			
3	0627	-3.1	18	0021	12.6
TH	1254	11.7	F	0657	-1.4
	1923	1.6		1330	10.1
				1849	3.2
4	0032	14.7	19	0050	12.5
F	0714	-3.3	SA	0737	-1.2
	1340	11.5		1405	9.9
	1909	2.0		1927	3.5
5	0115	14.6	20	0124	12.1
SA	0803	-3.1	SU	0815	-0.8
	1429	11.1		1441	9.6
	2000	2.5		2006	3.9
6	0200	14.0	21	0153	11.7
SU	0854	-2.5	M	0854	-0.4
	1521	10.6		1523	9.3
	2057	3.0		2049	4.2
7	0252	13.0	22	0228	11.1
M	0950	-1.6	TU	0937	0.1
	1624	10.2		1605	9.1
	2158	3.5		2142	4.4
8	0355	11.7	23	0313	10.4
TU	1047	-0.6	W	1018	0.7
	1738	10.0		1653	9.1
	2309	3.7		2237	4.4
9	0512	10.5	24	0406	9.6
W	1150	0.3	TH	1107	1.3
	1849	10.3		1746	9.3
				2339	4.2
10	0027	3.5	25	0515	8.9
TH	0637	9.8	F	1154	1.8
	1252	1.1		1844	9.8
	1949	10.8			
11	0149	2.9	26	0050	3.5
F	0758	9.5	SA	0643	8.6
	1355	1.6		1248	2.2
	2040	11.4		1930	10.5
12	0255	1.9	27	0155	2.4
SA	0908	9.6	SU	0758	8.7
	1456	2.0		1351	2.5
	2125	11.9		2016	11.3
13	0348	0.8	28	0255	1.0
SU	1007	9.9	M	0908	9.1
	1541	2.2		1447	2.6
	2204	12.3		2103	12.2
14	0433	-0.1	29	0348	-0.5
M	1056	10.0	TU	1010	9.7
	1623	2.3		1541	2.5
	2242	12.5		2148	13.1
15	0511	-0.7	30	0439	-1.8
TU	1143	10.2	W	1105	10.3
	1704	2.5		1631	2.4
	2318	12.7		2236	13.9
			31	0526	-2.9
			TH	1200	10.8
				1718	2.2
				2326	14.4

JUNE

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0614	-3.6	16	0002	12.4
F	1248	11.2	SA	0643	-1.4
	1809	2.1		1324	10.0
				1831	3.4
2	0016	14.7	17	0036	12.4
SA	0701	-3.7	SU	0719	-1.4
	1337	11.4		1353	10.1
	1858	2.1		1912	3.4
3	0105	14.5	18	0111	12.2
SU	0750	-3.5	M	0754	-1.2
	1425	11.4		1425	10.2
	1953	2.3		1953	3.5
4	0153	13.9	19	0142	11.9
M	0842	-2.9	TU	0829	-0.9
	1513	11.3		1457	10.2
	2051	2.4		2035	3.5
5	0247	12.9	20	0215	11.4
TU	0930	-1.9	W	0907	-0.4
	1605	11.2		1529	10.2
	2150	2.6		2120	3.4
6	0343	11.6	21	0254	10.7
W	1022	-0.8	TH	0945	0.2
	1659	11.1		1608	10.3
	2256	2.7		2211	3.3
7	0450	10.3	22	0339	9.9
TH	1111	0.3	F	1024	1.0
	1901	11.1		1645	10.5
				2304	3.0
8	0000	2.6	23	0441	9.1
F	0609	9.2	SA	1104	1.8
	1207	1.5		1732	10.7
	1858	11.2			
9	0113	2.3	24	0003	2.5
SA	0730	8.7	SU	0600	8.4
	1303	2.5		1157	2.6
	1951	11.4		1830	11.1
10	0224	1.6	25	0113	1.8
SU	0845	8.5	M	0726	8.2
	1405	3.2		1254	3.2
	2040	11.6		1923	11.7
11	0321	0.9	26	0221	0.7
M	0948	8.7	TU	0843	8.4
	1503	3.5		1403	3.6
	2125	11.7		2021	12.4
12	0413	0.2	27	0325	-0.6
TU	1048	9.0	W	0957	9.0
	1554	3.7		1512	3.5
	2209	11.9		2119	13.1
13	0452	-0.4	28	0423	-1.8
W	1131	9.3	TH	1057	9.8
	1635	3.6		1612	3.1
	2249	12.1		2217	13.8
14	0531	-0.9	29	0514	-2.8
TH	1214	9.6	F	1148	10.6
	1716	3.6		1705	2.6
	2327	12.3		2314	14.3
15	0606	-1.2	30	0602	-3.4
F	1249	9.9	SA	1237	11.3
	1756	3.5		1758	2.1

TIME MERIDIAN 150° W. 0000 IS MIDNIGHT. 1200 IS NOON.
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CORDOVA, ALASKA, 1973

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

JULY

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0009	14.6	16	0024	12.5
SU	0649	-3.6	M	0657	-1.3
	1324	11.8		1328	10.8
	1850	1.8		1856	2.8
2	0058	14.5	17	0053	12.5
M	0734	-3.4	TU	0727	-1.2
	1406	12.2		1356	11.1
	1944	1.5		1932	2.5
3	0147	13.9	18	0128	12.3
TU	0819	-2.7	W	0801	-0.9
	1448	12.3		1422	11.3
	2035	1.5		2015	2.3
4	0235	12.8	19	0203	11.8
W	0905	-1.7	TH	0836	-0.4
	1532	12.2		1451	11.5
	2130	1.6		2057	2.2
5	0326	11.5	20	0238	11.1
TH	0950	-0.5	F	0907	0.4
	1618	12.0		1520	11.6
	2227	1.7		2140	2.0
6	0421	10.1	21	0321	10.2
F	1032	0.9	SA	0942	1.2
	1709	11.6		1555	11.6
	2325	1.9		2230	1.9
7	0532	8.9	22	0412	9.3
SA	1115	2.2	SU	1021	2.2
	1800	11.3		1640	11.6
				2329	1.7
8	0030	2.1	23	0525	8.3
SU	0657	8.1	M	1112	3.2
	1209	3.4		1735	11.6
	1857	11.1			
9	0143	1.9	24	0041	1.4
M	0820	7.8	TU	0703	7.9
	1312	4.2		1213	4.0
	1958	11.0		1844	11.8
10	0253	1.5	25	0157	0.8
TU	0932	8.0	W	0834	8.2
	1421	4.7		1335	4.4
	2049	11.1		1958	12.2
11	0348	0.8	26	0312	-0.2
W	1031	8.5	TH	0951	8.9
	1525	4.6		1456	4.2
	2142	11.4		2106	12.8
12	0433	0.2	27	0410	-1.4
TH	1120	9.0	F	1048	9.9
	1616	4.3		1601	3.4
	2225	11.7		2212	13.5
13	0514	-0.4	28	0502	-2.3
F	1157	9.6	SA	1137	11.0
	1702	3.9		1658	2.5
	2308	12.1		2308	14.1
14	0549	-0.9	29	0547	-2.8
SA	1230	10.1	SU	1223	11.9
	1740	3.5		1749	1.6
	2348	12.4			
15	0622	-1.2	30	0003	14.4
SU	1259	10.5	M	0630	-2.9
	1817	3.1		1300	12.6
				1839	0.9
			31	0049	14.3
			TU	0711	-2.6
				1339	13.1
				1927	0.5

AUGUST

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0134	13.7	16	0111	12.6
W	0753	-1.9	TH	0724	-0.4
	1415	13.2		1343	12.6
	2013	0.4		1947	0.9
2	0217	12.7	17	0148	12.1
TH	0831	-0.8	F	0759	0.2
	1451	13.0		1406	12.7
	2102	0.6		2029	0.7
3	0301	11.5	18	0223	11.4
F	0912	0.4	SA	0832	1.0
	1529	12.5		1441	12.8
	2152	1.1		2114	0.7
4	0352	10.1	19	0304	10.5
SA	0949	1.8	SU	0913	2.0
	1612	11.9		1514	12.6
	2243	1.6		2203	0.9
5	0450	8.8	20	0358	9.4
SU	1030	3.1	M	0952	3.0
	1653	11.2		1559	12.2
	2345	2.1		2306	1.1
6	0612	7.8	21	0512	8.4
M	1120	4.3	TU	1046	4.0
	1757	10.6		1658	11.8
7	0055	2.4	22	0015	1.3
TU	0752	7.5	W	0659	8.0
	1221	5.1		1155	4.8
	1912	10.3		1822	11.5
8	0216	2.2	23	0141	1.0
W	0909	7.9	TH	0837	8.5
	1349	5.5		1330	5.0
	2018	10.5		1949	11.8
9	0325	1.6	24	0259	0.2
TH	1015	8.5	F	0940	9.5
	1505	5.2		1453	4.3
	2119	10.9		2106	12.4
10	0413	0.9	25	0357	-0.7
F	1100	9.2	SA	1036	10.7
	1600	4.6		1601	3.1
	2213	11.5		2209	13.1
11	0451	0.1	26	0444	-1.4
SA	1131	9.9	SU	1117	11.8
	1645	3.8		1655	1.8
	2254	12.0		2304	13.7
12	0527	-0.4	27	0527	-1.8
SU	1202	10.6	M	1156	12.8
	1721	3.0		1741	0.7
	2330	12.4		2353	13.9
13	0556	-0.8	28	0606	-1.7
M	1227	11.3	TU	1233	13.5
	1757	2.3		1822	0.0
14	0006	12.7	29	0037	13.8
TU	0625	-0.9	W	0642	-1.3
	1254	11.8		1304	13.8
	1833	1.7		1906	-0.4
15	0038	12.8	30	0118	13.3
W	0656	-0.8	TH	0721	-0.5
	1317	12.2		1338	13.9
	1910	1.2		1948	-0.4
			31	0159	12.4
			F	0756	0.5
				1409	13.5
				2033	0.0

SEPTEMBER

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0239	11.3	16	0212	11.6
SA	0833	1.7	SU	0803	2.0
	1442	12.9		1406	13.7
	2115	0.6		2051	-0.4
2	0320	10.1	17	0254	10.6
SU	0909	2.9	M	0845	2.9
	1513	12.1		1445	13.3
	2203	1.3		2145	0.1
3	0409	8.9	18	0353	9.6
M	0950	4.0	TU	0932	3.9
	1552	11.2		1530	12.5
	2259	2.1		2247	0.7
4	0530	7.9	19	0515	8.8
TU	1037	5.0	W	1035	4.8
	1650	10.3		1640	11.7
				2359	1.2
5	0008	2.7	20	0703	8.7
W	0721	7.7	TH	1155	5.3
	1142	5.8		1815	11.1
	1813	9.8			
6	0129	2.8	21	0123	1.2
TH	0843	8.1	F	0823	9.5
	1317	6.0		1335	5.0
	1946	9.9		1950	11.3
7	0243	2.3	22	0237	0.8
F	0940	8.9	SA	0920	10.6
	1442	5.4		1456	3.8
	2053	10.4		2103	11.9
8	0338	1.6	23	0335	0.3
SA	1021	9.7	SU	1009	11.7
	1541	4.5		1554	2.4
	2148	11.1		2204	12.5
9	0417	0.9	24	0421	-0.1
SU	1050	10.5	M	1046	12.7
	1623	3.4		1644	1.0
	2229	11.7		2257	12.9
10	0449	0.4	25	0502	-0.2
M	1117	11.3	TU	1125	13.5
	1658	2.3		1724	-0.1
	2308	12.3		2343	13.1
11	0521	0.0	26	0539	-0.1
TU	1145	12.1	W	1158	14.0
	1733	1.3		1805	-0.8
	2345	12.6			
12	0551	-0.1	27	0026	13.0
W	1209	12.8	TH	0613	0.4
	1808	0.4		1231	14.2
				1843	-1.0
13	0021	12.8	28	0103	12.6
TH	0622	0.1	F	0649	1.1
	1236	13.3		1259	14.0
	1844	-0.2		1924	-0.9
14	0057	12.7	29	0141	11.9
F	0655	0.5	SA	0724	1.9
	1304	13.7		1330	13.6
	1923	-0.6		2001	-0.5
15	0132	12.3	30	0219	11.1
SA	0726	1.1	SU	0759	2.9
	1333	13.8		1400	13.0
	2006	-0.7		2043	0.2

DUTCH HARBOR, ALASKA, 1973

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

APRIL

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0140	2.9	16	0216	3.2
SU	0746	1.3	M	0937	0.3
	1355	2.8		1657	3.0
	1947	1.4		2144	2.4
2	0156	3.0	17	0240	3.1
M	0835	0.8	TU	1019	0.1
	1518	2.8		1819	3.2
	2029	1.8		2305	2.7
3	0219	3.1	18	0257	3.0
TU	0932	0.4	W	1106	0.0
	1645	2.9		1934	3.4
	2130	2.2			
4	0248	3.3	19	0042	2.8
W	1032	-0.1	TH	0315	2.9
	1820	3.1		1149	-0.1
	2233	2.6		2023	3.5
5	0331	3.4	20	1235	-0.1
TH	1130	-0.5	F	2106	3.6
	1930	3.3			
	2348	2.8			
6	0426	3.5	21	1318	-0.1
F	1232	-0.8	SA	2152	3.6
	2033	3.5			
7	0059	2.9	22	1401	-0.1
SA	0529	3.6	SU	2223	3.6
	1328	-1.0			
	2128	3.7			
8	0206	2.8	23	0442	2.7
SU	0637	3.6	M	0527	2.8
	1429	-1.0		1441	0.0
	2209	3.7		2256	3.5
9	0311	2.6	24	0444	2.6
M	0753	3.6	TU	0714	2.7
	1523	-0.9		1521	0.1
	2252	3.7		2319	3.4
10	0408	2.3	25	0506	2.5
TU	0902	3.5	W	0824	2.7
	1617	-0.6		1551	0.3
	2338	3.7		2336	3.3
11	0506	2.0	26	0521	2.2
W	1012	3.3	TH	0926	2.6
	1711	-0.2		1628	0.6
				2343	3.3
12	0013	3.6	27	0542	1.9
TH	0602	1.6	F	1035	2.6
	1127	3.1		1657	1.0
	1800	0.3		2351	3.3
13	0048	3.5	28	0616	1.4
F	0657	1.2	SA	1146	2.6
	1243	3.0		1730	1.4
	1852	0.9		2359	3.3
14	0119	3.4	29	0651	0.9
SA	0752	0.8	SU	1310	2.6
	1406	2.9		1804	1.8
	1944	1.4			
15	0147	3.3	30	0014	3.5
SU	0848	0.5	M	0729	0.4
	1532	2.9		1440	2.8
	2040	1.9		1841	2.2

MAY

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0037	3.6	16	0112	3.3
TU	0823	-0.2	W	0953	-0.3
	1603	3.0		1855	3.6
	1936	2.7			
2	0106	3.8	17	0100	3.3*
W	0912	-0.6	TH	1036	-0.3
	1723	3.3		1950	3.7
	2039	3.0			
3	0149	3.9	18	1115	-0.3
TH	1009	-1.0	F	2033	3.8
	1834	3.5			
	2200	3.2			
4	0241	3.9	19	1151	-0.3
F	1104	-1.2	SA	2108	3.8
	1931	3.8			
	2328	3.3			
5	0347	3.9	20	1232	-0.2
SA	1205	-1.3	SU	2135	3.8
	2020	3.9			
6	0053	3.1	21	1313	-0.1
SU	0503	3.7	M	2156	3.7
	1303	-1.2			
	2100	4.0			
7	0205	2.8	22	1347	0.1
M	0621	3.5	TU	2211	3.7
	1400	-1.0			
	2143	4.1			
8	0310	2.3	23	1417	0.4
TU	0748	3.3	W	2222	3.6
	1457	-0.6			
	2218	4.1			
9	0416	1.8	24	0501	2.2
W	0905	3.1	TH	0745	2.4
	1550	-0.1		1452	0.7
	2253	4.1		2227	3.5
10	0514	1.3	25	0515	1.8
TH	1033	2.9	F	0921	2.3
	1640	0.5		1521	1.1
	2328	4.0		2231	3.6
11	0609	0.8	26	0531	1.3
F	1159	2.8	SA	1052	2.3
	1729	1.2		1554	1.5
	2359	3.9		2239	3.7
12	0659	0.4	27	0557	0.7
SA	1329	2.8	SU	1223	2.4
	1824	1.8		1623	2.0
				2254	3.8
13	0028	3.7	28	0633	0.1
SU	0745	0.1	M	1348	2.6
	1500	2.9		1659	2.4
	1913	2.3		2317	4.1
14	0051	3.6	29	0717	-0.5
M	0830	-0.1	TU	1514	2.9
	1630	3.1		1740	2.8
	2021	2.8		2346	4.3
15	0103	3.4	30	0802	-1.0
TU	0912	-0.2	W	1633	3.2
	1745	3.4		1837	3.1
	2132	3.1			
			31	0029	4.4
			TH	0853	-1.3
				1728	3.5
				1952	3.4

JUNE

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0121	4.4	16	1038	-0.4
F	0949	-1.5	SA	2031	3.7
	1821	3.7			
	2126	3.4			
2	0216	4.3	17	1115	-0.3
SA	1043	-1.5	SU	2052	3.7
	1906	3.8			
	2303	3.3			
3	0329	4.0	18	1150	-0.2
SU	1143	-1.4	M	2103	3.6
	1946	4.0			
4	0039	3.0	19	1225	0.0
M	0445	3.7	TU	2111	3.6
	1239	-1.1			
	2023	4.1			
5	0155	2.5	20	1254	0.3
TU	0620	3.3	W	2112	3.5
	1335	-0.6			
	2058	4.2			
6	0307	1.9	21	1323	0.6
W	0749	2.9	TH	2117	3.5
	1429	-0.1			
	2139	4.2			
7	0407	1.2	22	0421	1.8
TH	0926	2.7	F	0759	2.1
	1518	0.6		1358	1.0
	2214	4.2		2121	3.5
8	0509	0.6	23	0437	1.2
F	1057	2.7	SA	0952	2.1
	1615	1.2		1427	1.5
	2247	4.1		2130	3.7
9	0557	0.2	24	0457	0.6
SA	1229	2.7	SU	1131	2.2
	1704	1.8		1450	1.9
	2316	4.0		2145	3.9
10	0646	-0.2	25	0534	0.0
SU	1359	2.9	M	1300	2.4
	1758	2.4		1531	2.3
	2343	3.8		2208	4.1
11	0729	-0.4	26	0614	-0.6
M	1522	3.1	TU	1416	2.7
	1853	2.8		1612	2.7
				2241	4.3
12	0001	3.7	27	0658	-1.1
TU	0814	-0.5	W	1525	3.0
	1644	3.3		1655	2.9
	1942	3.2		2322	4.5
13	0012	3.6	28	0746	-1.4
W	0849	-0.6	TH	1627	3.2
	1801	3.5		1804	3.1
	2053	3.4			
14	0009	3.5	29	0009	4.6
TH	0928	-0.5	F	0837	-1.6
	1910	3.6		1703	3.3
				1930	3.2
15	0100	3.5*	30	0112	4.5
F	1005	-0.5	SA	0931	-1.6
	2004	3.7		1743	3.5
				2107	3.1

TIME MERIDIAN 165° W. 0000 IS MIDNIGHT. 1200 IS NOON.
HEIGHTS ARE RECKONED FROM THE DATUM OF SOUNDINGS ON CHARTS OF THE LOCALITY WHICH IS MEAN LOWER LOW WATER.
*NEITHER HIGH NOR LOW WATER BUT AN INTERMEDIATE VALUE TO SHOW PERIOD OF APPROXIMATE STAND.

DUTCH HARBOR, ALASKA, 1973

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

JULY

DAY	TIME H.M.	HT. FT.
1 SU	0214	4.2
	1023	-1.5
	1826	3.6
	2243	2.9
2 M	0323	3.8
	1118	-1.1
	1907	3.7
3 TU	0019	2.4
	0446	3.3
	1212	-0.6
	1944	3.9
4 W	0136	1.8
	0622	2.9
	1309	-0.1
	2019	4.0
5 TH	0250	1.2
	0804	2.6
	1404	0.5
	2056	4.0
6 F	0348	0.6
	0940	2.6
	1501	1.1
	2132	4.0
7 SA	0443	0.1
	1114	2.7
	1554	1.7
	2207	3.9
8 SU	0531	-0.3
	1239	2.8
	1650	2.1
	2236	3.8
9 M	0617	-0.6
	1354	3.0
	1739	2.5
	2305	3.7
10 TU	0700	-0.7
	1510	3.1
	1830	2.8
	2326	3.6
11 W	0741	-0.7
	1625	3.2
	1903	3.1
	2341	3.5
12 TH	0818	-0.7
	1700	3.2*
	2342	3.5
13 F	0858	-0.6
	1800	3.3*
	2357	3.5
14 SA	0932	-0.5
	1900	3.3*
15 SU	0012	3.4
	1007	-0.4
	1900	3.2*
	2000	3.3
16 M	0100	3.2*
	1036	-0.2
	1955	3.2
17 TU	1111	0.0
	1954	3.2
18 W	1140	0.3
	1954	3.1
19 TH	0218	2.2
	0437	2.2
	1215	0.7
	1957	3.2
20 F	0244	1.7
	0701	2.0
	1252	1.1
	2003	3.2
21 SA	0314	1.1
	0852	2.0
	1327	1.5
	2018	3.4
22 SU	0348	0.5
	1029	2.2
	1354	1.9
	2037	3.6
23 M	0426	-0.1
	1153	2.4
	1437	2.2
	2103	3.9
24 TU	0507	-0.6
	1302	2.6
	1518	2.5
	2139	4.1
25 W	0550	-1.1
	1357	2.8
	1601	2.7
	2226	4.3
26 TH	0639	-1.4
	1457	2.9
	1705	2.8
	2315	4.4
27 F	0727	-1.5
	1534	3.0
	1818	2.8
28 SA	0011	4.3
	0820	-1.5
	1615	3.0
	1935	2.7
29 SU	0108	4.1
	0909	-1.2
	1652	3.1
	2103	2.5
30 M	0215	3.7
	1003	-0.9
	1733	3.2
	2232	2.1
31 TU	0339	3.3
	1058	-0.4
	1810	3.4
	2354	1.6

AUGUST

DAY	TIME H.M.	HT. FT.
1 W	0509	2.9
	1154	0.1
	1851	3.5
2 TH	0111	1.1
	0650	2.7
	1252	0.7
	1928	3.5
3 F	0220	0.5
	0826	2.6
	1351	1.2
	2010	3.6
4 SA	0315	0.1
	0954	2.7
	1447	1.6
	2048	3.5
5 SU	0408	-0.3
	1111	2.8
	1549	2.0
	2127	3.5
6 M	0457	-0.5
	1220	2.9
	1640	2.3
	2203	3.5
7 TU	0540	-0.6
	1326	3.0
	1728	2.5
	2226	3.4
8 W	0627	-0.6
	1431	3.0
	1804	2.7
	2254	3.4
9 TH	0707	-0.6
	1532	2.9
	1832	2.8
	2322	3.3
10 F	0743	-0.5
	1628	2.9
	1848	2.8
	2344	3.3
11 SA	0818	-0.4
	1711	2.8
	1911	2.8
12 SU	0012	3.2
	0950	-0.2
	1744	2.8
	2002	2.7
13 M	0048	3.1
	0922	0.0
	1747	2.7
	2117	2.5
14 TU	0137	2.8
	0957	0.3
	1752	2.7
	2233	2.3
15 W	0240	2.6
	1018	0.6
	1757	2.7
	2336	1.9
16 TH	0422	2.3
	1101	1.0
	1806	2.8
17 F	0036	1.4
	0606	2.2
	1136	1.3
	1824	2.9
18 SA	0127	0.9
	0757	2.3
	1233	1.7
	1842	3.1
19 SU	0215	0.3
	0922	2.4
	1321	2.1
	1915	3.3
20 M	0303	-0.2
	1037	2.6
	1410	2.3
	1954	3.5
21 TU	0352	-0.6
	1134	2.8
	1459	2.5
	2037	3.8
22 W	0438	-0.9
	1234	2.9
	1548	2.6
	2126	3.9
23 TH	0528	-1.1
	1315	2.9
	1643	2.5
	2221	4.0
24 F	0617	-1.2
	1352	2.9
	1735	2.4
	2316	4.0
25 SA	0706	-1.0
	1433	2.9
	1844	2.2
26 SU	0020	3.8
	0[illegible]55	-0.7
	1510	3.0
	1955	2.0
27 M	0128	3.5
	0945	-0.3
	1545	3.0
	2103	1.6
28 TU	0[illegible]45	3.2
	0938	0.2
	1626	3.1
	2220	1.2
29 W	0413	2.9
	1039	0.7
	1708	3.1
	2335	0.8
30 TH	0547	2.8
	1141	1.2
	1750	3.1
31 F	0037	0.4
	0721	2.8
	1247	1.6
	1830	3.1

SEPTEMBER

DAY	TIME H.M.	HT. FT.
1 SA	0137	0.1
	0840	3.0
	1354	1.9
	1919	3.1
2 SU	0235	-0.2
	0955	3.1
	1455	2.1
	2000	3.1
3 M	0324	-0.3
	1057	3.2
	1551	2.2
	2043	3.1
4 TU	0412	-0.4
	1152	3.2
	1636	2.4
	2117	3.1
5 W	0457	-0.4
	1243	3.1
	1714	2.5
	2152	3.1
6 TH	0539	-0.3
	1324	3.0
	1742	2.5
	2227	3.2
7 F	0618	-0.2
	1407	2.9
	1811	2.5
	2257	3.1
8 SA	0656	0.0
	1442	2.8
	1839	2.4
	2339	3.1
9 SU	0725	0.2
	1457	2.7
	1914	2.3
10 M	0021	2.9
	0754	0.5
	1512	2.6
	1957	2.0
11 TU	0116	2.8
	0829	0.8
	1520	2.6
	2051	1.7
12 W	0233	2.6
	0906	1.2
	1529	2.7
	2148	1.4
13 TH	0353	2.6
	0941	1.5
	1548	2.8
	2243	0.9
14 F	0529	2.6
	1030	1.9
	1613	2.9
	2339	0.5
15 SA	0706	2.7
	1124	2.3
	1648	3.1
16 SU	0032	0.1
	0821	3.0
	1233	2.5
	1731	3.3
17 M	0129	-0.3
	0924	3.1
	1336	2.7
	1826	3.4
18 TU	0226	-0.6
	1019	3.3
	1432	2.7
	1922	3.6
19 W	0318	-0.8
	1106	3.3
	1523	2.7
	2024	3.7
20 TH	0411	-0.9
	1149	3.3
	1617	2.5
	2127	3.7
21 F	0500	-0.7
	1226	3.3
	1711	2.3
	2230	3.7
22 SA	0552	-0.5
	1259	3.3
	1812	1.9
	2338	3.5
23 SU	0641	-0.1
	1336	3.3
	1906	1.6
24 M	0048	3.3
	0727	0.4
	1409	3.2
	2009	1.2
25 TU	0708	3.1
	0823	1.0
	1440	3.2
	2106	0.8
26 W	0336	3.0
	0924	1.5
	1516	3.2
	2207	0.5
27 TH	0508	3.1
	1027	2.0
	1551	3.1
	2309	0.2
28 F	0629	3.2
	1138	2.3
	1629	3.1
29 SA	0003	0.1
	0746	3.4
	1258	2.5
	1716	3.0
30 SU	0055	-0.1
	0848	3.5
	1412	2.6
	1804	3.0

TIME MERIDIAN 165° W. 0000 IS MIDNIGHT. 1200 IS NOON.
HEIGHTS ARE RECKONED FROM THE DATUM OF SOUNDINGS ON CHARTS OF THE LOCALITY WHICH IS MEAN LOWER LOW WATER.
*NEITHER HIGH NOR LOW WATER BUT AN INTERMEDIATE VALUE TO SHOW PERIOD OF APPROXIMATE STAND.

JUNEAU, ALASKA, 1973

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

APRIL

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0027	15.8	16	0100	17.5
SU	0628	0.8	M	0714	-1.2
	1241	16.0		1333	16.2
	1847	0.0		1920	0.7
2	0100	17.1	17	0133	17.8
M	0709	-0.9	TU	0750	-1.8
	1320	16.8		1412	16.2
	1922	-0.4		1955	1.1
3	0134	18.1	18	0204	17.7
TU	0746	-2.3	W	0823	-1.9
	1401	17.2		1447	15.9
	1959	-0.4		2028	1.6
4	0206	18.9	19	0233	17.4
W	0828	-3.2	TH	0859	-1.7
	1441	17.3		1521	15.3
	2034	0.0		2102	2.3
5	0244	19.2	20	0303	16.9
TH	0909	-3.5	F	0932	-1.2
	1526	16.8		1557	14.6
	2115	0.7		2133	3.1
6	0322	19.0	21	0336	16.3
F	0952	-3.2	SA	1007	-0.4
	1611	16.0		1633	13.7
	2156	1.7		2212	4.0
7	0405	18.2	22	0411	15.4
SA	1040	-2.3	SU	1046	0.5
	1702	14.8		1715	12.9
	2243	2.9		2249	4.9
8	0456	17.1	23	0446	14.5
SU	1135	-1.1	M	1131	1.5
	1804	13.7		1804	12.1
	2342	4.2		2334	5.8
9	0555	15.7	24	0535	13.5
M	1242	0.2	TU	1226	2.4
	1918	13.0		1909	11.7
10	0057	5.2	25	0042	6.3
TU	0708	14.5	W	0636	12.6
	1359	1.1		1330	3.1
	2040	13.0		2020	11.8
11	0230	5.2	26	0207	6.2
W	0839	13.8	TH	0754	12.2
	1518	1.4		1439	3.3
	2157	13.7		2122	12.5
12	0400	4.2	27	0321	5.3
TH	1004	14.0	F	0915	12.3
	1625	1.2		1544	3.0
	2256	14.9		2213	13.6
13	0501	2.7	28	0425	3.7
F	1114	14.7	SA	1026	13.0
	1719	0.8		1636	2.5
	2343	16.0		2257	14.9
14	0553	1.1	29	0516	1.8
SA	1209	15.4	SU	1121	14.0
	1806	0.6		1721	2.0
				2337	16.2
15	0025	16.9	30	0559	-0.1
SU	0635	-0.3	M	1211	15.1
	1254	15.9		1806	1.5
	1843	0.5			

MAY

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0015	17.5	16	0102	17.0
TU	0644	-1.9	W	0729	-1.5
	1259	16.0		1358	15.0
	1850	1.1		1932	2.9
2	0057	18.6	17	0133	17.1
W	0726	-3.3	TH	0805	-1.7
	1345	16.6		1435	15.0
	1932	1.0		2007	3.1
3	0135	19.3	18	0206	16.9
TH	0808	-4.2	F	0838	-1.7
	1431	16.8		1510	14.8
	2014	1.1		2040	3.4
4	0218	19.5	19	0240	15.6
F	0851	-4.4	SA	0913	-1.4
	1517	16.6		1545	14.4
	2058	1.6		2115	3.8
5	0303	19.2	20	0313	16.2
SA	0939	-4.0	SU	0948	-0.9
	1606	16.1		1621	14.0
	2145	2.2		2154	4.2
6	0352	18.4	21	0348	15.6
SU	1031	-3.1	M	1027	-0.2
	1659	15.5		1702	13.6
	2241	3.1		2233	4.7
7	0447	17.2	22	0427	14.8
M	1125	-1.8	TU	1106	0.6
	1757	14.8		1745	13.3
	2342	3.9		2318	5.2
8	0548	15.7	23	0509	13.9
TU	1226	-0.4	W	1148	1.4
	1904	14.4		1832	13.1
9	0055	4.4	24	0017	5.4
W	0658	14.3	TH	0600	13.1
	1330	0.9		1239	2.2
	2013	14.4		1922	13.3
10	0218	4.2	25	0123	5.2
TH	0820	13.5	F	0709	12.4
	1439	1.7		1334	2.9
	2116	14.8		2015	13.7
11	0335	3.3	26	0234	4.4
F	0940	13.2	SA	0818	12.1
	1545	2.2		1437	3.3
	2214	15.4		2106	14.4
12	0438	2.1	27	0341	3.0
SA	1051	13.5	SU	0937	12.4
	1642	2.4		1538	3.4
	2305	16.0		2200	15.4
13	0530	0.8	28	0439	1.2
SU	1150	14.0	M	1048	13.1
	1729	2.5		1636	3.3
	2346	16.5		2251	16.5
14	0615	-0.2	29	0530	-0.6
M	1238	14.5	TU	1149	14.1
	1812	2.6		1730	2.9
				2337	17.7
15	0025	16.9	30	0619	-2.3
TU	0654	-1.0	W	1241	15.0
	1317	14.8		1820	2.5
	1851	2.7			
			31	0025	18.6
			TH	0707	-3.7
				1332	15.8
				1909	2.1

JUNE

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0116	19.3	16	0148	16.6
F	0755	-4.5	SA	0823	-1.6
	1421	16.4		1456	14.6
	1957	1.9		2024	3.7
2	0203	19.6	17	0223	16.6
SA	0842	-4.8	SU	0855	-1.6
	1510	16.7		1529	14.7
	2048	1.8		2100	3.7
3	0253	19.3	18	0258	16.3
SU	0928	-4.4	M	0930	-1.3
	1559	16.7		1604	14.7
	2139	2.0		2139	3.7
4	0345	18.5	19	0333	15.9
M	1017	-3.6	TU	1005	-0.9
	1649	16.4		1637	14.6
	2233	2.4		2216	3.8
5	0441	17.3	20	0409	15.3
TU	1106	-2.3	W	1038	-0.2
	1741	16.1		1711	14.6
	2331	2.8		2259	3.9
6	0538	15.8	21	0450	14.5
W	1200	-0.7	TH	1115	0.6
	1834	15.8		1748	14.6
				2345	3.9
7	0037	3.2	22	0535	13.6
TH	0639	14.3	F	1154	1.6
	1255	0.9		1829	14.6
	1932	15.5			
8	0147	3.2	23	0042	3.7
F	0751	13.1	SA	0630	12.7
	1354	2.3		1243	2.6
	2028	15.3		1918	14.8
9	0303	2.8	24	0149	3.2
SA	0909	12.4	SU	0744	12.0
	1458	3.3		1337	3.5
	2127	15.3		2009	15.1
10	0406	2.0	25	0257	2.3
SU	1023	12.3	M	0858	11.8
	1559	4.0		1446	4.2
	2220	15.5		2109	15.6
11	0501	1.2	26	0403	0.9
M	1124	12.6	TU	1020	12.2
	1655	4.3		1557	4.4
	2309	15.7		2212	16.4
12	0550	0.3	27	0504	-0.6
TU	1221	13.2	W	1131	13.1
	1744	4.3		1703	4.0
	2356	16.0		2311	17.4
13	0633	-0.4	28	0601	-2.2
W	1306	13.7	TH	1232	14.3
	1827	4.2		1802	3.4
14	0033	16.3	29	0009	18.3
TH	0710	-1.0	F	0653	-3.6
	1345	14.1		1323	15.4
	1908	4.0		1856	2.6
15	0113	16.5	30	0102	19.1
F	0746	-1.4	SA	0742	-4.4
	1421	14.4		1411	16.4
	1946	3.8		1948	1.8

TIME MERIDIAN 120° W. 0000 IS MIDNIGHT. 1200 IS NOON.
HEIGHTS ARE RECKONED FROM THE DATUM OF SOUNDINGS ON CHARTS OF THE LOCALITY WHICH IS MEAN LOWER LOW WATER.

JUNEAU, ALASKA, 1973

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

JULY

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0156	19.5	16	0207	16.7
SU	0828	-4.8	M	0835	-1.8
	1458	17.1		1506	15.3
	2039	1.3		2041	2.7
2	0245	19.3	17	0240	16.7
M	0914	-4.5	TU	0905	-1.7
	1542	17.4		1535	15.6
	2128	1.1		2119	2.4
3	0334	18.6	18	0315	16.4
TU	0959	-3.6	W	0936	-1.3
	1630	17.5		1604	15.8
	2217	1.1		2155	2.2
4	0425	17.4	19	0350	15.8
W	1043	-2.3	TH	1009	-0.6
	1712	17.2		1634	15.9
	2312	1.5		2233	2.1
5	0518	15.8	20	0430	15.0
TH	1128	-0.6	F	1040	0.3
	1800	16.6		1709	15.9
				2318	2.1
6	0007	2.0	21	0513	14.0
F	0613	14.2	SA	1119	1.4
	1214	1.2		1744	15.7
	1848	16.0			
7	0108	2.4	22	0007	2.2
SA	0716	12.7	SU	0604	12.9
	1307	2.9		1203	2.7
	1937	15.3		1827	15.6
8	0216	2.6	23	0109	2.2
SU	0830	11.6	M	0711	11.9
	1406	4.4		1256	4.0
	2033	14.8		1925	15.4
9	0327	2.5	24	0221	1.8
M	0952	11.2	TU	0833	11.4
	1512	5.3		1407	4.9
	2134	14.5		2034	15.4
10	0434	1.9	25	0341	1.0
TU	1105	11.5	W	1003	11.7
	1622	5.6		1531	5.2
	2235	14.6		2147	15.5
11	0530	1.2	26	0448	-0.3
W	1205	12.2	TH	1121	12.7
	1717	5.4		1648	4.6
	2324	15.0		2258	16.8
12	0613	0.3	27	0549	-1.8
TH	1252	13.0	F	1221	14.2
	1806	4.9		1753	3.5
				2359	17.9
13	0012	15.6	28	0641	-3.1
F	0654	-0.5	SA	1309	15.6
	1329	13.7		1850	2.2
	1851	4.3			
14	0054	16.1	29	0056	18.7
SA	0729	-1.1	SU	0728	-4.0
	1404	14.3		1356	16.8
	1929	3.7		1939	1.0
15	0131	16.5	30	0148	19.2
SU	0802	-1.6	M	0810	-4.3
	1437	14.9		1439	17.7
	2006	3.1		2026	0.1
			31	0233	19.1
			TU	0854	-3.9
				1516	18.2
				2112	-0.3

AUGUST

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0321	18.4	16	0255	16.8
W	0933	-3.0	TH	0908	-1.1
	1558	18.2		1526	17.0
	2155	-0.3		2131	0.3
2	0404	17.2	17	0332	16.3
TH	1011	-1.6	F	0939	-0.4
	1637	17.8		1555	17.1
	2243	0.2		2206	0.2
3	0453	15.7	18	0411	15.5
F	1051	0.1	SA	1012	0.6
	1718	17.0		1627	16.9
	2328	1.0		2249	0.4
4	0541	14.1	19	0456	14.4
SA	1133	1.9	SU	1049	1.9
	1757	16.0		1706	16.6
				2337	0.8
5	0023	1.9	20	0545	13.2
SU	0636	12.4	M	1132	3.3
	1216	3.7		1751	16.0
	1842	14.9			
6	0124	2.7	21	0040	1.4
M	0744	11.2	TU	0649	12.0
	1311	5.2		1229	4.7
	1939	14.0		1856	15.3
7	0241	3.1	22	0156	1.7
TU	0913	10.6	W	0821	11.4
	1428	6.2		1349	5.7
	2048	13.5		2014	14.9
8	0400	2.8	23	0322	1.2
W	1039	10.9	TH	0957	11.8
	1551	6.4		1525	5.7
	2202	13.6		2139	15.3
9	0501	2.1	24	0436	0.2
TH	1144	11.8	F	1112	13.2
	1654	5.9		1647	4.6
	2305	14.2		2255	16.2
10	0550	1.1	25	0536	-1.1
F	1227	12.8	SA	1209	14.8
	1750	5.0		1.50	3.0
	2356	15.1		2.56	17.4
11	0631	0.1	26	0624	-2.2
SA	1306	13.8	SU	1751	16.4
	1831	4.0		1841	1.3
12	0034	15.9	27	0050	18.3
SU	0706	-0.7	M	0709	-2.9
	1337	14.8		1332	17.6
	1910	2.9		1926	-0.1
13	0113	16.5	28	0139	19.7
M	0736	-1.3	TU	0750	-3.0
	1404	15.6		1411	18.5
	1944	2.0		2009	-1.1
14	0148	16.9	29	0221	18.6
TU	0807	-1.6	W	0828	-2.6
	1431	16.2		1447	19.8
	2021	1.2		2049	-1.5
15	0221	17.0	30	0303	18.0
W	0839	-1.5	TH	0904	-1.6
	1457	16.7		1521	18.6
	2054	0.7		2129	-1.3
			31	0345	17.0
			F	0939	-0.3
				1556	19.0
				2212	-0.7

SEPTEMBER

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0427	15.6	16	0353	15.9
SA	1017	1.2	SU	0947	1.5
	1630	17.0		1556	17.9
	2251	0.3		2227	-1.0
2	0510	14.1	17	0440	14.8
SU	1054	2.9	M	1024	2.7
	1707	15.8		1637	17.2
	2334	1.5		2318	-0.1
3	0557	12.5	18	0535	13.5
M	1135	4.5	TU	1115	4.1
	1748	14.6		1728	16.2
4	0033	2.7	19	0019	0.9
TU	0702	11.3	W	0645	12.5
	1227	5.9		1219	5.4
	1845	13.5		1836	15.1
5	0149	3.6	20	0137	1.6
W	0831	10.6	TH	0815	12.1
	1344	6.9		1349	6.1
	1959	12.8		2003	14.5
6	0311	3.6	21	0305	1.5
TH	1004	10.9	F	0946	12.8
	1521	7.0		1528	5.5
	2125	12.9		2138	14.8
7	0426	2.9	22	0419	0.8
F	1112	11.9	SA	1052	14.3
	1636	6.1		1644	4.0
	2239	13.6		2253	15.7
8	0518	2.0	23	0516	-0.1
SA	1153	13.1	SU	1143	15.8
	1727	4.8		1739	2.1
	2330	14.6		2350	16.7
9	0559	1.0	24	0605	-0.8
SU	1224	14.3	M	1224	17.2
	1806	3.4		1828	0.4
10	0009	15.6	25	0041	17.5
M	0530	0.2	TU	0646	-1.1
	1257	15.4		1307	18.3
	1844	2.0		1910	-1.0
11	0051	16.4	26	0125	17.9
TU	0703	-0.4	W	0725	-1.0
	1326	16.5		1342	18.9
	1920	0.7		1951	-1.8
12	0126	16.9	27	0208	17.9
W	0735	-0.7	TH	0801	-0.6
	1352	17.3		1413	19.0
	1955	-0.3		2027	-2.0
13	0201	17.2	28	0245	17.4
TH	0808	-0.7	F	0835	0.3
	1420	17.9		1446	18.6
	2028	-1.1		2105	-1.8
14	0238	17.2	29	0324	16.5
F	0937	-0.3	SA	0911	1.3
	1448	18.2		1519	18.0
	2105	-1.5		2141	-1.1
15	0313	16.7	30	0401	15.4
SA	0912	0.4	SU	0945	2.6
	1521	18.2		1551	17.0
	2144	-1.5		2217	0.0

TIME MERIDIAN 120° W. 0000 IS MIDNIGHT. 1200 IS NOON.
HEIGHTS ARE RECKONED FROM THE DATUM OF SOUNDINGS ON CHARTS OF THE LOCALITY WHICH IS MEAN LOWER LOW WATER.

KETCHIKAN, ALASKA, 1973

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

APRIL

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0001	14.7	16	0030	16.2
SU	0604	1.0	M	0647	-0.8
	1211	15.0		1305	15.0
	1817	0.2		1853	0.9
2	0037	15.9	17	0105	16.5
M	0643	-0.5	TU	0724	-1.3
	1253	15.7		1345	14.9
	1852	-0.1		1928	1.3
3	0109	16.9	18	0137	16.5
TU	0722	-1.8	W	0757	-1.5
	1336	16.1		1420	14.6
	1930	0.0		2003	1.8
4	0144	17.5	19	0208	16.3
W	0803	-2.7	TH	0832	-1.3
	1418	16.1		1457	14.1
	2009	0.3		2034	2.5
5	0219	17.8	20	0241	15.8
TH	0844	-3.0	F	0906	-0.9
	1502	15.6		1534	13.4
	2047	1.0		2107	3.2
6	0300	17.7	21	0312	15.2
F	0931	-2.7	SA	0941	-0.2
	1550	14.8		1613	12.6
	2128	1.9		2142	4.0
7	0343	17.0	22	0347	14.4
SA	1020	-2.0	SU	1024	0.6
	1642	13.7		1655	11.8
	2217	3.0		2224	4.8
8	0435	16.0	23	0426	13.6
SU	1117	-0.9	M	1105	1.5
	1744	12.7		1746	11.2
	2312	4.1		2311	5.5
9	0531	14.8	24	0511	12.7
M	1221	0.2	TU	1200	2.3
	1854	12.1		1848	10.8
10	0032	4.9	25	0018	6.0
TU	0647	13.7	W	0615	11.9
	1335	0.9		1306	2.8
	2016	12.1		1956	11.0
11	0203	5.0	26	0137	5.8
W	0815	13.1	TH	0730	11.5
	1454	1.2		1411	3.0
	2133	12.8		2058	11.6
12	0328	4.1	27	0251	5.0
TH	0937	13.3	F	0848	11.6
	1600	1.1		1511	2.8
	2228	13.9		2149	12.6
13	0437	2.7	28	0355	3.6
F	1044	13.8	SA	0956	12.2
	1653	0.8		1608	2.4
	2314	14.8		2231	13.8
14	0526	1.3	29	0446	1.8
SA	1137	14.4	SU	1054	13.1
	1738	0.7		1654	1.9
	2355	15.7		2313	15.1
15	0610	0.1	30	0532	0.0
SU	1224	14.8	M	1146	14.1
	1817	0.7		1738	1.5
				2352	16.3

MAY

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0617	-1.6	16	0033	15.9
TU	1235	14.9	W	0705	-1.1
	1820	1.3		1331	13.7
				1902	3.0
2	0033	17.3	17	0108	15.9
W	0702	-2.9	TH	0740	-1.4
	1321	15.4		1407	13.7
	1904	1.2		1938	3.2
3	0115	17.9	18	0143	15.8
TH	0744	-3.7	F	0814	-1.3
	1407	15.6		1445	13.5
	1947	1.3		2014	3.4
4	0156	18.2	19	0215	15.6
F	0831	-4.0	SA	0849	-1.1
	1453	15.4		1521	13.2
	2033	1.7		2049	3.8
5	0241	17.9	20	0247	15.1
SA	0918	-3.7	SU	0922	-0.7
	1544	14.9		1557	12.9
	2121	2.3		2126	4.2
6	0328	17.2	21	0325	14.6
SU	1009	-2.8	M	1000	-0.1
	1637	14.3		1639	12.5
	2213	3.1		2207	4.6
7	0426	16.1	22	0404	13.8
M	1104	-1.7	TU	1043	0.6
	1737	13.7		1720	12.2
	2315	3.7		2254	4.9
8	0525	14.8	23	0449	13.0
TU	1204	-0.4	W	1124	1.3
	1842	13.4		1809	12.1
				2351	5.1
9	0028	4.2	24	0536	12.3
W	0634	13.5	TH	1215	2.0
	1306	0.7		1900	12.3
	1945	13.4			
10	0151	4.0	25	0057	4.8
TH	0757	12.7	F	0645	11.6
	1416	1.5		1306	2.6
	2050	13.7		1951	12.7
11	0307	3.2	26	0206	4.1
F	0914	12.4	SA	0801	11.3
	1517	2.0		1407	3.0
	2148	14.3		2042	13.4
12	0411	2.1	27	0314	2.8
SA	1021	12.6	SU	0914	11.5
	1614	2.3		1507	3.1
	2237	14.8		2138	14.3
13	0506	1.0	28	0409	1.2
SU	1119	12.9	M	1021	12.2
	1703	2.5		1605	3.1
	2316	15.3		2227	15.4
14	0551	0.0	29	0503	-0.5
M	1210	13.3	TU	1122	13.1
	1745	2.7		1700	2.8
	2357	15.7		2316	16.5
15	0630	-0.7	30	0554	-2.1
TU	1253	13.6	W	1216	13.9
	1827	2.8		1752	2.5
			31	0003	17.4
			TH	0643	-3.4
				1309	14.7
				1843	2.2

JUNE

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0052	18.1	16	0121	15.5
F	0731	-4.2	SA	0757	-1.3
	1357	15.2		1432	13.3
	1931	2.0		1956	3.7
2	0140	18.3	17	0156	15.5
SA	0817	-4.5	SU	0830	-1.3
	1448	15.4		1503	13.4
	2021	1.9		2032	3.7
3	0231	18.1	18	0231	15.3
SU	0906	-4.2	M	0905	-1.1
	1534	15.4		1538	13.5
	2113	2.1		2111	3.7
4	0321	17.4	19	0306	14.9
M	0957	-3.4	TU	0939	-0.8
	1626	15.2		1613	13.4
	2206	2.4		2151	3.7
5	0413	16.3	20	0345	14.3
TU	1046	-2.2	W	1012	-0.2
	1718	14.9		1649	13.4
	2304	2.8		2232	3.8
6	0513	14.8	21	0426	13.5
W	1137	-0.8	TH	1049	0.5
	1809	14.6		1724	13.4
				2321	3.7
7	0012	3.0	22	0511	12.7
TH	0615	13.4	F	1130	1.4
	1231	0.7		1805	13.5
	1906	14.4			
8	0123	3.0	23	0019	3.5
F	0726	12.2	SA	0605	11.8
	1330	2.0		1217	2.3
	2004	14.2		1854	13.7
9	0233	2.7	24	0121	3.0
SA	0841	11.5	SU	0716	11.2
	1432	3.0		1313	3.2
	2101	14.3		1950	14.0
10	0342	2.0	25	0230	2.1
SU	0953	11.3	M	0839	10.9
	1529	3.7		1416	3.8
	2156	14.4		2047	14.6
11	0438	1.2	26	0337	0.8
M	1100	11.6	TU	0956	11.3
	1627	4.1		1525	4.0
	2243	14.6		2150	15.4
12	0529	0.5	27	0440	-0.6
TU	1151	12.0	W	1107	12.2
	1716	4.2		1631	3.9
	2326	14.9		2249	16.3
13	0610	-0.2	28	0536	-2.[illegible]
W	1241	12.4	TH	1204	13.2
	1801	4.1		1732	3.2
				2345	17.2
14	0008	15.2	29	0629	-3.4
TH	0649	-0.7	F	1256	14.3
	1320	12.8		1827	2.6
	1843	4.0			
15	0043	15.4	30	0037	18.0
F	0724	-1.1	SA	0719	-4.2
	1357	13.1		1347	15.1
	1918	3.8		1920	1.9

TIME MERIDIAN 120° W. 0000 IS MIDNIGHT. 1200 IS NOON.
HEIGHTS ARE RECKONED FROM THE DATUM OF SOUNDINGS ON CHARTS OF THE LOCALITY WHICH IS MEAN LOWER LOW WATER.

KETCHIKAN, ALASKA, 1973

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

JULY

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1 SU	0131	18.3	16 M	0141	15.6
	0805	-4.5		0811	-1.5
	1433	15.7		1440	14.0
	2012	1.4		2014	2.8
2 M	0221	18.2	17 TU	0215	15.5
	0849	-4.2		0841	-1.4
	1518	16.1		1509	14.3
	2103	1.2		2051	2.5
3 TU	0310	17.5	18 W	0246	15.3
	0935	-3.4		0912	-1.1
	1600	16.1		1541	14.5
	2152	1.2		2128	2.3
4 W	0358	16.3	19 TH	0327	14.7
	1020	-2.2		0941	-0.6
	1648	15.9		1610	14.6
	2248	1.5		2206	2.1
5 TH	0451	14.8	20 F	0404	14.0
	1104	-0.6		1016	0.3
	1733	15.4		1645	14.6
	2343	1.9		2250	2.1
6 F	0546	13.2	21 SA	0451	13.0
	1150	1.0		1052	1.3
	1821	14.8		1721	14.5
				2343	2.1
7 SA	0045	2.3	22 SU	0540	12.0
	0650	11.7		1133	2.4
	1244	2.7		1806	14.4
	1913	14.2			
8 SU	0154	2.5	23 M	0045	2.0
	0803	10.7		0647	11.0
	1340	4.0		1228	3.6
	2011	13.8		1903	14.3
9 M	0303	2.3	24 TU	0158	1.6
	0922	10.3		0811	10.5
	1445	4.9		1339	4.5
	2110	13.6		2012	14.4
10 TU	0409	1.8	25 W	0313	0.8
	1038	10.5		0939	10.8
	1552	5.2		1501	4.8
	2211	13.7		2126	14.9
11 W	0506	1.1	26 TH	0422	-0.4
	1139	11.1		1053	11.8
	1653	5.1		1618	4.3
	2300	14.1		2234	15.8
12 TH	0555	0.4	27 F	0523	-1.8
	1224	11.8		1154	13.1
	1742	4.7		1723	3.3
	2348	14.5		2335	16.8
13 F	0630	-0.3	28 SA	0616	-3.0
	1303	12.5		1243	14.4
	1824	4.2		1820	2.2
14 SA	0026	15.0	29 SU	0031	17.6
	0705	-0.9		0703	-3.7
	1338	13.1		1328	15.5
	1901	3.7		1909	1.1
15 SU	0105	15.4	30 M	0120	18.1
	0738	-1.3		0749	-4.0
	1409	13.6		1410	16.3
	1939	3.2		2000	0.3
			31 TU	0205	17.9
				0828	-3.7
				1451	16.8
				2044	-0.1

AUGUST

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1 W	0254	17.2	16 TH	0232	15.6
	0909	-2.8		0840	-0.9
	1532	16.8		1502	15.6
	2131	-0.1		2103	0.4
2 TH	0341	16.1	17 F	0308	15.1
	0947	-1.5		0913	-0.3
	1608	16.4		1531	15.7
	2219	0.3		2141	0.3
3 F	0426	14.6	18 SA	0345	14.3
	1027	0.1		0948	0.6
	1651	15.7		1607	15.5
	2304	1.0		2224	0.4
4 SA	0517	13.0	19 SU	0430	13.3
	1111	1.8		1023	1.8
	1733	14.8		1648	15.2
	2359	1.8		2314	0.8
5 SU	0615	11.4	20 M	0524	12.1
	1156	3.4		1106	3.0
	1821	13.8		1731	14.7
6 M	0100	2.5	21 TU	0018	1.2
	0726	10.2		0631	11.0
	1250	4.8		1205	4.3
	1917	13.0		1834	14.2
7 TU	0217	2.8	22 W	0136	1.4
	0848	9.7		0758	10.5
	1403	5.8		1323	5.2
	2023	12.6		1954	13.9
8 W	0338	2.6	23 TH	0259	0.9
	1015	10.0		0933	10.9
	1523	6.0		1454	5.2
	2137	12.7		2119	14.3
9 TH	0441	1.9	24 F	0411	-0.1
	1116	10.8		1044	12.1
	1631	5.6		1615	4.2
	2237	13.3		2228	15.2
10 F	0529	1.0	25 SA	0509	-1.2
	1201	11.7		1139	13.6
	1722	4.8		1718	2.8
	2325	14.0		2331	16.3
11 SA	0608	0.2	26 SU	0600	-2.2
	1237	12.6		1223	15.0
	1804	3.9		1811	1.3
12 SU	0008	14.7	27 M	0022	17.1
	0639	-0.5		0643	-2.7
	1308	13.4		1304	16.1
	1840	2.9		1858	0.0
13 M	0046	15.3	28 TU	0109	17.5
	0712	-1.0		0724	-2.8
	1337	14.2		1343	16.9
	1919	2.1		1943	-0.8
14 TU	0121	15.7	29 W	0154	17.3
	0740	-1.3		0803	-2.3
	1404	14.8		1420	17.3
	1954	1.4		2024	-1.2
15 W	0154	15.8	30 TH	0236	16.7
	0809	-1.3		0839	-1.5
	1432	15.3		1453	17.1
	2026	0.8		2105	-1.1
			31 F	0319	15.7
				0915	-0.3
				1531	16.6
				2145	-0.6

SEPTEMBER

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1 SA	0400	14.4	16 SU	0331	14.6
	0951	1.2		0921	1.5
	1606	15.7		1534	16.4
	2229	0.3		2203	-0.9
2 SU	0445	12.9	17 M	0420	13.5
	1029	2.7		1000	2.6
	1643	14.7		1617	15.7
	2314	1.4		2255	-0.2
3 M	0536	11.4	18 TU	0517	12.4
	1112	4.2		1048	3.8
	1730	13.5		1704	14.9
4 TU	0009	2.5	19 W	0002	0.7
	0641	10.3		0628	11.4
	1205	5.5		1153	5.0
	1822	12.5		1816	14.0
5 W	0125	3.2	20 TH	0117	1.2
	0809	9.7		0752	11.2
	1320	6.4		1322	5.6
	1936	11.9		1945	13.5
6 TH	0251	3.2	21 F	0239	1.1
	0940	10.0		0920	11.8
	1455	6.4		1458	5.0
	2101	12.0		2114	13.8
7 F	0401	2.6	22 SA	0353	0.5
	1042	10.9		1024	13.1
	1608	5.6		1614	3.7
	2209	12.6		2225	14.6
8 SA	0454	1.8	23 SU	0450	-0.2
	1125	12.0		1113	14.5
	1657	4.5		1712	2.0
	2303	13.5		2322	15.5
9 SU	0529	1.0	24 M	0537	-0.8
	1158	13.0		1155	15.8
	1742	3.3		1800	0.4
	2345	14.4			
10 M	0604	0.3	25 TU	0014	16.2
	1229	14.1		0620	-1.0
	1817	2.0		1237	16.7
				1843	-0.8
11 TU	0024	15.1	26 W	0057	16.5
	0637	-0.2		0657	-0.9
	1256	15.0		1310	17.3
	1853	0.8		1924	-1.5
12 W	0059	15.6	27 TH	0134	16.4
	0708	-0.5		0736	-0.4
	1325	15.8		1346	17.5
	1925	-0.2		2000	-1.8
13 TH	0133	15.9	28 F	0219	16.0
	0738	-0.5		0810	0.3
	1353	16.4		1420	17.2
	2002	-0.9		2039	-1.6
14 F	0213	15.8	29 SA	0257	15.2
	0809	-0.1		0843	1.3
	1424	16.7		1452	16.6
	2040	-1.3		2115	-1.0
15 SA	0250	15.4	30 SU	0338	14.1
	0844	0.5		0919	2.5
	1457	16.7		1526	15.7
	2118	-1.3		2152	0.0

TIME MERIDIAN 120° W. 0000 IS MIDNIGHT. 1200 IS NOON.
HEIGHTS ARE RECKONED FROM THE DATUM OF SOUNDINGS ON CHARTS OF THE LOCALITY WHICH IS MEAN LOWER LOW WATER.

KODIAK, ALASKA, 1973

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

APRIL						MAY						JUNE					
DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0517	0.8	16	0611	-0.5	1	0534	-1.0	16	0630	-1.0	1	0655	-2.7	16	0029	9.1
SU	1127	8.0	M	1222	7.7	TU	1156	7.5	W	1255	6.8	F	1324	7.3	SA	0725	-1.2
	1733	0.3		1806	1.0		1727	1.3		1808	2.3		1835	1.9		1354	6.6
	2347	8.5					2340	9.8								1900	2.7
2	0600	-0.2	17	0015	9.2	2	0621	-1.8	17	0018	9.2	2	0046	10.7	17	0105	9.0
M	1210	8.3	TU	0648	-0.9	W	1242	7.7	TH	0705	-1.1	SA	0744	-2.8	SU	0800	-1.2
	1806	0.3		1303	7.6		1809	1.3		1332	6.8		1413	7.5		1429	6.7
				1840	1.3					1843	2.4		1926	1.9		1937	2.7
3	0019	9.2	18	0049	9.3	3	0021	10.3	18	0050	9.1	3	0135	10.6	18	0141	8.8
TU	0639	-1.0	W	0723	-1.1	TH	0705	-2.3	F	0740	-1.1	SU	0830	-2.7	M	0832	-1.0
	1255	8.3		1342	7.4		1331	7.7		1409	6.7		1503	7.6		1504	6.8
	1841	0.4		1910	1.6		1852	1.5		1918	2.6		2018	1.9		2016	2.7
4	0054	9.7	19	0119	9.2	4	0102	10.5	19	0125	9.0	4	0227	10.0	19	0216	8.5
W	0721	-1.5	TH	0758	-1.0	F	0754	-2.5	SA	0815	-1.0	M	0920	-2.2	TU	0904	-0.8
	1339	8.2		1421	7.1		1419	7.5		1448	6.6		1552	7.6		1539	6.9
	1918	0.7		1939	2.0		1938	1.7		1953	2.7		2117	2.0		2058	2.7
5	0129	10.0	20	0150	9.0	5	0146	10.4	20	0200	8.7	5	0323	9.2	20	0251	8.1
TH	0806	-1.8	F	0833	-0.8	SA	0842	-2.4	SU	0851	-0.8	TU	1008	-1.5	W	0937	-0.4
	1423	7.8		1458	6.7		1511	7.3		1527	6.4		1645	7.6		1615	7.0
	1957	1.1		2014	2.3		2027	2.0		2030	2.9		2221	2.1		2140	2.7
6	0206	10.0	21	0222	8.7	6	0235	10.0	21	0229	8.4	6	0419	8.3	21	0333	7.5
F	0851	-1.7	SA	0910	-0.4	SU	0933	-1.9	M	0930	-0.4	W	1058	-0.6	TH	1012	0.0
	1511	7.3		1536	6.3		1608	7.0		1605	6.3		1736	7.7		1650	7.1
	2038	1.6		2049	2.7		2121	2.3		2111	3.1		2327	2.1		2234	2.6
7	0249	9.8	22	0253	8.3	7	0330	9.3	22	0310	7.9	7	0522	7.2	22	0418	6.9
SA	0943	-1.3	SU	0951	0.0	M	1027	-1.2	TU	1009	-0.1	TH	1148	0.3	F	1047	0.5
	1609	6.7		1622	5.9		1706	6.8		1651	6.3		1831	7.8		1730	7.4
	2124	2.2		2124	3.1		2221	2.6		2157	3.3					2330	2.4
8	0338	9.3	23	0333	7.8	8	0431	8.4	23	0353	7.4	8	0044	2.0	23	0511	6.2
SU	1041	-0.8	M	1037	0.5	TU	1127	-0.5	W	1050	0.4	F	0637	6.3	SA	1130	1.1
	1711	6.2		1719	5.6		1809	6.8		1735	6.3		1239	1.1		1811	7.7
	2219	2.7		2213	3.4		2342	2.8		2256	3.3		1928	8.0			
9	0438	8.6	24	0418	7.3	9	0542	7.6	24	0444	6.8	9	0159	1.6	24	0040	1.9
M	1147	-0.2	TU	1129	0.9	W	1227	0.2	TH	1133	0.8	SA	0756	5.8	SU	0628	5.6
	1827	5.9		1821	5.5		1916	7.1		1823	6.6		1334	1.8		1215	1.7
	2333	3.1		2312	3.6								2019	8.1		1902	8.0
10	0552	7.9	25	0519	6.8	10	0104	2.6	25	0005	3.1	10	0309	1.1	25	0156	1.3
TU	1301	0.3	W	1228	1.2	TH	0703	6.9	F	0550	6.3	SU	0913	5.6	M	0754	5.3
	1950	6.1		1923	5.7		1330	0.8		1223	1.2		1428	2.4		1314	2.2
							2015	7.4		1910	6.9		2105	8.3		1957	8.5
11	0109	3.1	26	0036	3.6	11	0224	2.0	26	0118	2.6	11	0404	0.5	26	0303	0.4
W	0721	7.4	TH	0636	6.4	F	0825	6.5	SA	0705	5.9	M	1023	5.6	TU	0919	5.4
	1415	0.5		1329	1.4		1431	1.2		1316	1.5		1522	2.7		1418	2.5
	2056	6.7		2020	6.2		2108	7.9		2001	7.5		2154	8.5		2057	9.1
12	0236	2.6	27	0200	3.1	12	0335	1.3	27	0228	1.8	12	0453	0.0	27	0407	-0.5
TH	0847	7.3	F	0759	6.3	SA	0938	6.4	SU	0828	5.8	TU	1118	5.9	W	1033	5.8
	1518	0.6		1424	1.4		1522	1.6		1409	1.8		1616	2.9		1525	2.6
	2151	7.3		2109	6.8		2151	8.3		2047	8.1		2235	8.7		2154	9.7
13	0350	1.7	28	0306	2.3	13	0430	0.5	28	0329	0.7	13	0534	-0.5	28	0502	-1.5
F	0954	7.4	SA	0910	6.5	SU	1039	6.5	M	0942	6.0	W	1205	6.1	TH	1133	6.3
	1611	0.6		1519	1.4		1610	1.8		1506	2.0		1702	2.9		1630	2.5
	2230	8.0		2145	7.6		2232	8.7		2135	8.9		2315	8.9		2249	10.2
14	0443	0.8	29	0403	1.2	14	0512	-0.2	29	0425	-0.4	14	0615	-0.8	29	0557	-2.2
SA	1052	7.6	SU	1011	6.9	M	1128	6.7	TU	1046	6.4	TH	1242	6.3	F	1224	6.8
	1652	0.7		1601	1.3		1651	2.0		1558	2.1		1744	2.9		1730	2.2
	2311	8.5		2224	8.4		2308	9.0		2222	9.6		2354	9.0		2344	10.6
15	0530	0.1	30	0451	0.1	15	0553	-0.7	30	0515	-1.4	15	0650	-1.0	30	0644	-2.6
SU	1141	7.7	M	1105	7.2	TU	1213	6.8	W	1141	6.8	F	1319	6.5	SA	1311	7.3
	1731	0.8		1646	1.3		1732	2.2		1653	2.0		1822	2.8		1824	1.8
	2344	8.9		2302	9.1		2343	9.1		2312	10.2						
									31	0606	-2.2						
									TH	1236	7.1						
										1744	2.0						
										2357	10.6						

TIME MERIDIAN 150° W. 0000 IS MIDNIGHT. 1200 IS NOON.
HEIGHTS ARE RECKONED FROM THE DATUM OF SOUNDINGS ON CHARTS OF THE LOCALITY WHICH IS MEAN LOWER LOW WATER.

KODIAK, ALASKA, 1973

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

JULY

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0038	10.7	16	0048	9.0
SU	0732	-2.8	M	0736	-1.1
	1359	7.7		1403	7.1
	1918	1.5		1923	2.2
2	0127	10.5	17	0124	8.9
M	0813	-2.6	TU	0806	-1.1
	1442	8.1		1432	7.4
	2013	1.3		2001	2.0
3	0216	9.9	18	0159	8.6
TU	0858	-2.0	W	0835	-0.8
	1527	8.2		1501	7.6
	2107	1.3		2038	1.8
4	0311	9.1	19	0235	8.2
W	0941	-1.3	TH	0904	-0.4
	1612	8.3		1533	7.8
	2202	1.3		2121	1.7
5	0400	8.0	20	0314	7.6
TH	1021	-0.4	F	0933	0.1
	1657	8.3		1602	7.9
	2302	1.4		2205	1.6
6	0457	6.9	21	0357	6.9
F	1103	0.6	SA	1008	0.7
	1745	8.2		1637	8.1
				2302	1.5
7	0009	1.5	22	0450	6.1
SA	0600	5.9	SU	1043	1.4
	1145	1.6		1722	8.2
	1834	8.1			
8	0121	1.4	23	0007	1.3
SU	0719	5.2	M	0558	5.4
	1238	2.4		1132	2.0
	1927	8.0		1815	8.4
9	0236	1.2	24	0124	0.9
M	0847	5.0	TU	0734	5.0
	1334	3.0		1230	2.6
	2023	8.0		1921	8.6
10	0339	0.8	25	0244	0.3
TU	1004	5.1	W	0910	5.1
	1437	3.3		1347	3.0
	2117	8.1		2032	8.9
11	0436	0.3	26	0354	-0.5
W	1105	5.4	TH	1027	5.6
	1539	3.4		1508	2.9
	2206	8.3		2139	9.4
12	0520	-0.1	27	0452	-1.2
TH	1153	5.8	F	1123	6.3
	1636	3.2		1624	2.5
	2256	8.6		2243	9.9
13	0557	-0.6	28	0543	-1.9
F	1228	6.2	SA	1210	7.0
	1725	3.0		1724	1.9
	2335	8.9		2337	10.3
14	0634	-0.9	29	0628	-2.2
SA	1301	6.5	SU	1253	7.7
	1806	2.7		1819	1.3
15	0013	9.0	30	0032	10.4
SU	0705	-1.1	M	0713	-2.3
	1332	6.8		1334	8.2
	1845	2.4		1910	0.8
			31	0118	10.1
			TU	0750	-2.0
				1411	8.6
				2001	0.5

AUGUST

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0205	9.5	16	0145	8.6
W	0829	-1.4	TH	0800	-0.5
	1451	8.8		1419	8.3
	2047	0.4		2018	0.7
2	0253	8.7	17	0221	8.1
TH	0905	-0.7	F	0827	0.0
	1529	8.8		1448	8.5
	2136	0.5		2059	0.5
3	0338	7.7	18	0300	7.5
F	0940	0.2	SA	0858	0.5
	1609	8.6		1517	8.6
	2229	0.8		2144	0.5
4	0431	6.7	19	0343	6.8
SA	1016	1.2	SU	0931	1.1
	1650	8.3		1558	8.6
	2326	1.1		2237	0.6
5	0527	5.7	20	0441	6.0
SU	1057	2.1	M	1006	1.8
	1735	8.0		1641	8.5
				2342	0.7
6	0032	1.4	21	0551	5.3
M	0640	5.0	TU	1100	2.5
	1142	2.8		1734	8.4
	1833	7.6			
7	0151	1.4	22	0058	0.7
TU	0812	4.7	W	0728	4.9
	1241	3.4		1211	3.1
	1935	7.5		1858	8.3
8	0313	1.2	23	0226	0.3
W	0948	4.9	TH	0905	5.2
	1359	3.7		1345	3.3
	2046	7.6		2020	8.5
9	0414	0.7	24	0342	-0.2
TH	1045	5.3	F	1013	5.9
	1519	3.6		1512	2.9
	2147	7.9		2134	8.9
10	0455	0.3	25	0435	-0.8
F	1124	5.8	SA	1104	6.7
	1622	3.2		1624	2.1
	2235	8.2		2237	9.4
11	0530	-0.2	26	0524	-1.3
SA	1159	6.3	SU	1147	7.5
	1705	2.7		1721	1.2
	2318	8.6		2332	9.7
12	0605	-0.5	27	0605	-1.5
SU	1232	6.8	M	1226	8.3
	1748	2.2		1812	0.5
	2356	8.8			
13	0634	-0.8	28	0022	9.7
M	1255	7.3	TU	0644	-1.4
	1826	1.7		1303	8.8
				1858	-0.1
14	0032	8.9	29	0109	9.4
TU	0706	-0.8	W	0722	-1.0
	1324	7.7		1339	9.2
	1903	1.3		1942	-0.4
15	0109	8.8	30	0151	8.9
W	0732	-0.7	TH	0757	-0.5
	1351	8.1		1414	9.3
	1941	0.9		2026	-0.5
			31	0235	8.2
			F	0829	0.2
				1446	9.1
				2109	-0.2

SEPTEMBER

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0318	7.4	16	0251	7.3
SA	0902	1.0	SU	0830	1.1
	1521	8.8		1445	9.3
	2151	0.2		2124	-0.6
2	0402	6.5	17	0338	6.7
SU	0937	1.8	M	0905	1.7
	1558	8.3		1524	9.1
	2244	0.7		2221	-0.3
3	0453	5.7	18	0438	6.0
M	1012	2.6	TU	0948	2.4
	1639	7.8		1615	8.7
	2342	1.2		2323	0.1
4	0604	5.0	19	0555	5.4
TU	1053	3.2	W	1051	3.0
	1736	7.3		1722	8.2
5	0058	1.5	20	0044	0.4
W	0741	4.7	TH	0732	5.4
	1158	3.7		1211	3.3
	1850	7.0		1850	7.9
6	0220	1.5	21	0206	0.4
TH	0913	5.0	F	0853	5.8
	1334	3.9		1355	3.2
	2012	7.0		2015	7.9
7	0329	1.2	22	0315	0.1
F	1006	5.5	SA	0953	6.6
	1502	3.5		1519	2.4
	2121	7.3		2132	8.2
8	0416	0.7	23	0411	-0.2
SA	1049	6.0	SU	1039	7.4
	1600	2.9		1624	1.4
	2210	7.7		2233	8.5
9	0455	0.3	24	0456	-0.4
SU	1118	6.7	M	1115	8.2
	1649	2.2		1715	0.5
	2256	8.1		2326	8.7
10	0527	0.0	25	0539	-0.4
M	1147	7.3	TU	1154	8.9
	1728	1.5		1802	-0.3
	2334	8.4			
11	0556	-0.2	26	0011	8.7
TU	1213	7.9	W	0615	-0.2
	1806	0.8		1225	9.3
				1844	-0.9
12	0013	8.5	27	0057	8.5
W	0627	-0.2	TH	0651	0.2
	1239	8.4		1300	9.5
	1844	0.2		1925	-1.1
13	0051	8.5	28	0137	8.2
TH	0656	-0.1	F	0724	0.6
	1307	8.8		1335	9.5
	1918	-0.3		2001	-1.1
14	0127	8.3	29	0219	7.7
F	0726	0.2	SA	0755	1.2
	1339	9.1		1407	9.2
	1957	-0.6		2042	-0.8
15	0208	7.9	30	0258	7.0
SA	0755	0.6	SU	0829	1.8
	1409	9.3		1439	8.8
	2040	-0.7		2121	-0.3

TIME MERIDIAN 150° W. 0000 IS MIDNIGHT. 1200 IS NOON.
HEIGHTS ARE RECKONED FROM THE DATUM OF SOUNDINGS ON CHARTS OF THE LOCALITY WHICH IS MEAN LOWER LOW WATER.

SELDOVIA, ALASKA, 1973

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

APRIL

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0558	1.1	16	0024	19.2
SU	1207	17.8	M	0637	-1.8
	1812	0.1		1258	18.2
				1844	0.6
2	0027	18.9	17	0053	19.6
M	0634	-0.9	TU	0712	-2.4
	1247	19.0		1335	18.4
	1846	-0.4		1920	1.0
3	0057	20.2	18	0124	19.7
TU	0712	-2.6	W	0748	-2.5
	1328	19.7		1410	18.2
	1925	-0.6		1953	1.6
4	0131	21.1	19	0152	19.4
W	0751	-3.7	TH	0821	-2.1
	1410	19.9		1444	17.6
	2000	-0.3		2025	2.4
5	0207	21.4	20	0223	18.8
TH	0830	-4.2	F	0853	-1.4
	1455	19.4		1522	16.7
	2041	0.4		2100	3.3
6	0246	21.1	21	0254	17.9
F	0917	-3.9	SA	0927	-0.5
	1542	18.3		1559	15.6
	2124	1.5		2135	4.4
7	0329	20.2	22	0331	16.7
SA	1004	-2.9	SU	1004	0.7
	1633	16.9		1643	14.3
	2212	2.9		2218	5.5
8	0418	18.7	23	0407	15.5
SU	1059	-1.5	M	1046	1.9
	1734	15.4		1737	13.2
	2309	4.3		2305	6.5
9	0516	17.0	24	0452	14.2
M	1203	0.0	TU	1137	3.1
	1849	14.4		1838	12.5
10	0022	5.3	25	0009	7.2
TU	0629	15.4	W	0557	13.0
	1323	1.1		1246	3.9
	2010	14.2		1948	12.5
11	0155	5.4	26	0132	7.2
W	0800	14.6	TH	0718	12.4
	1443	1.4		1400	4.1
	2128	15.0		2056	13.2
12	0321	4.2	27	0249	6.1
TH	0929	14.9	F	0842	12.7
	1554	1.1		1508	3.8
	2225	16.2		2143	14.4
13	0429	2.5	28	0357	4.3
F	1040	15.8	SA	0953	13.8
	1647	0.7		1600	3.1
	2310	17.4		2226	15.9
14	0517	0.7	29	0441	2.2
SA	1132	16.8	SU	1051	15.2
	1730	0.4		1648	2.3
	2349	18.5		2304	17.4
15	0602	-0.8	30	0523	-0.1
SU	1217	17.7	M	1139	16.7
	1811	0.4		1730	1.6
				2343	19.0

MAY

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0605	-2.2	16	0018	18.4
TU	1224	18.0	W	0652	-2.0
	1815	1.0		1318	16.8
				1853	2.9
2	0021	20.3	17	0053	18.5
W	0647	-3.9	TH	0727	-2.1
	1311	18.9		1355	16.9
	1857	0.7		1930	3.1
3	0100	21.1	18	0126	18.4
TH	0732	-5.0	F	0800	-2.0
	1358	19.2		1430	16.8
	1942	0.7		2005	3.4
4	0142	21.4	19	0159	18.1
F	0815	-5.4	SA	0834	-1.7
	1447	19.0		1509	16.3
	2025	1.0		2041	3.8
5	0228	21.0	20	0234	17.5
SA	0903	-5.0	SU	0909	-1.0
	1535	18.4		1545	15.7
	2114	1.7		2120	4.4
6	0317	20.0	21	0313	16.7
SU	0954	-4.0	M	0946	-0.2
	1627	17.4		1627	15.0
	2207	2.6		2201	5.0
7	0408	18.6	22	0354	15.7
M	1046	-2.5	TU	1027	0.7
	1724	16.4		1712	14.4
	2308	3.5		2249	5.6
8	0509	16.8	23	0439	14.6
TU	1147	-0.8	W	1108	1.7
	1932	15.7		1757	14.0
				2344	5.9
9	0016	4.0	24	0532	13.5
W	0619	15.2	TH	1157	2.6
	1251	0.6		1848	14.0
	1936	15.5			
10	0138	3.9	25	0047	5.7
TH	0741	14.2	F	0638	12.7
	1406	1.7		1255	3.4
	2043	15.7		1940	14.3
11	0258	3.0	26	0202	4.9
F	0904	14.0	SA	0757	12.5
	1515	2.2		1402	3.9
	2140	16.3		2033	15.0
12	0403	1.7	27	0305	3.4
SA	1016	14.5	SU	0912	13.1
	1608	2.5		1502	3.9
	2229	17.0		2124	16.1
13	0454	0.4	28	0401	1.4
SU	1113	15.2	M	1019	14.2
	1654	2.6		1602	3.6
	2308	17.6		2213	17.5
14	0539	-0.7	29	0454	-0.8
M	1202	15.9	TU	1117	15.5
	1737	2.7		1657	3.0
	2346	18.0		2301	18.8
15	0618	-1.5	30	0543	-2.8
TU	1241	15.5	W	1211	16.9
	1818	2.8		1746	2.4
				2349	20.0
			31	0628	-4.4
			TH	1300	18.0
				1836	1.7

JUNE

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0039	20.9	16	0107	17.8
F	0717	-5.5	SA	0745	-1.8
	1349	19.7		1418	16.5
	1925	1.3		1948	3.7
2	0126	21.2	17	0142	17.9
SA	0804	-5.9	SU	0817	-1.8
	1437	19.9		1453	16.6
	2016	1.1		2027	3.7
3	0217	21.0	18	0219	17.7
SU	0953	-5.6	M	0952	-1.6
	1526	18.8		1528	16.5
	2106	1.2		2106	3.8
4	0306	20.1	19	0300	17.2
M	0939	-4.7	TU	0925	-1.0
	1615	18.4		1604	16.3
	2159	1.6		2145	4.0
5	0401	18.7	20	0336	16.4
TU	1030	-3.2	W	1002	-0.3
	1708	17.8		1639	16.0
	2256	2.1		2224	4.1
6	0459	17.0	21	0417	15.4
W	1124	-1.4	TH	1036	0.7
	1800	17.2		1719	15.7
				2313	4.7
7	0000	2.6	22	0506	14.4
TH	0603	15.3	F	1119	1.8
	1219	0.5		1754	15.6
	1855	16.6			
8	0110	2.8	23	0006	4.1
F	0714	13.9	SA	0603	13.4
	1320	2.2		1206	3.0
	1951	16.2		1843	15.6
9	0223	2.5	24	0110	3.6
SA	0832	13.2	SU	0714	12.7
	1420	3.6		1305	4.1
	2049	16.0		1934	15.9
10	0330	1.9	25	0219	2.6
SU	0947	13.1	M	0833	12.7
	1524	4.4		1414	4.8
	2139	16.1		2033	16.4
11	0428	1.0	26	0328	1.[illegible]
M	1054	13.7	TU	0952	13.4
	1619	4.8		1524	4.8
	2226	16.4		2133	17.3
12	0517	0.2	27	0429	-0.7
TU	1146	14.4	W	1101	14.[illegible]
	1709	4.8		1629	4.3
	2311	16.7		2235	18.4
13	0556	-0.5	28	0527	-2.6
W	1231	15.1	TH	1159	16.1
	1752	4.6		1727	3.3
	2349	17.1		2333	19.6
14	0635	-1.1	29	0615	-4.2
TH	1306	15.7	F	1250	17.5
	1833	4.2		1824	2.2
15	0027	17.6	30	0026	20.6
F	0710	-1.6	SA	0706	-5.4
	1345	16.2		1337	18.7
	1912	3.9		1915	1.2

TIME MERIDIAN 150° W. 0000 IS MIDNIGHT. 1200 IS NOON.
HEIGHTS ARE RECKONED FROM THE DATUM OF SOUNDINGS ON CHARTS OF THE LOCALITY WHICH IS MEAN LOWER LOW WATER.

SELDOVIA, ALASKA, 1973

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

JULY

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0118	21.2	16	0128	18.3
SU	0753	-5.8	M	0758	-1.8
	1424	19.4		1431	17.5
	2004	0.5		2008	2.8
2	0209	21.2	17	0207	18.4
M	0838	-5.6	TU	0831	-1.8
	1507	19.8		1500	17.8
	2053	0.2		2047	2.5
3	0300	20.5	18	0242	18.2
TU	0922	-4.6	W	0901	-1.4
	1553	19.6		1530	17.8
	2145	0.3		2122	2.4
4	0348	19.2	19	0321	17.5
W	1007	-3.1	TH	0935	-0.6
	1636	19.1		1601	17.7
	2236	0.8		2158	2.3
5	0439	17.5	20	0358	16.6
TH	1051	-1.1	F	1007	0.5
	1721	18.3		1630	17.5
	2331	1.5		2239	2.4
6	0537	15.6	21	0443	15.4
F	1137	1.1	SA	1046	1.8
	1806	17.3		1709	17.2
				2328	2.5
7	0029	2.2	22	0534	14.2
SA	0638	13.8	SU	1129	3.3
	1227	3.3		1754	16.8
	1854	16.3			
8	0138	2.7	23	0029	2.6
SU	0749	12.6	M	0644	13.1
	1329	5.0		1226	4.7
	1947	15.5		1845	16.5
9	0252	2.8	24	0140	2.3
M	0915	12.2	TU	0809	12.6
	1435	6.2		1336	5.8
	2046	15.1		1955	16.4
10	0359	2.4	25	0301	1.4
TU	1034	12.6	W	0936	13.1
	1544	6.6		1459	5.9
	2147	15.1		2110	16.9
11	0456	1.6	26	0413	-0.1
W	1133	13.5	TH	1051	14.5
	1642	6.3		1615	5.1
	2242	15.6		2221	18.0
12	0543	0.7	27	0514	-1.9
TH	1220	14.4	F	1146	16.2
	1733	5.7		1717	3.6
	2327	16.4		2326	19.3
13	0621	-0.1	28	0605	-3.5
F	1300	15.4	SA	1236	17.9
	1818	4.9		1815	1.9
14	0013	17.2	29	0021	20.6
SA	0656	-0.9	SU	0652	-4.6
	1329	16.2		1323	19.3
	1857	4.1		1903	0.5
15	0050	17.9	30	0110	21.4
SU	0726	-1.5	M	0736	-5.0
	1358	16.9		1402	20.4
	1932	3.4		1951	-0.6
			31	0159	21.5
			TU	0816	-4.7
				1441	20.8
				2037	-1.1

AUGUST

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0244	20.9	16	0223	19.2
W	0857	-3.7	TH	0832	-1.0
	1519	20.7		1451	19.5
	2120	-0.9		2056	0.4
2	0329	19.6	17	0300	18.7
TH	0935	-2.0	F	0903	-0.2
	1558	20.1		1522	19.4
	2205	-0.3		2132	0.4
3	0417	17.9	18	0342	17.7
F	1017	0.0	SA	0940	1.0
	1636	19.0		1551	19.0
	2252	0.8		2214	0.6
4	0503	16.0	19	0423	16.4
SA	1055	2.3	SU	1017	2.5
	1715	17.6		1630	18.4
	2340	2.1		2259	1.2
5	0557	14.1	20	0518	14.9
SU	1141	4.5	M	1103	4.1
	1757	16.2		1715	17.5
6	0042	3.3	21	0000	1.9
M	0704	12.5	TU	0625	13.5
	1234	6.4		1200	5.7
	1845	15.0		1813	16.6
7	0201	4.0	22	0115	2.3
TU	0838	11.8	W	0755	12.9
	1348	7.6		1321	6.7
	1954	14.2		1930	16.0
8	0328	3.9	23	0243	1.8
W	1015	12.2	TH	0931	13.5
	1515	7.9		1455	6.5
	2114	14.1		2102	16.4
9	0442	3.1	24	0402	0.5
TH	1117	13.3	F	1045	15.1
	1629	7.2		1613	5.0
	2222	14.8		2219	17.6
10	0523	2.0	25	0501	-1.1
F	1200	14.5	SA	1136	17.0
	1720	6.1		1714	3.0
	2313	16.0		2323	19.1
11	0602	0.8	26	0552	-2.4
SA	1231	15.7	SU	1217	18.8
	1759	4.8		1805	1.0
	2356	17.2			
12	0631	-0.1	27	0012	20.4
SU	1300	16.8	M	0633	-3.3
	1836	3.5		1258	20.2
				1850	-0.6
13	0037	18.2	28	0100	21.2
M	0702	-0.9	TU	0714	-3.5
	1327	17.9		1335	21.2
	1912	2.4		1933	-1.7
14	0112	19.0	29	0143	21.4
TU	0732	-1.3	W	0753	-3.0
	1355	18.7		1409	21.6
	1944	1.5		2015	-2.1
15	0148	19.3	30	0725	20.8
W	0801	-1.4	TH	0828	-1.9
	1424	19.2		1442	21.3
	2021	0.8		2054	-1.8
			31	0307	19.7
			F	0903	-0.3
				1516	20.5
				2132	-0.9

SEPTEMBER

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0349	18.2	16	0325	18.5
SA	0942	1.6	SU	0914	1.9
	1551	19.2		1518	20.1
	2215	0.4		2149	-0.9
2	0433	16.3	17	0410	17.1
SU	1017	3.6	M	0955	3.3
	1624	17.7		1602	19.1
	2255	2.0		2239	0.1
3	0521	14.4	18	0508	15.5
M	1102	5.6	TU	1044	4.9
	1703	16.1		1649	17.7
	2350	3.6		2340	1.3
4	0625	12.8	19	0620	14.1
TU	1147	7.3	W	1151	6.3
	1754	14.6		1758	16.3
5	0101	4.8	20	0059	2.1
W	0755	11.9	TH	0749	13.7
	1307	8.5		1317	6.9
	1905	13.5		1927	15.5
6	0244	5.1	21	0230	2.1
TH	0949	12.3	F	0919	14.5
	1449	8.6		1455	6.1
	2036	13.4		2058	15.9
7	0403	4.3	22	0347	1.1
F	1048	13.4	SA	1026	16.1
	1613	7.5		1609	4.2
	2159	14.3		2216	17.1
8	0454	3.1	23	0442	0.0
SA	1127	14.8	SU	1111	17.9
	1658	6.0		1704	2.0
	2254	15.6		2317	18.6
9	0527	1.9	24	0530	-0.9
SU	1156	16.2	M	1152	19.5
	1739	4.3		1751	0.0
	2336	17.0			
10	0602	0.9	25	0004	19.7
M	1221	17.5	TU	0611	-1.3
	1812	2.6		1228	20.7
				1833	-1.5
11	0015	18.3	26	0047	20.4
TU	0629	0.1	W	0648	-1.3
	1250	18.8		1301	21.4
	1844	1.1		1913	-2.4
12	0053	19.3	27	0130	20.6
W	0700	-0.3	TH	0726	-0.7
	1315	19.8		1335	21.6
	1918	-0.1		1950	-2.6
13	0128	19.8	28	0209	20.2
TH	0731	-0.4	F	0759	0.2
	1345	20.5		1406	21.2
	1954	-1.1		2025	-2.2
14	0203	19.9	29	0247	19.3
F	0804	0.0	SA	0835	1.5
	1412	20.8		1437	20.3
	2029	-1.5		2101	-1.2
15	0244	19.4	30	0325	18.0
SA	0837	0.7	SU	0909	3.0
	1445	20.7		1503	19.1
	2106	-1.5		2139	0.1

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SITKA, ALASKA, 1973

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

APRIL

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0008	9.3	16	0036	10.3
SU	0613	1.2	M	0701	-0.5
	1219	9.3		1315	9.1
	1825	0.6		1900	1.4
2	0037	10.0	17	0105	10.5
M	0653	0.1	TU	0737	-0.9
	1302	9.7		1355	9.1
	1901	0.6		1935	1.8
3	0109	10.7	18	0136	10.5
TU	0730	-0.9	W	0812	-1.1
	1346	9.9		1430	8.9
	1937	0.8		2006	2.2
4	0143	11.2	19	0204	10.4
W	0812	-1.6	TH	0846	-1.1
	1429	9.9		1509	8.6
	2012	1.1		2039	2.6
5	0219	11.4	20	0237	10.1
TH	0854	-2.0	F	0921	-0.9
	1515	9.6		1548	8.2
	2053	1.6		2110	3.1
6	0256	11.4	21	0306	9.8
F	0941	-2.0	SA	0958	-0.5
	1606	9.0		1629	7.7
	2135	2.3		2145	3.6
7	0339	11.1	22	0342	9.3
SA	1032	-1.6	SU	1039	0.0
	1701	8.4		1711	7.2
	2224	3.0		2224	4.0
8	0424	10.5	23	0419	8.8
SU	1128	-0.9	M	1124	0.6
	1806	7.8		1806	6.9
	2321	3.6		2311	4.4
9	0526	9.7	24	0504	8.1
M	1234	-0.3	TU	1215	1.1
	1923	7.5		1911	6.8
10	0039	4.0	25	0018	4.6
TU	0641	8.9	W	0603	7.6
	1348	0.3		1316	1.5
	2044	7.7		2019	7.0
11	0215	3.9	26	0150	4.5
W	0804	8.3	TH	0724	7.2
	1505	0.6		1422	1.7
	2148	8.2		2114	7.5
12	0340	2.2	27	0312	3.8
TH	0933	8.3	F	0854	7.1
	1612	0.7		1521	1.7
	2241	8.8		2158	8.1
13	0450	2.1	28	0409	2.7
F	1044	8.5	SA	1005	7.5
	1701	0.8		1612	1.7
	2326	9.5		2238	8.9
14	0541	1.1	29	0459	1.4
SA	1142	8.8	SU	1107	8.0
	1748	0.9		1657	1.6
				2314	9.7
15	0001	10.0	30	0544	0.1
SU	0624	0.2	M	1157	8.6
	1233	9.0		1739	1.6
	1826	1.1		2351	10.4

MAY

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0627	-1.1	16	0027	10.2
TU	1246	9.0	W	0718	-1.2
	1824	1.6		1345	8.2
				1905	2.9
2	0030	11.1	17	0102	10.2
W	0711	-2.1	TH	0753	-1.3
	1334	9.3		1424	8.2
	1905	1.8		1940	3.1
3	0109	11.5	18	0134	10.1
TH	0754	-2.7	F	0826	-1.3
	1421	9.4		1459	8.1
	1952	2.0		2014	3.3
4	0151	11.7	19	0207	9.9
F	0940	-3.0	SA	0902	-1.2
	1512	9.3		1536	8.0
	2037	2.3		2049	3.5
5	0236	11.6	20	0240	9.6
SA	0926	-2.8	SU	0938	-0.9
	1603	9.0		1617	7.8
	2125	2.7		2128	3.7
6	0323	11.1	21	0317	9.2
SU	1020	-2.3	M	1016	-0.5
	1658	8.7		1658	7.6
	2219	3.0		2207	3.9
7	0417	10.3	22	0354	8.7
M	1117	-1.5	TU	1055	0.0
	1759	8.4		1743	7.6
	2327	3.3		2259	4.1
8	0519	9.3	23	0441	8.1
TU	1213	-0.6	W	1136	0.5
	1903	8.3		1828	7.6
9	0045	3.4	24	0002	4.0
W	0629	8.4	TH	0536	7.5
	1319	0.2		1222	1.0
	2006	8.5		1919	7.8
10	0210	3.0	25	0113	3.7
TH	0753	7.7	F	0646	7.0
	1425	0.9		1317	1.5
	2107	8.8		2005	8.2
11	0326	2.3	26	0224	2.9
F	0917	7.5	SA	0805	6.7
	1527	1.5		1414	1.9
	2156	9.2		2051	8.7
12	0427	1.3	27	0330	1.9
SA	1030	7.5	SU	0926	6.9
	1617	1.9		1511	2.3
	2241	9.6		2137	9.3
13	0519	0.4	28	0424	0.6
SU	1129	7.7	M	1038	7.3
	1706	2.2		1604	2.5
	2321	9.9		2225	10.0
14	0600	-0.3	29	0515	-0.6
M	1224	8.0	TU	1139	7.8
	1754	2.5		1700	2.5
	2356	10.1		2309	10.7
15	0643	-0.8	30	0604	-1.8
TU	1308	8.1	W	1233	8.3
	1930	2.7		1755	2.6
				2355	11.3
			31	0652	-2.7
			TH	1325	8.8
				1844	2.5

JUNE

DAY	TIME H.M.	HT. FT.	DAY	TIME H.M.	HT. FT.
1	0043	11.7	16	0112	9.9
F	0741	-3.2	SA	0809	-1.4
	1414	9.1		1443	8.0
	1943	2.5		1953	3.5
2	0132	11.8	17	0148	9.8
SA	0828	-3.4	SU	0843	-1.4
	1503	9.2		1521	8.1
	2025	2.5		2035	3.4
3	0222	11.6	18	0223	9.6
SU	0918	-3.2	M	0913	-1.2
	1552	9.2		1557	8.1
	2119	2.5		2118	3.4
4	0312	11.0	19	0258	9.3
M	1006	-2.6	TU	0952	-0.9
	1645	9.2		1632	8.2
	2219	2.6		2157	3.4
5	0406	10.1	20	0340	8.8
TU	1055	-1.7	W	1025	-0.5
	1736	9.2		1706	8.3
	2320	2.6		2242	3.2
6	0509	9.1	21	0421	8.2
W	1146	-0.7	TH	1102	0.1
	1828	9.1		1741	8.4
				2337	3.0
7	0031	2.5	22	0514	7.6
TH	0618	8.1	F	1137	0.7
	1242	0.4		1821	8.6
	1921	9.1			
8	0142	2.1	23	0033	2.6
F	0732	7.2	SA	0613	7.0
	1335	1.4		1221	1.4
	2016	9.2		1903	8.8
9	0255	1.6	24	0142	2.0
SA	0852	6.7	SU	0729	6.5
	1435	2.2		1315	2.2
	2108	9.3		1952	9.2
10	0359	0.9	25	0245	1.2
SU	1009	6.7	M	0855	6.4
	1536	2.9		1416	2.8
	2155	9.4		2047	9.6
11	0456	0.3	26	0353	0.1
M	1119	6.8	TU	1012	6.7
	1625	3.3		1522	3.1
	2238	9.5		2143	10.1
12	0541	-0.3	27	0454	-1.0
TU	1214	7.1	W	1126	7.2
	1716	3.5		1628	3.2
	2319	9.6		2241	10.7
13	0624	-0.7	28	0548	-2.0
W	1257	7.4	TH	1223	7.8
	1801	3.6		1732	3.1
				2335	11.2
14	0001	9.7	29	0640	-2.8
TH	0659	-1.1	F	1312	8.4
	1338	7.6		1827	2.7
	1840	3.6			
15	0036	9.8	30	0030	11.5
F	0734	-1.3	SA	0728	-3.3
	1413	7.8		1403	9.0
	1921	3.5		1925	2.4

TIME MERIDIAN 120° W. 0000 IS MIDNIGHT. 1200 IS NOON.
HEIGHTS ARE RECKONED FROM THE DATUM OF SOUNDINGS ON CHARTS OF THE LOCALITY WHICH IS MEAN LOWER LOW WATER.

SITKA, ALASKA, 1973

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

JULY

DAY	TIME H.M.	HT. FT.
1 SU	0122	11.6
	0816	-3.4
	1449	9.4
	2016	2.0
2 M	0215	11.4
	0902	-3.1
	1533	9.6
	2111	1.7
3 TU	0306	10.8
	0948	-2.4
	1619	9.8
	2206	1.6
4 W	0357	10.0
	1029	-1.5
	1702	9.8
	2302	1.5
5 TH	0451	8.9
	1115	-0.4
	1746	9.6
6 F	0003	1.5
	0553	7.8
	1158	0.8
	1832	9.4
7 SA	0105	1.4
	0658	6.8
	1247	1.9
	1921	9.2
8 SU	0215	1.3
	0821	6.2
	1335	2.9
	2015	9.0
9 M	0322	1.0
	0943	6.0
	1439	3.6
	2108	8.9
10 TU	0425	0.5
	1100	6.2
	1546	4.0
	2159	8.9
11 W	0516	0.1
	1203	6.6
	1650	4.1
	2253	9.1
12 TH	0602	-0.4
	1245	7.0
	1739	3.9
	2336	9.3
13 F	0641	-0.8
	1318	7.4
	1826	3.7
14 SA	0017	9.5
	0718	-1.1
	1353	7.8
	1907	3.4
15 SU	0059	9.7
	0752	-1.3
	1424	8.1
	1944	3.0
16 M	0135	9.7
	0824	-1.4
	1457	8.4
	2022	2.8
17 TU	0211	9.6
	0853	-1.3
	1521	8.6
	2059	2.5
18 W	0246	9.4
	0925	-1.0
	1551	8.8
	2139	2.2
19 TH	0325	8.9
	0954	-0.5
	1623	9.0
	2220	2.0
20 F	0406	8.4
	1023	0.2
	1655	9.1
	2305	1.7
21 SA	0455	7.7
	1058	0.9
	1733	9.2
22 SU	0000	1.4
	0553	7.0
	1141	1.7
	1815	9.3
23 M	0103	1.1
	0704	6.4
	1228	2.6
	1907	9.4
24 TU	0212	0.6
	0831	6.1
	1334	3.3
	2009	9.5
25 W	0327	-0.1
	1000	6.4
	1455	3.7
	2116	9.8
26 TH	0438	-0.9
	1115	7.0
	1615	3.6
	2225	10.3
27 F	0538	-1.7
	1211	7.8
	1725	3.1
	2326	10.8
28 SA	0627	-2.4
	1300	8.5
	1824	2.4
29 SU	0026	11.1
	0715	-2.8
	1343	9.2
	1917	1.7
30 M	0115	11.3
	0759	-2.8
	1424	9.8
	2008	1.1
31 TU	0207	11.1
	0840	-2.4
	1505	10.1
	2057	0.6

AUGUST

DAY	TIME H.M.	HT. FT.
1 W	0255	10.5
	0919	-1.7
	1541	10.2
	2145	0.4
2 TH	0344	9.7
	1000	-0.8
	1619	10.1
	2235	0.5
3 F	0432	8.7
	1035	0.3
	1658	9.8
	2324	0.7
4 SA	0524	7.7
	1114	1.5
	1736	9.4
5 SU	0021	1.0
	0625	6.7
	1153	2.6
	1822	8.9
6 M	0124	1.2
	0739	6.0
	1244	3.5
	1916	8.5
7 TU	0239	1.3
	0910	5.7
	1350	4.2
	2016	8.2
8 W	0349	1.0
	1040	6.0
	1514	4.5
	2125	8.2
9 TH	0454	0.6
	1141	6.5
	1631	4.3
	2228	8.5
10 F	0539	0.1
	1224	7.0
	1726	3.9
	2319	8.9
11 SA	0620	-0.3
	1253	7.5
	1911	3.3
12 SU	0005	9.3
	0653	-0.7
	1322	8.1
	1849	2.8
13 M	0043	9.5
	0724	-0.9
	1351	8.6
	1927	2.2
14 TU	0120	9.7
	0755	-1.0
	1416	9.0
	2001	1.6
15 W	0158	9.7
	0824	-0.8
	1442	9.4
	2037	1.2
16 TH	0236	9.5
	0853	-0.5
	1509	9.6
	2115	0.8
17 F	0315	9.1
	0921	0.1
	1540	9.6
	2151	0.5
18 SA	0354	8.6
	0954	0.7
	1613	9.9
	2239	0.4
19 SU	0439	7.9
	1032	1.5
	1648	9.8
	2329	0.4
20 M	0536	7.2
	1109	2.4
	1730	9.6
21 TU	0031	0.4
	0654	6.5
	1204	3.2
	1831	9.4
22 W	0146	0.4
	0826	6.3
	1319	3.9
	1944	9.2
23 TH	0310	0.1
	0956	6.6
	1451	4.0
	2104	9.3
24 F	0424	-0.5
	1105	7.4
	1618	3.5
	2218	9.7
25 SA	0519	-1.1
	1152	8.3
	1723	2.6
	2325	10.3
26 SU	0612	-1.6
	1237	9.1
	1820	1.6
27 M	0021	10.6
	0653	-1.7
	1318	9.8
	1908	0.7
28 TU	0110	10.8
	0737	-1.6
	1353	10.3
	1952	0.0
29 W	0158	10.6
	0817	-1.1
	1428	10.6
	2034	-0.4
30 TH	0244	10.2
	0848	-0.4
	1502	10.6
	2116	-0.5
31 F	0325	9.5
	0921	0.5
	1536	10.4
	2203	-0.3

SEPTEMBER

DAY	TIME H.M.	HT. FT.
1 SA	0410	8.7
	0957	1.4
	1608	9.9
	2245	0.1
2 SU	0455	7.8
	1033	2.4
	1645	9.4
	2333	0.6
3 M	0550	6.9
	1114	3.3
	1727	8.8
4 TU	0031	1.2
	0702	6.2
	1155	4.1
	1816	8.2
5 W	0140	1.6
	0836	5.9
	1307	4.7
	1926	7.8
6 TH	0300	1.6
	1009	6.2
	1451	4.8
	2047	7.7
7 F	0409	1.3
	1102	6.8
	1611	4.4
	2202	8.0
8 SA	0500	0.8
	1139	7.4
	1706	3.7
	2258	8.5
9 SU	0542	0.4
	1214	8.0
	1752	2.8
	2344	9.0
10 M	0617	0.1
	1237	8.7
	1829	2.0
11 TU	0027	9.4
	0648	0.0
	1304	9.3
	1902	1.2
12 W	0105	9.7
	0717	0.0
	1331	9.8
	1939	0.4
13 TH	0142	9.8
	0751	0.2
	1357	10.3
	2014	-0.2
14 F	0221	9.7
	0820	0.5
	1429	10.6
	2049	-0.6
15 SA	0301	9.4
	0851	1.1
	1458	10.7
	2131	-0.8
16 SU	0347	8.9
	0929	1.7
	1535	10.6
	2216	-0.7
17 M	0433	8.2
	1007	2.5
	1616	10.3
	2309	-0.4
18 TU	0536	7.5
	1050	3.3
	1705	9.8
19 W	0012	0.1
	0650	7.0
	1157	4.0
	1809	9.3
20 TH	0128	0.4
	0821	7.0
	1325	4.3
	1932	8.9
21 F	0250	0.4
	0943	7.5
	1507	4.0
	2101	8.9
22 SA	0402	0.2
	1044	8.3
	1622	3.1
	2218	9.2
23 SU	0459	-0.1
	1128	9.1
	1722	1.9
	2323	9.7
24 M	0548	-0.2
	1207	9.9
	1813	0.8
25 TU	0016	10.1
	0627	-0.1
	1244	10.5
	1857	-0.1
26 W	0105	10.2
	0709	0.1
	1317	10.9
	1938	-0.7
27 TH	0147	10.1
	0743	0.6
	1350	11.0
	2014	-1.0
28 F	0228	9.8
	0815	1.2
	1421	10.9
	2052	-1.0
29 SA	0309	9.3
	0850	1.9
	1453	10.6
	2131	-0.7
30 SU	0351	8.7
	0925	2.7
	1524	10.1
	2207	-0.2

TIME MERIDIAN 120° W. 0000 IS MIDNIGHT. 1200 IS NOON.
HEIGHTS ARE RECKONED FROM THE DATUM OF SOUNDINGS ON CHARTS OF THE LOCALITY WHICH IS MEAN LOWER LOW WATER.

APPENDIX C

PROPOSED ALASKA WATER QUALITY STANDARDS

NOTICE OF PUBLIC HEARING
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
WATER QUALITY STANDARDS

NOTICE IS HEREBY GIVEN that the Department of Environmental Conservation, under Authority vested by AS 46.03.020(10)(A), AS 46.03.070, AS 46.03.080, proposes to adopt revisions to the water quality standards regulations.

All of the proposed revisions are being made at the request of the U.S. Environmental Protection Agency in order to comply with the requirements of the Federal Water Pollution Control Act Amendments of 1972.

Copies of the existing regulations and copies of the proposed revised regulations may be obtained by writing to the Commissioner, Department of Environmental Conservation, Pouch O, Juneau, Alaska 99801, or at the following locations:

City	Location
Juneau:	Department of Environmental Conservation (St. Ann's Center) 419 6th Street 586-6721
Anchorage:	Department of Environmental Conservation Regional Office McKay Building 274-5527
Fairbanks:	Department of Environmental Conservation Regional Office State Court and Office Building, Room 105 604 Barnette 452-1714

A summary of the proposed revisions is as follows:

18AAC 70.020 (a)(3) is revised to read "Class C. Water Contact Recreation."

18AAC 70.020 (b). On the table, Water Use Class C is revised to read "Water Contact Recreation"

On the table, column heading (1) is revised to read "Total Coliform Organisms. (see Note 1)."

On the table, Criteria A-1 is revised to read "Mean of 5 or more samples in any month less than 50 per 100 ml, except that ground water shall contain zero per 100 ml."

On the table, Criteria B-1 is revised to read "Mean of 5 or more samples in any month less than 1000 per 100 ml, and not more than 20% of samples during one month may exceed 2400 per 100 ml, except groundwater shall contain zero per ml."

On the table, Criteria F-1 is revised to add "except groundwater shall contain zero per 100 ml."

On the table, Column heading (3) is revised to read "pH (see note 3)".

On the table, Criteria A-3, B-3, C-3, D-3, E-3, F-3, and G-3 are revised to delete "(see note 3)".

18AAC 70.020 (b)

On the table, Criteria D-3 is revised to delete "Maximum pH change per hour is 0.5".

On the table, Criteria D-7 is revised to add to the existing criteria, "Residues shall be less than those levels which cause tainting of fish or other organisms and less than acute or chronic problem levels as determined by bioassay".

On the table, Criteria E-7 is revised to read "same as D-7".

On the table, Criteria F-7 and G-7 are revised to read "same as A-7".

On the table, Column heading (8) is revised to read "Settleable Solids-Suspended Material (includes sediment and dredge spoil and fill)".

On the table, Criteria D-9 is revised to read "Concentrations shall be less than those levels which cause tainting of fish or other organisms and less than acute or chronic problem levels as revealed by bioassay or other appropriate methods and below concentrations affecting the ecological balance."

On the table, Criteria E-9 is revised to read "same as D-9".

On the table, Criteria A-11, B-11, C-11, D-11, E-11, F-11 and G-11 are revised to read "The following criteria apply to all Water Uses, Class A through Class G:

"The concentrations of radionuclides in these waters shall be maintained at the lowest practicable level and shall not: (1) Exceed 1/30th of the Maximum Permissible Concentration values in water (MPCw) given for continuous occupational exposure in National Bureau of Standards Handbook 69 (see note 5);

(2) Exceed the concentrations specified in the USPHS Drinking Water Standards for waters used for domestic supplies; (see note 4);

(3) Result in the accumula ion of radioactivity in edible plants or animals that present a hazard to consumers;

(4) Be harmful to aquatic life."

Notes to the table. Note 5 is added to read "Wherever cited in these standards, National Bureau of Standards Handbook 69 means the handbook entitled "Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure". U.S. Department of Commerce, National Bureau of Standards Handbook 69, June 5, 1959, obtainable from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, or in any Regional Office of the Department of Environmental Conservation, and which is on file in the office of the Lieutenant Governor."

18AAC 70.020 (c) is revised to read "The analytical procedures used as methods of analysis to determine the quality of waters shall be in accordance with the 13th edition of Standard Methods for the Examination of Water and Wastewater published by the Water Pollution Control Federation, the American Water Works Association and the American Public Health Association (publication office: American Public Health Association, 1740 Broadway, New York, N.Y. 10019), or in accordance with other standards mutually approved by the Department and the U.S. Environmental Protection Agency."

18AAC 70.030 is revised to add paragraph (3) which reads "Waste discharge permits will define a mixing zone outside of which violations of the criteria will be determined. The mixing zone will be limited to a volume of the receiving water that will: (a) not interfere with biological communties or populations of important species to a degree which is damaging to the ecosystem, and,

(b) not diminish other beneficial uses disproportionately."

18AAC 70.050 (a)(1) The classification of Ship Creek is revised to read "Ship Creek - near Anchorage, Alaska - from the Ship Creek diversion structure at river mile 11.5 to the confluence with the Knik Arm of Cook Inlet- Classes B, C, D and G."

18AAC 70.050 (a)(2) The classification of Chena River is revised to read "Chena River - near Fairbanks, Alaska - from the confluence of the Chena River and Chena Slough to the confluence of the Chena River and Tanana River - Class C and D."

18AAC 70.050 (a)(3) is revised to read "Estuarine and marine waters - Classes C, D, E and G."

18AAC 70.050 (a)(4) is revised to read "the ground waters of the state - Classes A, B, F and G."

18AAC 70.080 is revised to read "Secondary treatment is required for all domestic wastes. All industrial waste discharges are required to have treatment equivalent to the best practicable control technology currently available for each industrial waste. If secondary treatment for domestic sewage and best practicable control technology currently available for industrial wastes is inadequate to achieve the water quality criteria as defined in sec. 20 of this chapter, higher levels of treatment will be required."

18AAC 70.081 is revised to read "CERTIFICATE OF REASONABLE ASSURANCE. Upon application to the department, the department may issue to the applicant a certificate that there is reasonable assurance, as determined by the Department, that a proposed activity of the applicant will comply with the requirements of Section 401 of the Federal Water Pollution Control Act Amendments of 1972, 86 Stat. 816."

18AAC 70.082 (a) is revised to add "The public notice may be issued jointly with the federal permitting agency."

18AAC 70.090 is revised to read "IMPLEMENTATION AND ENFORCEMENT. The plan for implementing and enforcing sec. 80 of this chapter shall be based upon achieving the minimum treatment levels specified in that section at the time of construction, for new discharges and as soon as possible but not later than July 1977, for existing discharges, and the plan shall consist of the following elements: (1) Waste discharge permits issued by the Department and those federal permits issued within the state and certified by the state pursuant to sec. 81 of this chapter;

(2) The Water Pollution Control Program Plan of the department, and;

(3) Plans developed by the department while implementing the

"continuing planning process" required by sec. 303(e) of the Federal Water Pollution Control Act Amendments of 1972, 86 Stat. 816."

18AAC 70.110 is revised to delete the definitions of "coastal waters" and "interstate waters".

Subsection (1) is revised to define "commissioner" (formerly subsection 2).

Subsection (2) is revised to read " 'Contact recreation' means any from of recreation Involving deliberate or accidental contact with water, and includes but is not limited to swimming, water skiing, fishing and commercial and recreational boating."

Subsection (4) is revised to read " 'dredge spoil and fill' means unpolluted solid material including but not limited to sand, silt, clay and rock which may be places in waters of the State."

Subsection (5) is revised to read " 'ground water' means water in the zone of saturation, which is the zone below the water table in which all interstices are filled with water."

Subsection (6) is revised to define "primary treatment" (formerly subsection 5).

Subsection (7) is revised to define "secondary treatment" (formerly subsection 6).

Subsection (8) is revised to define "sheen" (formerly subsection 7).

Subsection (9) is revised to read " 'sludge' means a combination of solids and liquids including, but not limited to an aggregate of oil or oil and matter of any other kind, having a combined specific gravity equivalent to or greater than that of water. Sludge does not mean 'dredge spoil and fill' "

NOTICE IS ALSO GIVEN that any person interested may present oral or written statements or arguments relevant to the action proposed at a hearing continuing until all interested persons have been heard at the following locations:

City	Location	Date	Time
Anchorage	Anchorage Westward Commodore Room	April 26	2:30 p.m., 7:30 p.m.
Juneau	Assembly Chambers Municipal Building	April 27	2:30 p.m., 7:30 p.m.
Ketchikan	City Council Chambers	April 28	2:30 p.m., 7:30 p.m.

or may mail written comments to the Commissioner, Department of Environmental Conservation, Pouch O, Juneau, Alaska 99801, if received before 4:30 p.m., May 10, 1973 . The Department of Environmental Conservation, upon its own motion or at the motion of any interested person, may thereafter adopt, amend, reject, or take no action relative to the proposals set out above without urther notice.

Dated at Juneau, Alaska this 23rd day of March 1973.

Max C. Brewer

Max C. Brewer, Commissioner

Section

18 AAC 70.010. WATER QUALITY STANDARDS. (a) The water quality standards set forth in this chapter shall apply to all waters of the state.

(b) Waters whose existing quality is better than the established standards shall be maintained at that high quality unless it has been affirmatively demonstrated to the department that a change is justifiable as a result of necessary economic or social development and that change shall not preclude present and anticipated use of such waters. Any industrial, public or private project or development which would constitute a new source of pollution or an increased source of pollution to high quality waters shall provide the highest degree of practicable treatment to maintain the high water quality. In implementing this policy, the Administrator of the Environmental Protection Agency will be kept advised in order to be able to discharge his responsibilities under the Federal Water Pollution Control Act as amended. (In effect before 7/28/59; a m. 5/24/70, Register 34; a m. 8/28/71, Register 39; a m.10/22/72, Register 44).

AUTHORITY: AS 46.03.010
AS 46.03.020(10)(A)
AS 46.03.070
AS 46.03.080

18 AAC 70.020. ESTABLISHMENT OF WATER USE CLASSIFICATION AND CRITERIA. (a) There are established seven water use classifications which are designated by the letters "A" through "G", inclusive. The water use classifications are as follows:

(1) Class A. Water supply, drinking, culinary, and food processing without the need for treatment other than simple disinfection and simple removal of naturally present impurities.

(2) Class B. Water supply, drinking, culinary, and food processing with the need for treatment equal to coagulation, sedimentation, filtration, disinfection, and any other treatment processes necessary to remove naturally present impurities.

(3) Class C. Water contact recreation.

(4) Class D. Growth and propagation of fish and other aquatic life, including waterfowl and furbearers.

(5) Class E. Shellfish growth and propagation, including natural and commercial growing areas.

(6) Class F. Agricultural water supply, including irrigation, stock watering, and truck farming.

(7) Class G. Industrial water supply (other than food processing).

(b) The water quality criteria applicable to each water use classification are as follows.

Water Quality Parameters / Water Uses	Total Coliform Organisms (see note 1)	Dissolved Oxygen mg/l or % Saturation	pH (see note 3)
A. Water supply, drinking, culinary and food processing without the need for treatment other than simple disinfection and simple removal of naturally present impurities.	Mean of 5 or more samples in any month less than 50 per 100 ml, except ground water shall contain zero per 100 ml.	Greater than 75% saturation or 5 mg/l.	Between 6.5 and 8.5
B. Water supply, drinking, culinary, and food processing with the need for treatment equal to coagulation, sedimentation, filtration, disinfection, and any other treatment processes necessary to remove naturally present impurities.	Mean of 5 or more samples in any month less than 1000 per 100 ml, and not more than 20% of samples during one month may exceed 2400 per 100ml, except ground water shall contain zero per 100 ml.	Greater than 60% saturation or 5 mg/l.	Between 6.5 and 8.5
C. Water Contact Recreation	Same as B-1	Greater than 5 mg/l.	Between 6.5 and 8.5
D. Growth and propagation of fish and other aquatic life, including waterfowl and furbearers.	Same as B-1 to protect associated recreational values.	Greater than 6 mg/l in salt water and greater than 7 mg/l in fresh water	Between 7.5 and 8.5 for salt water. Between 6.5 and 8.5 for fresh water.
E. Shellfish growth and propagation including natural and commercial growing areas.	Not to exceed limits specified in <u>National Shellfish Sanitation Program Manual of Operations, Part 1</u>, USPHS. (see note 2)	Greater than 6 mg/l in the larval stage. Greater than 5 mg/l in the adult stage.	Between 7.5 and 8.5
F. Agricultural water supply, including irrigation, stock watering, and truck farming.	Mean of 5 or more samples less than 1,000 per 100 ml with 20% of samples not to exceed 2,400 per 100 ml for livestock watering, for irrigation of crops for human consumption, and for general farm use, except ground water shall contain zero per 100 ml	Greater than 3 mg/l	Between 6.5 and 8.5
G. Industrial water supply (other than food processing).	Same as B-1 whenever worker contact is present.	Greater than 5 mg/l for surface water	Between 6.5 and 8.5

Turbidity, measured in Jackson Turbidity Units (JTU)	Temperature, as measured in degrees Fahrenheit (°F)	Dissolved inorganic substances
Less than 5 JTU	Below 60°F	Total dissolved solids from all sources may not exceed 500 mg/l.
Less than 5 JTU above natural conditions.	Below 60°F.	Numerical value is inapplicable.
Below 25 JTU except when natural conditions exceed this figure effluents may not increase the turbidity.	Numerical value is inapplicable.	Numerical value is inapplicable.
Less than 25 JTU when attributable to solids which result from other than natural origin.	May not exceed natural temp. by more than 2°F for salt water. May not exceed natural temp. by more than 4°F for fresh water. No change shall be permitted for temp. over 60°F. Maximum rate of change permitted is 0.5°F per hr.	Within ranges to avoid chronic toxicity or significant ecological change.
Less than 25 JTU of mineral origin.	Less than 68°F.	Within ranges to avoid chronic toxicity or significant ecological change.
Numerical values are inapplicable.	Between 60°F and 70°F for optimum growth to prevent physiological shock to plants.	Conductivity less than 1,500 micromhos at 25°C. Sodium adsorption ratio less than 2.5, sodium percentage less than 60%, residual carbonate less than 1.25 me/l, and boron less than 0.3 mg/l
No imposed turbidity that may interfere with established levels of water supply treatment.	Less than 70°F.	No amounts above natural conditions which may cause undue corrosion, scaling, or process problems.

Residues including Oils, Floating Solids, Sludge Deposits and Other Wastes	Settleable solids suspended solids (includes sediment & dredge spoil & fill)	Toxic or Other Deleterious Substances, Pesticides, and Related Organic and Inorganic Materials
Same as B-7	Below normally detectable amounts.	Carbon chloroform extracts less than 0.1 mg/l and other chemical constituents may not exceed USPHS Drinking Water Standards. (see note 4)
Residues may not make the receiving water unfit or unsafe for the uses of this classification; nor cause a film or sheen upon, or discoloration of, the surface of the water or adjoining shoreline; nor cause a sludge or emulsion to be deposited beneath or upon the surface of the water, within the water column, on the bottom, or upon adjoining shorelines.	No imposed loads that will interfere with established levels of water supply treatment.	Chemical constituents shall conform to USPHS Drinking Water Standards. (see note 4)
Same as B-7	No visible concentrations of sediment.	Below concentrations found to be of public health significance.
Same as B-7 plus the following: Residues shall be less than those levels which cause tainting of fish or other organisms and less than acute or chronic problem levels as determined by bioassay.	No deposition which adversely affects fish & other aquatic life reproduction and habitat.	Concentrations shall be less than those levels which cause tainting fish, less than acute or chronic problem levels as revealed by bioassay or other appropriate methods and below concentrations affecting the ecological balance.
Same as D-7	No deposition which adversely affects growth and propagation of shellfish.	Same as D-9
Same as B-7	For sprinkler irrigation, water free of particles of 0.074 mm or coarser. For irrigation or water spreading, not to exceed 200 mg/l for an extended period of time.	Less than that shown to be deleterious to livestock or plants or their subsequent consumption by humans.
Same as B-7	No imposed loads that will interfere with established levels of treatment.	Chemical constituents may not exceed concentrations found to be of public health significance.

<table>
<tr><th>Color, as measured in color units</th><th>Radioactivity</th><th>Aesthetic Considerations</th><th>Water Quality Parameters / Water Uses</th><th></th></tr>
<tr><td>True color less than 15 color units.</td><td rowspan="7">The following criteria apply to all water uses, Class A through Class G:

The concentrations of radionuclides in these waters shall be maintained at the lowest practicable levels and shall not

a) Exceed 1/30th of the maximum permissible concentration values in water (MPC_w) given for continuous occupational exposure in <u>National Bureau of Standards Handbook 69</u> (see note 5);

b) Exceed the concentrations specified in the <u>USPHS Drinking Water Standards</u> for water used for domestic supplies (see note 4);

c) Result in the accumulation of radioactivity in edible plants or animals that present a hazard to consumers;

d) Be harmful to aquatic life;</td><td>May not be impaired by the presence of materials or their effects which are offensive to the sight, smell, taste, or touch.</td><td>Water supply, drinking, culinary and food processing without the need for treatment other than simple disinfection and simple removal of naturally present impurities.</td><td>A.</td></tr>
<tr><td>Same as A-10</td><td>Same as A-12</td><td>Water supply, drinking, culinary, and food processing with the need for treatment equal to coagulation, sedimentation, filtration, disinfection, and any other treatment processes necessary to remove naturally present impurities.</td><td>B.</td></tr>
<tr><td>Same as A-10</td><td>Same as A-12</td><td>Bathing, swimming, recreation.</td><td>C.</td></tr>
<tr><td>True color less than 50 color units.</td><td>Same as A-12</td><td>Growth and propagation of fish and other aquatic life, including waterfowl and furbearers.</td><td>D.</td></tr>
<tr><td>True color less than 50 color units.</td><td>Same as A-12</td><td>Shellfish growth and propagation including natural and commercial growing areas.</td><td>E.</td></tr>
<tr><td>Inapplicable</td><td>Same as A-12</td><td>Agricultural water supply, including irrigation, stock watering, and truck farming.</td><td>F.</td></tr>
<tr><td>True color less than 50 color units.</td><td>Same as A-12</td><td>Industrial water supply (other than food processing).</td><td>G.</td></tr>
</table>

Notes:

1. Organisms of the coliform group shall be determined by Most Probable Number or equivalent membrane filter technique.

2. Wherever cited in these standards, the National Shellfish Sanitation Program, Manual of Operations, Part I, means Sanitation of Shellfish Growing Areas, 1965 revision, U.S. Department of Health, Education and Welfare, Public Health Service Publication No. 33, Part 1, obtainable from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (Price 45 cents), or in any Regional Office of the Department of Environmental Conservation, and which is on file in the office of the lieutenant governor.

3. Induced variation of pH conditions naturally outside this range may not exceed 0.5 pH unit and the pH change shall be only in the direction of this range. pH conditions naturally within this range shall be maintained within 0.5 pH unit of the natural pH.

4. Wherever cited in these standards, USPHS Drinking Water Standards means the Public Health Service Drinking Water Standards, 1962 revision, U.S. Department of Health, Education and Welfare, Public Health Service Publication No. 956, obtainable from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (Price 30 cents) or from any Regional Office of the Department of Environmental Conservation, and which is on file in the office of the lieutenant governor.

5. Wherever cited in these standards, National Bureau of Standards Handbook 69 means the handbook entitled "Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and Water for Occupational Exposure", U.S. Department of Commerce, National Bureau of Standards Handbook 69, June 5, 1959, obtainable from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, or in any Regional Office of the Department of environmental Conservation, and which is on file in the office of the lieutenant governor.

(c) The analytical procedures used as methods of analysis to determine the quality of waters shall be in accordance with the 13th edition of Standard Methods for the Examination of Water and Wastewater, published by the Water Pollution Control Federation, the American Water Works Association and the American Public Health Association, (publication office: American Public Health Association, 1740 Broadway, New York, New York 10019), or in accordance with other standards mutually approved by the department and the U.S. Environmental Protection Agency. (In effect before 7/28/59; am 5/24/70, Register 34; am 8/28/71, Register 39; am 10/22/72, Register 44; am / / , Register).

AUTHORITY: AS 46.03.020(10)(A)
AS 46.03.070
AS 46.03.080

18 AAC 70.030. PROCEDURE FOR DETERMINING WATER QUALITY CRITERIA. In determining the appropriate water quality criteria for any waters or portion of waters, the department shall adhere to the following procedure:

(1) If waters have more than one classification, the most stringent water quality criterion of all the classifications shall apply; and

(2) If a tributary water either receives a sewage waste discharge or industrial waste discharge, or has a lower classification than the confluence water, and the tributary water affects the quality of the confluence water, the most stringent water quality criteria applicable to either the tributary water or the confluence water shall apply to the tributary water; and

(3) Waste Discharge Permits will define a mixing zone outside of which violations of the criteria will be determined. The mixing zone will be limited to a volume of the receiving water that will

(A) not interfere with biological communities or populations of important species to a degree which is damaging to the ecosystem, and

(B) not diminish other beneficial uses disproportionately. In effect before 7/28/59; am 5/24/70, Register 34; am 8/28/71, Register 39; am 10/22/72, Register 44; am / / , Register).

AUTHORITY: AS 46.03.020(10)(A)
AS 46.03.070
AS 46.03.080

18 AAC 70.040. NATURAL CONDITIONS. Waters may have natural characteristics which would place them outside the criteria established by this chapter. The criteria established in this chapter apply to man-made alterations to the waters of the state. (In effect before 7/28/59; am 5/24/70, Register 34; am 8/28/71, Register 39; am 10/22/72, Register 44).

AUTHORITY: AS 46.03.020(10)(A)
AS 46.03.070
AS 46.03.080

18 AAC 70.050. CLASSIFICATION OF STATE WATERS. (a) Waters of the state that have been classified after public hearing, and their designated classes according to the Water Quality Standards are as follows:

(1) Ship Creek - near Anchorage, Alaska - from the Ship Creek diversion structure at river mile 11.5 to the confluence with the Knik Arm of Cook Inlet - Classes B, C, D & G.

(2) Chena River - near Fairbanks, Alaska - from the confluence of the Chena River and Chena Slough to the confluence of the Chena River and Tanana River - Classes C & D.

(3) All marine and estuarine waters - Classes C, D, E & G.

(4) The ground waters of the state - Classes A, B, F & G.

(b) The other fresh waters of the state are generally in their original and natural conditions and as such are considered suitable to serve all classifications established in sec. 20 of this chapter and are so classified, until reclassified. (In effect before 7/28/59; am 5/24/70, Register 34; am 8/28/71, Register 39; am 10/22/72, Register 44; am / / , Register).

AUTHORITY: AS 46.03.020(10)(A)
AS 46.03.070
AS 46.03.080

18 AAC 70.060. PERMITS. Repealed 10/22/72. (In effect before 7/28/59; am 5/24/70, Register 34; am 10/22/72, Register 44).

18 AAC 70.070. TABLE - WATER QUALITY CRITERIA FOR WATERS OF THE STATE OF ALASKA. Consolidated into sec. 20(b) 10/22/72. (In effect before 7/28/59; am 5/24/70, Register 34; am 8/28/71, Register 39; am 10/22/72, Register 44).

18 AAC 70.080. MINIMUM TREATMENT. Secondary treatment is required for all domestic sewage wastes. All industrial waste discharges are required to have treatment equivalent to best practicable control technology currently available as shall be defined for each industrial waste. If secondary treatment for domestic sewage and best practicable control technology currently available for industrial wastes is inadequate to achieve water quality criteria as defined in sec. 20 of this chapter, higher levels of treatment will be required (Eff. 8/24/70, Register 34; am 8/28/71, Register 39; am 10/22/72, Register 44; am / / Register).

AUTHORITY: AS 46.03.020(10)(A)
AS 46.03.070
AS 46.03.080
AS 46.03.710

18 AAC 70.081. CERTIFICATE OF REASONABLE ASSURANCE. Upon application to the department, the department may issue to the applicant a certificate that there is a reasonable assurance, as determined by the department, that a proposed activity of the applicant will comply with the requirements of section 401 of the Federal Water Pollution Control Act Amendments of 1972, 86 Stat. 816. (Eff. 12/16/70, Register 36; am 10/22/72, Register 44; am / / , Register).

AUTHORITY: AS 46.03.020(9)
AS 46.03.020(10)(A)

18 AAC 70.082. PUBLIC NOTICE OF APPLICATION. (a) When certification pursuant to sec. 81 of this chapter has been requested, the department shall cause to be published a public notice of the application. The public notice shall invite interested parties to submit to the department comments regarding the proposed certification. Such comments shall be received by the department until 30 days after the publication of the public notice provided for in this section. The public notice may be issued jointly with the federal permitting agency.

(b) The public notice of application shall contain the name and address of the applicant, the activity sought to be certified as in compliance with the water quality standards, the location of the affected waters, and the location and type of discharge.

(c) The public notice of application shall be published at least once in a newspaper having general circulation within the borough in which the proposed activity will take place; however, if the proposed activity will take place in the unorganized borough, or if there is no newspaper of general circulation within the borough, then the newspaper shall be one of general circulation within the judicial district in which the proposed activity will take place. (Eff. 12/16/70, Register 36; am 10/22/72, Register 44; am / / , Register).

AUTHORITY: AS 46.03.020(9)
AS 46.03.020(10)(A)

18 AAC 70.083. PUBLIC HEARING. In addition to the notice of application provision of this chapter, the department may hold public hearings on certification applications. (Eff. 12/16/70, Register 36; am 10/22/72, Register 44).

AUTHORITY: AS 46.03.020(9)
AS 46.03.020(10)(A)

18 AAC 70.084. NOTICE OF PUBLIC HEARING. (a) If a public hearing is to be held, the department shall cause to be published a notice of public hearing in the manner set forth in sec. 82(c) of this chapter. The notice shall contain the time and place of the public hearing, a summary of the certification application and all other information specified in sec. 82 of this chapter. The department may combine the notice of application provided for in sec. 82 of this chapter with the notice of public hearing provided for in this section.

(b) If a public hearing on the application for certification is to be held, it shall be held no sooner than 30 days after publication of the notice of public hearing. At the hearing, the department may receive comments from the public and other individuals, entities, or governmental agencies involved, together with comments from the applicant. Such comments may be filed with the department in writing at or before the time of the hearing, and reasonable oral comments shall be permitted.

(c) Nothing in this chapter shall prevent the consideration of more than one application at any public hearing when proper public notice has been given. (Eff. 12/16/70, Register 36; am 10/22/72, Register 44).

AUTHORITY: AS 46.03.020(9)
AS 46.03.020(10)(A)

18 AAC 70.085. ACTION UPON APPLICATION. The department may take action upon an application for certification any time after a 30 day period has elapsed from the date of publication of the notice provided for in sec. 82 of this chapter. However, if a public hearing is held as provided in sec. 83 of this chapter, the department may act upon the application any time after the public hearing. (Eff. 12/16/70, Register 36; am 10/22/72, Register 44).

AUTHORITY: AS 46.03.020(9)
AS 46.03.020(10)(A)

18 AAC 70.090. IMPLEMENTATION AND ENFORCEMENT PLAN. The plan for implementing and enforcing sec. 80 of this chapter shall be based upon achieving the minimum levels of treatment specified in that section at the time of construction for new discharges and as soon as possible but not later than July 1977 for existing discharges, and the plan shall consist of the following elements:

(1) Waste discharge permits issued by the department and those federal permits issued within the state and certified by the state pursuant to sec. 81 of this chapter;

(2) The Water Pollution Control Program Plan of the department; and

(3) Plans developed by the department while implementing the "continuing planning process" required by sec. 303(e) of the Federal Water Pollution Control Act Amendments of 1972, 86 stat. 816. (Eff. 8/28/71, Register 39; am / / , Register).

AUTHORITY: AS 46.03.020(10)(A)
AS 46.03.060
AS 46.03.070
AS 46.03.080

18 AAC 70.100. PENALTIES. A person who violates any provision of this chapter is guilty of a misdemeanor and upon conviction is punishable by a fine of not more than $5,000 or by imprisonment for not more than one year, or both. Each unlawful act or each day of violation constitutes a separate offence. (Eff. 10/22/72, Register 44).

AUTHORITY: AS 46.03.020(10)(A)
AS 46.03.710
AS 46.03.760

18 AAC 70.110. DEFINITIONS. Unless the context indicates otherwise, in this chapter

(1) "commissioner" means the Commissioner of the Department of Environmental Conservation.

(2) "contact recreation" means any form of recreation involving deliberate or accidental contact with water, including but not limited to swimming, water skiing, fishing, and commercial and recreational boating.

(3) "department" means the Department of Environmental Conservation.

(4) "dredge spoil and fill" means unpolluted solid material including but not limited to sand, silt, clay and rock which may be placed in the waters of the state.

(5) "ground water" means water in the zone of saturation, which is the zone below the water table in which all interstices are filled with water.

(6) "primary treatment" means the method of removal of settleable, suspended and floatable solids from water by the application of mechanical force or gravitational forces, or both and may include processes such as sedimentation, flotation, screening, centrifugal action, vacuum filtration, dissolved air flotation, and others designed to remove settleable, suspended and floatable solids.

(7) "secondary treatment" means the method of removal of dissolved and colloidal materials that in their unaltered state, as found in water, are not amenable to separation through the application of mechanical forces or gravitational forces or both. Secondary treatment may include processes such as bio-absorption, biological oxidation, wet combustion, other chemical reactions, and adsorption on surface-active media, change of phase, or other processes that result in the removal of colloidal and dissolved solids from waters.

(8) "sheen" means an iridescent appearance on the surface of the water.

(9) "sludge" means a combination of solids and liquids including but not limited to an aggregate of oil or oil and matter of any other kind having a combined specific gravity equivalent to or greater than that of water. Sludge does not mean dredge spoil and fill.

(10) "waters" means lakes, bays, sounds, ponds, impounding reservoirs, springs, wells, rivers, streams, creeks, estuaries, marshes, inlets, straits, passages, canals, the Pacific Ocean, Gulf of Alaska, Bering Sea and Arctic Ocean, in the territorial limits of the state, and all other bodies of surface or underground water, natural or artificial, public or private, inland or coastal, fresh or salt, which are wholly or partially in or bordering upon the state or under the jurisdiction of the state. (am 5/24/70, Register 34; am 8/28/71, Register 39; am 10/22/72, Register 44; am / / , Register).

AUTHORITY: AS 46.03.020(10)(A)
AS 46.03.070
AS 46.03.080

APPENDIX D

SEAFOOD PROCESSING WASTE CHARACTERISTICS

TABLE D-1

CANNERY "A" SALMON WASTE CHARACTERISTICS[7/]

Parameter*	Sample Number 1	2	3	4	5	6
pH	7.0	7.0	6.8	6.5	6.5	6.5
Turbidity JTU	500	800	930	>5,000	>5,000	>5,000
Total Solids	1,970	4,730	6,580	214,880	256,000	338,000
Dissolved Solids	1,800	2,830	3,920	13,850	65,400	13,000
Suspended Solids	170	1,900	2,660	201,030	190,600	325,000
Ash	870	1,160	1,780	21,400	21,600	57,600
Protein	1,050	2,400	3,700	127,000	171,000	148,000
Oil	50	530	700	70,000	63,000	132,000
COD	620	1,770	2,540	110,500	33,100	188,000
BOD	760	2,350	4,800	160,000	45,000	236,000
NaCl	500	1,030	1,100	2,500	5,200	5,400

* Units are mg/l unless otherwise stated.

Sample Description and Flow

Sample 1 = Fish bin flume water, grab sample.
Sample 2 = Cannery waste, composite sample, 7,200 gph flow.
Sample 3 = Fish house liquid, composite sample, 28,620 gph flow.
Sample 4 = Fish house waste grinder, composite sample, 1,350 gph flow.
Sample 5 = Head cooker waste, grab sample, ca 370 gph.
Sample 6 = Raw heads for oil (ground), grab sample.

Waste Disposal Practices

Fish heads rendered for oil.
Fish house wastes ground.
All wastes flumed to central discharge.

TABLE D-2

CANNERY "B" SALMON WASTE CHARACTERISTICS[7/]

Parameter*	Sample Number								
	1	2	3	4	5	6	7	8	9
pH	6.6	6.4	6.8	6.4	6.0	6.0	6.0	6.2	6.2
Turbidity JTU	4,000	2,400	2,000	1,600	40	<25	80	300	3,000
Total Solids	35,730	20,860	11,825	31,910	31,450	23,400	31,450	32,400	37,130
Dissolved Solids	12,770	11,745	8,520	10,285	31,450	23,400	30,750	32,400	35,900
Suspended Solids	22,960	9,115	3,305	21,625	0	0	700	0	1,230
Ash	3,530	1,700	1,105	2,112	27,100	20,500	26,350	26,500	26,600
Protein	26,500	16,500	8,600	27,000	<50	<50	<50	60	6,300
Oil	7,460	370	440	1,725	10	10	25	20	40
COD	41,660	13,820	7,960	20,800	865	860	1,010	1,440	4,990
BOD	39,300	16,150	8,670	8,175	200	60	340	810	5,430
NaCl	780	445	510	780	25,600	17,400	26,500	25,000	21,300

Sample Description and Flow

Sample 1 = Main outfall flow before grinder, composite, 6,400 gph.**
Sample 2 = Chute from chink, composite sample, 1,000 gph.
Sample 3 = Dewatered material from grinder, composite sample.
Sample 4 = Filler waste, composite sample, 385 gph.**
Sample 5 = Fish bin flume water (salt), grab sample, 11,280 gph.**
Sample 6 = Receiving water under grinder (no canning), grab sample.
Sample 7 = Receiving water under grinder (canning), grab sample.
Sample 8 = Salt brine from tender, grab sample.
Sample 9 = Dry tender washout water, grab sample.

Waste Disposal Practices

No recovery of by-products.
Fish house wastes flumed to a grinder.
Cannery wastes dropped through floor at filler machines.

* Units are mg/l unles otherwise noted.
** Signifies use in waste vs. production calculations (436 cases per hour).

TABLE D-3

CANNERY "C" SALMON WASTE CHARACTERISTICS[7/]

Parameter*	Sample Number 1
pH	6.7
Turbidity JTU	1,500
Total Solids	5,700
Dissolved Solids	5,150
Suspended Solids	550
Ash	870
Protein	4,000
Oil	170
COD	3,490
BOD	3,400
NaCl	510

Sample Description and Flow

Sample 1 = Main outfall flume (non-retained on net**), composite sample, 9,415 gph.

Waste Disposal Practices

Fish house wastes flumed to a net-bottomed gurry scow. Cannery wastes not determined.

* Units are mg/l unless otherwise noted

** Sample simulates wastes passing through bottom of gurry scow.

TABLE D-4

CANNERY "D" SALMON WASTE CHARACTERISTICS[7]

Parameter*	Sample Number						
	1	2	3	4	5	6	7
pH	6.8	7.0	7.6	6.3	6.7	6.2	6.7
Turbidity JTU	600	460	75	80	525	<25	160
Total Solids	2,170	1,880	310	25,110	1,430	30,470	1,460
Dissolved Solids	1,390	1,285	155	24,955	985	30,420	1,420
Suspended Solids	780	595	155	155	445	50	40
Ash	350	425	120	20,335	240	26,680	1,060
Protein	1,560	1,145	165	1,070	945	<50	190
Oil	60	30	15	185	70	10	10
COD	1,770	945	190	3,170	1,595	790	370
BOD	1,325	850	165	690	970	70	240
NaCl	190	185	50	17,000	95	26,000	850

Sample Description and Flow

Sample 1 = Main outfall flow, composite sample, 22,670 gph.**
Sample 2 = Floor drain, 4# packing room, grab sample, 600 gph.**
Sample 3 = Butchered fish scrubber, grab sample, 7,200 gph.
Sample 4 = Salt water, egg transport flume, grab sample, 2,250 gph.
Sample 5 = Sliming table waste, grab sample.
Sample 6 = Fish bin flume to chink bins (salt water) grab sample, 2,700 gph.**
Sample 7 = Fresh water flume, slime table to filler bin grab sample.

Waste Disposal Practices

Heads, tails, eggs, and milt recovered.
Fish house wastes flumed to dock face and discharged without grinding.

* Units are mg/l unless otherwise noted.
** Signifies use in waste vs. production calculations (300 cases per hour).

TABLE D-5

COMPARISON OF UNIT WASTE LOADS[7]

Parameter*	Salmon Waste Load (lb/case of product)	
	Cannery "B"†	Cannery "D"††
Wet Fish Waste Solids†††	26.4	7.8
Total Solids	8.8	2.5
Suspended Solids	5.8	0.9
Dissolved Solids	3.0	1.7
Ash	0.7	0.5
NaCl	0.2	0.2
Oil	1.2	0.1
Protein	6.9	1.7
COD	8.1	1.8
BOD	6.2	1.4

† No waste recovery. See Table D-2.
†† Heads, tails, eggs, and milt recovered. See Table D-4.
††† Approximate wet weight of total fish waste solids based on typical salmon waste makeup of one-third solids and two-thirds moisture.
* Units are mg/l unless otherwise noted.

TABLE D-6

CRAB WASTE CHARACTERISTICS (COOKING WHOLE CRAB) 9/

Sample	Live Weight grams	Cooked Weight grams	Total Solids %	C.O.D. ppm	Solids grams	Solids % of total	C.O.D. lb/100 lbs Live Weight
Whole crab							
No. 1	1,090	982					
No. 2	1,045	973					
No. 3	965	900					
Total	3,100	2,855	(27.2% of live weight)				
Legs and Bodies		1,743					
Backs		190	60.2		114.3	13.6	(1.96)
Viscera		530					
Picking Line Shell		615	55.8		353.0	41.8	(5.90)
Leg Meat		563	22.6		127.0	15.1	
Body Meat		404	21.4		86.5	10.3	
Cooking Water		2,150 ml	2.2	13,600	47.3	5.6 (mostly salt)	0.94
Viscera + Wash Water		2,280 ml	6.3	80,400	143.7	17.1	5.90
Picking Water		4,000 ml	0.5	8,400	20.0	2.4	1.08
Total					891.8	105.9	15.78

TABLE D-7

CRAB WASTE CHARACTERISTICS (LIVE BUTCHERED CRAB) 9 /

Sample	Live Weight grams	Cooked Weight grams	Total Solids %	C.O.D. ppm	Solids grams	Solids % of total	C.O.D. lb/100 lbs Live Weight
Whole crab							
No. 1	815						
No. 2	923	1,413 (legs & bodies)					
No. 3	980						
Total	2,718		27.5 of live weight				
Backs	183		57.8		106	14.2	(2.07)
Viscera + Water	2,280		5.3	67,200	121	16.2	5.60
Cooking Water		2,520 ml	1.1	7,600	28	3.7	0.70
Picking Waste		540 ml	55.8		302	40.3	(5.87)
Wash Water		4,000 ml	0.3	7,600	12	1.6	1.1:
Leg Meat		465	23.3		109	14.6	
Body Meat		322	21.6		70	9.4	
Total					748	100.0	14.35

TABLE D-8

SHRIMP PROCESSING (RAW PEELING) WASTE CHARACTERISTICS 9/

Analysis

Sample	Weight grams	Total Solids %	Suspended Solids %	C.O.D. ppm	5 Day B.O.D. ppm	N ppm
Raw shrimp	1,815	25.7		304,000		
Washed shells	1,292	18.3		173,000		
Cooked meat	439	19.8		267,000		
Cooking and cooling water	1,046	4.26	0.43	36,300	18,000	5,850
Peeling and washing water	6,248	1.81	0.49	23,900	9,800	2,180

Distribution

	Solids			C.O.D.	
Sample	grams	total %	waste %	grams	waste %
Raw shrimp	467	100		552	
Washed shell	236	50.5	60.0	224	57
Cooked meat	87	18.6		117	
Cooking and cooling water	44.5	9.5	11.3	38	10
Peeling and washing water	113	24.2	28.7	130	33

TABLE D- 9

SHRIMP PROCESSING (PEELING AFTER STEAMING) WASTE CHARACTERISTICS 9/

Analysis

Sample	Weight grams	Total Solids %	Suspended Solids %	C.O.D. ppm	5 Day B.O.D. ppm	N ppm
Raw shrimp	1,818	25.7		304,000		
Washed shells	1,325	20.1		173,000		
Cooked meat	470	21.4		267,000		
Cooking and cooling water	2,563	1.58	0.37	19,200	9,600	2,500
Peeling and washing water	5,865	1.24	0.63	17,500	7,800	1,680

Distribution

	Solids			C.O.D.		
Sample	grams	total %	waste %	grams		waste %
Raw shrimp	467	100		505		
Washed shells	267	57.2	70.2	254		70
Cooked meat	101	21.6		136		
Cooking and cooling water	40.5	8.7	10.7	34		10
Peeling and washing water	72.8	15.6	19.1	84		23

APPENDIX E

PROCESS DIAGRAMS, WASTE SOURCES, AND WASTE DISPOSAL METHODS AT SELECTED ALASKA SEAFOOD PROCESSORS

Figure E-1. New England Fish Co., Chatham

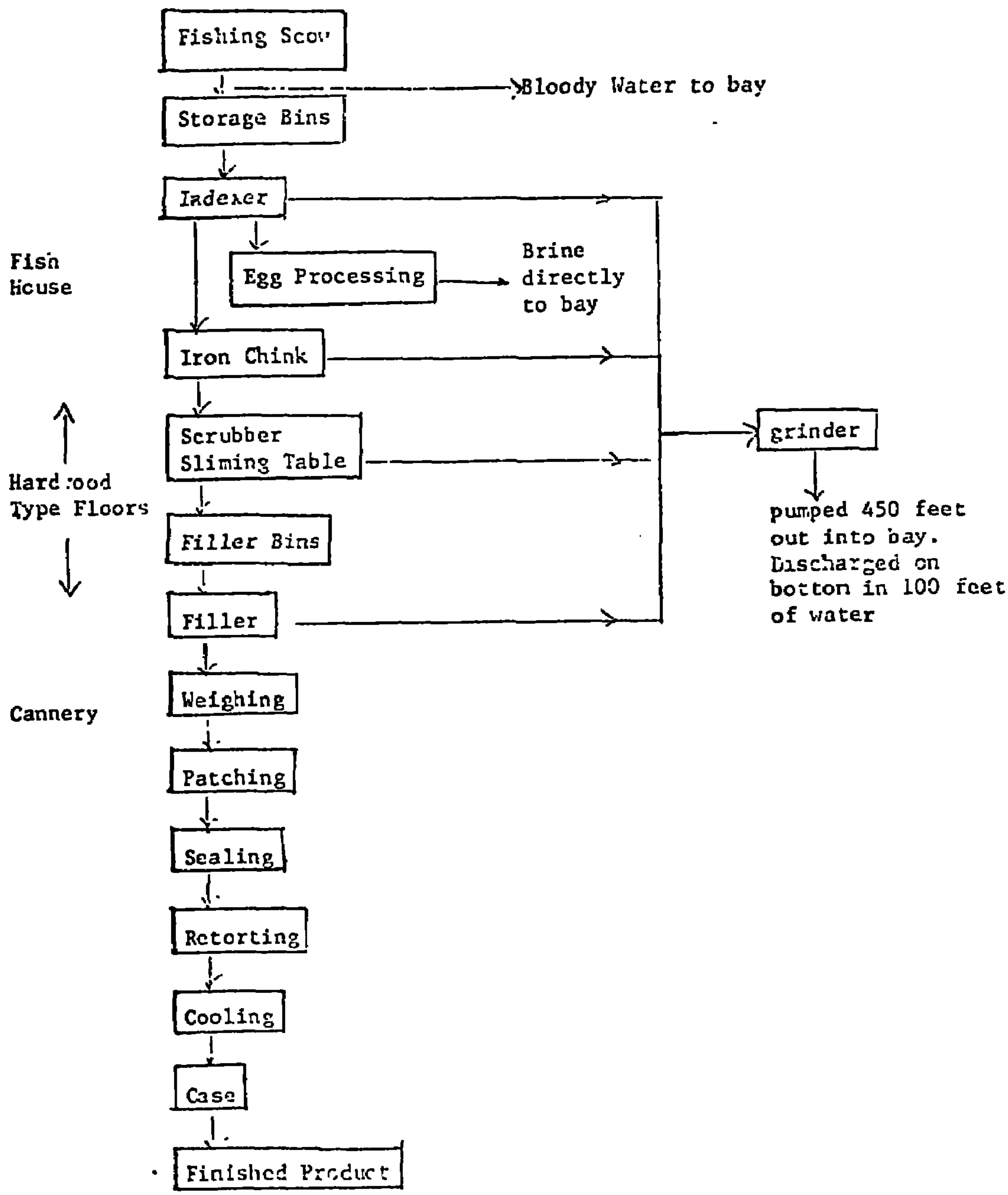


Figure E-2. Peter Pan Seafoods, Excursion Inlet

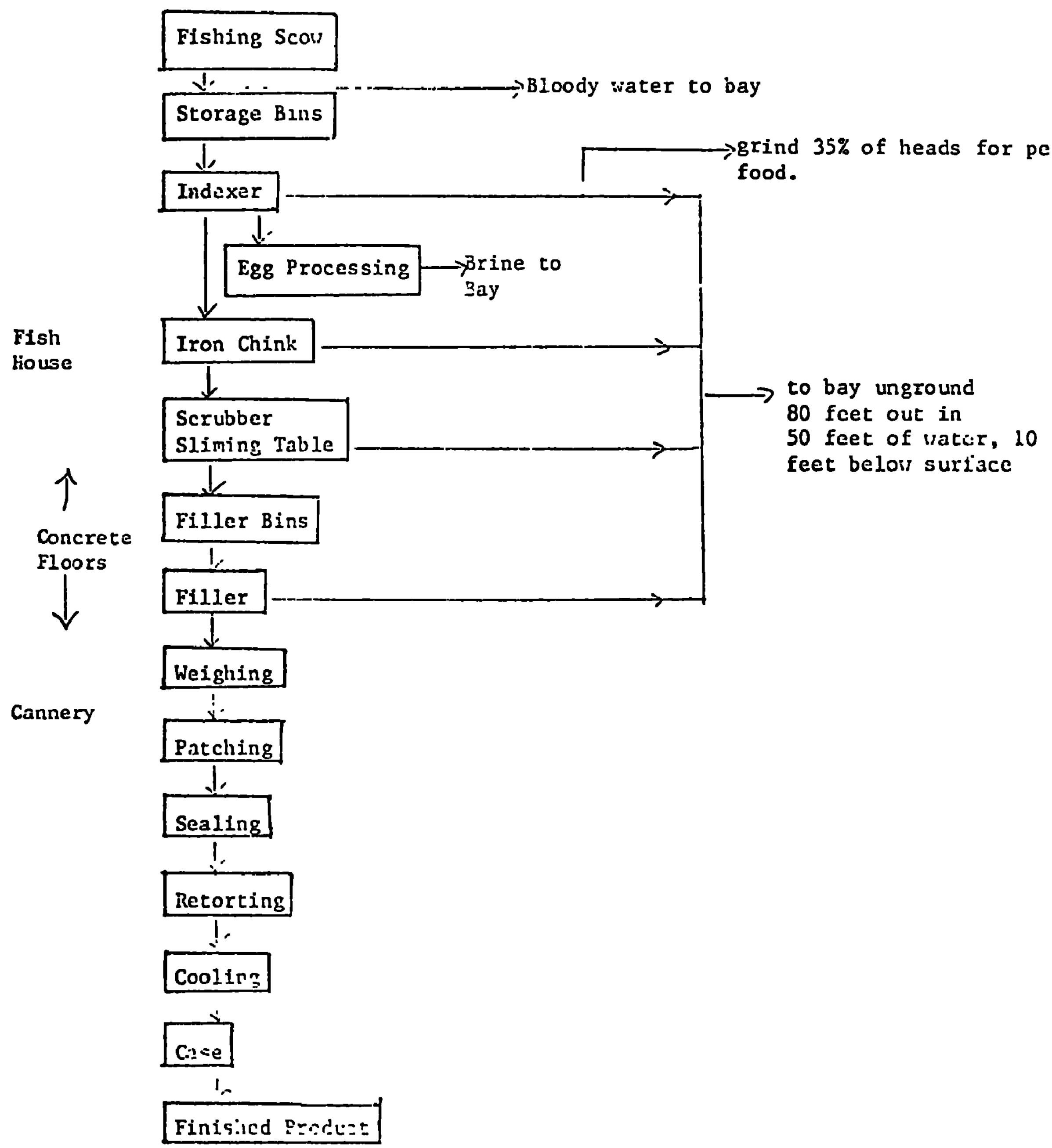


Figure E-3. Peter Pan Seafoods, Hawk Inlet

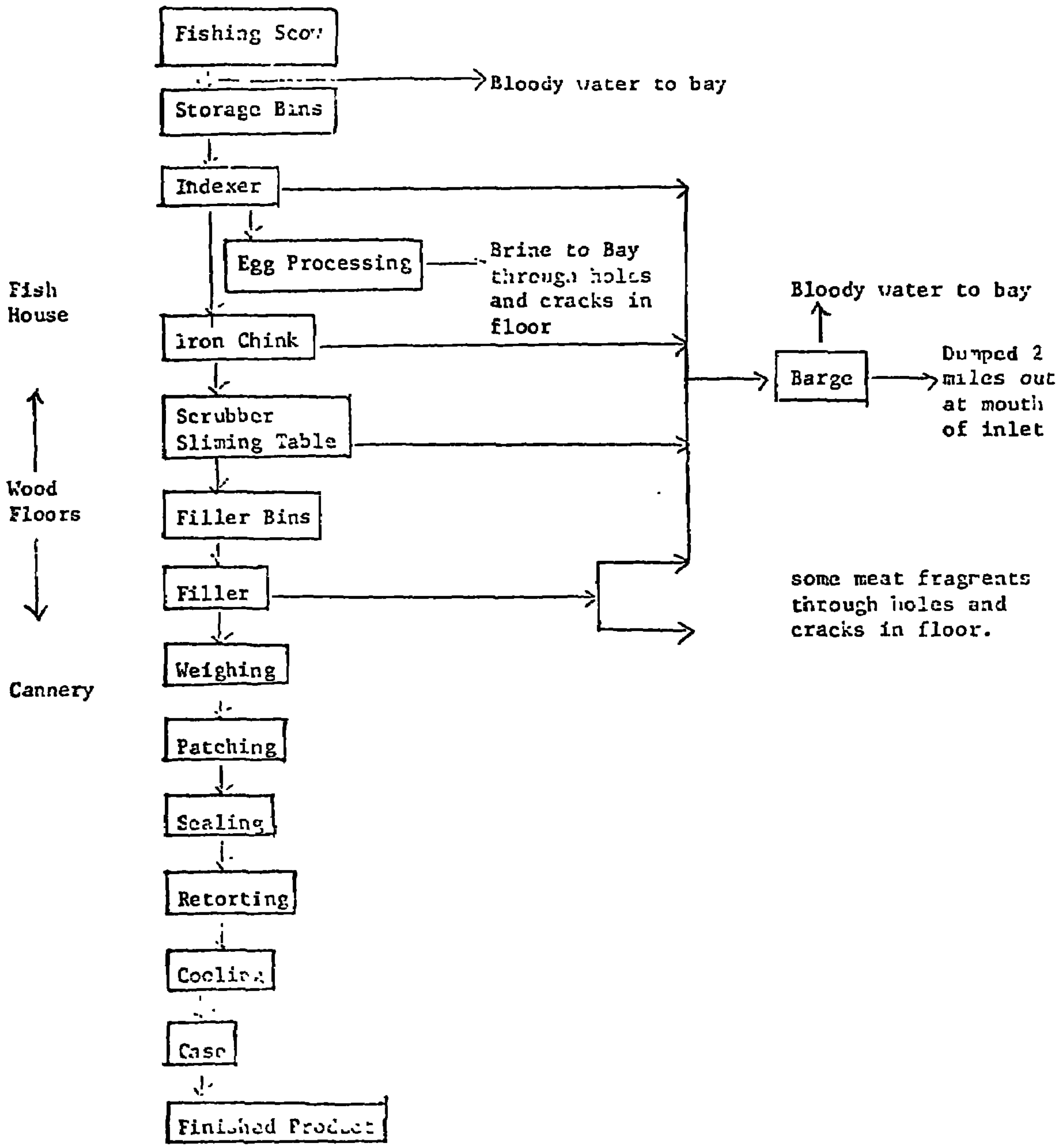


Figure E-4. Alaska Glacier Seafood Company - Petersburg

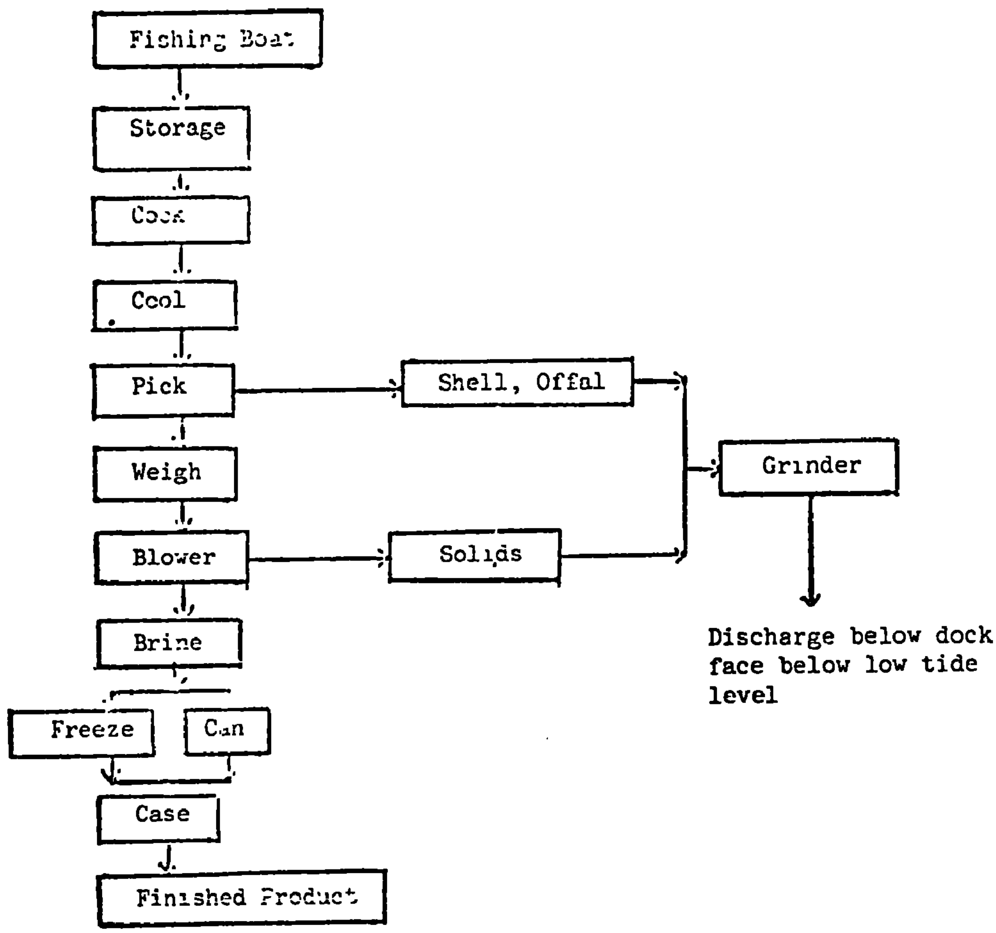


Figure E-5. Petersburg Fisheries Inc., Petersburg

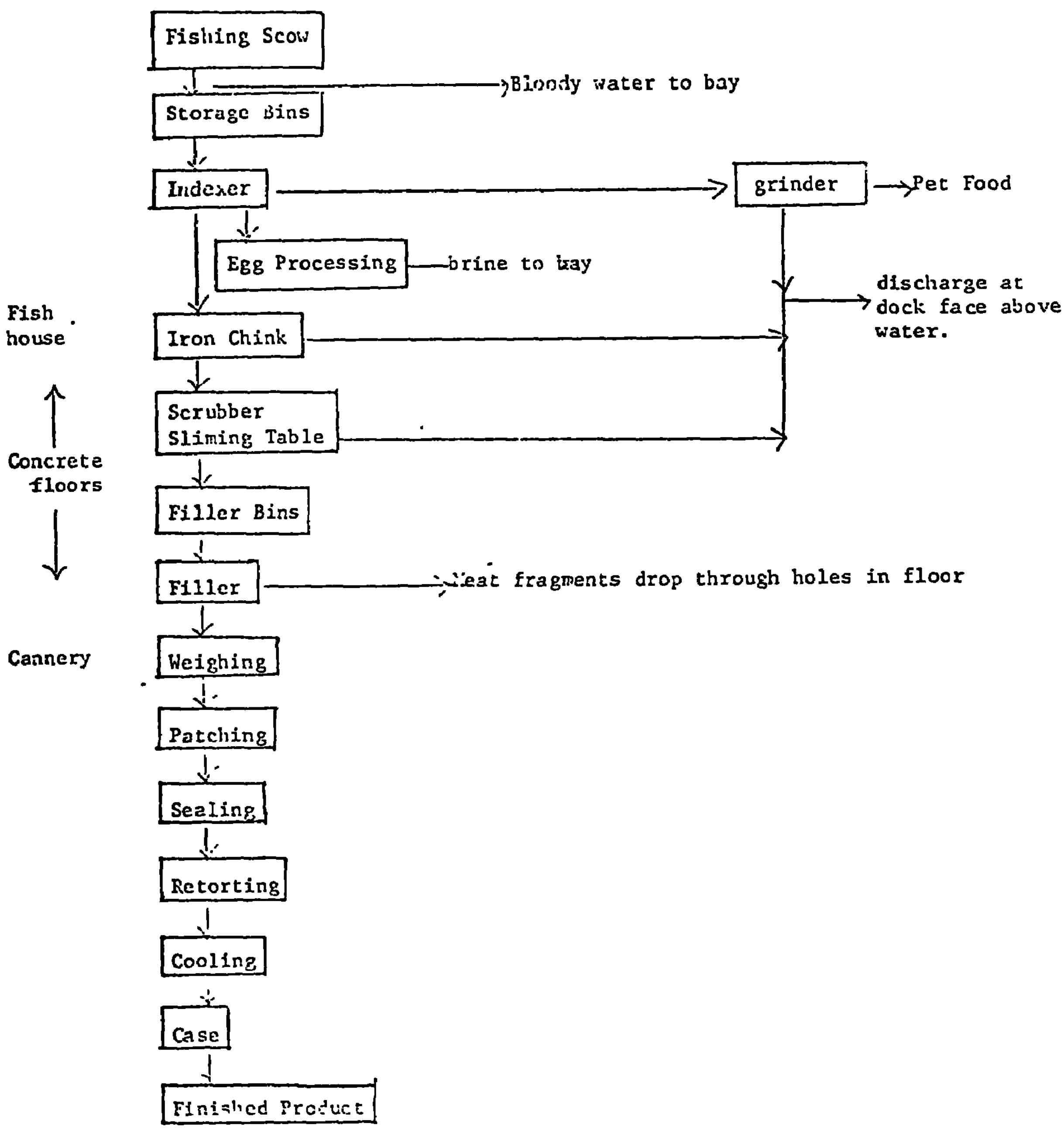


Figure E-6. Whitney Fidalgo Seafoods, Petersburg

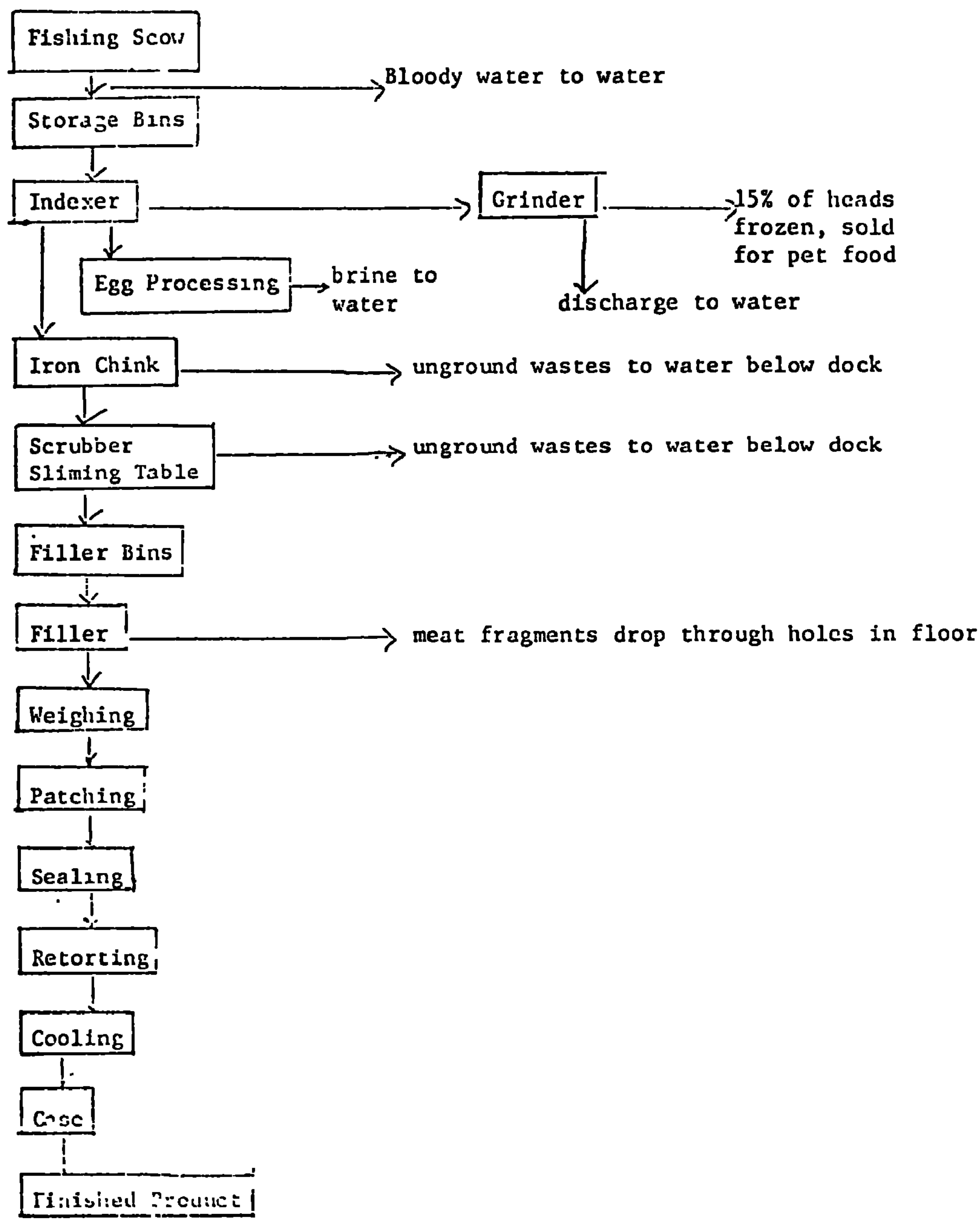


Figure E-7. Point Chehalis Packers, Cordova

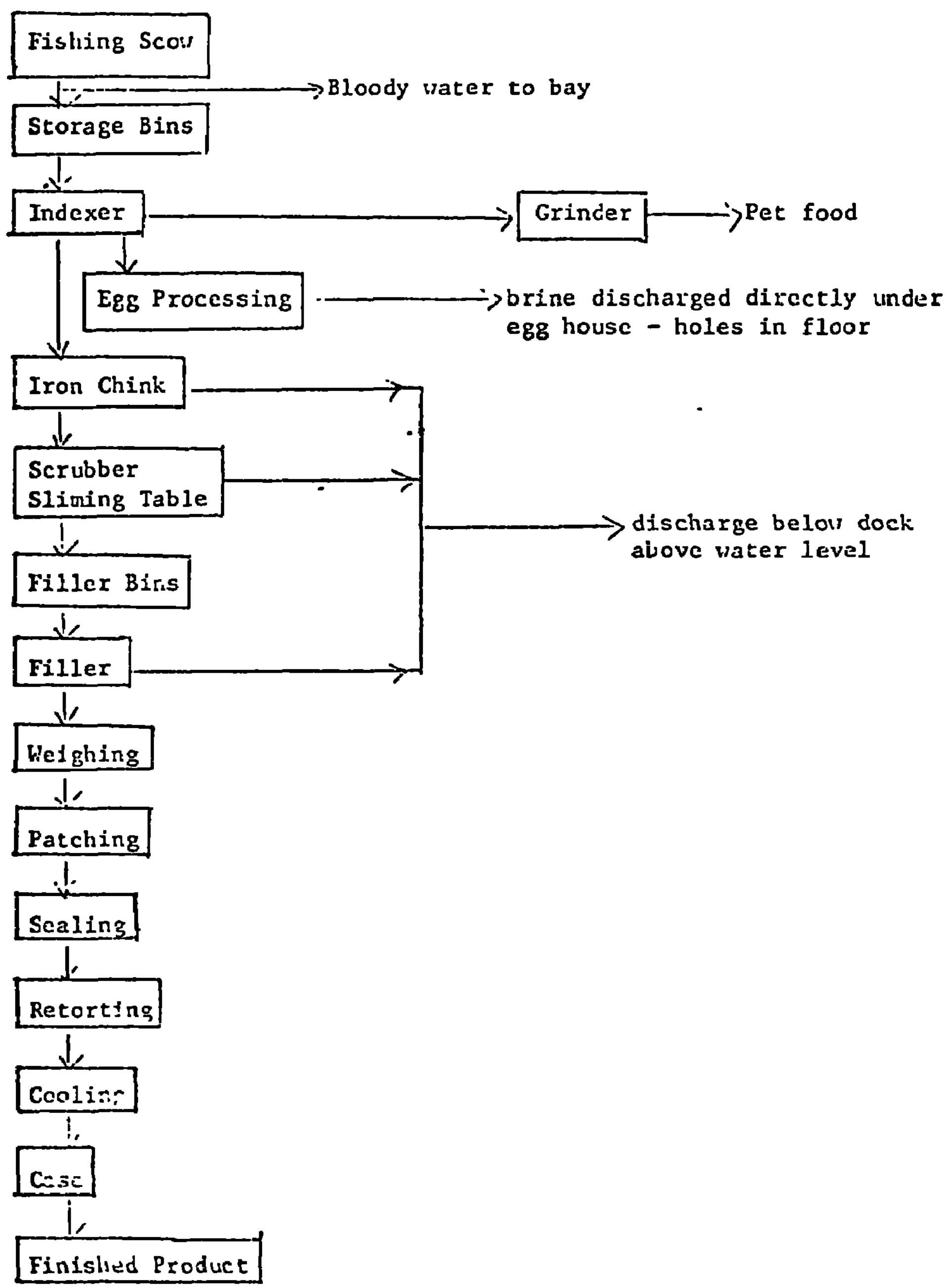


Figure E-8. St. Elias Ocean Products, Cordova

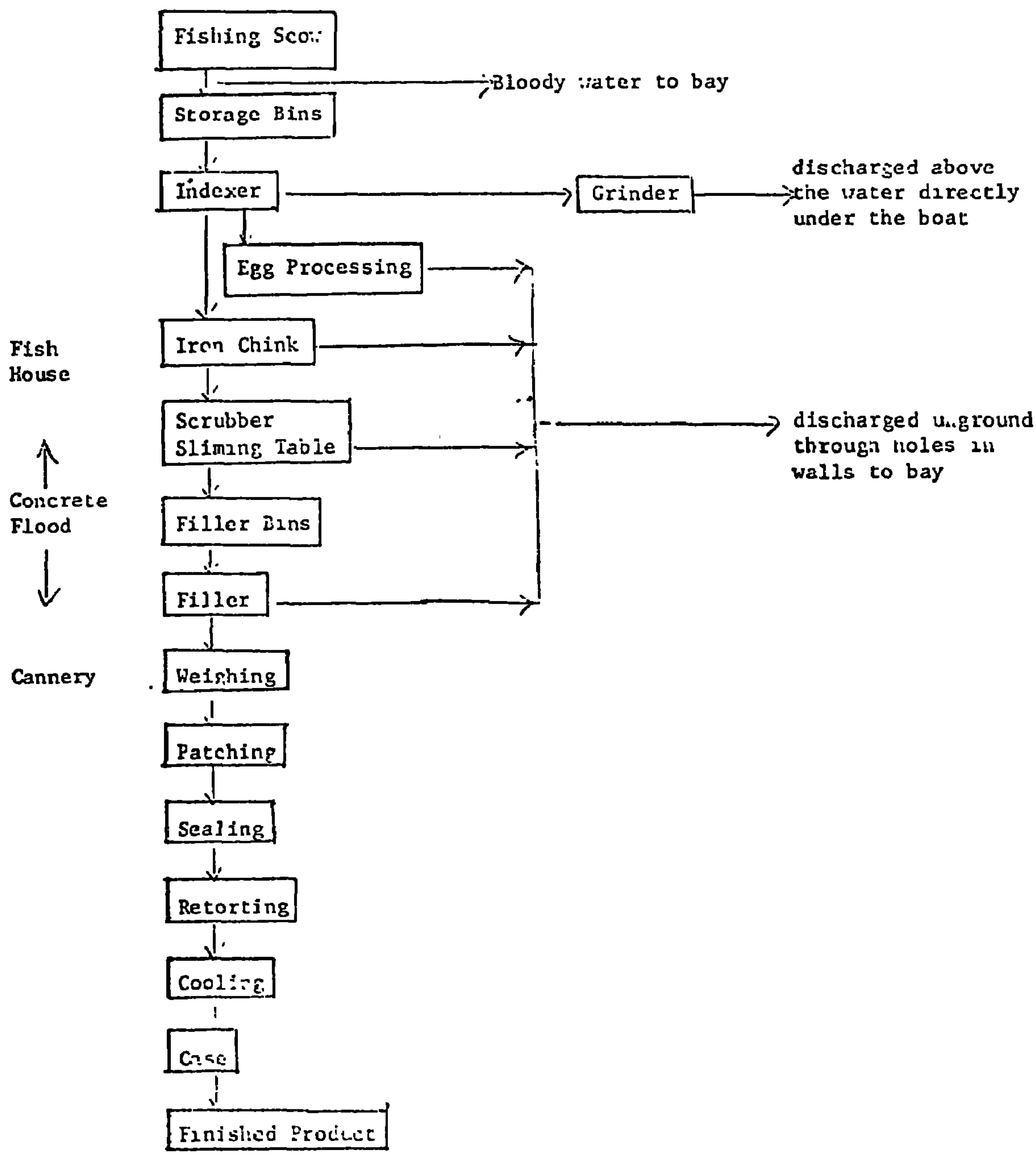


Figure E-9. Orca Pacific Packing Company, Orca

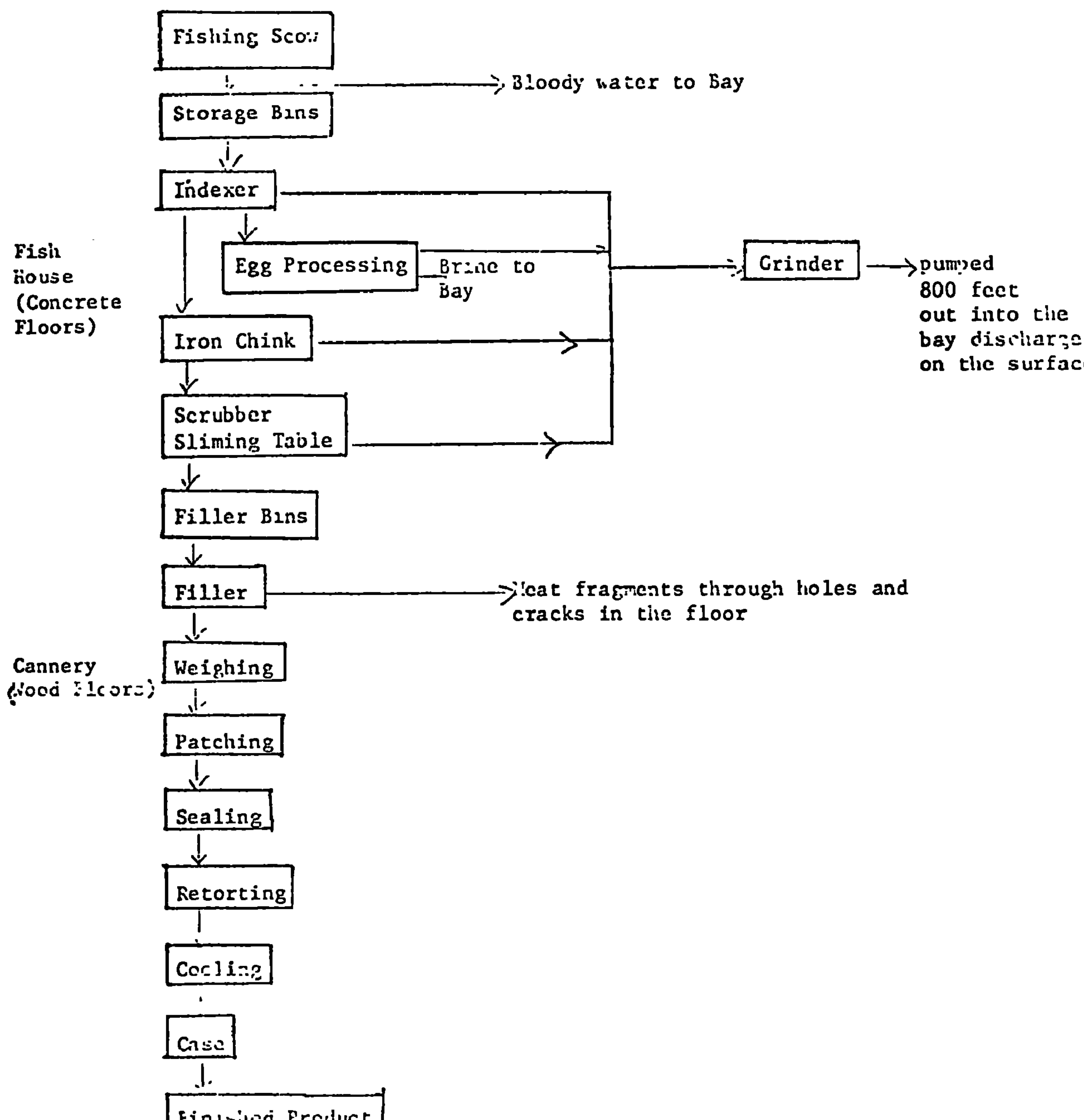


Figure E-10. Alaska Packers, Larsen Bay

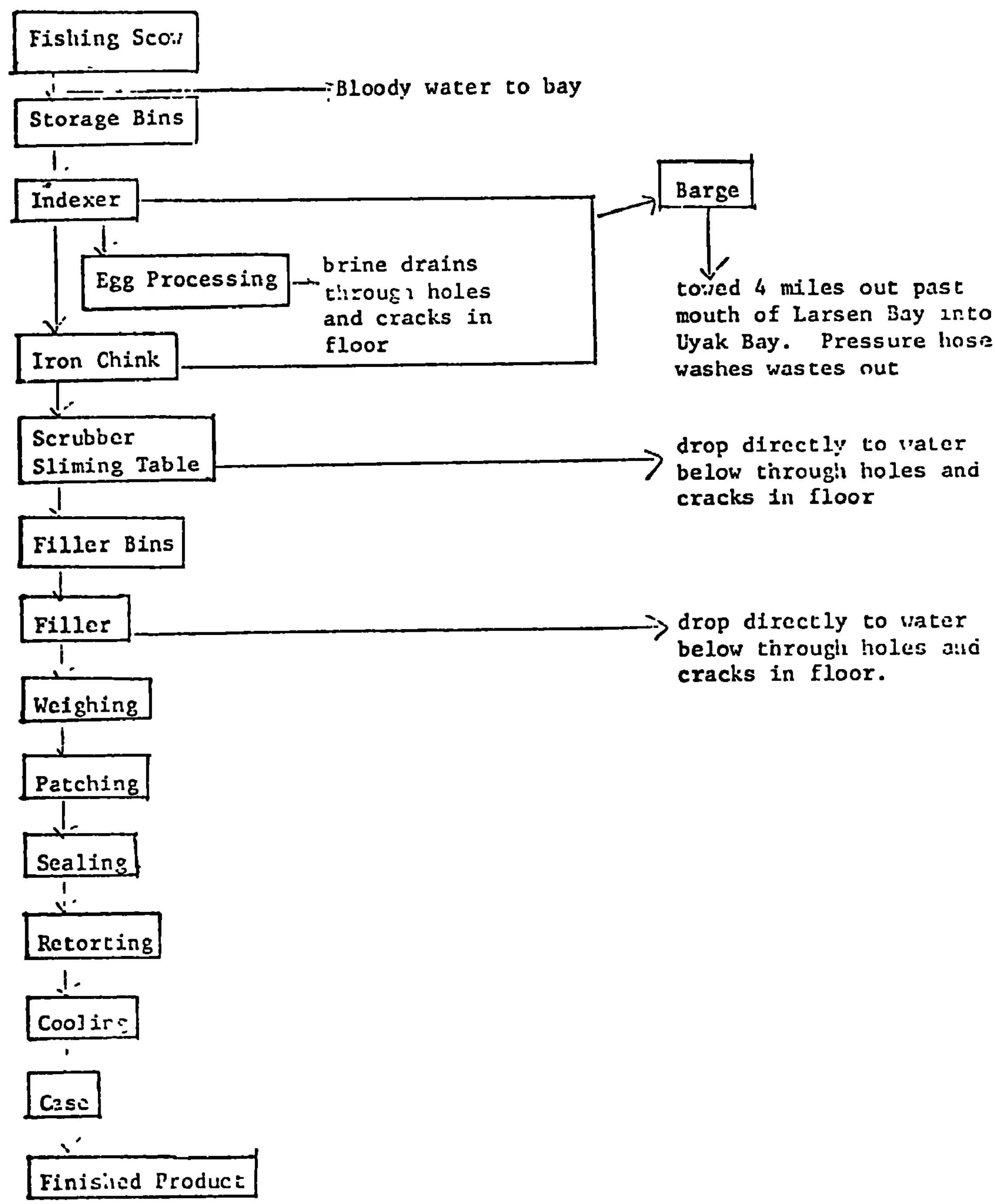


Figure E-11. New England Fish Co., Uganik Bay

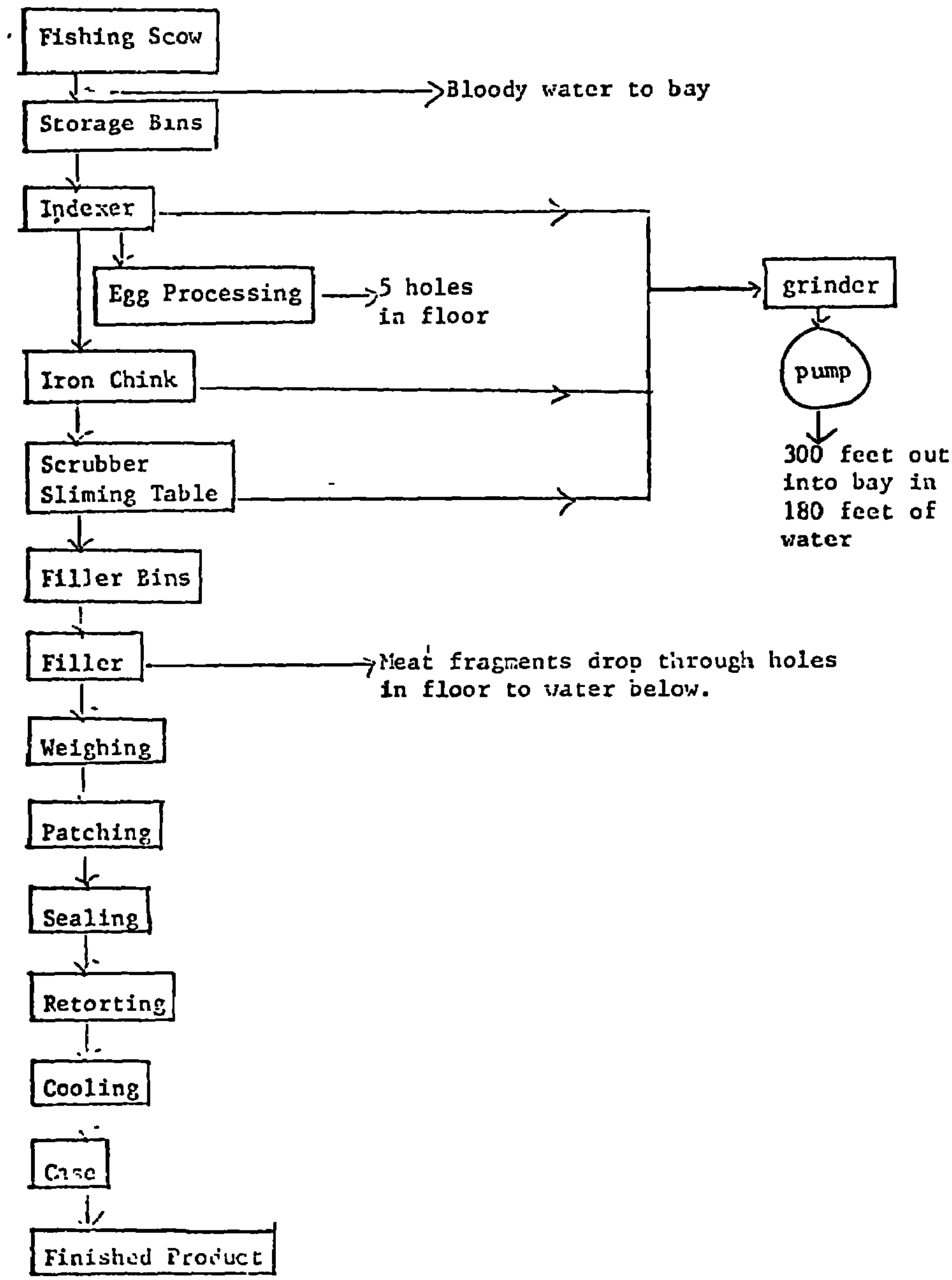


Figure E-12. Alaska Packers Association, Chignik

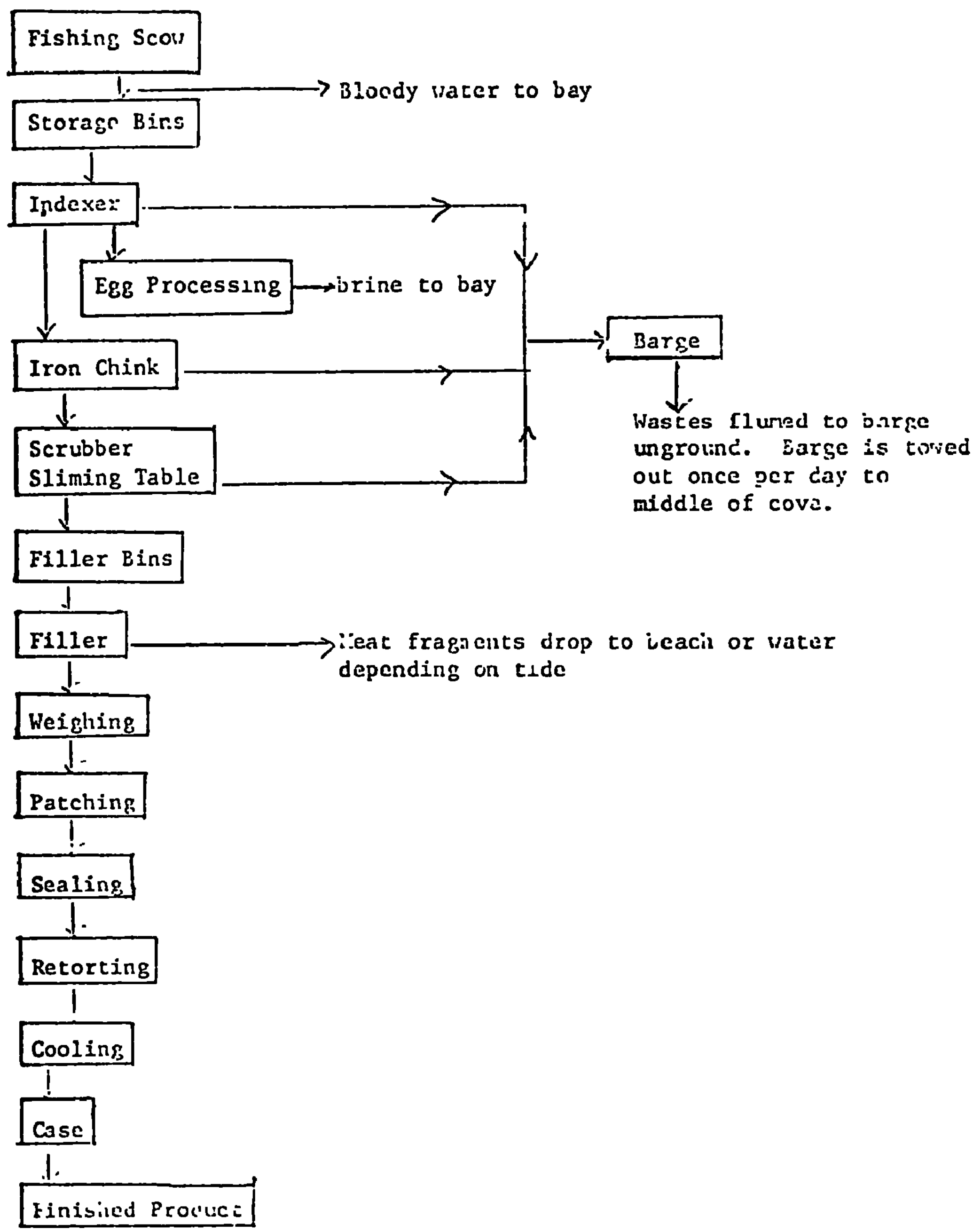


Figure E-13. Peter Pan Seafoods, False Pass

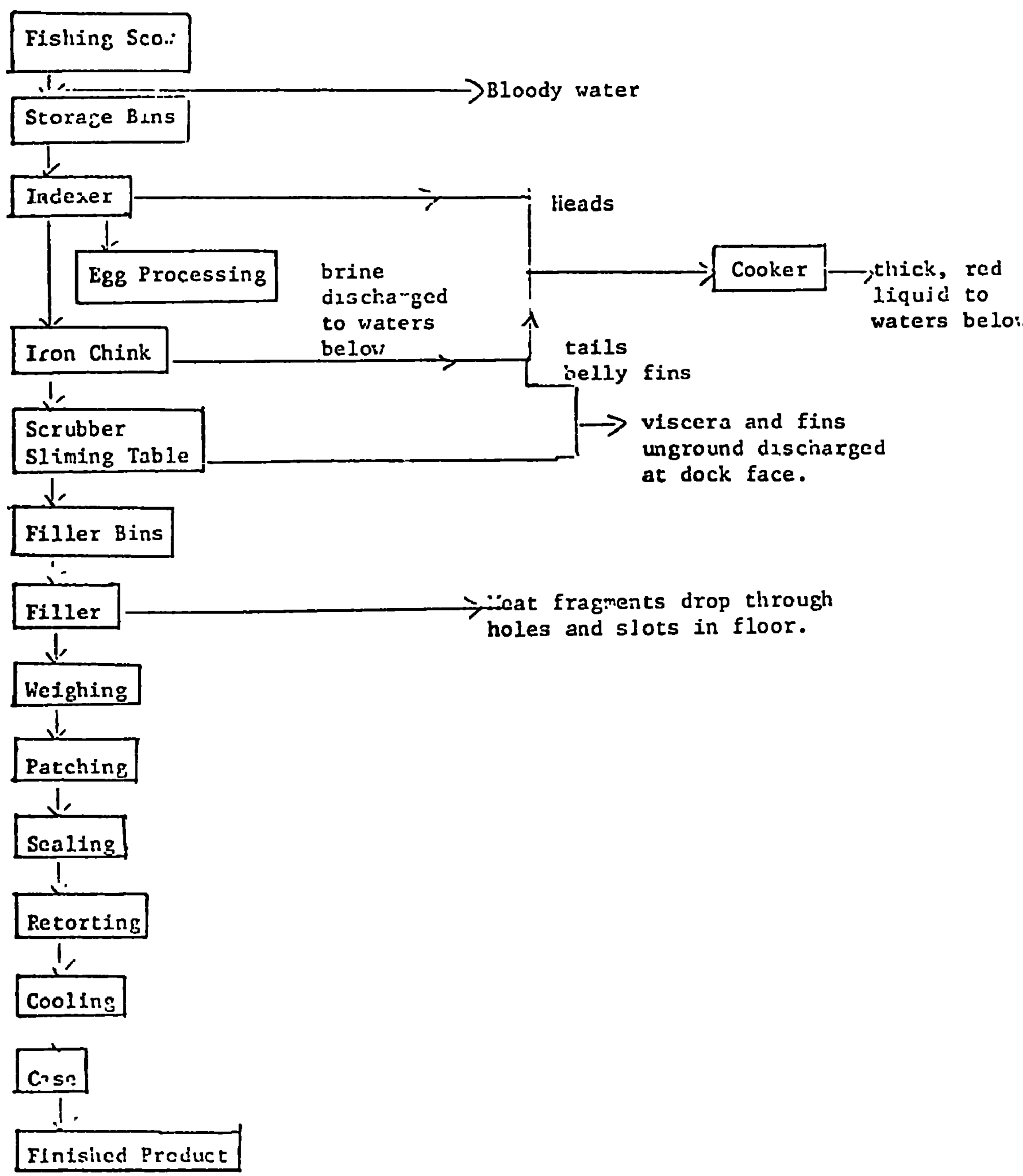


Figure E-14. Peter Pan Seafoods, King Cove

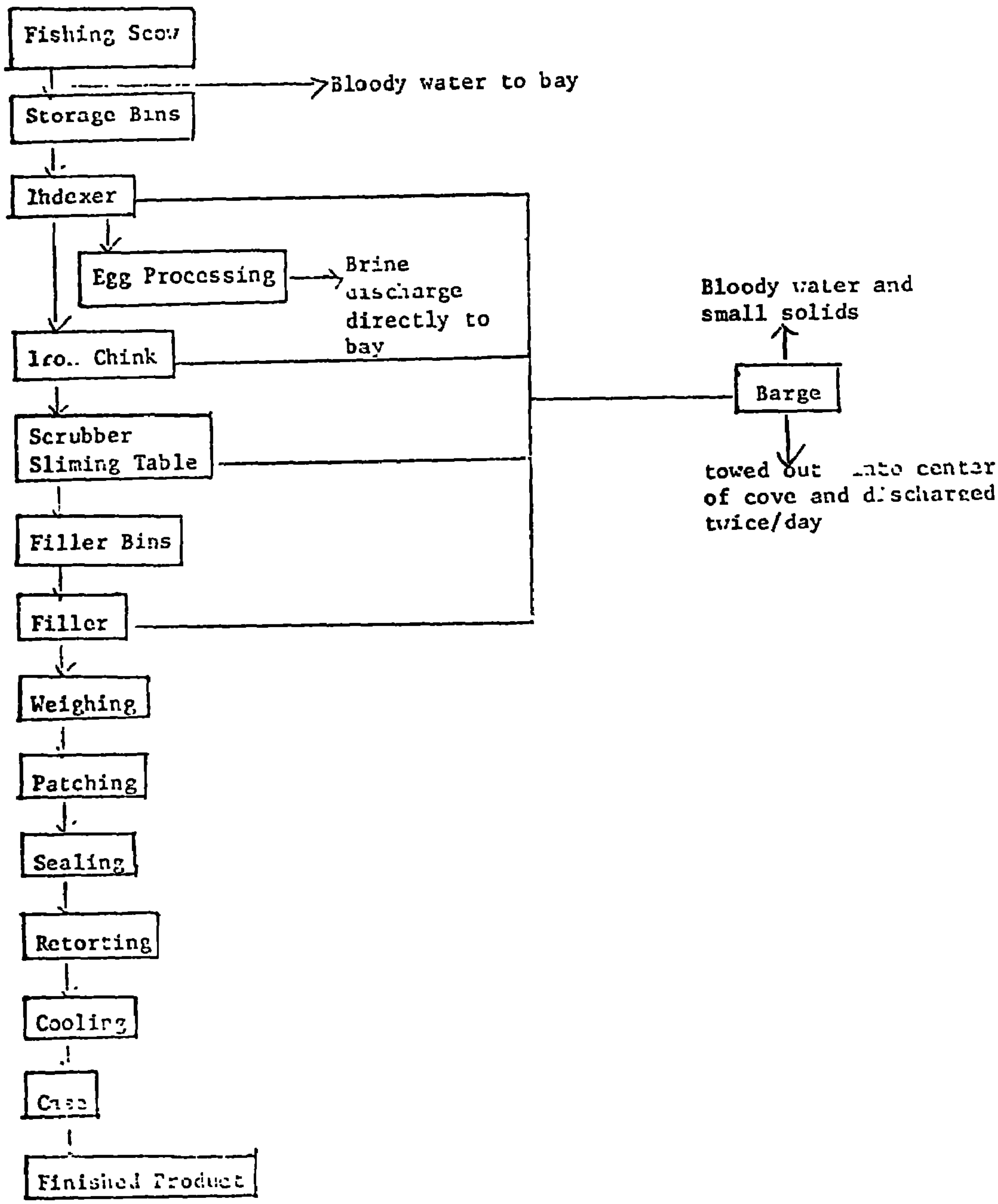


Figure E-15. Peter Pan Seafoods, Squaw Harbor

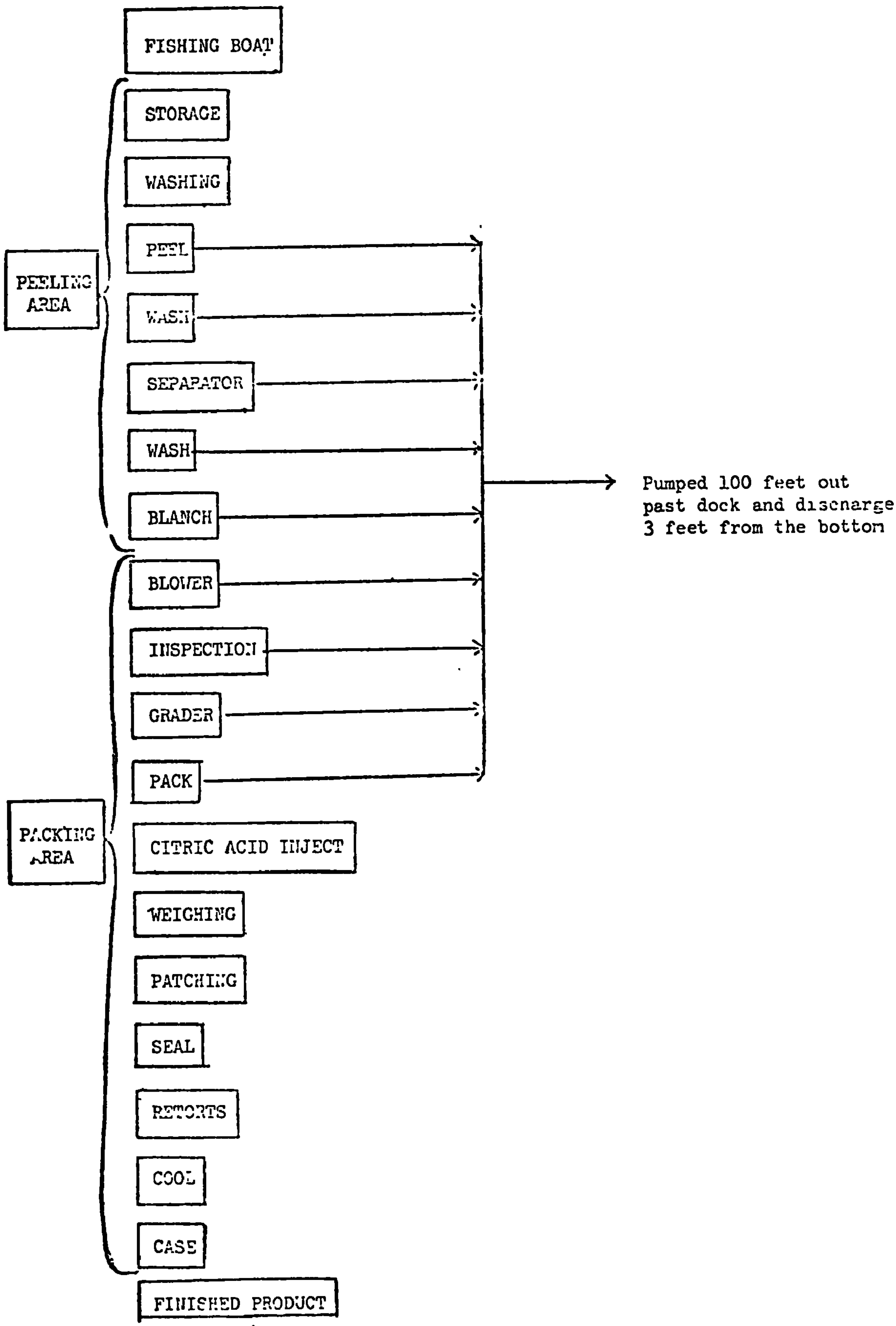


Figure E-16. Wakefield Fisheries, Sand Point

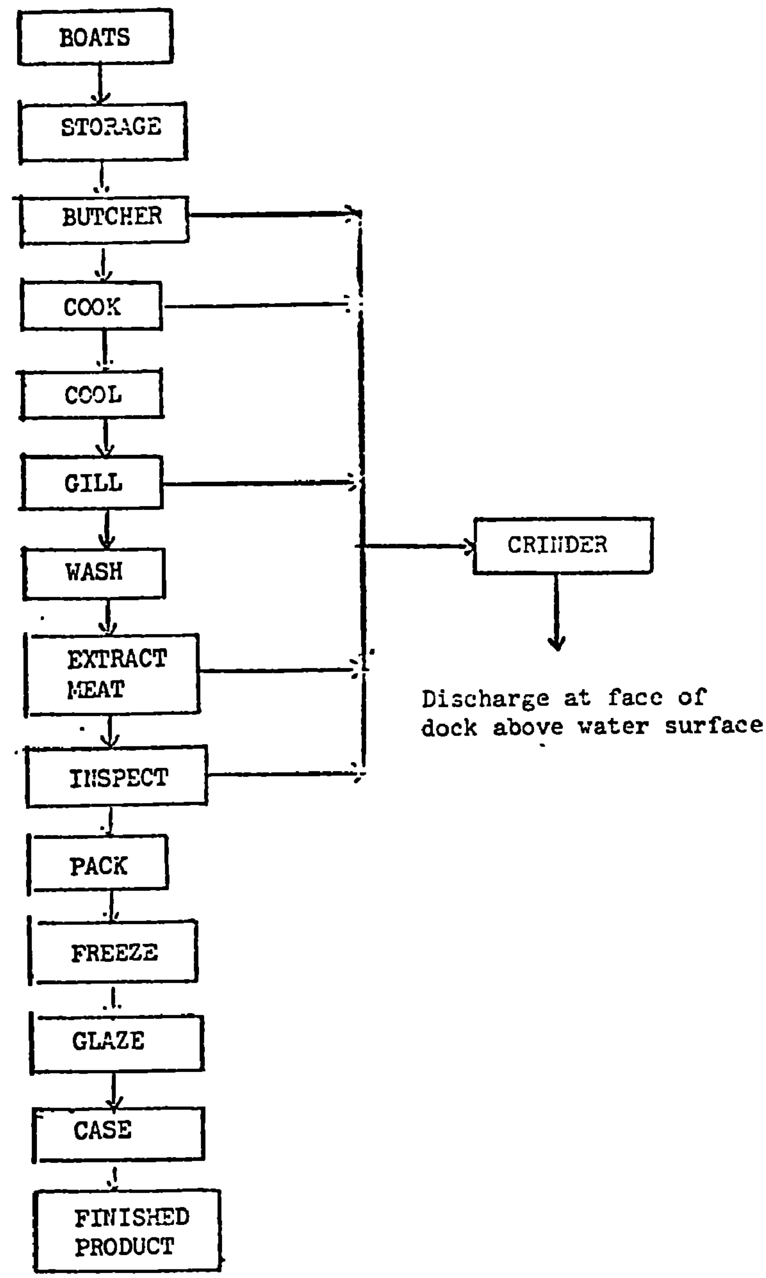


Figure E-17. Alaska Packers Association, So. Naknek River

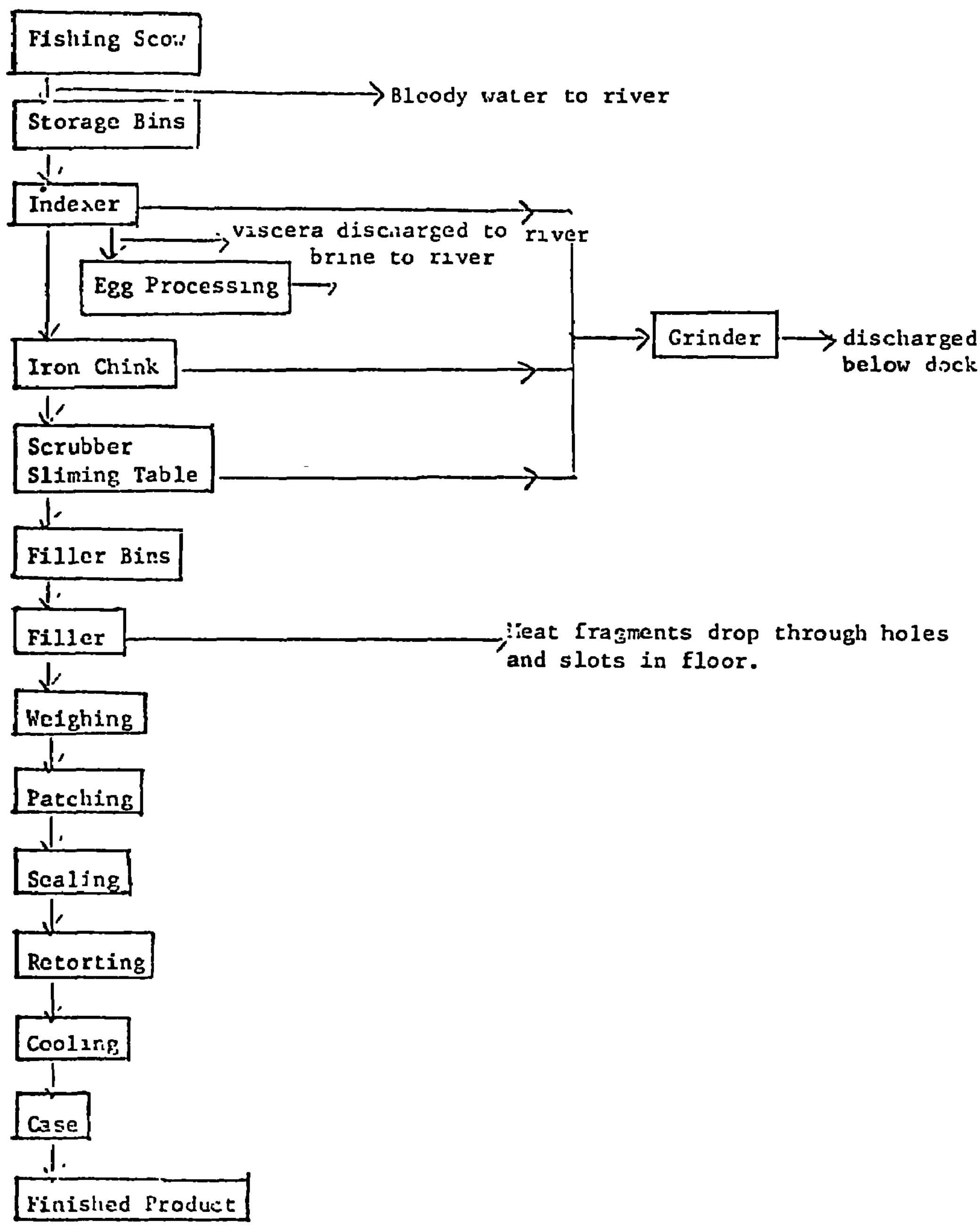


Figure E-18. Bumble Bee Seafoods, So. Naknek River

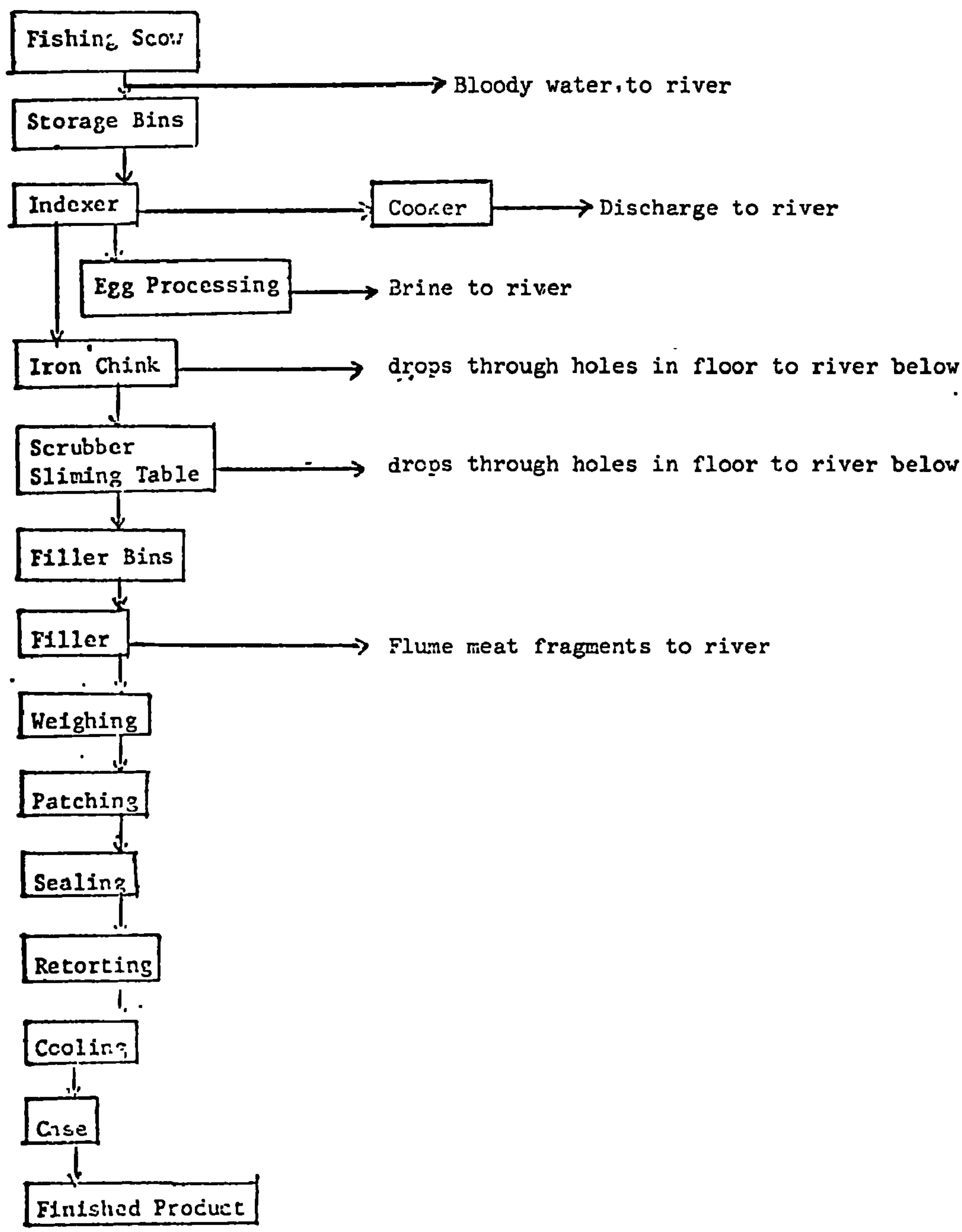


Figure E-19. Nelbro Packing Co., Naknek River

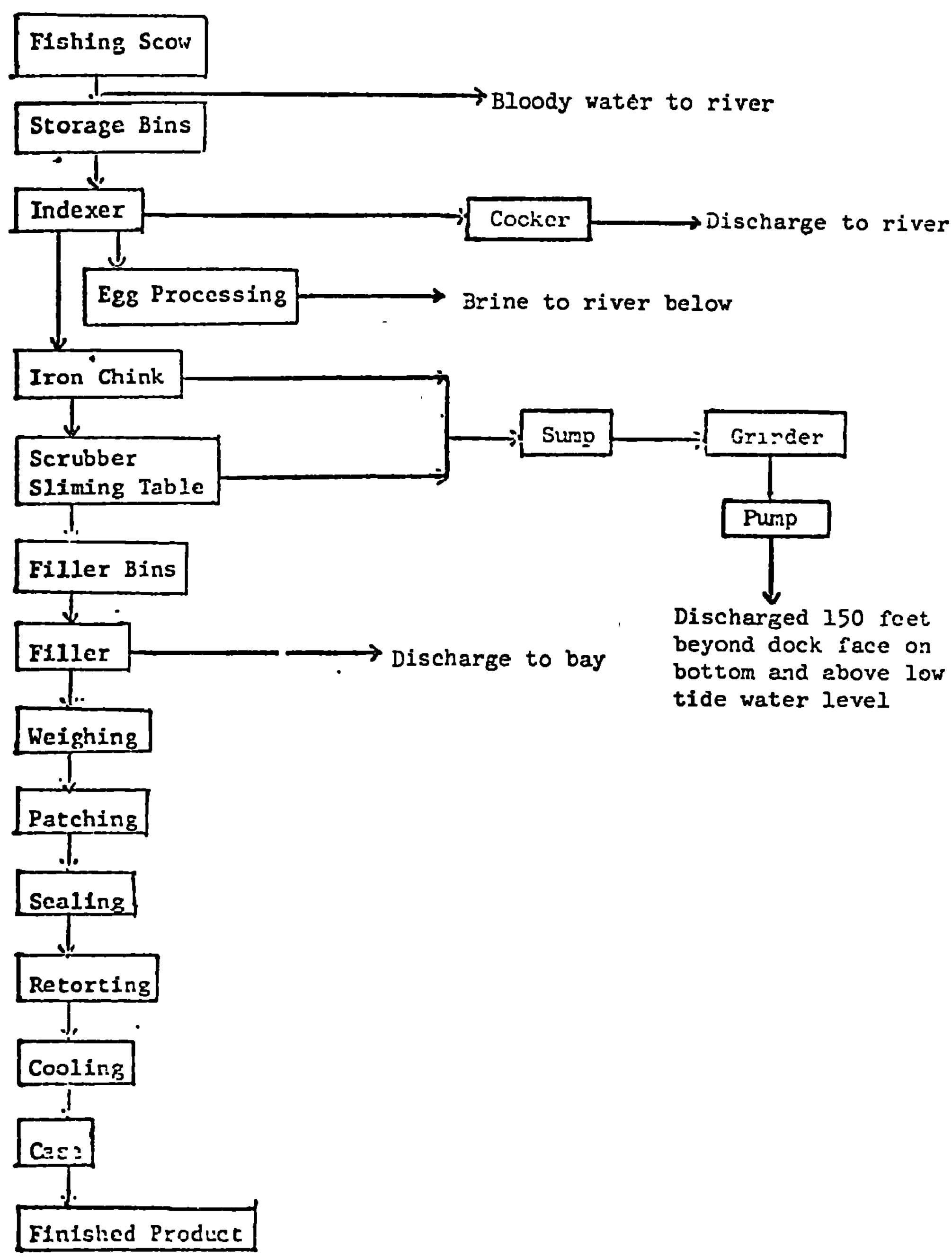


Figure E-20. Red Salmon Cannery, Naknek River

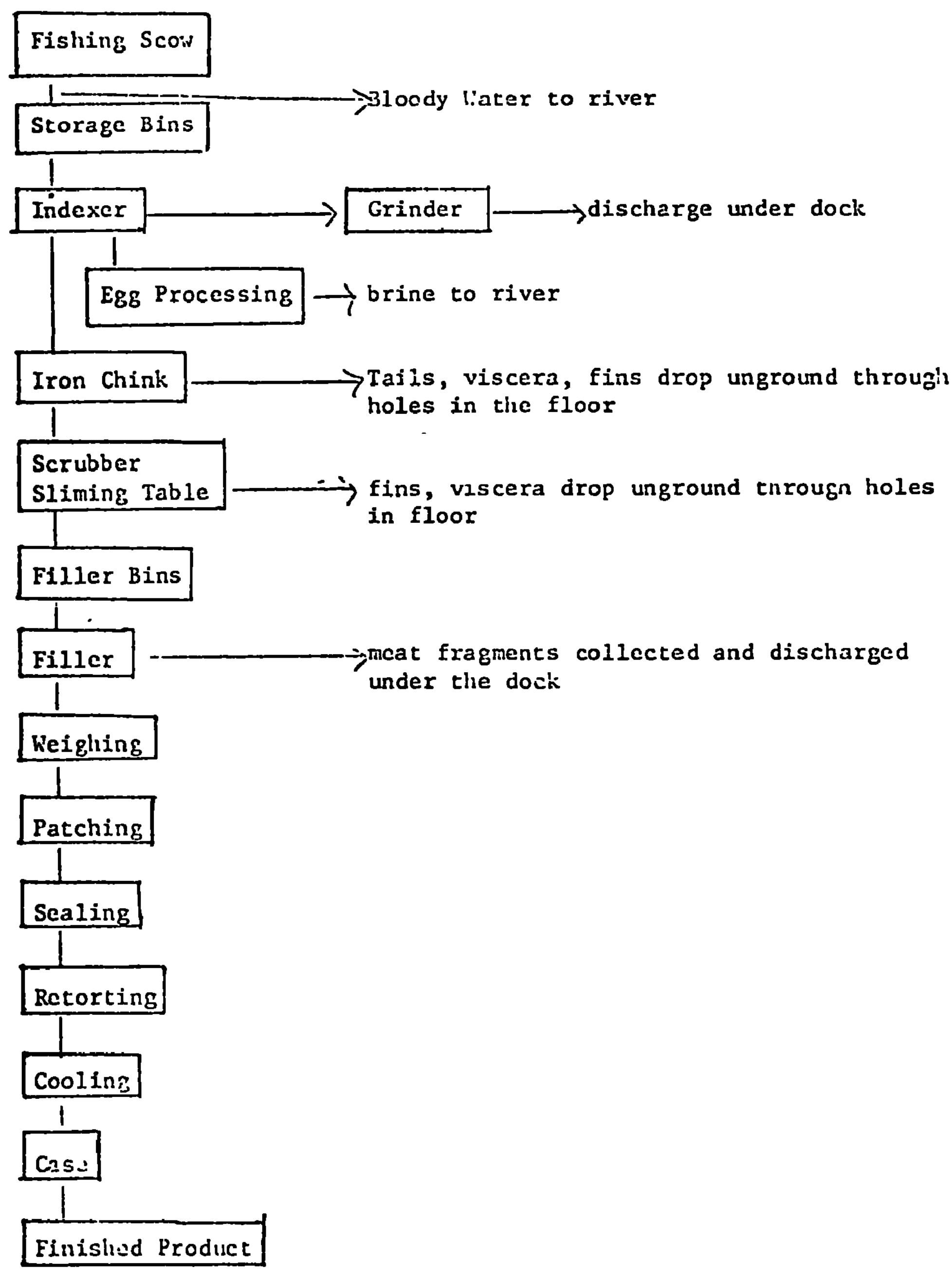


Figure E-21. Whitney Fidalgo Seafoods, Naknek River

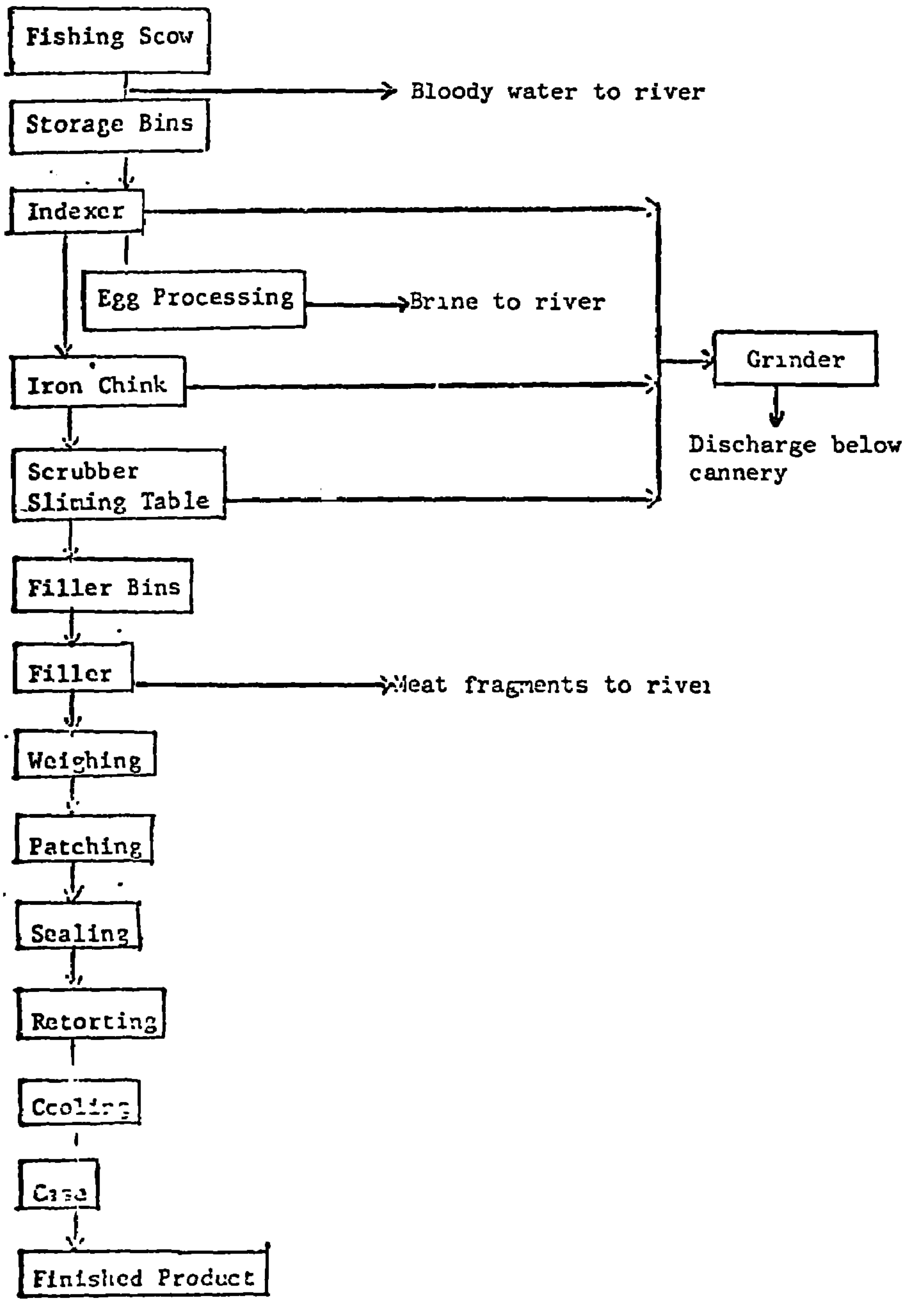


Figure E-22. Columbia Wards Fisheries, Ekuk

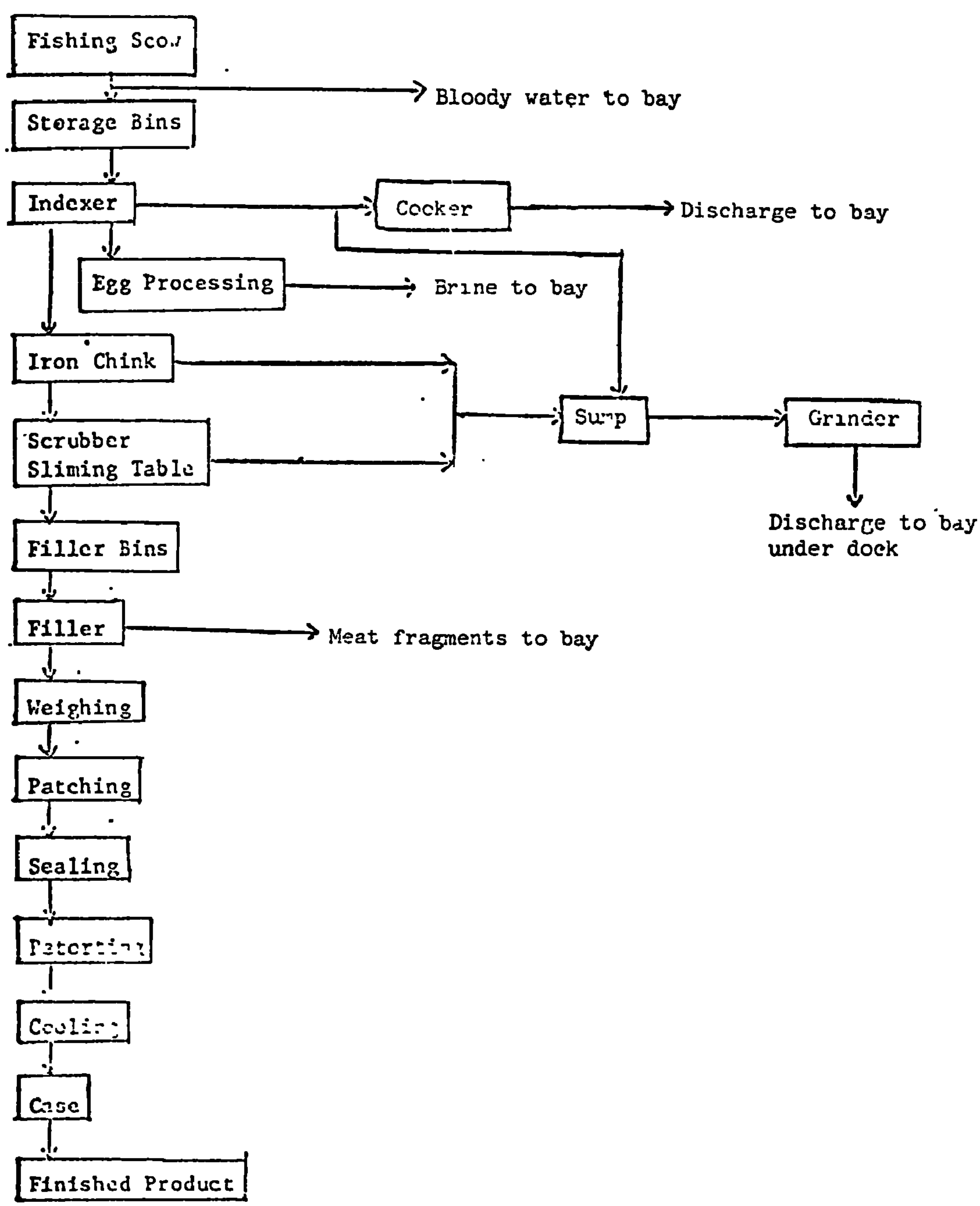


Figure E-23. Peter Pan Seafoods, Dillingham

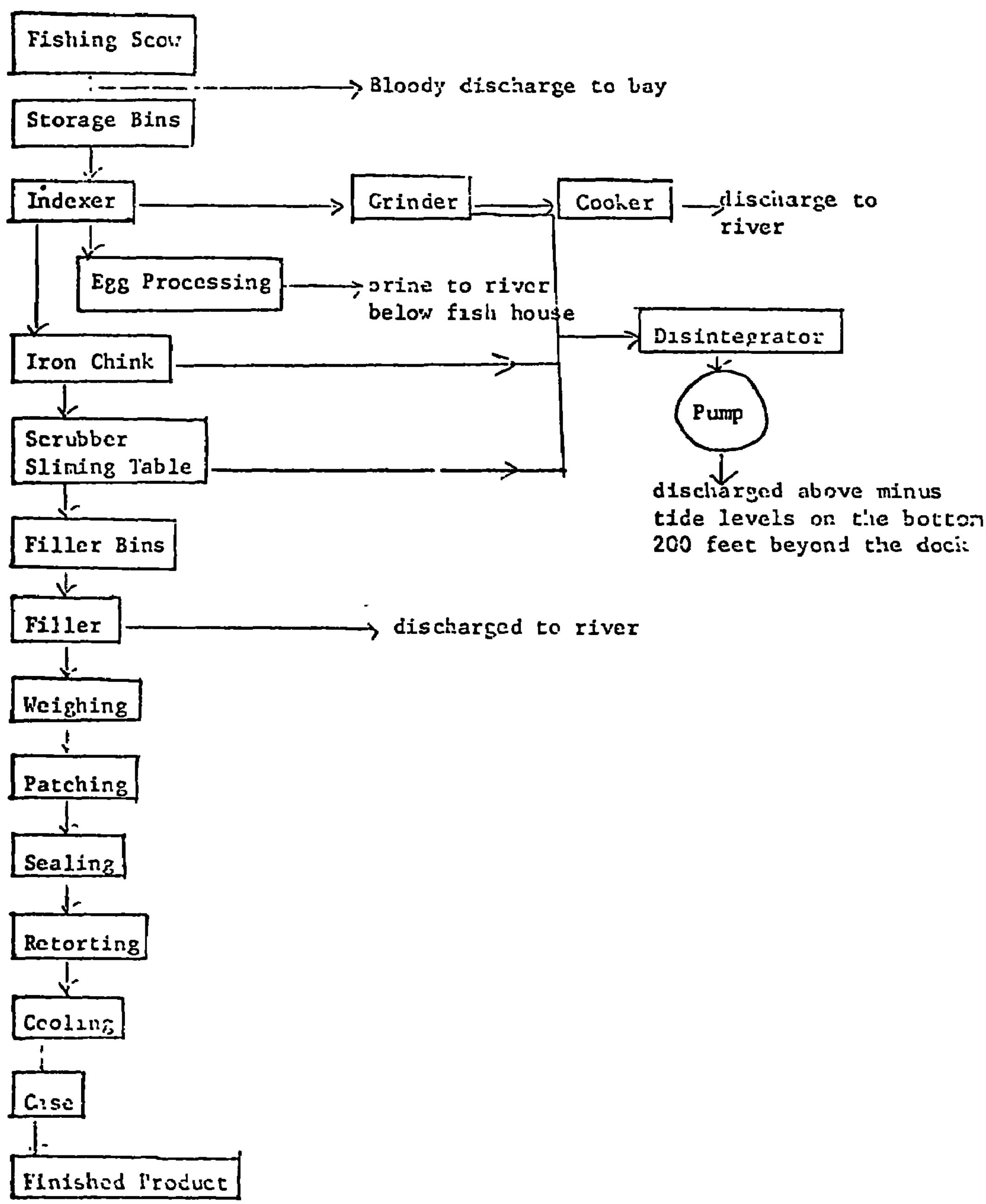


Figure E-24. American Freezerships (M/V Theresa Lee), Akutan

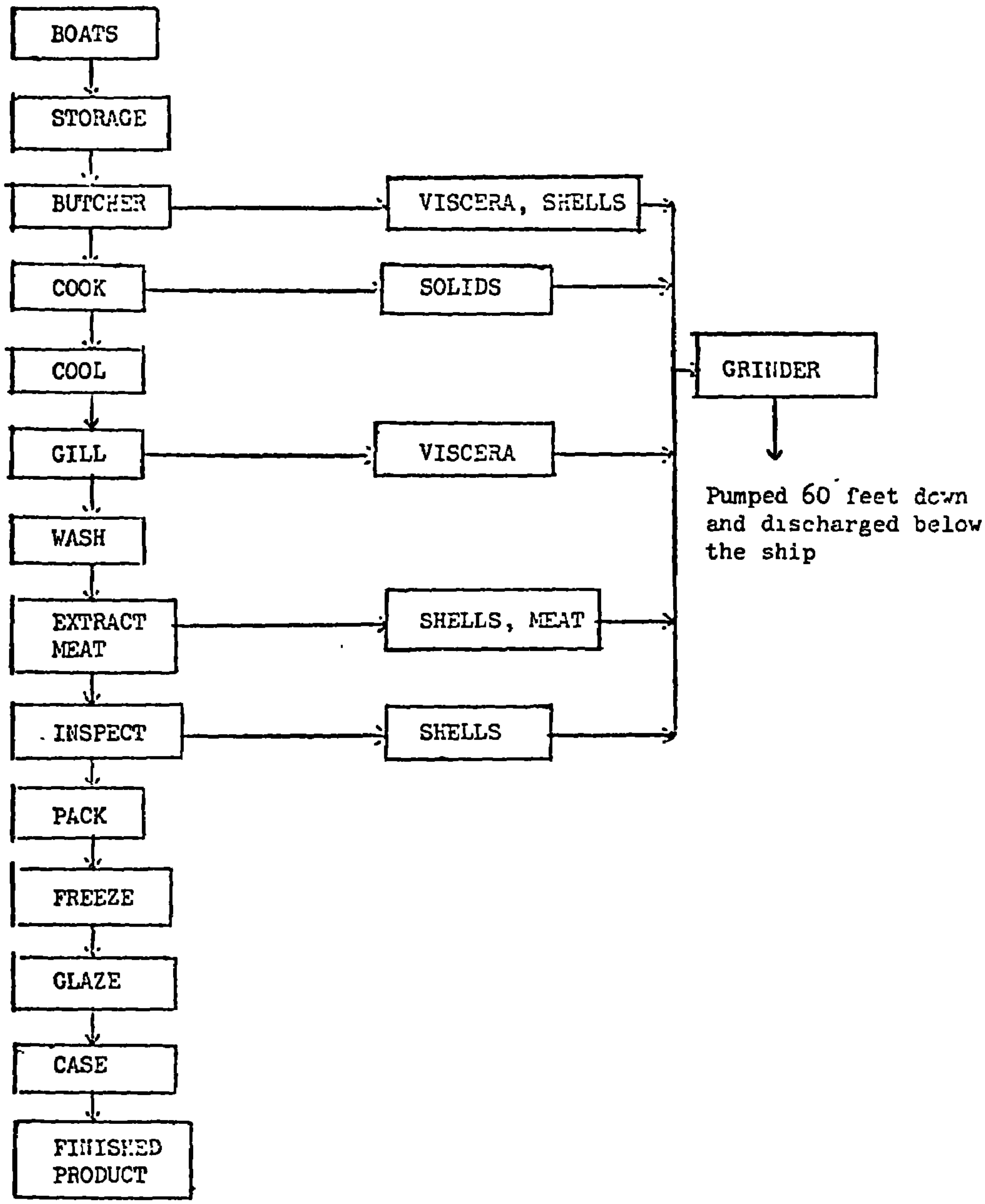


Figure E-25. Wakefield Fisheries (M/V Akutan), Akutan

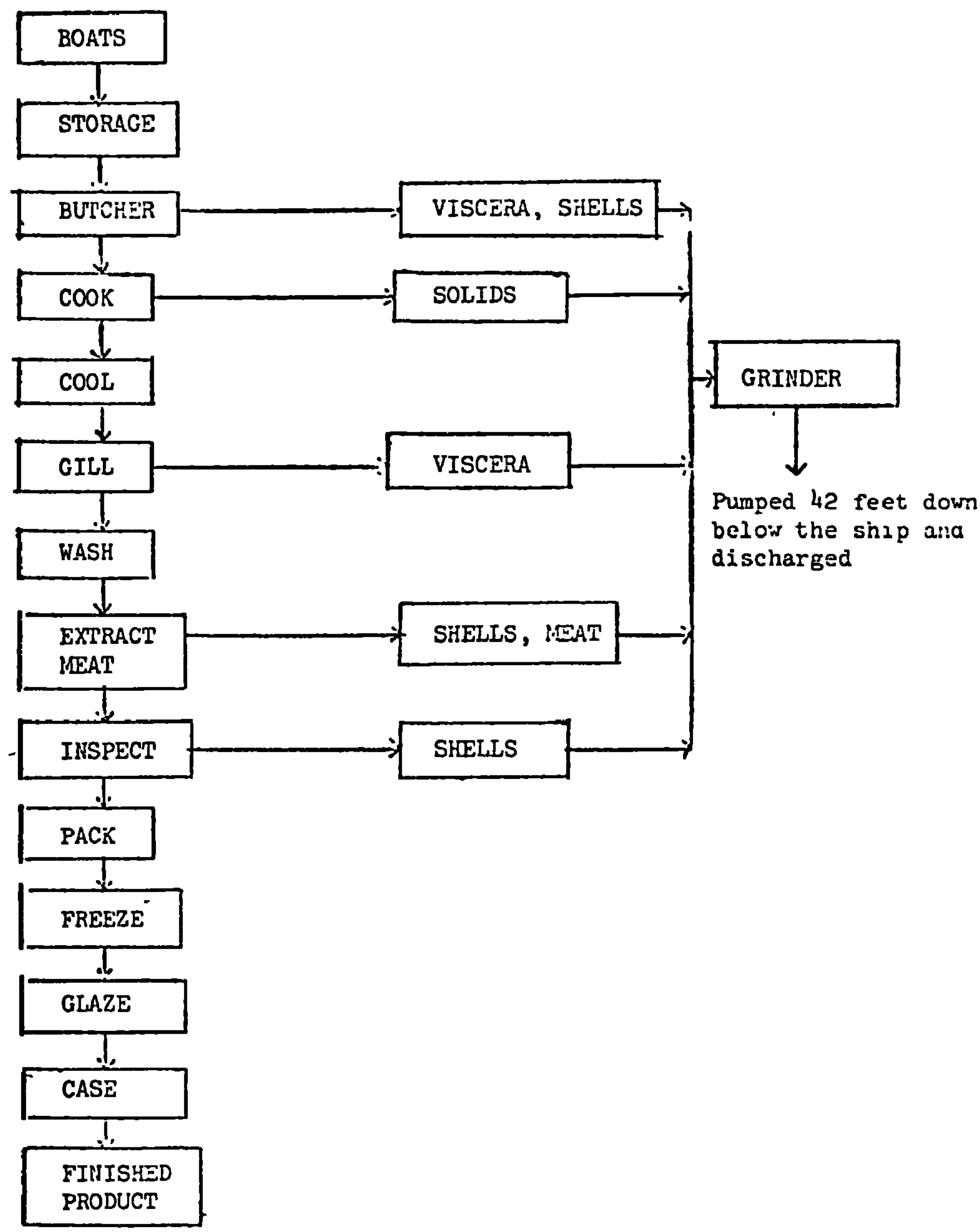


Figure E-26. Pan Alaska Fisheries, Alaska

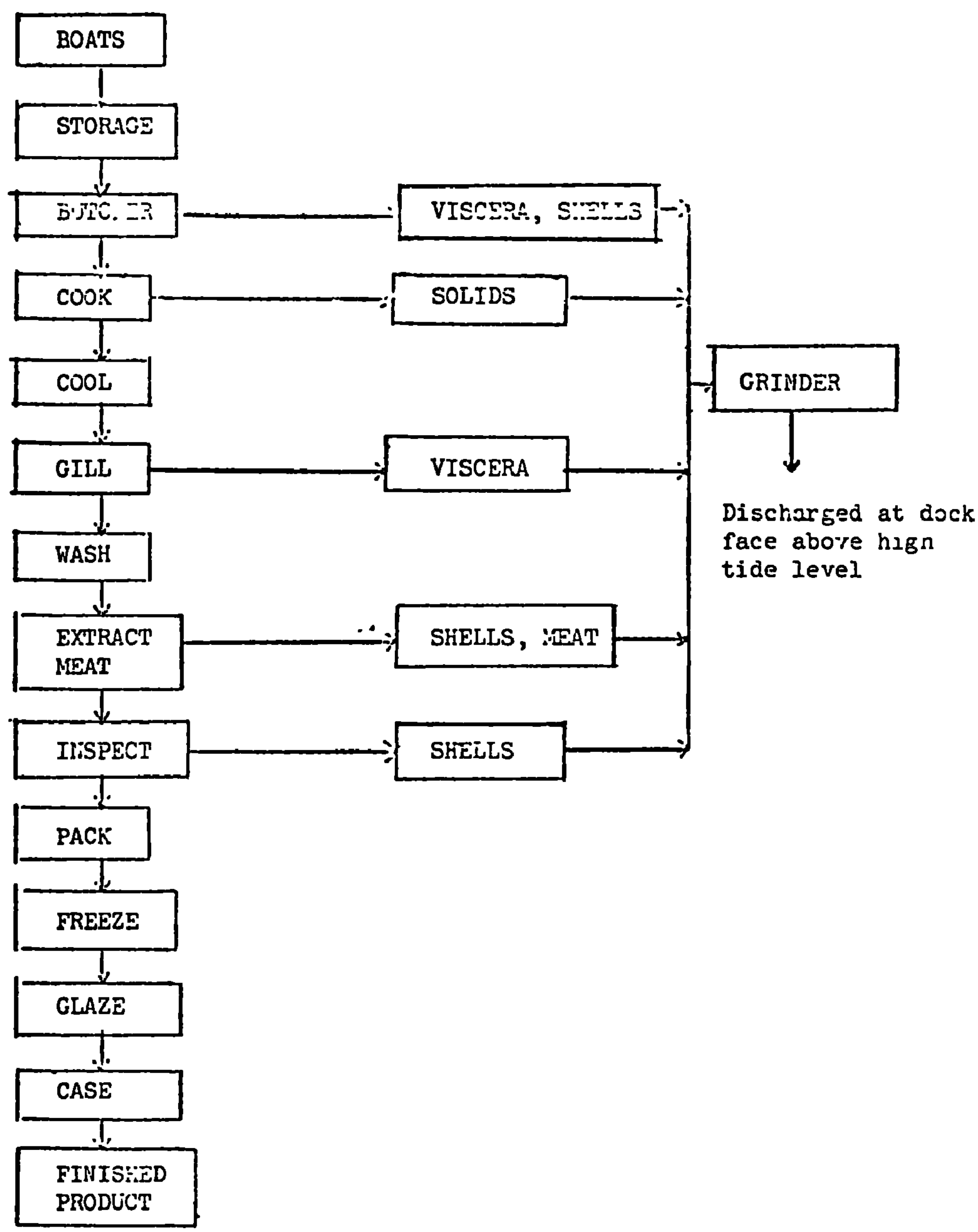


Figure E-27. Pt. Adams Packing Co. (M/V Northgate), Dutch Harbor

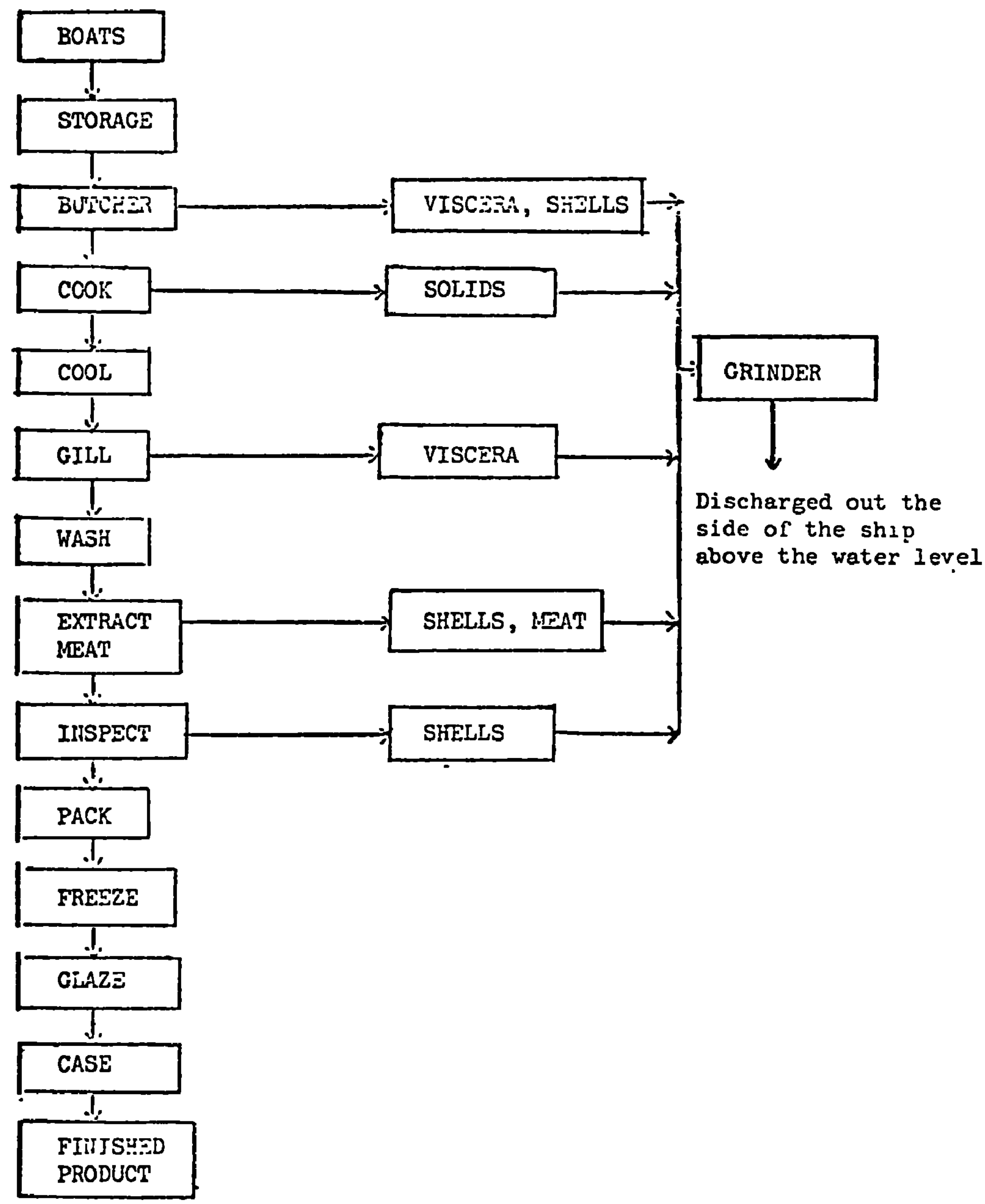
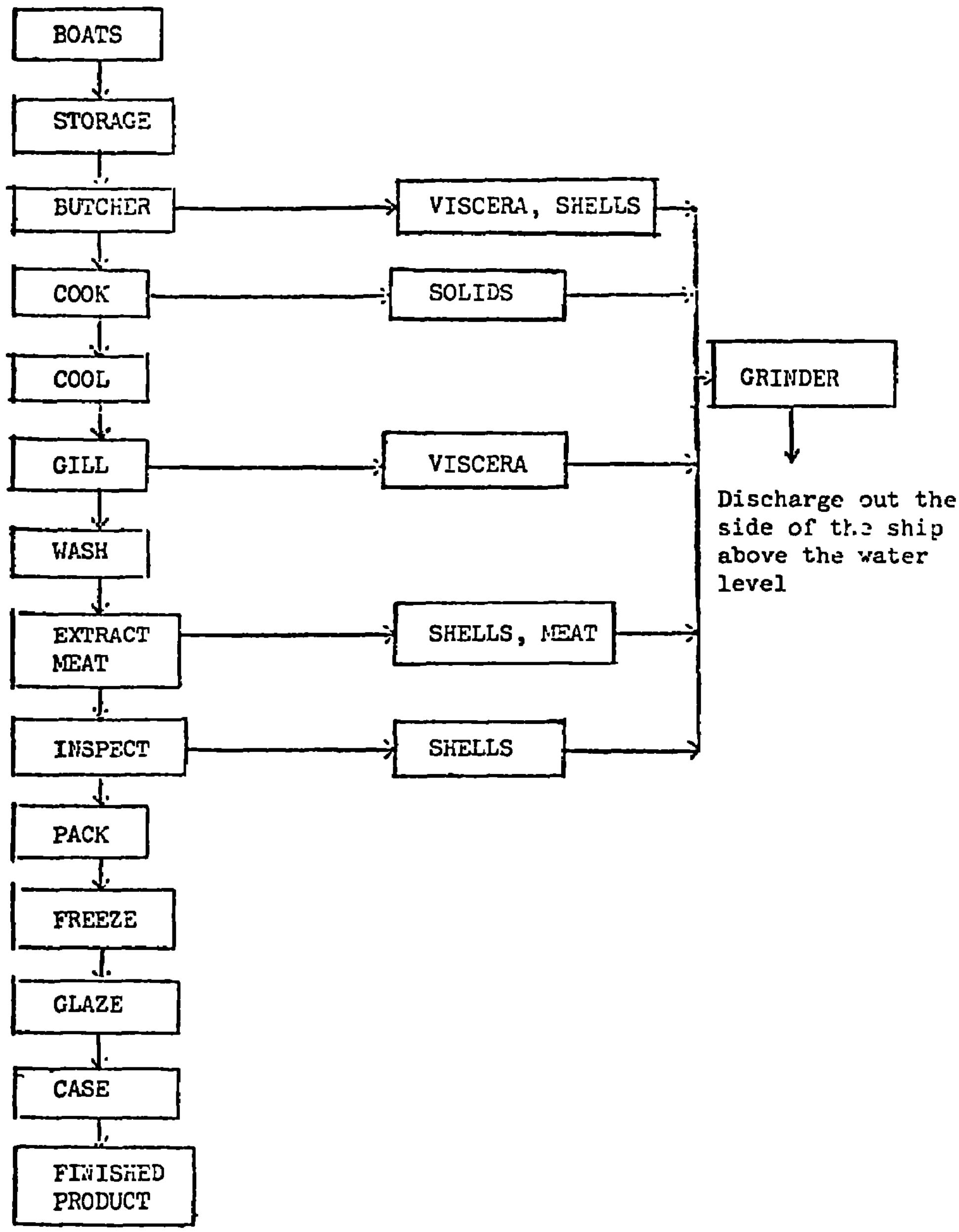


Figure E-28. Vita Foods (M/V Viceroy), Dutch Harbor



APPENDIX F

LOCATIONS AND RECEIVING WATER CHARACTERISTICS FOR SELECTED SEAFOOD PROCESSING PLANTS

Figure F-1. New England Fish Co., Chatham

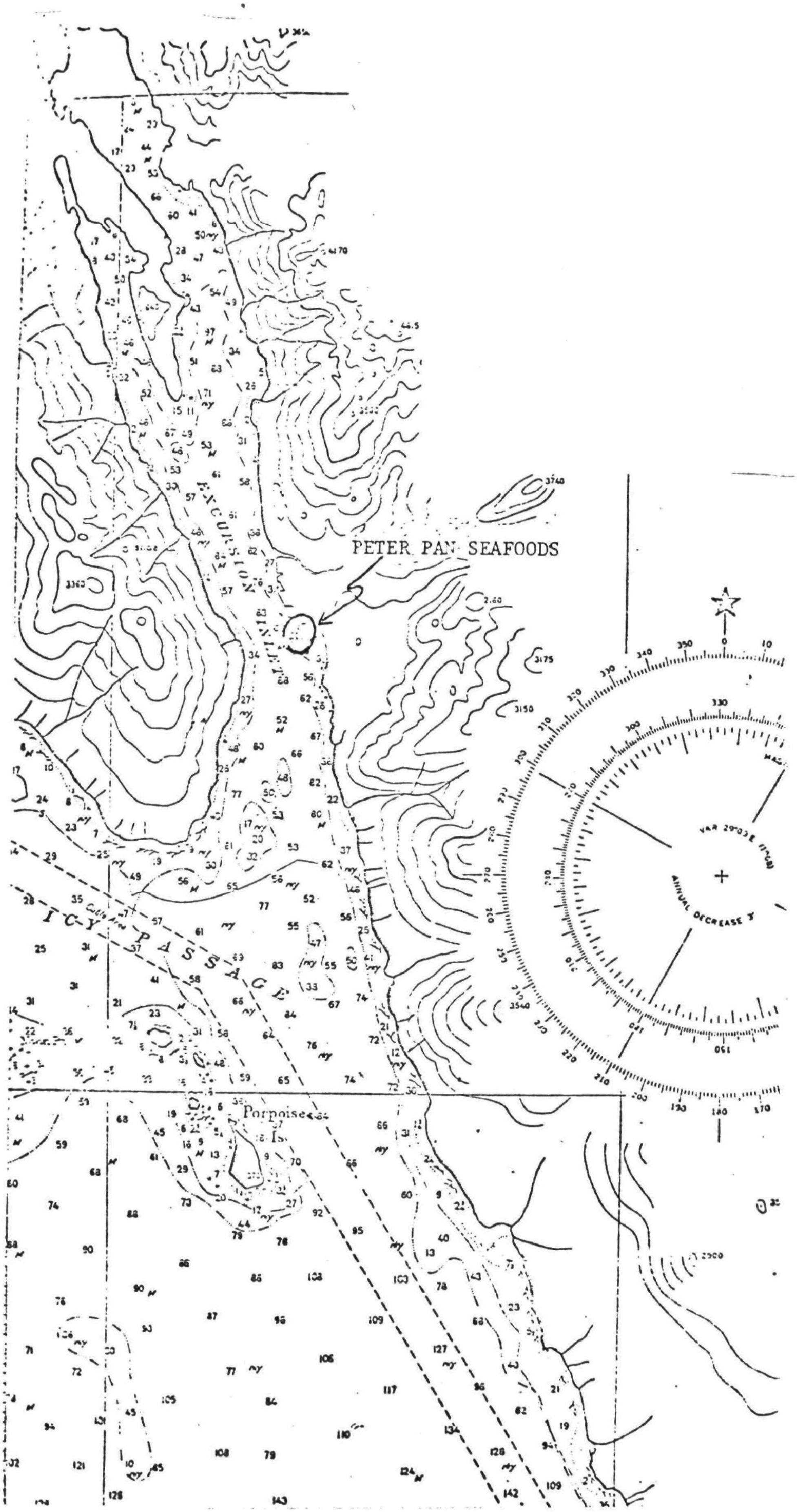


Figure F-2. Peter Pan Seafoods, Excursion Inlet

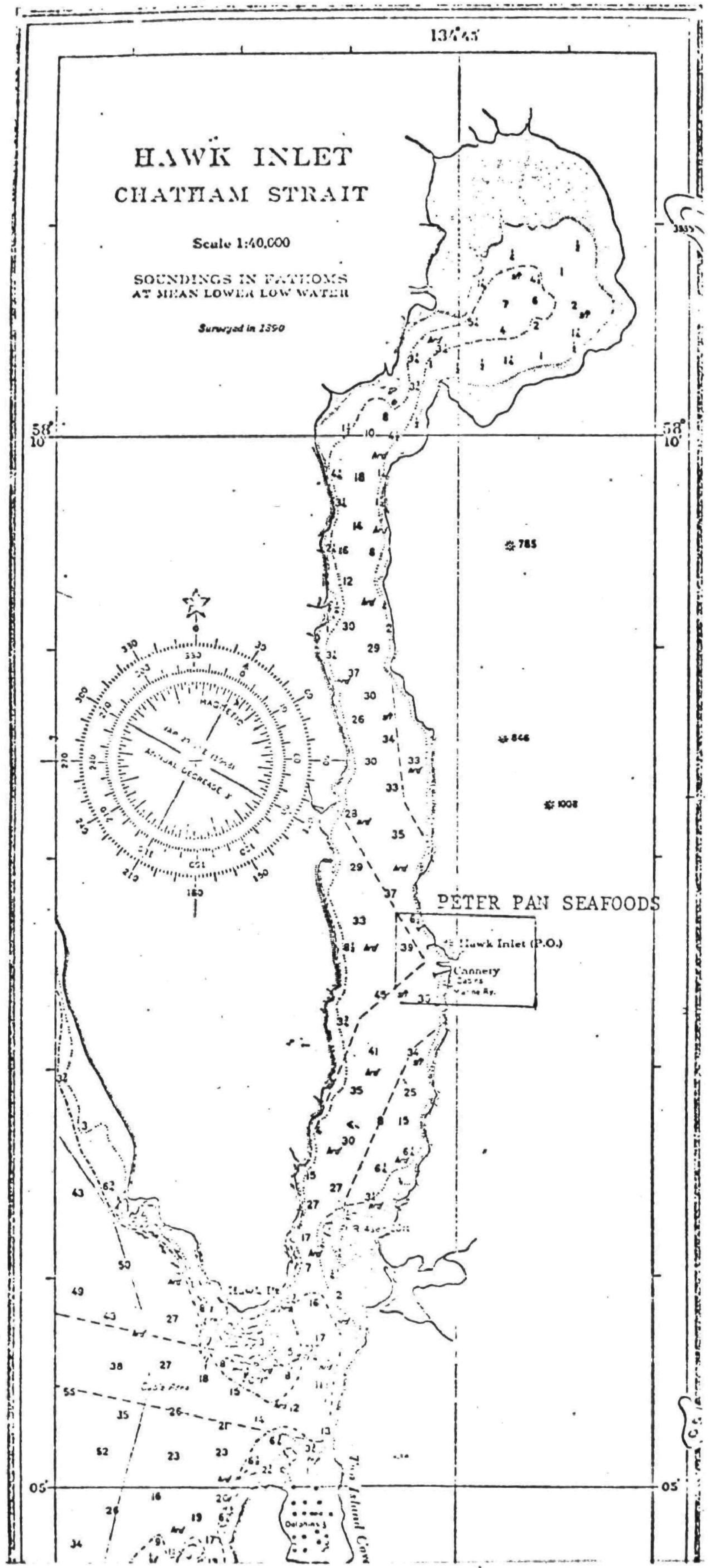


Figure F-3. Peter Pan Seafoods, Hawk Inlet

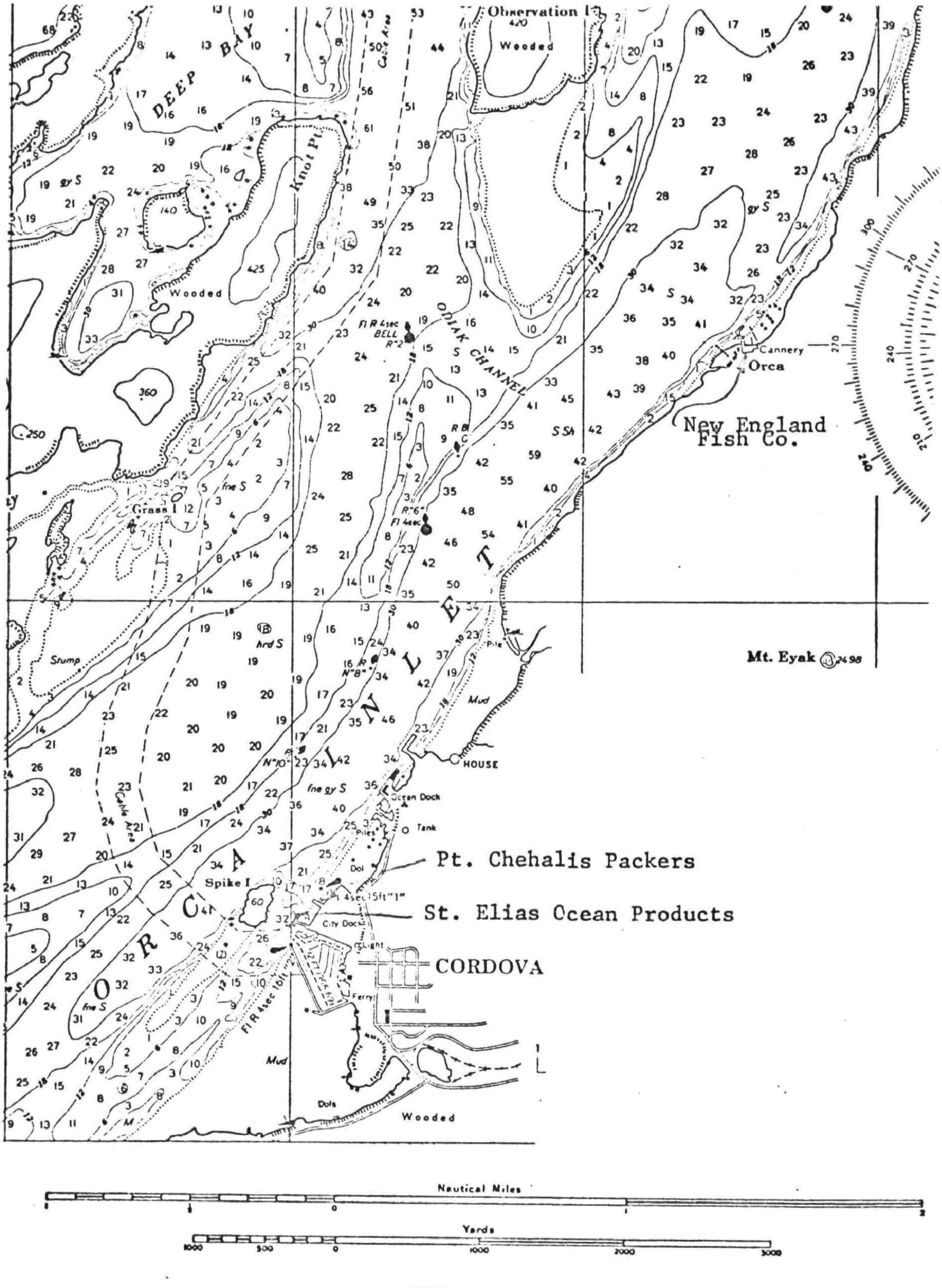


Figure F-4. Locations of Cordova and Orca Seafood Processors

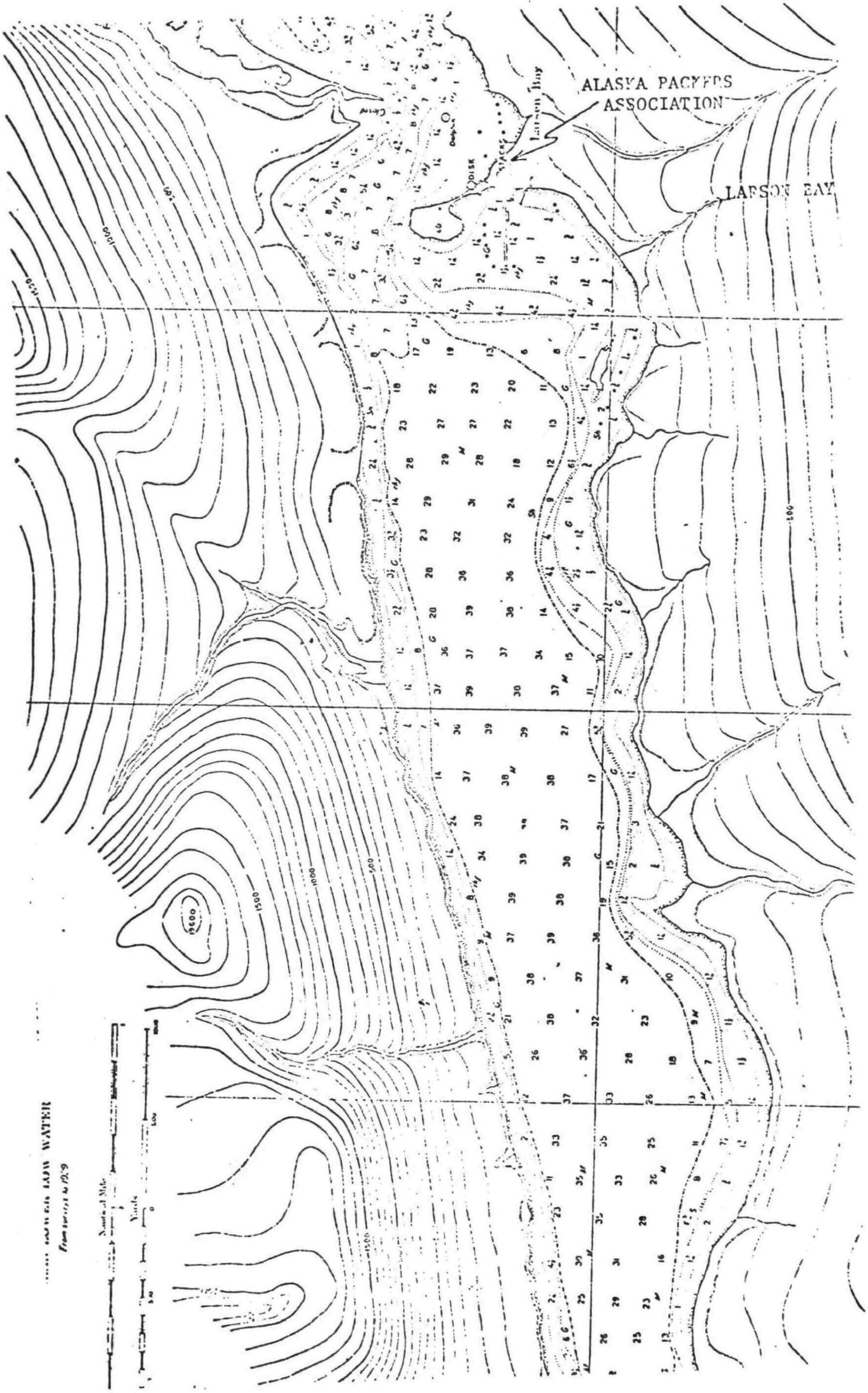


Figure F-5. Alaska Packers Association, Larsen Bay

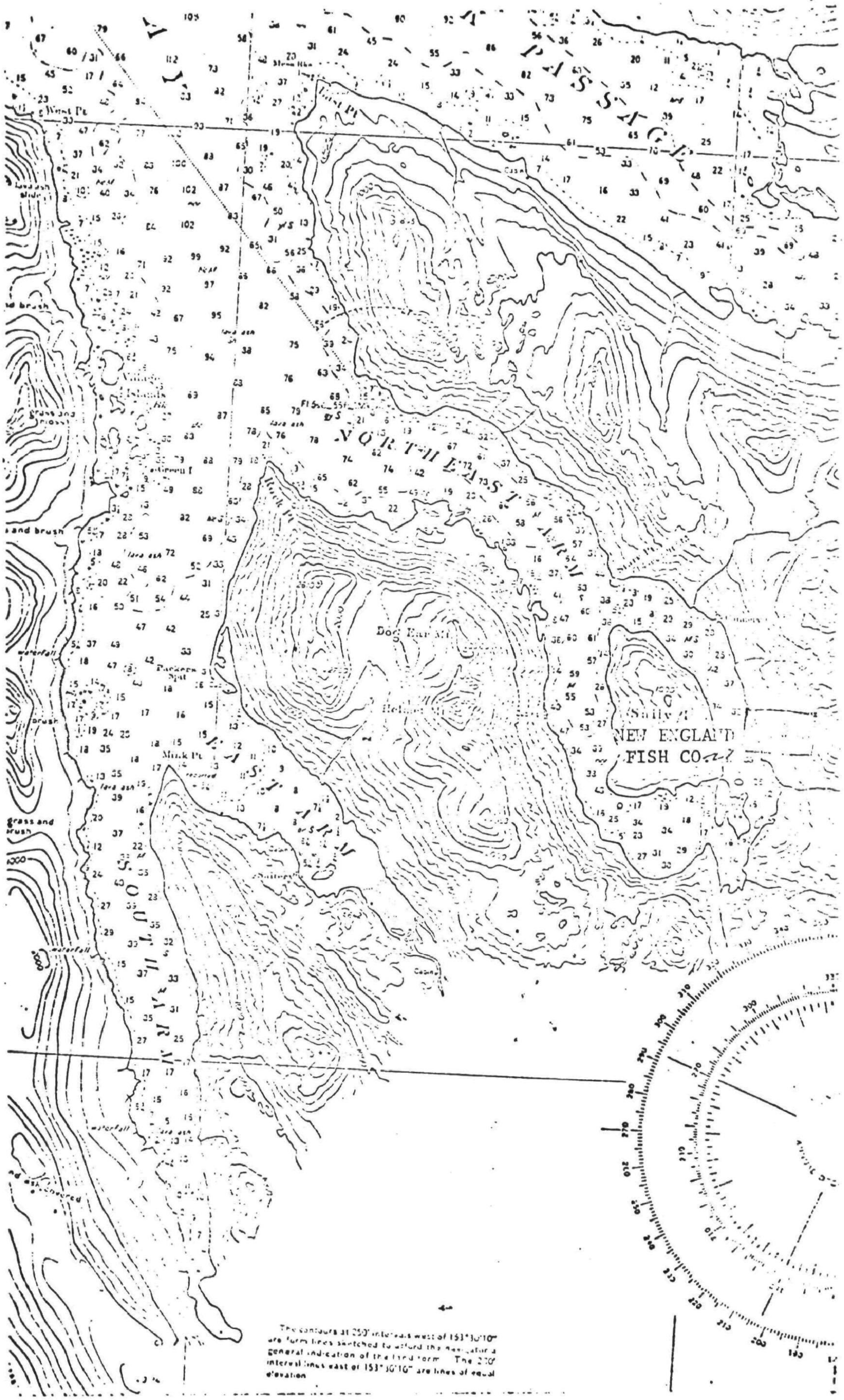


Figure F-6. New England Fish Co., Uganik

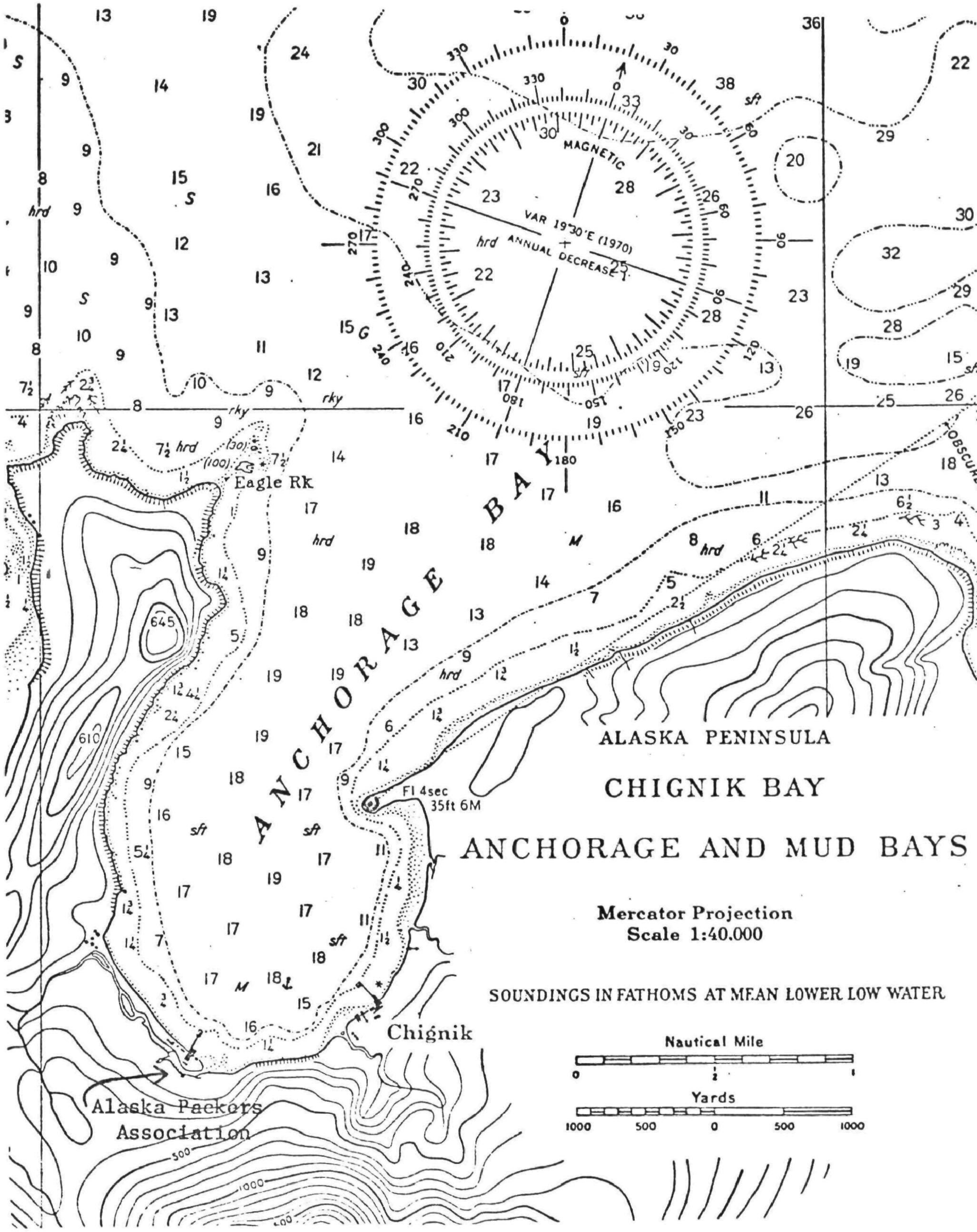
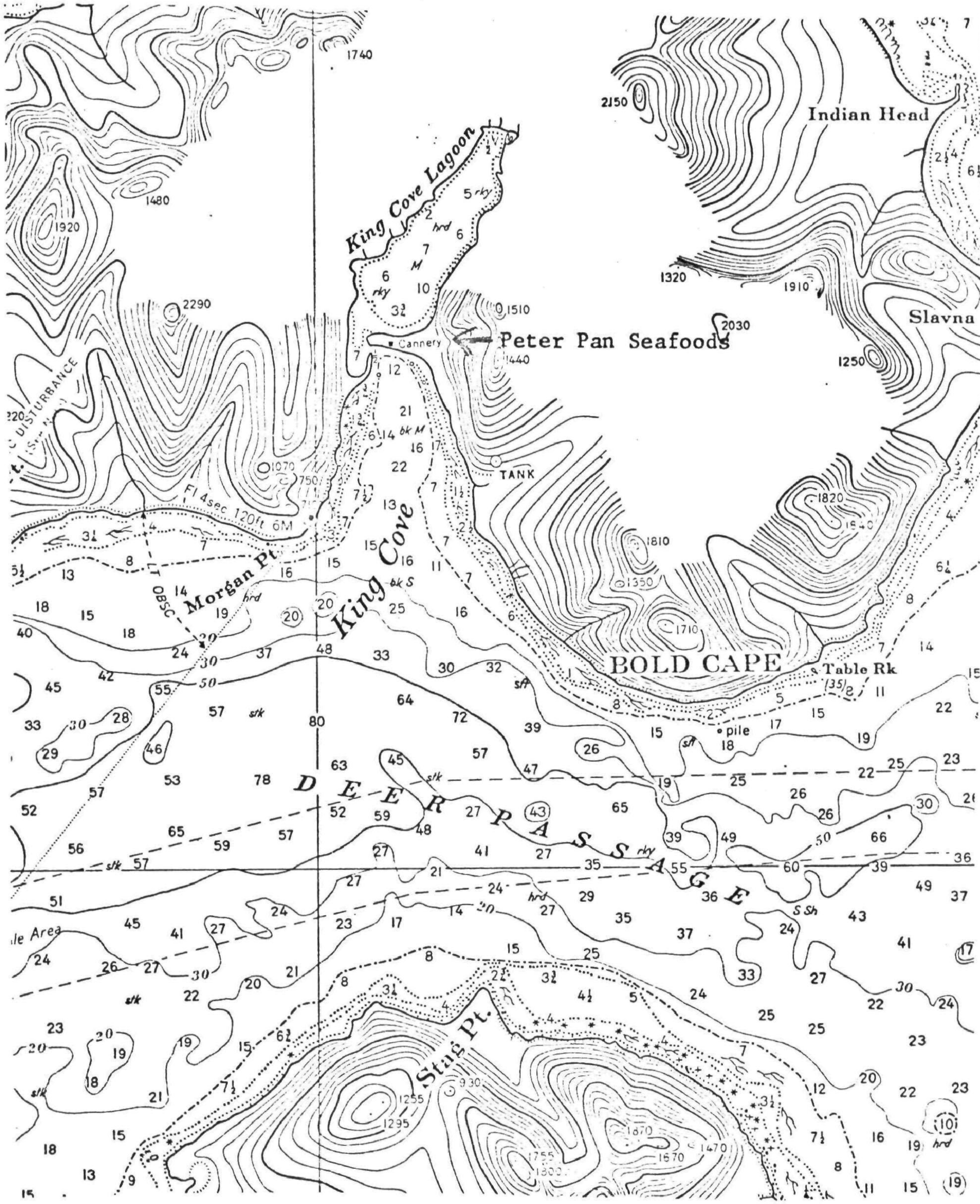


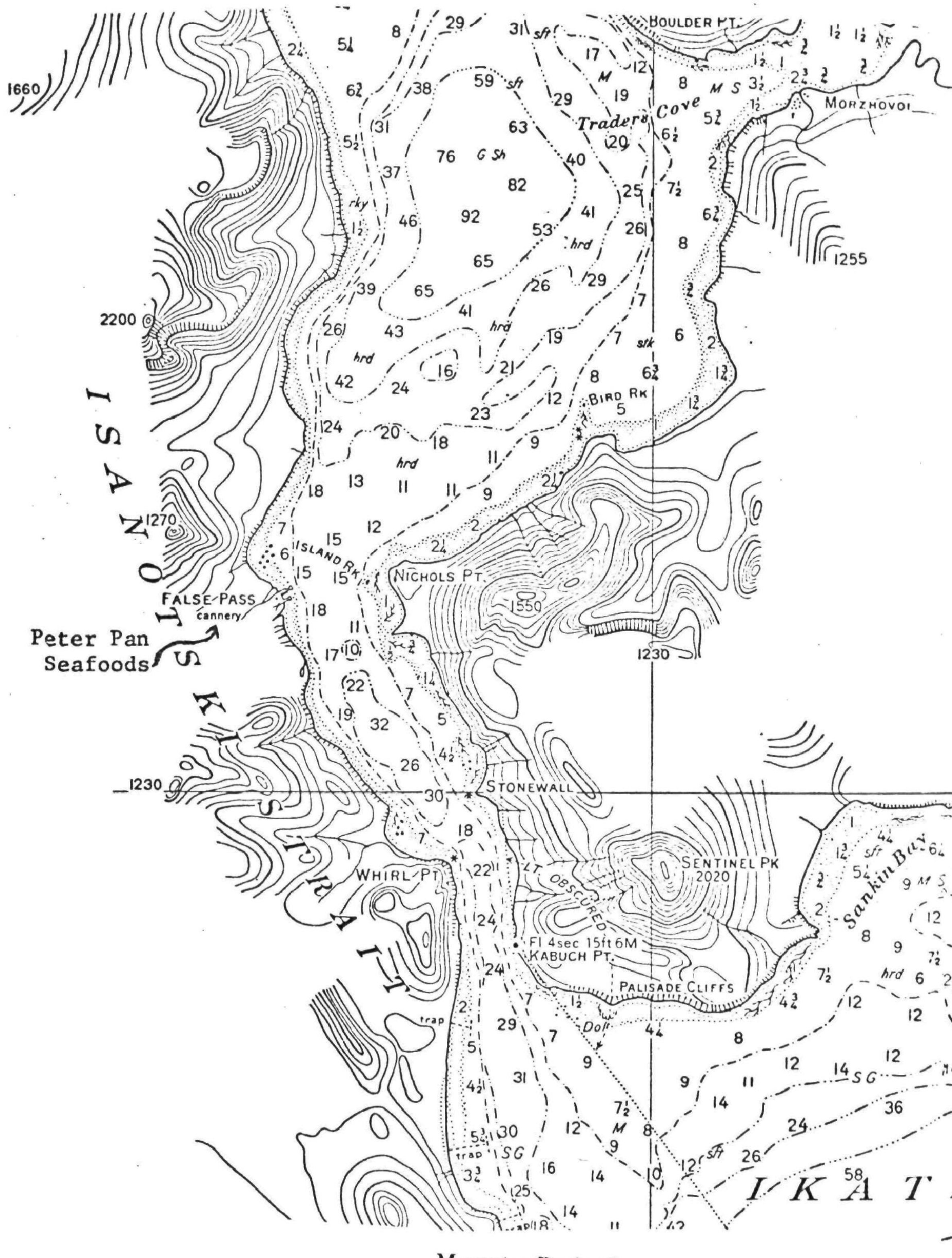
Figure F-7. Alaska Packers Association, Chignik



Mercator Projection
Scale 1:80,000 at Lat. 55°10′

SOUNDINGS IN FATHOMS
AT MEAN LOWER LOW WATER

Figure F-8. Peter Pan Seafoods, King Cove



Mercator Projection
Scale 1:80,660 at Lat. 54°50′
Scale 1:80,000 at Lat. 55°10′

SOUNDINGS IN FATHOMS
AT MEAN LOWER LOW WATER

Figure F-9. Peter Pan Seafoods, False Pass

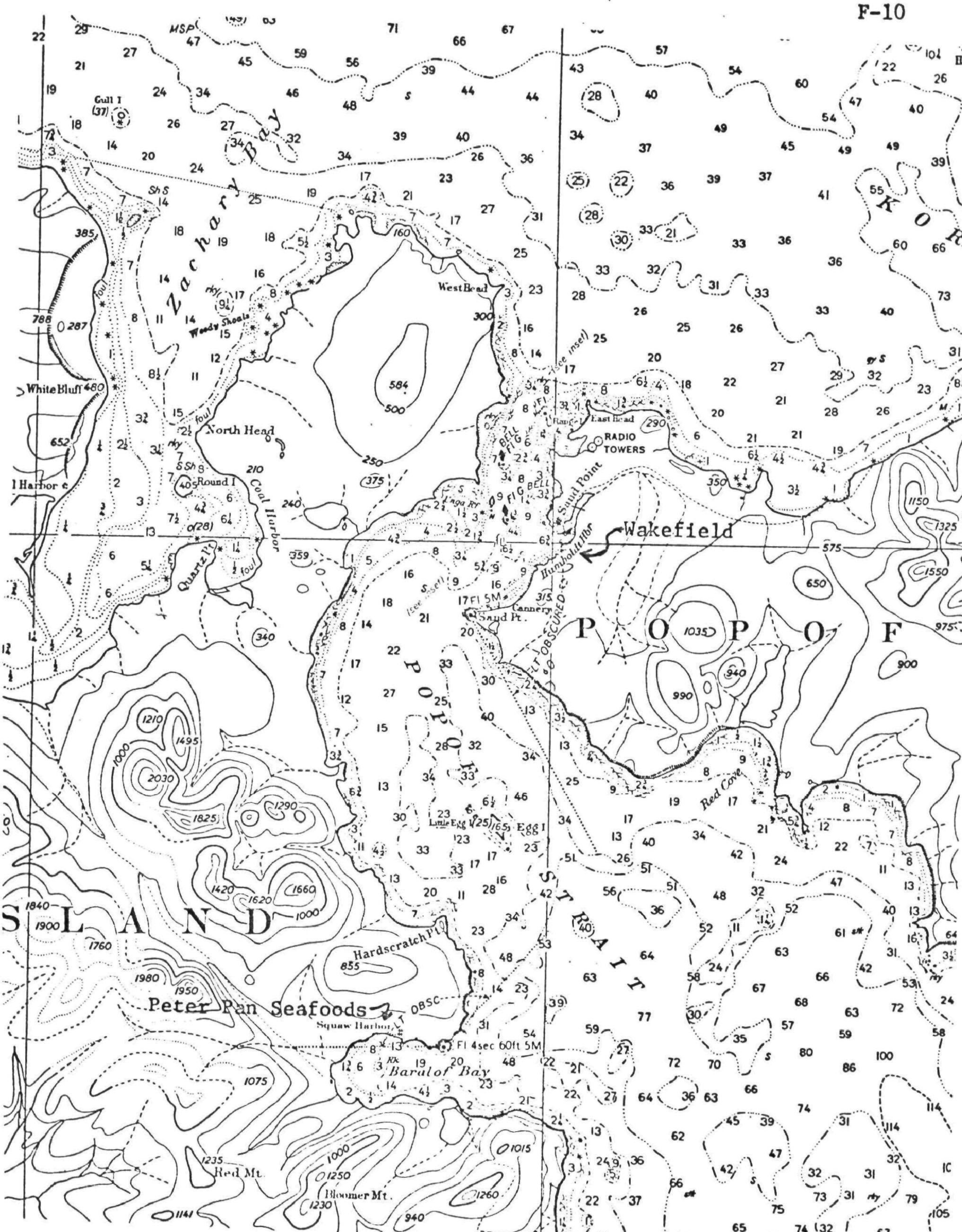


Figure F-10. Sand Point and Squaw Harbor Plant Locations

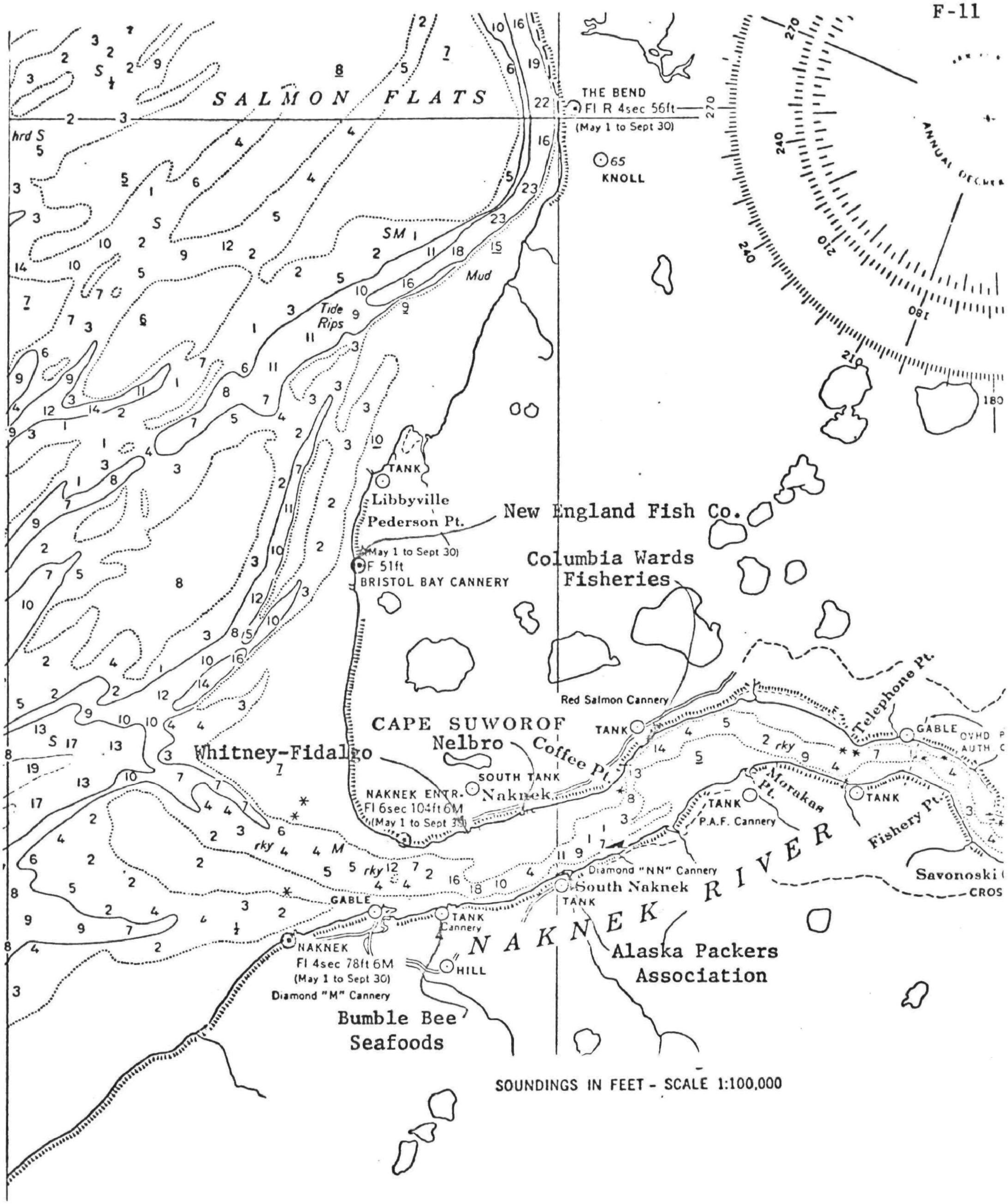
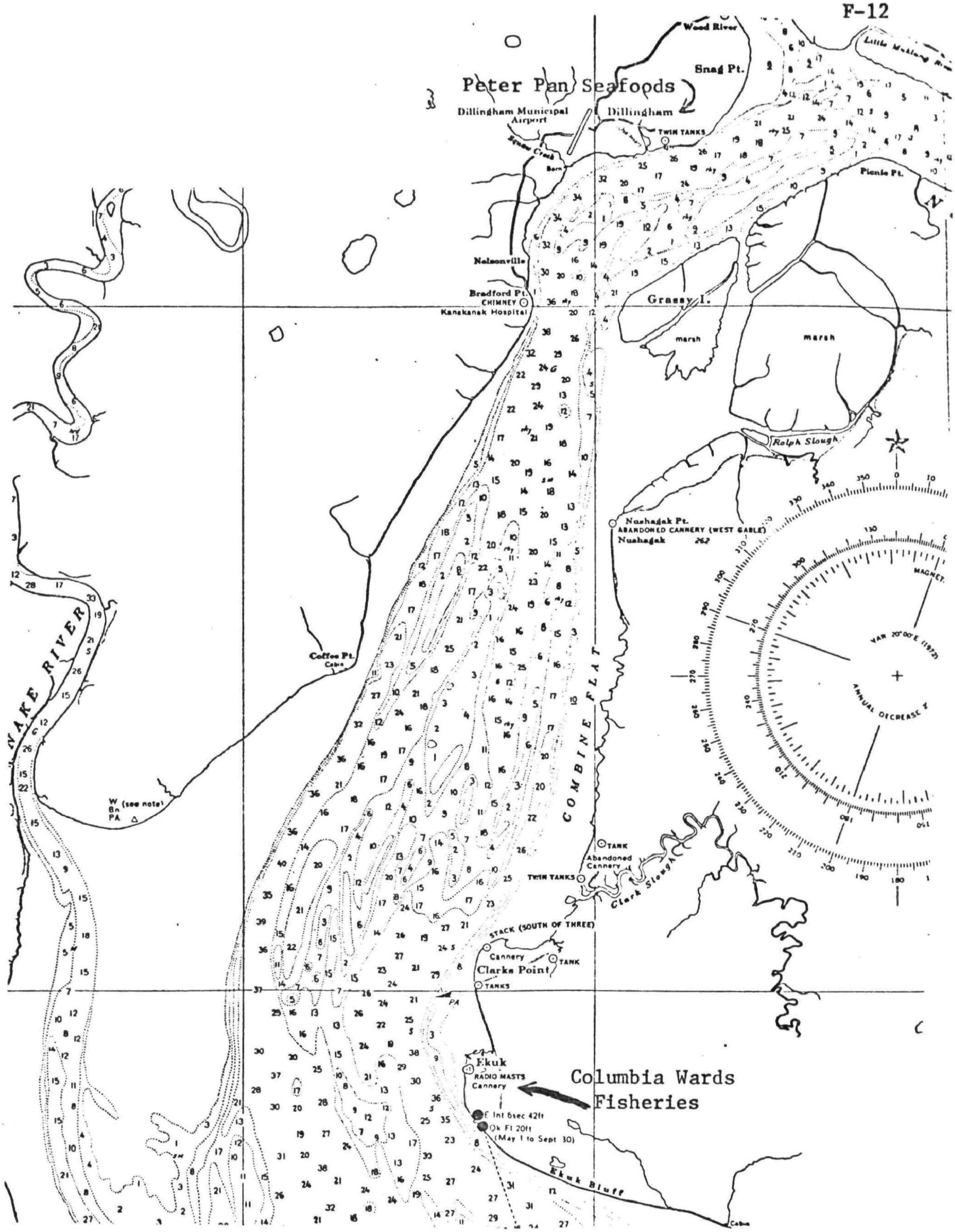


Figure F-11. Locations of Naknek Area Canneries



SOUNDINGS IN FEET
AT MEAN LOWER LOW WATER

Figure F-12. Ekuk and Dillingham Plant Locations

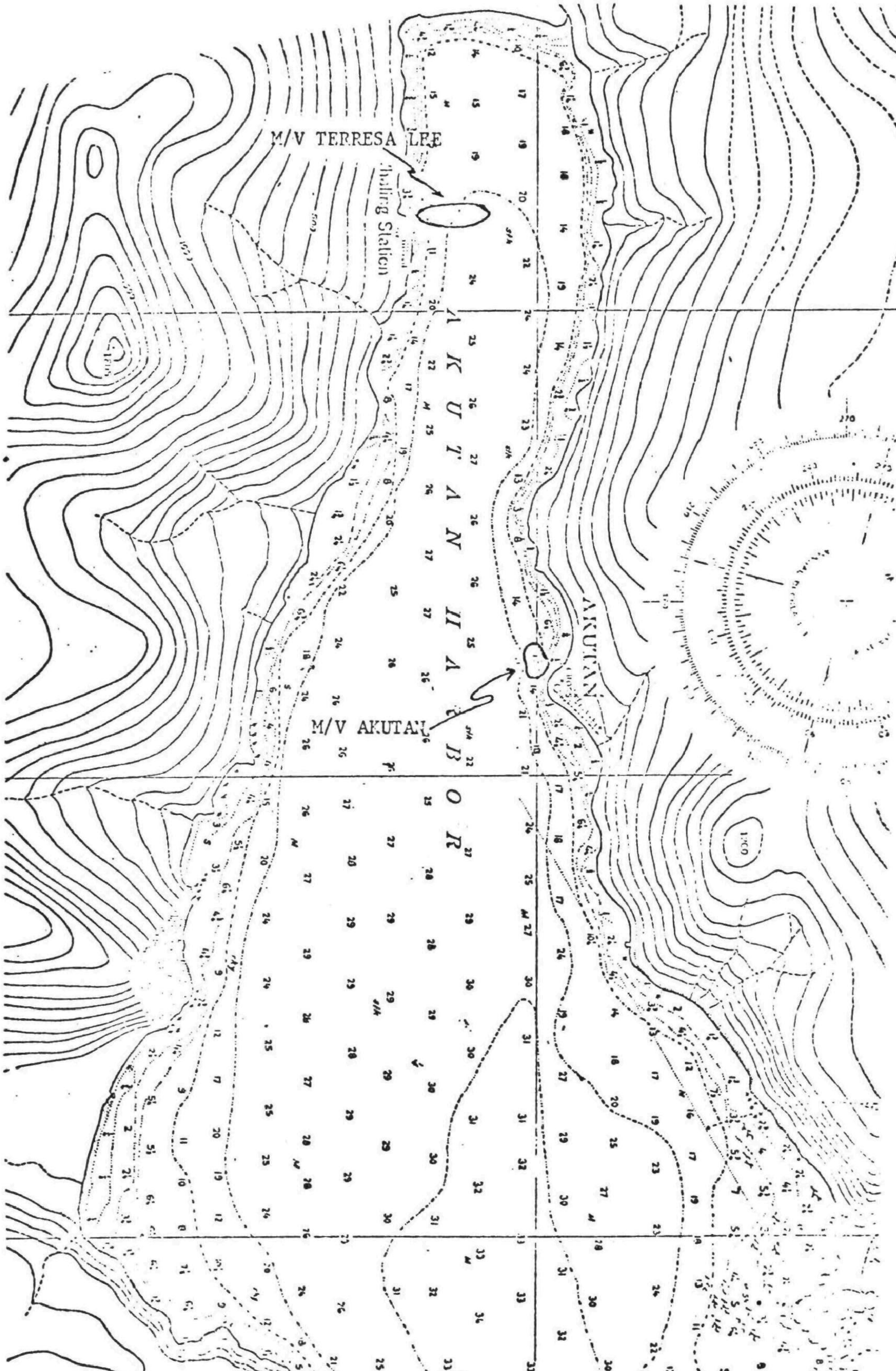


Figure F-13. Akutan Plant Locations

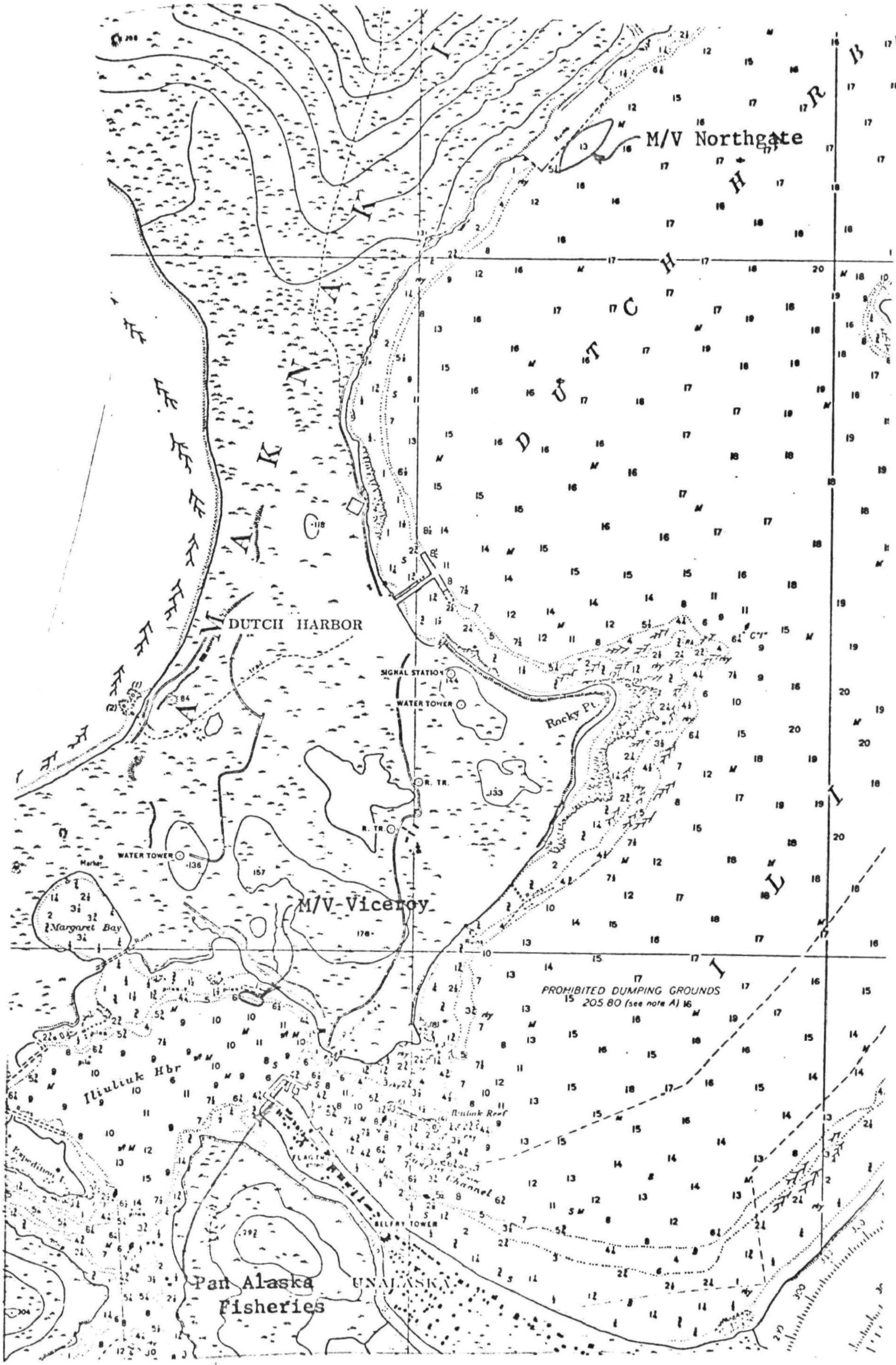


Figure F-14. Locations of Dutch Harbor and Unalaska Seafood Processors