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Report to Congress

Section 74

Seafood Processing Study Executive Summary

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SECTION 74 SEAFOOD PROCESSING STUDY

EXECUTIVE SUMMARY

A REPORT TO THE CONGRESS OF
THE UNITED STATES

prepared by the

U.S. ENVIRONMENTAL PROTECTION AGENCY
EFFLUENT GUIDELINES DIVISION
WASHINGTON, D.C. 20460

September 1980

NOTICE

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

SEP 24 1980

THE ADMINISTRATOR

Honorable Walter F. Mondale
President of the Senate
Washington, D.C. 20510

Dear Mr. President:

In accordance with the provisions of Section 74 of the Clean Water Act of 1977 (P.L. 95-217), the Environmental Protection Agency (EPA) is hereby submitting a report entitled Section 74 Seafood Processing Study. The report consists of an executive summary with various appended studies and supporting material.

The report presents the results of extensive data collection efforts to determine the ecological consequences of marine disposal of seafood processing wastes. Also included in the study is an assessment of technologies for control of seafood waste discharges and for utilization of the nutrients contained in the wastes. The work conducted during this study has covered a wide variety of seafood commodities and processing locations and includes field sampling in Alaska and Oregon, site visits to a variety of seafood processing locations and review of pertinent literature and industry-supported studies.

In conducting the study required by Section 74, EPA enlisted aid from a variety of sources, including academic institutions, consulting firms and Federal and State agencies. In addition, EPA has worked in close cooperation with the seafood industry throughout the study effort. Industry representatives were consulted during the initial planning phase of the study and they have been given the opportunity to review and comment upon the major study documents.

It is apparent from the information collected during this study that the ecological impacts of seafood waste discharges are highly variable and not easily predicted. In light of this, the conclusions presented in the executive summary do not contain any specific recommendations for management of these wastes.

I hope that this report will be useful to you in development of any future policy or legislation regarding the seafood processing industry. I appreciate this opportunity to be of service to you.

Sincerely yours,

Douglas M. Costle

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

SEP 24 1980

THE ADMINISTRATOR

Honorable Thomas P. O'Neill Jr.
Speaker of the House of Representatives
Washington, D.C. 20515

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SCS Engineers, Inc., Long Beach, California, under the direction of Mr. Michael A. Caponigro, conducted a biological and water quality study in Kenai and Cordova, Alaska.

The EPA Corvallis Environmental Research Laboratory, Marine and Fresh Water Ecology Branch, Newport, Oregon, under the direction of Michael Swartz, conducted a biological and water quality study in Yaquina Bay, Oregon.

The Institute of Marine Science at the University of Alaska, Fairbanks, Alaska, under the direction of Mr. David Burrell, conducted a study of biological aspects of crab processing waste disposal practices, and, under the direction of Mr. Howard Feder, a biological and water quality study at Dutch Harbor, Alaska.

Development Planning and Research Associates, Manhattan, Kansas, under the direction of Mr. Thomas Eyestone and Mr. Robert Buzenberg, conducted a market feasibility study of seafood waste reduction in Alaska.

The Edward C. Jordan, Company, Inc., Portland, Maine, under the direction of Mr. David B. Ertz and with the assistance of Mr. George Murgel, evaluated technology for seafood processing waste treatment and utilization.

The Institute for Marine and Coastal Studies at the University of Southern California, Los Angeles, California, under the direction of Dr. Dorothy Soule, evaluated the ecology of the outer Los Angeles and Long Beach harbors and the potential for "bioenhancement" by seafood wastewaters.

Brown and Caldwell Consulting Engineers, Inc., under the direction of Mr. Steve Bingham and Mr. Tony Harber, conducted studies of crab processing waste disposal alternatives for Dutch Harbor, Alaska.

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CHAPTER I

INTRODUCTION

Section 74 of the Clean Water Act of 1977 requires the Environmental Protection Agency (EPA) to investigate the ecological effects of seafood waste discharges and to identify treatment and waste utilization technologies applicable to seafood processing operations. This section reads as follows:

> "Sec. 74. The Administrator of the Environmental Protection Agency shall conduct a study to examine the geographical, hydrological, and biological characteristics of marine waters to determine the effects of seafood processes which dispose of untreated natural wastes into such waters. In addition, such study shall examine technologies which may be used in such processes to facilitate the use of the nutrients in these wastes or to reduce the discharge of such wastes into the marine environment. The results of such study shall be submitted to Congress not later than January 1, 1979."

Under the Section 74 mandate, EPA developed a study plan which included summarizing existing information as well as new data collection. Work conducted during this study covers a variety of major seafood processing locations and processing situations. Ecological effects investigations include sampling efforts in Oregon and Alaska, site visits to New England, the Atlantic Coast, and the Gulf Coast and an in-depth assessment of a study conducted in southern California (Los Angeles Harbor). Similarly, the technology assessments performed as part of the study include processors in all locations.

In performing these investigations, EPA enlisted support from a variety of sources, including the University of Alaska Institute of Marine Science, EPA research personnel, experts in the industry, and several consulting firms. In addition, EPA requested the cooperation of a number of Federal and state agencies in a review and critique of the Los Angeles Harbor study submitted by the tuna processing industry.

In terms of waste control, the Nation's seafood processing facilities have improved during the past decade. The majority of seafood processors are discharging significantly less waste solids to (primarily) coastal receiving waters than was common ten years ago. Because of influences in the marketplace and awareness of resource conservation, the industry has been encouraged to use these solids for by-product manufacturing. Many locations now produce pet food, fish meal and fish oil.

Although there has been considerable improvement in the availability of technologies to process seafood wastes, the seafood industry contends that in many geographical areas treatment of wastes is unnecessary. This is based in the belief that these wastes are natural and pose no threat to the marine environment, and moreover, the nutrients supplied by these wastes have a generally beneficial effect on the marine ecosystem. This thesis is presented in detail in the Los Angeles Harbor study report submitted to EPA by the industry. EPA has devoted considerable effort to an assessment of the data and concepts presented in this study.

The information and conclusions contained in this document have been developed specifically to satisfy the Section 74 requirement and are entirely separate from the ongoing development of technology based regulations for the seafood industry. Because the technologies identified during this study are in various stages of development and applicability, no technology alternatives are being recommended in this report.

CHAPTER II

CONCLUSIONS

A. Ecological Effects

This research study and the available literature indicate that some coastal areas can assimilate or disperse large amounts of waste without serious effect, while other areas are adversely impacted by seafood waste discharges. The observations of impact-free discharge sites in areas of favorable currents are consistent with generally accepted concepts that problems associated with soluble waste components can be avoided with adequate dispersion at the source, however, these observations cannot be generalized with respect to settleable particulates. Initial dispersion sufficient to avoid seabed accumulation at the discharge site does not guarantee that particulates might not subsequently accumulate in downcurrent seabed depressions, bays, or tidal flats. It is evident that the ecological impact from seafood waste disposal is not a simple phenomenon. The following sections discuss specific findings, the nature of the waste discharges, the types of effects documented and variable factors at discharge sites affecting the observed impacts. Finally, the concept of "bioenhancement" is discussed.

Site-Specific Effects

The most severe effects were documented at Dutch Harbor, Alaska where processors discharge many tons of shellfish waste solids annually. EPA investigations revealed that these wastes are accumulating on the bottom from season to season and that they are smothering most bottom life across broad areas in the vicinity of the discharge points. In contrast, another field study conducted at Cordova, Alaska, where processors also discharge untreated waste solids, detected less ecological damage; the effects noted in this study were generally limited to the immediate vicinity of the discharge point. Studies at Kenai, Alaska (untreated wastes) and Yaquina Bay, Oregon (partially treated wastes) revealed little detectable impact on the environment.

Variability of Waste Discharges

Seafood processing operations are by no means uniform in the nature of their wastewater discharges to marine waters. Investigations during this study reveal that Alaskan processors generally discharged whole or ground waste solids, while processors in the contiguous states generally employ wastewater screening prior to discharge, which results in relatively small particles of waste solids being released to the marine waters. Some of the larger seafood canners in the contiguous states, such as tuna processors, employ dissolved air flotation treatment systems prior to wastewater discharge. This treatment results in the removal of a significant portion of the seafood waste solids and oil and grease generated by these processing operations.

Seafood processing wastewater characteristics also vary with the type of species processed. A major distinction may be made between finfish and shellfish; finfish wastes are characterized as high in protein, while shellfish wastes contain lesser amounts of protein along with a high percentage of the polysaccharide, chitin. Finfish wastes, such as salmon wastes, are generally more easily dispersed or degraded by receiving waters than shellfish wastes. Seafood commodities may be further distinguished by their oil content. Some species, such as sardine, contain high levels of oil, while others, including shrimp and bottom fish, contain relatively small amounts of oil and grease.

Types of Effects Documented

Waters receiving seafood wastes vary widely with respect to the observable effects caused by the waste discharges. As noted above, some areas are able to assimilate significant quantities of untreated wastes while other areas show serious ecological damage from these wastes. The types of harmful effects detected during this study include the following:

1. Solids accumulation - Excessive amounts of waste solids can result in their accumulation on the bottom which, in turn, leads to the physical smothering of bottom dwelling organisms with possible negative effect on the quality of the water above. This type of impact was detected at Dutch Harbor, Alaska.

2. Excessive Oxygen Demand - Seafood wastes discharged in any form may exert a heavy demand on the available oxygen in the receiving waters. This oxygen demand is the result of bacterial decomposition of the wastes. Areas with limited tidal or current movement are most susceptible to this type of problem.

3. Excessive Oil Discharge - The processing of certain commercial species results in the discharge of large quantities of fish oil. Rather than mixing uniformly with the receiving waters, this oil generally floats on the surface and may result in a variety of problems including damage to marine birds, shoreline property and boats. Several sardine processing locations periodically experience these problems.

4. Aesthetic Effects - Discharge of seafood wastes can result in a variety of aesthetic problems including visible floating fish parts and oil, attraction of scavenger birds and malodorous conditions.

Major Factors Relating to Observed Impacts

In conducting ecological effects studies and evaluating the literature, EPA has attempted not only to define the effects of seafood waste disposal at individual sites, but also to delineate the site-specific factors. The two most significant site-specific factors identified by EPA are the amount of waste discharged and the hydrological conditions of the receiving waters. It is apparent that most seafood processing locations are capable of assimilating a small amount of waste without ecological damage. Areas with strong tidal or current flushing are able to disperse relatively large amounts of waste material as compared to areas where water movement is slow. Generally, enclosed bays, bayous, and slow moving rivers are most susceptible to solids accumulations or oxygen depletion.

Other site-specific variables influence to a lesser extent the observable effects at individual sites. First, the type of seafood commodity processed has some relationship to the observed effect. Generally, shellfish waste is less easily dispersed than is finfish waste. The processing of oily species often results in a residue formed on receiving waters near the discharge point. Second, in addition to hydrological conditions, there are other characteristics of the receiving waters affecting to some extent their ability to assimilate wastes. The most significant of these are the native marine species present and the chemical characteristics of the receiving waters. Generally, species which have the greatest tolerance for depressed dissolved oxygen levels are best able to survive near the outfall locations and, in some cases, to utilize the wastes as food. Regarding water chemistry, areas where both dissolved oxygen levels are near saturation and nutrient levels are generally low are much better able to assimilate waste discharges than are areas with naturally low oxygen levels or high nutrient levels.

Bioenhancement

"Bioenhancement" is a concept advanced by the seafood industry, which in effect states that the discharge of seafood wastes provides nutrients which can be utilized by marine species to increase or "enhance" aquatic populations. EPA, in conjunction with scientists from other Federal and state agencies, has conducted an assessment of this concept as presented in a document submitted by the industry relating to the effects of tuna processing waste discharges in Los Angeles Harbor (Appendix E-1).

It is well known that seafood wastes and many other types of natural wastes, contain potentially valuable nutrients. However, it is apparent from the inter-agency review of the industry document that "bioenhancement" is a highly controversial concept among marine scientists. Scientists generally agree that the nutrients supplied by seafood wastes can potentially cause an increase in certain aquatic populations. They do not concur, however, that such an increase is desirable and point to evidence that increases are mainly among pollution-tolerant "scavenger" populations. They also point out that the Los Angeles Harbor report does not address a large number of potential adverse effects from the waste discharges, including increased fish disease, and increased accumulations of toxic compounds and metals already present in the harbor (from other discharges or caused by runoff).

It appears, then, that "bioenhancement" is a poorly understood and controversial concept. Additional, longer term, research by marine biologists is necessary in order to understand fully the effects of seafood waters enrichment of marine ecosystems. Current knowledge of this subject is incomplete and could not be effectively and safely incorporated into a waste management policy. A detailed review of the Los Angeles Harbor study is presented later.

B. Technology Assessments

Treatment Technology - Non-Alaskan

For non-Alaskan seafood processing facilities, applicable waste control technology includes modifications within the processing plant to reduce waste generation at the source and end-of-pipe treatment systems to remove solids from wastewater prior to discharge. Applicable end-of-pipe systems include simple screens for small non-mechanized facilities and relatively more elaborate dissolved air flotation systems for larger or mechanized facilities. Biological treatment systems, popular treatment for other types of food wastes, are not applicable for most seafood facilities for several reasons. First, these systems are best suited for digesting a continuous waste discharge; seafood operations are often intermittent which would require frequent, difficult start-up and shut-down of these systems. Second, biological systems typically require more land than is available at many seafood processing locations.

Treatment Technology - Alaskan

There are fewer feasible waste control technologies available for Alaskan processors than for processors in the contiguous states. Alaskan seafood processors are different from the non-Alaskan processors because of their geographic isolation, weather conditions, high construction and transportation costs and other factors. In-plant modifications with wastewater screening for solids removal provide a measure of waste control for Alaskan facilities.

A limited amount of experimental work has been done to evaluate the effectiveness of outfall diffuser systems and near-shore discharge systems as a means of effectively dispersing waste particles. Continued research on these systems may show them to be environmentally acceptable alternatives to end-of-pipe treatment in some areas.

Waste Utilization Technology - Non-Alaskan

Technologies are available to seafood processors in the contiguous states to utilize most waste solids in secondary products and by-products. The tuna industry currently manufactures a variety of products from wastes including pet foods, fish meal and oil. Other segments of the industry are less advanced in their production and marketing techniques. For a few large integrated processors, fish meal is a profitable and well-established by-product.

A problem persists regarding shellfish waste utilization. The only established by-product process applicable to these wastes (generated by wastewater screening) is drying for meal production. Shellfish meal is considerably lower in value than finfish meal and marketing the meal is often difficult. In fact, many shellfish meal plants are operating at a deficit. Consequently, major research and development is needed to develop chitin (a polysaccharide common to all shellfish) production as a feasible industry. In particular, the research and development should explore the potential uses of chitin and develop improved production techniques and markets for the product.

Waste Utilization Technology - Alaskan

Waste utilization technologies are less established in Alaska than in the contiguous states. EPA's analysis of prospective fish meal plants in Alaska shows that the majority of plants would be unprofitable if built. This is due to high construction and transportation costs in Alaska and to competition from alternative products.

Shellfish meal production is even less economically feasible in Alaska than in the contiguous states, due to higher production and transportation costs as well as the low value of this product. Chitin production, however, is potentially profitable in Alaska because of the enormous amount of shrimp and crab waste solids. Continued research in this area may eventually make large-scale production feasible.

Until a profitable by-product process is developed for Alaska, barging of wastes for deep water disposal remains the least expensive alternative in many areas for processors that operate wastewater screens to remove seafood solids.

CHAPTER III

ECOLOGICAL INVESTIGATIONS

1. STUDY OBJECTIVES AND METHODS

EPA initiated an assessment of the effects current waste disposal practices in the seafood processing industry have on marine waters. The assessment also includes a rather detailed examination of alternative technologies which could help reduce seafood waste discharges by utilizing nutrients present in the waste material. (See Chapter IV).

To this end, EPA's first obligation was to identify the effects attributable to the disposal of raw, untreated seafood waste discharges to marine or estuarine waters. Historical evidence indicates that these effects are usually site-specific; in light of this, EPA has also attempted to identify any factors governing the relative severity of the effects. Mitigating factors might range from something as elementary as the quantity of waste discharged, to the more complex relationship between the type and amount of waste discharged and the assimilative capacity of the surface water receiving the waste.

Because of the intricacy of the interrelationship among site-specific factors, EPA has not developed a set of criteria for management of the wastes. EPA has, however, developed a detailed and consistent methodology for measuring the ecological effects from the wastes. This methodology, as outlined in the following paragraphs, includes visual inspections, analyses of water quality and nutrient levels, analyses of sediment samples and benthic (bottom dwelling marine life) sampling.

A principal element of EPA's investigations was on-site inspection of waste disposal sites and practices to obtain first-hand information on excessive accumulations of waste solids or to make visual evaluations. Observations were made both on and below the surface.

Investigations also included an analysis of water and sediment quality. The water quality parameters monitored include dissolved oxygen concentrations, hydrogen sulfide levels, nutrient levels, temperature, and salinity. Similar tests were conducted on sediment samples. A deficiency in dissolved oxygen, i.e., the amount of oxygen present in water as a dissolved gas, is an historically accepted indication of accelerated biological activity (i.e., waste decomposition). Hydrogen sulfide is a toxic gas emitted as a result of the decomposing process in the absence of dissolved oxygen. Concurrent with the water quality investigations at each Alaskan site, sediment samples were analyzed to determine the presence of pathogenic bacteria growing in the accumulations of seafood waste.

Because of the short-term nature of the site investigations, the studies included sampling of the macrobenthic, or large, bottom-dwelling organisms in order to determine whether or not waste material was unduly taxing any species. Organisms of this sort are long-lived, permanent residents of an area and are particularly useful in short-term ecological studies. They can be employed as indicator species for a disturbed area because they tend to remain stationary, react to long-range environmental changes, and, by their presence or absence, generally reflect the biological health of local marine waters.

Section 74 specifies that EPA focus its study efforts on untreated seafood waste discharges. This most commonly occurs in Alaska; unlike seafood processors in the contiguous states, most Alaskan plants simply grind their wastes before discharging them into marine waters. A small number of processors in Alaska have installed equipment to capture solids for separate disposal. Following consultation with the seafood industry, three Alaskan sites, each having processors discharging untreated waste, were selected for investigation during the study. These sites, Dutch Harbor, Cordova, and Kenai (Figure 1) reflect a variety of circumstances and differ according to the type of seafood processed (shellfish versus finfish), number of plants discharging, quantity of wastes discharged, and types of marine life indigenous to outfall areas.

These sites also provided for an opportunity to assess hydrological conditions (tidal changes and current strength) which vary from active (Kenai), to moderate (Cordova), to negligible (Dutch Harbor). Hydrological activity (flushing action) is important chiefly as a means for waste dispersion, and may dictate the amount of waste an area assimilates. For example, a processing plant situated near water with active, highly mobile currents may discharge its waste and rely on the current to disseminate it, thereby minimizing localized effects. Another facility, located near water with little or no circulation or flushing action, may discharge waste in an amount equal to that of a facility near water with active currents and find that the weaker currents allow a harmful build-up of waste near the discharge point.

As an additional field investigation site, Yaquina Bay, Oregon was selected both for general comparisons with the Alaskan situation and to provide details applicable to the Pacific Northwest. All processors in Yaquina Bay have installed screens to remove most solids from processing effluents prior to discharge.

The field sampling information was further complemented by a literature review of historical studies, including earlier work on

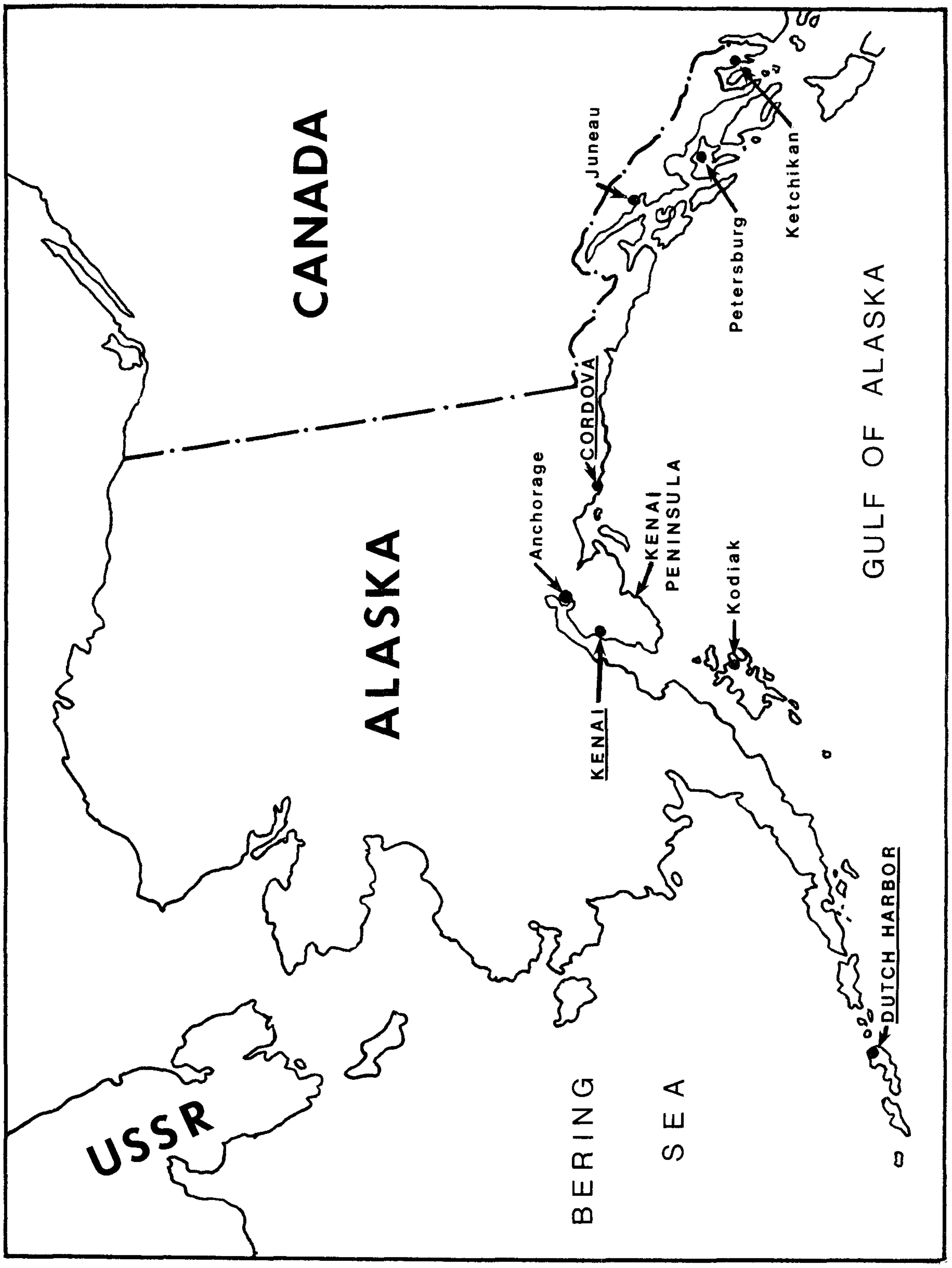

Figure 1. Location of Alaskan
Sampling and Study Sites.

Alaskan sites dealing with the effects of seafood wastes discharged into receiving waters.

In addition to the Alaska and Oregon studies, EPA has reviewed a long-term study which was conducted in Los Angeles Harbor by the University of Southern California. Also, a number of other processing areas have been visited, including New England, the mid-Atlantic and Southeastern states and the Gulf Coast. The objective of these visits was to identify and document waste generation and disposal practices and effects and any local or site specific problems and issues of concern (see Figure 2 and 3 and Table 1).

In summary, a rather wide range of locations and circumstances have been investigated. This gives reasonable assurance that entirely site specific conditions can be properly assessed as to relevance in general comparisons; general comparisons are made where similarities of commodity, waste controls, hydrology, etc., warrant.

2. BACKGROUND AND HISTORICAL STUDIES

The authors of the University of Alaska's report on Dutch Harbor, Alaska expressed considerable concern about the lack of background data on the condition of the water and benthic environment at the individual plant locations. Because much of EPA's Section 74 work is unprecedented (i.e., no background data exists), this concern proved exceedingly relevant to the situation which confronted EPA while conducting the Section 74 study. The Agency's objective in the ecological portion of the study has been to provide details about the ecological status of marine environments receiving raw, untreated, seafood processing wastes. The site studies described below should not be regarded as definitive and unchanging; rather, they should be viewed as indicators of existing conditions at waste disposal sites, and used to forecast the type of conditions likely to persist or worsen in the event that the discharge of untreated waste continues.

The following paragraphs summarize the limited number of studies conducted in the past to evaluate seafood waste discharge effects. Following this summary, section 3 presents the new studies conducted in response to Section 74.

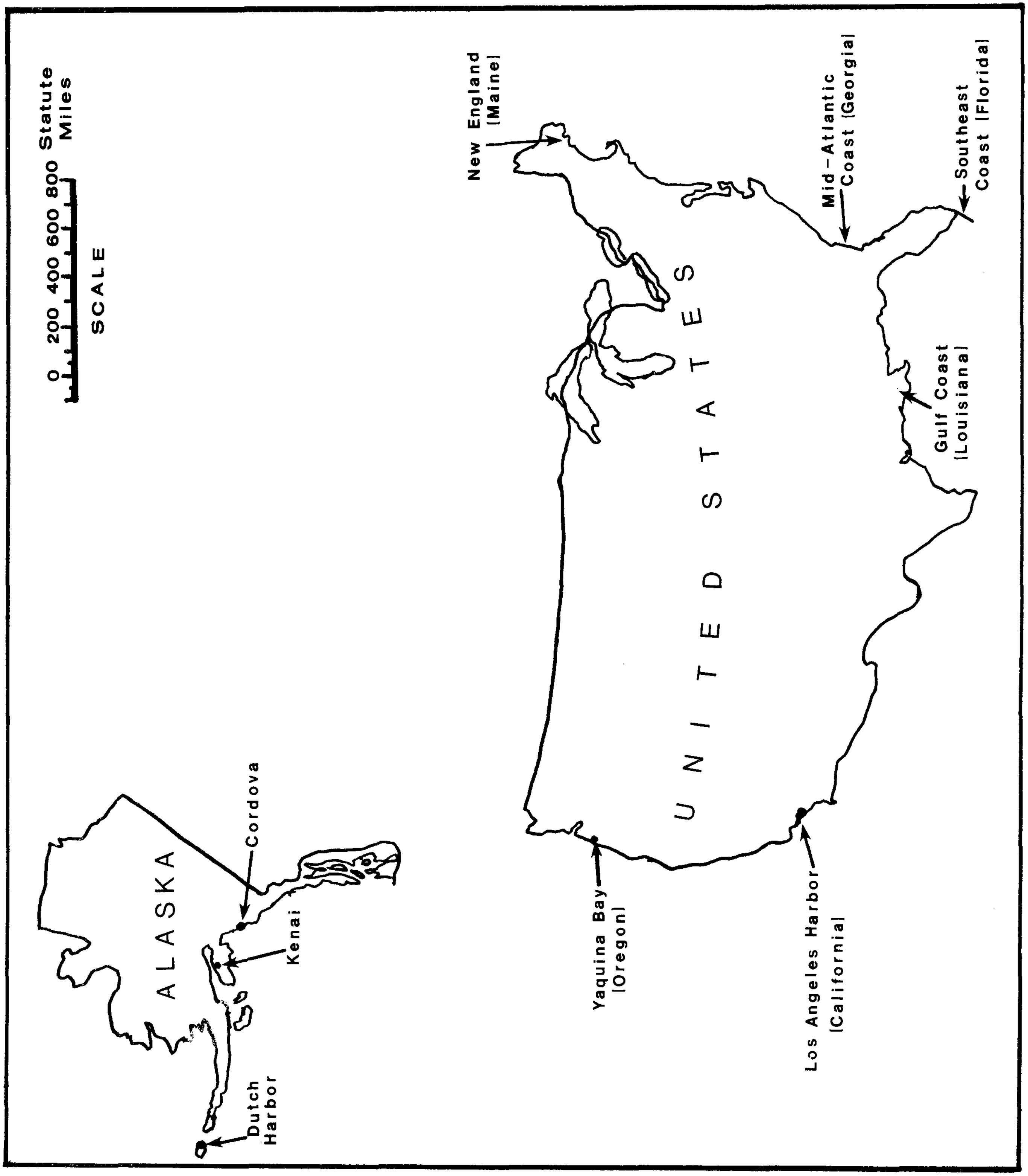

Figure 2. Map of the United States illustrating the geographic coverage of investigations for the Section 74 study.

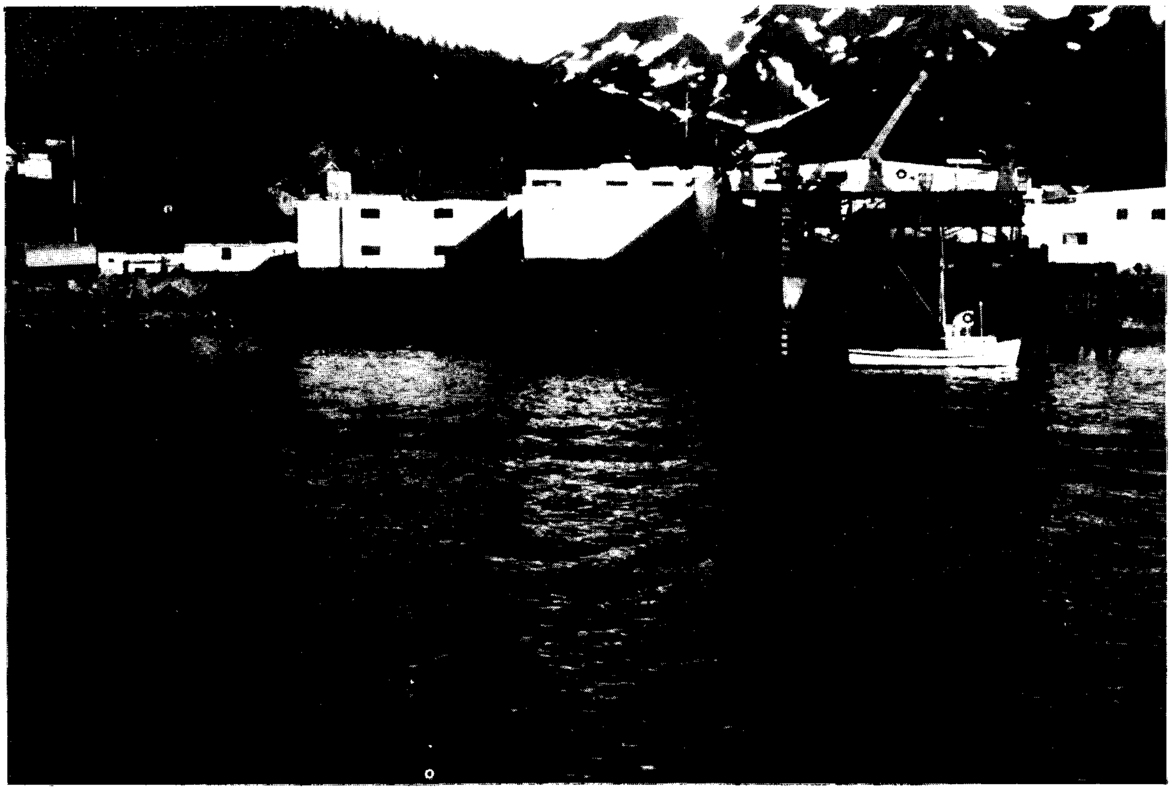

Figure 3: Typical development of dock processing operations in Alaska.

TABLE 1

GEOGRAPHICAL COVERAGE OF THE SECTION 74 SEAFOOD PROCESSING STUDY

Site Location	Type of Study	Authors	Appendix Reference
Dutch Harbor (Alaska)	Ecological-EPA Sponsored	University of Alaska	A-2
Kenai (Alaska)	Ecological-EPA Sponsored	SCS Engineers	B-1
Cordova (Alaska)	Ecological-EPA Sponsored	SCS Engineers	B-1
Yaquina Bay (Oregon)	Ecological-EPA Sponsored	EPA Corvallis Research Laboratory	C-1
Alaska	Pathogenic-EPA Sponsored	University of Alaska	D-1
Los Angeles Harbor	Ecological-Industry Sponsored	USC Harbors Enviromental Projects	E-1
New England (Maine)	Site Visit	EPA, Effluent Guidelines Division	F-5
Mid-Atlantic Coast (Georgia)	Site Visit	EPA, Effluent Guidelines Division	F-1
Southeast Coast (Florida)	Site Visit	EPA, Effluent Guidelines Division	F-4
Gulf Coast (Louisiana)	Site Visit	EPA, Effluent Guidelines Division	F-3

A. Dutch Harbor

Because of the volume of processing activity, its relatively confined receiving waters, and its potential to exhibit ecological instability, Dutch Harbor is a site frequently chosen for environmental investigations. Unlike most major seafood processing areas, for which little historical data exists, a substantial amount of data, describing Dutch Harbor's topography and water quality, is available.

Researchers from the University of Alaska conducted the first such study in 1968. Their efforts were directed toward determining how and to what extent the decaying of organic seafood processing wastes has affected the quality of receiving waters. For purposes of comparison, they sampled nearby water not receiving waste effluent, and found it was typical of unenriched seawater. But water taken from Iliuliuk Bay and Harbor (see Figure 4), nearer to the outfall points, had high ammonia concentrations (a product of protein decomposition) and/or low dissolved oxygen concentrations. (Dissolved oxygen is consumed in the decomposition process.) Both symptoms were believed to be a result of the seafood waste build-up and can be hazardous to marine life.[1]

The first time EPA conducted research in the Dutch Harbor areas was in 1975 when researchers from Region X conducted a water quality survey in response to the post-1970 escalation in processing activity. Data were gathered in this effort to provide a foundation for future comparison. Another more comprehensive study was scheduled for October 1976. Together, these investigations would serve as a basis for assessing the processors' compliance status with National Pollutant Discharge Elimination System (NPDES) permit requirements.

According to the combined studies, Dutch Harbor's water quality was generally poor. Low dissolved oxygen concentrations, along with high ammonia and phosphorous concentrations, were pervasive. In some areas, large waste accumulations were observed. Researchers believed that these waste accumulations were responsible for the low dissolved oxygen and high ammonia and phosphorous condition. They concluded that the waste had amassed because tidal currents in the enclosed portion of the harbor, where several outfalls are located, were insufficient to disperse the waste.[2]

In 1977, EPA again conducted a water quality survey in Dutch Harbor. This study was designed to gain more information about changes in shellfish waste accumulations from one processing season to the next. Researchers set out to measure hydrogen sulfide levels, a toxic by-product of waste decomposition, in both aging and recent shell deposits.[3]

For the most part, researchers found waste accumulation still greatly exceeded the rate of dispersion or decomposition. In certain cases, sludge beds were creating adverse conditions for marine life.

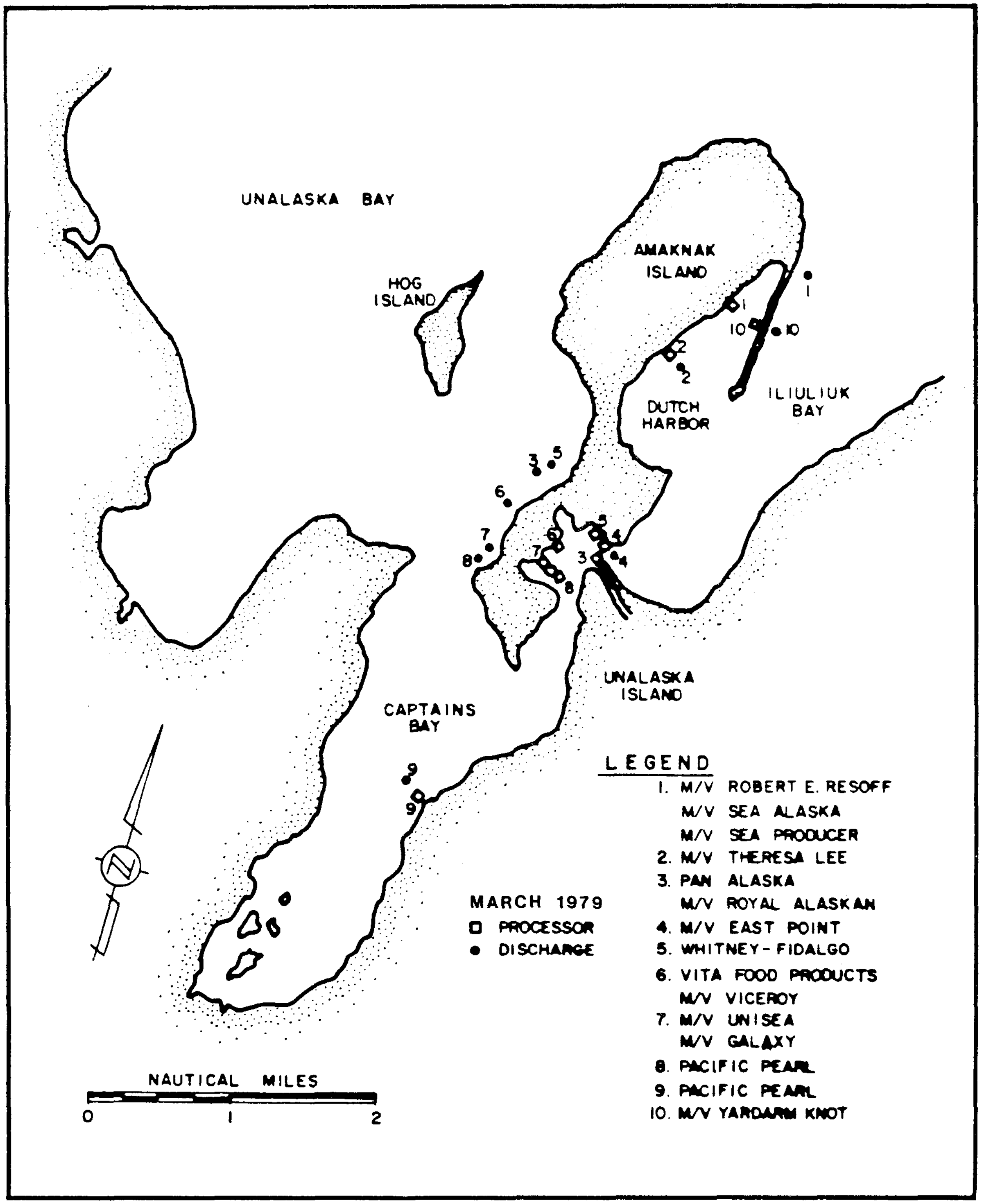

Figure 4. Location of Seafood processors in Dutch Harbor, Alaska.

Shellfish waste deposits were most prominent within a 30-meter radius of the discharge site. In this area, the waste smothered all immobile organisms; in other areas, shallower deposits had equally adverse effects on clams. Hydrogen sulfide levels greatly exceeded the concentration reported to constitute a hazard for aquatic life (Figure 5).

Also in 1977, researchers from the University of Alaska returned to Dutch Harbor under the auspices of the Association of Pacific Fisheries, this time to conduct a hydrographic survey. In addition to evaluating water quality, the hydrographic study was designed to record the area's physical characteristics (i.e. high and low water marks, bottom composition, and current speed) so that some determination could be made regarding the suitability of the area between Hog and Amaknak Islands as a location for a waste outfall.[4]

After considering current speed and direction, along with other relevant data, the researchers concluded that the northern portion of the channel between Hog and Amaknak Islands would be a more satisfactory location for an outfall than those presently in use along the shore. They suggested as another alternative a deep water (42 foot) discharge disposal site near the northeast side of Amaknak Island (Figure 4).

In response to growing evidence and concerns about waste accumulations from EPA Region X, Dutch Harbor crab processors engaged Brown and Caldwell Consulting Engineers in 1978 to explore the feasibility of shore area waste outfall/diffuser systems. It was felt that these systems would effectively eliminate any massive buildup of shells. Such systems were purported to provide for better, more efficient waste dispersion by exploiting wind and wave activity.

In their exploration of waste disposal alternatives, Brown and Caldwell postulated that an outfall/diffuser system in the shore area off the west and northeast sides of Amaknak Island would be a promising solution. Observations of the area revealed strong, active currents necessary for dispersing significant amounts of waste. Although their study concluded that it remained uncertain whether dispersal sufficient to meet NPDES requirements could be achieved, they recommended that a test system be constructed.[5]

In 1979, Brown and Caldwell continued in their investigation of alternative disposal systems in Dutch Harbor. Principal among their undertakings was the operation of an outfall/diffuser test system on the west side of Amaknak Island. The report indicates that this method is promising as a disposal option.

All of Brown and Caldwell's work, while addressing the importance of site-specific factors, emphasize shore outfall/diffuser systems, properly located in turbulent waters, as the most desirable of waste

Figure 5: Photograph of bottom sample taken from Dutch Harbor, Alaska, showing bubbles of noxious gases evolving from decaying sludge and absence of benthic life.

disposal alternatives for the Dutch Harbor region. Furthermore, they recommend that waste be ground to one-quarter-inch particles and that existing outfalls be modified and, where possible, relocated to maximize waste dispersal.

Brown and Caldwell considered two other means of waste disposal: barging and deepwater discharge from fishing vessels. In both cases, the waste material must be screened and loaded for disposal in deep water (42+ feet), away from shore areas. Either of these methods would prevent shore build-ups, but there may be some problems inherent in each. In the case of barging, seafood processors would be required to operate a tug and barge or dump scow. Discharge from fishing vessels eliminates the expenses associated with barging, but this study indicates that storage difficulties and fishermen's resistance make this alternative less attractive.[6]

B. Other Alaskan Sites

In the last ten years, both EPA and the seafood processing industry have funded several studies which focus on the effects of untreated waste disposal in Alaska. Collectively, these studies support the contention that the severity of any one site's waste disposal problem depends primarily on the amount of processing activity in the area, and on the flushing capacity of the receiving waters.

In 1970, the Fisheries Research Institute (FRI) of the University of Washington (Seattle) performed a preliminary ecological survey of Bristol Bay and Kodiak Island, Alaska. This was done after the northwest canning industry expressed concern over the effects of salmon processing waste discharges on receiving waters in the northwest.

The FRI study indicated that, though there were temporal depressions in dissolved oxygen concentrations, waste from processors had no serious or significant effect on marine organisms. The study noted further that these dissolved oxygen depressions were confined to the discharge area and were eliminated by a twice-daily flushing from the tides. Similar results at seven processing sites in British Columbia were also reported.[7]

In 1971 EPA Region X reported on the problem created by seafood processors' waste discharged in Kodiak Harbor, St. Paul Harbor, and Gibson Cove, Alaska. These three embayments, in an area having the highest concentration of seafood processing in the state, receive waste from 15 processing plants in or near the city of Kodiak on Kodiak Island. In this study, EPA researchers found that the waste had exerted a substantial negative effect on the water quality so that they believed these conditions might upset the ecological balance or pose a severe threat to marine life. Additionally, they noted a massive accumulation of waste on the bottom. They estimated that these sludge-like deposits covered 52 acres. Samples of bottom sediment near processor outfalls contained no benthic life, while those collected away from the outfall areas did.[8] Figure 6 is a photograph of salmon waste dredged from the bottom in the vicinity of a salmon cannery outfall at Port Bailey, Kodiak Island, Alaska.

In 1971, the National Canners Association and Petersburg Fisheries funded a study to evaluate any impacts resulting from waste disposal in Petersburg, Alaska. Essentially, the findings indicated that processors' wastes did not have a major effect on water quality during this particular time; dissolved oxygen concentrations were standard. Scavenging fish and birds fed heavily on waste. Other data showed that the remainder of the waste was eventually dispersed by the currents.[9]

In contrast, laboratory studies by Nakatani and Beyer, assessing the effects of salmon processing waste effluent on juvenile salmon, indicated that a prolonged exposure could prove fatal. Approximately 20 hours of exposure to diluted waste effluent solutions were enough to result in fatalities.[10]

3. EPA SECTION 74 STUDIES

A. Dutch Harbor

Of the several sites sampled by EPA during the Section 74 study, Dutch Harbor exhibited conditions which were substantially worse than any of the others. University of Alaska scientists, who were conducting the study, again found that "processing wastes are accumulating adjacent to outfalls off Amaknak Island, and existing water currents do not provide sufficient energy for adequate dispersal of wastes" (Appendix A-2, page 8). Here, the wastes place an inordinate demand on the oxygen supply, and overload the ecological system. Essentially, the decaying, undispersed wastes absorb oxygen from the water, making it difficult, if not impossible, for indigenous marine life to survive.

Researchers also found during their study that waters in some areas of Dutch Harbor and Iliuliuk Bay may have a tendency "to go anoxic" (lose dissolved oxygen) naturally in the fall months, because of little flushing action for most of the summer. Overloading the system with processing waste only accelerates and prolongs this condition. The stress from processing waste discharges severely reduces the number of species in this area. Those organisms not killed by the lack of oxygen may be smothered by fresh processing waste; the weak currents cannot transport the decaying material sufficiently to prevent serious, harmful accumulations.

Sediment samples and televised underwater observations revealed that Dutch Harbor and Iliuliuk Bay, along with the area immediately adjacent to processors' outfalls on the opposite side of Amaknak

Figure 6: Salmon waste dredged from the bottom in the vicinity of a salmon cannery outfall, Port Baily, Kodiak Island, Alaska.

Island, were the most severely affected by seafood processing waste disposal. Sediment in the Dutch Harbor/Iliuliuk Bay Basin was gray to black in color, and emitted a strong sulfide odor. Sediment at sampling stations near processors' outfalls was composed entirely of processing waste in various stages of decomposition.

Sulfide concentration was greatest in an area located within the old shellfish disposal area of several years ago (Station DUT 01A) (Figure 7). The ten bottom-dwelling organisms present here were primarily stress-tolerant polychaete worms. High sulfide concentrations were common throughout Dutch Harbor and Iliuliuk Bay, and also along the shore outfalls on the opposite side of Amaknak Island.

In summary, adverse impacts from seafood processing discharges were found in both the current disposal areas and in the old disposal sites which have not been used for several years. It appears that ecological damage to this region might be long-term because the wastes are accumulating year-to-year and winter storms and tides are insufficient to remove these wastes.

The University of Alaska scientists recommend that studies in this area be continued to develop a more precise picture of the waste impacts on the marine ecosystems. At the same time, this report expresses concern that continued discharge of wastes will cause added degradation and will eventually "...cover much of the nearshore bottom with serious sanitary and ecological problems to be expected." These scientists go on to recommend that "current seafood disposal practices be improved so that gross solids are either removed or dispersed by discharging effluent into areas of well-mixed waters" (Appendix A).

B. Cordova

EPA's study of the Cordova processing area (Figure 8) marked the first such effort. Much like the Dutch Harbor study, the Cordova study was designed to identify important site-specific factors which determine the nature of ecological impacts resulting from untreated waste discharges from seafood processing operations.

Seafood processing at Cordova is less extensive than at Dutch Harbor. Four processors (Dutch Harbor has 15) discharge their waste, principally ground shells and fish parts, into Orca Inlet. Current movement in the inlet, while greater than Dutch Harbor's, is insufficient at two discharge sites to disperse waste adequately (Figure 9).

Researchers found surface discoloration and floating debris near two processors' docks. At one, where floating debris was excessive, it appeared that whole crab shells and appendages had been dumped from the dock. At the other, a white-yellow discoloration on the surface

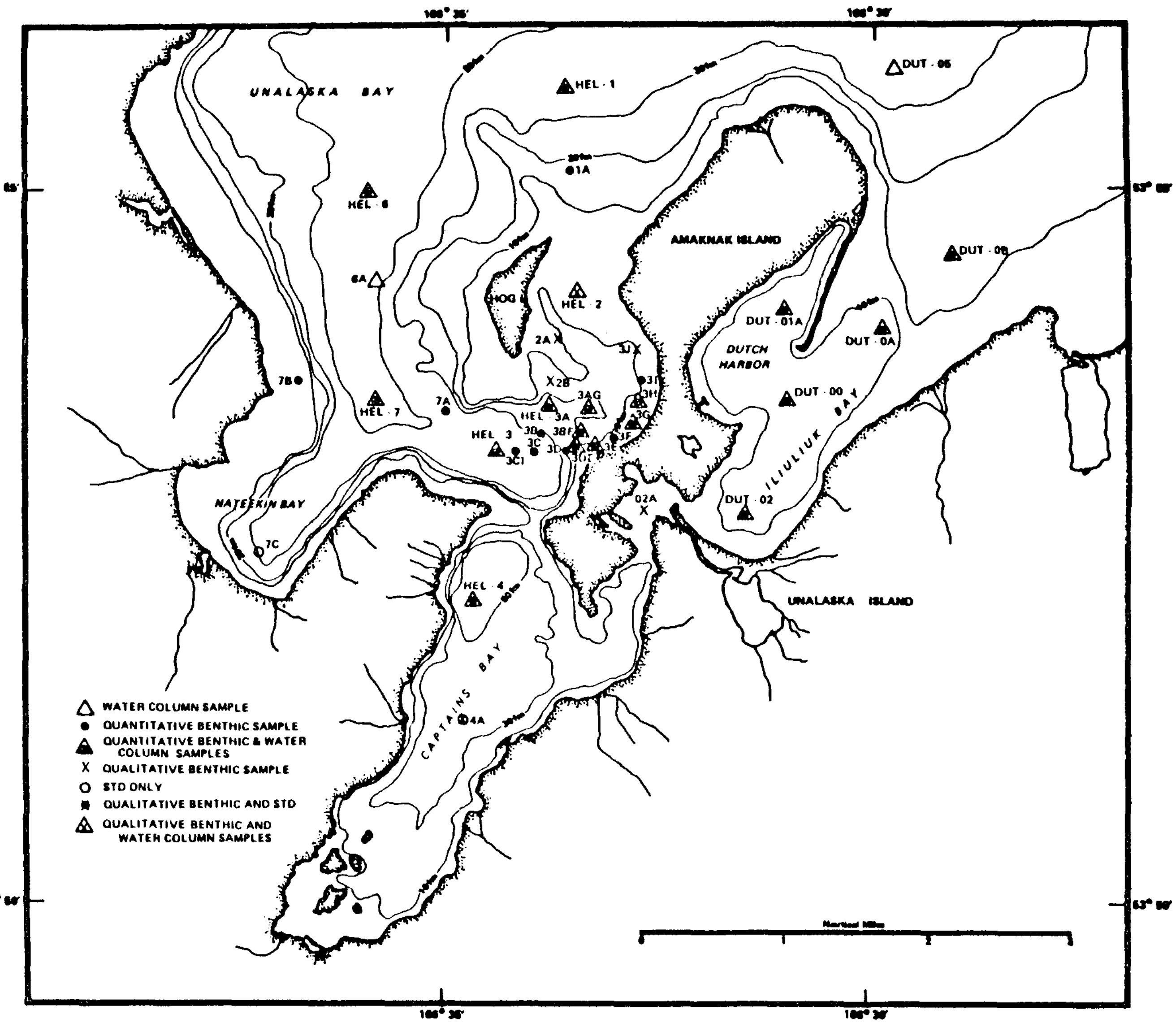

Figure 7. Hydrographic water chemistry, sedimentological and biological sampling grid in Dutch Harbor, Alaska.

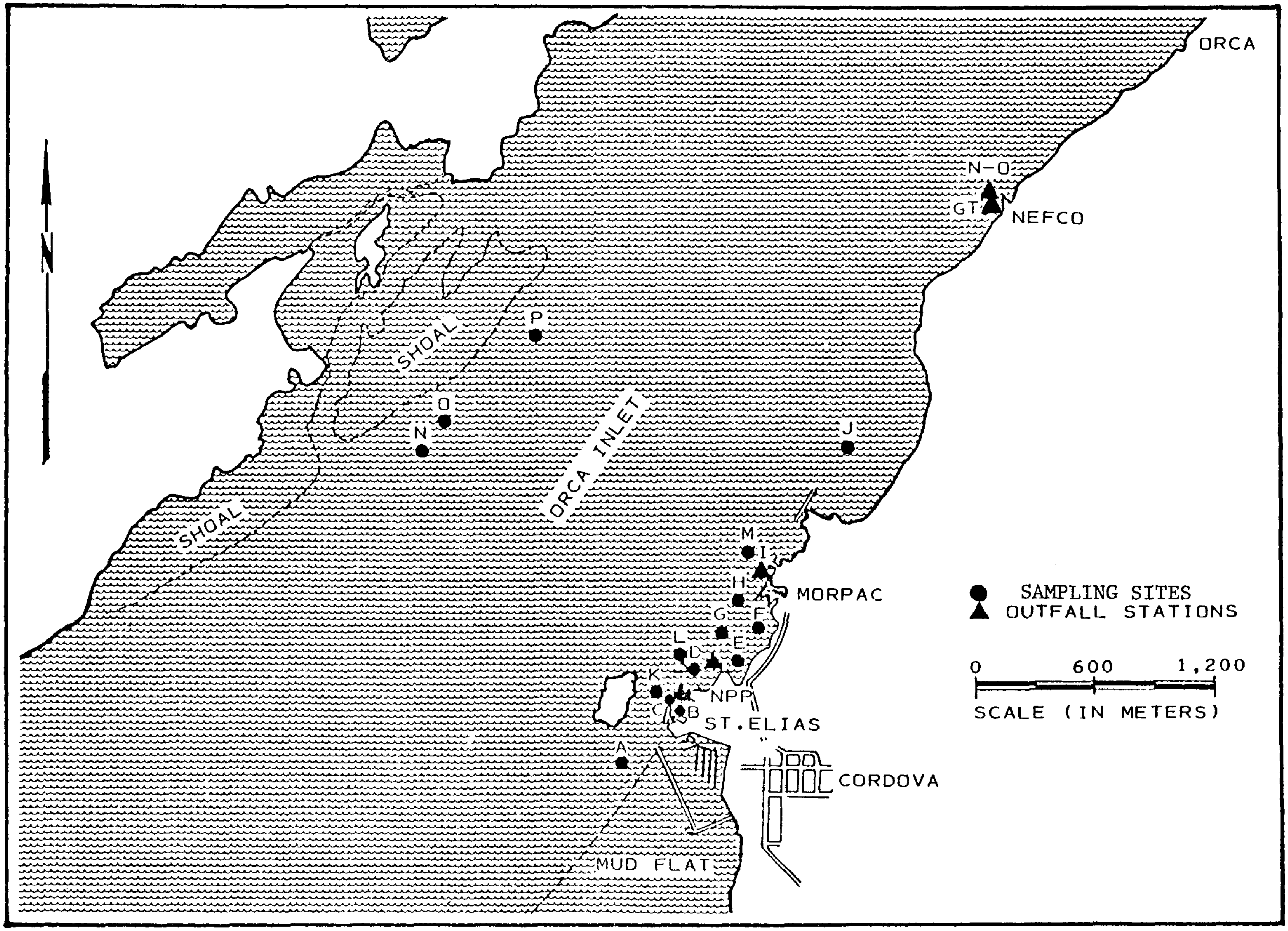

Figure 8. Location of sampling sites
at Cordova, Alaska.

Figure 9: Accumulations of whole fish parts taken from bottom of Orca Inlet, Cordova, Alaska.

water resulted from intermittent cannery discharges. Patches of floating debris had drifted over 45 meters from the discharge point.

Underwater photography revealed a waste accumulation directly beneath one processor's docks. All crab wastes had apparently been dumped from the dock (Figure 10). The wastes extended out from the dock in a semicircle for a distance of five meters. Piles of waste were found up to 25 to 30 centimeters (10 to 12 inches) deep. Several fish heads and crab shells were observed near one cannery outfall.

At another outfall waste discharges had cut a trough in the bottom of the harbor approximately three meters wide and six meters long. Because of the considerable amount of debris in it, its depth could not be determined, though divers estimated it to be one meter. Ninety percent of the waste appeared to be crab exoskeletons; the remainder fish tails and heads (Figure 11).

In comparison to the waste previously noted, processing waste at a third outfall was more finely ground and evenly distributed. Waste was restricted to a circular area extending 12 to 16 meters from the discharge point. No distinct piles were observed.

Bottom films of two outfall areas near the fourth processor, who was not operating during the study (1978), showed no evidence of any accumulation from past years.

Despite accumulations of waste in some areas, chiefly as a result of waste being dumped from processors' docks, Cordova's water quality was generally healthy. No test stations exhibited depressed dissolved oxygen concentrations; the benthic community(bottom dwelling marine life) generally showed signs of being stable and diverse, except for localized areas near discharge sites.

In a related bacteriological investigation of crab waste in Alaskan waters, University of Alaska scientists isolated <u>Vibrio anguillarum</u>, a pathogenic strain of bacterium common in intestinal tracts of fish, from a Cordova sample. <u>Vibrio anguillarum</u> is discharged into waters with waste material and is nourished by the waste in waters where temperature exceeds 10°C. Researchers noted that, "current disposal practices, in light of the growth of <u>Vibrio anguillarum</u> under these conditions, may be assumed to create hazards to fish and susceptible marine fauna" (Appendix D-2, page 2).

C. Kenai

The Kenai study, like the one at Cordova, was a first-time undertaking. In examining the Kenai area, the intent was to observe the effects of waste discharges on a marine environment different from the other two Alaskan sites (i.e., Dutch Harbor and Cordova) in terms of processing operations and hydrological conditions. Unlike these

Figure 10: Accumulation of crab shells, Cordova, Alaska.

Figure 11: Salmon & crab waste below processing facility, Cordova, Alaska.

other processing sites, the four processors at Kenai are several hundred meters apart and discharge into fast-moving waters (Figure 12).

Generally, tests showed water quality in this area to be unaffected by processing waste discharges. Surface dissolved oxygen values at all sampling stations were at or near saturation. Among the selected indicators, only salinity varied substantially and this variation was linked to changes in tidal and current flow.

Researchers did observe some water discolorations and waste accumulations at one processor's two outfalls. In one instance, this was because waste was discharged above the low-water level (Figures 13 and 14); in the other, the processor was simply discharging waste beneath the plants' dock. In both cases, the combination of current movement and tidal fluctuation flushed the river sufficiently each day to disperse these deposits.

Nutrient concentrations in the Kenai River were very low; variations among them were negligible and, in many cases, the concentration of several nutrients was below minimum detection levels.

The benthic community here was poorly developed; however, waste discharges were apparently not responsible for this. Researchers concluded that sediment type, tidal scourings, and salinity fluctuations are factors which, most likely, have influenced the sparse development of aquatic organisms.

The U.S. Fish and Wildlife Service, in pointing out possible shortcomings of both the Kenai and Cordova investigations, believed the studies were too brief and localized to formulate definite conclusions. They suggested that long-term ecological trends, away from discharge sites, need to be monitored before ultimate conclusions can be drawn. They warned further that an escalation in processing activity may result in increased ecological impact, and cautioned against ignoring the effects of industry expansion (Appendix B-4).

D. Yaquina Bay

As part of the Section 74 study, EPA initiated an investigation of the biological, sediment, and water conditions near processor outfalls in Yaquina Bay, Oregon (Figure 15). Processing operations in this area are substantially similar to those in Alaska except that these processors all employ screens to remove solids from waste effluent before discharge. In a broad sense, this study was intended to provide a comparison between the Alaskan sites which receive untreated waste, and waters which receive a screened or treated effluent.

For the most part, researchers found that processing effluent effects on water and sediment quality in Yaquina Bay were restricted to the

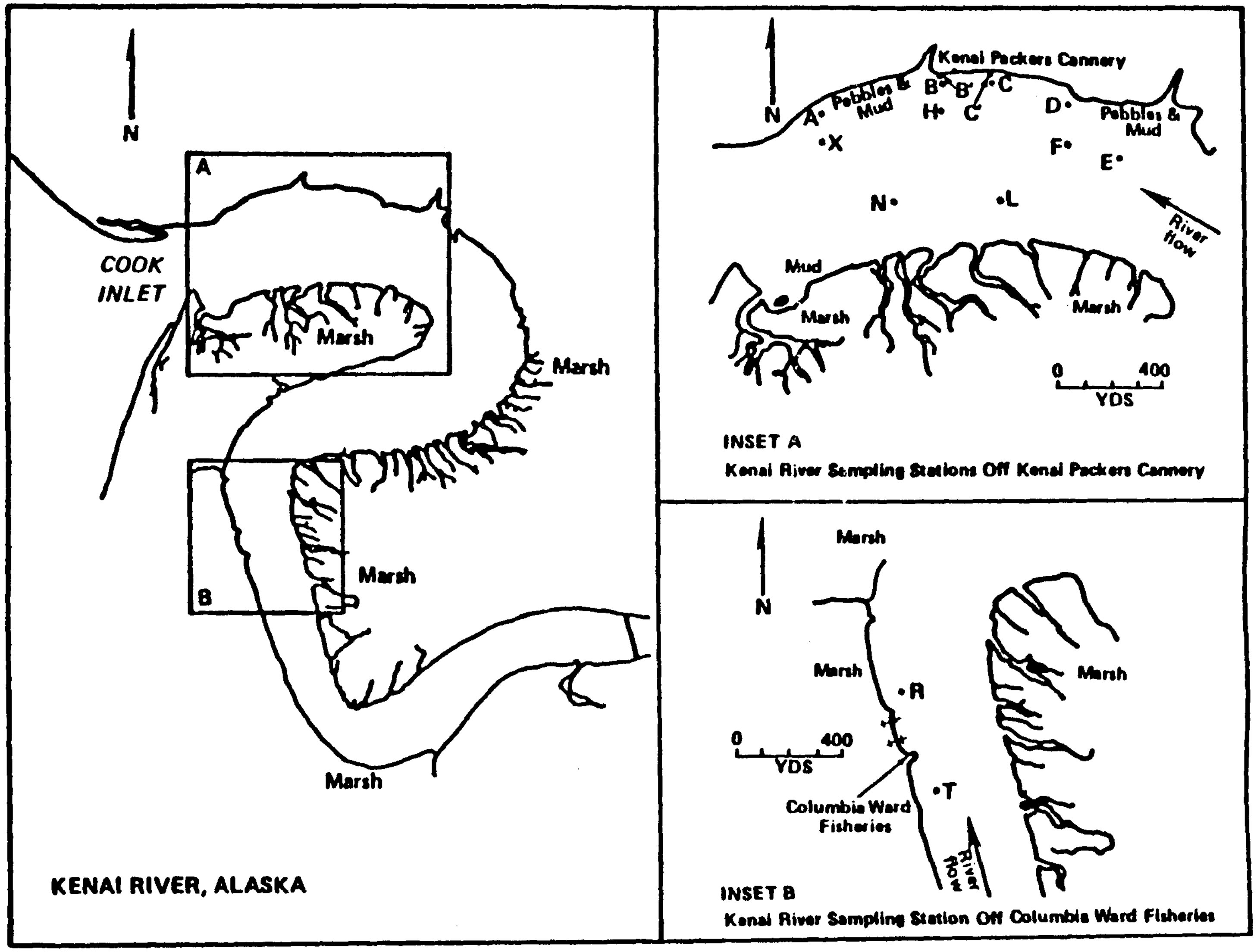

Figure 12. Location of sampling sites
in the vicinity of the Kenai River, Alaska.

Figure 13: Evidence of Seafood waste accumulations near seafood processor's outfall, Kenai, Alaska.

Figure 14: Accumulation of whole fish parts on Kenai River bank immediately downstream from cannery outfall.

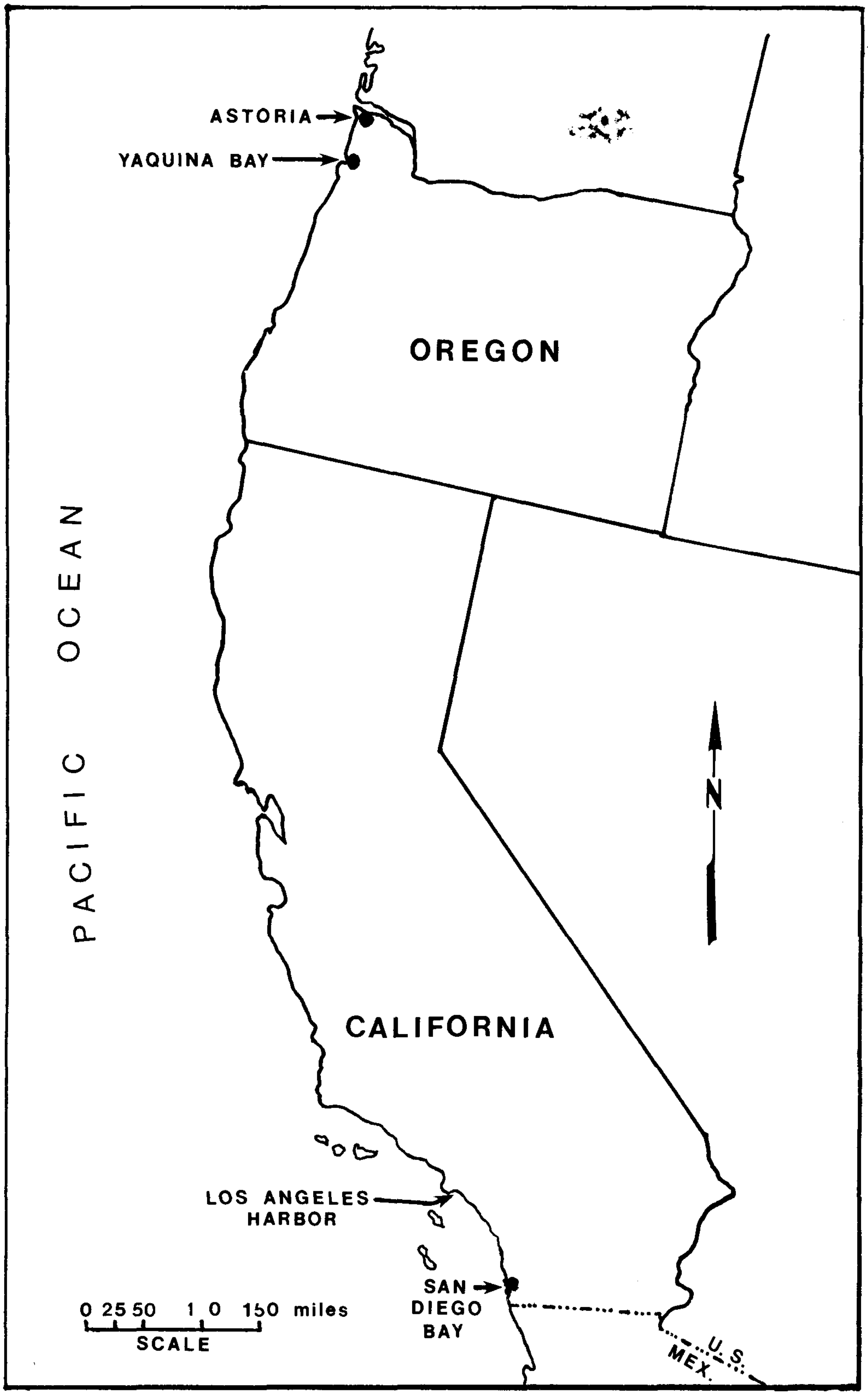

Figure 15. Map of West Coast United States sampling and study sites.

immediate vicinity of processors' docks. The effluent plume was quite turbid and contained high nutrient concentrations. Because of its initial low salinity, the effluent remains on the receiving water's surface where it mixes rapidly with estuarine water and is dispersed by strong tidal currents. The quality of water at the bottom along the immediate outfall areas was similar to that of other areas in the bay. Dissolved oxygen concentrations at both the surface and the bottom approached, in all cases, saturation.

In this area researchers found a diverse and abundant benthic community, the presence of which they attributed to screening practices and rapid current movement. The rapidly flowing current did not allow larger, incidentally unfiltered waste particles to amass on the bottom and smother benthic life. Television observations and dredged samples confirmed the effectiveness of wastewater screening in this area, and they revealed no accumulations of shells or other waste material.

Researchers also noted that their findings in Yaquina Bay resembled those of Beyer, Nakatani and Staude (1975) during a study of environmental conditions near salmon processors' outfalls in Petersburg, Alaska.[11] Dissolved oxygen concentrations were close to ambient values; turbidity was high in the immediate outfall area. The chief difference between the two areas was that Petersburg effluents were unscreened, and their discharge produced temporary accumulations of fish parts.

To an extent, current movement mitigated the effects of waste build-up in the Petersburg area; but at the opposite extreme, in cases where solid waste is discharged into confined waters, the effects can be disastrous for benthic life. In a 1959 study of Los Angeles Harbor and Newport Bay, California, where waters are relatively quiescent, Reish[12] and Barnard and Reish[13] found that <u>Capitella capitata</u>, a widely recognized pollution indicator species, accounted for 90 percent of the benthic population. In the Yaquina Bay study, <u>Capitella capitata</u> comprised only 7 percent of species' population, which led researchers to conclude that no "significant ecological alteration is indicated by the presence of an opportunistic species in the midst of such an abundance and variety of other benthic invertebrates" (Appendix C-1).

Although pelagic (i.e., migratory) species were found in the vicinity of processors' outfalls, their presence does not indicate that waste discharges are an integral part of the food chain. Aside from the fact that the Yaquina Bay study was a short-term one, during which EPA did not monitor species' movement, EPA recognizes that as a transient species, the fish feeding near the discharge area would likely feed elsewhere should the attractant cease being available.

E. Pathogenic Bacteria Study

In conjunction with Section 74 studies at Dutch Harbor, Cordova, and Kenai, University of Alaska scientists attempted to isolate pathogenic bacteria of the genus Vibrio from sediment samples obtained at processing waste disposal sites. They also attempted to determine whether or not certain pathogenic bacteria would utilize crab waste as a nutrient source in sea water with temperatures approximating those found at the disposal sites.

Temperature and nutrient availability are the chief factors which either permit or prohibit bacteria growth. Vibrio parahemolyticus could use crab meal as a nutrient source, producing growth at 25° and 37°C, but not at 5° or 10°C. It does not appear to be a health hazard in receiving waters where temperature remains below 10°C. As mentioned previously, Vibrio anguillarum, a similar parasitic strain, was isolated from one Cordova sample. It appears capable of feeding on crab meal and propagating at 5°C.

The researchers note that current disposal practices may lead to hazards to fish and other fauna which may be vulnerable to Vibrio.

4. LOS ANGELES HARBOR STUDY

Four fish canneries located in Terminal Island, California for many years have discharged wastewater to Los Angeles Harbor. These discharges have been associated with water quality problems in this area. State and Federal efforts to clean up the harbor have resulted in progressive improvements in waste treatment by the canners. Prior to 1974, the canners practiced only minimal waste treatment. During the period from January 1974 to September 1975, the canners installed dissolved air flotation (DAF) systems to provide primary treatment and in 1978 the cannery effluents were diverted to the newly completed Terminal Island Treatment Plant (TITP) which provided secondary treatment of the wastes.

The corpus of material currently referred to as the "Los Angeles Harbor Study" has an extensive and somewhat complex history. The University of Southern California Harbors Environmental Projects (HEP) has been conducting studies of the Harbor since 1971. These studies began as an attempt to develop a baseline inventory of the biology of the Los Angeles Harbor area (Figure 16) and have been supported over the years by a variety of sources, including the tuna industry, the City of Los Angeles and the U.S. Office of Sea Grant Programs.

The HEP work has resulted in two different study documents submitted to EPA concerning the effects of seafood processing discharges to the Harbor. The first, entitled "Marine Studies of San Pedro, California, Part 12, December 1976," was submitted in 1976 in support of the tuna industry's application for an exception to the requirements of the

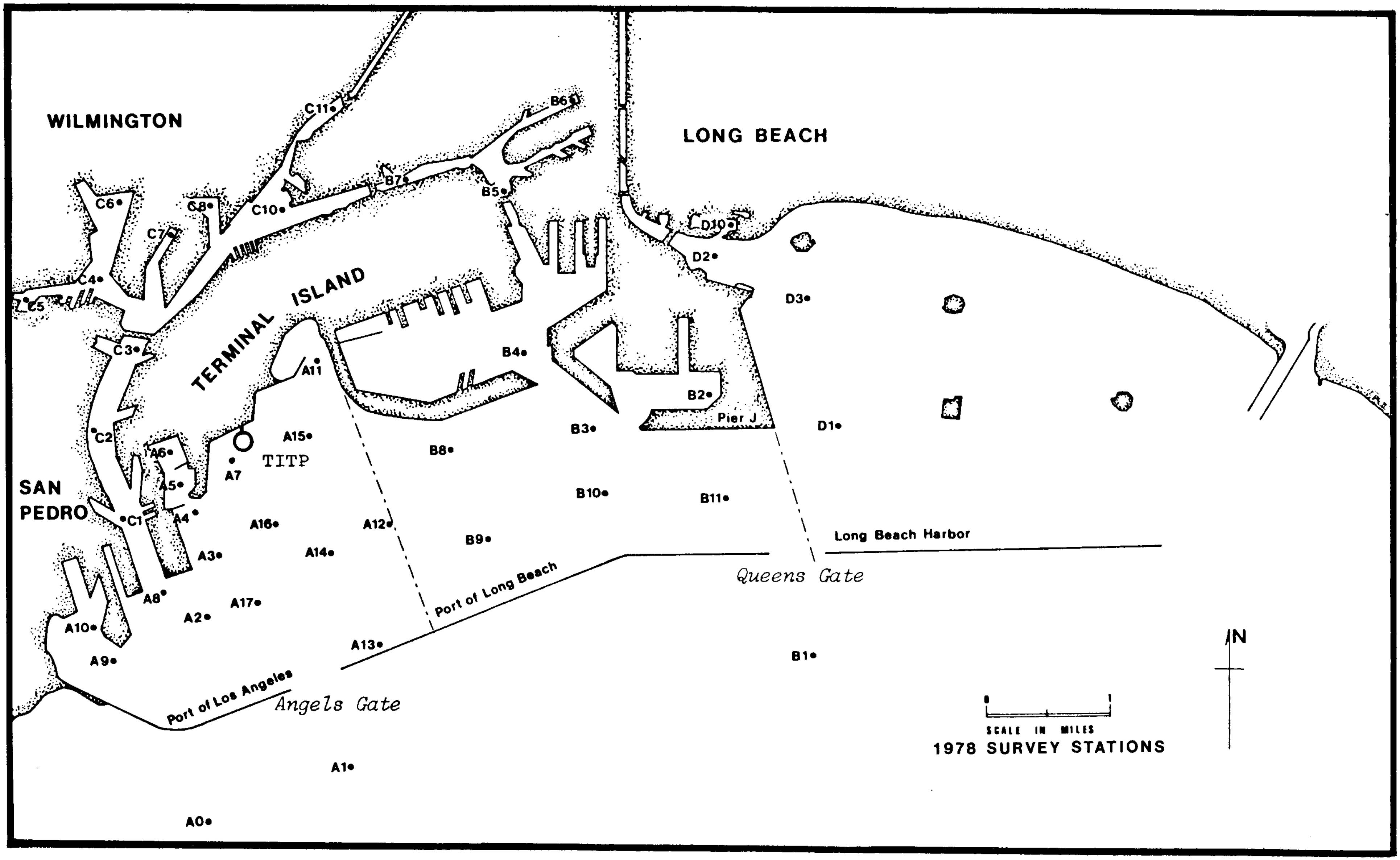

Figure 16. Location of Survey Stations in the 1978 Los Angeles Harbor Study.

California Bays and Estuaries Policy. The second document, "Ecological Changes in Outer Los Angeles-Long Beach Harbors Following Initiation of Secondary Waste Treatment and Cessation of Fish Cannery Waste Effluent" (also known as Part 16 of the Marine Studies of San Pedro Bay) was submitted to EPA in 1979 to be evaluated as part of the seafood study conducted under Section 74. These two, Part 12 and Part 16, documents are discussed separately below.

A. The Part 12 Study

The Part 12 study was completed by HEP in 1976 and was submitted to EPA by the Terminal Island canners in support of their application for exemption from the requirements of the California Bays and Estuaries Policy (BEP). The BEP is an approved State/Federal Water Quality Standard, pursuant to Section 303 of the Clean Water Act, and provides that all municipal and process wastewater discharges "shall be phased out at the earliest practicable date," unless it can be shown that a discharge is non-toxic and "enhances" the quality of the receiving water. Unfortunately, a definition of "enhancement" of receiving waters was not specified by the BEP. Toxicity test criteria are specified and require that undiluted wastewaters be used in 96-hour bioassay tests using standard test species, resulting in a specified percent survival rate for the test species individuals. In summary, the BEP sets forth two criteria (enhancement and non-toxicity) which must be met to permit continued discharge of wastewaters.

The Part 12 document, which was reviewed in the context of the BEP provisions, was the result of work by various HEP personnel over the period from 1971 to 1976. This document consisted of seven separate papers tied together by a summary. The research areas covered by the papers included feeding habits of marine organisms, species population studies, measurements of proteins and amino acid levels in the Harbor, mathematical modeling of dissolved oxygen (DO) levels in the water and toxicity bioassays.

The investigators proposed the term "bioenhancement" as a measure of the enhanced biological quality of receiving waters. Although the study did not formally define this term, the investigators assumed that any increase in biomass is improvement and measure "total biomass" as an indicator of bioenhancement. The basic premises of bioenhancement are that the cannery process wastes (characterized as high in BOD, proteinaceous suspended solids and oil and grease) provide nutrients necessary to the sustenance of a large fish population in the harbor.

The general consensus of the various papers in the study was that the Harbor could be divided into three zones of biological activity:

1) The area immediately in contact with the effluent discharge (the "zone of mortality"); this area showed low biological diversity and

productivity, high BOD and low DO. It was in this area that the effluents showed greatest toxicity.

2) The area where the effluents had been more thoroughly mixed; this area was an area of higher population value and a greater species diversity than the first. This "zone of bioenhancement" was attributed to the nutrients from the waste.

3) The outer area of the harbor which was less directly affected by the effluent loading in the harbor due to the greater proportional mix of water to effluent. Population values in this area were in the mid-range of those in the other two areas.

The authors of the study contended that the installation of DAF treatment systems by the canneries (in 1974) had sufficiently reduced the loadings of oxygen-demanding wastes to ensure that the massive fish kills that had happened in previous years would no longer occur. Further, the authors contended that, through the use of the study's dissolved oxygen model, the amounts of oxygen-demanding wastes could be optimized to allow maximum bioenhancement without adverse results.

Review by EPA

This study was determined in 1977 by EPA to be insufficient to support a finding of enhancement of the Harbor by the DAF-treated effluents. The document was reviewed by a variety of EPA personnel which concerns are delineated below:

1) Methodology and Approach

The study presented no baseline data concerning the Harbor water quality and species characteristics before commencement of the discharges. Without such data for comparison purposes, there was no basis to conclude that the Harbor had been enhanced by the discharges. The reviewers felt that the baseline data problem could have been mitigated to some extent through the use of control data collected at a nearby unpolluted site, rather than rely on data from outside the Harbor breakwaters where there was little similarity to the interior of the Harbor in terms of hydrographic conditions and indigenous species.

2) The Bioenhancement Conclusion

The authors of the summary for the Part 12 document concluded that the harbor (in 1976) was in a state of bioenhancement because of the cannery effluents. However, this strong conclusion contrasted with the tentative results presented by the various authors of the seven individual study papers who were more cautious and whose statments of results frequently contained such qualifiers as "appears to", "maybe", and "perhaps." In addition, the assumption that an increase in biomass is beneficial must include a caution that there are also various well-known adverse effects commonly occurring in nutrient-enriched systems. These adverse effects are evidenced by increased disease among fish populations, the proliferation of pollution-tolerant species and the potential for increased accumulation of toxic substances through an enriched food chain.

3) Management of Waste Discharges

The Part 12 study contained a proposed oxygen model for use as a management tool. From the model an optimum nutrient optimum level could be calculated for the Harbor. EPA review of the model revealed that the model could not accurately simulate the Harbor even at a steady state, or be able to predict accurately the consequences of variations in nutrient discharges.

4) BEP Toxicity Criteria

As noted earlier, the BEP set criteria which provide minimum toxicity standards to be attained by an undiluted wastewater discharge as a necessary requirement for a finding of enhancement. For the Part 12 study the HEP researchers used diluted effluents for most of the bioassays rather than the usual undiluted effluents. However, even the diluted wastewaters (collected from the outfall boils) were found to be highly toxic to the test organisms. This result was a strong indication that the wastes did not enhance the harbor's water (See Appendix E).

To conclude, the Part 12 study did not lend much support to the assertion that bioenhancement was occurring in Los Angeles Harbor in 1976. Unfortunately, to a great extent the information contained in the document showed considerable evidence of damage to the harbor. Of particular note was the existence of a "zone of mortality" near the discharges and the increased incidence of fish disease and the toxicity of the effluents.

B. The Part 16 Study

As described earlier, the Part 16 study was submitted to EPA in 1979 to be evaluated as part of the work conducted under Section 74 of the Clean Water Act. The report contains data collected by various researchers during the years 1971 to 1978 when the canneries gradually upgraded waste treatment practices to DAF (in 1974 and 1975) and finally to the secondary treatment provided by the TITP.

This work expands upon the hypothesis presented in the Part 12 study; the cannery wastes supply nutrients necessary to sustain a large marine population in the harbor. The study contains data on fish, benthic, plankton and bird populations. The authors conclude that the maximum bioenhancement occurred before the canneries improved waste treatment practices by installing DAF treatment; according to this view, the upgrading of waste treatment has caused a decrease in the enhancement effect. This is different from the earlier Part 12 study where the improved waste treatment was viewed as necessary to reduce oxygen demand and stress in the Harbor. The Part 16 study also differs from the earlier study in that the newer study does not address the polluted "mortality zone" in the vicinity of the outfalls.

Similar to the Part 12 study, the Part 16 study proceeds on the assumption that an increase in biomass is improvement and measures numbers of species, numbers of organisms and total biomass as indicators of bioenhancement; the type of organisms prevalent (i.e., pollution-tolerant species) and measurements of water quality (DO levels) are of lesser importance.

Review Board

In order to conduct a thorough and unbiased assessment of the Part 16 study, EPA requested review help from a number of different Federal and State of California agencies. The agencies were asked to provide scientists knowledgeable in marine studies and familiar with Los Angeles Harbor who could comment on the Part 16 study approach, methodology and conclusions. The review panel consisted of representatives from the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, the California Water Resources Control Board, the California Department of Fish and Game, and the Los Angeles Regional Water Quality Control Board as well as the EPA.

Review Board Findings

The reviewers criticisms were similar to EPA's original concerns about the Part 12 study. The major concerns are delineated below:

1) Methodology

The reviewers were concerned that a lack of comparative control data which might characterize a healthy harbor without cannery discharges would render the conclusions based on the data collected speculative. Another methodology problem cited was the failure to consider physical water quality data during the study; the cleanliness of the water and the oxygen availability should have been part of the marine assessment. Other factors which should have been considered include long-term fish population cycles, weather patterns, other nutrient sources to the harbor, and variable field conditions during sample collection (i.e., salinity, air and water temperature, etc.).

2) Data Collection and Results

Although the data collection methods used in the study were not clearly explained, it was apparent to the review scientists that collection methods used to sample fish and bird populations varied extensively from year to year. This inconsistent data collection makes it very difficult to determine whether observed population changes are due to effluent discharge changes or to the differing data collection techniques.

The reviewers were seriously concerned there were not enough data to support any conclusions regarding population trends.

3) The Bioenhancement Conclusion

Because of their concerns about methodology and data, most reviewers were not convinced that cannery wastes promoted the growth of marine species populations in Los Angeles Harbor. Even if some cause-and-effect relationship could be demonstrated between the effluent discharges and the numbers of organisms present in the "zone of enhancement", the reviewers disagreed that increased populations represented "enhancement."

Several reviewers felt that the surveys reflected an <u>attraction</u> of fish from the far side of the Harbor to the area where effluents were discharged rather than enhancement.

Also, the reviewers felt that even if the data reflected actual population increases, there was little indication that these increases were beneficial to the area. The majority of the increases attributed to untreated cannery wastes (i.e. prior to advanced treatment) were reported for such species as bacteria, bottom-dwelling worms and scavenger fish (such as the white croaker); the proliferation of which would not be considered enhancement.

The following section briefly presents some of the specific Part 16 study findings by section along with pertinent review board comments.

C. Part 16 Findings and Review Board's Comments

1. Fish Populations.

a. Part 16 Findings

According to trawl surveys in the outer areas of Los Angeles and Long Beach Harbors, the fish population dropped four-fold between 1973 and 1978, while party-boat catches outside the harbors doubled. Two fish species, reported to be the most common, were noticeably affected: white croaker and anchovy. White croaker population, previously the fish caught most often by shore anglers, dropped between 10 and 20-fold. Anchovy population fell 100-fold. A survey of fishermen's catches, taken by two California Department of Fish and Game (DFG) personnel at various locations around the harbor, indicated that fish population was greatest in the area of the TITP sewage outfall. HEP believed this to be the only remaining area in the harbor with high nutrient concentrations.

b. Review Board Comments

The California Department of Fish and Game (DFG) commented that trawl surveys reflect merely incidental catches, and not actual populations. They also felt sampling techniques and efforts in collecting data were inadequate (Appendix E-4).

The DFG cited as a further criticism the lack of supporting data or consideration of other factors such as salinity, water temperature, and other physical/chemical tests which would have allowed a comparison of population dynamics inside and outside of the harbor (Appendix E-4).

The U.S. Fish and Wildlife Service (USFWS) noted that the trawl survey lacked a control standard. To compensate, they claim researchers should have incorporated into the study findings from other pertinent research programs (Appendix E-6).

The USFWS commented also that the seasonal trend of fish abundance inside the harbor, with or without cannery discharges, has its peak in the summer, which coincides with pertinent discharge events. Thus, the USFWS believed that, since the two events are concurrent, the role of waste discharges in determining fish population remains unknown. The USFWS also pointed out that, because the original decline in fish population predated upgraded treatment, the drop-off cannot be solely the result of effluent changes (Appendix E-6).

The National Marine Fisheries Service (NMFS) noted that while some differences exist in pre- and post-cessation survey results of fish populations, these cannot be entirely attributed to the removal of untreated waste from the harbor. Many factors influence fish distribution and population, notably, yearly species failures and fishing pressure. The census, which supposedly showed diminished success of shore anglers, may have in fact shown a dispersal of fish because no attractant was available.

The DFG noted that the disparity which exists between off-shore (fourfold decrease) and harbor (100-fold decrease) anchovy density is not, necessarily, reflective of changes in the harbor. Data collected by the DFG in 1976 indicated that a reproductive failure caused a scarcity throughout Southern California harbor waters. This same type of reproductive failure could easily account for the depleted juvenile anchovy population in the harbor (Appendix E-4).

The entire review panel agreed that the fish population studies were inconclusive. They stressed, as major considerations in their determination, a lack of references to other sources (Southern California Edison - Long Beach Report and USFWS Studies) which have indicated a growth in fish population since 1978. The reviewers conjectured that the Part 16 fish population studies reflected merely a redistribution of fish within the harbor because waste outfalls had been cut off and were no longer offering an attractant source to the fish (Appendix E-7).

2. Bird Populations.

a. Part 16 Study Findings

Observations in the harbor area indicated that bird populations were approximately 40 percent lower than the 1973-1974 level. The changes were noted during the fall and winter months when the staff made a majority of the observations.

According to the survey, the gull species, sighted most often, decreased more than any other (nearly three-fold). Several other species were scarcer; however, the endangered Least Tern and Royal Tern increased between 1973-1974 and 1978.

Researchers speculated that changes in bird populations may have resulted, wholly or in part, from the removal of floating solids, or from there being substantially fewer anchovies in the harbor. In either case, researchers believed bird populations were altered by the absence of a food source.

b. Review Board Comments

The DFG believed that without data from years between the 1973-1974 survey and the 1978 survey, bird population trends could not be characterized accurately. They commented that the avian population was healthy and stable, and that, with fewer gulls preying on the eggs of the Least Tern, the Least Tern population increased (Appendix E-4).

The USFWS commented that the drop in the number of gulls, who are known scavengers, may have been a result of the cessation of processing effluent disposal. More generally, the USFWS noted that portions of the studies, especially the bird survey, lacked a control-site (Appendix E-6).

3. Phytoplankton Resources.

a. Part 16 Study Findings

Phytoplankton* productivity, chlorophyll a, and assimilation ratios in the Los Angeles Harbor area were monitored before, during, and after processing wastes were given secondary treatment. Productivity values reflect the ability of the phytoplankton present to produce organic matter photosynthetically under ambient conditions. Chlorophyll a values are a measure of the size of the phytoplankton population present. Assimilation ratios were calculated by dividing productivity values by the chlorophyll a concentrations.

Chlorophyll a values showed that growth patterns were unchanged during each period. This indicated, in general, that the changeover to secondary treatment had not disrupted the phytoplankton population. But productivity and assimilation ratios were greatly reduced, presumably as a result of inhibition by predator species, or a loss of nutrients (which limits phytoplankton's ability to photosynthesize).

b. Review Board Comments

The DFG was concerned that HEP did not include in their report additional data concerning phytoplankton and zooplankton resources in the inner Los Angeles Harbor area. The information is available in a report prepared by consultants to the Southern California Edison Company. The report addresses results stemming from environmental monitoring similar to that which HEP used in assessing changes in an environment resulting from a warm water point-source discharge.

4. Zooplankton Resources.

a. Part 16 Study Findings

The study found zooplankton** resources were least affected by the treatment alterations. Much of it circulates with tidal fluctuations and is not capable of moving about of its own volition. Because fewer fish were preying on the organisms, species diversity increased, though the number of organisms present varied greatly. Researchers noted that species diversity had increased, most likely, because of the reduced fish population, and not because the ecosystem had been enhanced.

Other samples indicated zooplankton were present in large amounts only outside the harbor and near the TITP outfall, a fact accounted for possibly by a reduction in nutrients elsewhere.

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*phytoplankton - passively floating or weakly mobile aquatic plant life.

**zooplankton - microscopic animals that swim weakly or float passively in water currents.

Researchers noted that species' composition altered, indicating a response to treatment conversion.

b. Review Board Comments

The review panel found that the data presented was inconclusive and that no significant effects evidenced. The changes observed were within the bounds of natural variability (Appendix E-7).

While the report mentioned that the density of fish eggs, fish larva, and ichthyoplankton* was substantially greater in 1978 than 1974, reviewers felt researchers did not consider a more obvious possibility: that the conversion to secondary treatment, not reduced predation by fish, may have been responsible for eliminating the stress on these resources. Bioassay results from the Part 12 Study support this explanation (Appendix E-7).

Comments on the phytoplankton section were that the HEP report did not include the data from the Edison report (Appendix E-7) in carrying out the study.

5. Benthic Resources.

a. Part 16 Study Findings

Since 1976, the principal trends seem to be, first, a sizeable decrease in the benethic (bottom-dwelling) population, especially among the usually abundant species, and second, a decline in the variety of species. The distribution of the benthic organisms did not change appreciably from 1975 to 1978.

Samples taken by HEP's research vessels in October 1978 showed faunal (animal organisms) changes both inside and outside of the harbor. Contrary to expectation, the drop in predator population did not produce an increase in diversity or population of benthic organisms. (Other studies have shown benthic worms to be a principal food for bottom fish, crustaceans, birds, and others. It had been postulated that a variation in benthic population would produce a corresponding change in predator population).

b. Review Board Comments

The entire review panel agreed that, though this section was the study's strongest, the data was insufficient to use as a basis for speculating on factors influencing fish population.

*ichthyoplankton - microscopic fish which move passively in aquatic ecosystems.

The USFWS commented that the data seemed to indicate the benthos was influenced more significantly by unnatural conditions (waste) than by natural ones (tides). In particular, the study clearly indicated a zone of mortality near the outfall, the effects of which must be weighed against any enhancement claim.

A reviewer from EPA's Corvallis laboratory commented that the description of survey and experimental methods were incomplete. Missing are details describing sampling apparatus, grab sample sizes, and the number of replicates at each station. The report also does not offer a statistical analysis of the benthic data; it is restricted to graphs of temporal patterns and benthic densities. Only the dominant species at a few stations are identified (Appendix E-5).

The Part 12 and 16 studies and review comments are presented in Appendix E of this report.

5. EPA SITE VISITS

In an effort to address the Section 74 mandate more completely, EPA supplemented its water quality studies and the industry-funded Los Angeles Harbor Study with site visits. EPA representatives noted waste treatment practices, and documented obvious visible effects of waste disposal on receiving environments in several major United States seafood processing areas (e.g., New England, Mid-Atlantic and Southeast Coasts, and the Gulf Coast). Though the discharge of untreated waste is restricted primarily to Alaska, several processing facilities in the contiguous states discharge amounts of fish oil and shellfish waste that the receiving environment may be incapable of assimilating. EPA representatives noticed that in some cases, even where waste was being screened, solids build-up in waters with little flushing action seemed excessive. But without sampling the precise effects of these conditions on receiving environments remains undetermined.

Depending on the type of seafood processed, and on the location of the plant, wastewater characteristics and applicable treatment technology vary. Waste treatment and disposal practices are governed by Federal, State and/or local restrictions as well as the utilization and disposal options afforded by the geographical location. Maine sardine canneries, for example, have a relatively low volume of wastewater, but their discharge usually contains high levels of oil and grease and BOD. Sardine waste solids generated by screening does not pose a disposal problem. It may be used, for instance, as lobster bait or sold to a reduction facility for the production of fish meal. In contrast, shrimp processors along the Gulf Coast generate a substantially greater volume of wastewater, usually with a high BOD level and a significant amount of shell fragments. Shrimp heads and hulls, depending on a plant's proximity to potential disposal sites, may be used as fertilizer, dried for use as an animal feed additive, or simply buried in a landfill area. As a general rule, processors look for the most direct and economical means of disposal.

A. New England

Although previous EPA work has characterized sardine effluent discharges in some detail, no precise, comprehensive studies of the Maine Coast have been done to determine the impact of these effluent discharges on receiving waters. Sardine cannery discharges generally have profuse amounts of fish oil in them which, after discharge, covers the surface of the receiving water. Much of this oil and other floating materials have been minimized by the installation of screens and oil separation units, but in some areas, effects of these discharges are still noticeable. Solids generated by screening are either sold to local lobstermen as bait or to a reduction facility where they are processed into fish meal and oil.

B. Mid-Atlantic and Southeast Coasts

Processors on Key West and Stock Island (Florida) process mostly shrimp, along with moderate amounts of lobster, crab, and finfish. Shrimp heads and hulls are the most prevalent type of waste generated.

Coastal waters around Key West and Stock Island receive discharges from a number of sources in addition to seafood processors, including sewage treatment plants and power plants, along with commercial and private boats. The surface of the waters near seafood waste discharge points appear murky and oily, and contain some floating debris. While seafood wastes are not entirely responsible for these conditions, they are contributing to the continuous degradation of the waters.

Further north, the Georgia Department of Environmental Protection (DEP) has recently required a major processor on the Georgia coast to achieve 85 percent BOD removal prior to discharging its wastewater. To do this, the company has installed dry cleanup procedures, screening, and has begun discharging a portion of its wastewater into the local, publicly-owned treatment works where secondary treatment is provided. Prior to these control measures, wastes had been discharged into a shallow ship slip, an area that receives little flushing action. Shells accumulated during this period, which resulted in numerous complaints about the pungent odor emanating from the decaying material. As another of the renovations, the company has moved its waste outfall into deeper water.

This processor has expressed dissatisfaction with the strict enforcement of water quality standards by the Georgia DEP, but state officials maintain that water quality standards are necessary to ensure the continued well-being of coastal waters which yield harvestable species, including shrimp.

C. Gulf Coast

There are approximately 15 to 20 shrimp canneries along the bays, rivers, and bayous of the Gulf Coast. Also in this area are a number of shrimp freezers and oyster processors.

Because of the diversity which exists among plant locations and receiving waters here, it is difficult to give a detailed account of waste disposal problems. Almost all wastewater emanating from these facilities has a high BOD level. Receiving waters in some areas are stagnant and murky; in other areas, currents are strong enough to dissipate wastes. Heavy solids (i.e., shells) pose a major problem relative to waste dissipation. Although some drying of shrimp shells is practiced, outlets for the dried by-product are difficult to identify. In the event that landfills are also unavailable, some processors have been permitted to discharge solids into receiving waters. Industry representatives acknowledge the need for continued research to develop alternatives, but claim such endeavors require investment capital which many processors presently cannot obtain.

CHAPTER IV

TECHNOLOGY ASSESSMENT

To present a more comprehensive image of the seafood processing industry, and to comply fully with the Section 74 stipulation, EPA has examined current seafood processing waste control practices, as well as those which might be initiated to further reduce discharges where necessary. EPA has also explored waste utilization and disposal alternatives. Generally, these involve by-product manufacturing or disposal either on land or in the ocean.

With the exception of larger tuna and fish meal processing facilities, the industry consists of many small, seasonal operations, most of which process intermittently depending on weather and raw material supply. Although some processors make an effort to maximize raw material usage and minimize water and waste contact, most have adopted rather limited and simple waste management practices.

Because tuna processors approach complete raw material utilization by year-round processing and by-product recovery, this segment should be assessed separately from the rest of the industry. Many of these plants recover by-products on-site, thereby minimizing the amount of waste entering treatment facilities and, subsequently, marine waters. At present, most major tuna processors have wastewater treatment technology in-place.

Existing waste management practices for the remainder of the industry are limited. Recovery of wasted raw material and more complete resource utilization depend on providing processors with the proper incentives, (profitability) as well as identifying new by-products and developing markets for them. By-product generation can increase profits by reducing treatment costs and providing seafood processors with additional earnings.

Some of the most applicable approaches to waste control are in-plant modifications to reduce the amount of wastes requiring treatment, wastewater screening, and dissolved air flotation* (DAF). Seafood processing wastewaters can be treated biologically, but the land required for this technology precludes its widespread application in the industry.

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*dissolved air flotation - a process in which air is compressed into the waste effluent, mixed to super-saturation, then released to generate minute air bubbles. As bubbles rise, they carry with them waste particles which can then be removed.

1. WASTE CONTROL AND TREATMENT

A. In-Plant Controls

1. Non-Alaskan.

For the tuna industry, thaw water recycling systems and reduced water consumption in other processing areas are efficient means of eliminating much wastewater. Some canneries presently recycle water used in the thawing stage which helps to reduce significantly the volume of wastewater requiring treatment.

In fish meal plants, preventing spills and curtailing water use during clean-up are ways in which wastewater generation and waste loads can be reduced. Some plants have begun recycling water used to unload raw material from boats. This water can be combined eventually with a more concentrated waste stream (stickwater) to form a salable by-product.

For the remaining segments of the seafood processing industry, the general approach to proper waste management remains consistent. The most effective in-plant measures for reducing waste discharges focus on controlling water use, limiting use of water for clean-up, and reducing the amount of raw materials entering the waste stream. Such measures result in reduced treatment costs. In cases where by-products are produced these measures result in additional income which can either partially or totally offset the costs associated with wastewater treatment.

2. Alaskan.

Seafood processors in Alaska have taken a much simpler approach toward processing waste management than have those in the contiguous states. Currently, grinding of waste materials for ocean discharge is the most prevalent disposal practice. Because it is so convenient and inexpensive, ocean discharge provides little incentive for processors to employ in-plant controls.

B. End-of-Pipe Treatment

1. Non-Alaskan.

The most common and basic end-of-pipe treatment is screening, where gross solids are removed prior to effluent discharge. Other, more advanced technologies, including dissolved air flotation, biological treatment (i.e. activated sludge) and filtration, are available but are not widely used by the seafood processing industry.

Except for major tuna and fish meal processors, the industry employs simple, treatment technologies. Screening, in conjunction with in-plant controls, is the most affordable and appropriate technology for seafood processing plants which generate low-volume waste flows from manual operations (hand-butchering and filleting). In automated (mechanical) plants, which generate larger volumes of waste, dissolved air flotation systems may be used after screening. Currently, dissolved air flotation is being used in a number of tuna canneries in California, Puerto Rico, and American Samoa. Its effectiveness has also been demonstrated for effluents from salmon processing, shrimp canning, and oyster canning.

Catfish processing facilities, usually located inland, can use biological treatment systems (e.g., aerated lagoons) where effluent can be stored and aerated until waste constituents have been effectively removed. Land for such systems is more readily available than in the coastal areas.

All of these end-of-pipe technologies have been demonstrated effectively in seafood processing plants both in the United States and abroad.

2. Alaskan.

Alaskan seafood processors practice unsophisticated waste treatment technologies. Most plants discharge untreated wastes (i.e., whole or ground waste solids) to receiving waters. Several plants, located in processing centers, simply screen solids from waste effluent, and transport them to a by-product manufacturer.

A combination of factors, including geographical location, land scarcity, adverse climate, and high construction costs makes treatment technologies more sophisticated than screening inapplicable to Alaskan processing operations.

2. SEAFOOD WASTE UTILIZATION AND DISPOSAL

A. Sources and Alternatives

The application of the various wastewater treatment technologies discussed above generates solid wastes. The problem of disposing of these wastes, especially shellfish wastes, has grown more serious in recent years because of the increased processing of shellfish, and the implementation of water pollution control regulations. Although most seafood processing waste is proteinaceous, seafood processors are not always equipped to make use of their waste because it is often not profitable to do so. In the past, the industry has had convenient disposal options (e.g., direct ocean discharge) which have discouraged attempts to use the waste as a by-product. Unfortunately, these convenient disposal methods have adversely affected water quality and marine life in some areas. Only a very few proposed solutions have proved to be both economically viable and environmentally sound (Figure 17).

1. Non-Alaskan.

Tuna canners have installed separate processing lines to produce petfood from fish portions inappropriate for human consumption. In addition, they also collect viscera and scraps which are subsequently processed into meal, oil and solubles.

Tuna processors that use dissolved air flotation to treat wastewater are faced with the problem of disposing of the resulting sludge. Currently, the sludge is landfilled but the possibility of using the sludge as an animal food additive (if it meets FDA regulations), or as a lowgrade fertilizer is being explored.

Production of fish meal from whole fish (menhaden and anchovies) generates a concentrated waste stream called stickwater. At modern facilities, stickwater is mixed with unloading water to make solubles. This product can be used to enhance the meal product or it can be marketed separately.

For the remaining segments of the industry, prudent waste management requires increased utilization of solids gathered from processing lines, screens, biological treatment systems, and dissolved air flotation systems. These sources provide potential raw materials for animal feeds, nutrient products, fertilizers, and other useful materials.

Secondary products, products suitable for human consumption which are not integral to the production process, offer an opportunity for seafood processors to use raw materials more completely. Development of secondary products can generate extra income, as well as reduce the amount of waste requiring treatment or disposal. The feasibility of secondary product development depends on plant location, species processed, equipment availability, and market conditions. It is noteworthy that as the cost of waste treatment increases, so too does the incentive for secondary product manufacturing.

In most cases, secondary product manufacturing involves additional flesh separation after primary product production. Flesh separator machines are available for finfish and shellfish processors which recover 37 to 60 percent of minced flesh. Compared to conventional finfish filleting techniques, which yield only 25 to 30 percent, this is a substantial reclamation.

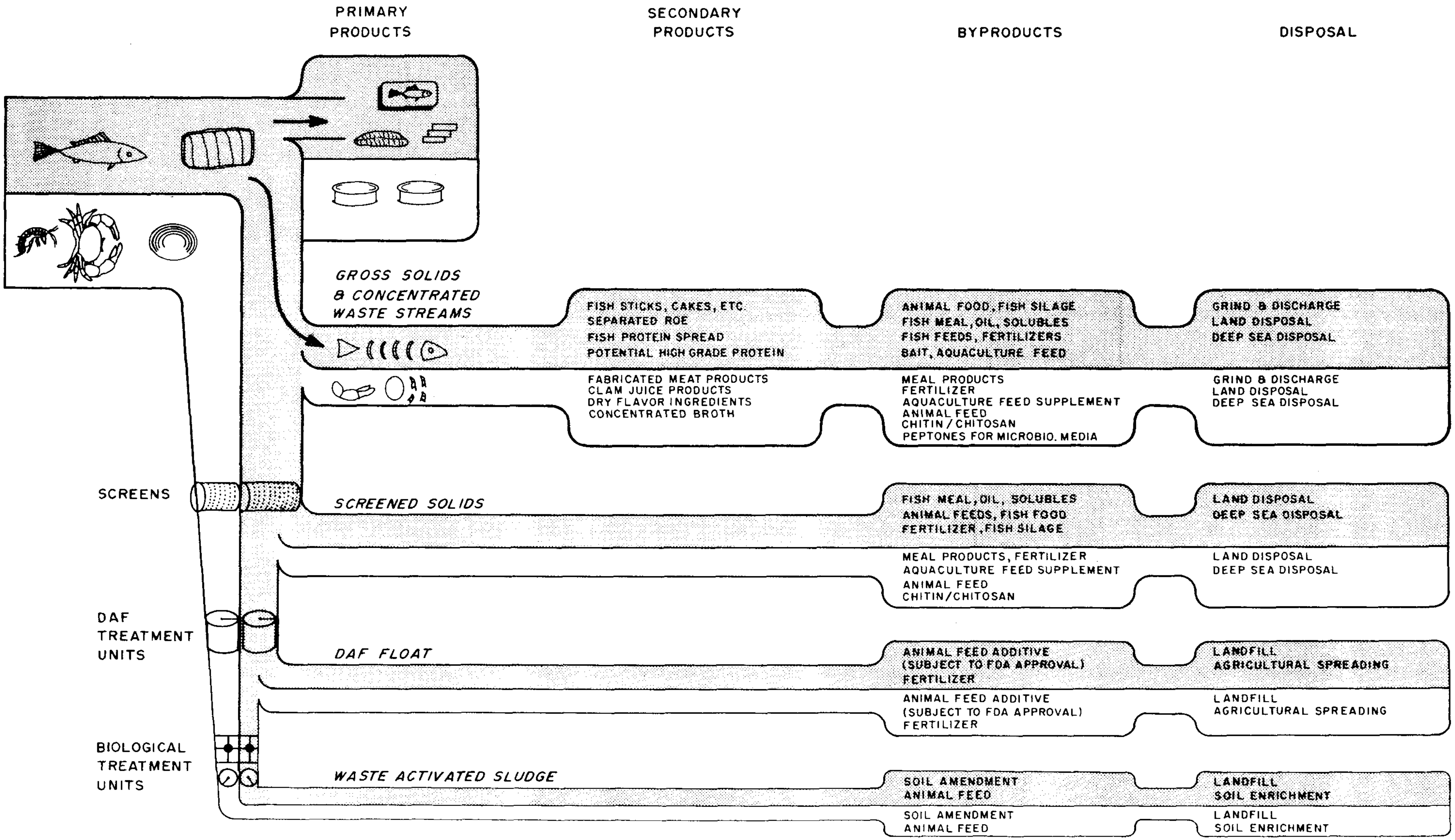

Figure 17. Options for disposal/utilization of wastes resulting from implementing waste management practices.

In addition to flesh recovery processes, liquid secondary products can also be recovered from isolated waste streams. The Sea Grant Institution has recently investigated the development of a product similar to clam juice from minced clam washwater and found it to be economically advantageous. Researchers also noted a significant concurrent reduction in the plant effluent's BOD5 waste load.

Solids not converted into secondary products or by-products must be disposed of on the land or in the ocean. Land disposal requires that a suitable site be available where seafood wastes may be incorporated into the soil to enhance nutrient levels. While this method does not yield a profit, to date processors have elected to bury wastes in a landfill as a means of simple, economical disposal. In the future, processors may be required to seek other disposal alternatives because landfills are increasingly less available because of local public health and odor problems.

2. Alaskan.

Waste categorization and disposal options for seafood processors in Alaska are more limited than in the contiguous states. Landfills are unavailable for seafood wastes, leaving only by-product manufacturing and ocean disposal as alternatives. Given the potential for environmental problems created by near-shore ocean disposal, barging seafood wastes to off-shore, deep water sites remains an acceptable disposal alternative for the seafood industry. In addition to barging, by-product manufacturing is an environmentally acceptable option. However, it is less easily accomplished in Alaska than in the contiguous states. This method represents the most environmentally sound manner of disposing with solid waste because, first, it eliminates the discharge of large volumes of wastes into the environment and, second, it transforms waste material into a marketable commodity. At the present time, by-product facilities are being operated in three Alaskan areas (Kodiak, Petersburg and Seward) to produce fish meal, fish oil, and/or shellfish meal.

Fish meal, made from fish processing waste (salmon, herring, bottom fish), may be used, among other things, as a protein source in animal feeds. However, national demand for fish meal is currently quite low. (It accounts for less than one percent of the total processed feeds produced in the United States.) Its chief competition is soybean meal; others are oil-seed meal, animal protein, and grain protein.

Shellfish meal is produced from shrimp or crab processing wastes and has a lower protein content than fish meal. The processors in Dutch Harbor could supply the raw material to produce 50 percent of the United States supply of shellfish meal. However, the low protein content of this product makes marketing the meal difficult.

Another potentially viable product is chitin. Chitin is an abundant, natural polysaccharide found in crustacean shells, insect exoskeletons, fungi, and certain other plants and animals. Its derivative, chitosan, is a deacetylized form of chitin which currently has no established major markets but many potential uses, including wastewater treatment (coagulation and ion-exchange), adhesives, and wound-healing sutures.

In addition to chitin, shellfish wastes are composed of water, protein, and calcium carbonate. Briefly stated, the steps for producing chitin from raw shellfish waste are: 1) the mechanical separation of loose protein; 2) the demineralization of the residual shell with dilute acid; 3) the deproteination of the remains with dilute alkali; and 4) the deactylization of chitin with caustic soda (which produces chitosan). Protein is the major by-product of chitin/chitosan manufacturing, and has an established market as an animal feed supplement. Chitin's complex extraction process makes it a more expensive commodity to produce than shellfish meal. As part of the Section 74 work, EPA has addressed the economic feasibility of chitin/chitosan production in Alaska (see next section).

Alaskan Market Feasibility Study

To investigate further the possibility of using the substantial amount of wastes generated by Alaskan processing facilities, EPA conducted a detailed economic assessment of hypothetical meal production or chitin production plants in this region (Appendix H-2). Alaska is different from the contiguous states because of limited land availability and high construction, operation and transportation costs. Raw material for by-products is inexpensive and plentiful, but the high production and shipping costs put Alaskan manufacturers at an economic disadvantage with other producers.

The major portion of this study focused on the feasibility of meal production, a proven technology for seafood waste utilization. The study compared meal production with barging, the other proven waste handling option for Alaskan processors. Hypothetical meal producing plants (in addition to the already existing facilities) were developed for each of the major processing areas.

The study showed meal production to be an economically unattractive waste handling option (when compared to barging) for most areas given 1977 prices and production levels. Major problems were underutilization of plant capacity (due to seasonality of processing waste generation) and the low value of shellfish meal that would be produced by some areas.

The study also indicated that meal production could become economically preferable to barging in some other areas if production were expanded to include other types of seafood products, such as bottomfish.

Feasibility of Chitin/Chitosan Production

In addition to shellfish meal production, researchers examined the feasibility of producing chitin/chitosan from low-value, seasonally plentiful shellfish waste (Appendix H-2). Currently, the technology for producing chitin and chitosan is only in the formative stage, but the numerous properties and potential applications of the product make commercial production a realistic possibility in the near future. Presently, there is one small manufacturer of chitosan in the United States (Seattle, Washington); most of the world's supply originates from a single Japanese manufacturer.

For purposes of this study, two hypothetical plants were developed: one on the east coast and the other on the west coast. Accordingly, the west coast plant would process shellfish (crab and shrimp) waste from Alaska and Puget Sound, and would produce 1.25 million pounds of chitin per year; the east coast facility, which would process blue crab processor's wastes, would manufacture one million pounds of chitin annually.

Because of the difficulty and expense in shipping chemicals necessary for chitin manufacturing to Alaska, researchers examined the feasibility of completing the extraction and stabilization portions of the process in Alaska, and then shipping the extracted chitinous material to Seattle for further chemical processing. Despite construction and operation cost disparities between the two plants, the limited data available to this study showed chitin/chitosan production to be an economically feasible alternative for shellfish waste disposal (when the selling price ranged from $1 to $2 per pound). Presently lacking in the development of full-scale production plants are a sustained market and consistent quality control. But because of chitin/chitosan's range of uses and seafood processors' need to identify economically and environmentally acceptable disposal alternatives, research will continue toward perfecting the chitin/chitosan manufacturing process.

Seafood processing researchers recommend that work actively continue in the area of seafood wastes solids recovery processes. Research is needed to develop more secondary product and by-product processes as well as extensive market research for these products. Specific needs include uses for dissolved air flotation sludge (currently not accepted by the FDA as an animal feed additive) and shellfish waste utilization techniques, with major emphasis on the chitin process.

CHAPTER V

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CHAPTER VI

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- b. Summary of the Bays and Estuaries policy
- c. Chronology of events
- d. Summary of study documents
- e. Summary of criticisms
- f. Other pertinent information

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CHAPTER VII

APPENDICES A THROUGH H

APPENDIX A

DUTCH HARBOR SECTION 74 STUDIES AND COMMENTS

A-1 Letter to Mr. Jeffery D. Denit, Effluent Guidelines Division (WH-552), U.S. Environmental Protection Agency, Washington, D.C.; Comments from the National Fisheries Institute and National Food Processors Association on the scope of the Section 74 study; authored by Jack L. Cooper, Director, Environmental Affairs; M. Kathryn Nordstrom, Fishery Affairs Coordinator; Roy E. Martin, Director, Science and Technology; and Gustave Firtschie, Director, Government Relations, Washington, D.C., July 14, 1978.

A-2 Feder, Howard M. and David C. Burrell. "Final Report to Environmental Protection Agency Impact of Seafood Cannery Waste on the Benthic Biota and Adjacent Waters of Dutch Harbor, Alaska." Institute of Marine Science, University of Alaska, Fairbanks, Alaska, April 1979. Grant No. 4 803922-03-2.

A-3 Letter to Mr. Albert J. Erickson, Acting Deputy Assistant Administrator for Water Planning and Standards, U.S. Environmental Protection Agency (WH-551), Washington D.C.; Comments on the report: Impact of Seafood Cannery Waste on the Benthic Biota and Adjacent Water at Dutch Harbor, Alaska, from Terry L. Letzell, Assistant Administrator for Fisheries, National Marine Fisheries Service, October 5, 1979.

A-4 Letter to Mr. Calvin Dysinger, Effluent Guidelines Division (WH-552), U.S. Environmental Protection Agency, Washington, D.C.; from Roger A. De Camp, Pacific Seafood Processors Association, Seattle, Washington, April 16, 1979.

A-5 Letter to Mr. Robert B. Schaffer, Director, Effluent Guidelines Division, U.S. Environmental Protection Agency, Washington, D.C.; Comments on Working Papers No. EPA 910-8-77-100 and 910-8-78-101: "The Dutch Harbor Studies." from Michael J. Spear, Associate Director, U.S. Fish and Wildlife Service, Washington, D.C., August 31, 1979.

A-6 Letter to Mr. Denton Sherry, President, Whitney-Fidalgo Seafood, Inc., Seattle, Washington; discussion of "remote" and "non-remote" site status, from C. Deming Cowles, Deputy

Commissioner, State of Alaska Department of Environmental Conservation, Juneau, Alaska, June 20, 1979.

A-7 Letter to Mr. Calvin Dysinger, Effluent Guidelines Division (WH 552), U.S. Environmental Protection Agency, Washington, D.C.; Review of "Impact of Seafood Cannery Waste on the Benthic Biota and Adjacent Water at Dutch Harbor, April 1, 1979," from Roger A. De Camp, Director, Technical Services, Pacific Seafood Processors Association, Seattle, Washington, August 17, 1979.

A-8 "Biological and Water Quality Implications of Current Crab Processing Waste Disposal Practices in Dutch Harbor, Alaska," Timothy J. Bechtel, Ph.D., Consulting Biologist, Pacific Seafood Processors Association, Seattle, Washington, March 1979.

APPENDIX B

OTHER ALASKAN SECTION 74 STUDIES AND COMMENTS

B-1 "Benthic Macrofauna, Sediment and Water Quality near Seafood Cannery Outfalls in Kenai and Cordova, Alaska," Final Report by Michael A. Caponigro, SCS Engineers, Long Beach, California for the U.S. Environmental Protection Agency, Contract No. 68-03-2578, February 15, 1979.

B-2 See A-3

B-3 See A-4

B-4 Letter to Mr. Robert B. Schaffer, Director, Effluent Guidelines Division, U.S. Environmental Protection Agency, Washington, D.C.; Review of Appendix B-1, from Michael J. Spear, Associate Director, U.S. Fish and Wildlife Service, Washington, D.C., August 31, 1979.

B-5 Report to Director, Fish and Wildlife Service, Washington, D.C.; "Report of Field Investigations of Finger Cove, Adak Island, January 15-22, 1979," from Leroy W. Soul, Deputy Alaska Area Director, Environmental Assessment Division, National Marine Fisheries Service, Juneau, Alaska, July 16, 1979.

APPENDIX C

NON-ALASKAN SECTION 74 STUDIES AND COMMENTS

C-1 "Benthic Macrofauna, Sediment and Water Quality near Seafood Cannery Outfalls in Yaquina Bay, Oregon," by Richard C. Swartz, Donald W. Schults, Waldeman H. DeBen, and Faith A. Cole, Marine and Freshwater Ecology Branch, Corvallis Environmental Research Laboratory, U.S. Environmental Protection Agency, Newport, Oregon, September 11, 1978.

C-2 See A-3

C-3 See A-4

C-4 See A-5

APPENDIX D

MISCELLANEOUS SECTION 74 STUDIES AND COMMENTS

D-1 "Trip Report, Section 74 Seafood Processing Study, Alaskan Water Quality Investigations, July 25 through August 3, 1978," by Peter M. Maher, Edward C. Jordan Co., Inc., Portland, Maine.

D-2 "An Investigation of Certain Aspects of Crab Processing Waste Disposal Practices: In Situ and In Vitro Responses of Vibrio Parahemoliticus and Vibrio Anguillarum," by H.M. Feder, Institute of Marine Science, University of Alaska, Fairbanks, Alaska and S.A. Norrell and K. Babson, University of Alaska, Anchorage, Alaska, undated.

D-3 See A-3

D4 See A-4

D-5 See A-5

APPENDIX E

LOS ANGELES HARBOR STUDY AND COMMENTS

E-1 "Ecological Changes in Outer Los Angeles - Long Beach Harbors Following Initiation of Secondary Waste Treatment and Cessation of Fish Cannery Waste Effluent," Marine Studies of San Pedro Bay, California, Part 16, by Harbors Environmental Projects, Dr. Dorothy Soule and Mikihiko Oguri, editors, University of Southern California, Los Angeles, April 1979.

E-2 Letter to Mr. L. Frank Goodson, Project Coordinator, Resources Agency, Sacramento, California; Review of Draft Environmental Impact Reports (EIR's), State Clearinghouse No. 79051509A, For City of Los Angeles, Terminal Island Treatment Plant, Project No. 1202; by Neil Dunham, Division of Water Quality, California State Water Resources Control Board, June 13, 1979; with interspersed responses by Harbors Environmental Projects as consultants to the City of Los Angeles, June 29, 1979.

E-3 Letter to Mr. L. Frank Goodson; Project Coordinator, Resources Agency, Sacramento, California; Review of Draft Environmental Impact Report (EIR), State Clearinghouse No. 79051509A, for Marine Studies of San Pedro Bay Part 16, Ecological Changes in Outer Los Angeles - Long Beach Harbors Following Initiation of Secondary Waste Treatment and Cessation of Fish Cannery Waste Effluent; from Neil Dunham, Division of Water Quality, California State Water Resources Control Board, July 2, 1979.

E-4 Letter to Mr. Jeffery D. Denit, Chief, Food Industry Group, U.S. E.P.A., Washington, D.C.; Review of the Marine Studies of San Pedro Bay, California, Part 16 study, edited by Dr. Dorothy Soule, from Robert G. Kaneen, State of California Department of Fish and Game, May 22, 1979; with interspersed responses by Harbors Environmental Projects, July 5, 1979; and errata sheet dated May 24, 1979 by Robert Kaneen.

E-5 Memorandum of review of the Marine Studies of San Pedro Bay, California, Part 16 study, edited by Dr. Dorothy Soule; from Mr. Richard C Swartz, Environmental Protection Agency Research Laboratory, Newton, Oregon, March 28, 1979; with additions in June 1979.

E-6 Letter to Mr. Robert Schaffer (WH-552), Director of Effluent Guidelines Division, U.S. E.P.A., Washington, D.C.; Draft Review of the Marine Studies of San Pedro Bay, California, Part 16 study edited by Dr. Dorothy Soule, by Jack Fancher, U.S. Fish and Wildlife Service, Laguna Niguel, California, October 19, 1979.

E-7 Memorandum to the Files by P.T. Brubaker summarizing findings and comments at an informal workshop convened April 5, 1979 to review the Part 16 Los Angeles Harbor Study, May 1, 1979.

E-8 Memorandum attachment to E-7 illustrating the Los Angeles Harbor Enhancement Study Review Criteria to be utilized by reviewers in evaluating the Part 16 study.

E-9 Letter to a mailing list agenda and the City of Los Angeles' report to the California Regional Water Quality Control Board for an Interagency/ Fish Cannery Workshop on Issues related to the Discharge of Municipal Effluent and Fish Cannery Wastes to Outer Los Angeles Harbor, compiled by Raymond M. Hertel, Executive Officer, California Regional Water Quality Control Board, October 1, 1979.

E-10 Response to letter in E-7 by Mr. Raymond M. Hertel dated October 1, 1979; by Clyde B. Eller, Region IX, U.S. Environmental Protection Agency, San Francisco, California, October 2, 1979.

E-11 Letter to Mr. Calvin Dysinger, Effluent Guidelines Division, U.S. E.P.A., Washington, D.C.; Personal Review of the Marine Studies of San Pedro Bay, California, Part 16 study, edited by Dr. Dorothy Soule, from Howard O. Wright, Environmental Specialist, Division of Water Quality, California State Water Resources Control Board, August 7, 1979.

E-12 Letter to Mr. Calvin Dysinger, U.S. E.P.A., Washington, D.C.; Review of the Marine Studies of San Pedro Bay, California, Part 16 study, edited by Dr. Dorothy Soule; from Rimmon C. Fay, Pacific Bio-Marine Labs, Inc., Venice, California, June 14, 1979.

E-13 Letter to Mr. William MacDeish, Bureau of Engineering, City of Los Angeles, San Pedro, California; Review of the Draft Environmental Impact Report on the Terminal Island Treatment Plant (TITP) Unit II-C, Harbor Outfall; from Donald B. Bright, Environmental Feasibility Studies, Los Angeles, California, July 11, 1979.

E-14 Letter to Mr. L. Frank Goodson, Project Coordinator, Resources Agency, Sacramento, California; Review of SCH 7951509A-DEIR Terminal Island Treatment Plant Unit II C Effluent Disposal System and Harbor Outfall; from California State Department of Fish and Game, June 7, 1979; with interspersed responses by Harbors Environmental Projects, undated.

E-15 See A-3

E-16 See A-4

E-17 "Critique on California Department of Fish and Game report to EPA on Dr. Soule's Marine Studies of San Pedro Bay, California, Part 16 study," by Rear Admiral O.D. Waters, Jr., U.S.N. (Ret), North Indialantic, Florida, June 30, 1979.

E-18 Letter to Dr. Dorothy Soule reviewing the Part 16 study, from Willard Bascom, Southern California Coastal Water Research Project, El Segundo, California, June 13, 1979.

E-19 Letter to Mr. Calvin Dysinger, U.S. Environmental Protection Agency, Washington, D.C.; Comments and observations on the Harbors Environmental Projects Part 16 report; from Dave Batlands, General Manager of Engineering Services, Star-Kist Foods, Inc., Terminal Island, California, September 13, 1979.

E-20 Letters to Mr. John P. Mulligan, Tuna Research Foundation, Inc., Washington, D.C.; Comments on the Harbors Environmental Projects Part 16 study; from Larry B. Simpson, Gulf States Marine Fisheries Commission, Ocean Springs, Mississippi, July 2, 1979; Melbourne R. Carriker, University of Delaware, Lewes, Delaware, August 2, 1979; James V. Chambers, Ph.D., Sciences and Extension Specialist, Purdue University Food Sciences Institute, West Lafayette, Indiana, September 10, 1979; Wayne E. Swingle, Executive Director, Gulf of Mexico Fishery Management Council, Tampa, Florida, June 27, 1979; June Lindstedt Siva, Senior Science Advisor, Environmental Sciences, Atlantic Richfield Company, Los Angeles, California, October 3, 1979.

E-21 Letter to Mr. Calvin J. Dysinger, Effluent Guidelines Division (WH-552), U.S. Environmental Protection Agency, Washington, D.C.; Comments on the Marine Studies of San Pedro Bay, California, Part 16 study; from Jack L. Cooper, Director, Environmental Affairs, National Food Processors Association, Washington, D.C., September 14, 1979.

E-22 Undated excerpt from an unpublished manuscript comparing the Harbors Environmental Projects data with data from a Southern California Edison Report.

E-23. Memorandum to the files by P.T. Brubaker, EPA, Region IX, which summarizes the issues pertaining to the L.A. Harbor Enhancement Study, September 26, 1977.

APPENDIX F

EPA SITE VISITS

F-1 EPA Site Visit to Brunswick, Georgia Shrimp Processing Facility.

F-2 Observations on the Disposal of Shrimp Heads into Shem Creek, Mt. Pleasant, South Carolina by G.A. Rhame for the EPA.

F-3 Site Visits to Louisiana Shrimp Canneries by Calvin Dysinger, Project Officer.

F-4 EPA Site Visit to Southern Florida Seafood Processing Facilities.

F-5 EPA Seafood Study - Site Visits to Maine Sardine Canneries.

APPENDIX G

TECHNOLOGY ASSESSMENT

G-1 "Technology for Seafood Processing Waste Treatment and Utilization, Section 74 Seafood Processing Study", final report prepared by the Edward C. Jordan Co., Inc., for the Environmental Protection Agency, March, 1980.

G-2 "Improving the Economics of Crustacean-Waste Disposal" by Peter M. Perceval and W.E. Nelson, CHI-AM International, Inc., 1979.

G-3 See A-3

G-4 See A-5

G-5 Letter to Mr. Calvin Dysinger, Effluent Guidelines Division (WH-552), U.S. Environmental Protection Agency, Washington, D.C.; Comments on Appendix G-1 from Jack L. Cooper, National Food Processors Association, Washington, D.C., April 17, 1979.

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APPENDIX H

MARKET FEASIBILITY STUDY

H-1 "Market Feasibility Study of Seafood Waste Reduction in Alaska", draft report prepared by Development Planning & Research Associates, Inc. for the Environmental Protection Agency, February 1979.

H-2 Letter to Mr. Sammy K. Ng, Office of Analysis and Evaluation (WH-586), U.S. Environmental Protection Agency, Washington, D.C.; Comments on the February 1979 Draft Report titled Market Feasibility Study of Seafood Waste Reduction in Alaska from Dr. Lawrence Van Meir, Director Economics and Statistics, National Food Processors Association, April 16, 1979.

H-3 See A-3

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