US Army Corps
of Engineers
Portland District

Chetco Ocean Dredged Material Disposal Site Evaluation

Final Report

July 1988

CHETCO OCEAN DREDGED MATERIAL DISPOSAL SITE EVALUATION

PORTLAND DISTRICT

US ARMY CORPS OF ENGINEERS

FINAL REPORT

CHETCO OCEAN DREDGED MATERIAL

DISPOSAL SITE EVALUATION

REPORT PREPARERS

Michael F. Kidby, P.E.	Civil Engineer	CENPP-PL-CH
A. Rudder Turner, Jr.	Oceanographer	CENPP-PL-CH
Danil R. Hancock	Oceanographer	Oregon State U. (IPA)
David R. Felstul	Environmental Specialist	CENPP-PL-CH
Stephan A. Chesser	Oceanographer	CENPP-PL-CH
William B. Fletcher	Hydrologist	CENPP-PL-CF
Kim Larson	Fishery Biologist	CENPP-PL-F
Geoffrey L. Dorsey	Wildlife Biologist	CENPP-PL-F
Steven J. Stevens	Landscape Architect	CENPP-PL-RM
Michael A. Martin	Archeologist	CENPP-PL-RM
L. Jerome Simpson	CE Technician	CENPP-PL-CF

SYLLABUS

This report was prepared by the Portland District, Corps of Engineers, to describe conditions at the existing interim ocean dredged material disposal site (ODMDS) at Chetco River, Oregon. The report also documents compliance of the ODMDS with requirements of the following laws:

Marine Protection, Research, and Sanctuaries Act (MPRSA) OF 1972,
National Environmental Policy Act of 1969,
Endangered Species Act of 1973,
National Historic Preservation Act of 1966, and the
Coastal Zone Management Act of 1972, all as amended.

The Chetco ODMDS received its interim designation from the Environmental Protection Agency (EPA) in 1977. The MPRSA requires that, for a site to receive a final ODMDS designation, the site must satisfy the specific and general disposal site criteria set forth in 40 CFR 228.6 and 228.5, respectively. This ODMDS (with final designation) will be used to dispose of sediments dredged by the Corps to maintain the Federally authorized navigation project at Chetco River. It will also be used for disposal of material dredged during other actions authorized by the MPRSA.

The main report contains an analysis of all criteria and factors required for final designation. Technical data and coordination letters gathered to address these criteria are contained in the six appendices following the main report.

This document is submitted to EPA for agency review and processing and satisfies Corps documentation responsibility in seeking a final ODMDS designation.

CHETCO OCEAN DREDGED MATERIAL
DISPOSAL SITE EVALUATION

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT'D)

TABLE OF CONTENTS (CONT'D)

TABLES

FIGURES

APPENDIXES

CHETCO OCEAN DREDGED MATERIAL
DISPOSAL SITE EVALUATION

PURPOSE AND NEED

PURPOSE

1. The purpose of this evaluation study is to determine if the existing interim ocean dredged material disposal site (ODMDS) at Chetco River, Oregon, designated by the U.S. Environmental Protection Agency (EPA) in 40 CFR 228.12, fully meets all criteria and factors set forth in Parts 228.5 and 228.6 of Title 40 CFR. These regulations were promulgated in accordance with criteria set out in Sections 102 and 103 of the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972. The report makes full use of existing information to discuss various criteria, supplemented by field data to describe environmental conditions within and adjacent to the site. Further, this document is intended to provide sufficient information to determine compliance with the Coastal Zone Management Act, Clean Water Act (water quality certification), Endangered Species Act, National Environmental Policy Act, and National Historic Preservation Act of 1966. Use of the site would be for disposal of material dredged for operation and maintenance of the Federally authorized navigation project at Chetco River, Oregon, and for disposal of dredged material from other dredging projects authorized in accordance with Section 103 of the MPRSA.

2. The evaluation of the Chetco River ocean disposal site uses ODMDS designation study procedures developed by a joint task force of EPA and U.S. Army Corps of Engineers (CoE) personnel in a draft workbook entitled, "Technical Guidance for the Designation of Ocean Dredged Material Disposal Sites," dated October 1983. In May 1984, further guidance on the general approach to designation studies for ODMDS was jointly developed by EPA and CoE. The report "Yaquina Bay Interim Ocean Dredged Material Disposal Site Evaluation Study," dated April 1985, prepared by Portland District, CoE, closely followed this guidance.

This report contains a main body which addresses the 5 general and 11 specific criteria, a general bibliography, and technical appendices which describe environmental processes and features in the study area.

3. The ODMDS evaluated in this report received an interim designation from EPA in 1977 as defined in 40 CFR 228.12(a). In its final designation, it will be used to dispose of sediments dredged by the CoE to maintain the Federally authorized navigation project at Chetco River, Oregon, and for disposal of materials dredged during other actions authorized in accordance with Section 103 of the MPRSA.

NEED

4. The interim ODMDS is a necessary part of the maintenance of the authorized project. No other environmentally or economically feasible estuary or upland disposal sites are now approved for use or are likely to be in the future. The Chetco River project was authorized for the following purposes:

a. To decrease waiting times for vessels crossing the bar;

b. To provide adequate channel dimensions for tugs, barges and commercial fishing vessels;

c. To provide mooring facilities for small boats which take advantage of project facilities;

d. To permit barge and small boat traffic upstream to river mile 0.2; and,

e. To provide a harbor of refuge.

5. Consequently, maintenance of the navigation channel to authorized depths is critical to keeping the river and harbor open and sustaining these vital components of the local and state economy.

BACKGROUND

GENERAL

6. The Chetco River enters the Pacific Ocean near the town of Brookings, Oregon, approximately 300 miles south of the Columbia River (see figure 1). The estuary is fed mainly by Chetco River and its tributaries, which originate in the Klamath Mountains. Chetco River drains 365 square miles and is 58 miles from its mouth to headwaters.

PROJECT

7. The Portland District, CoE, has been responsible for maintenance of navigable waterways of the North Pacific Coast since 1871. The existing navigation project at Brookings was originally authorized in the River and Harbor Act of March 2, 1945, and was modified in the River and Harbor Act of October 27, 1965. Due to navigational needs, two rubble mound jetties were constructed at the mouth of the Chetco River in 1957, with the north jetty being extended by 450 feet in 1965. Construction of a channel, turning basin and protective dike, removal of rock pinnacles, and annual maintenance dredging were authorized as well. Portions of the authorized project considered in this report are:

(a) An entrance channel 14 feet deep and 120 feet wide;

(b) A barge turning basin 14 feet deep, 250 feet wide, and 650 feet long; and,

(c) A small boat access channel 100 feet wide by 12 feet deep.

8. The frequency of maintenance dredging depends upon the volume of sediments transported into the estuary and the frequency and severity of storms that move sediments into the channel, creating a bar. From 1982 to 1985, an average of 42,400 cubic yards (cy) of sediment were dredged from the entrance channel and the entrance to the boat basin. The need for the ocean disposal site will continue for the foreseeable future, as it is an integral part of maintaining the channels to authorized depths.

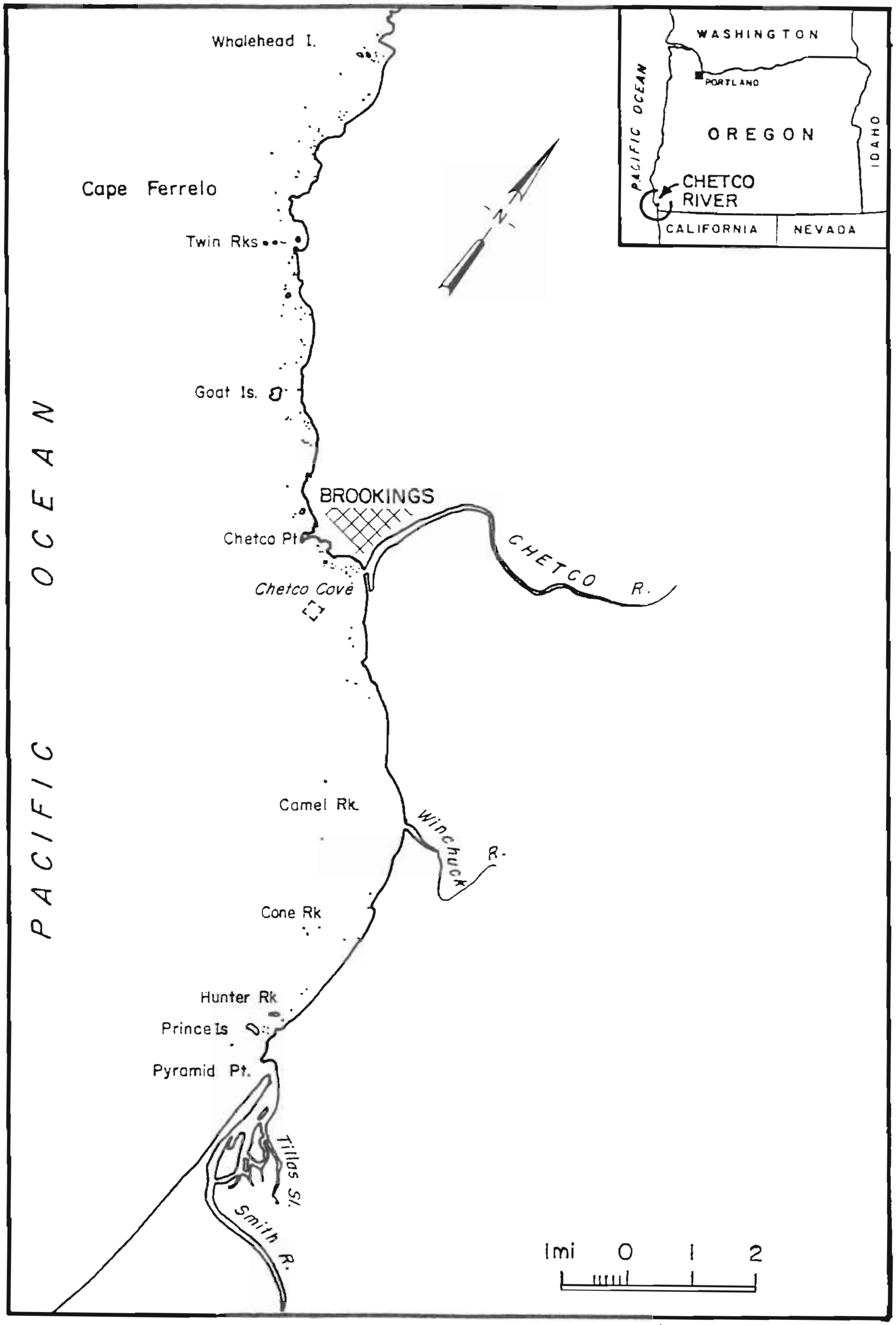


Figure 1
General Location of Chetco River

HISTORICAL ODMDS USE

9. The interim site, or areas in the same vicinity, have been used by Portland District since 1963. The site was designated an interim site in 40 CFR 228.12. The site designations in 1977 were an attempt by EPA to document and establish coordinates for historically used Corps of Engineers disposal sites. Interim designations were to lead to final designations or termination of their use, within 3 years of the interim designation. Since the 3-year period ended in 1980, extensions have been approved for continuing interim use of the sites, pending completion of required studies for final designation. This study will report on these requirements and request final site designation for the interim site from EPA.

10. The site designated interim in 40 CFR 228.12 was entitled, "Chetco River Entrance" and has the following coordinates:

42 01'56" N., 124 16'33" W.,
42 01'56" N., 124 16'09" W.,
42 01'38" N., 124 16'09" W.,
and 42 01'38" N., 124 16'33" W.

The approximate location of this site is one mile from the Chetco River entrance, with dimensions of 1800'x 1800' and an average depth of 70 feet. The site is the subject of this evaluation study to determine its feasibility for final EPA ocean disposal site designation.

11. Maintenance operations in the entrance channel have been performed by hopper dredge or hopper barge, and in the interior by hopper dredge, channel flusher, or, on a limited basis, by clamshell dredge. During summer months, the small shoal buildup in the inner portion of the project has been removed by the hopper dredges, Pacific and Yaquina, and placed in the EPA approved interim site. The sand flusher, Sandwick, has also been used to remove the shoals. To date, 749,000 cy have been disposed at sea, 420,706 of which has been disposed of in the designated offshore site since 1977.

DREDGED MATERIAL

12. The average annual volume of dredged material disposed offshore from 1976 to 1985 was 47,800 cy. The maximum and minimum quantities during this period were 76,300 cy and 7,800 cy, respectively. The annual volumes are given in appendix B, table B-1.

13. Shoaling occurs off the end of the north jetty and at the entrance of the boat basin. Grain size varies greatly, ranging from 0.3 mm to 7.0 mm. In addition, silt is occasionally dredged from the boat basin.

DISPOSAL SITE

14. The topography of the sea floor in the study area is highly irregular. There are numerous rock pinnacles to the west, east and southeast of the disposal site. Where bare rock is exposed, there are crevasses and ledges. Samples of disposal site sediment indicate a wide variation in grain size.

COMPATIBILITY OF SEDIMENT

15. The range of variation in grain size is similar for both the dredged material and the offshore sediments (appendix C). Material disposed offshore will always be in the vicinity of material of the same size. Sediment compatibility, therefore, should not be a problem.

EFFECTS OF PREVIOUS DISPOSAL

16. The most recent bathymetric survey showed no mounding in the disposal area. The dredged material would disperse from the site in the littoral drift system with movement expected to be to the north and offshore during the winter and lesser movement to the south in the summer. Disposal activities therefore, have had no noticeable impact on either the bottom sediment or bathymetry.

ECONOMIC GEOLOGY

17. The disposal site would have no effect on offshore mineral mining. No mining is currently going on in the area, nor is there a history of mining. Oil and gas exploration is concentrated farther to the north on the outer continental shelf. Therefore, no conflict is anticipated.

EVALUATION PROCEDURES

GENERAL

18. The procedures used to evaluate the Chetco ODMDS consisted of evaluating each of the five general and eleven specific criteria as required in 40 CFR 228.5 and 228.6. The results of the evaluations were then applied to a disposal area which lay within a Zone of Siting Feasibility (ZSF).

19. Dredging of the coastal ports is limited to a season from April through October. That limit is imposed by the weather and sea conditions that predominate in the Northwest. The size of the ZSF is controlled by the capability of available dredging equipment as allocated among the nine Oregon, one Washington, and four California coastal projects, and the hauling distance. The limited operating time available for completing the maintenance dredging along the Oregon coast, therefore, requires a combination of government and private dredges. In a typical year, the Chetco project requires equipment which will permit production of 6,000 cy per day or approximately 8 days of work. Longer hauling distances increase vessel operating costs and the time required for completion of the work. Based on these factors, the extreme practical limit of the Chetco ZSF is 1.5 nmi.

20. The natural and cultural resources of the area within the ZSF were identified from information obtained through review of literature, interviews with resource agencies and local users, and through site specific studies. Critical information was evaluated and mapped to identify areas of resource conflict. The selection of resources to use for this determination was dependent on whether the resource was considered limited. A coast-wide

resource, i.e., a flatfish spawning area, was not considered a limited resource and was not included in the overlay evaluation technique. Figure 2 shows the results of overlaying each of the individual resources to identify areas of highest cumulative resource value.

FORMAT

21. This report will constitute a site evaluation study, utilizing the procedures developed in the above referenced report and as required in 40 CFR, Parts 228.4(e), 228.5, 228.6, 228.9, and 228.12. The main body of the report addresses specifically all criteria and factors required in Parts 228.5 and 228.6. Technical information used to discuss these criteria and factors are contained in technical appendixes.

22. Procedures used to evaluate criteria and factors as discussed in the preceding section, are those developed in a workbook entitled, "General Approach to Designated Studies for Dredged Material Disposal Sites", EPA and USACE, May 1984 (see figure 3).

SITE SELECTION CRITERIA

23. The MPRSA requires that site evaluation be performed prior to final designation for continued use as an ocean disposal site. A site evaluation study is defined in 40 CFR 228.2(c) as:

> "The collection, analysis, and interpretation of all pertinent information available concerning an existing disposal site, including but not limited to, data and information from trend assessment surveys, monitoring surveys, special purpose surveys of other Federal agencies, public data archives, and social and economic studies and records of affected areas."

24. These studies are used to comply with and discuss criteria and factors listed in Parts 228.6 and 228.5. Criteria and factors are listed in tables 1 and 2.

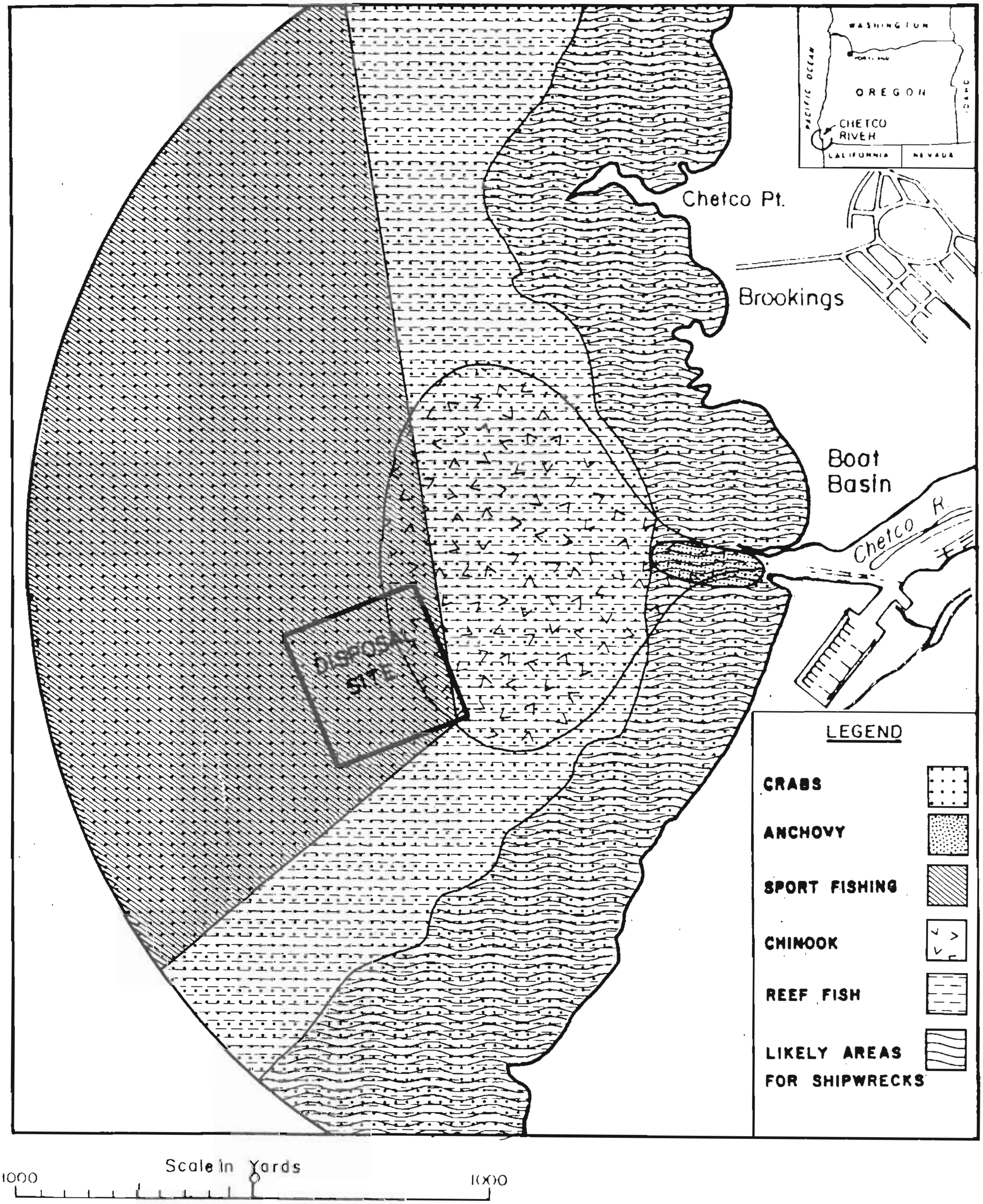


FIGURE 2

OVERLAY EVALUATION OF INDIVIDUAL RESOURCES

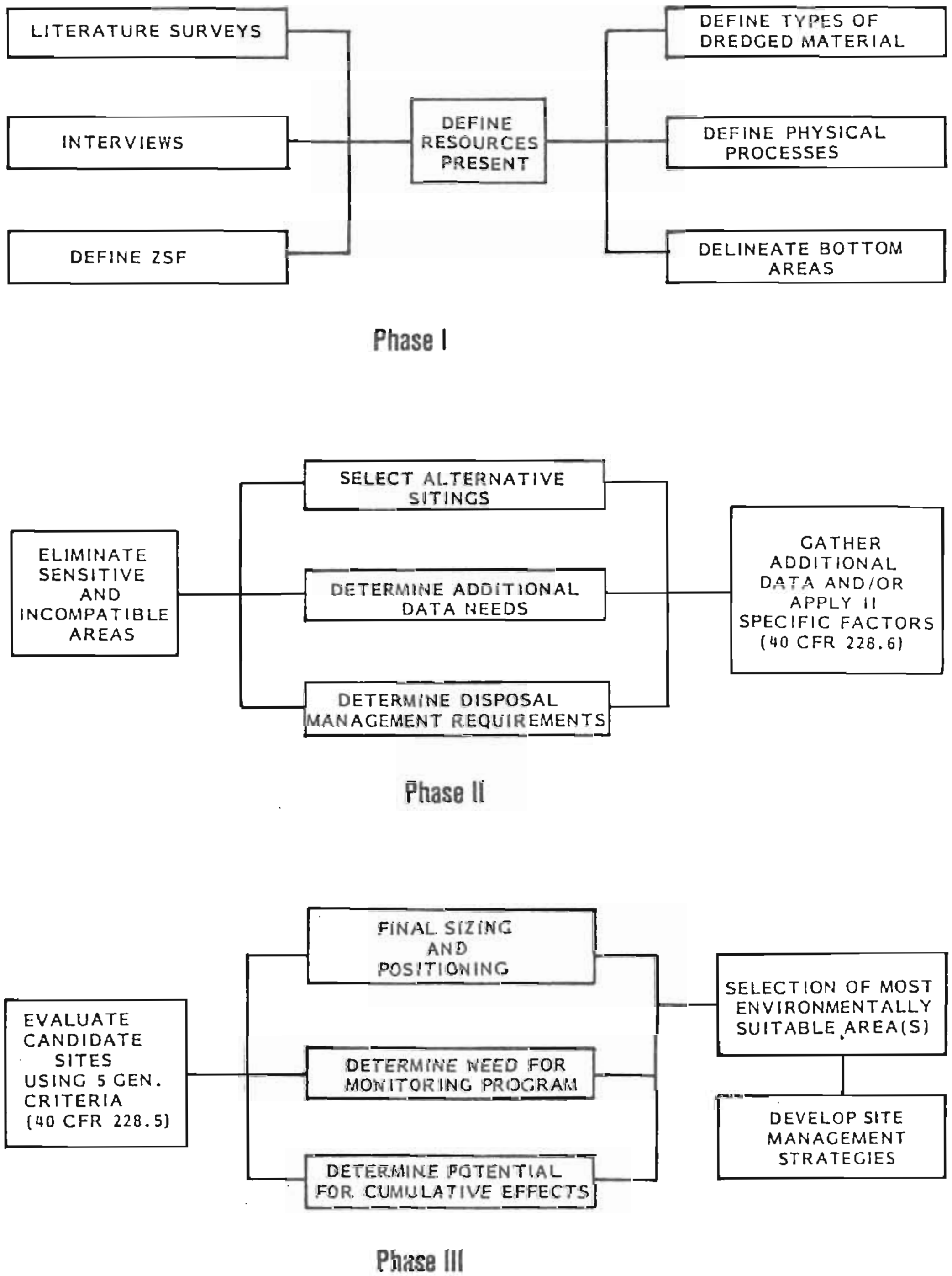


Figure 3
Overall Process for ODMDS Evaluation

Table 1

Eleven Specific Factors for Ocean Disposal Site Selection

1. Geographical position, depth of water, bottom topography, and distance from coast.

2. Location in relation to breeding, spawning, nursery feeding or passage areas of living resources in adult or juvenile phases.

3. Location in relation to beaches or other amenity areas.

4. Types and quantities of wastes proposed to be disposed of and proposed methods of release, including methods of packaging the waste, if any.

5. Feasibility of surveillance and monitoring.

6. Dispersal, horizontal transport, and vertical mixing characteristics of the area, including prevailing current velocity, if any.

7. Existence and effects of present or previous discharges and dumping in the area (including cumulative effects).

8. Interference with shipping, fishing, recreation, mineral extraction, desalination, shellfish culture, areas of special scientific importance and other legitimate uses of the ocean.

9. Existing water quality and ecology of the site, as determined by available data or by trend assessment or baseline surveys.

10. Potential for the development or recruitment of nuisance species within the disposal site.

11. Existence at or in close proximity to the site of any significant natural or cultural features of historical importance.

Table 2

General Criteria for the Selection of Ocean Disposal Sites

a. The dumping of material into the ocean will be permitted only at sites or in areas selected to minimize the interference of disposal activities with other activities in the marine environment, particularly avoiding areas of existing fisheries or shellfisheries, and regions of heavy commercial or recreational navigation.

b. Locations and boundaries of disposal sites will be chosen so that temporary perturbations in water quality or other environmental conditions during initial mixing caused by disposal operations anywhere within the site can be expected to be reduced to normal ambient seawater levels or to undetectable contaminant concentrations or effects before reaching any beach, shoreline, marine sanctuary, or known geographically limited fishery or shellfishery.

c. If at any time during or after disposal site evaluation studies, it is determined that existing disposal sites presently approved on an interim basis for ocean dumping do not meet criteria for site selection set forth in Section 228.5 - 228.6, the use of such sites will be terminated as soon as suitable alternative disposal sites can be designated.

d. The sizes of ocean disposal sites will be limited in order to localize for identification and control any immediate adverse impacts and to permit the implementation of effective monitoring and surveillance programs to prevent adverse, long-range impacts. The size, configuration, and location of any disposal site will be determined as a part of the disposal site evaluation or disignation study.

e. EPA will, wherever feasible, designate ocean dumping sites beyond the edge of the continental shelf and other such sites that have been historically used.

Sites Evaluated

25. The draft workbook and 40 CFR 228 separate evaluations given to new sites versus interim ODMDS. All alternative area sitings for the new ODMDS should be considered. An interim site can, however, be evaluated for continued use without examining other disposal site locations--providing all factors and criteria are fully examined. If a discussion of factors demonstrate that the existing site will not have an unacceptable adverse impact upon important resources, it is suitable for continuing use.

26. This approach will be employed for the Chetco River interim ODMDS evaluation. The first item under this approach is to conduct a literature search of existing information. The general bibliography of this search is provided at the end of the report. This bibliography was used as the initial step of all the technical appendixes.

27. Zone of Siting Feasibility (ZSF). The interim disposal site must be located within an economically and operationally feasible radius from the point of dredging. The draft workbook suggests establishing a ZSF. The ZSF at Chetco River was set as an arc transcribed 1.5 nautical miles out from rivermile (RM) 0 and ends both north and south at the beach (see figure 4).

28. The determination of a 1.5-mile limit is based on the amount of dredging necessary to maintain the channel to the authorized depth, the availability of dredging equipment that can be dedicated to that work, the volume per dredging unit, the time capability of equipment to dredge and haul the material to the disposal area, and the amount of time available annually to accomplish the necessary maintenance dredging.

29. The limit of the ZSF is controlled by the capability and availability of dredging equipment to remove up to 60,000 cubic yards. Present dredging is accomplished by a combination of government-owned and privately-owned hopper dredges. Portland District is limited by policy on the number of days which it can work the government-owned hopper dredge. Currently, 230 days are authorized, and must be allocated to other ports on the West Coast, as well as Chetco. Production capability of our dredge at this port is approximately 10,000 cubic yards per day--provided the haul distance is not more than 1.5 miles from the entrance. A disposal area located at a greater distance would reduce the capability of the dredge. Analyzing the

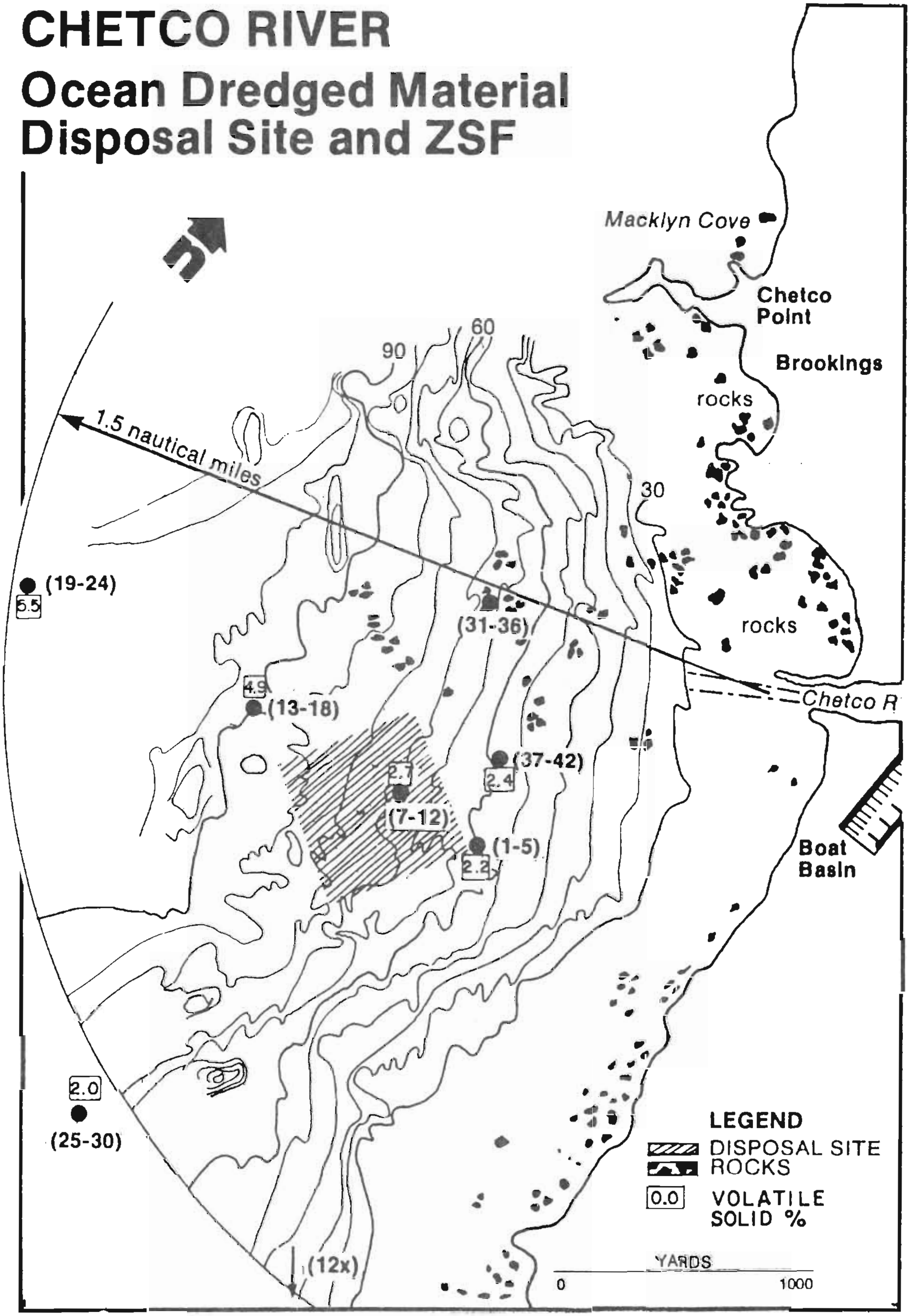


Figure 4

Chetco River ODMDS and ZSF

availability of work on the West Coast and that of contractor dredges capable of dredging this port, and the relatively small amount of material to be removed annually, it is unlikely that more than two pieces of contractor equipment would be available in any year and often the Corps may find there is no contractor-owned dredge available during the time period imposed by weather and sea conditions. Therefore, the outer limit of the ZSF is controlled by the capability of the available dredging plant and the limited dredging time period imposed by weather and sea conditions on the West Coast.

ALTERNATIVES

30. Ocean disposal of dredged materials is required for maintenance work near the river entrance. A hopper dredge must be used for this work because the rough seas encountered at the entrance are not suitable for safe operation of a pipeline dredge. Therefore, dredged material disposal must occur at an in-water site. There are no suitable sites in the estuary because of its narrowness and shallowness. In-bay disposal would have greater adverse environmental impacts than ocean disposal because estuarine habitats are generally more productive and far less extensive than are nearshore oceanic habitats.

31. Upland disposal is not feasible for economic and environmental reasons. Potential upland sites are available; however, because of the need to use a hopper dredge, it would be necessary to rehandle materials to use these sites. An in-water sump in the estuary would need to be dredged and material bottom-dumped into it, then pumped ashore with a pipeline suction dredge. This would be very costly and also would increase adverse environmental impacts of the project by adding the impacts of dredging an in-water estuarine site. Another adverse impact of upland disposal is that naturally occurring sediments would be removed from the littoral system and could cause erosion of nearby shorelines over the long term. Therefore, ocean disposal must be used if the authorized channel is to be maintained.

32. Two alternatives for ocean disposal were considered in detail for the Chetco ODMDS:

(1) Termination of ocean disposal at Chetco;

(2) Designation of the existing interim ODMDS.

APPLICATION OF SPECIFIC CRITERIA (228.6)

OVERVIEW

33. The determination of whether or not to continue disposal at the interim ODMDS will be based on a discussion of each of the 11 specific factors and 5 general criteria given in 40 CFR 228.6 and 228.5 and tables 1 and 2 of this report. The discussions of each factor and criteria which follow are general in nature, as they are discussed in detail in the technical appendixes. Each factor is examined and related to how it affects the continued use of the interim disposal site. Following the separate discussions, a comparison of all factors will be made. Resources of limited distribution within the ZSF, or which could be affected outside the ZSF, will be discussed, mapped, and compared to determine potential conflicts with the interim disposal site.

Geographic Location

34. Figure 4 indicates the location of Chetco interim ODMDS and bottom contours. The site lies in 50 to 70 feet of water, approximately 1.0 nautical mile offshore of the entrance to the Chetco River. Coordinates were presented in the Purpose and Need Section of this report. The site's center line is on a 270 degree azimuth. Bottom topography within the site is varied and is presented in detail in appendix B.

Distance from Important Living Resources

35. Aquatic resources of the site are described in detail in appendix A. The existing disposal site is located in the nearshore area and many nearshore pelagic organisms occur in the water column over the site. These include zooplankton (copepods, euphausiids, pteropods, and chaetognaths) and meroplankton (fish, crab and other invertebrate larvae). These organisms generally display seasonal changes in abundance. Since they are present over most of the coast, those from Chetco are not critical to the overall coastal population. Based on evidence from previous zooplankton and larval

fish studies, it appears that there will be no impacts to organisms in the water column (Sullivan and Hancock, 1978). The site is also adjacent to the neritic reefs and haystack rocks described in detail in appendix A. These reefs are unusual features along the coast and support a variety of aquatic organisms, including bull kelp (Nerocystis lutkeana) and its associated fish and invertebrate community. Recently, the Oregon Department of Fish and Wildlife (ODFW) has begun studying squid resources, and a spawning area offshore of the disposal site has been identified.

a. Benthic samples were collected at the locations shown in figure 4 and are discussed in detail in appendix A. Based on the analysis of benthic samples collected from the Chetco disposal site and the adjacent areas to the north and south, the disposal site contains a benthic fauna characteristic of nearshore, sandy, wave-influenced regions common along the coasts of the Pacific Northwest. The abundance and density of the infaunal community was found to be low at the disposal site, typical of shallow, nearshore, high energy habitats. The fauna is dominated by polychaete annelids (marine worms), small crustaceans (amphipods and cumaceans), molluscs (clams and snails), and echinoderms (sand dollars). The particular species identified from the disposal site are adapted to high energy environments and are able to withstand large sediment fluxes.

b. The disposal site is in an area where concentrations of common murres, gulls and other marine foraging species occur. Large concentrations have been observed shoreward of the interim site extending to and within the confines of the jetties. Concentrations undoubtedly occur at the site periodically. Concentrations of shorebirds, gulls, waterfowl, and other species occur in the Chetco estuary or on adjacent beaches.

c. Portland District has requested an endangered species listing for the site from U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). The brown pelican and the gray whale represent the only species which were listed. Based on previous biological assessments conducted along the Oregon coast regarding impacts to the brown pelican and the gray whale, no impact to either species is anticipated from the project. Letters of concurrence are included in appendix F, Comments and Coordination.

Distance from Beaches and other Amenities

36. Summer wave conditions may transport some sediment from the site shoreward and south, but the limiting depth for this movement is probably -40 to -50 feet mean lower low water (MLLW). The majority of disposal material is deeper than -50 feet MLLW, so little shoreward transport of dredged material is likely. Due to depth of disposal operations and the presence of the south reef, there is little possibility of beach nourishment by natural onshore movement of dredged material from the existing site.

Types and Quantities of Material to be Disposed

37. The interim disposal site will receive dredged materials transported by either government or private contractor hopper dredges. The current dredges available for use at Chetco have hopper capacities from 800 to 4,000 cubic yards. This would be the range in volumes of dredged material disposed of in any one dredging/disposal cycle. The approximately 48,000 cubic yards estimated to be removed annually from Chetco can be placed at the site in one dredging season by any combination of private and government plants (see discussion under ZSF). The dredges would be under power and moving while disposing. This allows the ship to maintain steerage.

38. The material to be dredged consists of medium to fine grain marine sands and coarser materials, including gravels and cobbles (appendix C, figures C-5,6,7). These materials are predominant in the entire project length, RM 0 to 2.8. Appendix C contains results of analyses performed on these materials. The sediments contain no excess concentrations of contaminants of concern (tables C-1 and 2), and are excluded from further biological and chemical testing as discussed in 40 CFR 227.13(b). The materials are also very similar to bottom materials at the interim disposal site and the entire nearshore area. Appendix B provides detailed grain size information for the disposal area and the dredged area.

Feasibility of Surveillance and Monitoring

39. The proximity of the interim disposal site to shore facilities creates an ideal situation for shore-based monitoring of disposal activities. There is, routinely, a Coast Guard vessel patrolling entrance and nearshore areas, so surveillance can also be accomplished by surface vessel.

40. If actual field monitoring of the disposal activities is required because of a future concern for a limited resource, several research groups are available in the area to perform any required work. The work could be performed from small surface research vessels at a reasonable cost.

Dispersal, Horizontal Transport, and Vertical Mixing Characteristics of the Area

41. The sediments dredged from the Chetco River entrance are predominantly marine sands and fluvial gravels. These are generally similar to sediments at the disposal site. Under winter wave conditions common to this part of the Pacific Coast, the sand component is highly mobile to a depth of 90-120 ft. Summer wave conditions commonly mobilize sands to a depth of 40-60 ft. Studies at Coos Bay show wave-generated currents can move this size sediment over 60 percent of the time during summer and winter and over 50 percent of the time during spring and fall (appendix B). While waves are responsible for resuspending bottom sediments, including dredged materials, it is the long-term mean current that determines the extent and direction of dispersal. While some winter storms would move gravels at the disposal site, these coarse sediments do not migrate very far away from the site and probably stay in the general area where they have been disposed.

42. The nearshore mean circulation is alongshore, closely paralleling the bathymetric contours, with a lesser onshore-offshore component. Circulation patterns are variable with season and weather conditions. In winter, the general shelf circulation is to the north, although short periods of southerly flow occur. Coos Bay studies suggest that offshore flow is more common in winter. This would indicate a tendency for sediment in the disposal site to move north and west under winter circulation conditions. During the remainder of the year, flow is southerly with lower current velocities than in winter. Periodic changes in summer wind direction lead to episodes of upwelling in which near-shore ocean water transport causes a compensating near-bottom onshore flow. These upwelling events occur between April and July and continue for several days at a time. Near-bottom flow in the vicinity of the disposal site during summer should be generally southerly with onshore/offshore flow varying due to local wind conditions.

Effects of Previous Disposals

43. Appendix B, table B-1 gives annual volumes of materials disposed for the last 10 years. On the average, 48,000 cubic yards have been disposed of annually. Future volumes are expected to be approximately the same. This volume has been required for the Corps to maintain the channel to its authorized depths (see discussion under ZSF).

44. The sidescan sonar map of the disposal site and adjacent areas (appendix B, figure B-5) shows an area of coarse sand/gravel covering about half of the site and extending north and west of the site up to 1200 feet, both offshore and toward the river entrance. This is most likely an accumulation of the coarser dredged material fractions that have remained in the same general area since disposal. There are no bathymetric anomalies associated with this deposit (no mounding). The feature will persist as long as coarse sediments are disposed in this area. This has not caused adverse impacts on habitat, however, since the overall area is characterized by a wide range of bottom types.

45. Literature and information searches revealed no information on the site prior to disposal. ODFW biologists (personal communication) indicated that they felt that, beyond the yearly site-specific impacts from disposal, there had been no significant cumulative impacts to the resources, and they recommended that the site be left at its present location (see discussion, appendix A).

46. No pre- or post-disposal water or sediment quality monitoring has been performed. Based on information presented in appendix C, there should be no historical or future chemical impacts on the marine environment surrounding the disposal site. Sediments disposed are physically the same as the sample collected in close proximity to the disposal site (appendix B), and no chemical contaminants are present in higher concentrations in either one (tables C-1 and 2). The elutriate analysis discussed in appendix C also showed minimal contaminant releases during this simulated disposal operation with receiving water from the interim disposal site.

Interference with Other Uses of the Ocean

47. This section examines potential interference with other legitimate uses of the ocean.

a. Commercial Fishing. Two active commercial fisheries occur in the inshore area, salmon trolling and Dungeness crab fishing (appendix A). The length of the salmon fishing season varies each year depending upon the established quota; however, it normally extends from July to September. During this period, the potential exists for conflicts between the dredge and fishing boats. The Coast Guard and ODFW indicated that they were unaware that this had ever been a problem. The Dungeness crab season is from December 1 to August 15; however, most of the fishing is done prior to June and usually ends early because of the increase in soft shell crabs in the catch which are not marketable. As a result, most crab fishing is done outside of the normal dredging season and it is unlikely that a conflict would result. ODFW feels a potential squid fishery may exist offshore from the existing site (see appendix A). No fishery exists at present, but stocks may be sufficient to support a fishery if a market develops. There are no existing commercial fish or shellfish aquaculture operations that would be impacted by continued use of the existing disposal site.

b. Recreational fishing. Recreational fishing opportunities are extensive and varied in the Chetco area (appendix D). Primary activities include fishing, camping, and sightseeing. The small boat harbor is used extensively in the summer by recreational fishermen. Private party and charter boat recreational fishing for both salmon and rock and reef fish occur in nearshore areas. The salmon fishing season coincides with the commercial season and extends from early summer until the quota for the area is reached. Recreational fishing boats have a potential for conflicting with dredging operations; however, none has been reported to date. It is unlikely that any significant conflict will develop in the near future.

c. Offshore Mining Operations. All considerations for offshore mining and oil/gas leases are in the development stages. The disposal site is not expected to interfere with any of the proposed operations, as most exploration programs are scheduled for the outer continental shelf.

d. Navigation. No conflicts with commercial navigation traffic have been reported and none are expected, due to the light traffic in the Chetco River area. This situation is not expected to change substantially. Rock pinnacles that are navigation hazards occur nearshore and in the southern

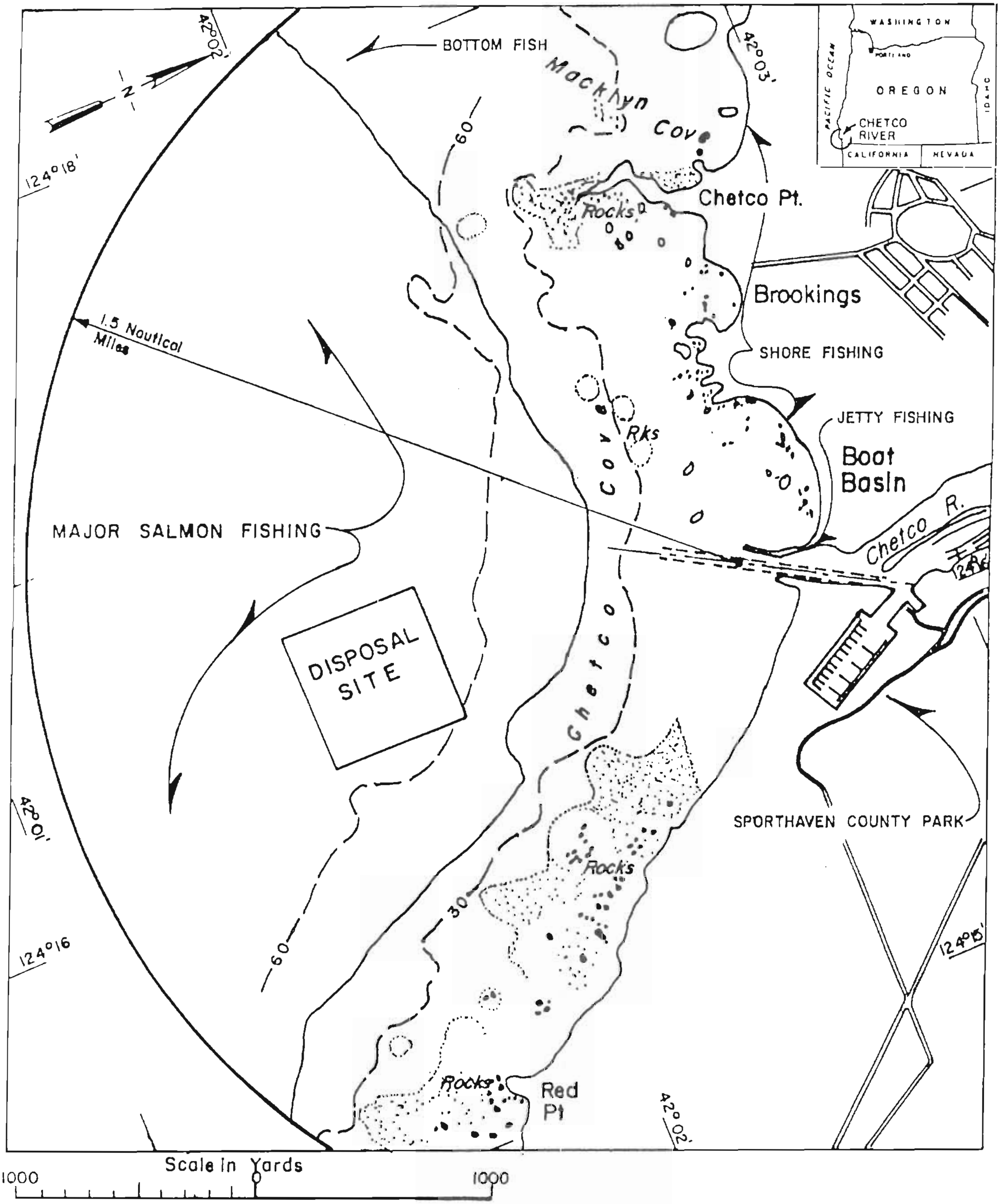


Figure 5
Recreational Resources

part of the ZSF. These submerged and emergent pinnacles should be avoided when considering final position of the ODMDS.

e. Scientific. There are no known transects or other scientific study locations that could be impacted by the disposal site.

f. Coastal Zone Management. Local comprehensive land use plans for the Chetco area have been acknowledged and approved by the State of Oregon. These plans discuss ocean disposal and recognize the need to provide for suitable offshore sites for disposal of dredged materials. In addition, this site evaluation document establishes that no significant effects on ocean, estuarine, or shoreland resources are anticipated, as Goal 19 of the Oregon Statewide Planning Goals and Guidelines requires.

48. The proposed action has been determined by the Corps to be consistent with the acknowledged local comprehensive plans and the State of Oregon Coastal Zone Management Program. The State of Oregon, Department of Land Conservation and Development has reviewed this consistency determination with a request to provide written notification of their findings. Their letter is included in appendix F, "Comments and Coordination", of the final document.

Existing Water Quality and Ecology

49. Water and sediment quality analyses conducted at several Oregon ODMDS are discussed in appendix C. These studies have not shown persistent adverse water quality impacts from ocean disposal of entrance shoal sands. Such impacts are not expected from dredged material disposal at the Chetco ODMDS.

50. The ecology of the area can be discussed in general terms based on information presented in appendix A. From available information, the offshore area within and adjacent to the ODMDS is a typical northwest Pacific mobile sand community, shifting to the north and southeast to a neritic reef system, also described in appendix A. This determination is based mainly on fisheries, shellfish, and geophysics data. These sand communities are ubiquitous to nearshore ocean habitats off Oregon; disposal at the Chetco ODMDS is not expected to impact these communities. The site

is sufficiently removed from rock and kelp habitats so that they also will not be impacted by ocean disposal.

Potential for Recruitment of Nuisance Species

51. All materials to be dredged and transported to the interim disposal site have been classified as noncontaminated marine sands (appendix C). They have further been discussed as being similar to sediments from the interim disposal site. It is, therefore, highly unlikely that any nuisance species could be established at the disposal site. Nuisance species are considered as any undesirable organism not previously existing at the disposal site and either transported to or attracted there because of the disposal of dredged materials and capable of establishing themselves there.

Existence of Significant Natural or Cultural Features

52. Neritic reefs, common off the southern Oregon coast, comprise a unique ecological feature. They support a wide variety of invertebrates and fish species unique to rocky areas, as well as bull whip kelp communities. These areas are sheltered from wave action and, when receiving nutrients from both the ocean and the estuaries as they do within the ZSF, are unusually highly productive. The ODMDS is removed from these areas.

53. The cultural resource literature search of the Chetco River study area, described in appendix E, did not document any wrecked vessels in the project area. This is consistent with the fact that the Chetco River historically has not been a major shipping point on the coast. Most export commodities, especially timber products, have been transported by rail and barge rather than by lumber schooner or ship.

54. Wrecks could occur in the area that have not yet been discovered. However, based on previous investigations in other Oregon coastal settings (Yaquina Bay, Coquille, Columbia River Mouth), beaches, surf zones, neritic reefs, and shallow waters are the most likely areas for shipwreck occurrence. The ODMDS is removed from these areas. Also, there were no indications of wrecks from the side scan sonar survey completed during geophysical investigations within the ZSF.

55. It has been determined, based on the considerations in appendix E, that there will be no cultural resources impacts from designation of the Chetco

ODMDS. Appendix E, along with supplementary side scan sonar data, has been reviewed by the Oregon State Historic Preservation Officer to determine whether they concur with this finding. Their coordination letter is included in appendix F.

APPLICATION OF GENERAL CRITERIA (228.5)

GENERAL

56. An evaluation of an ODMDS is based on the 11 specific factors in 40 CFR 228.6 of the ocean dumping regulations and criteria. The 11 factors have been discussed in the preceding section. The next step is to utilize the 11 specific factors to discuss requirements of the five General Criteria (40 CFR 228.5).

Minimal Interference with Other Activities

57. The first of the five criteria require that a determination be made as to whether the site will minimize interference of the proposed disposal operations with other uses of the marine environment. This determination will be made by overlaying several individual maps presented in the technical appendixes onto a base map, giving bathymetry and location of the interim disposal site, and ZSF. The selection of figures to use for this determination was dependent on whether the resource was considered limited. A coast-wide resource, i.e. flat fish spawning area, was not considered a limited resource and was not included in the overlay evaluation technique. The following figures, depicting spatial distribution of specific resources, were included in the evaluation of resources of limited distribution.

- o Navigation Hazards Area/Other Recreation Areas
- o Shellfish Areas
- o Critical Aquatic Resource
- o Commercial and Sport Fishing Areas
- o Geological Features
- o Cultural, Historically Significant Areas

58. Figure 2 is a composite of all of the above figures and demonstrates, by various line densities, areas to avoid when placing a disposal site. The

denser the grid of lines, the more critical the area, as more interactions between various limited resources, are taking place. As the figure shows, the existing site is within a minimal conflict area in the ZSF, with the exception of the chinook salmon fishing area. This area is fished summer and fall of each year (actual length of the fishing season is set annually by Pacific Fisheries Management Council). Disposal operations can take place from May through October of each year. While this represents a temporal overlap, communications with ODFW personnel (appendix A) indicate no observable conflicts between the two uses of the area. The remaining lighter area of salmonid fishery is not concentrated in one location or time of year, and there have been no observable conflicts between fishermen and disposal operations. Appendix A contains a discussion of all potential conflicts within the ZSF with living resources, and concludes that there have been no major conflicts in the past or predictable conflicts in the near future.

Minimizes Changes in Water Quality

59. The second of the five general criteria required changes to ambient seawater quality levels occurring outside the disposal site be within water quality standards and that no detectable contaminants reach beaches, shoreline, sanctuaries, or geographically limited fisheries or shellfisheries. Figure 2 was utilized to determine the potential for effects on items mentioned above. The nature of material has already been discussed as clean sand; because of this no significant contaminant or suspended solids releases are expected. There should be no water quality perturbations to be concerned with moving toward a limited resource. Bottom movement of deposited material is discussed in appendix B and in general shows a net offshore movement for the finer fractions. Coarser fractions stay in the same general area.

Interim Sites Which Do Not Meet Criteria

60. The evaluation indicates that the interim disposal site would meet the criteria and factors established in 40 CFR 228.5 and 228.6. No reported problems or complaints have been received by the Corps on use of this site. The site is environmentally acceptable for the types and quantities of dredged material it presently receives.

Size of Sites

61. The fourth general criterion requires that the size, configuration and location of the site will be evaluated as part of the study. The Chetco River interim ODMDS is a square 1,800 feet x 1,800 feet. While most other Oregon ODMDS are rectangular, the Chetco ODMDS is similar in areal size and location to those sites. This disposal site is considered dispersive and is of adequate size to accommodate the annual volumes of material it presently receives. Public notices issued for ocean disposal operations at various Federally authorized projects, as required by MPRSA, have not generated concerns about significant impacts from their use. Also, no comments have been received about the size, shape, or location of the interim disposal sites. The Chetco site is located close enough to shore and harbor facilities that monitoring and surveillance programs, if required, could easily be accomplished.

Sites Off the Continental Shelf

62. Any possible disposal sites off the continental shelf in the Oregon area are at least 20 nautical miles offshore. By contrast, the Chetco ZSF extends a maximum of only 1.5 nautical miles from shore. Therefore, utilization of a continental slope disposal site is economically infeasible. The project could not be maintained if a slope site was required. Also, use of a site off the continental shelf would result in loss of the dredged sediments from the nearshore littoral transport system, which could cause detrimental bottom or shoreline changes in the ZSF. Further, very little is known of the ecology of benthic communities on the continental slope, and disposal in this area could cause impacts of unknown severity. For these reasons, designation of an ODMDS off the continental shelf is not desirable, either economically or environmentally.

CONFLICT MATRIX ANALYSIS

63. Once the specific and general site selection criteria were addressed for the proposed disposal site, a conflict matrix analysis was completed. Portland District developed the matrix format to simplify the general and specific site criteria review process and has used the matrix for several ODMDS studies. Each area of consideration on the conflict matrix addresses

at least one general and specific criteria. Table 3 contains comments pertinent to the criteria for the proposed site. In addition to the conflict matrix, operational constraints and cost were considered for the site.

AFFECTED ENVIRONMENT

64. A brief summary of the existing conditions at the proposed disposal site (figure 6) is presented below and is the basis for evaluating the suitability of the sites for ocean disposal. More detailed information on the affected environment is presented in the appendixes.

PHYSICAL ENVIRONMENT

65. The topography of the seabed in the vicinity of the proposed disposal site is highly irregular, from areas which are relatively smooth to clusters of rock pinnacles. The contours generally form an embayment sloping to the southwest. Depths at the site range from 60 to 85 feet. Previous disposal operations have not created a noticeable mound. Bathymetric surveys made in 1984 and 1985 showed no change in topography.

66. Bottom sediments range from fine sand to rock outcroppings. About half of the site consists of scattered rock exposures while the remainder consists of sand, coarse sand and gravel. Finer sediments are carried in suspension and are quickly removed from the site by longshore and offshore currents. Coarser sediments remain at the site for longer periods but are eventually removed offshore by currents. The zone of active sediment movement in the area extends to a depth of about -150 feet. The thinness of the sediment layer indicates that there is no long term accumulation of sediment offshore from the Chetco River estuary.

67. The materials dredged from the mouth of the Chetco River are medium to coarse sands with occasional gravels similar in range to the existing

Table 3

Chetco Ocean Dredged Material Disposal Area Conflict Matrix
for Evaluating Potential for Conflict with Required Considerations
of the Marine Protection Research and Sanctuaries Act

AREA OF CONSIDERATION	CONFLICT	POTENTIAL CONFLICT	NO CONFLICT	BENEFICIAL USE	COMMENTS	RELEVANT SPECIFIC FACTORS (From Table 1 & 40CFR 228.6)	RELEVANT GENERAL CRITERIA (From Table 2 & 40CFR 228.5)
1. Unusual Topography			X			1, 6, 8, 11	a
2. Physical Sediment Compatibility			X		Material to be dredged is rock, cobbles, and sand. Variation of material to be dredged is matched by disposal site material.	2, 4, 9	b, c, d
3. Chemical Sediment Compatibility			X			3, 4, 7, 9	a, b, c, d
4. Influence of Past Disposal			X		No mounding-dumping on similar materials. Some evidence of "short dumping" adjacent to east boundary of site.	5, 7, 9, 10	a, b, d
5. Living Resources of Limited Distribution			X			2, 3, 6, 8, 11	a, b, d
6. Commercial Fisheries		X			Salmon trolling, bottom trawling throughout area. No known areas of concentrated effort in ZSF.	2, 8	a, b
7. Recreational Fisheries		X			Salmon, bottom fishery. No evidence of problem currently.	2, 8	a, b
8. Breeding/Spawning Areas			X			2, 8	a, b
9. Nursery Areas		X			Juvenile flatfish nursery area.	2, 8	a, b
10. Feeding Areas			X		Pelagic birds; marine mammals.	2, 8	a, b
11. Migration Routes		X			Adult and juvenile salmonids; many pelagic birds, and marine mammals.	2, 8	a, b
12. Critical Habitats of Threatened or Endangered Species			X		T&E species present: brown pelican, 5+ species of whale. No critical habitat designated in area.	2, 8	a, b
13. Spatial Distribution of Benthos			X			2, 8, 10	a, b
14. Marine Mammals			X		Present	2, 8	a, b
15. Mineral Deposits			X			1, 8	a, b, e
16. Navigation Hazard		X			Potential for collisions with troll fishing vessels in fog conditions; has not been a problem historically.	1, 8	a, b, d
17. Other Uses of Ocean (cables, pipelines, etc.)			X			8	a, b, d
18. Degraded Areas			X			4, 6, 7	a, b, d
19. Water Col. Chem./Phys. Characteristics			X			4, 6, 9	a, b, d
20. Recreational Uses			X			2, 8, 11	a, b, c, d
21. Cultural/Historic Sites			X			11	b
22. Physical Oceanography: Waves/Circulation			X			1, 3, 6, 7	a, b, d
23. Direction of Transport/Potential for Settlement			X			1, 3, 6, 7	a, b, d
24. Monitoring			X			5	c
25. Shape/Size of Site (orientation)			X			1, 4, 7	d
26. Size of Buffer Zone		X			Potential for material loss to rock pinnacles inshore; no documented problem.	2, 3, 4, 7, 11	b, d
27. Potential for cumulative Effects			X			4, 7	c, d

Table 3
Conflict Matrix

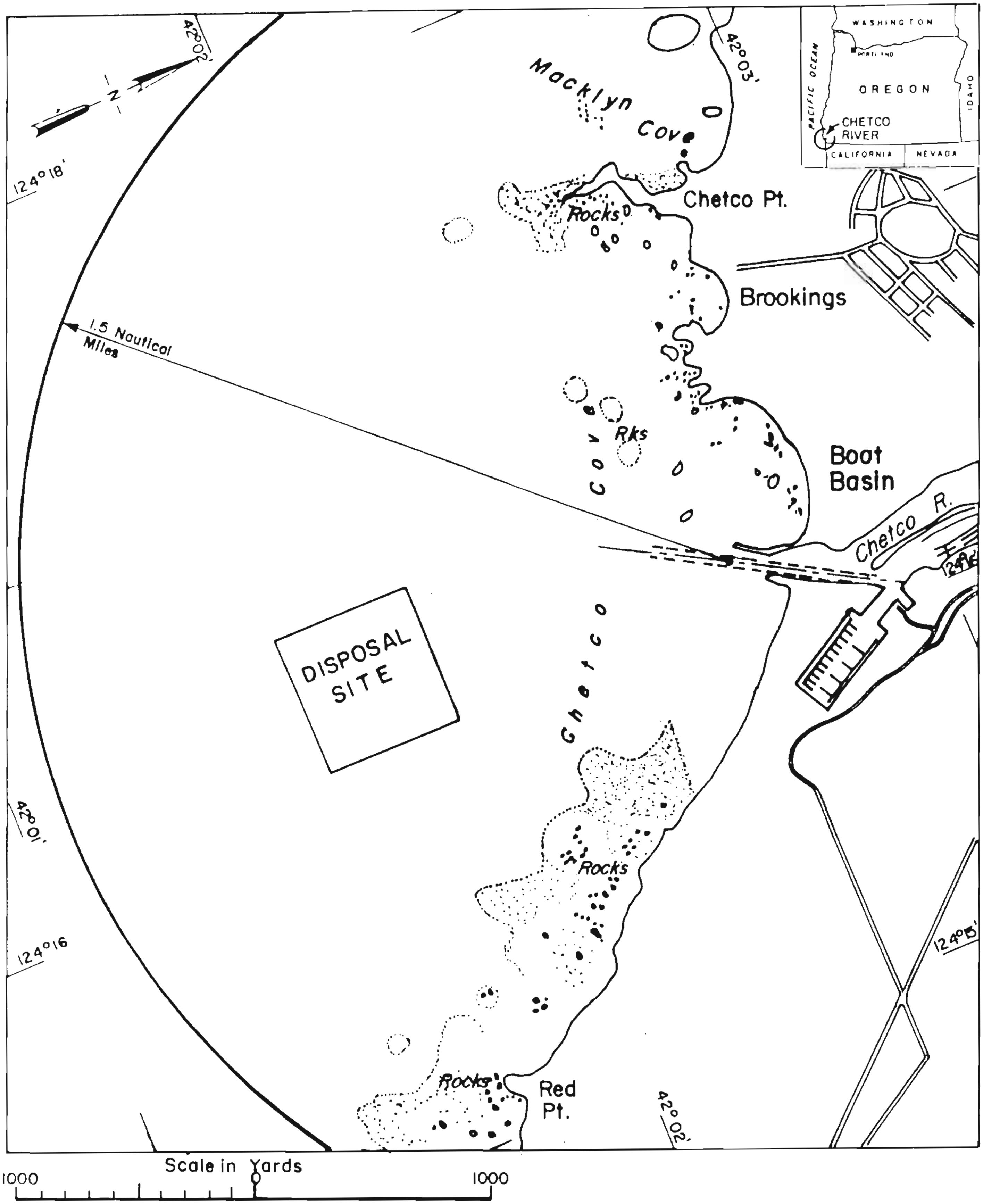


Figure 6

Proposed Disposal Site Location

nearshore sediments. Dredging volumes for the past 10 years range from 8,000 to 80,000 cubic yards, averaging 48,000 cubic yards per year.

68. Water and sediment quality in the vicinity of the channel entrance and disposal site is typical for seawater of the Pacific Northwest with no known sources of pollutants.

BIOLOGICAL ENVIRONMENT

69. The disposal site is located in the nearshore environment and the overlying waters contain many nearshore pelagic organisms. These include zooplankton (copepods and euphausiids) and meroplankton (fish, crabs, and other invertebrate larvae). These organisms generally display seasonal changes in abundance with maximum abundance occurring from February to July.

70. Benthic sampling in the vicinity of the disposal site indicates variation of species with the sediment type. The sand cobble community is characterized by the scale worm, barnacles, and archiannelids, in addition to the more typical polychaetes, cumaceans, and amphipods. Juvenile Dungeness crabs are also found in high densities. The sand environments are characterized by polychaete annelids and numerous species of cumaceans, gammarid amphipods, molluscs, and snails. The species inhabiting the sandy environments are generally more mobile types which tolerate or require high sediment flux. Juvenile crabs are also abundant in this environment.

71. Commercially and recreationally important macroinvertebrates such as shellfish and Dungeness crabs occur in the Chetco vicinity. Most of these species are found in shallower habitats than the disposal site. Pelagic and demersal fish species in the vicinity of the disposal site include coho and chinook salmon, steelhead, surfperch, starry flounder, lingcod, English, Dover, petrale sole, and sablefish.

72. Numerous species of birds and mammals occur in the pelagic, nearshore, and shoreline habitats in and surrounding the proposed disposal site. Principal species found offshore are gulls, cormorants, auklets, pigeon, guillemots, tufted puffins, and harbor seals. Several species of special concern, i.e. gray whale, bald eagle, peregrine falcon, and brown pelican occasionally occur along the coast. The brown pelican and gray whale are

the only species listed by the U.S. Fish and Wildlife Service and the National Marine Fisheries Service which are likely to occur in the area offshore from the Chetco River.

SOCIO-ECONOMIC ENVIRONMENT

73. The Chetco River enters the Pacific Ocean at the City of Brookings, Oregon, and navigation on the river is critical to the local economy. The City of Brookings has a population of 3,470, while Curry County's population is 17,000.

74. The Chetco Bay area is popular with recreationists because of the spectacular coastal scenery and excellent fishing opportunities both offshore and in the Chetco River. The area is increasing in popularity as a small boat harbor and has excellent facilities for the thousands of anglers who fish here annually. The offshore area also supports a moderate commercial fishery, primarily for salmon, rockfish, and sole. Dungeness crab is also commercially harvested in the estuary and offshore. The fishing and tourist industries are the primary sources of income to the local economy.

75. Lumber and other wood products are barged from Brookings Harbor and are a significant component of the local economy. No significant mineral or petroleum deposits are known to exist in the vicinity of the proposed disposal site.

76. Cultural resource investigations indicate that no significant archeological or historic resources exist in the vicinity of the disposal site.

ENVIRONMENTAL EFFECTS

GENERAL ENVIRONMENTAL EFFECTS

77. The proposed action is the designation of a site for ocean disposal of dredged material. Designation of the site would not have any direct

environmental effects, but it would subject the site to use as an ocean disposal area. Therefore, this document addresses the likely effects of disposal at the site based upon the current Operation and Maintenance dredging program for the Chetco River navigation project. A separate evaluation of the suitability of dredged material and disposal impacts will be conducted for each proposed disposal action as required under Section 103 of the MPRSA.

EFFECTS ON PHYSICAL ENVIRONMENT

78. Disposal of the expected dredged material at the proposed disposal site would not have a significant effect on the physical environment. The material ranges in size from fine sand to gravel. This is comparable to the variation in sediment size found in or near the disposal site. Some rocky bottom habitat might also be buried by sand deposited on it. The dredged material would disperse from the site in the littoral drift system with movement expected to be to the north and offshore during the winter and lesser movement to the south in summer. No mounding is expected to occur.

79. The material to be dredged consists of clean sand containing no contaminants of concern in excess levels and would be excluded from further biological and chemical testing as discussed in 40 CFR 227.13(b). Therefore, disposal would not introduce contaminants to the sediments at the disposal site or degrade water quality, other than short term turbidity.

80. No mineral resources are expected to be affected by disposal.

EFFECTS ON BIOLOGICAL ENVIRONMENT

81. Impacts to the biological environment would be primarily to the benthic community. Some mortality would occur as a result of smothering. Most of the benthic species present are motile and adapted to a high energy environment with shifting sands. Therefore, many would likely survive the effects of disposal. In addition, some recolonization would occur from surrounding areas since the sediments would be compatible. The rate of

recolonization would be affected by disposal frequency. Impacts could be greater in the rocky portion where more species are found and many of them are sessile or encrusting forms which are susceptible to smothering.

82. Larger, more motile organisms such as fish, birds, and marine mammal species would likely avoid the disposal activity or move out once it has begun. They would be exposed to short term turbidity at most. Therefore, impacts are expected to be limited to disturbance rather than injury or mortality.

83. The brown pelican and the gray whale are the only endangered species indicated by the USFWS and NMFS as likely to occur in the project area. Biological assessments addressing impacts to these species have been prepared and it was determined that no significant impact to either species is anticipated from the designation or use of the ocean disposal site.

EFFECTS ON SOCIO-ECONOMIC ENVIRONMENT

84. The designation of an ocean disposal site for dredged material off the mouth of the Chetco River would allow the continued maintenance of the navigation channel. This would result in waterborne commerce remaining an important component of the local economy. If a site is not designated, maintenance dredging would cease for lack of adequate disposal sites. The channel would shoal in and become unsafe or unusable. Shipping and fishing traffic would have to be directed through other ports and the local economy would suffer.

85. No known mineral or economic resources would be impacted by disposal at the proposed site.

86. Few impacts to recreation are expected to occur. Recreational fishery resources would be temporarily displaced during disposal operations. Time delays for recreational boaters caused by the passing of the dredge or an increase in navigation hazards during congested periods could occur. Conflicts such as these can be considered an inconvenience rather than a threat to recreational activity.

87. There would be a short-term reduction in aesthetics at the disposal site as a result of turbidity following disposal. The material would settle rapidly and not affect any areas outside of the disposal area. No impacts would occur on the beach or adjacent recreation areas.

88. It is unlikely that any cultural resources are present in the proposed disposal site. Therefore, designation or use of the site is not expected to have any impact on cultural resources.

89. In reviewing proposed ocean disposal sites for consistency with the Coastal Zone Management (CZM) plan, they are evaluated against Oregon's Statewide Goal 19 (Ocean Resources). Local jurisdiction does not extend beyond the baseline for territorial seas and, therefore, local plans do not address offshore sites. Goal 19 requires that agencies determine the impact of proposed projects or actions. Paragraph 2.g of Goal 19 specifically addresses dredged material disposal. It states that agencies shall "provide for suitable sites and practices for the open sea discharge of dredged material which do not substantially interfere with or detract from the use of the continental shelf for fishing, navigation, or recreation, or from the long-term protection of renewable resources". Decisions to take an action, such as designating an ocean disposal site, are to be preceded by an inventory and based on sound information and on an understanding of the resources and potential impacts. In addition, there should be a contingency plan and emergency procedures to be followed in the event that the operation results in conditions which threaten to damage the environment.

90. Ocean disposal sites for dredged material are designated following guidelines prepared by the EPA (Ocean Dumping Regulations). Site selection is to be based on studies and an evaluation of the potential impacts (40 CFR Part 228.4(e)). This meets the requirements of State Goal 19 for decisions to be based on inventory and a sound understanding of impacts. The five general and eleven specific criteria for the designation of a site presented in 40 CFR 228.5 and 228.6 outline the type of studies to be conducted and the resources to be considered. According to 40 CFR Part 228.5(a), ocean disposal will only be allowed at sites "selected to minimize the interference of disposal activities with other activities in the marine environment, particularly avoiding areas of existing fisheries or shellfisheries, and regions of heavy commercial or recreational navigation". Monitoring is to be conducted at ocean disposal sites; and if adverse

effects are observed, use of the site may be modified or terminated. The requirements of the ocean dumping regulations are broad enough to meet the need of Goal 19. Therefore, the designation of this site for ocean disposal of dredged material following the ocean dumping regulations would be consistent with Goal 19 and the State of Oregon's Coastal Zone Management Plan.

COORDINATION

91. Procedures used in this evaluation and the proposed continued use of the interim site has been discussed with the following State and Federal agencies.

- o Oregon Department of Fish and Wildlife
- o Oregon Department of Environmental Quality
- o Oregon Dept. of Land Conservation and Development
- o Oregon Division of State Lands
- o U.S. Coast Guard (Newport Station)
- o U.S. Fish and Wildlife Service
- o National Marine Fisheries Service
- o U.S. Environmental Protection Agency

92. The agencies were briefed on evaluation techniques and existing information was requested of them. A formal public involvement program designed to receive comments from all state and local agencies, private groups, and individuals will be carried out by EPA during the final site designation process. Coordination letters received in response to requests to evaluate consistency determinations made in this document are included in appendix F.

93. This proposed Federal action requires concurrence or consistency for three Federal laws from the responsible agencies as indicated below.

o Endangered Species Act of 1973, as amended	U.S. Fish & Wildlife Service National Marine Fisheries Service

o National Historic Preservation Act of 1966, as amended	State Historic Preservation Officer
o Coastal Zone Management Act of 1972, as amended	Oregon Department of Land Conservation and Development

Consistency or concurrence letters from the above listed agencies are included in appendix F. State water quality certification, required by Section 401 of the Clean Water Act, will be obtained for individual dredging actions.

GENERAL BIBLIOGRAPHY

Anderson, G.C., 1978. Biological oceanography of the coastal waters off Washington, UW/Oceanography Research Abstract.

Anderson, I., 1982. Near-inertial motions off the Oregon coast. Masters thesis, Oregon State University, Corvallis, OR.

Araniegu, J.R.L., 1975. Shoreline changes due to jetty construction on the Oregon Coast, MS, OSU, Ocean. ORESU-X2-75-007.

Baldwin, E.M., 1976. Geology of Oregon. Univ. of Oregon, Kendall/Hunt Pub. Co., 170 pp.

Barner, Debra Carol, 1982. Shell and Archaeology: An Analysis of Shellfish Procurement and Utilization on the Central Oregon Coast, unpublished MA thesis, OSU, Corvallis, OR.

Barnes, James Ray, 1967. The morphology and ecology of Echinorhynchus lageniformis Ekbaum, 1938 (Acanthocephala). Corvallis, Oregon. MS thesis. OSU. 42 pp.

Bayer, R., 1983. Ore Aqua Company Biologist, Newport, OR. Personal communication.

Beardsley, Alan Jackson, 1969. Movement and angler use of four foodfishes in Yaquina Bay, Oregon. Corvallis, OR. PhD thesis. OSU. 173 pp.

Becker, Clarence Dale, 1955. Larval setting and survival of young oysters, Ostrea lurida Carp., under laboratory conditions. Corvallis, OR. MS thesis. OSU. 97 pp.

Beckham, Stephen Dow, 1977. The Indians of Western Oregon. This Land was Theirs. Coos Bay, OR:Arago Books.

Berglund, Lisette Aline, 1972. Laboratory studies of successional patterns in assemblages of attached estuarine diatoms. Corvallis, OR. MS thesis. OSU. 71 pp.

Bodavarsson, G.M., 1975. Ocean wave-generated microseisms at the Oregon Coast. MS thesis, OSU, 83 pp.

Boettcher, R.S., 1967. Foraminiferal trends of the Central Oregon shelf, MS OSU.

Bourke, R.H., 1972. A study of the seasonal variation in temperature and salinity along the Oregon-Northern California coast. PhD thesis, Oregon State University, Corvallis, OR.

Bourke, R.H., B. Glenne, and B.W. Adams, 1971. The nearshore physical oceanographic environment of the Pacific NW coast. OSU Ref 71-45, Dept. of Oceanography, OSU, Corvallis, OR.

Bourke, Robert Hathaway, 1969. Monitoring coastal upwelling by measuring its effects within an estuary. Corvallis, Oregon. MS thesis. OSU. 54 pp.

Burt, W.V. and B. Wyatt, 1964. Drift bottle observations of the Davidson Current off Oregon. Dept. Ocean. Tech. Rept. 34, Oregon State Univ., Corvallis, OR.

Burt, W.V., 1962-63. Oregon oceanographic studies OSU/Oceanography NSF-G19783/GP-622.

Bushnell, D.C., 1964. Continental shelf sediments in the vicinity of Newport, Oregon. MS thesis, OSU, 107 pp.

Butler, Jerry Allan, 1968. Effects of the insecticide Sevin on the cockle clam Clinocardium nuttallii (Conrad). Corvallis, Oregon. MS thesis. OSU. 54 pp.

Byrne, J.V. and D.A. Panshin, 1977. Continental shelf sediments off Oregon. OSU Sea Grant Pub. 8.

Byrne, J.V. and L.D. Kulm, 1967. Natural indicators of estuarine sediment movement. J. Waterways and Harbors Division, 93(WW2), Proceedings Paper 5220, pp 181-194, American Society of Civil Engineers.

Byrne, J.V., 1962. Geomorphology of the continental terrace off the central coast of Oregon. Ore Bin 24:65-74.

Byrne, J.V., 1962. Here's a look at offshore Oregon. The Oil and Gas Journal. July 23, 1962, pp 116-119.

Byrne, J.V., 1963. "Coastal erosion, Northern Oregon", in Essays in Marine Geology, Clements, ed., pp 11-33.

Carey, A., Pearcy, Richardson, Demory, Tyler, and Warren, 1980. Pleuronecticl Production System and its Fishery; OSU/Oceanography Sea Grant Research Abstract.

Carey, A.G., 1965. Preliminary studies on animal-sediment interrelationships off the central Oregon Coast, Ocean Sci & Ocean Eng 1:100-101.

Chambers, D.M., 1969. Holocene sedimentation and potential placer deposits on the continental shelf off the Rogue River, Oregon. MS thesis, OSU, 102 pp.

Choir, B., 1975. Pollution and tidal flushing predictions for Oregon's estuaries, OSU, Civil Eng. ORESU-X2-75-010.

Chriss, T.M., 1977. Optical evidence of sediment resuspension, Oregon continental shelf. EOS, 58(6),410, American Geophys. Union Spring meeting, Washington, D.C.

Collins, C.A., 1964. Structure and kinematics of the permanent oceanic front off the Oregon coast. Masters thesis, Oregon State University, Corvallis, OR.

Collins, C.A., 1968. Description of measurements of current velocity and temperature over the Oregon continental shelf, July 1965-Feb 1966. PhD thesis, Oregon State University, Corvallis, OR.

Collins, C.A., H.C. Creech and J.G. Pattullo, 1966. A compilation of observations from moored current meters and thermographs, Vol. I. OSU

Dept. Ocean Data Rep. 23, Ref. 66-11, Oregon State University, Corvallis, OR.

Collins, C.A. and J.G. Pattullo, 1970. Ocean currents above the continental shelf off Oregon as measured with a single array of current meters. J. Marine Research 28(1), 51-68.

Creech, H.C., 1978. An intense October NE Pacific Storm, in Mariners Weather Log 22:90-92.

Creech, C., 1981. Nearshore wave climatology, Yaquina Bay, Oregon (1971-1981). OSU Sea Grant Program Rep. ORESU-T-81-002, Oregon State University, Corvallis, OR.

Crook, Gene Ray, 1970. In situ measurement of the benthal oxygen requirements of tidal flat deposits. Corvallis, Oregon. MS thesis. OSU. 113 pp.

Cutchin, D.L. and R.L. Smith, 1973. Continental shelf waves: low-frequency variations in sea level and currents over the Oregon continental shelf, J. of Physical Ocean., 3(1),73-82.

Cutchin, D.L., 1972. Low frequency variations in the sea level and currents over the Oregon continental shelf, thesis, Oregon State University, Corvallis, OR.

DeMort, Carole Lyk, 1970. The culture and biochemical analysis of some estuarine phytoplankton species. Corvallis, Oregon. PhD thesis. OSU. 157 pp.

Denner, W., 1963. Sea water temperature and salinity characteristics observed at Oregon coast stations in 1961, MS thesis, Oregon State University, Corvallis, OR.

DeRycke, Richard James, 1967. An investigation of evaporation from the ocean off the Oregon coast, and from Yaquina Bay, Oregon. Corvallis, Oregon. MS thesis. OSU.

Detweiler, J.H., 1971. A statistical study of Oregon coastal winds. MS thesis, Oregon State University, Corvallis, OR.

Elvin, Patricia J., 1972. An ultrastructural study of early cleavage in Mytilus. Corvallis, Oregon. MA thesis. OSU. 60 pp.

EPA, 1971. Oceanography of the nearshore coastal waters of the Pacific Northwest relating to possible pollution, Water Pollution Control Research Series, 2 volumes, Environmental Protection Agency.

Fagan, David D., 1885. History of Benton County, Oregon . . . etc. Portland: A.G. Walling Printer.

Fonseca, T., 1982. On physical characteristics of upwelling events off Oregon and Peru. Masters thesis, Oregon State University, Corvallis, OR.

Fox, W.T., and R.A. Davis, 1974. Beach processes on the Oregon coast, July, 1973. Tech Rep 12, ONR Contract N00014-69-C-0151, Williams College, MA.

Gabriel, W.L. and Tyler, 1980. Preliminary analysis of Pacific Coast demersal fish assemblages. Mar. Fish Review 42:83-85.

Gibbs, Jim, 1968. West Coast Windjammers in Story and Pictures. Seattle: Superior Publishing Co.

Goodwin, C.R., Emmett and Glenne, 1970. Tidal study of three Oregon estuaries, OSU/CE Bull 45.

Goodwin, Carl Raymond, 1974. Estuarine tidal hydraulics - one dimensional model and predictive algorithm. Corvallis, Oregon. PhD thesis. OSU. 220 pp.

Greeney, William James, 1971. Modeling estuary pollution by computer simulation. Corvallis, Oregon. MS thesis. OSU. 77 pp.

Gross, M.G., B.A. Morse, and C.A. Barnes, 1969. Movement of near-bottom waters on the Continental shelf off the northwestern US, JGR, 74:7044-7047.

Hallermeier, R.J., 1981. Seaward Limits of Significant Sand Transport by Waves: An Annual Zonation for Seasonal Profiles. CETA 81-2, USACE/CERC.

Hancock, D.R., P.O. Nelson, C.K. Sollitt and K.J. Williamson, 1981. Coos Bay Offshore Disposal Site Investigation Interim Report, Phase I, February 1979-March 1980. Report to U.S. Army Corps of Engineers, Portland District, Portland, OR, under contract no. DACW57-79-C-0040, Oregon State University, Corvallis, OR.

Hanson, Alfred Warren, 1970. The symbiotic relationships and morphology of Paravortex sp. nov. (Tubellaria, Rhabdocoelida) a parasite of Macoma nasuta Conrad 1837. Corvallis, Oregon. MS thesis. OSU. 42 pp.

Harris, D.L., 1972. "Wave estimates for coastal regions", in Shelf Sediment Transport: Process and Pattern, D.L. Swift, D.B. Duane and O.H. Pilkey, eds., Dowden, Hutchinson and Ross, Inc.

Hartlett, J.C., 1972. Sediment transport on the Northern Oregon continental shelf. PhD thesis, OSU, 120 pp.

Hartman, Michael Colyn, 1972. A green algal symbiont in Clinocardium nuttallii. Corvallis, Oregon. PhD thesis. OSU. 65 pp.

Hawkins, Dan Lee, 1971. Metabolic responses of the burrowing mud shrimp, Callianassa californiensis, to anoxic conditions. Corvallis, Oregon. MS thesis. OSU. 43 pp.

Hickey, B., 1980-81. Pollutant transport and sediment dispersal in the Washington-Oregon coastal zone. UW/Oceanography Research Abstract.

Hogue, E.W., 1982. Sediment Disturbance and the Spatial Distributions of Shallow Water Meiobenthic Nematodes on the Open Oregon Coast, in Journal of Marine Research, 40(3):551-573.

Hunter, R.E., 1980. Coastal sedimentary processes study. USGS, Menlo Park, research abstract.

Huyer, A., J. Bottero, J.G. Pattullo and R.L. Smith, 1971. A compilation of observations from moored current meters and thermographs. Vol. V. OSU Dept. Ocean. Data Rep. 46, Ref. 71-1, Oregon State University, Corvallis, OR.

Huyer, A., 1971. A study of the relationship between local winds and currents over the continental shelf off Oregon. MS thesis, Oregon State University, Corvallis, OR.

Huyer, A. and J.G. Pattullo, 1972. A comparison between wind and current observations over the continental shelf off Oregon, Summer 1969. J. Geophys. Res. 77(18), 3215-3220.

Huyer, A., 1973. Vertical distributions of temperature, salinity, and sigma-t from observations from R/V Yaquina during coastal upwelling experiment, 1972, Dept. Ocean. Data Rep. 73-6, Oregon State University, Corvallis, OR.

Huyer, A. and R.L. Smith, 1974. A subsurface ribbon of cool water over the continental shelf off Oregon Jour. Phy. Ocean. 4:381-391.

Huyer, A., 1974. Coherence at low frequencies in currents observed over continental shelf off Oregon and Washington, EOS 55(12), p 1135, Amer. Geophysical Union.

Huyer, A., R.D. Pillsbury, and R.L. Smith, 1975. Seasonal variation of the alongshore velocity field over the continental shelf off Oregon. Lim. and Ocean. 20(1), 90-95.

Huyer, A. and R.L. Smith, 1977. "Physical characteristics of Pacific Northwestern coastal waters", in The Marine Plant Biomass of the Pacific Northwest Coast, R.W. Krauss, ed., Oregon State University Press, Oregon State University, Corvallis, OR.

Huyer, A. and R.L. Smith, 1979. Studies of the physical oceanography over the Oregon continental margin, OSU/Oceanography Research Abstract.

Huyer, A., E.J.C. Sobey and R.L. Smith, 1979. The spring transition in currents over the Oregon continental shelf. J. Geophys. Res. 84(C11), 6995-7011.

James, W.P., 1970. Air photo analysis of water dispersion from ocean outfalls. PhD, OSU, CE.

Karlin, R., 1980. Sediment sources and clay mineral distributions of the Oregon Coast. Jour. Sed. Pet 50:543-560.

Kitchen, J., 1977. Particle size distributions and the vertical distribution of suspended matter in the upwelling region off Oregon. Dept. Ocean. Contract Report, Ref. 77-10. Oregon State Univ., Corvallis, OR., also 1978 MS thesis, OSU.

Kitchen, J., J. Zaneveld and H. Pak, 1978. The vertical structure and size distributions of suspended particles off Oregon during the upwelling season. Deep Sea Res. 25, 453-468.

Kjeldsen, Chris Kelvin, 1967. Effects of variations of salinity and temperature on some estuarine macro-algae. Corvallis, Oregon. PhD thesis. OSU. 157 pp.

Klingemen, P.C., et al., 1969. Coastal processes - Oregon littoral drift, marine geotechnique preliminary study, OSU Dept. Civil Engr. CE572.

Komar, P.D., 1975. A Study of the Effects of a Proposed Extension of the Siuslaw River Jetties. OSU/Oceanography Report to USACE, Portland District.

Komar, P.D., Lizarraga-Arciniegar and Terich, 1975. Oregon coasts shoreline changes due to jetties; OSU/Oceanography report ORESU-R-76-002.

Komar, P.D., R.H. Neudeck, and L.D. Kulm, 1972. Observations and significance of deep-water oscillatory ripple marks on the Oregon continental shelf, in Shelf Sediment Transport, Swift, et al., eds., pp 601-619

Krygier, E.E. and W.G. Pearcy. 1986. The role of estuarine and offshore nursery areas for young English sole, Parophrys vetulus Girard, of Oregon. Fishery Bulletin 84(1):119-132.

Kulm, L.D. and J.V. Byrne, 1966. Sedimentary response to hydrography in an Oregon estuary, Marine geology, v4, pp 85-118.

Kulm, L.D. and J.V. Byrne, 1967. Sediments of Yaquina Bay, Oregon, in Estuaries, Pub 83, AAAS pp 226-238.

Kulm, L.D., Scheidegger, Byrne and Spigai, 1968. A preliminary investigation of the heavy mineral suites of the coastal rivers and beaches of OR and N. Calif. The Ore Bin 30:165-180.

Kulm, L.D., R.C. Roush, J.C. Hartlett, R.H. Neudeck, D.M. Chambers, and E.J. Runge, 1975. Oregon Continental Shelf Sedimentation: Interrelationships of Facies Distribution and Sedimentary Processes, in Journal of Geology, v. 83, n. 2, pp 145-175.

Kulm, L.D., 1977. Coastal morphology and geology of the ocean bottom - the Oregon region, in The Marine Plant Biomass of the Pacific NW Coast, Drauss, ed., pp 9-36.

Lannan, James Edmund, Jr., 1973. Genetics of the Pacific oyster; biological and economic implications. Corvallis, Oregon. PhD thesis. OSU. 104 pp.

Lee, D., 1967. Geopotential anomaly and geostrophic flow off Newport, Oregon, MS thesis, Oregon State University, Corvallis, OR.

Lidrich, Joseph Stanley, 1970. The behavior of the pea crab (Fabia subquadrata in relation to its mussel host, Mytilus californianus. Corvallis, Oregon. PhD thesis. OSU. 53 pp.

Lizarraga-Arciniega, J.R. and P.D. Komar, 1975. Shoreline changes due to jetty construction on the Oregon coast, OSU Sea Grant Pub. No. ORESU-T-75-004, Oregon State University, Corvallis, OR.

Lizarraga-Arciniega, J.R., 1976. Shoreline changes due to jetty construction on the Oregon coast, MS thesis, Oregon State University, Corvallis, OR.

Lough, R.G., 1976. Larval Dynamics of the Dungeness Crab, Cancer magister, off the Central Oregon Coast, 1970-71. Fish. Bull. 74(2):353-376.

Lough, Robert Gregory, 1969. The effects of temperature and salinity on the early development of Adula californiensis (Pelecypoda - Mytilidae). Corvallis, Oregon. MS thesis. OSU. 92 pp.

Main, Stephen Paul, 1972. The distribution of epiphytic diatoms in Yaquina Estuary, Oregon. Corvallis, Oregon. PhD thesis. OSU. 112 pp.

Maloney, N.J., 1965. Geology of the continental terrace off the central coast of Oregon, PhD, OSU, 233 pp.

Markham, John Charles, 1967. A study of the animals inhabiting laminarian holdfasts in Yaquina Bay, Oregon. Corvallis, Oregon. MA thesis. OSU 62 pp.

Marthaler, J.G., 1976. Comparison of sea level and currents off the Oregon coast using mean monthly data. MS thesis, Oregon State University, Corvallis, OR.

Martin, John Varick, 1970. Salinity as a factor controlling the distribution of benthic estuarine diatoms. Corvallis, Oregon. PhD thesis. Oregon State University. 114 pp.

Maser, C., B.R. Mate, J.F. Franklin and C.T. Dyrness, 1981. Natural History of Oregon Coast Mammals. USDA For. Serv. Gen. Tech. Rep. PNW-133, 496 pp. Pac. Northwest For. and Range Exp. Stn., Portland, OR.

Maughan, P.M., 1963. Observations and analysis of ocean currents above 250 m off the Oregon coast. MS thesis, Oregon State University, Corvallis, OR.

McCrow, Lynne Tucker, 1972. The ghost shrimp, Callianassa californiensis Dana, 1854, in Yaquina Bay, Oregon. Corvallis, Oregon. MS thesis. OSU. 56 pp.

Miller, C.B., 1980. Ecology and reproductive biology of Calanus marshallae in the Oregon upwelling zone, OSU/OCEANOGRAPH Contract OCE76-21958 A01.

Miller, M.C., 1978. Lab and Field investigations on the.movement of sand tracer under the influence of water waves PhD, OSU, Ocean.

Mills, Randall V., 1950. Railroads Down the Valley: Some Short Lines of the Oregon Country: Palo Alto, Pacific Books.

Montagne-Bierly, 1977. Yaquina Bay Hopper Dredge Scheduling Analysis - Offshore Disposal Site Inspection. Report to USACE, Portland District.

Moores, C.N.K, L.M. Bogert, R.L. Smith and J.G. Pattullo, 1968. A compilation of observations from moored current meters and thermographs, Vol II, Dept. Ocean. Data Rep. 30, Ref 68-5, Oregon State University, Corvallis, OR.

Moores, C.N.K. and R.L. Smith, 1968. Continental shelf waves off Oregon. J. Geophys. Res. 73(2), 549-557.

Moores, C.N.K., 1974. Coastal upwelling experiment. I. Profiling current July-7 Aug 1972), R/V Cayuse cruises C7208-F1 and C7208-F2 (15-18 August and 21-24 August 1972) Dept. Ocean. Data Rep., Oregon State University, Corvallis, OR.

Morgan, J.B. and R.L. Holton, 1977. A Compendium of Current Research and Management Programs Concerning Oregon's Estuaries, OSU Seagrant Pub. ORESU-L-77-004.

Murray, R.J., 1978. Application of LANDSAT-2 data for an inventory of eelgrass and kelp beds on the Oregon Coast, OSU/ERSAL research abstract.

National Marine Consultants, 1961. Wave statistics for twelve most severe storms affecting three selected stations off the coast of Washington and Oregon, during the period 1950-1960. Report to Corps of Engineers, Portland District, Portland, OR.

National Marine Consultants, 1961. Wave statistics for three deep-water stations along the Oregon-Washington coast. U.S. Army Corps of Engineers, Seattle District, Seattle, WA.

Neal, V.T., D.F. Keene and J.T. Detweiler, 1969. Physical factors affecting Oregon coastal pollution. Dept. Oceanography Ref. 69-28, Oregon State University, Corvallis, OR.

Nelson, P.O., C.K. Sollitt, K.J. Williamson and D.R. Hancock, 1983. Coos Bay Offshore Disposal Site Investigation Interim Report, Phase II-III, April 1980-June 1981. Report to U.S. Army Corps of Engineers, Portland District, Portland, OR, under contract no. DACW57-C-0040, Oregon State University, Corvallis, OR.

Nenendorf, K.K.E., 1982. Theses and dissertations on the geology of Oregon, 1899-1982. ODGMI Sp Paper 11.

Neudeck, R.H., 1971. Photographic investigation of sediment transport mechanics on the Oregon continental margin, MS, OSU.

North, W.B. and Byrne, 1965. Coastal landslides of N. OR. Ore Bin v27 n.11 pp. 217-241 also MS, OSU 1964 85 pp.

Oceanographic Institute of Oregon, 1984. An examination of the Feasibility of Extrapolating Infaunal Data From Coos Bay, Oregon, to Yaquina Bay, Oregon, Final Report, Portland District Corps of Engineers contract DACW57-84-M-1186.

O'Flaherty, Mary Louise, 1966. Taxonomy of some endophytic and epiphytic genera of Phaeophyta on the Oregon Coast. Corvallis, Oregon. MS thesis. Oregon State University. 65 pp.

Oregon Department of Fish and Wildlife. Pounds and value of commercially caught fish and shellfish landed in Oregon. 1978-1985. Portland, OR.

Pak, H. and R.V. Zaneveld, 1977. Bottom nepheloid layers and bottom mixed layers observed on the continental shelf off Oregon, JGR 82:3921-3931.

Pak, H. and R.V. Zaneveld, 1981. Mesoscale studies of flow regimes and fluxes of particulate matter in coastal waters. Report to US Dept. Energy under contract 902688 TICNO; 0077240, School of Oceanography, Oregon State University, Corvallis, OR.

Panshin, D.A., 1967. Sea level, winds, and upwelling along the Oregon coast. MS thesis, Oregon State University, Corvallis, OR.

Pattullo, J. and Denner, 1965. Processes affecting seawater characteristics along the Oregon Coast, Limn & Ocean. 10:443-450.

Peterson, C., Scheidegger and Komar, 1982. Sand disperal patterns in an active margin estuary of the NW US as indicated by sand composition, texture and bedforms Mar. Geol. 50:77-96.

Peterson, C., Scheidegger, Nem and Komar, 1983. Sediment composition and hydrography in 6 high-gradient estuaries of the NW US, Jour Sed Pet (in press).

Peterson, C.D., 1984. Sedimentation in small active margin estuaries of the NW US, PhD, OSU, Ocean. ORESU-X-84-001 R/CP-11.

Peterson, Paul Edward, 1973. Factors that influence sulfide production in an estuarine environment. Corvallis, Oregon. MS thesis. OSU 1974. 97 pp.

Peterson, W.K., 1970. Coastal and offshore survey, UW/Oceanography report(s), REF-M70-2, RLO-1725, NR-083-0.

Peterson, W.T. and C.B. Miller, 1976. Zooplankton Along the Continental Shelf off Newport, Oregon, 1969-1972: distribution, abundance, seasonal cycle, and year-to-year variations. Oregon State University, Sea Grant College Program Pub. No. ORESU-T-76-002. 111 pp.

Peterson, W.T., C.B. Miller and A. Hutchinson, 1979. Zonation and Maintenance of Copepod Populations in the Oregon Upwelling Zone. Deep-Sea Research 26A:467-494.

Pillsbury, R.D., 1972. A description of hydrography, winds and currents during the upwelling season near Newport, OR. PhD thesis, Oregon State University, Corvallis, OR.

Pillsbury, R.D., R.L. Smith and J.G. Pattulo, 1970. A compilation of observations from moored current meters and thermographs. Vol. III, Dept. Ocean. Data Rep. 40, Ref. No. 70-3

Plank, W.S. and H. Pak, 1973. Observations of light scattering and suspended particulate matter off the Oregon coast, June-Oct. 1972. School of Ocean. Data Rep. 55, Oregon State University, Corvallis, OR.

Prestedge, G.K., 1977. Stabilization of landslide along the Oregon Coast, OSU, Civil Eng. ORESU-X2-75-003.

Quinn, W.H., and Enfield, 1971. The development of forecast techniques for wave and surf conditions over the bars in the Columbia River Mouth and at the entrance to Yaquina Bay. OSU Ref 71-9.

Quinn, W.H., Creech, H.C. and D.O. Zopf, 1974. Coastal wave observations via seismometer, Mariners Weather Log 18:367-369.

Richardson, S.L. and W.G. Pearcy, 1977. Coastal and Oceanic Fish Larvae in an Area of Upwelling off Yaquina Bay, Oregon. Fish. Bull. 75(1):125-145.

Richardson, S.L., 1973. Abundance and Distribution of Larval Fishes in Waters off Oregon, May-October, 1969, with Special Emphasis on the Northern Anchovy, Engraulis mordax. Fish. Bull. 71(3):697-711.

Richardson, S.L., J.L. Laroche and M.D. Richardson, 1980. Larval Fish Assemblages and Associations in the Northeast Pacific Ocean Along the Oregon Coast, Winter-Spring 1972-1975. Estuarine and Coastal Marine Science (1980) II, 671-698.

Riznyk, Raymond Zenon, 1969. Ecology of benthic microalgai of estuarine intertidal sediments. Corvallis, Oregon. PhD thesis. OSU. 196 pp.

Rosenburg, D.H., 1962. Characteristics and distribution of water masses off the Oregon coast MS, OSU, Ocean.

Ross, Richard E., 1983. Archeological Sites and Surveys on the North and Central Coast of Oregon, in Prehistoric Places on the Southern Northwest Coast, ed. Robert E. Greengo, Seattle: Thomas Burke Memorial Washington State Museum, p. 213.

Roush, R.C., 1979. Sediment textures and internal structures: A comparison between Central Oregon continental shelf sediments and adjacent ocean sediment, MS, OSU, Ocean. ORESU-X2-79-001.

Roush, R.C., 1970. Sediment textures and internal structures: A comparison between Central Oregon continental shelf sediments and adjacent coastal sediments. MS thesis, OSU, 75 pp.

Runge, E.J., 1966. Continental shelf sediments, Columbia River to Cape Blanco, Oregon. PhD thesis, OSU, 143 pp.

Scheidegger, K.F., L.D. Kulm and E.J Runge, 1971. Sediment sources and dispersal patterns of Oregon continental shelf sands, Jour Sediment Petrol, v.41, pp 1112-1120.

Seymour, R.J., 1981. Coastal data information program monthly reports, 1981 through present. Calif. Dept. Boating and Waterways, Scripps Institute of Oceanography, La Jolla, CA.

Simons, Alexy, 1983. Cultural Resources in the Pacon Graving Dock Project Area. (Unpublished Report, on file U.S. Army Corps of Engineers, Portland District, Portland, OR.

Smallbone, N., 1974. Bays and Estuaries of Oregon. OSU/Oceanography Report.

Smith, R.L., 1964. An investigation of upwelling along the Oregon Coast PhD, OSU 83 pp.

Sobey, E.J.B., 1977. The response of Oregon shelf waters to wind fluctuations: differences and the transition between winter and summer. PhD thesis, Oregon State University, Corvallis, OR.

Sollitt, C.K., P.O. Nelson, K.J. Williamson and D.R. Hancock, 1983. Coos Bay offshore disposal site investigation final report, Report to U.S. Army, Corps of Engineers, Portland District, Portland, OR, under contract no. DACW57-79-C0040, Oregon State University, Corvallis, OR.

Spigai, J.J., 1970. Marine geology of the continental margin off southern Oregon, PhD, OSU, Ocean.

Stander, J.M. and R.L. Horton, 1978. Oregon and Offshore Oil. OSU Seagrant Pub. ORESU-T-78-004.

Steiner, R.G., 1978. Food habits and species composition of neritic reef fishes off Depoe Bay, Oregon, OSU, Fish & Wild., ORESU-X2-78-002.

Stevenson, M.R., 1966. Subsurface currents off the Oregon coast. PhD thesis, Oregon State University, Corvallis, OR.

Stevenson, M.R., J.G. Pattullo and B. Wyatt, 1969. Subsurface currents off the Oregon coast as measured by parachute drogues. Deep-sea Research, 16, 449-461.

Stevenson, M.R., R.W. Garvine and B. Wyatt, 1974. Lagrangian measurements in a coastal upwelling zone off Oregon. J. Phys. Ocean. 4(3), 321-336.

Stewart, R., 1967. An evaluation of grain size, shape and roundness parameters in determining depositional environment in Pleistocene sediments from Newport, OR. MS thesis, U of O.

Sullivan B. and D. Hancock, 1977. Zooplankton and Dredging, Research Perspectives and Critical Review, Water Resources Bulletin. American Water Resources Assc., Vol. B, No. 13.

Talbot, Theodore Webt., 1980. From the Journals of Lieut. Theodore Talbot, U.S.A. on his Journey Through Lincoln County and Along the Oregon Coast in 1849. Entries compiled and Notes on Contents by Leslie L. Haslan, Newport, OR. in Lincoln County Lore: A Reprinting of Five Early Publications of the Lincoln County Historical Society. Newport, Lincoln County Historical Society.

Thompson, Rogene Kasparek, 1967. Respiratory adaptations of two macrurous-anomuran mud shrimps, Callianassa californiensis and Upogebia pugettensis (Decapoda, Thalassinidea). Corvallis, Oregon. MS thesis. OSU. 63 pp.

Thum, Alan Bradley, 1972. An ecological study of Diatomovora amoena, an interstial acoel flatworm, in an estuarine mud flat on the central coast of Oregon. Corvallis, Oregon. PhD thesis. OSU. 185 pp.

Toner, Richard Charles, 1961. An exploratory investigation of the embryonic and larval stages of the bay mussel, *Mytilus edulis* L., as a bioassay organism. Corvallis, Oregon. MS thesis. OSU. 51 pp.

Tunon, N.A.A., 1977. Beach Profile Changes and Onshore-Offshore Sand Transport on the Oregon Coast. MS thesis. OSU/Oceanography, 58 pp.

USACE, 1883. Annual Report to the Chief of Engineers. Portland District Library, Portland, OR.

USACE, 1974. Coastal Reconnaissance Study Oregon and Washington, June 1974. Portland District, Portland, OR.

USACE, 1980. Findings of Compliance and Non-compliance, Operations and Maintenance Dredged Material Disposal Activities at Coastal Project. Portland District, Portland, OR.

USACE, Unpublished data. Littoral Environmental Observation Program (LEO). U.S. Army Corps of Engineers, Portland District, Portland, OR.

USGS, Analysis of Elutriate, Native Water, and Bottom Material in Selected Rivers and Estuaries in Western Oregon and Washington. Open File Report 82-922.

Voth, David Richard, 1972. Life history of the caligoid copepod Lepeophtheiros hospitalis Frasser 1920 (Crustaceai Caligoida). Corvallis, Oregon. PhD thesis. OSU. 114 pp.

Waldron, K.D., 1955. A survey of the bull kelp resources of the Oregon Coast in 1954, Fish Comm. of OR, Res. Brief 6(2)15.

Walker, John David, 1974. Effects of bark debris on benthic macrofauna of Yaquina Bay, Oregon. Corvallis, Oregon. MS thesis. OSU. 94 pp.

White, S.M., 1970. Mineralogy and geochemistry of continental shelf sediments off the Washington-Oregon coast, Jour Sediment Petrol, v.40, pp 38-54.

Willingham, William F., 1983. Army Engineers and the Development of Oregon. A History of the Portland District, U.S. Army Corps of Engineers, Portland District, Portland, OR.

Wilson, William Joseph, 1974. The effects of concentration and particle size of suspended materials on growth and condition of the Pacific oyster (*Crassostrea gigas*). Corvallis, Oregon. MS thesis. OSU. 65 pp.

Wright, T.L., 1976. A description of the coastal upwelling region off Oregon during July-August 1973. Thesis, Oregon State University, Corvallis@ OR.

Wyatt, B., 1973. Coastal upwelling ecosystems analysis: STD measurements off the Oregon coast August 1973, Inter-American Tropical Tuna Commission Rpt 9.

Wyatt, B., D.A. Barstow, W.E. Gilbert and J.L. Washburn, 1971. Drift bottle recoveries and releases off the Oregon coast 1961 through 1970. Dept. Ocean. Data Rep. 50, Ref. no. 71-36, Oregon State University, Corvallis, OR.

Yao, N.C.G. and S. Neshyba, 1976. Bispectrum and cross-bispectrum analysis of wind and currents off the Oregon coast: I. Development., Dept. Ocean. Research Report, Ref. No. 76-!1, Oregon State University, Corvallis, OR.

Yao, N.C.G., 1974. Bispectral and cross-bispectral analysis of wind and currents off Oregon coast. PhD thesis, Oregon State University, Corvallis, OR.

Zimmerman, Steven T., 1972. Seasonal succession of zooplankton population in two dissimilar marine embayments on the Oregon Coast. Corvallis, Oregon. PhD thesis. OSU. 212 pp.

Zontek, Terry, 1983. Late Prehistoric Archeological Sites on the Oregon Coast. Unpublished MA thesis, Interdisciplinary Studies, OSU, Corvallis, OR.

Zopf, D., Creech and Quinn, 1976. The wave meter: a land-based system for measuring nearshore ocean waves. OSU/Sea Grant ORESU-R-76-013.

Zopf, D.O., H.C. Creech and W.H. Quinn, 1977. Mariners Weather Log 21(5), 305-306, Washington, D.C.

APPENDIX A

LIVING RESOURCES

APPENDIX A

LIVING RESOURCES

TABLE OF CONTENTS

TABLES

FIGURES

APPENDIX A

LIVING RESOURCES

Introduction

1.1 Information on aquatic resources was obtained from a field sampling program conducted in July 1985. In addition, a thorough utilization of a variety of published and unpublished reports, theses, and personal communications with the Oregon Department of Fish and Wildlife (ODFW) Marine Resources Division biologists have been utilized in the preparation of this technical appendix. Critical resources were determined primarily by whether the resource was unique to the area or was in limited abundance along the Oregon coast. In 1978, the Portland District issued a report entitled "Technical Report, Chetco River Hopper Dredge Scheduling Analysis". The study included a cursory analysis of the physical and biological conditions of the offshore disposal site and a series of bottom photographs which clearly illustrate the coarse material in a portion of the site.

1.2 To determine the extent of these gravel/cobble beds and the suitability of the general area for fish trawling, the Portland District conducted an underwater video survey of the Chetco disposal site during August of 1984. These video tapes confirmed the gravel/cobble deposits and rocky outcrops existing in the area and precluded fisheries trawling in the area.

Plankton and Fish Larvae

1.3 Distribution and abundance of inshore planktonic species vary depending upon nearshore oceanographic conditions. In the summer when the wind is from the northwest, surface water is moving south and away from the shore. Colder, more saline, nutrient-rich water then moves up from depth into the shore. This upwelling phenomenon can extend up to 10 km offshore and last from days to weeks depending upon the strength and duration of the wind. Zooplankton taxa during this time are predominantly those from subarctic water masses.

1.4 For the general Oregon Coast, winter winds are primarily out of the west and southwest and surface waters are transported inshore. The zooplankton community during this time consists of species from the transitional or Central Pacific water masses.

1.5 Very little specific information has been collected from the nearshore waters off the southern Oregon Coast. Oregon State University studied a hydrographic line off Brookings which extended from 5 to 165 n miles offshore. These studies provide a basis for understanding the general characteristics of the oceanic water masses of the Southern Oregon Coast. Since water masses between the central and southern Oregon coasts are similar, the pelagic fauna should exhibit a high degree of correspondence.

1.6 Lee (1971) discussed the copepods in a 1963 collection from the southern Oregon coast and Peterson and Miller (1976) and Peterson et al. (1979) provide a fairly comprehensive account of the zooplankton community off the central Oregon Coast (Newport, OR). The central Oregon study's summer and winter species are given below. In general, winter species are less abundant than summer species.

Table A-1

Seasonal Species Usage (Dominant Copepod Species)
in Decreasing Order of Abundance

Winter Species	Summer Species
Pseudocalanus sp.	Pseudocalanus sp.
Oithona similis	Acartia clausii
Paracalanus parvus	Acartia longiremis
Acartia longiremis	Calanus marshallae
Centrophages abdominalis	Oithona similis

1.7 Other taxa collected were of minor importance as compared to the copepod abundance except for a few organisms during parts of the year. A list of the other taxa collected is given in tables A-2 and A-3.

TAXA	TOTAL RELATIVE DENSITY			FREQUENCY		
	1969	1970	1971	69	70	71
Calanus nauplii	119.5	695.5	172.7	21	40	28
Other Copepod nauplii	43.1	68.1	52.3	10	20	20
Amphipods	8.5	18.5	15.7	5	15	14
Euphausiid nauplii	46.3	85.9	84.0	5	26	18
Euphausiid calyptopis	13.3	14.5	17.2	4	17	11
Euphausiid furcilia	30.2	13.6	17.7	14	20	10
Thysanoessa spinifera	35.4	4.0	87.3	2	7	11
Evadne nordmanni	73.7	58.9	9.8	17	26	2
Podon leukarti	2.8	115.3	5.2	2	12	1
Pteropods	10.2	24.6	60.6	11	22	35
Chaetognaths	89.4	50.3	30.8	25	33	34
Oikopleura	69.2	85.7	66.5	11	15	21
Ctenophores	6.0	2.5	34.9	7	5	19
Scyphomedusae	22.9	70.9	22.8	13	28	22
decapod shrimp mysis	142.7	52.6	45.3	16	24	22
barnacle nauplii	59.3	168.3	231.4	8	32	28
barnacle cypris	4.4	64.0	8.3	2	19	10
polychaete post-trochophores	16.2	20.1	21.4	5	23	15
bivalve veligers	170.5	258.9	68.3	20	40	27
gastropod veligers	28.9	79.2	42.2	16	33	23
hydromedusae	6.1	3.2	10.3	2	2	11
unidentified annelid without parapodia	8.2	23.1	35.8	3	3	16
pluteus	0.0	16.0	117.6	0	5	11
large round eggs (fish)	36.8	25.0	17.8	11	13	12
Calanus eggs	870.1[a]	168.7	226.1	10	28	25
euphausiid eggs, early	55.0	686.1	449.6	11	29	24
euphausiid eggs, late	70.0	57.5	39.6	2	16	14
other fish eggs	19.1	35.1	34.3	12	18	18

a = biased by a single observation of 760 individuals/m^3.

The following taxa were found in less than five samples: radiolarians, foraminifera, siphonophores, planula larva, trochophores, *Tomopteris*, heteropods, *Clione*, phoronid larva, ascidian larva, salps, auricularia larva, imm starfish, decapod protozoeas, unusual barnacle nauplii, *Stylocheiron abbreviatum*, anchovy eggs, and four miscellaneous unidentified meroplanktonic taxa.

Total relative density and frequency of occurrence of other holoplanktonic taxa and meroplankton taken within 18 km of the coast during 1969, 1970 and 1971 upwelling seasons. Table entries are sums of average abundances at each of four stations.[1]

Table A-2

Other Taxa Collected

TAXA	TOTAL RELATIVE DENSITY			FREQUENCY		
	1969-70	1970-71	1971-72	69-70	70-71	71-72
Calanus nauplii	1188.7a	165.9	35.1	10	15	15
Other Copepod nauplii	29.1	122.5a	20.2	11	13	12
Amphipods	5.9	4.8	5.0	12	4	10
Euphausiid nauplii	2.8	108.4a	3.4	4	5	4
Euphausiid calyptopis	6.4	56.1a	14.5	13	4	8
Euphausiid furcilia	3.1	0.4	7.6	7	2	5
Evadne nordmanni	5.8	24.1	4.8	2	2	4
Podon leukarti	126.3a	27.3	116.4a	4	2	4
Pteropods (*Limacina*)	66.0	88.0	14.2	17	15	13
Chaetognaths	62.9	47.4	22.4	20	19	13
Oikopleura spp.	551.9	101.2	75.6	22	16	15
Ctenophores	7.0	6.2	10.3	8	8	9
Scyphomedusae	10.0	94.3	16.6	5	6	10
Salps	0.9b	***	***	9	0	0
Isopods	0.5	0.7	***	2	3	0
Mysids	0.2	3.3	2.1	2	1	2
decapod shrimp mysis	3.1	21.4	5.6	7	10	11
barnacle nauplii	309.1	192.7	77.9	11	6	12
barnacle cypris	8.7	188.1a	16.8	4	4	12
polychaete post-trochophores	41.5	13.5	70.8	12	8	11
bivalve veligers	87.8	98.2	118.4	20	18	15
gastropod veligers, assorted	31.3	27.6	37.2	19	18	15
gastropod A	***	1.0	***	0	6	0
hydromedusae	9.2	1.8	3.3	4	2	3
annelids lacking parapodia	40.0	74.9	21.9	5	4	11
echinoderm pluteus	41.7	0.8	22.1	5	2	4
large round eggs (fish)	9.0	5.5	4.9	6	11	8
Calanus eggs	36.5	36.7	4.7	10	11	4
euphausiid eggs	***	274.7a	2.8	0	6	3

a = high value the result of one station or sampling date
b = a value of $34.3/m^3$ on 29 October 1969 was ommitted from the summation

The following taxa were found in less than five samples: The euphausiids *Thysanoessa spinifera* and *Euphausia pacifica*, amphipod larvae and eggs, ostracods, cumaceans, siphonophores, *Sagitta scrippsii*, *S. bierii*, *S. minima*, *Lepas* nauplii, other unidentified barnacle nauplii, echinoderm bipinnaria, imm. starfish, imm. sea urchins, planula larvae, trochophores, foraminifera, radiolarians, *Tomopteris*, cyphonautes larvae, other fish eggs, and six miscellaneous unidentified meroplanktonic taxa.

Total relative density and frequency of occurrence of other holoplanktonic and meroplanktonic taxa taken within 18 km of the coast during three winters. Table entries are sums of relative densities at each of four stations.[1]

Table A-3

Other Taxa Collected

1.8 The other plankton species of importance is the megalops larval stage of the Dungeness crab (Cancer magister). Lough (1976) has reported that megalops occur inshore from January to May and are apparently retained there by the strong longshore and onshore components of the surface currents in the winter. After May, the megalops metamorphoses into juvenile crabs and settle out of the plankton, moving into rearing areas in the estuary.

1.9 Fish larvae are a transient but important member of the inshore coastal plankton community. Their abundance and distribution has been described by Richardson (1973), Richardson and Pearcy (1977), and Richardson et al (1980).

1.10 Three species assemblages have been described off the Oregon coast; coastal, transitional, and offshore. In general, the species in the coastal and offshore assemblages never overlapped while the transitional species overlapped both the coastal and offshore groups. The break between the coastal and offshore groups occurred at the continental slope.

1.11 The coastal group is dominated by smelts (Osmeridae) making up over 50 percent of the larvae collected. Other dominant species included the English sole (*Parophrys vetulus*), sanddab (*Isopsetta isolepis*), starry flounder (*Platichthys stellatus*), and tom cod (*Microgadus proximus*). Maximum abundance occurred from February to July when greater than 90 percent of the larvae were collected. Two peaks of abundance were present during this period, one in February and March (24 percent of the larvae) and one in May to July (68 percent of the larvae) following upwelling. Dominant species during each peak are shown in table A-4.

Benthic Invertebrates

1.12 Benthic invertebrates play an important role in secondary productivity of nearshore marine systems. They are not only a direct source of food for many demersal fishes, but play an active part in the shredding and breakdown of organic material and in the reworking of sediment.

1.13 Knowledge of the benthic communities off the nearshore central Oregon coast is increasing due, in large measure, to studies done with the offshore disposal site investigations conducted by Portland District.

Table A-4
Dominant Fish Larval Species
During the Two Peaks of Abundance

	February to March	May to July
Smelt (Osmeridae)	1.51*	4.12
English sole (*Parophrys vetulus*)	4.09	
Sandlance (*Ammodytes hexapterus*)		1.76
Sanddab (*Isopsetta isolepis*)	1.73	2.21
Tom cod (*Microgadus proximus*)		2.03
Slender sole (*Lyopsetta exilis*)	1.07	

* Biological index - Ranking method that averages abundance and frequency of occurrence in samples. 5 to 1 in decreasing order.

1.14 Previous investigations of the Oregon coast include an evaluation of offshore disposal sites near the mouth of the Columbia River by Richardson et al. 1973, a quantitative study of the meiobenthos at Moolach Beach north of Yaquina Bay entrance (Hogue 1982) and an outfall study for an International Paper Company outfall near Gardiner, Oregon. (Unpublished, n.d.). Site-specific information is now available in final reports for Coos Bay (Hancock et al., 1981, Nelson et al., 1983, and Sollitt et al., 1984) and for Yaquina Bay (USACOE, 1985). Similar benthic studies have been conducted at seven other ocean disposal sites along the Oregon coast and the data is being analyzed for final site designation. These comprise the total benthic infaunal data base available for the Oregon Coast.

1.15 To provide site-specific benthic information to supplement the existing data and characterize the Chetco interim disposal site, the Portland District COE collected and analyzed thirty-five benthic infaunal samples from seven stations located as shown in figure A-1. Six replicate bottom samples were taken from each of the seven stations using a modified Gray-O'Hara box corer which sampled a .096 m area of the bottom.

1.16 One sediment sample from each station was sent to the North Pacific Division's Materials Testing Laboratory for determination of grain size and organic content. The remaining five box-core samples were sieved through a

0.5 mm mesh screen; organisms retained on the screen were preserved in 10 percent buffered formalin. Infaunal organisms were then picked from the sediment, counted and identified to the lowest taxon practicable by Marine Taxonomic Services.

Results

1.17 The stations sampled in the region of the Chetco River Interim Disposal Site (figure A-1) were found to vary widely in substrate texture (table B-3). The NW portion of the site contained medium to large (>30 cm) smoothly rounded cobble stones, while the easterly margin of the site was a mixture of sand with interspersed rocks. It has not been determined if the large cobbles were previously transported to the site by the hopper dredges or result from natural causes. They extend slightly shoreward of the disposal site. The deeper western portion of the interim disposal site contains a fine grained sand substrate typical of the many high energy nearshore coastal environments found along the Oregon Coast. Based on the sediments, the Chetco Interim Disposal site is unique from all other disposal sites studied.

1.18 The organic content of the sediments as measured by percent volatile solids is very low--as would be expected based on the coarse sediments and high energy. Volatile solids are shown in table C-1.

1.19 The benthos of the Chetco offshore disposal site was found to consist of two bottom types, sandy (which is typical of nearshore high energy environments), and sand mixed with cobbles which is not commonly encountered. The latter type was found only at station 1 and 2 which lie in the northeast corner of the interim disposal site. Station 1 had the highest amount of cobbles and the mixed sediment type resulted in the highest number of species represented in the sampling of the Chetco disposal site.

1.20 The community is represented by the psammnitic (sand-dwelling) fauna and the epizoic and encrusting fauna. The sand-cobble community is characterized by the scale worm Hesionura coineaui difficilis (1156/sq. m), barnacles (200/sq.m), Archiannelida (390/m), as well as the more typical psammnitic polychaetes, cumaceans, and gammarid amphipods.

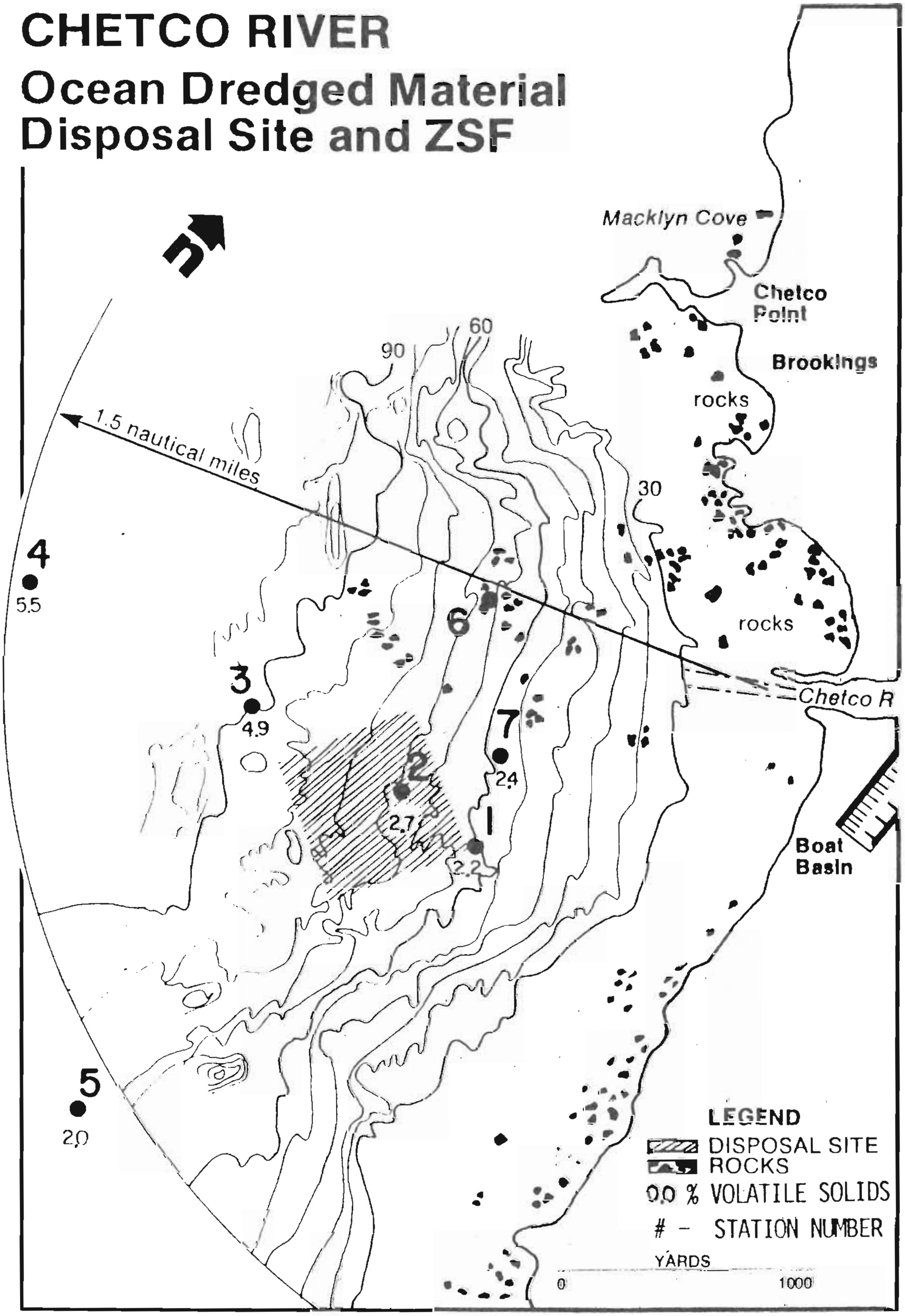


Figure A-1

Chetco River Sample Stations

1.21 The sandy bottom stations located offshore and the stations located to the north and south of the interim disposal site are characterized by polychaete annelids such as Magelona sacculata, Chaetozone setosa, or Spiophanes bombyx, and numerous species of cumaceans, gammarid amphipods, molluscs and snails. The species inhabiting the sandy stations are generally the more motile psammnitic forms which tolerate or require high sediment flux. Juvenile Dungeness crab (Cancer magister) were found at all stations sampled.

1.22 Figure A-2 compares mean infaunal densities (for five replicate box core samples) at the four stations within the site and the north and south reference stations. General levels of density ranged between 1210 and 3377 /m in the interim site, and from 947-3010 for the reference sites. These values are slightly above those sampled at other disposal sites along the Oregon coast.

1.23 Mean densities (#/sq. m) decrease with increasing water depth at both the interim and reference sites. Juvenile Dungeness crabs had a density of $35/m^2$ (figure A-3). Mean density for the other major taxonomic groups are shown in figures A-4 and A-5.

1.24 Figure A-6 compares diversity, species richness and equitability of benthic infauna by depth for the Chetco offshore disposal site and for the reference stations to the north and south. The values for each of these factors were found to be very similar for each station in the study area. Due to factors such as seasonality and sediment patchiness which produce large between-sample variation, little significance can be placed on the observed trend.

1.25 Based on the data on benthic invertebrate abundance, density, and diversity from the study area and the reference areas to the north and south of the Chetco interim disposal site, no impact from past disposal activities was observed.

Macroinvertebrates

1.26 The dominant commercially and recreationally important macroinvertebrate species in the inshore coastal area are shellfish and

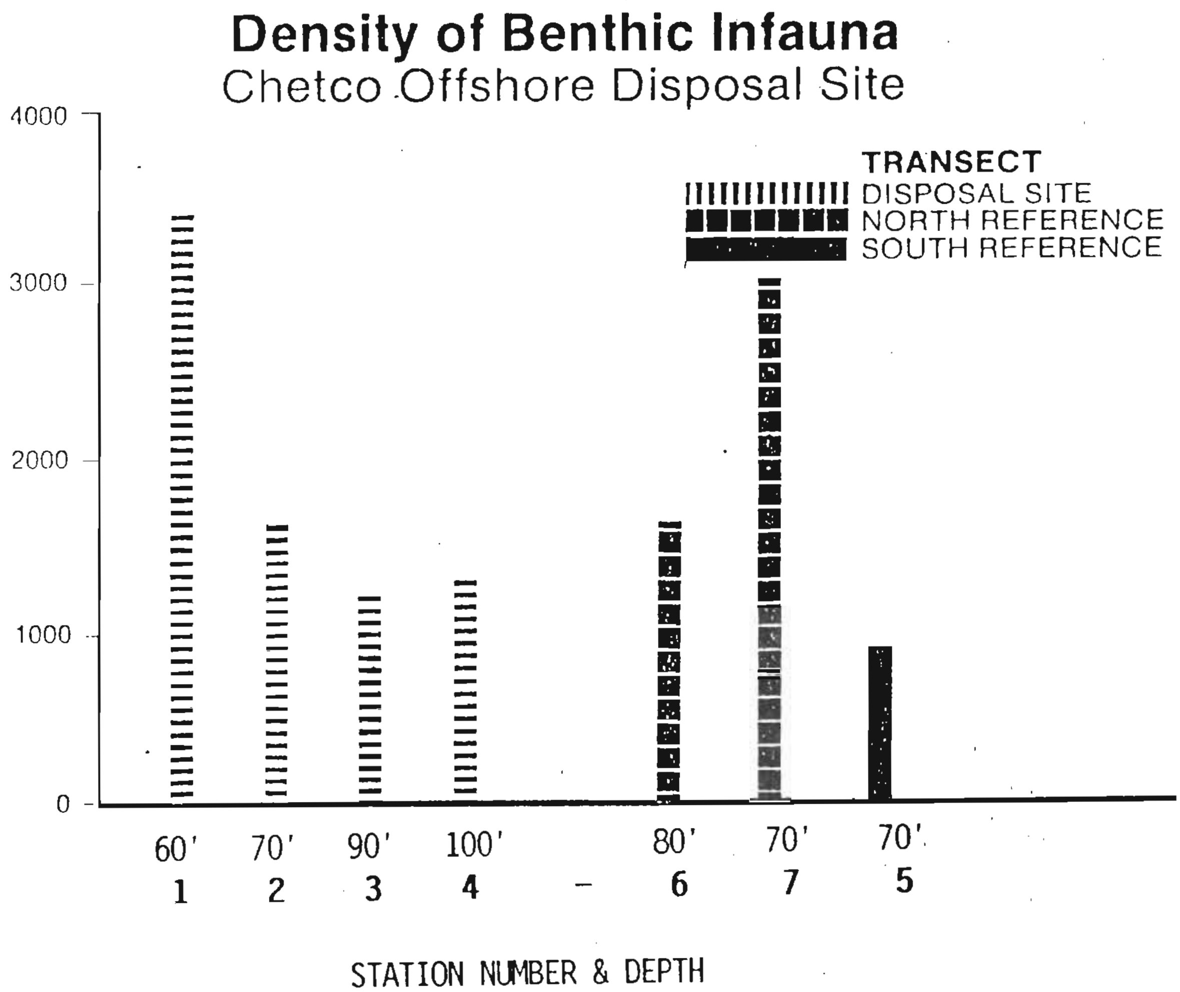


Figure A-2
Density of Benthic Infauna

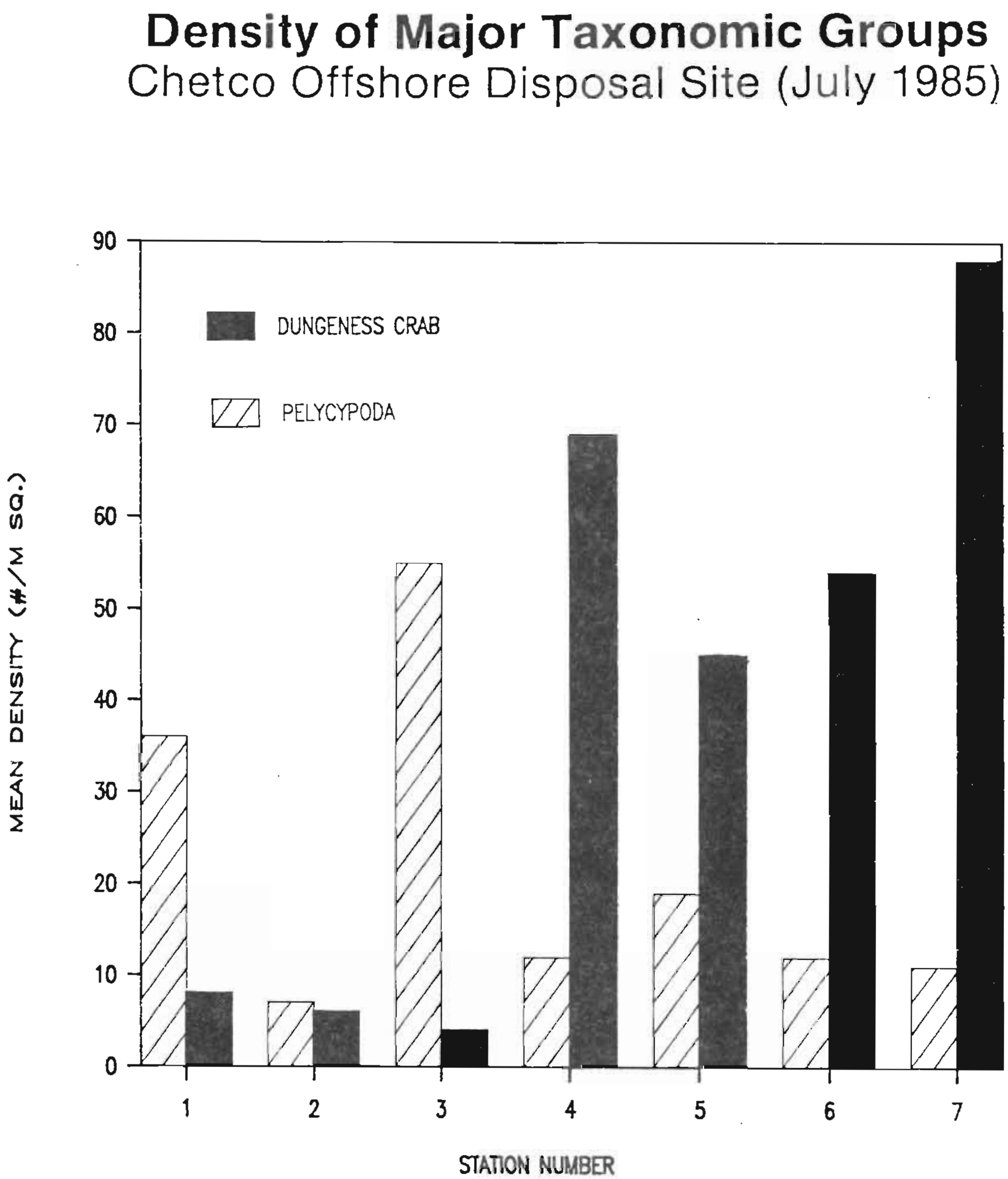


Figure A-3

Density of Major Taxonomic Groups (Dungeness Crab & Pelecypoda)

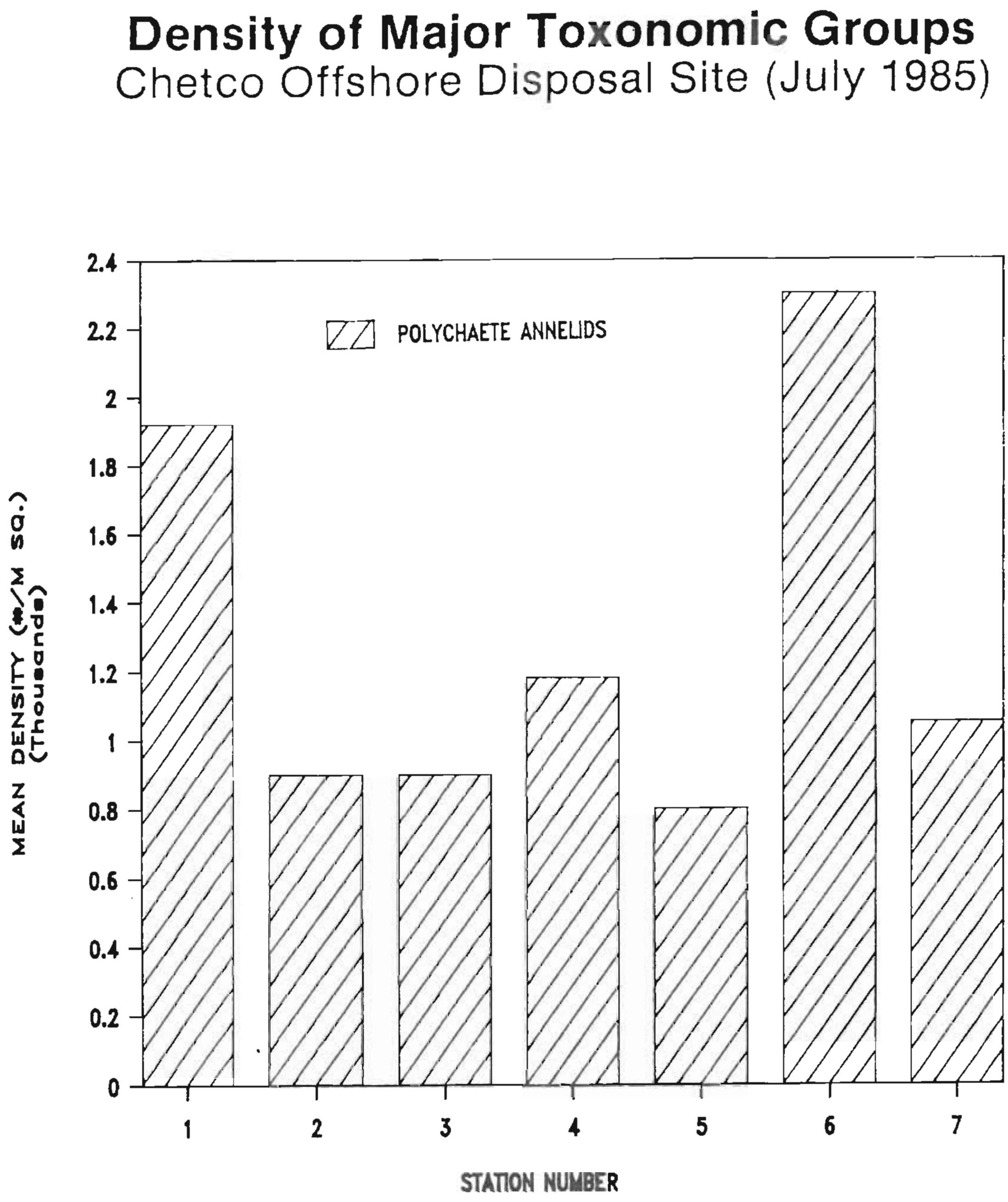


Figure A-4

Density of Major Taxonomic Groups (Polychaete Annelids)

Density of Major Taxonomic Groups
Chetco Offshore Disposal Site (July 1985)

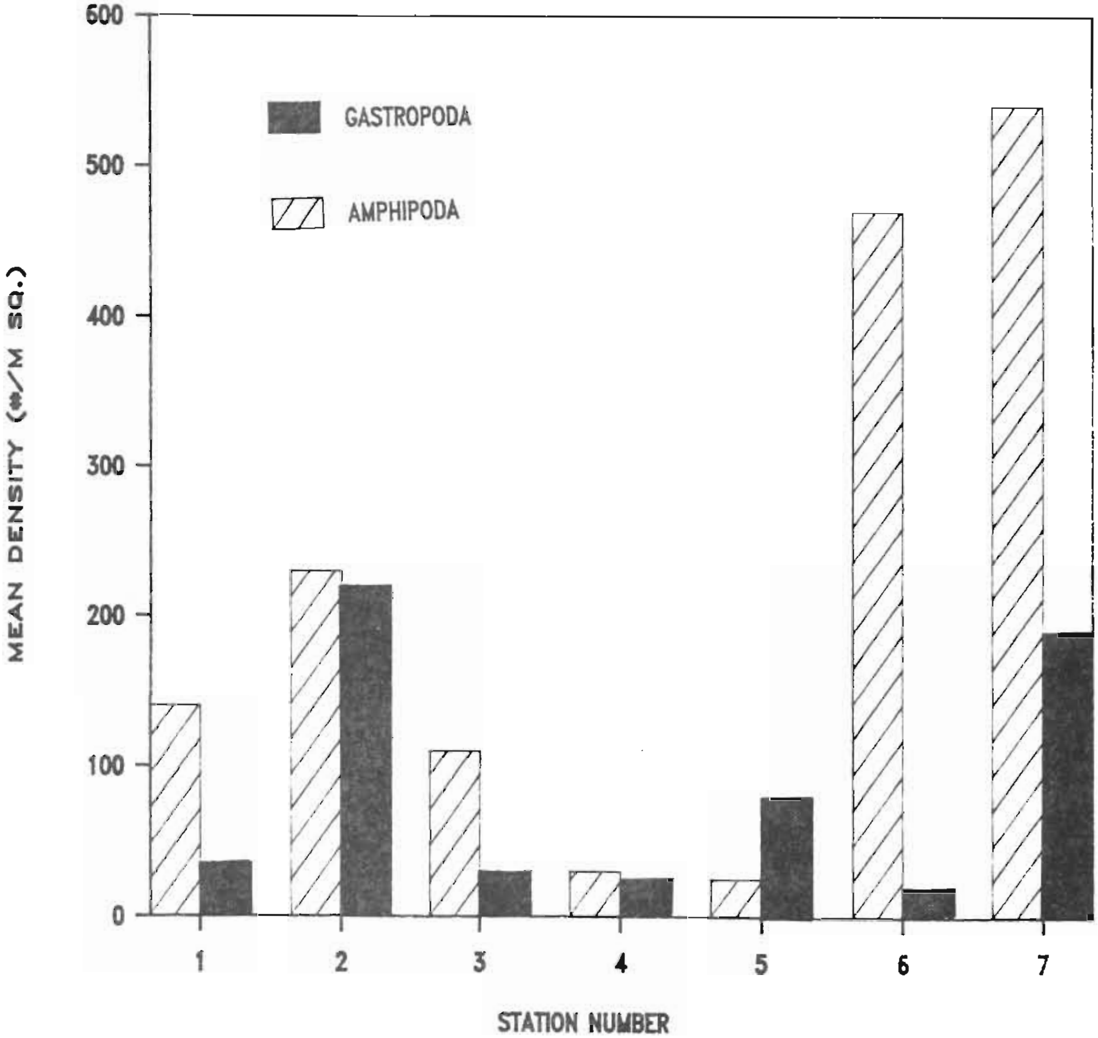


Figure A-5
Density of Major Taxonomic Groups (Amphipoda & Gastropoda)

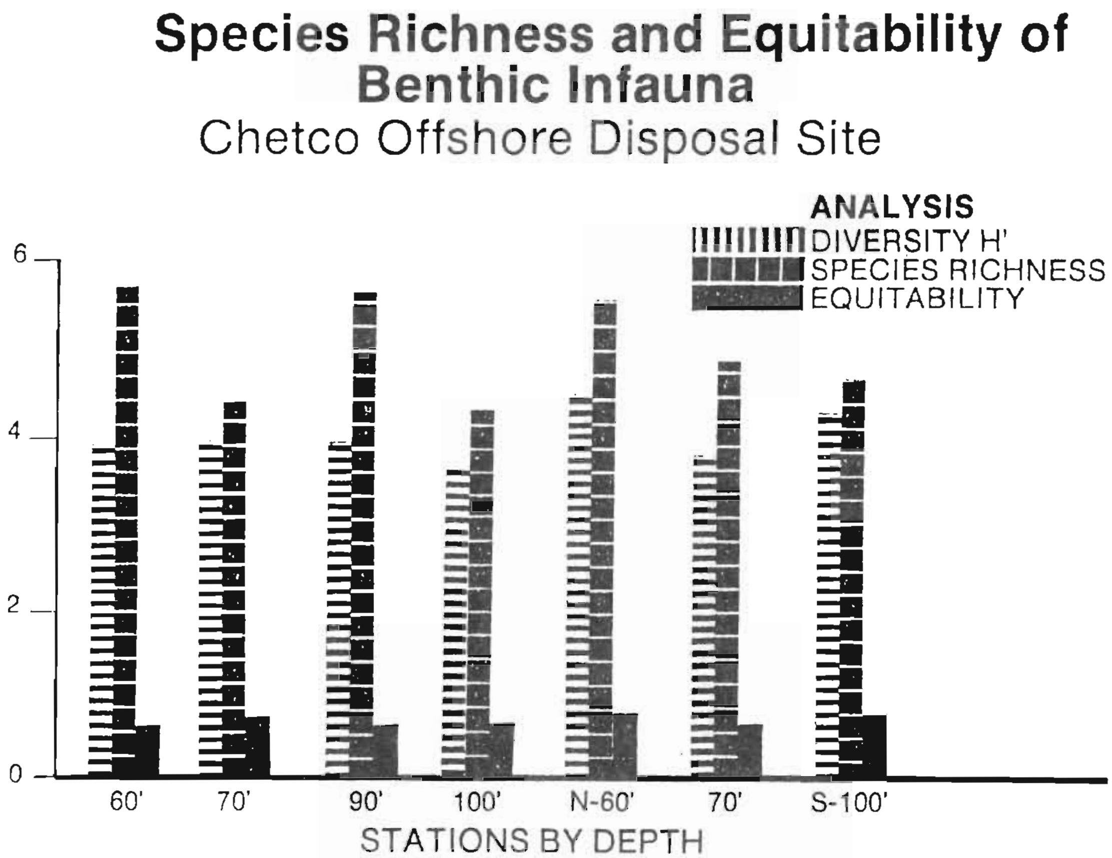


Figure A-6
Species Richness and Equitability of Benthic Infauna

Dungeness crabs. Shellfish distribution is shown in figure A-7. Clam beds are located north of Chetco Point and Macklyn Cove. Dungeness crab adults occur on sandflat habitat throughout the nearshore area. The presence of Dungeness crab near the Chetco River is typical of conditions along the entire Oregon coast. They spawn in offshore areas and the juveniles rear in estuaries.

Fisheries

1.27 The nearshore area off the Chetco River mouth also supports a variety of pelagic and demersal fish species. Coho and chinook salmon, steelhead and searun cutthroat trout, migrate through the estuary to upriver spawning areas.

1.28 Surfperch, starry flounder, lingcod, black rockfish and cabezon all inhabit the lower estuary. Anchovies and smelt can be found at the entrance to the bay.

1.29 Various rocky reef species are found associated with the jetties.

1.30 Demersal species present in the nearshore area are mostly residents, demonstrating little coastwise movement. However, species such as sablefish, petrale sole and English sole do undertake extensive coastal migrations.

1.31 Distribution and abundance varies with species, season, depth, and in the case of bottom fish, sediment type. Resident lingcod and rockfish species inhabit the many rock outcroppings and reefs to the north and east of the disposal site.

1.32 English, Dover, and petrale sole move from deep offshore waters in winter to shallow nearshore waters in summer. Shallow inshore waters are important nursery areas for juvenile English sole (Krygier and Pearcy, 1986). Most of the flatfish species occur over sandy bottom types.

1.33 Littleneck clams are common in gravel pockets northwest of the bay entrance. Abalone are found along the reefs and rock outcroppings to the north and east of the disposal site and octopi occur in nearshore areas.

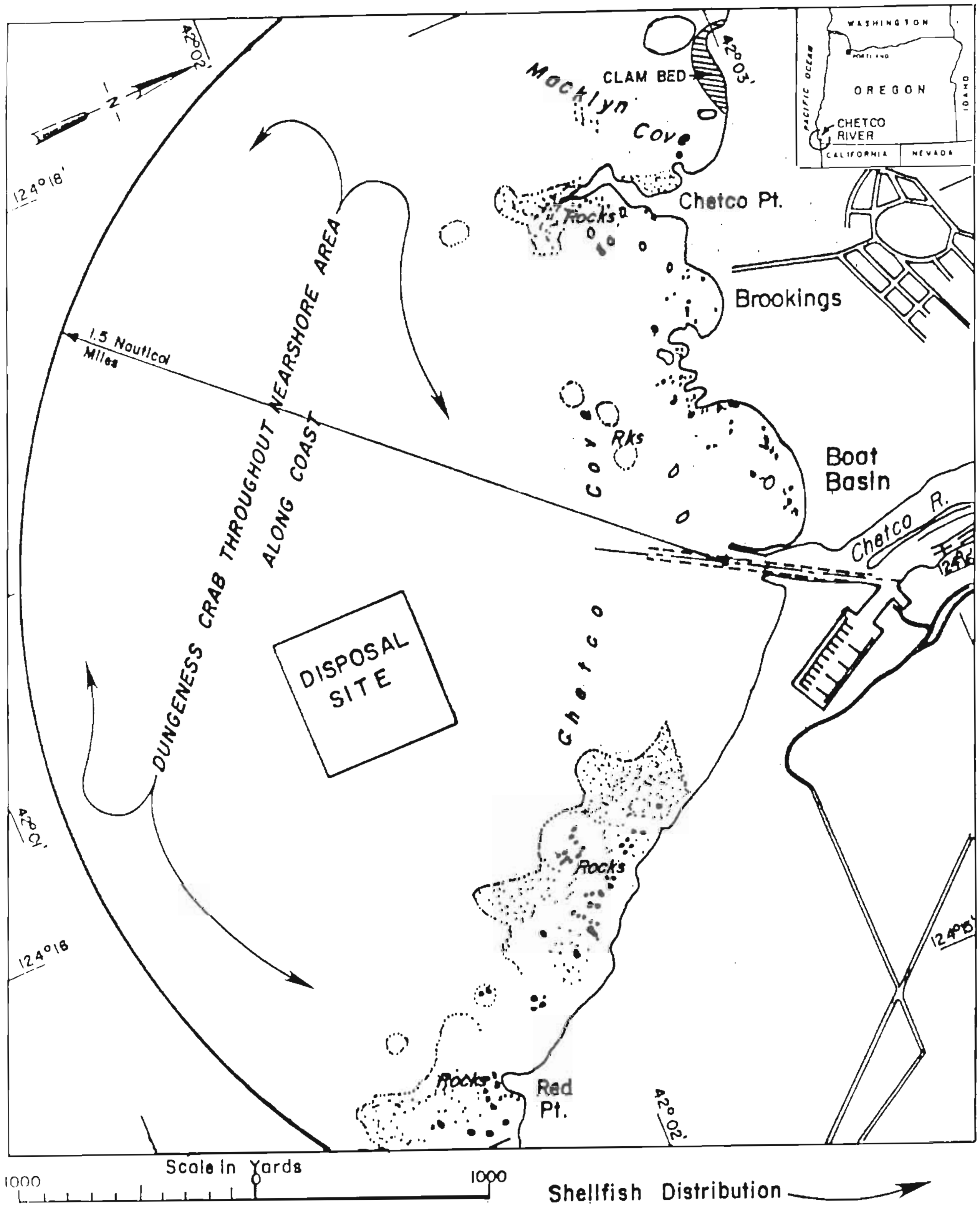


Figure A-7
Shellfish Distribution

1.34 Dungeness crab occur in and around the disposal site, off the bar, and in the bay.

1.35 Market squid schools can be found all along the Oregon coast. They spawn over sandy bottoms in nearshore, shallow waters. The egg cases fall to the bottom where they anchor themselves by secreting a glue-like resin onto sand particles. Although ODFW has not conducted spawning surveys along the southern Oregon coast, crab fishermen have reported egg clusters attached to crab pots in and around the disposal site (personal communication from ODFW).

Commercial and Recreational Fisheries

1.36 The near shore area around Chetco supports both commercial and recreational fisheries. The nearshore area around the disposal site is where the bulk of the recreational salmon fishery occurs, as well as some commercial troll fishing. Salmon seasons for both fisheries usually begin in June, and are subject to closure when quotas are met.

1.37 Recent (1980-1985) commercial harvests of Coho salmon recorded at Brookings have ranged from 0 pounds in 1984 to 184,288 in 1981. Chinook landings over the same period ranged from 4962 pounds in 1985 to 694,386 in 1981 (ODFW Annual Reports).

1.38 Commercial rockfish landings from 1980 to 1985 ranged from 1,345,114 pounds (1983) to 2,638,706 (1982). Sablefish landings have increased from 123,428 pounds landed in 1981, to 544,523 pounds in 1984.

1.39 Over one million pounds of Dover sole were commercially harvested in 1984. English, rex and petrale sole are taken in moderate quantities from nearshore areas.

1.40 Commercial and recreational Dungeness crab harvest sites surround the disposal site. Dungeness are commercially taken from December through September. Commercial landings between 1980 to 1985 ranged from 583,248 pounds (1983) to 2,913,893 (1980).

1.41 The nearshore area supports a small commercial octopus and squid fishery.

Wildlife

1.42 Numerous species of birds (table A-5) and marine mammals (table A-6) occur in the pelagic, nearshore, and shoreline habitats in and surrounding the proposed disposal site. Information on distribution and abundance of bird species is from the Seabird Colony Catalog (Varoujean, 1979) and Pacific Coast Ecological Inventory (USFWS 1981), except as indicated. Information on most species of shorebirds is lacking. Therefore, their abundance and distribution can only be addressed in general terms. They occur along much of the coast primarily as migrants and/or winter residents. A few species of shorebirds--including western snowy plover, black oystercatcher, killdeer, and spotted sandpiper--nest along the coast. Several species of special concern, the bald eagle, peregrine falcon, and brown pelican, occasionally occur along the coast and may use the ZSF or the surrounding areas. Pelicans and peregrine falcons are often associated with headlands, ocean beaches, spits and offshore rocks. Pelagic birds (e.g. scoters, petrels) probably use the ZSF and adjacent waters for foraging.

1.43 Data on marine animals is from the Natural History of Oregon Coast Mammals, Maser et al. (1981), Pearson and Verts (1970), and the Pacific Coast Ecological Inventory (USFWS 1981), except as indicated. Except for seals and sea lions, information on marine mammals is extremely limited. Whales are known to occur throughout coastal waters, primarily during migrations, but population estimates and information on areas of special use generally are not available.

1.44 A number of species of shorebirds and waterfowl (table A-5) use the shoreline habitats at the mouth of the Chetco River. Brown pelicans, a federally listed endangered species, use this area. Outside the ZSF, several important species and wildlife habitats occur and could be affected. Whalehead Island is an important nesting and congregating area for seabirds, including approximately 1/10 of Oregon's breeding population of Leach's storm petrels, 1/3 of Oregon's pigeon guillemots, and 1/5 of Oregon's tufted puffins. Gulls, cormorants, common murres, and Cassin's auklets also nest on Whalehead Island. House Rock and Twin Rock have nesting populations of comorants. Approximately 1/2 of Oregon's population of Leach's storm petrels nest on Goat Island, as do about 1/4 of the Brandt's cormorants, about 1/4 of the western gulls, 1/4 of the pigeon guillemots, and 1/3 of the tufted puffins. Common murres and Cassin's auklets also nest on Goat

	HABITAT USE			
CATEGORY/SPECIES	BREEDING	WINTERING	MIGRANTS	SUMMER NON-BREEDERS
SHOREBIRDS				
black oystercather	X	X		
snowy plover	X	X		
greater yellowlegs			X	
black turnstone		X	X	
northern phalarope			X	
western gull	X	X		
Heermann's gull		X		
glaucous-winged gull		X		
killdeer	X	X		
spotted sandpiper	X	X		
surfbird		X		
wandering tattler			X	
semipalmated plover			X	
least sandpiper		X	X	
dunlin		X		X
western sandpiper		X	X	
sanderling		X	X	
California gull		X		
ring-billed gull		X		
mew gull		X		
Bonaparte's gull		X		
Sabine's gull			X	
long-billed dowitcher			X	
black turnstone		X	X	
SEABIRDS				
fork-tailed storm petrel	X	X		
Leach's storm petrel	X	X		
double-crested cormorant	X	X		
Brandt's cormorant	X	X		
pelagic cormorant	X	X		

1 From Gabrielson and Jewett (1970) and Bertrand and Scott (1973).

Table A-5

Bird Species in Vicinity of Disposal Site

	HABITAT USE			
CATEGORY/SPECIES	BREEDING	WINTERING	MIGRANTS	SUMMER NON-BREEDERS
SEABIRDS (con't)				
common murre	X	X		
pigeon guillemot	X	X		
marbled murrelet	X	X		
Cassin's auklet	X	X		
rhinoceros auklet		X		
tufted puffin	X	X		
fulmar		X		
pink-footed shearwater			X	
sooty shearwater			X	
WATERFOWL				
common loon	X	X		
arctic loon		X		
red-throated loon		X		
western grebe	X	X		
red-necked grebe	X	X		
horned grebe	X	X		
pied-billed grebe	X	X		
Canada goose		X		
black brandt		X		
mallard	X	X		
pintail		X		
American wigeon		X	X	
green-winged teal		X		
redhead		X	X	
canvasback		X		
ring-necked duck		X		
greater scaup		X		
lesser scaup		X		
common goldeneye		X		
Borrow's goldeneye		X		
bufflehead		X		
harlequin		X		
black scoter	X	X		
white-winged scoter	X	X		

Table A-5

Bird Species in Vicinity of Disposal Site

	HABITAT USE			
CATEGORY/SPECIES	BREEDING	WINTERING	MIGRANTS	SUMMER NON-BREEDERS
WATERFOWL (con't)				
surf scoter	X	X		
ruddy duck		X		
common merganser		X		
red-breasted merganser		X		
great blue heron	X	X		
American coot	X	X		
brown pelican				X
OTHER				
bald eagle	X	X		
peregrine falcon		X	X	

Table A-5

Bird Species in Vicinity of Disposal Site

CATEGORY/SPECIES	HABITAT USE BREEDING	WINTERING	MIGRANTS
SEALS AND SEA LIONS			
harbor seal	X	X	
northern elephant seal		X	X
stellar sea lion	X	X	X
California sea lion		X	X
WHALES			
northern right whale		Along Oregon coast in winter.	
gray whale		Along Oregon coast during Feb. to May while migrating to and from breeding and feeding grounds. Estimated total population 11000-15000. Some may be staying in Oregon water during winter. (R. Brown, pers. commun.)	
blue whale		Off Oregon coast from late May to June and August to October.	
fin whale		Occur off Oregon Coast during May to September	
sei whale		Summer to early fall	
minke whale		Late summer to early fall	
humpback whale		April to October	
sperm whale		Late summer to fall	
giant bottlenose whale		Uncommon, June to October	
short-finned pilot whale		Winter	
grampus		Uncommon, spring to summer	
killer whale		Winter	

Table A-6

Marine Species in Vicinity of Disposal Site

	HABITAT USE		
CATEGORY/SPECIES	BREEDING	WINTERING	MIGRANTS
WHALES (còn't)			
false killer whale		Uncommon	
common dolphin		Uncommon, spring to summer	
northern right whale dolphin		Rare, spring to summer	
Dall's porpoise		Common, throughout year	
harbor porpoise		Common, throughout year	
Pacific white-sided dolphin		Common, throughout year	

Table A-6
Marine Species in Vicinity of Disposal Site

Island. Cone Rock is a nesting area for western gulls, pelagic cormorants, and pigeon guillemots. Black oystercatchers, western gulls, Brandt's cormorants, pelagic cormorants and pigeon guillemots nest on Hunter Rock and Prince Island. Leach's storm petrels, double-crested cormorants, rhinoceros auklets, and tufted puffins also nest on Prince Island.

LITERATURE CITED

Bayer, R., 1983. Ore Aqua Company Biologist, Newport, OR. Personal communication.

Bertrand, G.A. and J.M. Scott, 1973. Check-list of the Birds of Oregon Museum of Nat. Hist. Oregon State Univ. Corvallis, OR. 17 pp.

Gabrielson, J.N. and S.G. Jewett, 1970. Birds of the Pacific Northwest. Dover Publications, Inc. New York, N.Y. 650 pp.

Hancock, D.R., P.O. Nelson, C.K. Sollitt, K.J. Williamson, 1981. Coos Bay Offshore Disposal Site Investigation Interim Report Phase I, February 1979- March 1980. Report to U.S. Corps of Engineers, Portland, District, Oregon, for Constract No. DACW57-79-C-0040. Oregon State University, Corvallis, OR.

Hogue, Wayne E, 1982. Seasonal Changes in the Abundance and Spatial Distribution of a Meiobenthic Assemblage on the Open Oregon Coast and its Relationship to the Diet of 0-age Flatfishes. Ph.D. thesis, OSU, Corvallis, OR. 125 pp.

Lee, W. 1971. The copepods in a collection from the southern Oregon coast, 1963. M.S. Thesis, Oregon State Univ., Corvallis, 62pp.

Lough, R.G., 1976. Larval Dynamics of the Dungeness Crab, Cancer magister, off the Central Oregon Coast, 1970-71. Fish. Bull. 74(2):353-376.

Maser, C., B.R. Mate, J.F. Franklin and C.T. Dyrness, 1981. Natural History of Oregon Coast Mammals. USDA For. Serv. Gen. Tech. Rep. PNW-133, Pac. Northwest For. and Range Exp. Stn., Portland, OR. 496 pp.

Montagne-Bierly Associates, Inc., 1977. Yaquina Bay Hopper Dredge Scheduling Analysis. Prepared for: U.S. Army Corps of Engineers, Portland District, Navigation Division, P.O. Box 2946, Portland, OR 97208-2946.

Nelson, P.O., C.K. Sollitt, K.J. Williamson, D.R. Hancock, 1983. Coos Bay Offshore Disposal Site Investigation Interim Report Phase II, III, April 1980- June 1981. Report submitted to the U.S. Army Corps of Engineers, Portland District for Contract No. DACW57-79- 0040. Oregon State University, Corvallis, OR.

Oceanographic Institute of Oregon, 1983. An examination of the Feasibility of Extrapolating Infaunal Data from Coos Bay, Oregon to Yaquina Bay, OR. Final report USACOE, Portland District contract #DACW57-84-M- 1186.

Pearcy, W.G. and S.S. Myers, 1974. Larval Fishes of Yaquina Bay, Oregon: A Nursery Ground for Marine Fishes? Fish. Bull. 72(1):201-213.

Pearson, J.P. and B.J. Verts, 1970. Abundance and distribution of harbor seals and northern sea lions in Oregon. Murrelet. 51:1-5.

Peterson, W.T., C.B. Miller and A. Hutchinson, 1979. Zonation and Maintenance of Copepod Populations in the Oregon Upwelling Zone. Deep-Sea Research 26A:467-494.

Peterson, W.T. and C.B. Miller, 1976. Zooplankton Along the Continental Shelf off Newport, Oregon, 1969-1972: distribution, abundance, seasonal cycle, and year-to-year variations. Oregon State University, Sea Grant College Program Pub. No. ORESU-T-76-002. 111 pp.

Richardson, S.L., J.L. Laroche and M.D. Richardson, 1980. Larval Fish Assemblages and Associations in the Northeast Pacific Ocean Along the Oregon Coast, Winter- Spring 1972-1975. Estuarine and Coastal Marine Science (1980) II, 671-698.

Richardson, S.L. and W.G. Pearcy, 1977. Coastal and Oceanic Fish Larvae in an Area of Upwelling off Yaquina Bay, Oregon. Fish. Bull. 75(1):125-145.

Richardson, S.L., 1973. Abundance and Distribution of Larval Fishes in Waters off Oregon, May-October, 1969, with Special Emphasis on the Northern Anchovy, Engraulis mordax. Fish. Bull. 71(3):697- 711.

Richardson, M.D., A.G. Carey, and W.A. Colgate., 1977. An Investigation of the Effects of Dredged Material Disposal on Neritic Benthic Assemblages off the Mouth of the Columbia River. Phase II. DACW57-76-R-0025.

Sollitt, C.K., D.R. Hancock, P.O. Nelson, 1984. Coos Bay Offshore Disposal Site Investigation Final Report Phases IV, V, July 1981-September 1983. U.S. Army Corps of Engineers, Portland District, Portland, Oregon, for Contract No. DACW57- 79-C-0040, Oregon State University, Corvallis, OR.

Steiner, R.G., 1978. Food Habits and Species Composition of Neritic Reef Fishes off Depoe Bay, OR. Masters Thesis, Oregon State University.

U.S. Dep. of Interior Fish and Wildlife Serv., 1981. Pacific coast ecological inventory.

Varoujean, D.H., 1979. Seabird colony catalog: Washington, Oregon, and California. U.S. Dep. Interior Fish and Wildl. Serv., Region I., Portland, OR. 456 pp.

Waldron, K.D., 1954. A Survey of the Bull Kelp Resources of the Oregon Coast in 1954. Res. Briefs, Fish. Comm. of Oregon. 6:2:15-20.

APPENDIX B

GEOLOGICAL RESOURCES, OCEANOGRAPHIC PROCESSES AND SEDIMENT TRANSPORT OF THE CHETCO ZSF

APPENDIX B

GEOLOGIC RESOURCES, OCEANOGRAPHIC PROCESSES AND SEDIMENT TRANSPORT OF THE CHETCO ZSF

TABLE OF CONTENTS

TABLES

FIGURES

APPENDIX B

GEOLOGIC RESOURCE, OCEANOGRAPHIC PROCESSES, AND SEDIMENT TRANSPORT OF THE CHETCO ZSF

GEOLOGICAL RESOURCES

Regional Setting

1.1 The Chetco River empties into the Pacific Ocean about 300 miles south of the mouth of the Columbia River. It lies within the Cape Ferrelo littoral cell, which extends for approximately 40 km from Cape Ferrelo in the north to Point St. George in the south (figure B-1). The Chetco River has one of the smallest estuaries on the Oregon coast (Percy, et al, 1974). The watershed lies entirely within the Klamath Mountains. Immediately north of the mouth of the Chetco are cliffs and sea stacks. To the north of the river mouth, the coastline is elevated with rugged bluffs rising above narrow beaches, with numerous islands and stacks. To the south, broad beaches rise rapidly to raised marine terraces and low inland hills. No sand dunes of consequence are found in this area. From the mouth of the river to about river mile eight (RM 8), the valley consists of an alluvial plain varying between 1/2 and 1/4 mile wide (USACE, 1975). The continental shelf extends about 25 km out from the mouth of the Chetco. The shelf and slope are characterized by a series of flat terraces or benches (Byrne, 1963). Sand covers the bottom for a distance of about 2 km out from the shore. After a thin zone of mixed sand and mud, the bed is blanketed by a thin layer of mud. This mud layer is usually less than 10 cm thick off the Rogue river to the north (Kulm, 1977).

1.1.1 The Chetco ZSF is within the Brookings subcell of the Crook Pt. littoral cell. The coastline bordering the littoral cell consists of about 6 miles of rugged cliffs and pocket beaches from Cape Ferrelo down to Brookings, 8 miles of broad beaches fronting raised marine terraces

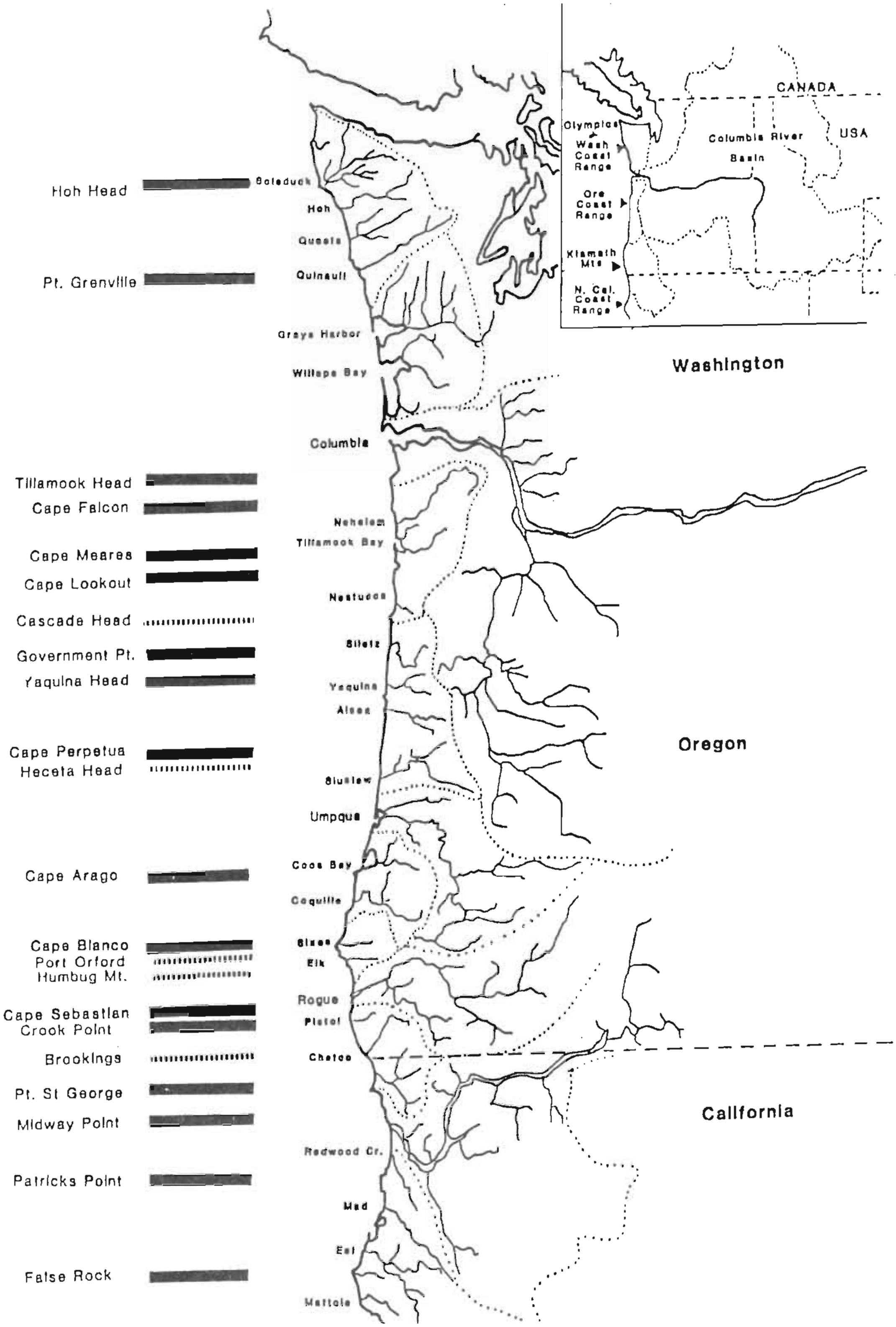


Figure B-1
Littoral Cell Location Map

to the mouth of the Smith River, and 12 miles of prograding shoreline south to Pt. St. George (Beaulieu et al 1974, Peterson, pers. com. 1986).

Regional Geology

1.2 The Chetco River is, after the Rogue, the major stream draining the western Klamath Mountains in Oregon. The Klamaths are made of Mesozoic marine sediments and igneous rocks that have been folded, faulted and subjected to varying degrees of metamorphism, and Tertiary igneous intrusives. The tectonic history of the Klamath mountains is complex, with several episodes of folding and faulting, which have continued up to the present. Parts of the Klamaths have been subjected to tectonic events since the late Jurassic. The late Cretaceous and early Cenozoic was a time of quiescence, but since the end of the Eocene, faulting and uplift have affected the area (Baldwin 1981, Baldwin and Beaulieu 1973, Dott, 1971).

1.2.1 The Chetco River flows mainly through rocks of the Dothan Formation, which consists of rhythmically bedded sandstone, siltstone, some conglomerates and bedded cherts, and volcanics (Figure B-2). The Dothan formation was deposited along the continental margin during the late Jurassic (Baldwin and Beaulieu, 1973). Other formations within the Chetco's drainage basin are the Colebrook Schist, Gneissic rocks, peridotite and serpentinite of Jurassic age, and dacitic intrusions from the Tertiary. The coastline, from just north of the California border up to about Whalehead Island, is bordered by the Dothan formation. The next five miles are made of the Jurassic Otter Point Formation, with the final distance up to Crook Point consisting of the Cretaceous Hunter Cove Formation and some Quaternary deposits. Southward from the California border to the southern terminus of the cell the shoreline is a prograding beach (Dott, 1971).

1.2.2 The region is currently undergoing tectonic uplift, but that has been surpassed by the post Pleistocene rise in sea level. During the Pleistocene glaciations, the massive amount of water stored in the glaciers caused a drop in sea level. The end of the Ice Age and the melting of the glaciers resulted in a global sea level rise of 125 m (Curry, 1965). Fluctuating sea level, in conjunction with tectonic

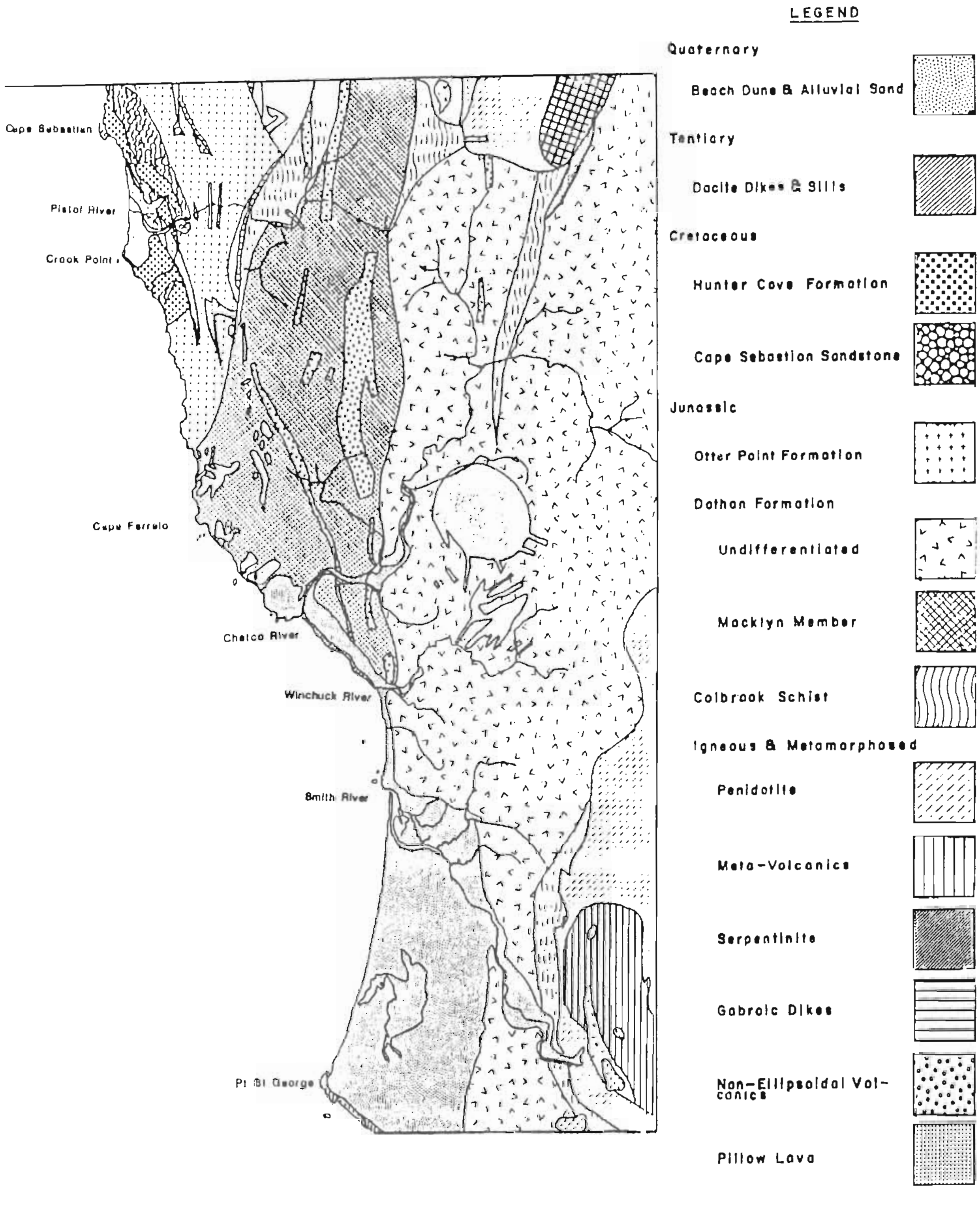


Figure B-2
Watershed Geology

uplift of the Klamaths, led to the formation of several raised marine terraces as well as the incision of valleys to below the present sea level. Near Brookings, the raised terraces are about 80 m above sea level. The rise in sea level "drowned" the river and stream valleys that had been incised in the Coast Range and coastal plain. This produced the large coastal estuaries and allowed the development of the alluvial plains bordering the lower reaches of the Chetco River.

1.2.3 The sand deposits that cover the nearshore sea bed were delivered by streams that eroded rocks in the coastal mountains, and by the sea attacking both bedrock and marine deposits left over from previous high stands of the sea. An undetermined amount of bedload material is currently escaping through the estuaries and eroding from the shoreline. Fine silts and clays supplied by these sources are removed or prevented from settling out in the nearshore zone by the high wave energy, leaving fine sand covering the sea bed for a distance of several kilometers offshore.

Economic Geology

1.3 The Chetco River and its tributaries flow through bedrock containing mineralized zones, and has several reaches containing gold placer deposits. Despite this, no large concentrations of black sands have been identified close to the mouth of the river. The closest deposit is seven miles to the north and has a heavy mineral concentration of 10-30% (Grey and Kulm, 1985). Minerals of primary interest in black sands are gold, platinum, and chromite, but the sands also contain numerous other heavy minerals (Ramp, 1973). The offshore deposits north of the Chetco are not currently being mined. Offshore gravel deposits elsewhere along the Oregon coast have been considered as potential sources of aggregate. While individual samples of gravel were found within the ZSF, no large deposits have been found close to the mouth of the Chetco river. While there have been several attempts to find oil and gas along the Oregon coast, no test well has turned up more than traces of either. No test well off the Oregon coast had been drilled south of Cape Blanco as of 1985.

Sediment Sources

1.4 There are three external sources for sediment in the littoral cell. These are input from fluvial sources, dredging, and coastal erosion.

1.4.1 The Chetco estuary has a hydrographic ratio (HR) of about 1. It is therefore very fluvially dominated and, thus, most of its bedload sediment will be transported into the ocean (Peterson, pers com 1986). The HR is discussed more fully under Local Processes.

1.4.2 Two other rivers enter the littoral cell, the Winchuck River, a few miles south of the Chetco, and the Smith River, which is in California. The Winchuck has a mean discharge of under 90 cfs, so is at best a very minor contributor of sediment. The Smith River, on the other hand, is larger than the Chetco and also has a HR of about 1. Mineralogical studies have shown that the Smith and Chetco Rivers are the major sediment sources for the littoral cell.

1.4.3 A second source of sediment is coastal erosion. Runge (1966) estimated 780,000 cy of material were added annually by erosion along the coast of Oregon. Studies providing information on specific rates of erosion and material contribution are not available. The National Shoreline Study (COE, 1971) identified the coastline north of Brookings up to Cape Ferrelo as being subjected to critical erosion, and up to Crook Point to "non-critical erosion". The Beach and Dunes of the Oregon Coast report (USDA and OCCDC, 1975) agrees in general with the shoreline survey, but shows little erosion between Cape Ferrelo and Crook Point. In neither study was any data given on erosion rates. The portion of the littoral cell experiencing critical erosion is prone to landsliding. The largest landslide is the Hooskanaden slide. These slides move slowly and intermittantly, their rate increased by heavy rainfall and the removal of their toes by wave action. The slides are continuous sources of sediment for the littoral zone. South of Brookings, the beaches and terrace faces are stable, and may show some signs of progradation (Stembridge, 1976). At best, this stretch of the coast has little effect on the sediment budget. The progradational beaches south of the Smith River mouth are a net sediment sink. They take a large, though undetermined, percentage of the material contributed by the Smith River.

1.4.4 In the Cape Ferrelo littoral cell, the only offshore disposal of dredged material occurs off the mouth of the Chetco River. The type of dredged material depends on both the location and hydrologic conditions. Dredging during or just after high flows is more likely to pick up fluvial sediments than dredging done during periods of low flow, when marine sediments have intruded into the mouth. The further upstream dredging is done, the more likely it is that fluvial sediments will be encountered. Since the Chetco River has a HR of less than 1, nearly all the sediment load should eventually be carried out into the ocean. This means that the net contribution of dredging to the sediment budget is much smaller than the amount of material disposed of offshore.

1.4.5 Dredging of the entrance of the Chetco River began in 1963. The current offshore disposal site was designated in 1977. Between 1976 and 1985, the average dredging volume was 47,800 cy, with maximum and minimum quantities of 76,300 and 7,800 cy, respectively (table B-1).

Table B-1
Dredging Volumes at Chetco

Year	Cubic Yards (C.Y.)
1976	60,100
1977	7,800
1978	56,750
1979	44,230
1980	54,300
1981	76,300
1982	52,556
1983	59,715
1984	31,874
1985	35,045
10-Year Average	47,792

*Includes both Corps and contract hopper dredging.

The authorized project provides for an entrance channel 120 feet wide and 14 feet deep, a barge turning basin 250 feet wide, 650 feet long and 14 feed deep, and a small boat access channel 100 feet wide and 12 feet deep. Shoaling occurs off the end of the north jetty between RM 0 and RM -0.2, and at the entrance to the boat basin between RM 0.1 and RM 0.3 (figure B-3). Dredging is done between April and October.

1.4.6 In determining the importance of the various potential sources, the mineral assemblages of the sediments and the sources can be useful. In the case of the Cape Ferrelo cell, three different mineral abundance ratios have been used to define the cell. The littoral sands have a high ratio of orthopyroxene to clinopyroxeen (2.5:1), a subequal ratio of pyroxene to amphibole (0.5:1), and a high ratio of metamorphic amphibole to hornblend (2:1). In addition, there are significant amounts of olivine (15%). The two major rivers (Chetco and Smith) that enter the littoral cell have heavy mineral assemblages that correlate with that of the littoral sands. This shows that the majority of the sediment is fluvially derived (Chesser and Peterson 1987, Peterson, pers. com. 1986).

1.4.7 The seabed in the ZSF is covered by a wide variety of material. The most recent sampling showed that mean grain size varies from as fine as 0.05 mm in deep water to 18.0 mm close to the nearshore side of the designated disposal site. The one sample taken within the designated disposal site had a mean grain size of 0.25 mm (table B-2). A scarcity of samples and unsystematic placement of sampling sites prevents the determination of sediment distribution patterns from the samples.

1.4.8 There is also a wide variety of grain sizes in the sediments from shoals that are dredged in the Chetco River entrance. The entrance to the boat basin had the finest material sampled with a median grain size of 0.3 mm. The coarsest material (median grain size 7 mm) was found at the inner shoal, between the entrance to the boat basin and the end of the jetties, and is classified as silty, sandy gravel. The outer shoal is composed of coarse sand similar to that found on nearby beaches. Comparison of samples taken in 1974 and in 1981 showed consistency in median grain size for each shoal, but distribution of sizes within each sample varied considerably, as shown by the differences in mean grain

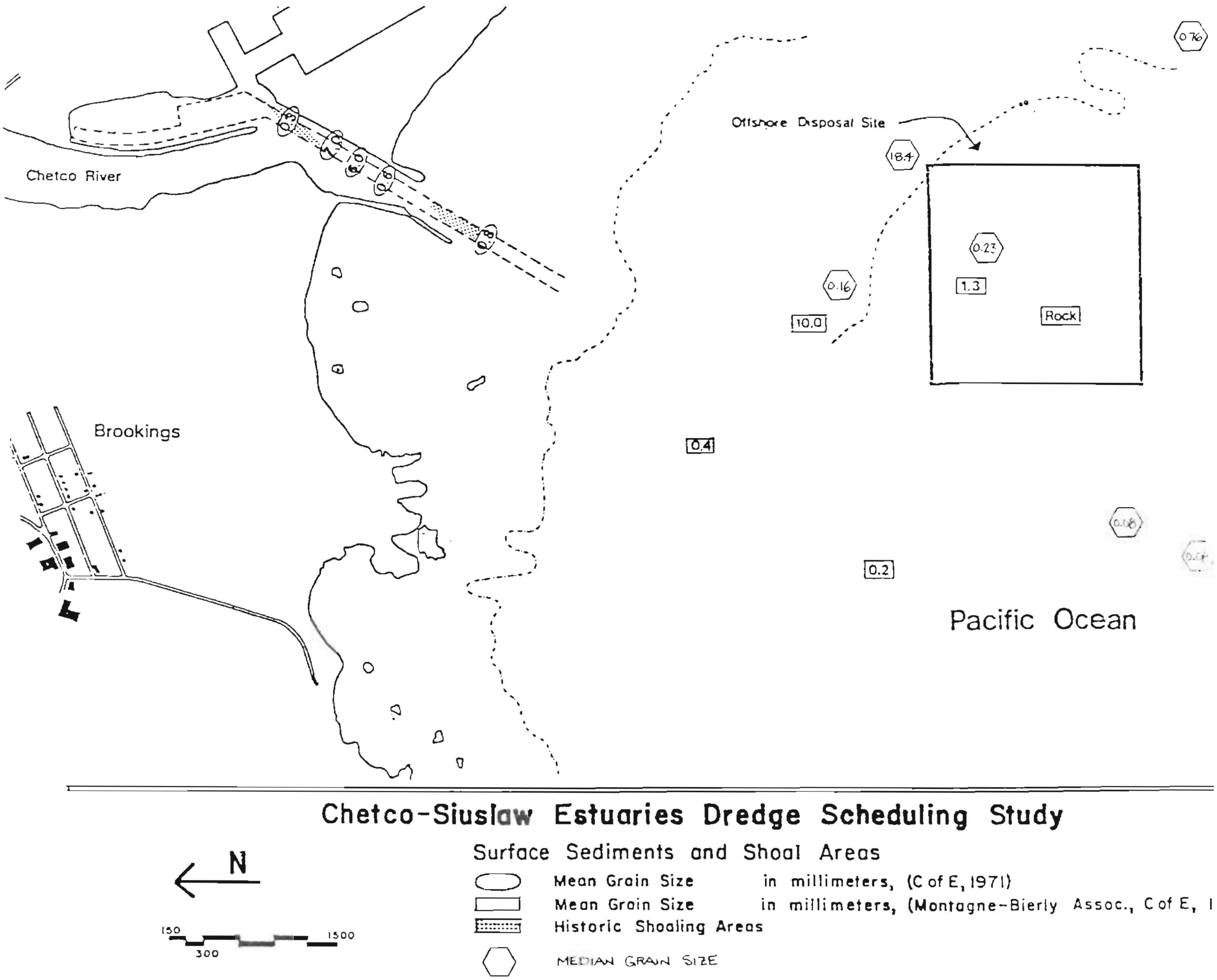


Figure B-3
Entrance Shoals and Offshore Sample Locations

Table B-2

Chetco Offshore Sediment Samples

Date	Sample	Mz (mm)	D50	D90	% fines	depth
8 May 1978	1-a	8.51	10	26	0	50
"	1-b	11.08	14	25	0	50
"	2-a	1.66	1.4	12	0	69
"	2-b	2.39	1.2	41	0	69
"	4-a	0.19	0.19	0.30	3	76
"	4-b	0.2	0.20	0.28	2	76
"	5-a	0.31	0.32	0.59	1	44
"	5-b	0.33	0.33	0.59	0	44
17 Aug 1984	002	7.46	8.88	22.	2	74
"	005	0.28	0.26	0.35	0	20
"	006	0.18	0.17	0.32	2	45
"	008	0.11	0.125	0.17	12	105
16 Jul 1985	c-1	18.0	18.4	39.4	0	60
"	c-6	18.8	21.1	36.8	0	60
"	c-12	0.24	0.23	0.57	1	72
"	c-13	0.06	0.08	0.19	42	90
"	c-24	0.05	0.08	0.14	41	96
"	c-30	0.77	0.76	4.76	1	102
"	c-37	0.15	0.16	0.26	7	72
"	c-38	0.14	0.14	0.25	9	54

Note: Mean grain size (Mz) calculated using Folk and Ward's (1954) parameters. Grain size given in millimeters.

size (table B-3). The difference was most extreme for the inner shoal, which had a large percentage of fines in 1981 but not in 1974. The outer shoal was more poorly sorted in 1974 than 1981, and had slightly more coarse material. Without more sampling, it is not possible to evaluate how close the samples are to the average or extremes of the dredged sediments. The sediments of the inner shoal appear to be primarily fluvial in origin, transported during winter and spring freshets. The outer shoal is made of littoral sand, perhaps including sand that had been transported beyond the jetties and injected into the littoral system. The extent of intrusion of littoral sediments into the estuary and ejection of fluvial sediments out of the river mouth is controlled by the river discharge. High discharge pushes fluvial sediments out, while low discharge allows littoral sands to move upstream.

Table B-3
Chetco River Entrance Samples

Sample	Location	D50	Mz	D90	%fines
	1971				
1	St.12	0.295	0.27	0.64	2
2	St. 9	0.84	0.80	10.4	2
	1972				
1	Out. shoal	6.0	4.23	10.9	1
	1974				
1	Buoy 9	6.9	5.66	23.0	0
2	End N jetty	0.74	0.84	6.4	1
	1976				
1	Buoy 9	0.60	0.77	10.0	4
	1981				
1	Buoy 9	6.0	1.74	23.0	20
2	End N jetty	0.71	0.69	1.5	0

Note: Grain size given in millimeters.

Conditions in the ZSF

1.5 The headlands, cliffs, stacks and the rocky, submarine outcrops in the Chetco Cove area are part of the Dothan Formation of Late Jurassic time. The Dothan Formation consists of thin to thick, hard, bedded sandstone and mudstone with minor amounts of volcanic rock (greenstone), chert and conglomerate. These were deposited in continental slope and deep ocean floor envirionments shoreward of the island arc that is represented by the Otter Point Formation (Beaulieu and Hughes, 1976). The Dothan formation is seperated from the more highly deformed Otter Point Formation to the west by the Carpenterville shear Zone (Dott, 1971). The Carpenterville Shear Zone is a zone of thrusting, along which the Otter Point Formation moved relatively eastward beneath the Dothan Formation in Late Jurassic or Cretaceous time. This shear zone lies at least two miles west of the Chetco study area and is considered to be inactive (Beaulieu and other, 1976). Very little is known about the bedrock structure adjacent to the Chetco study area. No faults have been mapped or projected into the study area (USACE, 1986).

1.5.1 The topography of the sea bed in the ZSF is highly irregular. There are rock pinnacles both in the northwest part of the surveyed area and along the east and southern sides of the designated disposal site, as well as scattered outcrops throughout the area. The bed directly west of the Chetco river mouth is relatively smooth down to a depth of at least 78 feet. The slope there is about 15.6/1000, but such regularity is the exception within the ZSF. In general, the contours arc, forming an embayment opening toward the southwest.

1.5.2 The quantities of material disposed at the designated disposal site have not created a noticeable mound. Bathymetric surveys made in 1984 and 1985 showed no change in the bed topography. However, in the northeastern part of the site, the border between the zones designated in the seismic survey as "sand/silt" and "scattered rock exposures" is marked by higher ground on the "sand/silt" side. This indicates a somewhat thicker sediment layer in the "sand/silt" zone.

1.5.3 Though the bathymetric surveys are unable to give a detailed picture of the surface of the disposal site, inspection by divers in 1978 gave some idea of the small scale topography of the bed both within and outside the site. Shortly after a dump, the bed was found to be covered with rolling, non-oriented mounds with a relief of about one to two feet, and an unstable substrate. In areas unaffected by dredging, the sandy bottom appeared to be flat with ripples one to three inches apart. Where no sediment covered the bed, the rolling, rocky substrate featured shelves and ledges two to four feet high, crevices and depressions (USACE 1978). No followup survey was done to see how the mounds of disposal material were modified through time.

1.5.4 Figure B-4 shows the results of the July 1985 sidescan sonar survey of the Chetco ZSF. The ZSF contains a wide variety of bottom conditions and materials. Generally, this area can be segregated into scattered rock exposures and massive rock outcrops in the south, east and northeast, and more or less continuous sediment covering the north, center and southwest. What was interpreted as "sand-silt" covered all of the latter section except for a portion of the center where there is "coarse sand or gravel". Bottom sampling confirmed the "coarse sand or gravel" as being that, while the "sand/silt" fell clearly into the range of sand.

1.5.5 Three subsurface seismic profiles were made in an east west direction (see figure B-5). They show the unconsolidated sediment cover ranging from 4 to 46 feet thick, with exposed or near surface rock in places. Profile 1 is in the south. It begins in the east with very thin sediment cover and exposed mounds of bedrock. From mark 216 westward, the sediment layer gradually increases to a maximum thickness of 46 feet. Profile 2 transects the disposal site. It goes from exposed rock in the east through a wedge of sediment that thickens to about 15 feet, which is maintained through the disposal area until abruptly pinching out at the west end. The third profile shows 15 to 25 feet of sediment for 2/3 of the way from east to west, with rocks poking up in several places in the western third. The bedrock surface is irregular with pinnacles protruding through the covering in numerous places.

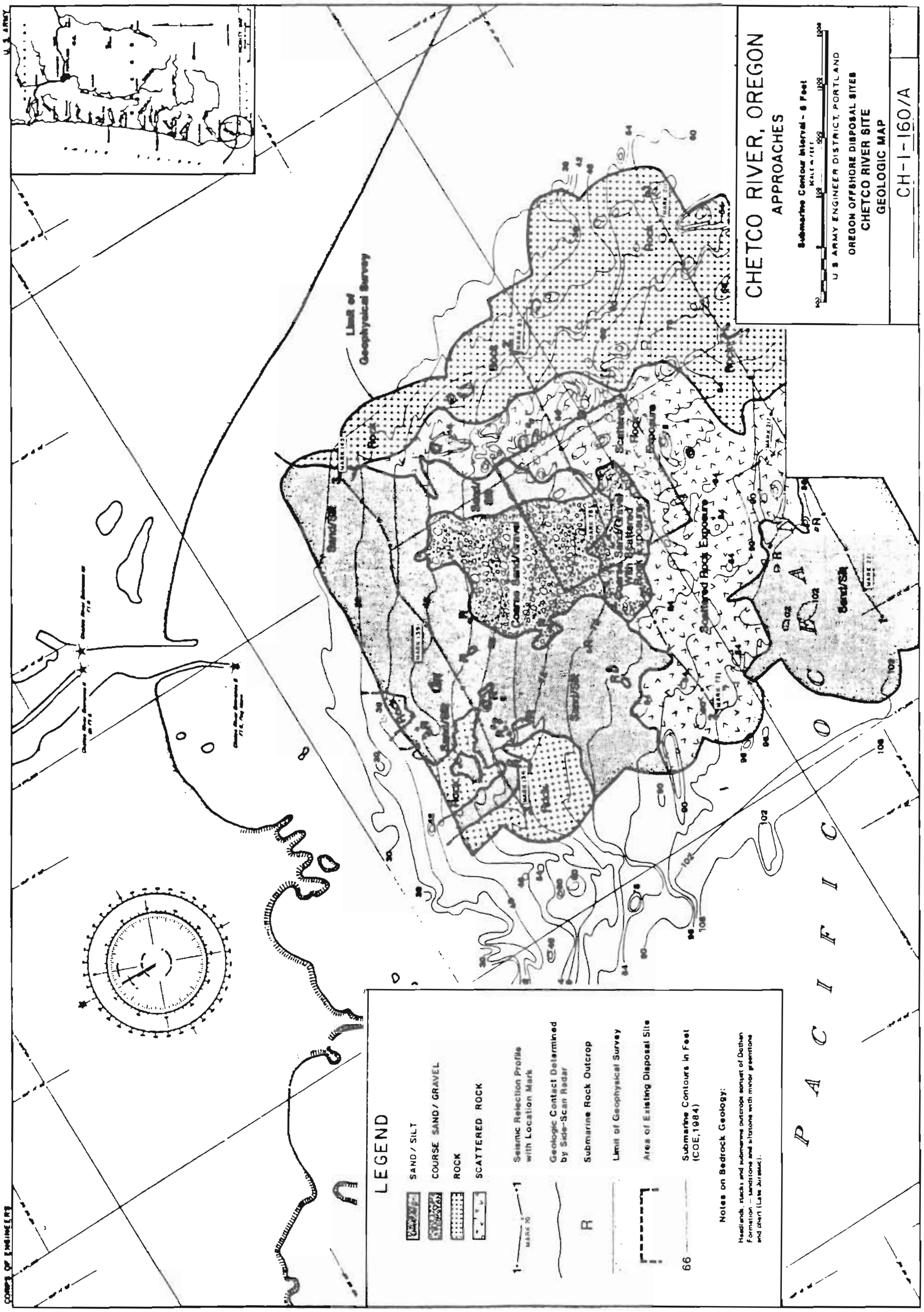
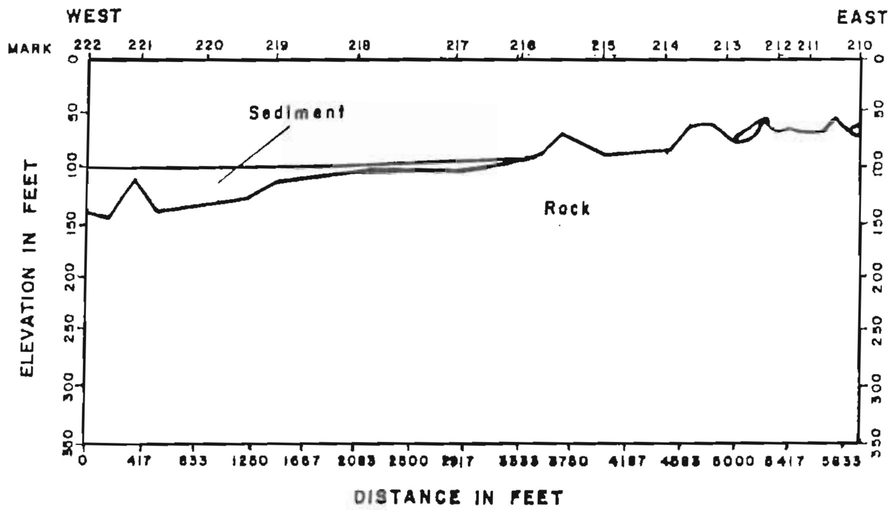
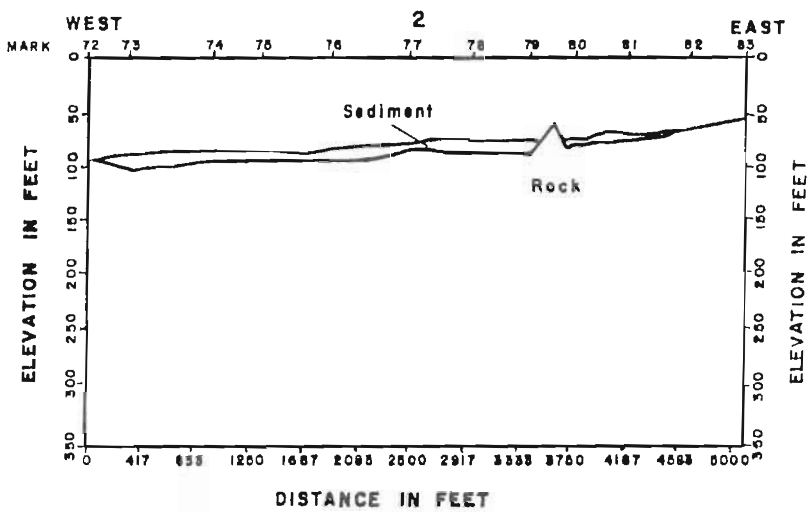


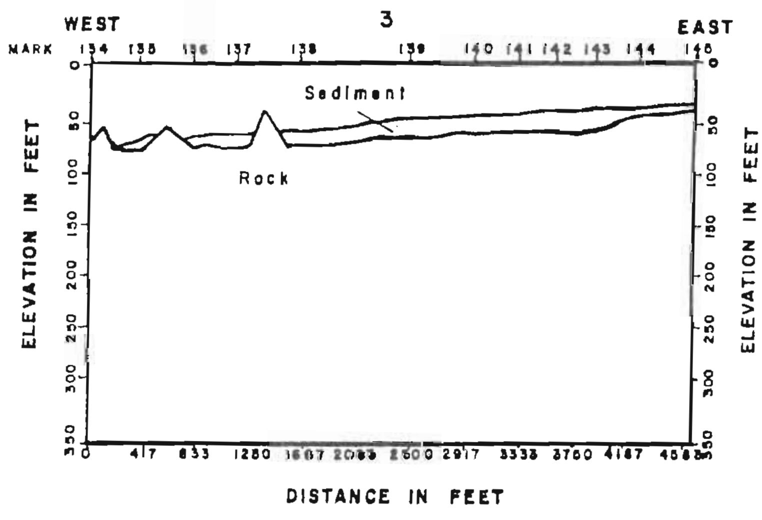
Figure B-4
Sidescan Sonar Survey





NOTE:

BEDROCK CONSISTS OF DOTHAN FORMATION— SANDSTONE AND SILTSTONE WITH MINOR GREENSTONE AND CHERT (LATE JURASSIC).



CHETCO RIVER PROFILE

ELEVATION DATUM IS MLLW FROM FATHOMETER RECORDINGS.

LOCATION BY PORTLAND DISTRICT, COE.

Figure B-5
Seismic Profiles

OCEANOGRAPHIC PROCESSES

Coastal Circulation

2.1 Coastal circulation near the Chetco ZSF is directly influenced by large-scale regional currents and weather patterns in the northwestern Pacific Ocean. Seasonal and short period currents due to regional weather patterns are more important at Chetco than farther north. Strub et al. (1987) describe a transition in oceanographic regimes near the latitude of Chetco. During winter, strong low pressure systems with winds and waves predominantly from the southwest contribute to strong northward currents. During the summer, high pressure systems dominate and waves and winds are commonly from the north. In both seasons, there are fluctuations related to local wind, tidal and bathymetric effects. The configuration of the coastline minimizes the effects of southerly waves in the summer at Chetco. Along the southern Oregon coast, this southerly wind in summer creates a mass transport of water offshore which results in upwelling of bottom water nearshore. Figure B-6 illustrates these influences at Chetco.

Ocean Waves and Tide

2.2 Ocean waves arriving at Chetco are generated by distant storms and by local winds. Distant storms produce waves that arrive at the coast as swells which are fairly uniform in height, period and direction. Local winds produce seas which contain a mixture of wave heights, periods and directions. Generally, local seas have higher waves and shorter periods than incoming swell. Waves generated by local winds, i.e., seas, generally approach the coastline from the SW to S sectors during autumn and winter, but from the N to NW sectors in spring and summer. The longer period swells generated by more distant storms approach generally from the NW to W or W to SW sectors. Local storms are considered to generate higher waves than swell with the highest waves always occurring during the winter and approaching from the SW to S sectors. The shortest sea and swell periods occur during the summer. Longest period swell generally occurs during autumn while longest period seas occur during winter. Figure B-7 illustrates the variability in monthly significant wave height.

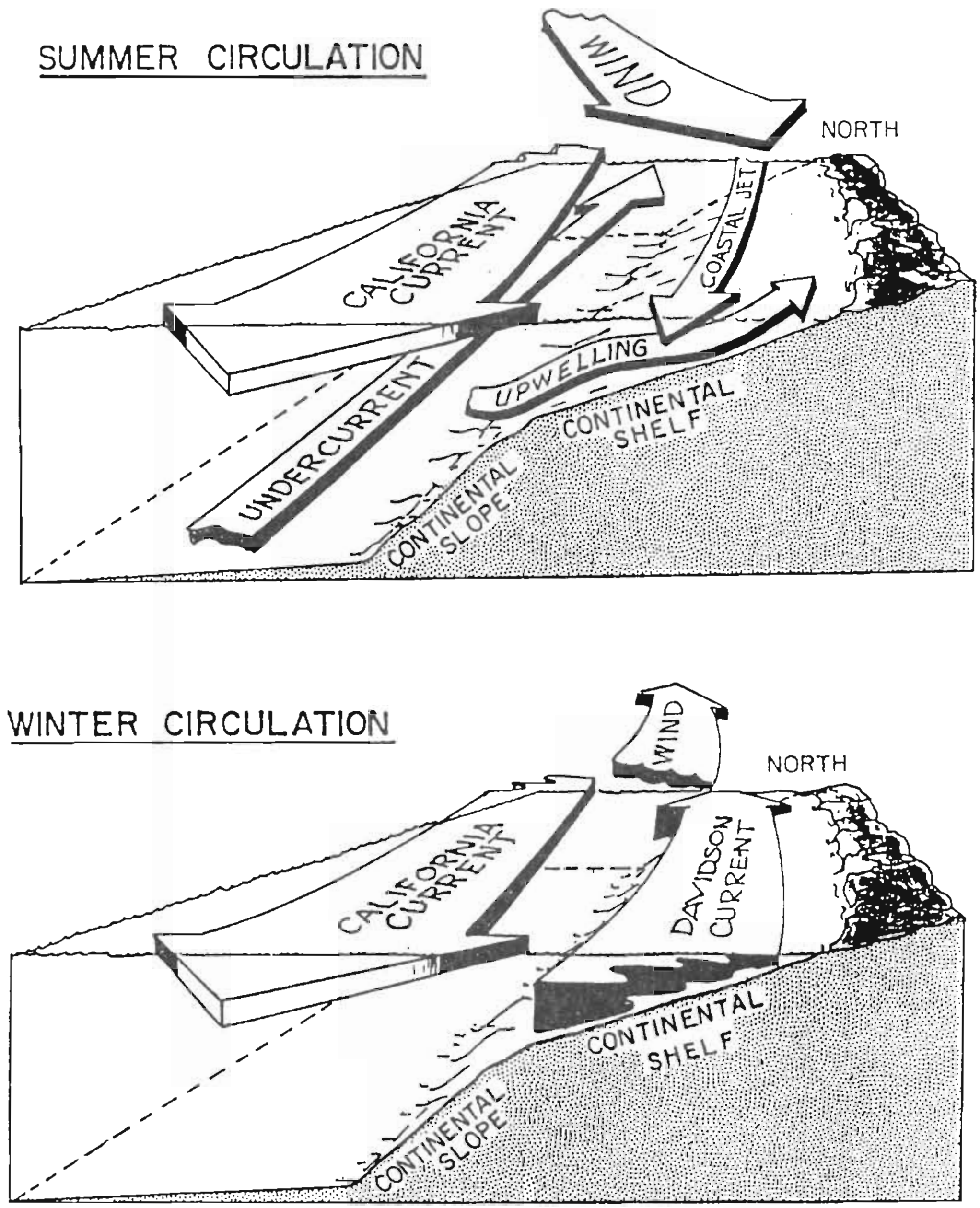


Figure B-6
Oregon Coastal Circulation

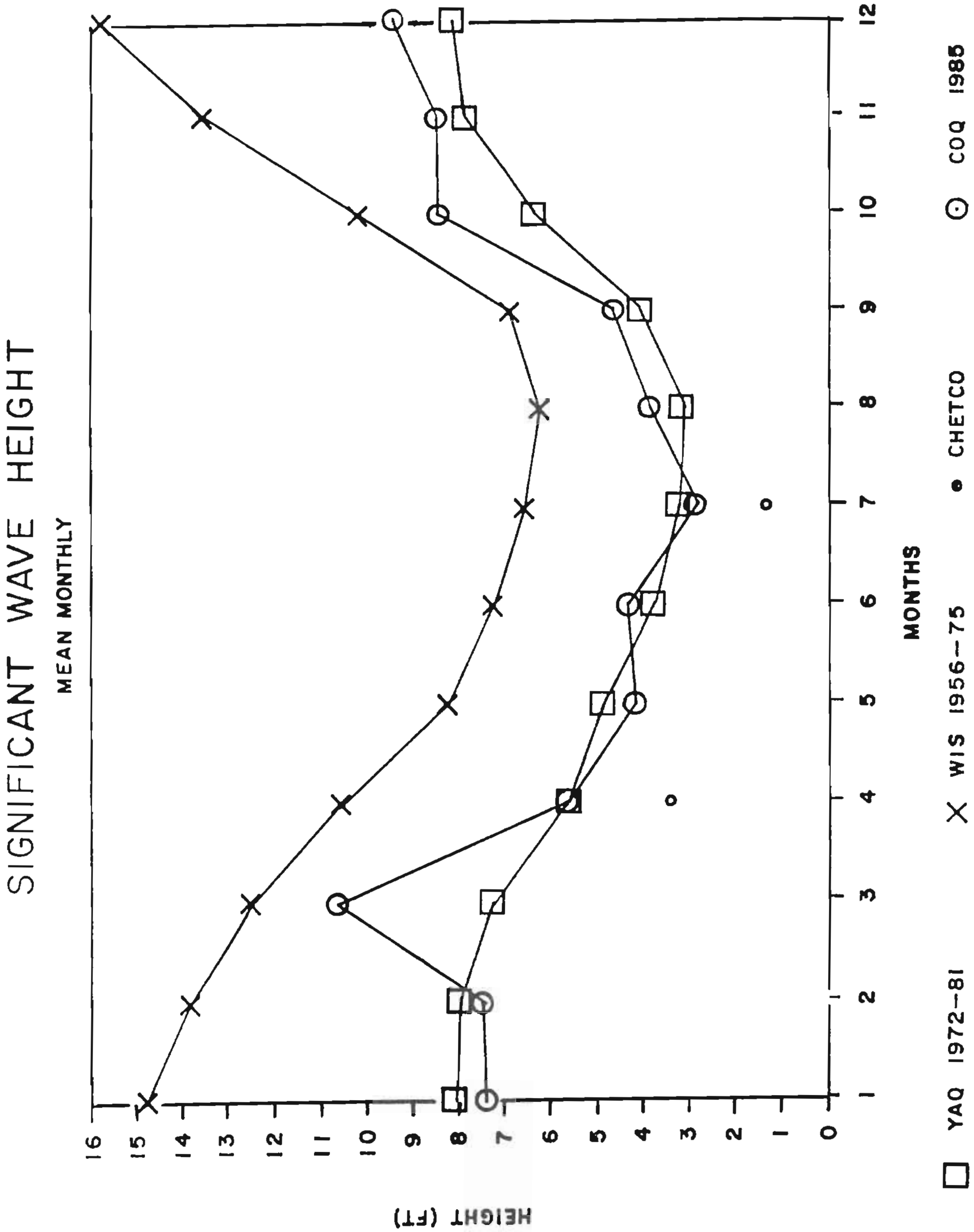


Figure B-7
Seasonal Wave Climate

Wave hindcasts ,(WES), are plotted in figure B-7 for comparison with the Yaquina ten-year monthly average and Coquille 1985 monthly average. Chetco 1985 monitoring data are plotted as an average in figure B-7 and in detail on figure B-10.

2.2.1 Superimposed upon the slowly-varying regional or seasonal circulation are periodic currents due to the tides, which are very important nearshore. Tidal currents are rotary currents that change direction following the period of the tide. Thus, the tidal currents generally flood and ebb twice daily. Direction and speed of nearshore tidal currents is highly variable. Tidal current speeds have been measured at lightships along the Pacific coast and reported by NOAA (1986). Hancock et al. (1984), Nelson et al. (1984) and Sollitt et al. (1984) summarize current meter data offshore from Coos Bay between May 1979 and March 1983. These reports substantiate the influence of tides on nearshore bottom currents. Bottom current records were found to be dominated by tidal influence with the maximum velocities associated with tides, including spring tide effects. These tidal influences were additive to currents produced by surface waves and winds. One station closest to the estuary was noticeably affected by the ebb current.

Local Processes

2.3 The Chetco ocean disposal site is within 1 mile of the estuary entrance. Boggs and Jones (1976) work on the Sixes esturary illustrates the varying influence of tidal and river forces. The Chetco is similar to the Sixes in that both are strongly influenced by river discharge, especially in winter months when net transport is seaward under high riverflow. By contrast, during summer, low riverflow net transport is into the estuary. This constant, but seasonally varying, river outflow combines with tidal flows to produce a highly variable influence on the nearshore circulation. In the estuarine part of the river, the ebbing tide adds to the normal river discharge to produce a net ebb dominance. The Sixes shows little or no longterm accumulation of fine sediments in the estuary and net bypassing of sand-size sediments into the ocean. This should also be true of the Chetco. Figure B-8 illustrates these local processes.

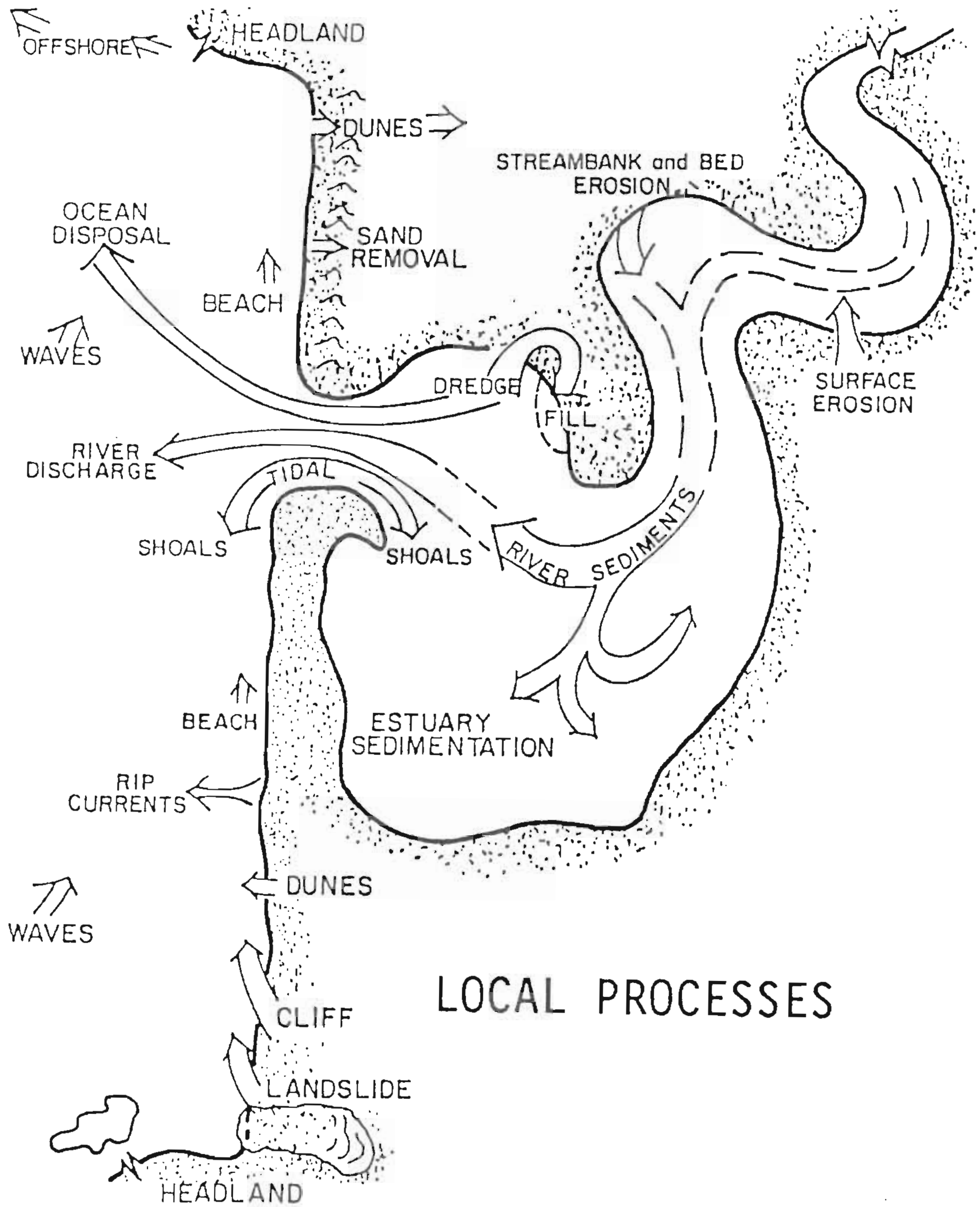


Figure B-8
Local Processes

2.3.1 The Chetco estuary is very small, having a surface area of about 140 acres (Percy and others, 1974). The mean diurnal tidal prism is 29 x 10^6 cu. ft. (table B-4). The Chetco River is 58 miles long and drains an area of 359 sq. mi. Mean annual discharge is 1,685 cfs, with the greatest flow in February, averaging 4000 cfs, and low flow in September of about 130 cfs. The mean annual discharge for a 6-hour period is 3.67 x 10^7 cu. ft. Peterson et al. (1984) use the hydrographic ratio (HR) to compare the tidal prism with the river discharge for the same six-hour period. The tidal prism is estimated as the volume of water brought into the estuary by each flood tide. The six-hour river discharge is estimated from the annual average discharge. The higher the HR, the more tidally dominated the estuary. During summer low riverflows, the HR for the Chetco is over 10. For the average annual riverflow, the HR is less than 1. On an annual basis, bedload sediment is probably discharged to the ocean at Chetco (Peterson, personal communication).

Table B-4
Important Characteristics of the Study Area

Project	Drainage Basin Area Sq. Miles (A)	Esturarine Tidal Prism Cu. Ft. 10^6 (P)	Avg. River Discharge Cu. Ft./Sec (D)	HR Hydro Ratio (P/6D)	Maximum Discharge
Chetco	359	29	1,700	<1	66000

* Note: 6D is the volume of discharge for a 6-hour period; the numbers are from Percy et al. (1974) and Johnson (1972).

Site Monitoring

2.4 Current meters were deployed near the Chetco ocean disposal site in 1985. The meters were attached to moorings at depths from 72 to 78 feet. Bottom current records were obtained from April 13-27 and from July 14-28, 1985. These periods were picked to represent typical winter and summer conditions. Figure B-9 illustrates the daily average bottom

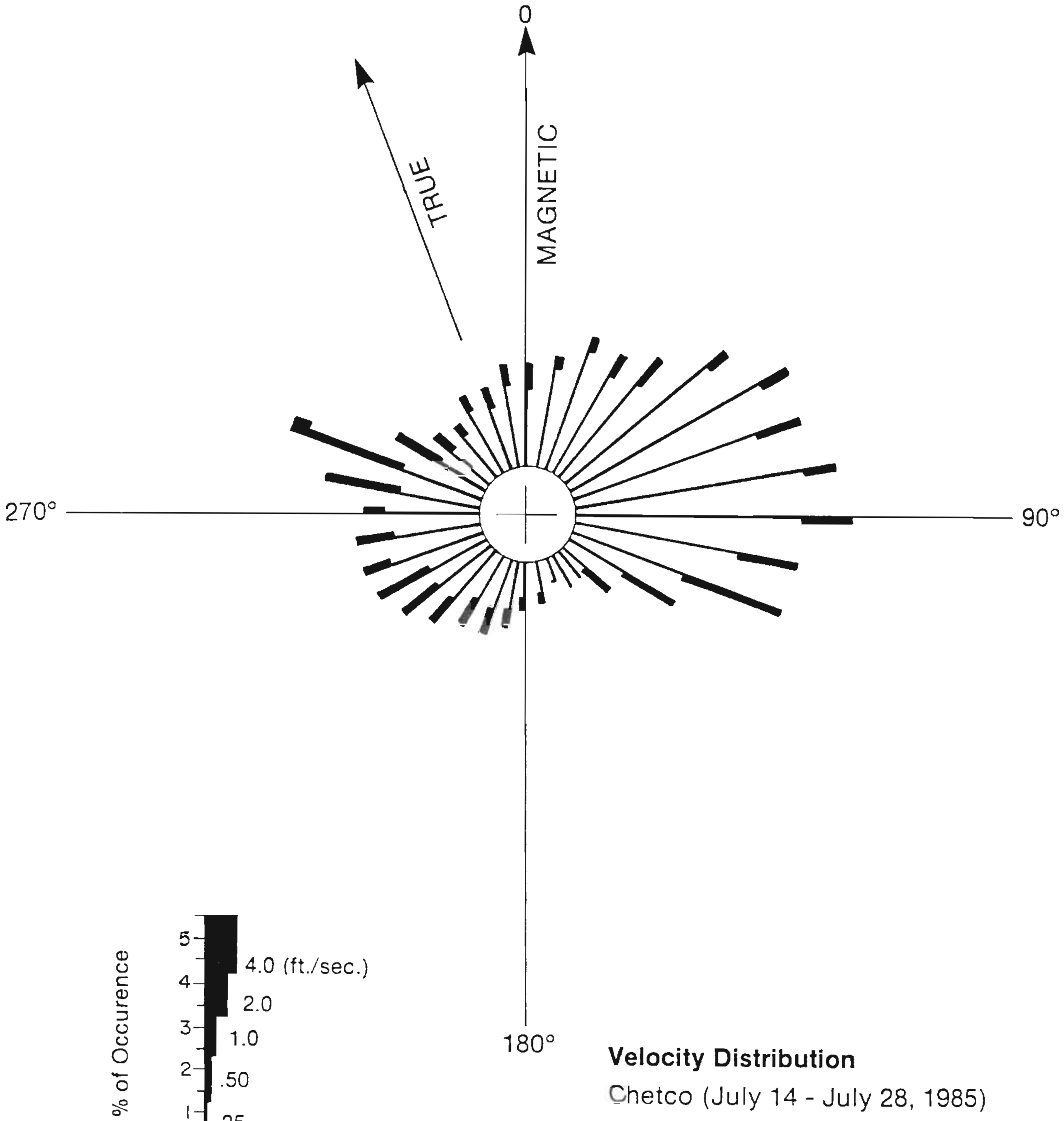
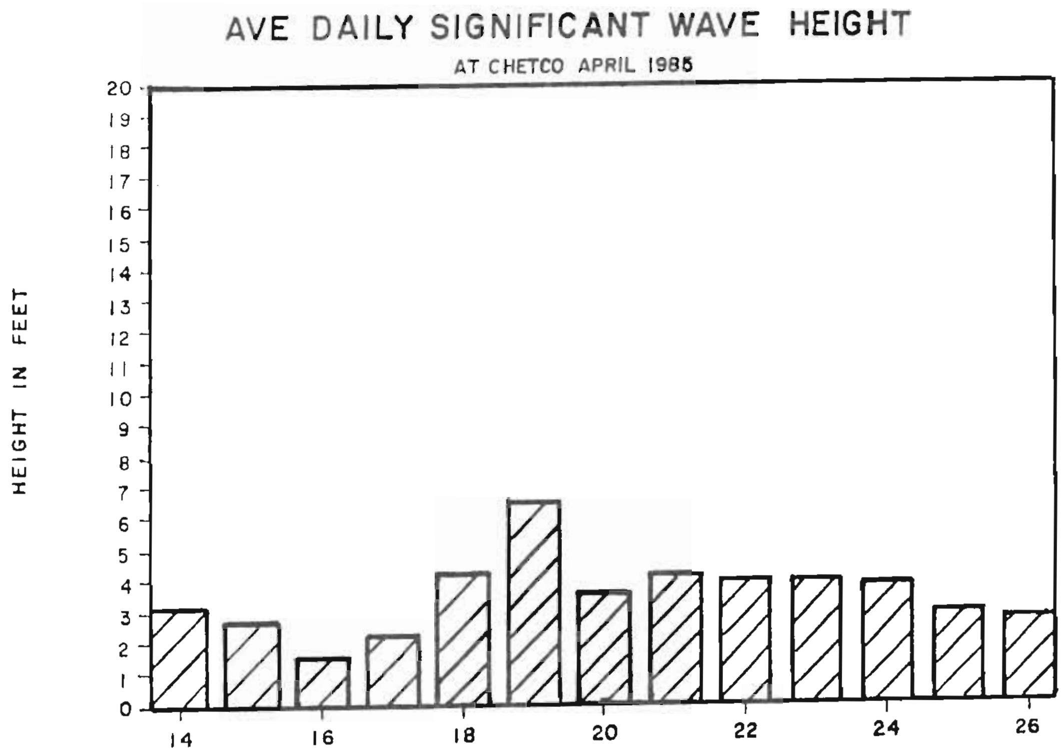


Figure B-9
Current Data at Chetco

current speed and direction for the summer record. In this current rose, each bar represents the direction the current is moving. The length of the bar represents the percent of occurrence of the current in that direction and the width of the bar represents the range of velocity.

2.4.1 Wave records near the ocean disposal site were obtained from April 14-27 and from July 14-28, 1985. Significant wave heights were computed for these six-month periods as shown in figure B-10. The short period records were analyzed for directional wave spectra as well as the period and significant height. The wave and current data with grain size and depth were used to compute a predicted sediment transport rate and direction for the period.

2.4.2 Detailed current measurements have been obtained from other similarly situated Oregon nearshore dredge material disposal sites. The most thorough study has been conducted at Coos Bay, Oregon. Seasonal measurements made over two-week periods showed currents at the 25-m-deep disposal site averaged between 20 and 30 cm/s at one-third the water depth during the summer and between 30 and 60 cm/s during the winter and spring. Near-bottom currents were generally between 10 and 20 cm/s with downslope flow components predominating over upslope components. Near-bottom waters exhibited downslope movement to depths in excess of 40 m during the summer and deeper than 70 m during the winter. Similar conditions are expected to exist at the interim Chetco disposal site since both sites are in similar depth regimes.



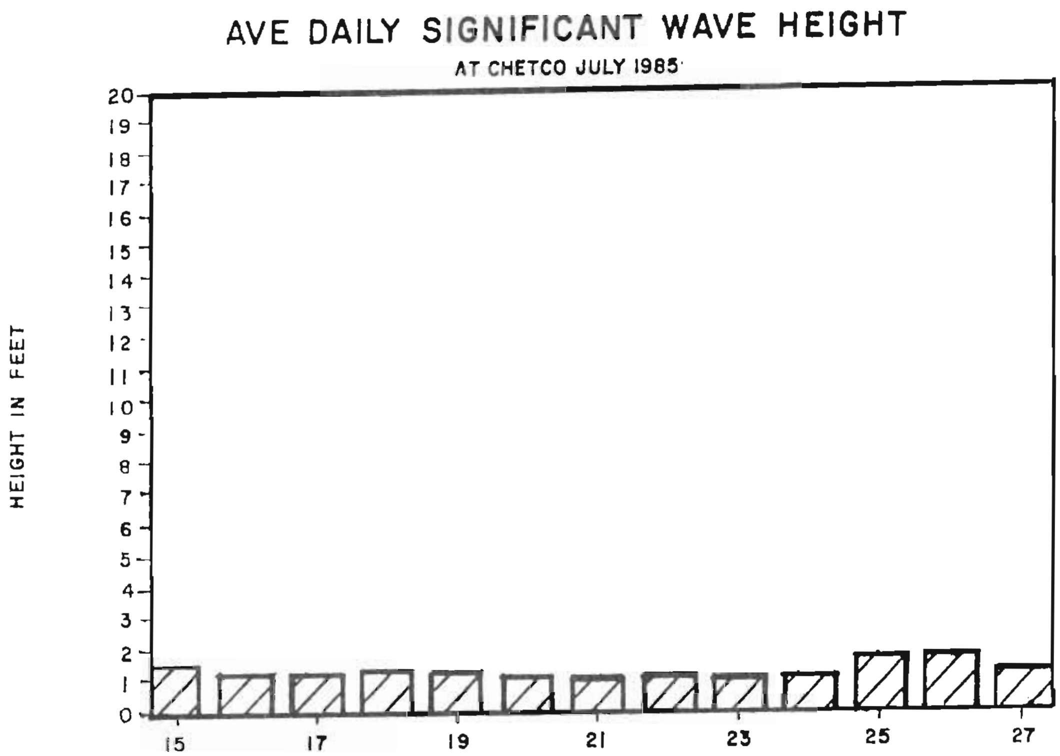


Figure B-10
Wave Data at Chetco

SEDIMENT TRANSPORT

The Littoral System

3.1 Introduction. At the Chetco dredging project, offshore disposal sites must be located to keep dredged material in the active littoral zone for downdrift beach nourishment and to prevent the dredged material from returning to the entrance channel. This requires knowledge of the direction and rate of longshore transport as well as offshore transport. Previous sections contained discussions of geologic factors and the oceanographic environment which affect sediment transport. This section will contain a discussion of this information as it applies to the littoral system and sediment movement at the Chetco disposal site.

3.1.1 Sediment movement in the littoral zone consists of two mechanisms depending upon the size of the sediment. Anything finer than sand size is carried in suspension in the water and is relatively quickly removed far offshore. The almost total lack of silts and clays within the Chetco ZSF attests to the efficiency of this mechanism. Sediments sand size or coarser may be occasionally suspended by wave action near the bottom, and are moved by bottom currents or directly as bedload. Tidal, wind and wave forces contribute to generating bottom currents which act in relation to the sediment grain size and water depth to produce sediment transport.

3.1.2 Hallermeier (1981) defined two zones of sand transport based on wave conditions. The inner littoral zone is the area of significant year-round alongshore and onshore-offshore transport by breaking waves. The outer shoal zone is affected by wave conditions regularly enough to cause significant onshore-offshore transport. Using Hallermeier (1981) and longterm wave data from Newport (Creech, 1981), the following table was derived for sand transport off Oregon.

Table B-5

Surf/Shoal Zone Depths

	Littoral (Surf Zone)	Offshore (Shoal Zone)
Summer	0-28 Feet	28-83 Feet
Winter	0-51 Feet	51-268 Feet
Annual	0-44 Feet	44-142 Feet

Depth-Limited Transport

3.2 Hancock et al. (1984) calculated the probability for wave-induced current velocities at various depths off Coos Bay. From other studies, a critical velocity of 20 cm/sec has been shown necessary to erode sediment in the 0.2 mm sand size, common off Chetco and Coos Bay. In general, the probability of wave-induced sand movement is very small beyond a depth of about 150 feet. Various sedimentologic studies have suggested an offshore limit of modern sand movement at the 60-foot depth, while others push this limit out to over 100 feet. Recent work suggests that this offshore limit can be better defined for specific areas. Work on this is in progress (Peterson, personal communication).

Chetco Littoral Cell

3.3 Figure B-2 shows the Cape Ferrelo Littoral Cell which extends approximately 40 km north from Point St. George to Cape Ferrelo and contains the Chetco, Winchuck and Smith Rivers. Sandy beaches extend over 20 km south from the Smith River and about 8 km south from the Chetco River. Seacliffs and terraces, with scattered pocket beaches, make up the remainder of the shoreline. Based on comparison of tidal and river discharge, it appears that both the Chetco and Smith Rivers are presently contributing sediments to the littoral cell. The quantity of sediment carried by the Smith River has resulted in a progradational shoreline. Heavy mineral assemblages of the rivers (Kulm et al, 1968) correlate with the littoral sand mineralogies within the littoral cell (Peterson, personal communication). This indicates that the primary source of sand within the cell is riverine. Less is known about shoreline source contributions, although the progradational nature of

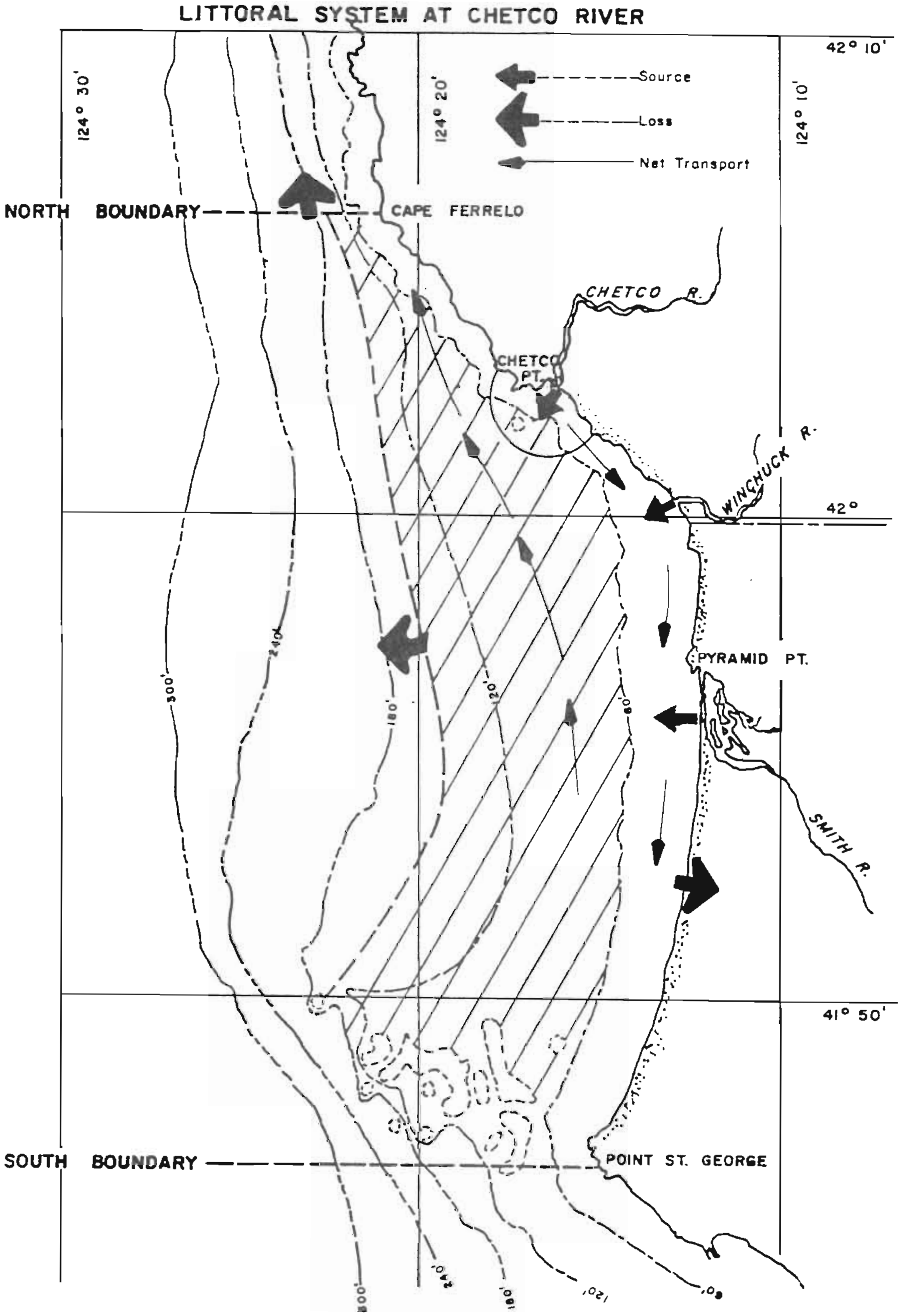


Figure B-11
Chetco Littoral System

the Smith River area would indicate little shoreline retreat in this area. There are indications that little or no sediment is bypassed at the southern headland, while the northern boundary is less distinct (Peterson, personal communication).

Table B-6 identifies the possible sources and losses of littoral sediments in the littoral cell:

Table B-6

Sources	Losses
1. Rivers Chetco Smith	1. Estuaries 2. Dune Growth 3. Headland Bypass
2. Erosion Dunes Terraces Seacliffs	4. Offshore Transport 5. Ocean Disposal
3. Headland Bypassing	
4. Onshore Transport	

Chetco Sediment Transport

3.4 As shown by figure B-12, the rocky headlands north of the Chetco disposal site limits wave approach from the north and the seaward extension of Point St. George limits southerly waves. LEO observations support net nearshore transport to the south as does the extension of the shoreline between the Smith River and Point St. George. From previous studies, there is estimated to be a potential for up to 370,000 cubic yards of sand and gravel discharged by the Chetco annually, of which less than 100,000 cubic yards is sand sized. LEO data indicates most or all of this material is transported southward. The thinness of the sediment cover shown by geophysical mapping may support this.

3.4.1 Figure B-11 is a generalized description of seasonal sediment transport in the Chetco ZSF using available information. The bathymetry and sediments are complex offshore, influencing any theoretical predictions. From both Hallermeier (1981) and observed currents and sediment mineralogy, the zone of active bottom sediment movement probably extends to almost -150 feet. The area where longshore currents predominate is shoreward of about -60 feet. The summer current records indicate southerly transport with both onshore and offshore components. During the winter storms, the Chetco River discharges sands and gravels in the nearshore. As riverflow drops, some of the gravels accumulate to form an inner channel shoal while the finer sands accumulate in the nearshore next to the south jetty. There is no longterm sediment accumulation offshore of Chetco as indicated by the thinness of the sediment layer. During the summer, there is a net southward transport of the sand-size sediment.

Ocean Disposal Site

3.5 Chetco Point on the north protects the disposal site somewhat from northwesterly storms. Offshore, there are large areas of bare rock or scattered rock exposures. There is a relatively thin and discontinuous layer of fine sand and gravel with no distinctive mounding or thickening related to river or disposal sediments. The highly irregular offshore bathymetry also affects the rate and direction of bottom sediment movement. There is no bathymetric evidence of past disposal. Disposing of 48,000 cubic yards annually, as in the past, should cause no mounding problems in the future.

3.5.1 Bottom photographs from 1978 seem to distinguish fresh disposal material from native sediments, but there is such a wide variety of bottom types and sediment types that sediment compatibility should be no problem. Due to the diversity of bottom sediment and small quantity of disposal, there is no need for a continuous monitoring program. If disposal operations change or a potential impact is identified, further bottom photography and sampling would be warranted.

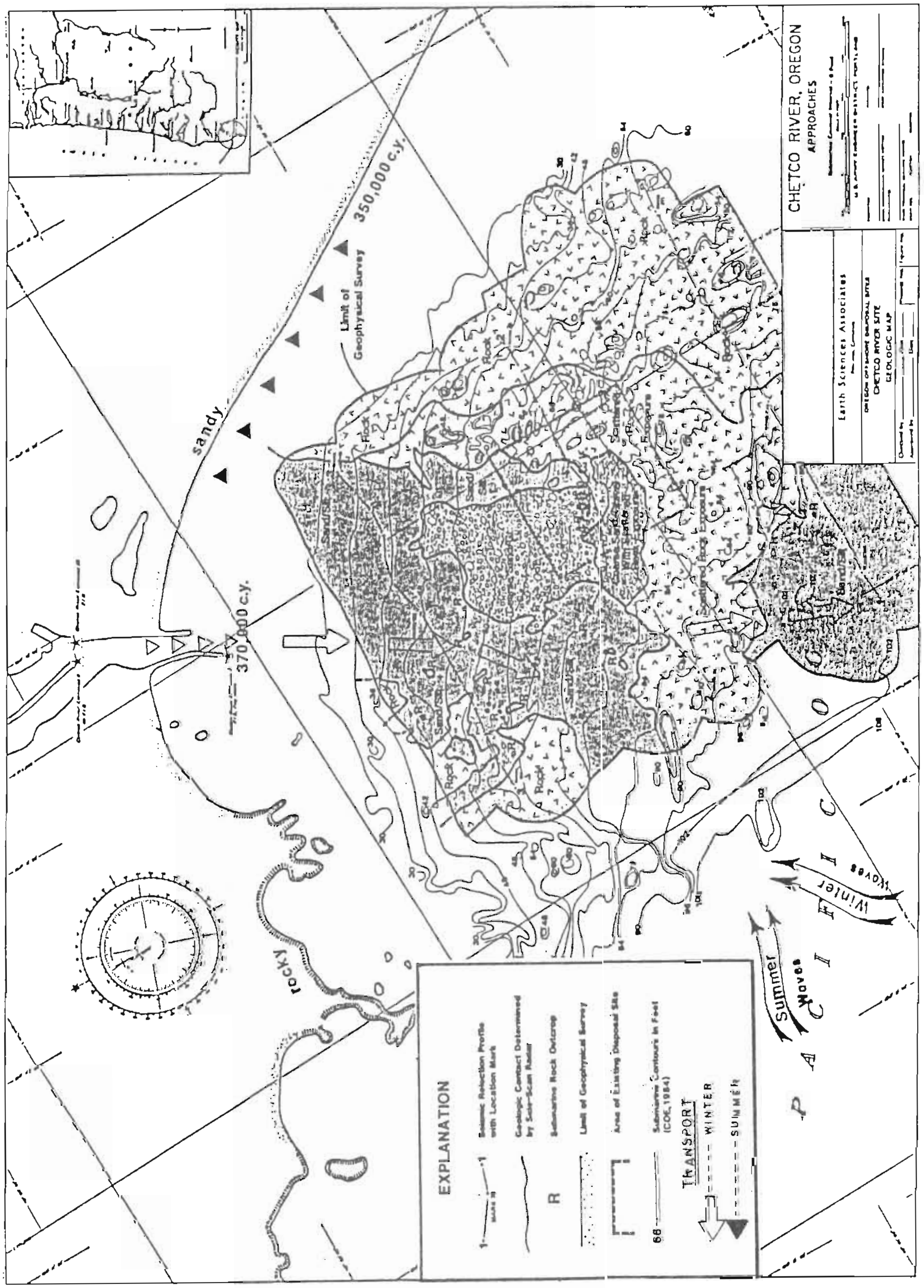


Figure B-12
Sediment Transport at Chetco

LITERATURE CITED

Baldwin, E. M., 1981. Geology of Oregon. Kendall/Hunt, Debuque, Iowa. 170 pp.

Baldwin, E. M. and J.D. Beaulieu, 1973. Geology and Mineral Resources of Coos County, Oregon: Oregon Dept. Geol. Min. Ind. Bull. 80. 82 pp.

Beaulieu J. D. and Hughes, 1976. Land Use Geology of Western Coos County, Oregon. Oregon Dept. Geol. Min. Ind. Bull. 90. 148 pp.

Beaulieu, J. D., P.W. Hughes, and R.K. Mathiot, 1974. Geologic Hazards Inventory of the Oregon Coastal Zone. Oregon Dept. Geol. Min. Ind. Misc. Paper 17. 94 pp.

Boggs, S. and C.A. Jones, 1976. Seasonal Reversal of Flood-tide Dominant sediment Transport in a Small Oregon Estuary. Geol. Soc. Am. Bull. v87, pp 419-426.

Byrne, J. V. 1963. Geomorphology of the Oregon Continental Terrace south of Coos Bay: Ore Bin v25 pp 149-157.

Chesser, S. A., and C.D. Peterson, 1987. Littoral cells of the Pacific Northwest coast (in) Kraus, N. C. (ed), Coastal Zone '87 Proceedings. ASCE New York. pp 1346-1360.

Creech, C., 1981. Nearshore wave climatology, Yaquina Bay, Oregon (1971-1981). OSU Sea Grant Program Rep. ORESU-T-81-002; NOAA-82060305 submitted to National Oceanic and Atmospherics Admin., Rockville, MD. Oregon State Univ., Corvallis, OR.

Dott, R. H. Jr., 1971. Geology of the Southwest Oregon Coast West of the 124th Meridian: Oregon Dept. Geol. Minl Ind. Bull. 69, 63 pp.

Grey, J. J., and L.D. Kulm, 1985. Mineral Resources Map; Offshore Oregon: Oregon Dept. Geol Min. Ind. Geol Map Series 37.

Hallermeier, R. J., 1981. Seaward Limit of Significant Sand Transport by Waves. CETA 81-2, USACE/CERC, 23 pp.

Hancock, D.R., P.O. Nelson, C.K. Sollitt, and K.J. Williamson, 1981. Coos Bay Offshore Disposal Site Investigation Interim Report, Phase 1, February 1979-March 1980. Report to U.S. Army Corps of Engineers, Portland District, Portland, OR, under contract not DACW57-79.C0040, Oregon State University, Corvallis, OR.

Johnson, J.W., 1972. Tidal Inlets on the California, Oregon and Washington Coasts. Hyd. Eng. Lab. Pub. HEL 24-12, UC Berkely, CA.

Kulm, L.D., 1977. Coastal morphology and geology of the ocean bottom-the Oregon region, (in) Draus, (ed.) Marine Plant Biomass of the Pacific Northwest Coast, pp 9-36.

Kulm, L.D. K.F. Scheidegger, J.V. Byrne, and J.J. Spigai, 1968. A preliminary investigation of the heavy mineral suites of the coastal rivers and beaches of Oregon and Northern California. Ore Bin v30, pp 165-184.

Nelson, P.O., C.K. Sollitt, K.J. Williamson, and D.R. Hancock, 1983. Coos Bay Offshore Disposal Site Investigation interim Report, Phase II-III, April 1980-June 1981. Report to U.S. Army Corps of Engineers, Portland District, Portland, OR, under contract no. DACW57-79-C0040, Oregon State University, Corvallis, OR.

Percy, K.L., C. Sutterlin, D.A. Bella, P.C. Klingeman, 1974. Description and Information Sources for Oregon Estuaries. Sea Grant/ Oregon State University, Corvallis, OR. 294 pp.

Peterson, C.D., W. Scheidegger, W. Nem, and P.D. Komar, 1984. Sediemnt compostion and hydrography in 6 high gradient estuaries of the Northwest United States. Jour. Sed. Pet. v56, pp 86-97.

Ramp, L., 1973. Metallic mineral resources, (in) E.M. Baldwin, and J.D. Beaulieu, (eds.) Geology and Mineral Resources of Coos County, OR: Oregon Dept. Geol. Min. Ind. Bull. 80, pp 41-62.

Runge, E.J., 1966. Continental Shelf Sediments, Columbia River to Cape Blanco, Oregon. Unpub. PhD thesis, Oregon State Univ. 143 pp.

Sollitt, C.K., P.O. Nelson, K.J. Williamson, and D.R. Hancock, 1984. Coos Bay Offshore Disposal Site Investigation Final Report, Report to U.S. Army Corps of Engineers, Portland District, Portland, OR, under contract no. DACW57-79-C0040, Oregon State University, Corvallis, OR.

Stembridge, J.E., 1976. Recent Shoreline Changes of the Oregon Coast: National Technical Information Service (AD A04 8436), Springfield, VA, 46 pp.

Strub, P.T., J.S. Allen, A. Huyer, R.L. Smith, and R.C. Beardsley, 1987. Seasonal cycles of currents, temperatures, winds and sea level over the Northeast Pacific continental shelf; 35N to 48N: Journal of Geophysical Research, v92, n. c2, pp 1507-1526.

United States Army Corps of Engineers, North Pacific Division, 1971. National Shoreline Study; Inventory Report Columbia North Pacific Region, Washington and Oregon, 80 pp.

United States Army Corps of Engineers, Portland District, 1975. Chetco, Coquille and Rogue Estuaries, Final Environmental Impact Statement. Portland, OR.

United States Army Corps of Engineers, Portland District, 1978. Chetco River Hopper Dredge Scheduling Analysis. Portland, OR.

United States Army Corps of Engineers, Portland District, 1986. Geologic and Seismic Investigations of Oregon Offshore Disposal Sites. Portland, OR.

United States Department of Agriculture, Soil Conservation Service and Oregon Coastal Conservation and Development Commission, 1975. Beaches and Dunes of the Oregon Coast. 141 pp.

APPENDIX C

SEDIMENT AND WATER QUALITY

APPENDIX C

SEDIMENT AND WATER QUALITY

TABLE OF CONTENTS

TABLES

FIGURES

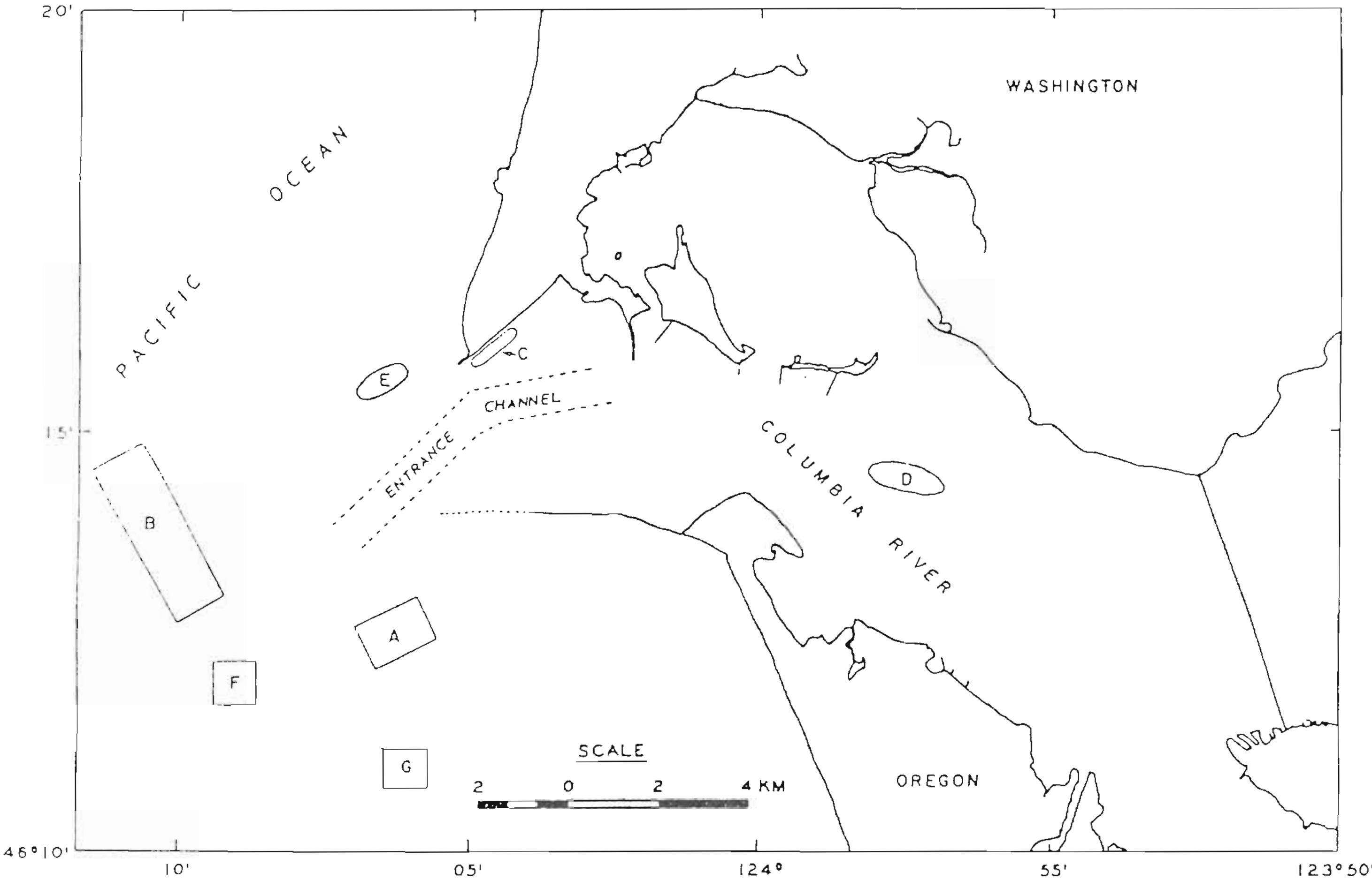
APPENDIX C

SEDIMENT AND WATER QUALITY

General

1.1 General criterion (b) and specific factors 4, 9, and 10 of 40 CFR 228.5 and 228.6 require sediment and water quality evaluations indicative of both the dredging areas and disposal sites. Dredged materials placed in interim-designated ODMDS along the Oregon coast usually consist of medium to fine sands taken from entrance bar shoals and deposited on slightly finer continental shelf sands. This is the case at Chetco with the exception that some coarser sediments, including gravels, make up some of the disposed sediments. Because of their coarse nature, similarity to ODMDS sediments, isolation from known existing or historical contaminant sources, and the presence of strong hydraulic regimes, the dredged materials are exempt from further testing according to provisions of 40 CFR 227.13(b). Consistent with this EPA regulation, therefore, analyses of Chetco sediments have been limited to physical variables. However, water and sediment quality impacts associated with disposal of sands and silts at Oregon ODMDS have been studied in detail at the two largest navigation projects, the Mouth of the Columbia River (MCR) and Coos Bay, as described below.

1.2 The MCR project was one of the Aquatic Disposal Field Investigations conducted as part of the Dredged Material Research Program (DMRP) in the mid-1970's (Boone et al. 1978, Holton et al. 1978). The DMRP was a nationwide program conducted by the Corps of Engineers to evaluate environmental impacts of dredging and dredged material disposal. The MCR studies included work at an experimental ODMDS, site G, located south of the MCR channel at an average depth of 85 feet (figure C-1). Following baseline physical, chemical, and biological characterizations of the site, a test dumping operation disposed of 600,000 cubic yards of medium to fine sands (median grain diameter = 0.18 mm) during July - August 1975. Sediments at the disposal site were a fine to very fine sand (median grain diameter = 0.11 - 0.15 mm).



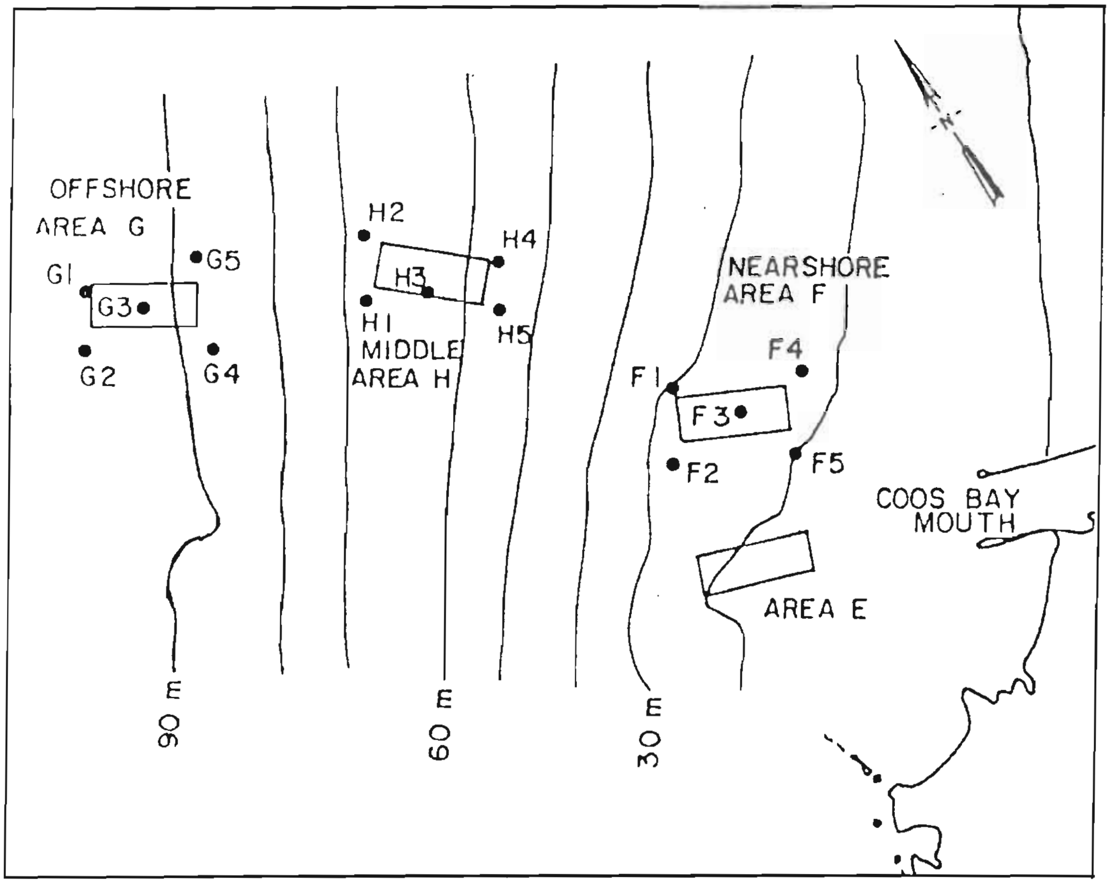
Columbia River entrance channel and ODMDS, including experimental disposal site G (From Boone et al. 1978).

Figure C-1
Columbia River Entrance Channel and ODMDS

1.3 Monitoring results indicated a mound of slightly coarser sediment within the site that gradually mixed with ambient sediments and dissipated over several months. Water quality monitoring during disposal showed no elevation of toxic heavy metals, including Cu, Zn, Cd, and Pb, with some nontoxic elevation of Fe and Mn. Nutrient fluctuations were associated primarily with tidal variations, as were chlorophyll A and particulate organic carbon. Dissolved oxygen remained high throughout disposal operations. Sediment quality remained high, with slight but nontoxic increases in Pb (from 2 to 4 mg/kg) and Hg (from 0.008 to 0.05 mg/kg) recorded before and after disposal at area G. Oil & grease values in the sediments decreased slightly after disposal, while there were no elevations in ammonia. The authors concluded that there were no adverse impacts in terms of water/sediment quality or toxicity from disposal of MCR sands at area G. They attributed fluctuations in tested variables primarily to sediment and suspended particulate input from the Columbia River, biological activity and processes, and laboratory difficulties associated with repeated measurements close to analytical detection limits.

1.4 An evaluation of areas offshore from Coos Bay was conducted under Corps contract by Oregon State University researchers. This was done to designate a new ODMDS for fine grain sediments from upper Coos Bay and Isthmus Slough (Hancock et al. 1984, Nelson et al. 1984, Sollitt et al. 1984, U.S.A.C.E. Portland District 1984). The program, conducted in five phases during 1980 - 1984, included baseline physical, biological, and chemical surveys of offshore areas followed by selection of candidate sites and a test dump/monitoring study at proposed site H (figure C-2). This site was subsequently designated by EPA as the final site for fine Coos Bay sediments (51 FR 29927 - 29931, dated 21 August 1986).

1.5 The dump/monitoring program at site H consisted of disposal of 60,000 cubic yards of fine sediments from Isthmus Slough, accompanied by water quality and benthic monitoring during disposal operations and followed by post-disposal monitoring of the site and adjacent areas over the next 18 months. Elevations in ammonia, Cu, and Mn were observed during disposal and in some cases approached acute toxicity thresholds. However, these elevations were of short duration. No substantial elevations of other contaminants or changes in dissolved oxygen, oxy-redox potential, turbidity, or pH were observed. Sediments at the site showed elevated levels of



Coos Bay sample station locations for chemical, biological, and physical studies at interim-designated and candidate ODMDS (From U.S.A.C.E. Portland District 1984).

Figure C-2
Coos Bay Sample Station Locations

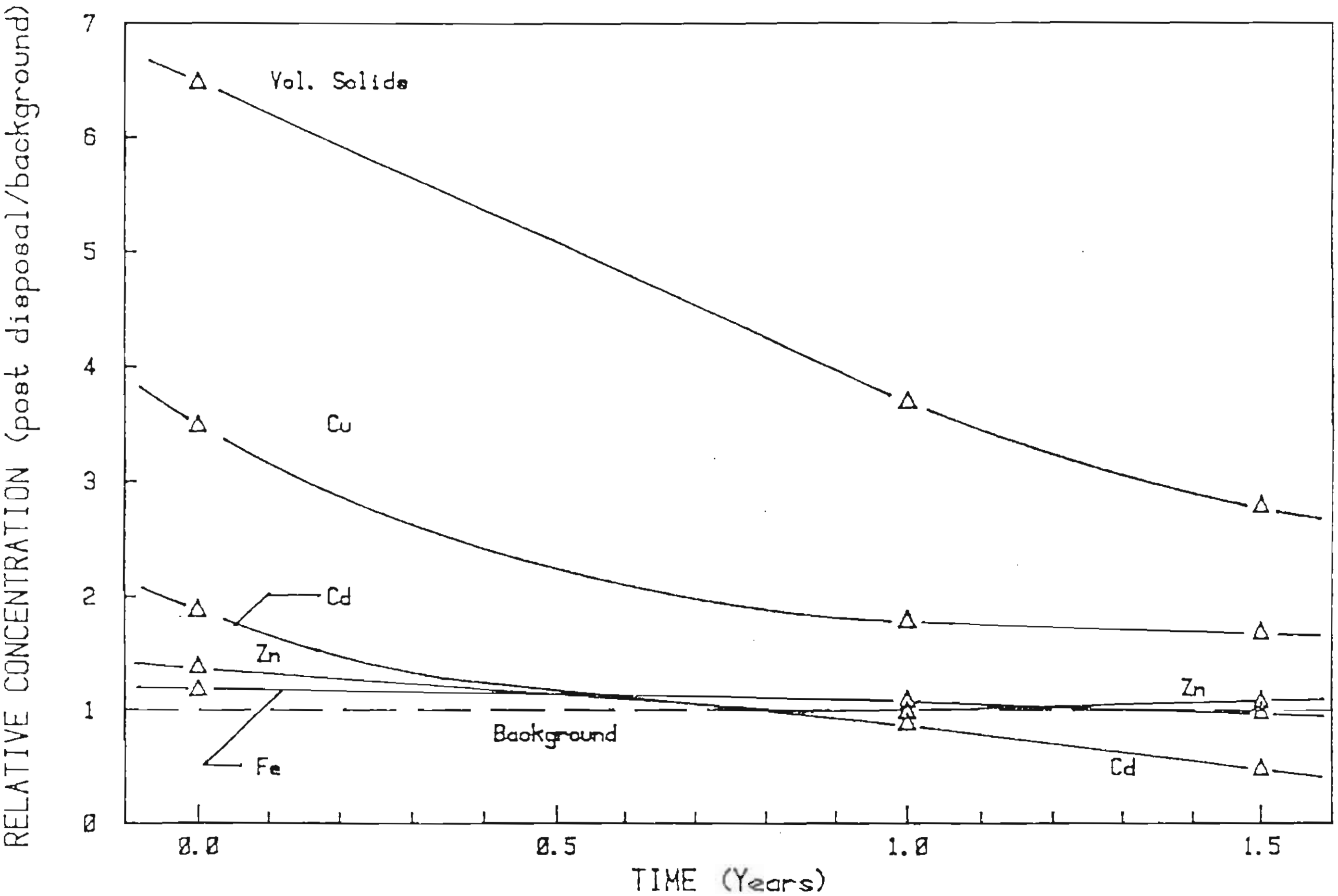
volatile solids, fines, and heavy metals that gradually decreased over the 18-month monitoring period (figure C-3). Total volatile solids level was found to be the most sensitive and reproducible indicator of contaminants levels and its use was recommended as a monitoring tool to utilize during further disposal operations at site H.

Current Study

1.6 Sediment samples from the channel of the Chetco Federal navigation project were collected by COE, Portland District in June 1974 and February 1981. The Chetco offshore disposal site was sampled in August 1985. Locations of these sampling stations are shown in figure C-4. Volatile solids in the channel sediments were slightly elevated over those at the disposal site (table C-1).

1.7 The grain size distribution curves for Chetco channel sediments show poorly sorted sandy gravel in the portion of the channel that is actively dredged (figures C-5,6). The sample taken from the vicinity of Buoy 9 (RM 0.15) in 1981 was an exception, showing about 20% silt present. This is the Tier I threshold value at which Portland District's tiered testing guidelines recommend chemical testing. However, there is no historical evidence of pollution and disposal site sediments (figure C-7) generally have characteristics similar to those in the channel.

1.8 No chemical analysis of sediments that are presently ocean-disposed, or of sediments at the ODMDS, has been completed. The federal project at Chetco, however, does extend into the boat basin and chemical analyses have been performed on finer sediments there (table C-2). Disposal of these materials at the ODMDS would require a separate evaluation, possibly including bioassay testing, according to 40 CFR 227.13(c) and 227.32. However, the COE has not dredged this part of the project since its construction and is unlikely to do so in the foreseeable future. It is appropriate, therefore, to designate the Chetco ODMDS based on projected disposal of main river entrance channel sediments only.



(From Sollitt et al. 1984).

Figure C-3
Coos Bay ODMDS: Recovery of Selected Sediment Chemical Parameters at Disposal Site-Samples Containing Dredged Material

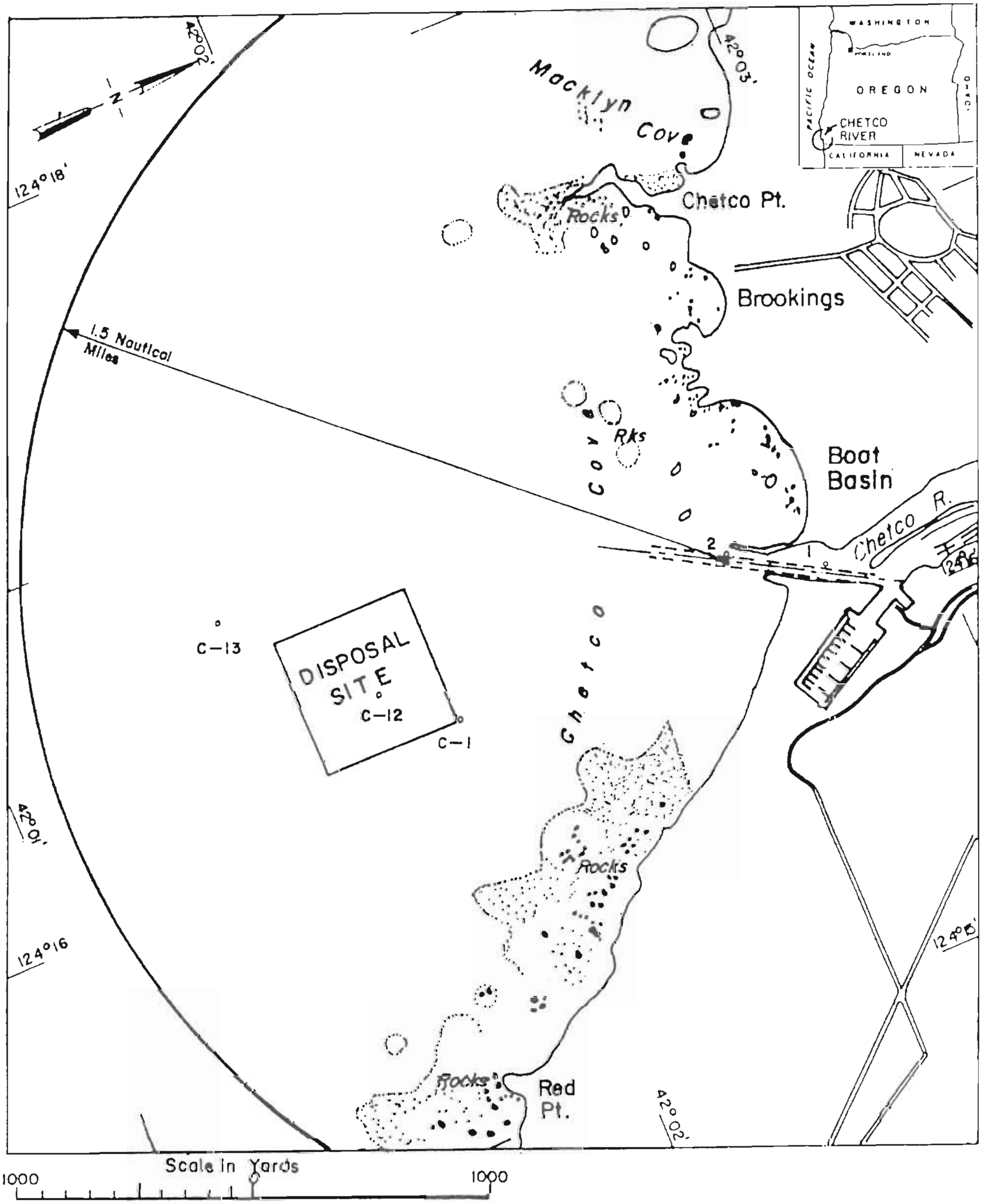


Figure C-4

Sediment Sampling Stations at the Chetco ODMDS and Dredging Site

Sample #	Site	Date	% silts	% volatile solids
1	end of north jetty	4 Jun 1974	0.0	2.24
2	near buoy #9	4 Jun 1974	0.0	2.13
1	end of north jetty	17 Feb 1981	0.0	1.29
2	near buoy #9	17 Feb 1981	20.0	7.19
C-1	E. corner disposal site	Jul 1985	0.0	2.2
C-12	middle disposal site	Jul 1985	0.0	2.7
C-13	W. of disposal site	Jul 1985	40.0	4.9

Table C-1
Physical Analysis of Chetco River Sediments

Sample #	Site	Date	% silts	% volatile solids
2	turning basin entrance	6 Apr 1982	89	not measured
4	upper end turning basin	6 Apr 1982	38	not measured

Sample #	As	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Zn	(in ppm)
2	9	3	10	37	9000	<10	300	0.14	41	
4	8	3	30	72	20000	20	220	0.15	85	
$\bar{x}$ =	8.5	3	20	54.5		~15	260	.145	63	

Sample #	Chlordane	DDD	DDE	Dieldrin	Lindane	Methoxychlor	PCBs	(in ppb)
2	B.D.	B.D.	0.1	B.D.	B.D.	B.D.	1	
4	2	0.1	B.D.	0.1	0.1	1.5	5	

(B.D. = Below Detection Limits)

Table C-2
Chemical Analysis of Chetco River Boat Basin Sediments

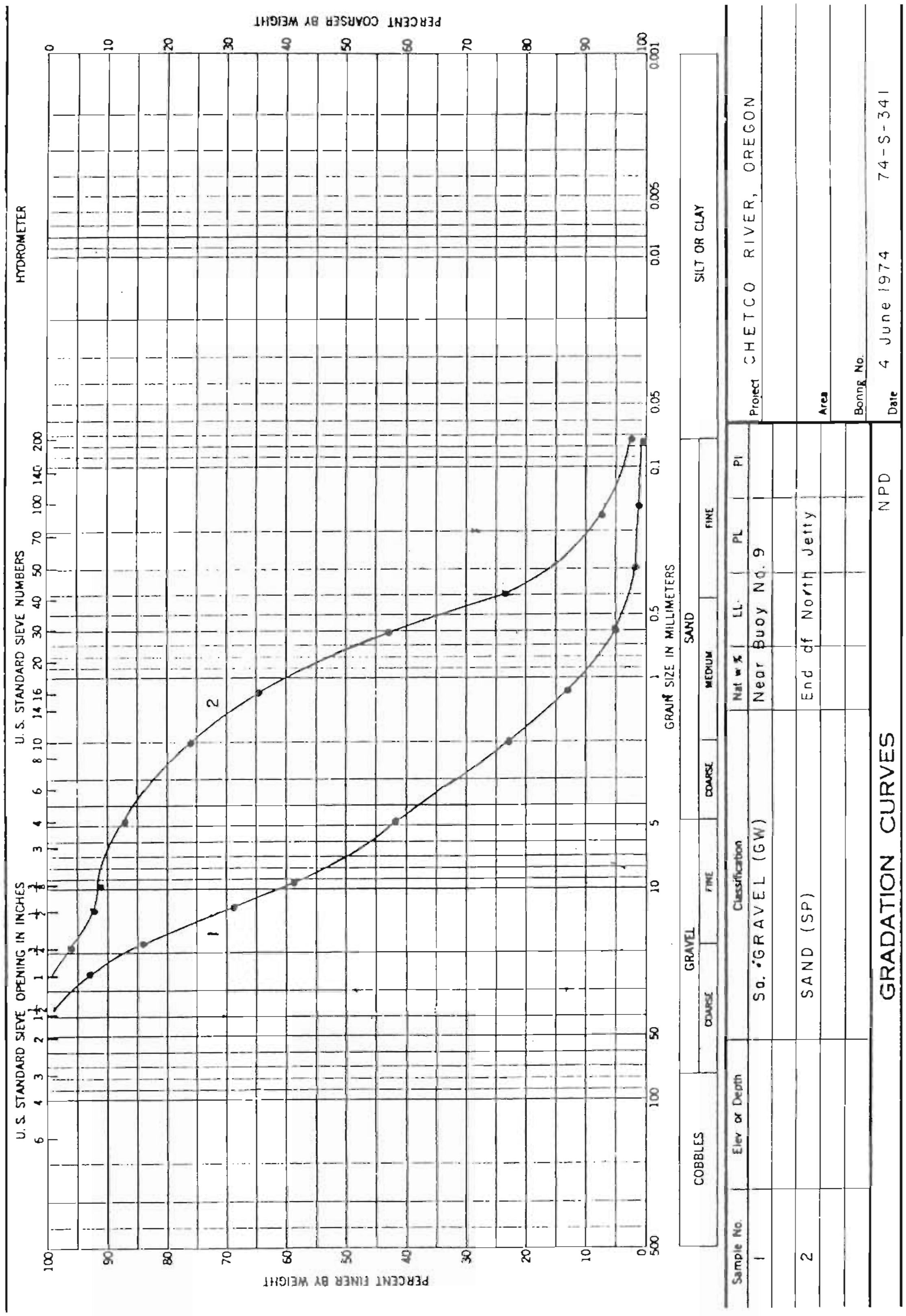


Figure C-5
Gradation Curves, Chetco River Entrance Channel, 1974

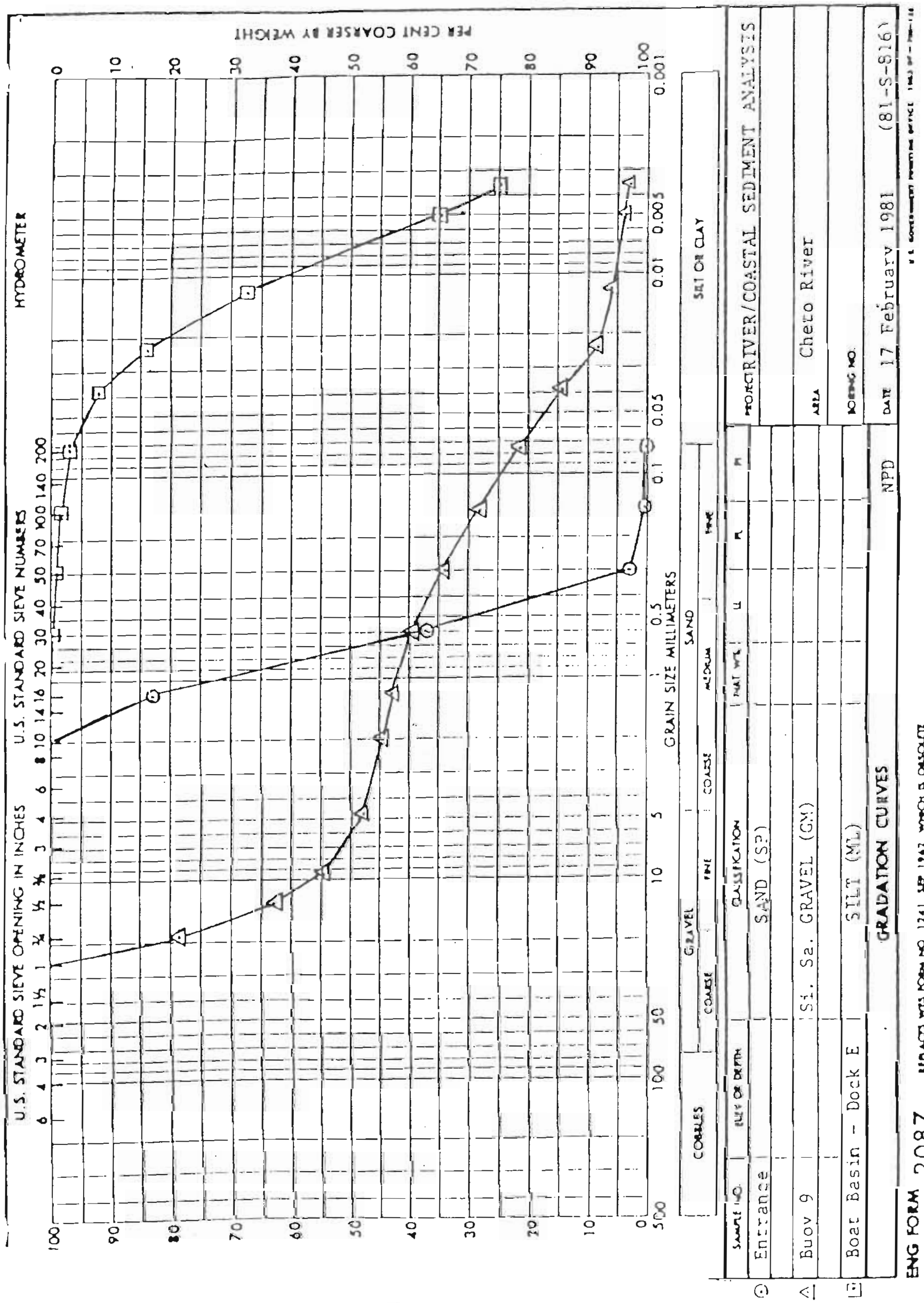


Figure C-6

Gradation Curves, Chetco River Entrance Channel, 1981

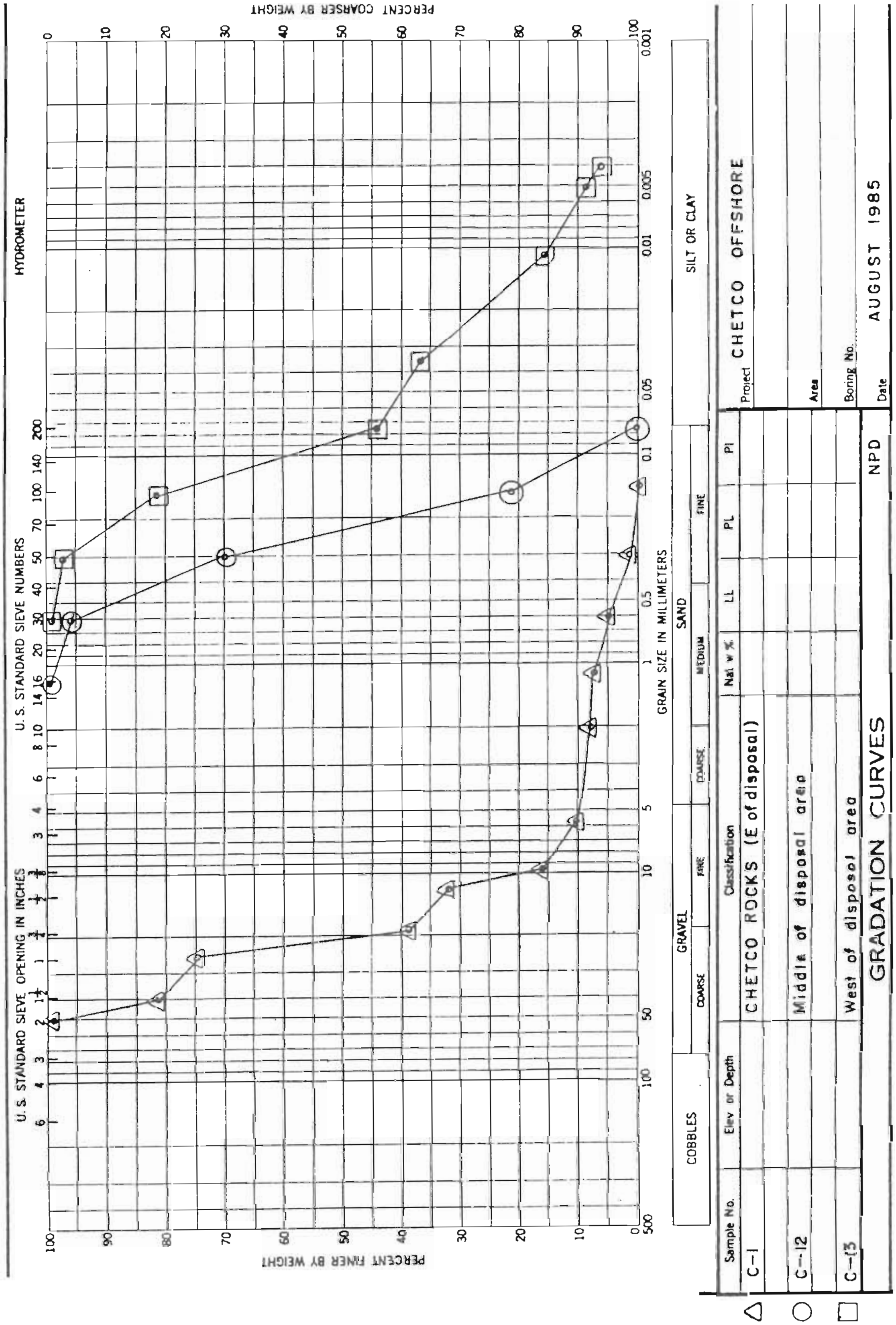


Figure C-7

Gradation Curves, Chetco ODMDS, 1985

LITERATURE CITED

Boone, C.G., M.A. Granat, and M.P. Farrell. 1978. Aquatic disposal field investigations, Columbia River disposal site, Oregon: Evaluative summary. DMRP Technical Report D-77-30. Environmental Laboratory, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. 100 pp.

Fuhrer, G.J. 1984. Chemical analyses of elutriates, native water, and bottom material from the Chetco, Rogue, and Columbia Rivers in western Oregon. Open-file Report 84-133. U.S. Geological Survey, Portland, OR. 57 pp.

Hancock, D.R., P.O. Nelson, C.K. Sollitt, and K.J. Williamson. 1984. Coos Bay offshore disposal site investigation, interim report, Phase I. Oregon State University contract report. U.S. Army Corps of Engineers, Portland District, Portland, OR.

Holton, R.L., N.H. Cutshall, L.I. Gordon, and L.F. Small. 1978. Aquatic disposal field investigations, Columbia River disposal site, Oregon: Appendix B: Water column, primary productivity and sediment studies. DMRP Technical Report D-77-30. Environmental Laboratory, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. 53 pp. + appendices.

Nelson, P.O., C.K. Sollitt, K.J. Williamson, and D.R. Hancock. 1984. Coos Bay offshore disposal site investigation, interim report, Phases II, III. Oregon State University contract report. U.S. Army Corps of Engineers, Portland District, Portland, OR.

Sollitt, C.K., D.R. Hancock, and P.O. Nelson. 1984. Coos Bay offshore disposal site investigation, final report, Phases IV, V. Oregon State University contract report. U.S. Army Corps of Engineers, Portland District, Portland, OR. 355 pp. + appendices.

U.S.A.C.E. Portland District. 1984. Coos Bay offshore disposal site investigation, summary. U.S. Army Corps of Engineers, Portland District, Portland, OR. 31 pp.

APPENDIX D

RECREATIONAL USE

APPENDIX D

RECREATIONAL USES

TABLE OF CONTENTS

FIGURES

APPENDIX D

RECREATIONAL USES

Recreational Use Areas

1.1 The Chetco Bay area is popular with recreationists because of the spectacular coastal scenery and excellent fishing opportunities both offshore and in the Chetco River. The area is increasing in popularity as a small boat harbor and has excellent facilities for the thousands of anglers who fish here annually. Figure D-1 identifies the recreational use areas located within the ZSF. Primary activities include fishing, camping and sightseeing.

1.2 Sporthaven County Park is the only public park located within the ZSF. This trailer park is located adjacent to the boat basin and is used primarily by fishermen. Harris Beach State Park is located approximately 2 miles north of Brookings. This facility is not within the ZSF but is close enough to the proposed site that it may experience some impacts from disposal operations.

1.3 Easy access and good fishing opportunities make this one of the most popular jetty fisheries along the Oregon Coast. The most popular season of use is April through October. Perch and rockfish are popular from spring through summer followed by salmon fishing beginning in the late summer and extending into early fall.

1.4 Some of the northwest coast's best offshore fishing is available off the mouth of the Chetco River. Charter boat services are available year-round but are most popular during salmon season from July through September. The remainder of the year, the charter boats fish the nearby coastal reefs for bottom fish.

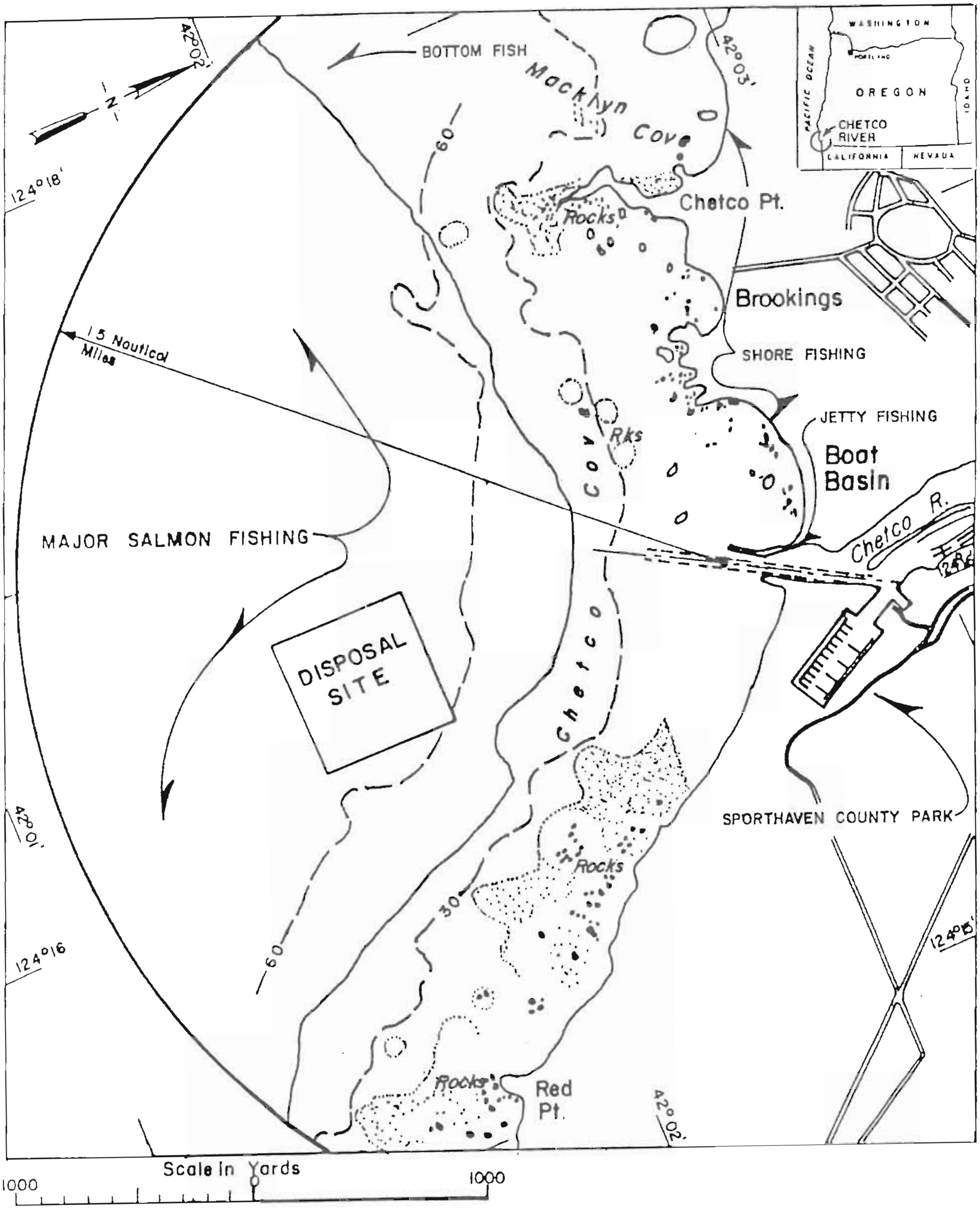


Figure D-1
Recreational Use Areas

1.5 The rocky coastline of southern Oregon offers some unique recreational opportunities not found along the northern beaches. Abalone are abundant around the rocks and can be harvested during extremely low tides. The proximity of the rocks to the shoreline also provide anglers the opportunity to fish for rockfish and bottom fish from the shore. In addition, the area has some gravel pockets along the beach which are reported to be good for digging littleneck clams.

Impacts of Disposal Operations

1.6 The disposal site identified on the map is located in a popular offshore fishing area. Few conflicts are expected to occur between fishermen and dredge operations because of the availability of alternate fishing sites. The displacement of fishing boats from the dump site during disposal operations would be an inconvenience to fishermen but does not pose a threat to any recreational activity.

1.7 Additional conflicts between disposal operations and recreationists could occur as the dredging vessel is enroute to the disposal site. These conflicts could include time delays for recreational boaters caused by the passing of the dredge, an increase in navigation hazards during congested periods particularly at the mouth of the river, and disruption of fishing activity as the dredge passed through popular fishing areas. None of these conflicts pose a serious threat to recreational activity. The only serious threat is the potential for collisions between recreational boaters and dredge traffic. Confrontations of this nature are rare due to the slow speed at which the dredge moves. The potential for collisions can be expected to remain low unless there is a significant change in operating procedures.

1.8 When dredge material is deposited at the disposal site, the surrounding water conditions will deteriorate. This will result in a reduced visual quality of the area and could possibly disrupt the feeding patterns of sport fish. Both of these situations would be temporary and normal conditions would return as soon as the sediment had settled.

1.9 Sediment deposition along the beach is another possible consequence of disposal operations. If the slope of the beach is altered significantly, it could impact local clam beds. Another potential problem with beach nourishment is the accumulation of foreign material on the beaches. If the dredged material is a different color or texture than the existing material, the result could be a reduction in the visual quality of the area.

Conclusion

1.10 Continued use of the current disposal site should have little impact on existing recreation. Some inconveniences will be experienced by recreational boaters and fishermen, but disposal operations appear to pose no serious threat to recreation.

1.11 If future studies indicate that disposal operations are either detrimental to ocean fauna or are found to be disrupting sediment deposition along the coastline, further information should be collected to determine more specifically to what extent these impacts will affect recreation. Until any of these impacts are observed, future disposal of dredge material at the present site is not expected to have any substantial effects on recreation.

APPENDIX E

CULTURAL RESOURCES

APPENDIX E

CULTURAL RESOURCES

TABLE OF CONTENTS

TABLES

FIGURES

APPENDIX E

CULTURAL RESOURCES

Prehistoric Cultural Resources

1.1 The earliest known inhabitants of the area in which the towns of Brookings and Harbor are now located were the Chetco Indians. The Chetco, who referred to themselves as the Cheti, are believed to have first settled in the area around 1,000-3,000 years ago. Considered one of the largest of the twelve coastal tribes, the Chetco inhabited nine villages in the vicinity of the Chetco River (1). Their territory included the land between Cape Ferrelo and the Winchuck River and to the east as far as the coast range (2).

1.2 The details of Chetco prehistory have not been defined (3). According to the Oregon State Historic Preservation Office records, only two archeological sites have been reported in the vicinity of the Chetco River mouth (4). These sites probably are the remains of historically reported Chetco Indians villages.

1.3 Little is known of the economy of the historic Chetco Indians (5). Their location at the mouth and lower reaches of the Chetco River suggests similarities with other coastal Indian groups. Consistent with this view, the most likely uses of the project areas would have been as a transportation route and a procurement area for fish or marine mammals, although historic evidence indicates that tidal zones, beaches, rocky shorelines, and estuaries were the primary areas within which marine resources were taken (6). If offshore areas were used during subsistence activities, it is unlikely that these activities or the artifacts of technology employed during subsistence would leave any significant cultural deposits within the study area.

Historical Overview

1.4 The first recorded white man to contact the Chetco Indians was Jedediah Smith. Smith led a party of eighteen fur trappers from the Great Salt Lake to California and then north along the Pacific coast. The party camped along the Chetco River on 24 June 1828 (7). In the early 1830's, following Smith's expedition, fur trappers began to travel northward along the Pacific coast over what developed as the California-Oregon Coast Route. When the travelers reached the Chetco River, they encountered a ferry operated by the Chetco Indians. It was not until 1853 that the first permanent settlers arrived in Chetco. The settlers, consisting of twelve white males, established their homesteads in the midst of the Chetco territory (8).

1.5 Relations between the Chetco Indians and the settlers were friendly until 1854. At this time, A. F. Miller, one of the original twelve settlers, burned down several dwellings in an Indian village. Miller, believing that newly discovered gold mines would attract more settlers to the Chetco area, selected the village site for further expansion (9). These actions resulted in a war with the Chetco Indians. At the end of the war, the remaining Chetco Indians were placed on reservations.

1.6 By 1860, Chetco had established itself as a community which consisted mainly of farms. There was no formal town (10). The 1860 U.S. Census reveals that there were eleven family unit households in the Chetco region. The majority of the heads of households were either farmers or laborers. The family units were small, averaging two children apiece. The parents were relatively young, with husbands averaging 35 years of age and wives, 24 years (11).

1.7 The relationship of Chetco to regional markets is uncertain. Initially, the local economy focused on subsistence activities. Lack of export commodities inhibited the growth of a town and limited development of transportation routes. Supplies for the Chetco households were either taken upriver by boat or packed in over a rough trail (12). What goods and ties with the outside world the pioneering Chetco community required is not evident in the historic record. One compiler of shipwrecks records the loss of 2500 lbs. of freight brought to Chetco from Crescent City, California, in an open whaleboat (West,nd.:9). Shipments of goods in this small volume in open boats suggests that they were informally arranged, and occurred on an as-needed basis. Whaleboats, especially doublended ones, have a tradition of use for short-hauls in the coastal trade, especially in situations where freight is landed on exposed beaches (Blackburn,1978:371). As export production increased through the later 1800's, steamers and coastal schooners carried the agricultural products of the Chetco valley to California markets (Douthit,1986:20).

1.8 Throughout the late nineteenth century, Chetco grew slowly. It was a struggle for survival instead of town development. In 1880, the census taker found thirty-seven households in the area. The average number of children per households rose from two to three, with the average age of the parents rising to 42 for males and 35 for females (13). The U.S. Censuses up to 1900 revealed farming as the main occupation, followed closely by laborers. By 1900, the Chetco community had taken on a more settled and diversified aspect. Although the statistics of families remained consistent with those of 1880, the variety of occupations grew. The 1900 census also revealed that dairy farming had become the prime agricultural activity in the Chetco area. (This information can be found on table E-1.) Butter and cheese were the main export of the area by 1895 (14). From this time on, dairy products remained an important element of the Chetco economy.

1.9 During the early 1900's, Judge John L. Childs operated a small water powered sawmill approximately 12 miles up the Chetco River. He floated cut lumber downstream and then loaded them by a cable system onto steamers in Chetco Cove (15). The sawmill closed in 1925, but logs continued to be transported on the Chetco River to load on Japanese ships until the 1930's.

1.10 In 1912, the Brookings Timber Company from west Minnesota bought land along the north side of Chetco River to develop a lumber mill. The development of the mill included the construction of a town, logging railroad, and ocean harbor facilities. This settlement named Brookings, began in 1913. Since steamers were unable to enter the Chetco River, all supplies and outgoing lumber were moved on a double track cable system between the shore and the vessel (16).

1.11 The California and Oregon Lumber Company (C&O) bought the Brookings Lumber Company soon after its construction. C&O built a 1,200 foot wharf from the shore into Chetco Cove. Over its lifetime, the wharf was used to load 400 million board feet of timber (17).

1.12 In the early 1920's, there was an attempt to develop port facilities in Brookings. The Corps of Engineers carried out a preliminary survey, but they did not recommend a project. In 1923, the mills exported $1,871,420 worth of wood and paper products from the harbor. The largest export in this classification was lumber cut from cedar trees (18). Before any attempts were

TABLE E-1

Occupations Of All Working Individuals In Chetco Area

(1860 - 1900)

occupations	year			
	1860	1870	1880	1900
Blacksmith	1	1	1	2
Butter Maker				3
Carpenter			5	1
Clerk		1		
Cook	1	1		
Cooper	1	1	1	1
Dairy Farmer			1	4
Dairy Laborer			1	
Farmer	10	11	5	39
Farm Laborer	7	7	1	21
Fisherman	2	2		
Goat Herder			1	
Hotel Keeper				1
House Carpenter				1
Laborer	7	2	24	11
Lawyer	1	1	1	
Machinist				1
Mail Carrier			1	2
Miner	4	4	2	
Post Mistress				1
Prospector				2
Raising Stock	10	10	11	1
Sailor			2	1
Teacher				5
Wood Chopper				1
Total	44	41	57	98

*Compiled from the 1860, 1870, 1880, and 1900 U.S. Censuses made to improve Chetco Cove, the lumber industry began to decline. In 1924, a slump in the redwood market caused the C&O to close, ending ten years of business. After the mill's closure, Brookings became deserted except for a few landholders (19).

1.13 Despite the closure of the lumber mill, low-level freight traffic continued in Chetco. In 1923, shipments totaled $2,504,020 compared to $1,447,025 in 1925. After 1925, shipments declined rapidly. Between 1926 and 1934, only two years, 1927 and 1929, had any shipments recorded. No commerce, moreover, crossed the bar at Chetco Cove from 1943 and 1952 (20).

1.14 Brookings began to recover from the failure of the lumber market through the development of various new markets. Mining, flower bulb sales, and recreational attractions led to renewed growth of the area. As part of the new expansion, the Corps constructed two jetties at the mouth of the Chetco River in 1957. These structures stabilized the channel, benefitting commercial fishing and facilitating the development of an economy dependent on the natural resources of the region (21).

Historical Cultural Resources

1.15 The primary focus of the ODMDS cultural resource investigations has been a literature search to locate historic shipwrecks. Documenting the expected type of cultural resources responds in part to the requirements of historic preservation legislation for surveys to locate cultural resources, development of procedures to evaluate their significance, and determination of effects of project undertakings on those resources. When wrecks are located, this information is added to a shipwreck data base and used in the initial screening process to determine whether potential projects may impact shipwreck sites.

1.16 Many of the shipwrecks on the Oregon Coast are documented in the historic literature. However, the early historic record is frequently incomplete. There is the possibility that unidentified wrecks are present along the Oregon coastline, since many vessels operated without reporting their activities. In order to predict the likely locations of undocumented shipwrecks, wreck site data developed during the literature search for the ODMDS investigations is used as a basis for a general model of wreck distribution along the Oregon Coast. The model is used to identify likely areas within each project site.

1.17 The shipwreck model operates on the following premises: (1) Wrecks are most likely to occur during particular seasons of the year; and (2) during these periods, wrecks are deposited in particular areas as determined primarily by current and wind patterns. Modeling the seasonality of wrecks and integrating the general area of wreck sites has produced the following wreck site distribution shown on figure E-1. Relying on previous investigations of other coastal settings (Yaquina Bay, Coquille, Columbia River Mouth) (22), the beaches and former surf zones are the areas with the highest likelihood of historic wrecks. The next most likely areas are located in the shallow nearshore environments- for example, the present surf zones and in the vicinity of navigation hazards such as reefs, and areas of shoaling. The least likely areas are associated with depths in which ships can safely operate.

1.18 The model's reliability is conditioned by several factors. For example, a positive relationship exists between identified wreck sites and the probability of finding unidentified wrecks. In areas where high levels of ship traffic occur, wreck sites are more frequent. Conversely, in areas where ship traffic is low, wreck sites are infrequent. The frequency and timing of wrecks in an area may indicate trade activity over a long period of time. For instance, a long series of wrecks or early isolated wreck sites may indicate places where early trade with Native Americans occurred, as well as the places of early pioneer colonization. Finally, wreck sites resulting from seemingly random events, such as the beaching of Spanish galleons blown off trans-Pacific trade routes, or the stranding of Japanese junks damaged in their coastal waters and carried on major ocean currents to the coasts of North America.

1.19 Despite the fact that wrecks are most likely to occur within the shallow-nearshore environment, Historic Preservation Legislation requires evaluation of all project areas. In addition, the cultural resource values of shipwrecks may be inversely related to its association with areas of likely occurrence. That is, wrecks in deep offshore environments may have a higher research value than those in the high probability areas. This is because wrecks in deeper areas are more likely to survive intact, contain the highest

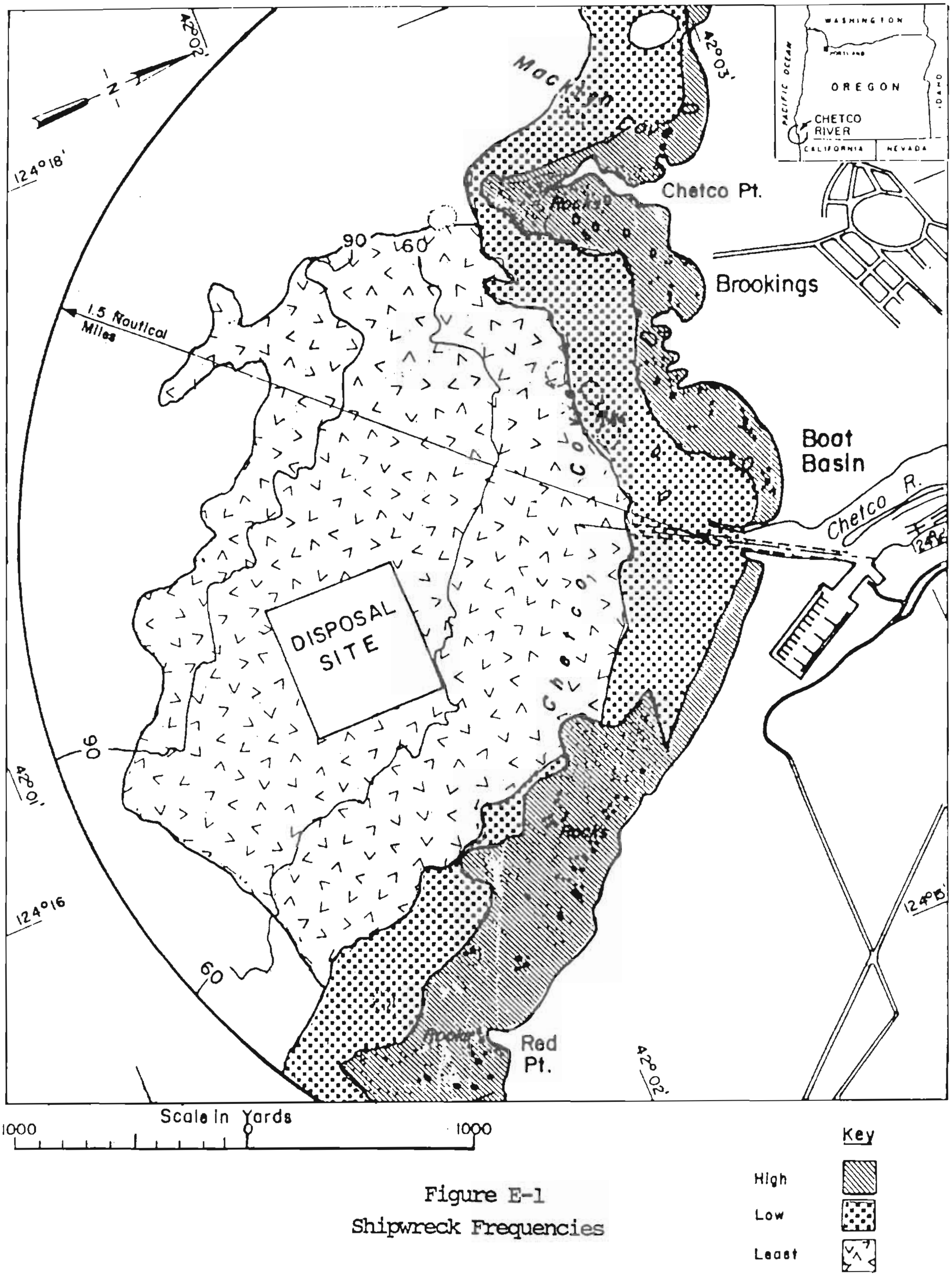


Figure E-1
Shipwreck Frequencies

density of artifacts and to be the least likely to have been the focus of salvors or removed as navigation hazards.

1.20 Identifying the likely areas of wreck sites can be a useful tool. As a planning tool, it will help reduce potential impacts to areas where unreported wrecks may be found. When there is flexibility in the planning process, project areas can be oriented away from high probability areas, reducing the likelihood of encountering a submerged wreck during underwater surveys. If project areas must include high probability locations, then site evaluations (as with any study area) will include determining whether evidence of shipwrecks is present.

Chetco Project Shipwrecks

1.21 Whether wreck sites in the Chetco vicinity conform to the general pattern of wreck distribution along the Oregon coastline can only be inferred. The number of shipwrecks in the Chetco vicinity is small. The literature search documented the occurence of only two wrecks within the study area. In 1855, a whaleboat transporting freight from Crescent City, California, capsized off the Chetco River. Forty years later, in 1895, the derelict steam auxiliary schooner, Maid of Oregon grounded at Chetco. She had taken on water earlier in her voyage and had anchored off Chetco to seek aid; southeast gales drove her ashore (West,nd.:74).

1.22 The small number of wrecks is consistent with the general pattern of development in the Chetco vicinity. Historically, Chetco was never a major shipping point on the coast. Development of its major export commodity, timber, occurred in the early 1900's. This lumber was cable loaded onto ships bound for the Japanese market. In the 1920's, lumber production expanded with the construction of the mill and the town of Brookings. The lumber from the Brookings mill was transported to Crescent City by railroad rather than by lumber schooner, as was typical of the other lumber ports on the Oregon Coast.

1.23 The sea floor in the project area was investigated using a side scan sonar. Though this work was primarily undertaken in support of environmental and geomorphical purposes, side scan sonar images were also evaluated to determine if they indicated the presence of shipwrecks (23). Evidence of shipwrecks may include the presence of structural remains of ships, sediment mounding indicating the burial of vessels, or ballast or cargo remnants indicating the site of a decayed vessel. No shipwreck signatures or evidence of shipwrecks (such as piles of ballast stones) were located by the side scan sonar study of the Chetco study area (24).

LITERATURE CITED

1 Peterson, Emil, R. and Alfred Powers, 1977. A Century of Coos and Curry: History of Southwest Oregon. Coos-Curry Pioneer and Historical Association, Coquille, OR, p. 22.

2 Beckham, Steven Dow, 1974. Historical and Archaeological Resources of Oregon Coastal Zone. Oregon Coastal Conservation and Historical Commission, Salem, OR, p. 16. For further information on the Chetco Indians, see reference (5) below.

3 Cressman, Luther, 1977. Prehistory of the Far West. University of Utah Press, Salt Lake City, UT, pp 194-195.

4 Personnel Communication form the Oregon State Historic Preservation Office.

5 Ruby, Robert H. and John A. Brown, 1986. A Guide to the Indian Tribes of the Pacific Northwest. University of Oaklahoma Press, p. 20. Minor, Rick and Kathryn Anne Toepel, 1983. Patters of Aboriginal Land Use in the Southern Oregon Coastal Region. PREHISTORIC PLACES ON THE SOUTHERN NORTHWEST COAST, Robert Greengo (ed.), Thomas Burke Memorial Washington State Museum, Seattle, WA.

6 Beckham, Steven Dow, 1977. The Indians of Western Oregon, This Land was Theirs. Arago Books, Coos Bay, OR, p. 77.

7 Brainard, Max, 16 May 1963. Brookings Background Steeped in Folklore, Indians, Jedediah Smith First White Visitor. BROOKINGS HARBOR PILOT. Olsen, Edward G., et al, 1979. Then Til Now in Brookings-Harbor: A Social History of the Chetco Community Area. Coastal Printing Company, Brookings, OR, p. 10.

8 Olsen, 1979. p. 11.

9 Peterson and Powers, 1977. p. 88.

10 Olsen, 1979. p. 15.

11 US Census Bureau, 1860. 8th Census of the United States, Curry County, Oregon. National Archives, Washington, D.C.

12 Olsen, 1979. p. 16.

13 US Census, 1880.

14 State of Oregon, 1897. Biennial Report of the Secretary of State. State Printing Office, Salem, OR, p. 316.

15 Barret, Marge, 27 September 1974. Remember When: Water Traffic Plays Big Role. COOS BAY WORLD.

16 Olsen, 1979. pp 27-28.

17 Olsen, 1979. pp 40-41.

18 US Army Corps of Engineers, 1924. Annual Report of the Chief of Engineers, 1924. Government Printing Office, Washington D.C., p. 1345.

19 Zelmer, Judy, 22 May 1975. Nutting Home Being Restored. BROOKINGS-HARBOR PILOT.

20 US Army Corps of Engineers, 1927, 1937, 1953. Annual Report of the Chief of Engineers 1927, 1937, 1953.

21 Government Printing Office, 21st US Congress, House Document 817, 77th Congress, 2nd Session, pp 2-4.

22 US Army Corps of Engineers, Portland District, April 1985. Yaquina Bay Interim Ocean Disposal Site Evaluation Study, Appendix E, Cultural Resources. Draft.

23 US Army Corps of Engineers, Portland District, March 1985. Geologic and Seismic Investigation of Columbia River Mouth Study Area. Prepared by Earth Sciences Associates, Palo Alto, California, and Geo Recon International, Seattle, Washington.

24 US Army Corps of Engineers, Portland District, January 1985. Geologic and Seismic Investigation of Oregon Offshore Disposal Sites, "Chetco". Prepared by Earth Sciences, Palo Alto, California, and Geo Recon International, Seattle, Washington.

APPENDIX F

COMMENTS AND COORDINATION

APPENDIX F
COMMENTS AND COORDINATION

TABLE OF CONTENTS

LETTERS

APPENDIX F

COMMENTS AND COORDINATION

Comments

1.1 The Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA) requires that, for a site to receive a final ODMDS designation, the site must satisfy the specific and general disposal site criteria set forth in 40 CFR 228.6 and 228.5, respectively. The final designation procedures also require documentation of recommended disposal site compliance with MPRSA and with the following laws:

National Environmental Policy Act of 1969,
Endangered Species Act of 1973,
National Historic Preservation Act of 1966, and the
Coastal Zone Management Act of 1972, all as amended.

1.2 The data provided in this document was compiled to satisfy these laws and has been coordinated with appropriate and necessary State and Federal agencies.

Coordination

1.3 The procedures used in this ODMDS final designation study have been discussed with the following agencies:

Oregon Department of Fish and Wildlife
Oregon Department of Environmental Quality
Oregon Division of State Lands
U.S. Coast Guard
U.S. Fish and Wildlife Service
National Marine Fisheries Service, and
U.S. Environmental Protectione Agency.

1.4 Following completion of a preliminary draft of this document, statements of consistency or concurrence will be sought regarding three State or Federal laws. The statutes and responsible agencies are:

Coastal Zone Management Act of 1972, as amended	Oregon Department of Land Conservation and Development
National Historic Preservation Act of 1966, as amended	Oregon State Historic Preservation Officer
Endangered Species Act of 1973, as amended	U.S. Fish and Wildlife Service National Marine Fisheries Service

1.5 Consistency or concurrence letters from these agencies will follow. State water quality certifications, as required by Section 401 of the Clean Water Act, will be obtained for individual dredging actions.

1.6 A formal public involvement program designed to receive comments from all State and local agencies, private groups and individuals will be accomplished by EPA upon submittal of this document containing the request for final site designation.

NEIL GOLDSCHMIDT
GOVERNOR

Department of Land Conservation and Development

1175 COURT STREET NE, SALEM, OREGON 97310-0590 PHONE (503) 373-0050

July 12, 1988

A. J. Heineman
Chief, Planning Division
Corps of Engineers
P.O. Box 2946
Portland, Oregon 97208-2946

RE: Chetco River Ocean Disposal Site Evaluation

Dear Mr. Heineman:

Thank you for the opportunity to review the draft Ocean Disposal Site Evaluation for the Chetco River Navigation Project. You have requested that the Department concur with the Corps' determination that the project is consistent with the Oregon Coastal Management Program (OCMP).

The site evaluation report includes findings against Statewide Planning Goal 19, Ocean Resources, which is the most applicable policy of the OCMP. The report does a commendable job of assessing the compatibility of continued dredged material disposal at the interim site with Goal 19 requirements and the criteria of the Marine Protection, Research, and Sanctuaries Act. The Department concurs that final designation of the interim disposal site is consistent with the OCMP.

The Department understands that EPA will carry out a formal public involvement program during the final site designation process. The Department may reexamine the consistency of the project with the OCMP during the EPA process if new information is available at that time.

Thank you for the opportunity to review the document for consistency with the OCMP. Please contact Patricia Snow of my staff if you have any questions.

Sincerely,

James F. Ross
Director

JFR:PS/sp
<per>

cc: Steve Stevens, COE
Glen Hale, DLCD

Department of Transportation
STATE HISTORIC PRESERVATION OFFICE
Parks and Recreation Division
525 TRADE STREET SE, SALEM, OREGON 97310

April 6, 1988

G. A. Newgard
Chief Regulatory and Resource Branch
Portland Corp of Engineers
PO Box 2946
Portland, OR 97208-2946

RE: Permanent Off-Shore Disposal Site
Chetco River and Bar
Curry County

Our staff archeologist has reviewed the report prepared by Michael Martin for the proposed permanent off-shore disposal site for materials dredged from the Chetco River and Bar. The area set up for disposal has been surveyed with a side-scan sonar and was negative. Our office concurs with the finding of "No Effect". If you have any questions you can contact Dr. Leland Gilsen at 378-5023.

Sincerely,

D. W. Powers, Deputy
State Historic Preservation Officer

DWP:jn
NEWGARD.LTR

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northwest Region
7600 Sand Point Way NE
BIN C15700, Bldg. 1
Seattle, Washington 98115

AUG 17 1987

F/NWR3:1514-04 js

Mr. Richard N. Duncan
Chief, Fish and Wildlife Branch
Department of the Army
Portland District Corps of Engineers
P.O. Box 2946
Portland, OR 97208

Dear Mr. Duncan:

This is in response to your August 3, 1987 letter to our Portland Office regarding an Endangered Species Act biological assessment for the gray whale at the Chetco Harbor Dredged Material Disposal Site Designation. We have reviewed the biological assessment and concur with your determination that populations of endangered/-threatened species (gray whales) under our purview are not likely to be adversely affected by the proposed action.

This concludes consultation responsibilities under Section 7 of the ESA. However, consultation should be reinitiated if new information reveals impacts of the identified activity that may adversely affect listed species or their critical habitat, a new species is listed, the identified activity is subsequently modified or critical habitat determined that may be affected by the proposed activity. If you have any new information or questions concerning this consultation, please contact Joe Scordino at FTS 392-6110.

Sincerely,

Thomas E. Kruse
for Rolland A. Schmitten
Regional Director