

A LITERATURE REVIEW, BIBLIOGRAPHIC LISTING, AND
ORGANIZATION OF SELECTED REFERENCES RELATIVE
TO PACIFIC SALMON (*ONCORHYNCHUS* SPP.) AND ABIOTIC
AND BIOTIC ATTRIBUTES OF THE COLUMBIA RIVER
ESTUARY AND ADJACENT MARINE AND RIVERINE
ENVIRONS, FOR VARIOUS HISTORICAL PERIODS:
MEASURE 7.1A OF THE NORTHWEST POWER PLANNING
COUNCIL'S 1994 FISH AND WILDLIFE PROGRAM

REPORT 4 OF 4
FINAL REPORT

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PREFACE

This report is one of four prepared to address Measure 7.1 A in the Northwest Power Planning Council's (Council) Fish and Wildlife Program (Program) dated December 1994 (NPPC 1994). Measure 7.1 A calls for the Bonneville Power Administration (BPA) to fund an evaluation of salmon survival, ecology, carrying capacity, and limiting factors in freshwater, estuarine, and marine habitats. Additionally, the Measure asks for development of a study plan based on critical uncertainties and research needs identified during the evaluation. This report deals with the information found during the review of relevant literature to evaluate carrying capacity. This review is a precursor and component to the development of a study plan for carrying capacity. Three other reports were prepared based on the work addressing Measure 7.1A:

1. "Evaluation of Carrying Capacity: Measure 7.1 A of the Northwest Power Planning Council's 1994 Fish and Wildlife Program, Report 1 of 4."
2. Study Plan For Evaluating Carrying Capacity, Measure 7.1 A of the Northwest Power Planning Council's 1994 Fish and Wildlife Program. Report 2 of 4."
3. "Proceedings from a Workshop on Ecological Carrying Capacity of Salmonid Habitats in the Columbia River Basin. Measure 7.1 A of the Northwest Power Planning Council's 1994 Fish and Wildlife Program. Report 3 of 4."

ACKNOWLEDGMENTS

My sincere thanks to the people who helped with this study. Dr. Mark Schneider, formerly of BPA, wrote the statement of work that started the study. Nora Berwick and John Marsh of Council staff helped interpret Measure 7.1 A. Tom Vogel of BPA was the contracting officer's technical representative for the project after Dr. Schneider moved to the National Marine Fisheries Service. Duane Neitzel at the Pacific Northwest National Laboratory placed this report into the final format, consistent with the first three reports of this series.

Dr. Christopher Shenvood, Battelle, Marine Sciences Laboratory, Sequim, Washington provided extensive hard copies of Columbia River related reference materials that were reviewed and annotated for this study. Dr. Charles Simenstad, Fisheries Research Institute, University of Washington, Seattle, Washington was most helpful in providing his expertise and suggestions as to a variety of reference sources related to the Columbia River estuary.

ABSTRACT

This report contains the results of a literature review on the carrying capacity of Pacific salmon in the Columbia River Basin. The objective of the review was to find the information gaps relative to the determinants of salmon carrying capacity in the Columbia River Basin. The review was one activity designed to answer questions asked in Measure 7.1 A of the Councils Fish and Wildlife Program (NPPC 1994). Based, in part, on the information learned during the literature review and the other work accomplished during this study the Pacific Northwest National Laboratory (PNNL) staff¹ **concluded that the approach inherent in 7.1A will not increase understanding of ecology, carrying capacity, or limiting factors that influence salmon under current conditions.** Measure 7.1 A requires a definition of carrying capacity and a list of determinants (limiting factors) of capacity. The implication or inference then follows that by asking what we know and do not know about the determinants will lead to research that increases our understanding of what is limiting salmon survival. It is then assumed that research results will point to management actions that can remove or repair the limiting factors. Most ecologists and fisheries scientists that have studied carrying capacity clearly conclude that this approach is an oversimplification of complex ecological processes. To pursue the capacity parameter, that is, a single number or set of numbers that quantify how many salmon the basin or any part of the basin can support, is meaningless by itself and will not provide useful information.

To increase understanding of ecology, carrying capacity, and limiting factors, it is necessary to deal with the complexity of the sustained performance of salmon in the Columbia River Basin. Density independent factors affect salmon performance, as well as density dependent factors. Factors that affect performance in one part of the salmon life cycle can manifest their effect in later phases of the life cycle. Factors can have different effects on different populations in different parts of the Columbia Basin or marine environment. Factors can affect different populations or stocks in different ways. There are potential negative impacts of focusing on abundance alone (KRC 1995). For example, how do the many populations and stocks of salmon affect one another? When we understand the ecological complexity of salmon performance, the region will be better able to make decisions to improve salmon survival in the basin.

The PNNL team suggests that the region evaluate carrying capacity from more than one viewpoint. Platt (1964) provides a method for scientific inquiry and Pepper (1966) provides at least four views that can be used to define capacity in a way that helps identify critical uncertainties and research needs while dealing with the complexity of salmon performance.

The PNNL team recommends that the region use the contextualistic view for evaluating capacity. Capacity, from the contextual view, is a component of salmon performance, and is inseparable from diversity and productivity. To evaluate capacity, in this way, they recommend that the region compare conditions in the Columbia River Basin to historic conditions using the methods described as the Patient-Template Analysis (Lichatowich et al. 1995).

¹ The carrying capacity study was lead by Pacific Northwest National Laboratory (PNNL) staff. The conclusions reported here are the results of their work.

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Chapter 1: INTRODUCTION

Measure 7.1 A in the Northwest Power Planning Council's (Council) Fish and Wildlife Program (Program) dated December 1994 calls for the Bonneville Power Administration (BPA) to fund an evaluation of salmon survival, ecology, carrying capacity,² and limiting factors in freshwater, estuarine, and marine habitats. The Measure has two parts (7.1 A. 1 and 7.1 A.2). The objective of the evaluation (7.1 A. 1) is to increase understanding of the ecology, carrying capacity, and limiting factors that influence salmon survival under current conditions. The second part of the Measure (7.1 A.2) asks for the development of a study plan based on the critical uncertainties and research needs identified during the evaluation of carrying capacity. This report contains the results of a literature review conducted during our evaluation of carrying capacity and our development of a study plan.

Eight specific elements are listed in Measure 7.1 A. 1 to include in the evaluation. They are:

1. Analysis of competition between non-native species and anadromous salmonids and competitive interaction resulting from hatchery management practices.
2. Estimate of current salmon carrying capacity for the Columbia River mainstem, tributaries, estuary, plume and nearshore oceans for juvenile fish.
3. Evaluation of the effects of the alteration and timing of the ocean plume on salmon survival caused by the construction and operation of the hydroelectric system.
4. Identification of residence time for juvenile salmonids and their level of smoltification.
5. Identification of management measures to protect and improve estuary habitat as well as increase the productivity of the estuary.
6. Recommendations for management responses to fluctuating estuary and ocean conditions such as adjusting total numbers of releases to take such conditions into account.
7. Identification of critical uncertainties and research needs, and estimates of incremental gains in survival from improvements in each area.
8. Monitoring program to identify optimal timing for residency in the estuary and nearshore environment.

To address all eight issues and accomplish the objective of the evaluation of capacity, we were told by Council staff to:

- Review existing data.
- Conduct a workshop.
- Use the information from the review and the workshop to define capacity and list the determinants of capacity.
- Ask, “**What** do we know about the determinants of carrying capacity?”
- Ask, “**What** do we not know about the determinants of carrying capacity?”

² In this report and the others in this series, the terms: capacity, carrying capacity, and ecological carrying capacity are used interchangeably. Attempting to remain consistent with the intent of Measure 7.1 A, the terms are used to describe “*the upper level for a population, beyond which no major increase can occur*” (Odum 1959). Many authors that are cited throughout this paper have other definitions for these terms or use them in a specific context with other population descriptors. I have tried very carefully to cite these authors and strongly suggest that readers **turn** to the original books or articles for clarification.

- Ask, “What research can we do to understand what we do not know about carrying capacity?”
- Ask, “What management actions can we implement immediately. relative to carrying capacity. that will improve salmon survival?”
- Use the information collected and the answers to the questions to develop a study plan based on the critical uncertainties and research needs identified in the evaluation.

This approach is illustrated in Figure 1. The study plan would provide a basis to implement management actions and conduct research. Results of the research and management actions would lead to increased understanding of capacity. This in turn would produce implementation of an ecosystem approach to protect and enhance salmon in the Columbia River Basin.

In pursuing answers to the questions asked in Measure 7.1 A. 1. the authors of Reports 1, 2, and 3 (Neitzel and Johnson 1996a,b; Johnson et al. 1996) concluded. however. that this approach would not meet the objective. That is. the approach illustrated in Figure 1 would not increase understanding of ecology. carrying capacity. or limiting factors that influence salmon under current conditions. Responding to the elements in Measure 7.1 A. 1 requires a specific definition of carrying capacity and a list of determinants (limiting factors) of capacity. The information learned during this review of ecological literature helped lead Neitzel and Johnson (1996a,b) and Johnson et al. (1996) to the conclude that the proposed approach breaks down (Figure 2) if one attempts to define capacity as a simple ecological parameter (Odum 1959. Reeves et al. 199 1).

The capacity parameter, that is. a single number or set of numbers that quantifies how many salmon the basin or any part of the basin can support. will not provide useful information. To increase understanding of ecology. carrying capacity. and limiting factors. it is necessary to deal with the complex interrelationships among the characteristics of salmon performance, including diversity, capacity. and productivity (Paulik 1973, Hankin and Healey 1986. Moussalli and Hilbom 1986. Hilbom and Walters 1992, Mobrاند et al. in press). Accordingly. Neitzel and Johnson (1996a) revised the approach to evaluate capacity (Figure 3). The approach they used followed the work on scientific discovery by Platt (1964) and the work on world hypotheses by Pepper (1966).

This report contains a review of carrying capacity literature for the Columbia River Basin. The review was focused on Columbia River estuary. The organization of the search process is described in Chapter 2. The literature sources used are described in Chapter 3. The results of this review are stated in Chapter 4. The report ends with conclusions and recommendations to the region for continuing a review of literature related to the carrying capacity of Columbia River salmon (Chapter 5). Chapter 5 also contains the conclusions and recommendations from the other reports for this study. The books. journal articles. and technical reports cited in this report are referenced in Chapter 6. The report includes four appendices. Appendix A is an annotated list of over 300 references that were reviewed. Appendix B is a matrix that sorts the references by time period and Columbia River Basin environ.. Appendices C and D are the matrices that can be used to categorically organize the references.

Several other activities are part of this study. PNNL staff prepared an evaluation of carrying capacity. They outlined necessary elements of a study plan to define the critical

uncertainties and research needs related to carrying capacity in the Columbia Basin. They conducted a workshop in Portland, Oregon to address questions about definitions and determinants of carrying capacity. The results of these activities are presented in separate reports to BPA.

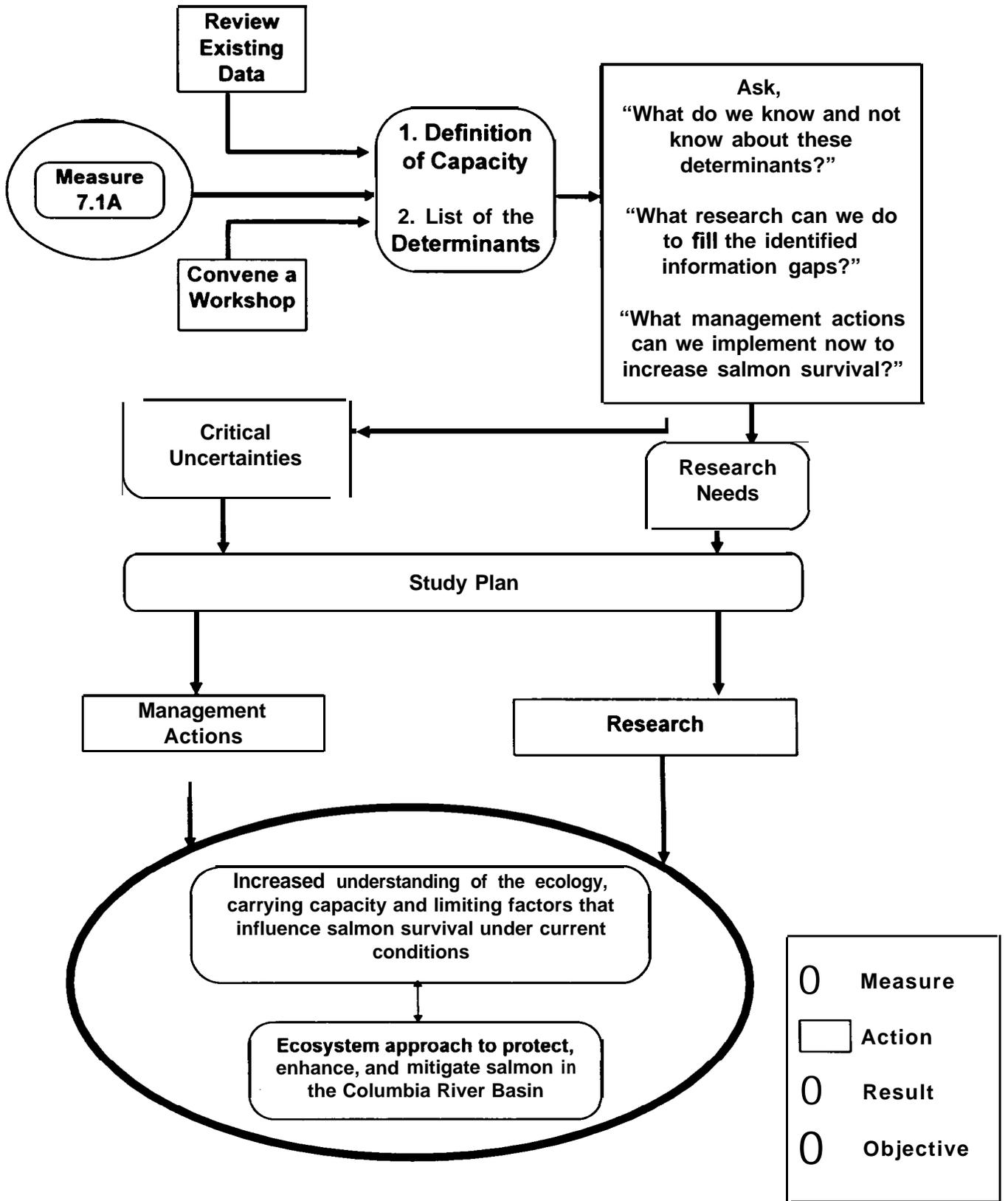


Figure 1. Flow Diagram Illustrating the Approach First Used to Analyze Carrying Capacity and Develop a Study Plan.

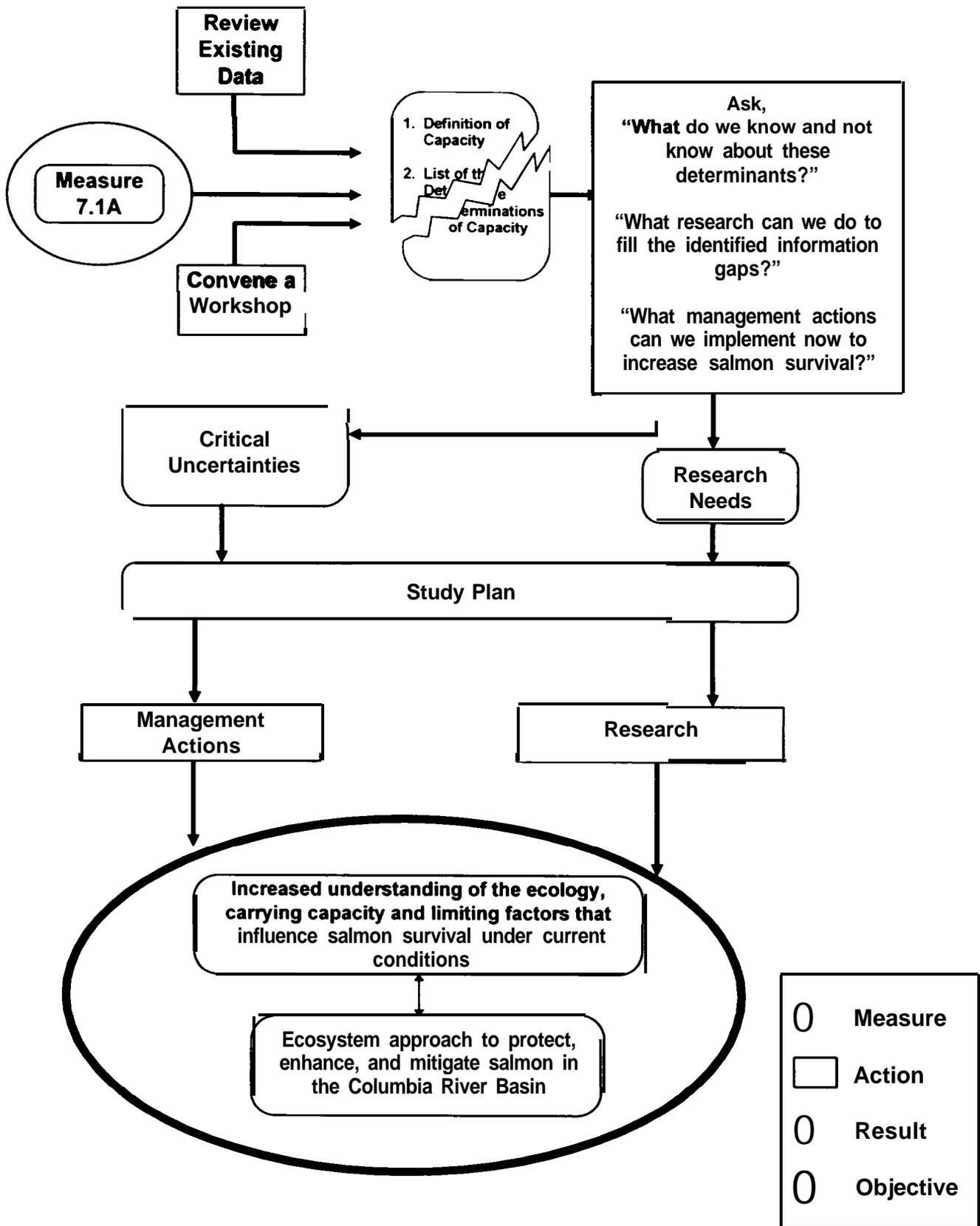


Figure 2. Flow Diagram Illustrating the Breakdown in the Approach First Used to Analyze Carrying Capacity and Develop a Study Plan.

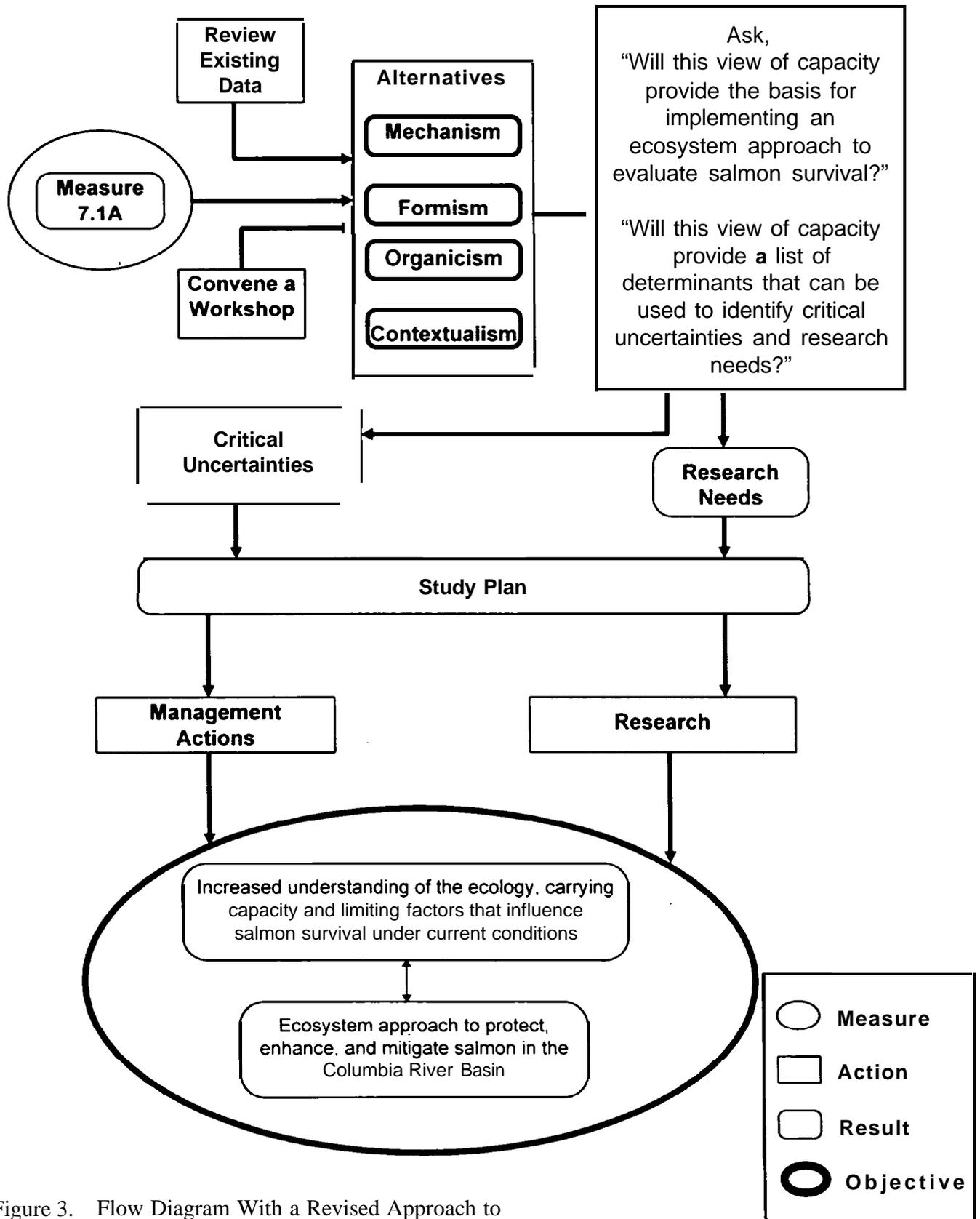


Figure 3. Flow Diagram With a Revised Approach to Analyze Carrying Capacity and Develop a Study Plan.

Chapter 2: LITERATURE-REVIEW ORGANIZATION

Pacific salmon stocks (Ricker 1954, Nehlsen et al. 1991) transition between and occupy various marine, estuarine and riverine environs during their life cycle. Through natural selection and adaptation each salmon stock has evolved and adapted a life history strategy. for selecting. occupying. exploiting. and surviving a complex of habitats and niches (Lichatowich and Mobrand 1995, Lichatowich et al. 1995) that are encountered during their temporal and spatial transitions downstream and upstream through various environs (Table 1). The habitats/niches of each environ possess distinctive abiotic and biotic attributes (Table 2), which are continually effected by natural processes (geological. physical, chemical, and biological). Each attribute is described in terms of measures, and these measures have values that statistically average and deviate within a range of values, seasonally and annually (Neitzel et al. In Preparation). The effectiveness of a fish with a specific life history strategy in 1) occupying, exploiting, and surviving a diverse range of niches and 2) adjusting to and compensating for significant deviations in values of attribute measures, within a continuum of environs and associated diversity of habitats/niches is an indicator of a stock's productivity and fitness over the long-term. Thus, a life history strategy is described in the three dimensional context of abiotic and biotic attributes in association with both a temporal component and a spatial component (attribute vs. time vs. space).

| | |
|-------------------------------------|---|
| Pacific Ocean | Oceanic Zone: Region off the Columbia River beyond 20 radial miles of the river mouth |
| Columbia Plume | Freshwater Effluent Zone: Region of the freshwater influence of the Columbia River within 20 radial miles of the its mouth |
| Columbia Estuary | Seawater Intrusion Zone: Portion of Columbia River having seawater intrusion; mouth of river to a maximum distance approximately at RM 30 (Jay 1984). |
| Columbia Estuary | Tidal River Zone: Portion of Columbia River having no seawater intrusion, but affected by ocean tides; above RM 30 to RM 142 (below Bonneville dam). |
| Columbia River Non-Tidal River Zone | Portion of Columbia River not affected by ocean tides; above RM 142 above Bonneville Dam |

The Columbia River Basin, prior to 1792 (pre European-American settlement), harbored a diversity of Pacific salmon stocks (*Oncorhynchus* spp.); and the relative abundance, productivity, and range of these stocks primarily fluctuated according to natural processes that effected abiotic and biotic attributes (measures) of the habitat/niches within the riverine, estuarine, and marine environs. After 1800, European-American settlement and commerce

| Table 2. Categories and Descriptions of Abiotic and Biotic Attributes | |
|--|--|
| Abiotic | |
| Quantity | Characteristics and measures related to discharge of the Columbia River (e.g., 210k cfs on 20 January 1915). |
| Quality | Characteristics and measures related to the water quality and chemistry of the Columbia River (e.g., temperature, pH, DO, turbidity). |
| Channel | Characteristics and measures related to the physical and geologic morphology of the Columbia River channel (e.g., meander of north channel located between Kalama and Lewis Rivers dredged and straightened in 1926). |
| Riparian | Characteristics and measures related to the physical and geologic morphology of the Columbia River riparian zone/habitat (e.g., saltwater marsh located near Astoria, Oregon. River Mile 1.2 drained and back-filled in December 1899). |
| Uplands | Characteristics and measures related to the physical and geologic morphology of upland areas (outside of the riparian zone) peripheral to the Columbia River (e.g., In 1836, John McGoughlin initiated cutting of Douglas fir and western cedar at Vancouver, Washington for export to the Sandwich Islands (Hawaiian Islands)). |
| Biotic | |
| Productivity/ Abundance | Characteristics and measures related to the population numbers and productive capacity for a salmon species or stock of Columbia River origin (e.g., U.S. Bureau of Fisheries captured 320 chinook salmon fry in a beach seine set at the mouth of the Grays River, Washington on March 30, 1935). |
| Morphometrics | Characteristics and measures related to the truss measures, weight condition and developmental factors, etc. for a salmon species or stock of Columbia River origin (e.g., chinook salmon landed at the Oak Point Cannery in June 1869 averaged 25 lbs. per fish). |
| Behavior and Demographics | Characteristics and measures related to the run timing, sex/age class composition, homing, etc. for a salmon species or stock of Columbia River origin (e.g., The run entry of the spring salmon was 5 days late in 1919). |
| Natural Prey and Predators | Characteristics and measures related to the food forage items and natural enemies for a salmon species or stock of Columbia River origin (e.g., salmon trollers observed exceptional numbers of California sardine off-shore of the Columbia River and Grays Harbor in 1903). |
| Survival/Mortality | Characteristics and measures related to the survival and mortality for a salmon species or stock of Columbia River origin (e.g., 20 adult sockeye of Yes Bay origin, released by U.S. Bureau of Fisheries returned to the lower Clackamas Hatchery in 1922). |
| Fauna/Flora | Characteristics and measures related to structure of animal and plant community (ies) associated with and descriptive of the aquatic, riparian, and upland habitats of the Columbia River estuary, plume, and peripheral Pacific Ocean waters. |

within the Columbia River Basin initiated physical interventions (e.g., mining, logging, and agriculture) that either gradually or dramatically effected changes to the abiotic and biotic attributes (measures) of the riverine and estuarine environs and associated aquatic, riparian, and upland habitats from pristine conditions. It is assumed that these effects (significant deviations in values for measures) upon attributes disrupted equilibrium of infra- and extra-stock behaviors (stock life history strategies), and affected selective adaptations, reduced productivity, and/or extinctions within the complex of indigenous stocks.

During the period of the late 1800s through the 1950s, in-river and marine exploitation of Columbia River salmon in concert with ever increasing water and land resources development (e.g., irrigation, hydroelectric, navigation, and uplands projects) further exasperated the decline in the diversity, productivity, relative abundance, and range of salmon stocks in the Columbia River Basin. Cumulative effects of fisheries harvest and water/land development during this period appear to have dramatically reduced diversity in Columbia Basin salmon. The reduced diversity appears to result from altered habitat. Habitat changed dramatically from the pre-1800s that sustained a greater diversity of life history strategies. This significant alteration of pre-development habitat probably caused a shift in the dynamic equilibrium of abiotic and biotic conditions. These conditions historically generated and sustained a higher productivity and relative abundance of salmon in the Columbia Basin.

The Columbia River Basin, prior to 1792 (pre European-American settlement) illustrates a wide diversity in and an abundance of habitat and associated niches within its riverine and estuarine environs as compared to those of the present day. The following assumptions are posed regarding the diversity and abundance of Pacific salmon temporally (Periods 1 through 6) in the Columbia River Basin:

1. In comparing conditions prior to European-American settlement with the present day, a greater diversity of stock life history strategies existed, and these strategies allowed Pacific salmon species to occupy, utilize, and survive in accessible habitats/niches within various environs.
2. The large numerical abundance of Pacific salmon species was due to the greater diversity in life history strategies and the advantageous utilization of all accessible habitats/niches by these stock life histories.
3. The set of attributes (abiotic and biotic measures), effecting diversity in stock life history strategies, productivity, relative abundance, and range are applicable to stock evaluative and comparative purposes over the various historical time periods (Table 3) in the Columbia Basin.
4. Prior to European-American settlement and exploitation (Period 1), the productivity and relative abundance of Columbia River stocks fluctuated and changed according to influences of natural processes on attributes/measures effecting life history strategies of Pacific salmon species.
5. Since European-American settlement (Periods 2 through 6), the productivity and relative abundance of Columbia River stocks have fluctuated and changed according to influences of natural processes and man-induced interventions that alter attributes/measures effecting life history strategies of Pacific salmon stocks.

| | |
|----------------------|---|
| Pre-1830 (Period 1) | Period Of Pristine Conditions-Salmon Stocks And Habitat Relatively Unaltered By European and American Settlements |
| 1830-1888 (Period 2) | Period Of Early Growth Of Columbia River Commercial Fisheries |
| 1889-1922 (Period 3) | Period Of Relative Stability In Columbia River Salmon Stocks And Fisheries |
| 1923-1938 (Period 4) | Period Of Decline In Columbia River Salmon Stocks And Fisheries Prior To Mainstem Dam Construction |
| 1939-1958 (Period 5) | Period Of Decline In Columbia River Salmon Stocks And Fisheries Following Mainstem Dam Construction |
| Post-1958 (Period 6) | Period Of Major Modification and Control Of Columbia Flow Regime; And Relative Stability In Columbia River Salmon Stocks and Fisheries Followed By Collapse Of Stocks And Fisheries |

In order to evaluate and reconcile past, present, and future productivity, relative abundance and range of Pacific salmon stocks in the Columbia River Basin, it is important to have both qualitatively and quantitatively descriptions.

1. Stock life history strategies, existing at the time of European-American discovery and exploration, in terms of temporal-spatial behaviors for selecting, occupying, utilizing, and surviving a complex of habitats and niches of the various environs.
2. Critical measures and their statistical values (means and ranges), associated with abiotic and biotic attributes, of various environs temporally and spatially utilized by various life history strategies at the time of European and American discovery and exploration.
3. Alterations of habitats/niches of various environs and associated changes and/or manipulations to critical abiotic/biotic measures of attributes after European and American discovery and exploration.

The evaluation of the ecology, carrying capacity, and limiting factors that influence salmon survival in the Columbia River can be greatly assisted through focused research of Columbia Basin history which derives, organizes, and evaluates information/data for each time period (Table 3). An historical evaluation should:

1. Determine and characterize stock life history strategies.
2. Qualify and quantify critical abiotic/biotic measures of attributes associated stock life history strategies.
3. Chronicle, describe, and quantify alterations to values (of attribute/measures) habitats/niches associated with stock life history strategies Information, data of pre-1830 through the 1860s.

Periods 1 and 2 can be used to determine and or extrapolate a baseline for stocks and stock life history strategies, and to characterize (qualitatively and quantitatively) the measures for attributes of the habitats/niches of each environment. Comparative analysis, evaluation and correlation of historical information/data for Periods 1 through 6 should determine singular and cumulative alterations/manipulations that have affected the diversity and/or productivity of various stock life history strategies for Pacific salmon in the Columbia River Basin.

This review is a precursor and component to the development of a study plan for increasing the region's understanding of ecology, carrying capacity, and limiting factors that influence the survival of salmon under current conditions. An objective of this review was to provide the region with a information to determine what is knoun and not known about the determinants of carrying capacity.

Chapter 3: LITERATURE SOURCES

Personal consultations were made with Dr. Charles Simenstad (Fisheries Research Institute, University of Washington, Seattle, Washington) and Dr. Christopher Sherwood (Battelle Marine Science Laboratory, Sequim, Washington). They contributed some reference candidates, related to the Columbia River estuary and adjacent environs, that assisted in this literature review.

Information in this review was derived from various reference materials (published and unpublished) such as books, papers, magazines, and manuscripts, contained in the collections of the University of Washington libraries (Seattle, Washington), Battelle Pacific Northwest Division (Sequim and Richland, Washington), and the National Marine Fisheries library (Northwest Fisheries Research Center Montlake, Seattle, Washington). Selected references and bibliographies, dating from the late nineteenth century to the present, were reviewed for information pertaining to (1) the description of Pacific salmon species and their life history strategies, (2) description of abiotic and biotic attributes associated with the habitats, niches of marine, estuarine and adjacent environs; and (3) events, activities, and actions that may have effected alterations and manipulations to habitats/niches of marine, estuarine, and adjacent environs (plume and riverine) of the Columbia River. Reference documents, that were personally acquired, were annotated for informational contents; all references derived in the course of this review were cited according to author, date, title, publication source, document repository (library location and call number), and provided an annotation or comment (Appendix A).

Most references (books, papers, magazines, and manuscripts) were accessed for repository location using the computerized library system of the University of Washington, and acquired from the comprehensive collections of the University of Washington libraries (e.g., Fisheries and Oceans, Suzzallo, Northwest Collections, etc.). Dr. Christopher Sherwood provided three boxes of reference documents related to the Columbia River. These documents were reviewed for their relevance to the review purpose, cited, and annotated for informational content.

Reports of the Columbia River Estuary Data Development Program (CREDDP and the U.S. Army (Corps of Engineers) served as the primary references for developing and expanding the informational base and references of this review.

The current repositories and locations of all references cited in the bibliography are provided in Appendix A. Hard copies for many of the annotated references were acquired and serially identified with a reference code (BMSL #), and are consistent with the Reference # of the bibliography (Appendix A). The reference hard copies are retained at the Pacific Northwest National Laboratory in Richland, Washington.

Chapter 4: RESULTS

A bibliography of 332 references, dating from the late 1800s to the present day, was developed (Appendix A). The bibliography contains a selected listing of 206 annotated references and 126 unannotated references relevant to the attributes (abiotic and biotic), processes (physical, chemical, and biological), Pacific salmon species, general projects history, and miscellaneous information of the Columbia River estuary and adjacent marine/riverine environs (Pacific Ocean plume, tidal river, and non-tidal river). Unannotated references were cited in a manner that facilitates future acquisition, review, and annotation of information. Based on a computerized search (using key words) and a review of literature cited/bibliography sections of many documents (related to the Columbia River Basin), the bibliography of selected references, generated from this review, only represents a limited subset of hundreds of documents (published and unpublished), pertinent to Pacific salmon stocks and their associated environs and habitats/niches, that have been generated since the latter nineteenth century to the present.

Reports of the Columbia River Estuary Data Development Program (CREDDP) provided significant information (abiotic/biotic attributes and geological/physical/chemical/biological processes) and reference sources for Time Period 6. Whereas the U.S. Army reports (War Department, Chief of Engineers, and Portland District Corps of Engineers) contributed significant information (abiotic attributes and project history) and reference sources for Time Periods 2 through 5.

Annotated references were organized (by reference numbers) in matrices (Appendix B, Matrices 1 through 6) for each Time Period, according to General Attribute and Information Categories and Location/Environ. These matrices illustrate the quantity and diversity of reference materials for various historical periods, and their relevance to the aforementioned categories.

Numerous references, regarding the estuarine, tidal river, and riverine (non-tidal river) environs were reviewed and annotated for Periods 2 through 6. The majority of the information for Periods 2 through 4 is related to abiotic attributes and general history/projects description (e.g., channelization, diking, and channel maintenance), contained in U.S. Army. Annotations for references of the War Department/Chief of Engineers reports provided a guide (manuscript page numbers) to locating information/data within each report, relative to various estuarine/tidal river environs of the Columbia River. Annotated references for Periods 2 through 5 are also primarily related to abiotic attributes and general history/description of projects, whereas those of Period 6 are, for the most part, related to abiotic and biotic attributes. A limited number of annotated references regarding life history information for Pacific salmon species were derived from this review; but a wealth of information in this category is available for Period 6 in the National Marine Fisheries Service (NMFS) publications, and many of these NMFS publications are cited as unannotated references in the bibliography.

Annotated references regarding the information for the Pacific Ocean and Columbia River plume environs were not derived for Periods 1 through 5, but extensive information (abiotic and biotic) for these environs is available for Period 6. It should be noted that relevant information regarding marine environs (plume and marine) off Washington and Oregon coast for

Periods 2 and 3 does exist in the biological survey reports (surveys of the U.S.S. Albatross) of the U.S. Commission of Fish and Fisheries (later known as the U.S. Bureau of Fisheries).

Chapter 5: CONCLUSIONS AND RECOMMENDATIONS

The literature review achieved the purpose of finding the types and general content of information relevant to attributes of the Columbia River estuarine and adjacent environs for various time periods. The bibliography of selected references only represents a limited subset of thousands of documents (published and unpublished), pertinent to Pacific salmon stocks and their associated environs and habitats/niches, that have been generated since the latter part of the nineteenth century to the present.

Extensive information regarding attributes (abiotic and biotic measures) and Pacific salmon life histories is available for Period 6, and this information should provide an excellent foundation for describing and evaluating the present-day attributes (abiotic/biotic) and stock life history strategies of the Columbia River estuary.

Extensive information regarding abiotic attributes of the Columbia River is available for Periods 3 through 5, and should provide the foundation for describing abiotic attributes, and for directly determining and/or extrapolating statistical values for associated measures. Limited literature regarding biotic attributes and stock life history strategies was obtained for the Columbia River estuary during these periods (3 through 5). Specific biotic attributes and stock life history strategies information for Periods 3 through 5, related to the Columbia River estuary and adjacent marine and tidal river environs, is probably available as published/unpublished documents of the U.S. Fish and Wildlife Service (and its predecessors U.S. Bureau of Fisheries, U.S. Commission of Fish and Fisheries), state fisheries agencies (Washington, Oregon, and Idaho), U.S. Army Corps of Engineers (District Engineers), and other private/public entities (planners and developers of aquatic and riparian habitats of the Lower Columbia River Basin).

Significant information regarding abiotic/biotic attributes (measures) of Columbia River estuary and tidal river environs (Lower Columbia River Basin, mainstem Columbia and tributaries) for Period 2 is available in the US Army reports (War Department and Chief of Engineers reports) selected information of these Army documents is identified within the annotations of the bibliography in Appendix A. This information should provide the basis for (a) describing various abiotic attributes of the Columbia River estuary, tidal river, and riparian/upland habitats prior to significant alterations; and (b) determining biotic attributes and probable stock life history strategies, either directly or by inferences, for the Columbia River estuary during Periods 1 and 2.

Sparse information regarding attributes and salmon stocks life histories of the Columbia River estuary and adjacent marine/riverine environs is available for Period 1. A previous historical review (Costello 1996) indicates that relevant information for Period 1 can be derived from manuscripts and diaries of explorers (e.g., Charles Wilkes, J.C. Fremont), missionaries (e.g., John Spaulding, Narcissa Whitman), and early settlers (e.g., John McLoughlin, John Astor).

The literature review for deriving information relevant to attributes (abiotic and biotic) and Pacific salmon life histories of the Columbia River estuarine and adjacent environs for time Periods 1 through 6 should be continued. The next phase of the literature review should be focused on derivation of more specific information/data regarding (a) abiotic/biotic attributes and

Pacific salmon life history/stock life history strategies for Periods 1 through 5, and (b) Pacific salmon life history/stock life history strategies for Periods 1 and 2.

Either upon completion or during the next phase of the literature review, pertinent qualitative and quantitative information for various attributes (measures) should be extracted from the reference documents, and organized in a matrix format, as suggested in Appendices C and D. This information/data organization (matrix) will provide the documented sources and repository of numerical values for describing critical abiotic/biotic measures for attributes of the Columbia River estuary and adjacent marine/ riverine environs for Periods 1 through 6.

A baseline for salmon stocks and associated life history strategies should be established. Each life history strategy should include: (a) the temporal and spatial continuum of habitat/niches for the riverine and estuarine environs utilized by a stock, and (b) a listing of the measures for various attributes critical to stock productivity within said habitats/niches. This baseline of stocks can be determined directly from and/or extrapolated through historical information for Periods 1 and 2. Based on a previous literature review of the Columbia River Basin (Costello 1996), the chinook salmon (*O. tshawytscha*) is suggested as the first candidate species for the exercise in determining baseline stocks/stock life history strategies, since the historical information for this species appears to be more readily accessible in published documents (e.g., U.S. Commission of Fish and Fisheries/U.S. Bureau of Fisheries reports) of Periods I and 2.

Based on Appendix C, numerical values (means and ranges) for various critical measures of attributes can be organized in a matrix format, as suggested in Appendix D, for derivation, comparison, and evaluation of environmental stability/deviation over time (Periods 1 through 6); and changes in stock (s) life history strategies and productivity and relative abundance of a stock(s) may be correlated with numerical values for these attribute measures.

The information derived and organized following these recommendations should be evaluated using innovative methodology(ies) to generate information that can be used for reconciliation of goals, objectives, and strategies for increasing the survival of salmon under current conditions. The Patient-Template Analysis (Lichatowich et al. 1995) is an innovative method that could be used.

To place these conclusions and recommendations in context with the rest of this study, it is important to look back at the conclusions and recommendations of the three other reports generated for the evaluation of carrying capacity (Neitzel and Johnson 1996a,b; Johnson et al, 1996). Pursuing the capacity parameter as a single number or set of numbers that quantifies how many salmon the basin or any part of the basin can support, will not provide useful information to meet the objective of Measure 7.1 A. This is the mechanistic view of salmon population dynamics and it will not work. The region “*must recognize and protect...diversity... It is not enough to focus only on the abundance of salmon*” (NRC 1995). We have to realize the quality of whatever happens to be at the present time. Then, significance lies in the purpose of what we are pursuing. Bella (1995) describes the need to move toward a “*healthy environment strategy.*” He claims that the assessment and management of the many activities responsible for the decline of salmon in the Pacific Northwest are hindered by fundamental misconceptions. Management and policy have been dominated by presumptions that fail to grasp the complexity of human and salmon interactions (Bella 1995). To increase the region’s understanding of ecology, carrying

capacity, and limiting factors that influence salmon survival under current conditions, the region must deal with the complexity of issues such as carrying capacity. Thus, the following conclusions and recommendations should be considered:

- Strong inference (Platt 1964) is needed to evaluate carrying capacity in the Columbia River Basin. All proposed research and proposed management actions should include the steps defined by Platt (1964): devise alternative hypotheses; devise experiments, with alternatives, to exclude one or more of the hypotheses; carry out the experiment or action to get clean results; recycle this procedure.
- Carrying capacity is a complex concept that can be evaluated from a contextual point of view that is consistent with observations of salmon populations and can be used to develop a study plan to increase the region's understanding of ecology, carrying capacity, and limiting factors for salmon. The Council and BPA should use a contextual view to evaluate carrying capacity.
- From the contextual view, capacity is a component of salmon performance, and is inseparable from diversity and productivity. Capacity reflects the quality and the quantity of salmon and provides us with a relative measure of the size of a **population**³. The Program should incorporate the complex, interdependent relationship of diversity, productivity, and capacity into all the measures.
- Understanding capacity from a mechanistic view, the basis for Measure 7.1 A and much of the Program, could be useful for making a list of determinants, however, this view is not consistent with the complex nature of salmon life histories and Columbia River environs. The mechanistic view is not useful for developing a study plan. The mechanistic view of salmon in the Columbia Basin should not be used in the Program.
- The Patient-Template Analysis is a tool that could be used to evaluate carrying capacity and develop a study plan to increase our understanding of the ecology, carrying capacity, and limiting factors for salmon. The Council should call for a Patient-Template Analysis, as described by Lichatowich et al. (1995). The region will be able to evaluate carrying capacity under current conditions, compare current conditions to historic conditions and thus, predict possible future conditions for salmon in the Columbia River Basin.

In closing, Measure 7.1 A is a microcosm of the entire Program. It is based on a **framework**⁴ that is not working. The carrying capacity measure and the Program as a whole need a new framework. The new framework should be based on the recognition and protection of the

³ - Population size is not different from the mechanistic definition. What distinguishes capacity when it is defined in a contextual or historic event framework, is its inseparable link to diversity and productivity within a measure of performance for salmon. For further clarification of salmon performance we suggest Mobrand et al. (1996).

⁴ - During most of this report, we discuss definitions, hypotheses, and views. When we discuss the need for a new framework, we mean to use a broader term. We include three elements, when we use the word framework: theory, tasks and tools. The theory is the general proposition or principles we use to explain the events we observe. Theory results from our view of the ecosystem and the hypotheses that we test. The tasks are the commitments, processes, and institutional requirements needed to carrying out the Fish and Wildlife Program. The tools are the instruments of management needed to analyze data, schedule projects, resolve conflicts, and make sure our actions are moving us toward our objectives.

entire life cycle of salmon and not on abundance of salmon alone. The framework should be consistent with observations of salmon populations and incorporate the complexity of the population's attributes. The framework must accommodate the connectivity among life stages and the interrelationships among capacity, diversity, and productivity within the Pacific Northwest ecosystem. The contextual view provides the basis for a new framework.

Chapter 5: REFERENCES

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- Costello, R.J. 1996a *A Historical Perspective And Information For Activities And Actions Affecting The Pacific Salmon Species, Relative To Development And Management Of Land And Water Resources Within The Columbia River Basin, During The Period Of 1792-1967*. Prepared by Mobrاند Biometrics, Vashon, Washington for the Bonneville Power Administration, Portland, Oregon.
- Hankin, D.G., and M.C.Healey. 1986. *Dependence of exploitation rates for maximum yield and stock collapse on age and sex structure of chinook salmon (Oncorhynchus tshawytscha) stocks*. Canadian Journal of Fisheries and Aquatic Sciences 43: 1746-1 759.
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Prepared by the Pacific Northwest National Laboratory for the Bonneville Power Administration, Portland, Oregon.

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APPENDIX A

Bibliography Of Selected References Relative To Pacific Salmon (*Oncorhynchus* spp.), Abiotic And Biotic Attributes, And Projects History Of The Columbia River Estuary And Adjacent Marine/Riverine Environs

REFERENCE #00 1

Aleem, A. A. 1972. *Effect of river outflow management on marine life*. Mar. Biol. 15: 200-208. QH91 .A1 .M37, Fish and Ocean Library, U of W

Annotation Author presents information regarding the down-stream impacts of the Aswan **High** dam (Egypt) on marine life in coastal waters, with respect to nutrient inputs, phytoplankton, zooplankton, finfish, shellfish.

Note: Reference provides peripheral information that may be pertinent to the impacts and dynamics of Columbia river impoundments upstream of the estuary.

REFERENCE # 002

Alverson. D.L. 1972. *Bioenvironment features: An Overview*. In A.T. Pruter and D.L. Alverson (editors). The Columbia River estuary and adjacent ocean waters. p. 845-857. Univ. Washington Press, Seattle. TD 427. R3C64, Fish and Ocean Library,U of W.

Annotation Author summarizes the role and features of the Columbia river in terms of the following categories: 1) Conflicting Environment, 2) The River in the Sea, 3) Hanford- A Part of Man's Activities, 4) Radionuclides- the Changing Environment, and 5) A Consideration of Diel. Seasonal, and Annual Transport Patterns- Some Speculative Models.

REFERENCE ft 003

Bagnall, M.G. 1916. *Improvement of the mouth of the Columbia River, U.S. Corps of Engineers*. Professional memoirs. 8 (42) 687-720. 620.5 PR . Kane Hall Auxiliary Stacks. U of W.

Annotation Author provides a 1) description and physical data (substrate, tidal movement. etc) of the Columbia river entrance- pp. 687-690,2) history of various projects at the Columbia river entrance (e.g. channezation, jetting, bar dredging, etc.)- pp. 691-707, and 3) Illustrative maps/plates of the Columbia river entrance for the years 1885, 1895,1902. 1913. and 1916- p. 720.

REFERENCE # 004

Barnes, C.A.. A.C. Duxbury and B.A. Morse. 1972. *Circulation and selected properties of the Columbia River effluent at sea*. In A.T. Pruter and D.L. Alverson (editors), The Columbia River estuary and adjacent ocean waters. p. 41-80. Univ. Washington Press, Seattle. TD 427. R3 C64. Fish and Ocean Library, U of W.

Annotation Authors provide information on the distribution and circulation of the Columbia river effluent (a plume delimited by the 32.5 ‰ salinity isopleth) in the coastal waters of the northeastern Pacific off Oregon and Washington. Discuss the areal extent and location of the Columbia river plume which is controlled by seasonal climatic regimes, influenced by river discharge and winds. Describe the processes effecting the plume and properties (physical and chemical) seasonally associated with the plume. Discuss the seasonal trends and variability in the distribution and dispersion of the dissolved and suspended load of the plume. Numerous illustrations included to describe the characteristics and processes associated with the distribution and circulation of the Columbia river plume in the northeast Pacific.

REFERENCE # 005

Baxter, R.M. 1977. *Environmental effects of dams and impoundments*. *Annul. Rev. Ecol. Syst.* 8:255-283. QH 540.A53, Fish and Ocean Library, U of W.

Annotation Author provides 1) a general history and background of the impoundments, 2) Morphology and physical and chemical limnology of man-made lakes, 3) biology of reservoir ecosystems, 4) downstream effects of impoundments, 5) other consequences of impoundments, 6) summary and conclusions, and 6) a comprehensive listing of references on the subject.

REFERENCE #006

Blanchard, R.E. 1977. *Columbia River estuary physical alterations*. In M.H. Seaman (editor). *Columbia River estuary, inventory of physical, biological and cultural characteristics*. p. 209-1 to-209-22. Columbia River Estuary Taskforce, Astoria OR. GC 860. C6 C66 1977, Fish and Ocean Library, U of W.

Annotation The author discusses the man-induced physical alterations river bed. and adjacent riparian/upland areas of the Columbia river estuary, caused by following projects/activities (1) dredging & disposal for improvement and maintenance of river navigation (2) dikes & levees for flood control/protection. and (3) jetties/pile dikes for protection the river mouth entrance. Description of project histories, types. methods, and locations are discussed and supporting illustrations (tables and figures) are presented. Land disposal of dredging spoils are given with respect site, location (approximate river mile), habitat type. wildlife affected, and area size (in acres).

Note: Excellent reference for generally determining the location of projects by typed and general impacts.

REFERENCE #007

Bottom, D., K. K. Jones, and M.L. Herring. 1984. *Fishes of the Columbia River estuary*. Columbia River Data Development Program, Astoria, Oregon, 13 p. QH541.5. E8 F57 1984, Fish and Ocean Library. U of W; or PNL-007, Battelle Pacific Northwest Laboratory. Richland. WA.

Annotation Authors provide information regarding the composition, distribution. and invertebrate prey of selected fish species in the various estuarine zones (3 salinity zones), habitats (six types) of the Columbia river. based on National Marine Fisheries sampling activities (beach seine. purse seine & trawl) from February 1980 through July 1981. Discuss the discharge/salinity processes that seasonally affect fish assemblages and their associated prey in the Columbia river estuary and its plume. Anadromous salmon species (chinook, coho. and chum) are included within the fish assemblages; information regarding their seasonal & spatial distribution and prey ingestion (stomach analyses) are provided and illustrated in tables and figures of reference. The reference includes the following sections relative to invertebrate prey and fish assemblages: Salinity & Temperature, Species Composition & Distribution of Abundance, Location/Species Associations, Species Composition, Seasonality & Dominant Species, Physical Factors, and Prey Availability. Reference includes extensive literature list.

REFERENCE #008

Bottom, D., and K.K. Jones. 1990. *Species composition, distribution, and invertebrate prey of fish assemblages in the Columbia River estuary*. Prog. Oceanogr. 25:243-270. 55 1. 4605PR, Fish and Ocean Library, U of W; or PNL-008, Battelle Pacific Northwest Laboratory, Richland, WA.

Annotation Authors note that seasonality of abundance and species in an estuary reflect the timing of migration and the reproductive cycles of marine and anadromous species. Composition of the fish community and dominant species in the Columbia river estuary are similar to many smaller estuaries in the Pacific Northwest; these similarities reflect the influence of the nearshore marine environment on the fish community structure, and considerable physiological tolerance of many euryhaline species. The distribution of fish assemblages in the Columbia river estuary is influenced by large seasonal variation in river discharge and salinity; and within large areas and salinity zones, species assemblages use different habitat and prey. The distribution of abundance and the stomach fullness of fishes vary directly with the density of potential prey; it is hypothesized that fish production may be limited by dynamic physical processes that control prey availability or the feeding efficiencies of predators in the highly turbid water.

REFERENCE # 009

Davison, M.A., and R.D. Spencer. 1979. *Columbia river islands land status survey, Columbian White-Tailed Deer Study*. Project E-I, Study 2, Job 4, Section 4; Washington Department of Game, Olympia. Washington. QL737U55D3845, Forestry Resources Library, U of W.

Annotation. Author provides information regarding the status of habitat and ownership for 28 islands. located within 107 mile section of the lower Columbia river between Bonneville Dam and Cathlamet, Washington. Provides information for each island. with respect to geographic location/acreage, ownership (deed abstract), floral communities/habitat, historical, present, future uses of island. Includes information regarding alterations in terms of dredging, fill. and forest removal. etc. Note: Excellent Reference

REFERENCE # 010

Borgeld, J.C.. J.S. Creager, S.R. Walter and E.H. Roy. 1978. *A geological investigation of the Sedimentary environment at sites E, G, and H near the mouth of the Columbia River*. Dept. of Oceanography. University of Washington, Seattle; Final Report to U.S. Army, Corps of Engineers. Portland District. Portland, Oregon, unpaginated. GC978.C6G46. Fish and Ocean Library. U of W.

Annotation Authors present information for the physical nature of bottom sedimentation and sediment transport at dredged disposal sites E and G at the mouth of the Columbia river. Provide a synthesis of the history of improvements to the Columbia river mouth, and information (e.g. hydrology. physical oceanography, bathymetry etc.) related to the Columbia river and adjacent Pacific ocean waters. Includes extensive tables and graphics to illustrate data. results and background information (history, physical oceanography, etc.)

Note: Excellent reference.

REFERENCE # 0 11

Brzezinski, M.A., and R.L. Holton. 1983. *A report on the macroinvertebrates of the Columbia River estuary found in deposits of volcanic ash from May 18, 1980 eruption of Mount St. Helens.* Estuaries 6: 172-175. GC96. E87, Fish and Ocean Library, U of W.

Annotation Authors provide information regarding the effects of volcanic ash on macroinvertebrates in the upper section of the Columbia river estuary. Includes tables illustrating the species, vertical distribution and relative abundance in core samples containing ash layers.

REFERENCE # 012

Buchman, M.F. 1989. *A review and summary of trace contaminant data from coastal and estuarine Oregon.* U.S. Dep. Commer., NOAA Tech. Memo. NOS OMA-42, 110 p. GCI. N19 no.41 -42, Fish and Ocean Library, U of W.

Annotation Authors provide general information about existence, contribution, circulation, and distribution of trace contaminants (point source discharges, chlorinated hydrocarbons, polynuclear aromatic hydrocarbons, miscellaneous hydrocarbons, and trace metals) within and from Oregon estuaries, such as that of the Columbia river. Provide general introduction and perspective of the three principal features of the physical coastal oceanography applicable to Oregon in terms of seasonal oceanic surface currents, coastal upwelling, and the Columbia river plume.

REFERENCE # 013

Clark, S.M. and G.R. Snyder. 1970. *Limnological study of lower Columbia River, 1967-68.* U.S. Fish. Wildl. Serv. Sci. Rep. Fish. 610, 14 p. SH 11. A2856, Fish and Ocean Library, U of W.

Annotation Author provide limnological information/data at seven sampling stations (river kilometer: 166, 140, 135, 118, 106, 78, and 54) on the lower Columbia river (above the mouth of the Willamette river to below Puget Island) during the period of July 1967 - December 1968. Information included: physical (water temperature, turbidity, conductivity, & salinity), chemical (pH, dissolved oxygen, phosphate, silicate, calcium, magnesium & sodium), and biological (chlorophyll a & zooplankton).

REFERENCE # 014

Copeland, B.J. 1970. *Estuarine classification and responses to disturbances.* Trans. Am. Fish. Soc. 99: 826-835. 639. 2AM, Fish and Ocean Library, U of W.

Annotation Author provide a general classification/definition for estuaries in the United States; and describes the response to disturbances as related to estuary class/type. Associated tables and graphics aid in illustration and definition of classifications and responses to disturbances (e.g. physical).

REFERENCE # 015

Columbia River Estuary Data Development Program. 1973. *Bathymetric Atlas of the Columbia River.* Columbia River Estuary Data Development Program, Astoria, Oregon, 16 pp. QH54 1.5. E8 B37 1983, Fish and Ocean Library, U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 0 16

Columbia River Water Management Group. 1982. *Columbia River water management report for water year 1981*. 193 p., U.S. Army Corps Engineers, P.O. Box 2870, Portland, OR 97208. TC 425. C7 C65, Suzzallo Library, U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 017

Creager. J.S., L. Sims, C.R. Sherwood. E.H. Roy, R. Stewart, J. Barnett and G. Gelfenbaum. 1980. *Sedimentological study of the Columbia River Estuary*. Annual Report, Vancouver, Washington: Pacific Northwest River Basins Commission.

Comment Future candidate for researching call number & location, acquisition, review. and annotation.

REFERENCE # 018

Dahm, C.N., S.V. Gregory, and P.K. Park. 1981. *Organic carbon transport in the Columbia River*. Estuarine Coastal Shelf Sci. 13:645-648. GC96. E89, Fish and Ocean Library. U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 019

Dawley, E.M., C.W. Sims. and R.D. Ledgerwood. 1978. *A study to define the migrational characteristics of chinook and coho salmon and steelhead trout in the Columbia River estuary*. Northwest and Alaska Fisheries Center, Seattle, Coastal Zone & Estuarine Studies; Processed report, 23 p. QL638. S2 S784 1981, Fish and Ocean Library U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 020

Dawley, E.M., R.D. Ledgerwood, and A.L. Jensen. 1985. *Beach and purse seine sampling of juvenile salmonids in the Columbia River estuary and ocean plume, 1977-1983; Volume I: Procedures, sampling effort. and catch data*. Northwest and Alaska Fisheries Center, Seattle. Coastal Zone & Estuarine Studies; U.S. Dep. Commer., NOAA Tech. Memo. NMFS. F/NWC-74,206 p. SH11. A5)36/C55. 13.2 NMF, U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 021

Dawley. E.M., R.D. Ledgerwood. T.H. Blahm, C.W. Sims. J.T. Durkin. R.A. Kim, A.E. Rankis, G.E. Monan. and F.J. Ossiander. 1986. *Migrational characteristics, biological observations, and relative survival of juvenile salmonids entering the Columbia River estuary. 1966-1983*. Final report to Bonneville Power Administration. U.S. Dep. Energy. Contract DE-AI 79-84BP-39652. 256 p. QL639.5M541986, Fish & Ocean Library, U of W.

Annotation Authors provide a comprehensive treatment and extensive information regarding the migratory characteristics of juvenile anadromous salmonids (chinook and coho salmon and steelhead trout) in the Columbia river plume and estuary, during the period of 1965 - 1983. Behavior characteristics of juvenile salmonids are related to physical factors of the Columbia

river estuary and plume. The following information and data relative to salmon behavioral characteristics are: 1) distribution, 2) diel movement patterns, 3) migration timing, 4) rates of downstream movement, 5) fish size and estuarine residency. 6) survival rates. The following ancillary information is provided:

- 1) Food consumption of juvenile salmonids captured at Jones Beach;
- 2) Non-feeding juveniles 1979-81 and some effects of Mt. St. Helen eruption;
- 3) Diet of subyearling chinook salmon and effects of Mt. St. Helen eruption;
- 4) feeding characteristics of juveniles entering the estuary.

REFERENCE # 022

Dodge, R.O. 1976. *Construction of the 40-foot channel in Columbia River*. In: Rivers 76. Specialty conference of the Waterways Harbors and Coastal Division of the American Society of Civil Engineers, p. 257-279

Comment Future candidate for researching call number & location. acquisition, review. and annotation

REFERENCE # 023

Dum, J..G. Hockman. J.Howerton. and J. Tabor. 1984. *Key mammals of the Columbia River estuary*. Columbia River Estuary Data Development Program. Astoria. OR.. 116 p. QH541.5. E8K49 1984, Fish and Ocean Library. U of W; or PNL-023. Battelle Pacific Northwest Laboratory, Richland. WA

Annotation Authors provide extensive information about key mammalian species occurring the Columbia river estuary. with respect to 1) habitat use-2) period of birth. 3) relationship to other trophic levels, and 4) critical habitat. Extensive tables and graphics are provide to illustrate spatial and temporal occurrence and inhabitation of key mammals within the Columbia river estuarine zone.

REFERENCE # 024

Durkin, J.T.. T.C. Coley. K. Vemer, and R.L. Emmett. 1981. *An aquatic species evaluation at four self-scouring sites in the Columbia River estuary*.. Northwest and Alaska Fisheries Center. Seattle, Coastal Zone & Estuarine Studies: Report to the U.S. Army Corps of Engineers. Contract DACW57-79-F-0145,46 p. SH153.Un5386. NMFS Montlake Library. Northwest Fisheries Science Center. 2725 Montlake Blvd. E.. Seattle. WA 98112.

Comment Future candidate for acquisition. review and annotation.

REFERENCE # 025

Durkin, J.T., S.J. Lipovsky. and R.J. McConnell. 1979. *Biological impact of aflow-lane disposal project near Pillar Rock in the Columbia River estuary*. Report to the U.S. Army Corps of Engineers, Contract DACW57-77-062 1,92 p (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle WA 98112. SH153.Un5382, NMFS Montlake Library. Northwest Fisheries Science Center. 2725 Montlake Blvd. E.. Seattle. WA 98112.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 026

Duxbury, A.C., and N.B. McGary. 1968. *Local changes of salinity and nutrients off the mouth of the Columbia River*. Limnol. Oceanogr. 13:626-636. 591. 9205 LI, Fish and Ocean Library, U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 027

Ebel, W.J., C.D. Becker, J.W. Mullan, and H.L. Raymond. 1989. *The Columbia River-Towards a holistic understanding*. In D.P. Dodge (editor), Proceedings of the International Large River Symposium. Can. Spec. Publ. Aquat. Sci 106:205-219. GB561. 157 1986, Fish and Ocean Library, U of W.

Annotation Authors provide synopses of the Morphometry, Hydrology, Mainstem Flow Regimes, Sedimentation, Water Quality, Mainstem Temperatures, Productive Potential, Primary Production, Zooplankton, Secondary Production, General Productivity, Fish Species/Salmonid Resources & Fisheries of the Columbia River basin. They briefly discuss and provide a historical perspective of the Regional Exploitation and Development of fisheries and water resources of the Columbia river. and associated fish problems and mitigation strategies. Also discuss Institutional Arrangements in the Columbia basin per federal legislation. Brief notes of sedimentation and sediment load in the Columbia river estuary and adjacent ocean waters- p. 208

REFERENCE # 028

Emmett, R.L.. 1982. *The effects of the May 18, 1980 Mount St. Helens eruption on the food habits of four salmonid and two non-salmonid fishes in the Columbia River Estuary*. M.S. Thesis. Univ. Oregon, Eugene, 44 p.

Comment Future candidate for researching call number & location, acquisition. review. and annotation.

REFERENCE # 029

Emmett, R.L., D.R. Miller, T.H. Blahm. . 1986. *Food of juvenile chinook *Oncorhynchus tshawytscha*, and coho). kisutch, salmon off the northern Oregon and southern Washington coasts, May-September 1980*. Calif. Fish. Game 72:38-46.639.05 CA, Fish and Ocean Library, U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 030

Envirosphere Company. 1981. *The status of knowledge on the effects of log storage on the Columbia River estuary*. Report to the Pacific Northwest River Basins Commission, Contractor No. D-2.1,60 p. (Available from Pacific Northwest River Basins Commission, 1 Columbia River, Vancouver. WA 98004). QH541.5. E8.583 1981, Fish and Ocean Library, U of W, Note: Due 8/1 0/95 being repaired.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 031

Everitt, R.D., R.J. Beach, A.C. Geiger, S.J. Jefferies, and S.D. Treaty. 1981. *Marine mammal-fisheries interactions on the Columbia river and adjacent waters*, 1980. Report, 109 p., Available from Wash. State Dep. Wildlife. 600 Capitol Way N., Olympia, WA 98504.

Comment Future candidate for researching call number & location, acquisition. review. and annotation.

REFERENCE # 032

Fisher, J.P. and W.G. Pearcy. 1988. *Growth of juvenile coho salmon (*Oncorhynchus kisutch*) in the ocean off Oregon and Washington, U.S.A., in years of differing coastal upwelling*. Can. J. Fish. Aquat. Sci. 45: 1036-1044. SH1 . C366, Fish and Ocean Library, U of W.

Comment Future candidate for acquisition. review, and annotation.

REFERENCE # 033

Fox, D.S. Bell, W. Nehlsen, and J. Damron. 1984. *The Columbia River estuary: Atlas of physical and biological characteristics*. Lincoln and Allen, Co., Portland, OR, 84 p. G 1466. DI C6 1984, Fish and Ocean Library, U of W; Note: Library Use Only .

Comment Future candidate for acquisition. review, and annotation.

REFERENCE # 034

Frey, B.E., J.R. Lara-Lara, and L.F. Small. 1983. *Reduced rates of primary production in the Columbia River estuary following eruption of Mt. St. Helens on May 18, 1980*. Estuarine Coastal Shelf Sci. 17:213-218. GC96. E89. Fish and Ocean Library, U of W.

Comment Future candidate for acquisition. review, and annotation.

REFERENCE # 035

Frey, B.E., L.F. Small, and J.R. Lara-Lara. 1984. *Water column primary production in the Columbia River estuary*. Columbia River Estuary Data Development Program. Astoria, OR.. 133 p. QH541.5. E8 F73 1984. Fish and Ocean Library, U of W.

Comment Future candidate for acquisition. review. and annotation.

REFERENCE # 036

Furota, T., and R.L. Emmett. 1993. *Seasonal changes in the intertidal and subtidal macrobenthic invertebrate community structure in Baker Bay, lower Columbia River estuary*. Northwest and Alaska Fisheries Center, Seattle, Coastal Zone & Estuarine Studies; Processed Report, 31 p. SH1 1 .A365B no. 5. NMFS Montlake Library. Northwest Fisheries Science Center. 2725 Montlake Blvd. E., Seattle. WA 98112.

Comment Future candidate for acquisition, review. and annotation.

REFERENCE # 037 Gelfenbaum, G. 1983. *Suspended sediment response to semidiurnal and fortnightly tidal variations in a mesotidal estuary Columbia River, U.S.A.* Mar. Geology 52:39-57. QE500 M3 , Fish and Ocean Library, U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 038

Good, J-W., and D. Jay. 1977. *Columbia River estuary freshwater resources*. In M.H. Seaman (editor), *Columbia River estuary, inventory of physical, biological and cultural characteristics*, Sect. 202-1 to 202-I 8. Columbia River Estuary Data Development Program. GC860. C6 C66 1977, Fish and Ocean Library, U of W; or PNL-036, Battelle Pacific Northwest Laboratory, Richland, WA.

Annotation Authors describe the freshwater resources of the Columbia river estuary in terms of the total discharge of the Columbia river near Astoria, and the flow contribution of tributaries to Columbia river within the reach between Astoria, OR and Vancouver, WA. Present information for the total discharge of the Columbia near Astoria and estimate of estuarine tributary flow (-3.5 % or 9000 cfs of the total annual average) , based on monthly discharge data for the years 196 1- 1975. Selected data for Columbia river estuary tributary streams are illustrated. Streams listed as tributary to the Columbia estuary are: Skipanon river. Lewis & Clark river, Youngs river, John Day river, Big creek, Hunt creek, Gnat creek-Blind Slough, Plimpton creek, Grays river, Deep river, Skamokawa creek. Alder creek. Wallucut river, and Chinook river.

REFERENCE # 039

Haertel, L.S. 1970. *Planbon and nutrient ecology of the Columbia River Estuary*. Ph.D. Dissertation, Oregon State Univ., Corvallis, 71 p.

Comment Future candidate for researching call number & location, acquisition, review, and annotation

REFERENCE # 040

Haertel. L.S.. and L.C. Osterberg. 1967. *Ecology of zooplankton, benthos and fishes in the Columbia River estuary*. Ecology 48:459-472. 570.5 EC, Fish and Ocean Library & Nat. Sciences Libraries. U of W.

Annotation Authors present analytic results for 2 1 months of sampling of fauna (plankton, benthic invertebrates, and fishes) in the Columbia river estuary (Harrington Point, Astoria, and Chinook Point) during the period of 7 October 1963 - 14 July 1965. Information on invertebrate fauna of the Columbia river estuary are presented by: species type, season (spring, summer, fall. or winter) and salinity category (limnetic, oligohaline, mesohaline, polyhaline or euhaline); and species type. length frequency, salinity distribution, food habits (prey selection) for fish species are given.

REFERENCE # 041

Haertel. L.S.. L.C. Osterberg. H. Curl, and P.K. Park. 1969. *Nutrient and plankton ecology of the Columbia River estuary*. Ecology 50:962-978. 570.5 EC, Fish and Ocean & Library Nat. Sciences Libraries. U of W.

Annotation Authors present analytical results for 16 months of seasonal water sampling to acquire data regarding physical and chemical characteristics, nutrients, phytoplankton, and zooplankton in the Columbia river estuary during 1967 and 1968. Information shows the distribution of nutrients. phytoplankton, and zooplankton with respect to season and salinity, and also illustrates the interrelationships between plankton and nutrients.

REFERENCE # 042

Hazel, C.R. 1984. *Avifauna of the Columbia River estuary*. Columbia River Estuary Data Development, Astoria, OR. 85 p. QH541. E8 A95 1984, Fish and Ocean Library. U of W; or PNL-042. Battelle Pacific Northwest Laboratory, Richland. WA.

Annotation Author presents and describes information regarding key avian species and their associated habitat. key avian habitats and their avian species composition and food habits of key avian species within the Columbia river estuary. Tables and graphics are used to illustrate the spatial and temporal distribution of key avian species. and their associated habitats and food habits.

REFERENCE # 043

Hickson, R.E. 1922. *Changes in the mouth of the Columbia River 1903 to 1921*. Military Engineer. 14 (76), 211-214,257-258. 623.05 M. Kane Hall Auxiliary. U of W; or PNL-043. Battelle Pacific Northwest Laboratory, Richland, WA.

Annotation The author discusses the project to provide a 40 ft. deep and -1/2 mile wide channel at the mouth of the Columbia river. Discusses the history of jetty and dredging projects at the Columbia river mouth. Provides contour illustrative maps of the Columbia river estuary in the vicinity of Clatsop Spit and Sand Island during the periods of 1904- 1909. 1909- 19 13. 1913- 1917. and 19 17- 192 1; and cross-sections of the Columbia river bar at several locations for 1904. 1913. 1917. and 192 1. Briefly discusses the hydraulics and environment factors affecting materials(estimate of particle sizes) movement and deposition. Mentions the net effects of the north jetty as a stabilizing influence on conditions at the mouth of the Columbia river- pp. 2 11- 214 & 257-258

REFERENCE # 044

Hickson, R.E. 1930. *Shoaling on the lower Columbia River*. Military Engineer. 22 (123J.2 17- 219. 623.05 M. Kane Hall Auxiliary U of W.

Annotation Author provides brief summary of the physical and hydraulic characteristics of the lower Columbia river (Portland' Vancouver to the sea). Discusses and provides conclusions regarding the physical characteristics. movement and deposition of materials that effect shoaling (nature of and cause)- pp. 2 17-2 19.

REFERENCE # 045

Hickson, R.E. 196 1. *Columbia River ship Channel improvement and maintenace*. Proceedings of the American Society of Civil Engineers. Journal of the Waterways and Harbors Division. 87. 13. 7 1-93. paper 2883. TC 1. A42. Engineers Libray. U of W

Comment Future candidate for acquisition. review. and annotation.

REFERENCE # 046

Hickson, R.E. 1965. *Columbia River stabilization and improvement for navigation. Chapter Iv*. In: Symposium on Channel Stabilization Problems. Tech.Rep.No.1.. Vol.3. L'S Army Engineers. Waterways Experiment Station, Vicksburg. Mississippi. pp.IV-1 to IV-1 7. 8 plates. Z 8553. H9 US. Fish and Ocean Library. U of W.

Comment Future candidate for acquisition. review. and annotation.

REFERENCE # 047

Hickson, R.E. and F. W. Rodolf. 1950. *Case history of Columbia River jetties*. Presented by R.E. Hickson and F.W. Rodolf, Portland, Oregon District, Corps of Engineers, U.S. Army Portland 5, Oregon, at the Municipal Auditorium Long Beach. California October 1 1-1 3, 1950. PNL-047, Battelle Pacific Northwest Laboratory, Richland, WA.

Annotation Authors present 1) a brief description of the characteristics (watershed, hydrology, physiography and physical oceanography) for the Columbia river and its mouth/estuary prior to improvements; 2) history of the south jetty; 3) history of the north jetty; 4) shore changes south of the South Jetty; 5) shore changes north of the North Jetty; and 6) changes in the entrance since construction of the jetties. Includes bathymetry maps to illustrate changes at the Columbia river mouth.

REFERENCE # 048

Hinton, S.A., R.L. Emmett, and G.T. McCabe. 1992. *Benthic invertebrates and sediment characteristics in subtidal habitats at Rice Island, Columbia River estuary, December 1991 and March 1992*. Northwest and Alaska Fisheries Center, Seattle, Coastal Zone & Estuarine Studies; Report to the U.S. Army Corps of Engineers, contract E96920018,22 p. SHI53.Un5 16 1992, NMFS Montlake Library, Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA98112.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 049

Hinton, S.A., G.T. McCabe, and R.L. Emmett. 1990. *Fishes, benthic invertebrates, and sediment characteristics in intertidal and subtidal habitats at five areas in the Columbia River Estuary*. Northwest and Alaska Fisheries Center, Seattle, Coastal Zone & Estuarine Studies; Report to the U.S. Army Corps of Engineers, Contracts E86880158, E86890107, and E86900048.92 p. SHI53.Un5 14, NMFS Montlake Library, Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 050

Hinton, S.A. R.L. Emmett, and G.T. McCabe. 1992. *Fishes, shrimp, benthic invertebrates, and sediment characteristics in intertidal and subtidal habitats at Rice Island and Miller Sands, Columbia River estuary, 1991*. Northwest and Alaska Fisheries Center, Seattle, Coastal Zone & Estuarine Studies; Report to the U.S. Army Corps of Engineers, Contract E96910025. 53 p. SHI53.Un5 16, NMFS Montlake Library, Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 05 1

Holton. R.L., D.L. Higley, M.H. Brzezinski, K.M. Jones, and S.L. Wilson. 1984. *Benthic infauna of the Columbia River estuav*. Columbia River Estuary Data Development Program, Astoria . OR. 179 p. QH541.5. E8 B46 1984, Fish and Ocean Library, U of W; or PNL-05 1. Battelle Pacific Northwest Laboratory, Richland, WA.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 052

Jaske. R.T.. J.B. Goebel. 1967. *Effects of dam construction on temperatures of the Columbia River*. J. Am. Water Works Assoc. 59:935-942. 628.06 Am 3j, Engineering Library, U of W.
Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 053

Jay. D. 1984. *Circulatory processes in the Columbia River Estuary*. Columbia River Estuary Data Development Program. Astoria . OR. 169 p. QH541.5. E8 C49 1984. Fish and Ocean Library. U of W.

Annotation Author provides comprehensive information on the physical oceanography of the Columbia river estuarine, with respect to six areas: theory of estuarine circulation, tidal processes. system energetics. salinity distribution. salt transport, and low-frequency flow processes. Extensive tables and graphics illustrate the processes and dynamics of the Columbia river estuary with respect to its physical oceanography.

REFERENCE # 054

Jay. D. 1977. *Columbia River estuarine nutrients, mixing, and water quality*. In M.H. Seaman (editor). Columbia River Estuary. inventory of physical, biological, and cultural characteristics. Sect. 205-1 to 205-38 Columbia River Estuary Data Development Program. GC860. C6 C66 1977. Fish and Ocean Library. U of W.

Annotation Author presents an examination. information and illustrations of the seasonal and spatial characteristics for the physical, biological, chemical and cultural processes governing the concentrations of nutrients, dissolved oxygen, suspended particulate matter and pollutants in the Columbia river, its estuary, and the adjacent ocean waters. This presentation includes the following categories:

- A. Chemical budgets of the Columbia river. in terms of (1) Sources of variability, (2) Limiting factors in primary productivity, and (3) Nutrient ratios and limiting factors;
- B. Mixing of water masses and the spatial distribution of nutrients and particular matter. in terms of (1) Water mass analysis, (2) Mixing processes at the mouth of the Columbia river, (3) Nutrient distribution, transport and utilization, and (4) Cycling of particulate organic matter; and
- C. Water quality. in terms of (1) Water quality management in Washington & Oregon, and (2) Municipal and industrial waste.

REFERENCE # 055

Jay. D.A. and J.D. Smith. 1990. *Circulation density distribution, and neup-spring transitions in the Columbia River Estuary*. Progress in Oceanography. 25. 8 1-1 12 55 1.4605 PR, Fish and Ocean Library. U of W.

Annotation Authors provide an understanding of the dynamics and processes associated with water circulation (saltwater and freshwater) within the present day Columbia river estuary. Reference includes the following sections: Velocity Fields (tidal currents & residual flow). Salinity Distribution. Salt Transport (seasonal, temporal, and spatial)- Clatsop Spit & Upper Estuary.

REFERENCE # 056

Jay, D.A., B. Giese, and C.R. Sherwood. 1990. *Energetics and sedimentary processes in the Columbia River Estuary*. Progress in Oceanography, 25, 157- 174. 55 1.4605 PR, Fish and Ocean Library, U of W

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 057

Jones, K.K., L.A. Simenstad, D.L. Higley and D.L. Bottom. 1990. *Community structure, distribution, and standing stock of benthos, epibenthos, and plankton in the Columbia River Estuary*. Progress in Oceanography, 25, 211-241. 551.4605 PR, Fish and Ocean Library, U of W; or PNL-057, Battelle Pacific Northwest Laboratory, Richland, WA.

Annotation Authors provide information regarding the structure, distribution, and standing crop of benthic infauna, epibenthic fauna, zooplankton, and larval fishes in the various estuarine zones (3 salinity zones)/habitats (six types) of the Columbia river. based on 1980-1981 sampling of the Columbia river estuary. Provide 1) figures illustrating the spatial and temporal distribution of secondary producers in the tidal-fluvial, estuarine mixing, and plume & ocean zones, and 2) a table listing type and distribution (zone) of abundant invertebrate taxa in the Columbia river estuary (1980-81).

REFERENCE # 058

Judson, S. and D.F. Ritter. 1964. *Rates of regional denudation in the United States*. Journal of Geophysical Research, 69, 3395-3401. 538.705TE , Fish and Ocean Library, U of W; or PNL-058, Battelle Pacific Northwest Laboratory, Richland, WA.

Annotation Authors describe and present data regarding the rate of denudation various watersheds/regions within the United States. The lowest rate of denudation was found in the Columbia basin. Denudation is a factor measured in inches per thousand years, and is equal to a constant times the weight of annual sediment production per unit area of the drainage basin.

REFERENCE # 059

Jefferies, S.J., S.D. Treaty, and A.C. Geiger. 1984. *Marine mammals of the Columbia River estuary*. Columbia River Estuary Data Development Program, Astoria, OR. 62 p. QH541.5. E8 M37 1984, Fish and Ocean Library, U of W

Annotation Authors describe the seasonal distribution, abundance and feeding habits of pinnipeds (the harbor seal, California sea lion and Northern sea lion) in the Columbia river estuary. Primary and secondary prey of harbor seal and sea lion species are identified and quantified.

REFERENCE # 060

Johnsen, R.C., and C. W. Sims. 1973. *Purse seining for juvenile salmon and trout in the Columbia River estuary*. Trans. Am. Fish. Soc. 102:341-345. 639.2 AM. Fish and Ocean Library, U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 061

Jones, K.K., D. Bottom, and J. Lichatowich. 1984. *Zooplankton and larval fishes of the Columbia River estuary*. Columbia River Estuary Data Development Program, Astoria, OR. 36 p. QH541.5. E8 266, Fish and Ocean Library, U of W; or PNL-061, Battelle Pacific Northwest Laboratory, Richland, WA.

Annotation Authors provide information regarding the assemblages (three taxa categories), and distribution & abundance (temporal and spatial) of zooplankton, and types and temporal presence of larval fishes/eggs within the Columbia river estuary, based on sampling data of 1980- 1981. Figures and tables illustrate the types, composition, distribution, and seasonal abundance of zooplankton and larval fishes/eggs within the marine (RM-5 to RM- 10), mixing (RM- 10 to RM- 18) and freshwater (RM- 18 to RM-23) estuarine zones.

REFERENCE # 062

Lancaster, Samuel C. 1915. *The Columbia America's great highway*. Press of Kilham Stationary and Printing Company, Portland, Oregon. Copyright, 1915. in Great Britain. 625.7L22. Natural Sciences Library, General Stacks, U of W.

Annotation Author provides a general history of the Columbia basin, in terms of the human activities along the Columbia river. Excellent color photographs of the various locations along the Columbia river, viewed from the old Columbia highway route, are presented; illustrates various morphological attributes, habitat structure, etc. of these locations, situated on the lower Columbia river (Cascades area to Astoria).

REFERENCE # 063

Kujala, N. 1976. *Columbia Riverfishes and invertebrates*. Unpubl. manuscript. 16 p. (Available from Columbia River Estuary Study Taskforce. P.O. Box 175, Astoria, OR 97103)

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 064

Lara-Lara J.R., B.E. Frey, and L.F. Small. 1990. *Primary production in the Columbia river estuary. I. Spatial and temporal variability*. Pac. Sci. 44: 17-37. 505 PA. Fish and Ocean Library, U of W.

Comment Future candidate for acquisition, review, and annotation

REFERENCE # 065

Lara-Lara, J.R., B.E. Frey, and L.F. Small. 1990. *Primary production in the Columbia river estuary II. Grazing losses, transport, and a phytoplankton carbon budget*, Pac. Sci. 44:38-50 505 PA, Fish and Ocean Library, U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 066

Lincoln, J.H., and R.F. Foster. 1943. *Report on investigations of pollution in the lower Columbia River*. Washington State Pollution Commission and Oregon State Sanitary Authority.

143 p. (Available from Oregon Dep. Environmental Quality, 522, S.W. 5th, Portland, OR 97201).

Comment Future candidate for researching call number & location, acquisition, review, and annotation

REFERENCE # 067

Loch, J.J., and D.R. Miller. 1988. *Distribution and diet of sea-run cutthroat trout captured in and adjacent to the Columbia River plume, May-July 1980*. Northwest Sci. 62:41-48. 505NS, Forestry Library & Natural Sciences Libraries, U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 068

Lockett, J.B. 1959. *Interim considerations of the Columbia River entrance*. Paper 1902, Proceedings of the American Society of Civil Engineers, Journal of the Hydraulics Division, 85, HY-1, 17-40. TC 1. A39, Engineering Library, U of W; or PNL-068, Battelle Pacific Northwest Laboratory, Richland, WA.

Annotation Author provides the factors and considerations related to provision and maintenance of suitable channel of 48 ft depth and 0.5 mile width for entrance through the mouth of the Columbia river at mean lower low tide. **Presents** an excellent historical synopsis of the alterations to the Columbia river entrance and the river's channel from its mouth to the mouth of the Willamette river (RM 117.5); it includes project dates and description. Discusses various factors associated with the problem of maintaining the river entrance and channel according to specifications for navigation purposes; factors discussed are: river stage & discharge, wave action, sediment, littoral forces, currents, salinity and temperature. Includes many figures that illustrate factors discussed; these figures include:

- 1) bathymetric charts of the river entrance (1902, 1927 & 1957);
- 2) amount of cubic yards (and costs) dredged at the river mouth (1939-1958);
- 3) tidal & river discharge characteristics at the river mouth (1932);
- 4) wind effect on wave action (direction and %);
- 5) current velocity (time of measurement & ft/sec);
- 6) salinity (station, depth, and concentration); and
- 7) sediment (date & grain size).

Note: Reference provides a good historical synopsis for project altering the channel in the Columbia river estuary.

REFERENCE # 069

Lockett, J.B. 1962. *Phenomena affecting improvement of the lower Columbia River Estuary and entrance*. Presented at 8th Conference on Coastal Engineering, Mexico City, Mexico. U.S. Army, Corps of Engineers, Portland Division, Portland, OR, p. 695-755. 627.06 C76p1962, Fish and Ocean Library, U of W; or PNL-069, Battelle Pacific Northwest Laboratory, Richland, WA.

Annotation Author provides an introduction describing the Columbia river in terms of physical characteristics, run-off pattern, and role in economic development (includes table illustrating ocean borne commerce, in tons, by type and year). Describes the characteristics of the estuary in

terms of its extent and tidal influence (includes figures on of lower Columbia estuary and entrance)- pp. 695-700.

Provides history of Columbia estuary in terms of: 1) physical characteristics prior to improvements (includes maps of Admiral Vancouver and Sir Edward Belcher), 2) the 30 foot entrance project, authorized by Congress in 2 August 1882 (construction of the 4.5 mile south jetty and groins), 3) the 40 foot entrance project, furnished under the River and Harbors Act of March 3, 1905 (extension of the south jetty, and construction of a north jetty and groins), and 4) the 48 foot entrance project, in 1954 (provided 48 ft. deep channel throughout the 1/2 mile wide channel and construction of Jetty b)- pp. 700-709.

Notes experiences in construction, maintenance, and measurements and data acquisition (physical, chemical), salinity intrusion, shoaling & littoral processes. Discusses long-term trends of the Columbia river estuary, in terms of offshore and estuarine scour and shoal. Provides synopsis of various studies of the physical dynamics of the Columbia river estuary and associated natural processes and man-made structures- pp. 710-754

Includes numerous figures illustrating the physical and topographic characteristics of the Columbia river estuary during the 19th and 20th centuries.

REFERENCE # 070

Lockett, J.B. 1963. *Phenomena affecting improvement of the lower Columbia River Estuary and entrance*. Prepared for Federal Interagency Sedimentation. I.W.C.R., Jackson, Mississippi, 51 pp. QE58 I. F4 . Fish and Ocean Library, U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 071. Lockett, J.R. 1967. *Sediment transport and diffusion: Columbia Estuary and entrance* Proceedings of the American Society of Civil Engineers, Journal of the Waterways and Harbors Division. 93. WW-4. 167-175. TC 1. A42, Engineering Library, U of W.

Comment Future candidate for acquisition. review, and annotation.

REFERENCE # 072

Lutz, G.A.. and D.W. Hubbell. and H.H. Stevens. 1975. *Discharge and flow distribution, Columbia River estuary*. U.S. Geol. Survey Prof. Paper 433-P. U.S. Gov. Printing Office. Wash., D.C.. 31 p. 557.3 Un 3p. Engineering Library, U of W; or PNL-072, Battelle Pacific Northwest Laboratory, Richland. WA.

Annotation Authors present and describe results for discharge and flow distribution data of the Columbia river estuary at river miles 53.3 and 14.0 during the period of 1968-70.

REFERENCE # 073

McIntire, C.D.. and M.C. Amspoker. 1984. *Benthic primary production in the Columbia River estuary*. Columbia River Estuary Data Development Program, Astoria, OR. 103 p. QH541.5. E8 M29 1984, Fish and Ocean Library, U of W.

Annotation Authors determine and provide information on benthic primary production in the Columbia river estuary, with respect to mechanisms that control the production dynamics and species composition of benthic plant assemblages. Particular emphasis of their work was focused

on the effects of selected physical variables on structural and functional attributes of micro- and macro- vegetation, and on the biomass of benthic autotrophs of the estuarine tidal flats.

REFERENCE # 074

McCabe, G.T., and S.A. Hinton. 1990. *Benthic infauna and sediment characteristics in the Columbia River near Westport, Oregon, August 1989*. Northwest and Alaska Fisheries Center, Seattle, Coastal Zone & Estuarine Studies; Final report to U.S. Army Corps of Engineers, Contract ES68901 54, 10 p. QH104.5. N6 M39, 1990, Fish and Ocean Library, U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 075

McColgin, I. (editor). 1979. *Columbia River Estuary regional management plan*. Columbia River Estuary Data Development Program, Astoria, OR. HD1695. C73 C7 1979, Engineering Library (U of W; or PNL-075, Battelle Pacific Northwest Laboratory, Richland, WA.

Annotation The reference provides the results of planning work by the Columbia River Estuary Study Taskforce, local, state, federal and private entities regarding needs/concerns with respect to preservation of natural resources in the Columbia river estuary. The plan includes: Background (Part I), Regional Policies (Part 2). Management System and Development Standards (Part 3), Land and Water Use Plan (Part 4), Dredged Material Management Plan (Part 5), Restoration and Mitigation Plan (Part 6) Implementation (Part 7), and Appendices.

Note: Excellent reference containing all elements of a comprehensive resources management plan during this period.

REFERENCE # 076

McConnel, R.J., J.T. Durkin, D.A. Misitano, and H.R. Sanbom. 1973. *Checklist of aquatic organisms in the lower Columbia and Willamette Rivers*. Northwest and Alaska Fisheries Center, Seattle, Coastal Zone & Estuarine Studies; NWAFC Processed Rep., 5 p. Reprint File, NMFS Montlake Library. Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112.

Comment Future candidate for acquisition, review, and annotation

REFERENCE # 077

MacDonald, K.B. 1984. *Tidal marsh plant production of the Columbia River estuary*. Columbia River Estuary Data Development Program, Astoria, Oregon, 108 p. QH541.5. E8 T52 1984, Fish and Ocean Library, U of W; or PNL-077. Battelle Pacific Northwest Laboratory, Richland, WA.

Annotation The author describes the species composition, standing crop, and production dynamics of extensive areas of tidal marsh vegetation that fringe the shores of the Columbia river estuary and form many of its islands. Provides information on the abundance & production/decomposition rates (spatial and temporal) for species in the tidal marsh areas. Extensive illustrations (figures and tables) describe the types, distribution, percent cover. above-ground biomass for species (67) collected from 22 tidal marsh study sites in July 1980 and August 1981.

REFERENCE # 078

McIntire, C.D., and M.C. Amspoker. 1986. *Effects of sediment properties on benthic primary production in the Columbia River estuary*. Aquat. Botany. 24:249-267. QK102. A65, Fish and Ocean Library, U of W.

Comment Future candidate for acquisition, review. and annotation

REFERENCE # 079

McCabe. G.T.. W.D. Muir. R.L. Emmett. and J.T. Durkin. 1983. *Interrelationships between juvenile salmonids and nonsalmonid fish in the Columbia River estuary*. Fish. Bull., U.S. 81:815-826. 597 Un3. Fish and Ocean Library. U of W

Comment Future candidate for acquisition, review. and annotation.

REFERENCE # 080

McGavock, E.H.. P.R. Boucher, W.D. Wiggins, L.L. Reed. R.L. Blazs. and M.L. Smith. 1985. *Water Resources Data, Washington Water Year 1984*. USGS Water-Data Rep. WA-84. 427 p. GB 1225. W2A4. Fish & Ocean Libra?, U of W

Annotation Authors present river gaging information for water year 1984. including that for the Columbia river estuary at: 1) Longview, WA (monthly daily)-p. 380-381; and 2) Vancouver. WA, St Helen. OR. & near Astoria. OR (average monthly)- p. 382.

REFERENCE # 081

Misitano, D.A. 1977. *Species composition and relative abundance of larval and post-larval fishes in the Columbia River estuary*. Fish. Bull., U.S. 75:2 18-222. 597 Un3. Fish and Ocean Library, U of W.

Comment Future candidate for acquisition. review. and annotation.

REFERENCE # 082

Moore. C.R. and R.E. Hickson. 1939. *The lower Columbia River*. Military Engineer. 3 I(175). 19-23. 623.05 M, Kane Hall Auxiliary Stacks, U of W: or PNL-082. Battelle Pacific Northwest Laboratory. Richland. WA.

Annotation Author provides a historical account of the early discover/mapping of the Columbia river mouth. Generally describes the channel(s) conditions (physical and location) in 19th century. Illustrates and describes the conditions & dynamics of the Columbia entrance in 1851, in 1885 prior to construction of the south jetty, in 1913 after construction of the south jetty. and in 1937 prior to reconstruction of the north jetty and construction of jetty 'A'. Also discusses the dynamics (natural and man-induced) of Sand Island with respect the hydraulic and environmental factors. Discusses the: Jetty A and North Jetty Repair projects. River Channel Improvement project, Flood Control program, and military fortification project. The Flood Control program calls for construction of 23.1 miles of levee embankment, of pumping/tide boxes. excavation of drainage ditches. and pile dikes/bank revetments; the total cost of the program was estimated at \$7,293,000 and would furnish protection to 98,870 acres of land located along the Columbia river and its tributaries. Aerial photographs of the North Jetty. South Jetty. and Sand Island are included- pp. 19-23.

REFERENCE # 083

Neal, V.T. 1972. *Physical aspects of the Columbia River and its estuary*. In A.T. Pruter and D.L. Alverson (editors), *The Columbia River Estuary and adjacent ocean water*, P. 19-40. Univ. Washington Press, Seattle. TD 427. R3 C64, Fish and Ocean Library U of W.

Annotation Author provides a synopsis of the Columbia river in terms of its topography, climate, river flow, hydroelectric projects. navigation, geomorphology, saltwater intrusion, estuarine classification, wave effects, and flushing & pollution distribution.

REFERENCE # 084

Orem, H.J. 1963. *Discharge in the lower Columbia River basin, 1928-65*. USGS Circular 550, 24 p. QE 75. C5, Natural Sciences Library, U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 085

Oregon State University. 1975. *Physical characteristics of the Youngs Bay Estuarine Environs*. Report submitted to the ALUMAX Pacific Aluminum Corporation by the School of Engineering. Oregon State University, Corvallis, Oregon, 149 pp.

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 086

Park, P.K., M. Catalfomo, G.R. Webster, and B.H. Reid. 1970. *Nutrients and carbon dioxide in the Columbia River*. *Limnol. Oceanogr.* 15:70-79. 591. 9205 LI, Fish and Ocean Library, U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 087

Park, P.K., C.L. Osterberg, and W.O. Worster. 1972. *The chemical budget of the Columbia River*. In A.T. Pruter and D.L. Alverson (editors), *The Columbia River estuary and adjacent ocean waters*, p. 123-134. Univ. Washington Press, Seattle. TD 427. R3 C64, Fish and Ocean Library, U of W

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 088

Park, P.K., G.R. Webster, and Y. Yamamoto. 1969. *Alkalinity budget of the Columbia River*. *Limnol. Oceanogr.* 14:559-567. 591. 9205 LI, Fish and Ocean Library, U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 089

Petts, G.E. 1987. *Time-scales for ecological change in the regulated rivers*. In J.F. Craig and J.B. Kemper (editors), *Regulated streams*, p. 257-266. Plenum Press, New York. QH 541.5 S7157 1985, Fish and Ocean Library, U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 090

Pruter, A.T. 1972. *Review of commercial fisheries in the Columbia River and contiguous ocean waters*. In A.T. Pruter and D.L. Alverson (editors). The Columbia River estuary and adjacent ocean waters, p. 81-120. Univ. Washington Press. Seattle. TD 427. R3 C64. Fish and Ocean Library, U of W

Annotation Author provides a synopsis of important commercial fisheries in the Columbia river and adjacent northeastern Pacific ocean waters. Fisheries are categorized as species resident to the Columbia river. Columbia river anadromous species, and species resident in the adjacent ocean waters. Provides a brief history of the fisheries and commercial landing statistics. dating from the 19 th century.

REFERENCE # 091

Renfro, W.C., W.O. Forster, and C.L. Osterberg. 1972. *Seasonal and areal distributions of radionuclides in the biota of the Columbia River estuary*. In A.T. Pruter and D.L. Alverson (editors). The Columbia River estuary and adjacent ocean waters. p. 777-798. Univ. Washington Press, Seattle. TD 427. R3 C64. Fish and Ocean Library, U of W.

Annotation Authors provide information regarding the seasonal and areal distributions of radionuclides (Hanford origin) in the plankton (phytoplankton & zooplankton). starry flounder (*Platichthys stellatus*). sand shrimp (*Crangon franciscorum* Stimpson). and staghorn sculpin (*Leptocottus armatus* Girard) in the Columbia river estuary.

REFERENCE # 092

Roy, E.H., J.S. Creager, S.R. Walter and J.C. Borgeld. 1979. *An investigation to determine the bedload and suspended sediment transport over the outer tidal delta and monitor the sedimentary environment of sites E and D near the mouth of the Columbia River*. Final Report, December 1979. US Army. Corps of Engineers, Portland District, Portland, Oregon. 37 pp. figures. appendices.

Comment Future candidate for researching call number & location. acquisition. review. and annotation.

REFERENCE # 093

Roy, E.H., J.S. Creager, G. Gelfenbaum, C.R. Sherwood, and R.J. Stewart. 1982. *An investigation to determine sedimentary environments near the entrance to the Columbia River estuary*. Final Report. June 1982. US Army Corps of Engineers. Portland District. Portland. Oregon. 64 pp. figures appendices.

Comment Future candidate for researching call number & location. acquisition, review. and annotation.

REFERENCE # 094

Sanborn, H.R. 1973. *A list of henthic animals in the lower Willamette and Columbia River, August to October 1977* Northwest and Alaska Fisheries Center. Seattle. Coastal Zone & Estuarine Studies: NWAFC Processed Rep., 6 p. QH541.5. E8 S42 1984. Fish and Ocean Library. U of W.

Comment Future candidate for acquisition. review. and annotation.

REFERENCE # 095.

Sherwood, C.R., J.S. Creager, E.H. Roy, G. Gelfenbaum, and T. Dempsey. 1984. *Sedimentary processes and environments in the Columbia River estuary*. Columbia River Estuary Data Development Program, 183p. QH541.5. E8 S42 1984, Fish and Ocean Library, U of W.
Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 096

Sherwood, C.R., D.A. Jay, R.B. Harvey, P. Hamilton, and C.A. Simenstad. 1990. *Historical changes in the Columbia River estuary*. Prog. Oceanogr. 25:299-352. 551.4605 PR, Fish and Ocean Library. U of W; or PNL-096, Battelle Pacific Northwest Laboratory, Richland, WA.
Annotation Authors provide a comprehensive **synopsis of the historical & ages in the** hydrology, sedimentology, and physical oceanography of the Columbia river estuary. This history is based on: 1) Comparison of data digitized from U.S Coast and Geodetic Survey bathymetric surveys of 1867-75, 1926-37, and 1949-58, of the Columbia river estuary; and 2) Analyses of river discharge data for seasonal flow cycle. The reference includes the following sections: Historical Background (Jetty construction, and dredging activities), Fluvial Inputs, Changes in the Morphology of the Estuary, Analysis of Historical Circulation Patterns, Physical Effects of Changes in Morphology and Circulation, and Historic Changes in Ecosystem Structure and Processes. Include figures and tables illustrating the history of changes and alterations to the hydrology, bathymetry/morphology, and physical characteristics of the Columbia river estuary. Reference includes extensive literature listing.

REFERENCE # 097

Sherwood, C.R. and J.S. Creager. 1990. *Sedimentary geology of the Columbia River estuary*. Progress in Oceanography, 25, 15-79. 55 1.4605 PR, Fish and Ocean Library, U of W; or PNL-097, Battelle Pacific Northwest Laboratory, Richland, WA.
Annotation Authors provide a comprehensive overview for the sedimentary geology of the Columbia river estuary, with respect to sediment distribution, bedform distribution, suspended sediment distribution. based on over 2000 bottom samples. General sections of this reference include: Physical & Geological Setting, Previous Studies of Geological Processes, Suspended Sediments. Bottom Sediments, Bedforms & Large-Scale Morphology, and Sedimentary Environments. Extensive reference list included.

REFERENCE # 098

Sherwood, C.R., J.S. Creager, E.H. Roy, G. Gelfenbaum and T. Dempsey. 1984. *Sedimentary processes and environments in the Columbia River Estuary*. Columbia River Estuary Data Development Program. Columbia River Estuary Study Taskforce, Astoria, Oregon 3 17 pp. QH541.5. E8 S42 1984, Fish and Ocean Library, U of W.

Annotation Authors present information for:

- 1) the processes of sediment erosion, transportation, and deposition in the Columbia river estuary (saltwater intrusion zone), and the importance of these processes relative to the variety of temporal and spatial scales found in the estuary; and
- 2) characterization of the present geological conditions of the Columbia river estuary.

The reference includes information regarding:

- 1) the characterization of the estuary with respect to plate tectonics, sea level, sediment supply, hydrography, and physical oceanography;
- 2) estuarine bottom sediments with respect to grain size and mineralogy;
- 3) estuarine bedforms with respect to bathymetry and aerial photographs; and
- 4) estuarine suspended sediments with respect to spatial variability of grain size.

Includes extensive literature list.

REFERENCE # 099

Shippen, H. 1954. *Columbia River survey, ecological section*. Final report to the U.S. Fish Wildl. Serv., contract 14- 19-008-2220. 178 p. 27996. F5 S56 1954. Fish and Ocean Library, U of W. Annotation Author provides a listing of fish species reported in the Columbia river drainage. based on various published and unpublished references; associates fish species with reference sources contained in listing of abstracts/annotations. These references within the abstracts/annotations section of this report contain information regarding species description. distribution. habitat. food habits. reproduction. and predation. Some but limited information for fishes species inhabiting the estuarine zones of the Columbia river. Note: Excellent Source For Old References Regarding the Fish Species and Habitat (including anadromous salmonids) within the Columbia River Basin.

REFERENCE # 100

Simenstad. C.A. 1984. *Epibenthic organisms of the Columbia River estuary*. Columbia River Estuary Data Development Program. 55 p. QH 541.5. E8 S55 1984. Fish and Ocean Libra?. U of W; or PNL-100. Battelle Pacific Northwest Laboratory, Richland. WA. Annotation Author provides comprehensive information (spatial and temporal) for cpibenthic organisms/zooplankton (harpacticoid copepods. gammarid amphipods. and cumaceans). which occur in the Columbia river estuary. primarily within tidally inundated region (>0.0 m above MLLW) of the tidal flats and along the demersal slope habitats between 0.0 m and -1.0 m elevations. Extensive tables and graphics are provide to illustrate spatial and temporal occurrence and inhabitation of benthic infauna within the Columbia river estuarine zone.

REFERENCE # 101

Simenstad. C.A.. L.F. Small. C.D. McIntire. D.A. Jay. and C. Sherwood. 1990. *Columbia River estuary studies.. An introduction to the estuary, a brief history. and prior studies*, Prog. Ocean. 25: 1- 13. 55 1.4605 PR. Fish and Ocean Library. U of W; or PNL- 10 1 - Battelle Pacific Northwest Laboratory. Richland. WA. Annotation Authors provide a short synopsis on: 1) a description of the Columbia river estuary. 2) previous investigations and the Columbia River Estuary Data Development Program (CREDDP), and Definitions and Conventions in CREDDP. Figures illustrate the various regions & zones and bathymetry of the Columbia estuary. A table illustrates and quantifies the area of habitat types within each region of the Columbia estuary. Extensive reference list included.

REFERENCE # 102

Simenstad. C.A.. D. Jay. C.D. McIntire. W. Nehlsen. C. Sherwood. and L. Small. 1984. *The dynamics of the Columbia River estuarine ecosystem, Vol. I und II*. Columbia River Estuary Data

Development Program, Astoria, Oregon. 695 p. QH541.5. E8 D96 1984 V. 1 and QH541.5. E8 D86 1984 V. 2, Fish and Ocean Library, U of W; or PNL-072v1 and PNL-102v2, Battelle Pacific Northwest Laboratory, Richland, WA.

Annotation Authors present a synthesis of ecological information & data, derived the physical and biological studies carried out in the Columbia river estuary by CREDDP. The general sections of this reference are:

1. Regional setting and previous studies;
2. Circulatory processes;
3. Sedimentary geology;
4. Historical changes in Columbia river estuarine physical processes;
5. Conceptual framework for physical-biological integration;
6. Ecosystem processes; and
7. Ecosystem analyses by regions and habitat types.

REFERENCE # 103

Simenstad, C.A., D. Jay, and C.R. Sherwood. 1992. *Impacts of watershed management on land-margin ecosystems: The Columbia River estuary*. In R.J. Naiman (editor), *Watershed Management*, p. 266-306. Springer-Verlag, New York. TC 423.7. W38 1992, Fish and Ocean Library, U of W; or PNL-103, Battelle Pacific Northwest Laboratory. Richland, WA.

Annotation Based on their studies, Authors state that human alterations in watersheds, such as the Columbia river estuary, can affect the interaction between river flow and the tides, modifying circulation patterns important to estuarine food webs. Mean river flow has decreased ~ 20% since the 19th century (6% due to irrigation withdrawal and 12-14% to climate variability). River flow regulation has reduced the spring freshet flows to 50% of natural level, and has increased fall minimum flows by 10 - 50%; reduction in spring freshet has reduced the modern-day sediment input to the estuary by - 25% of that recorded in the latter part of the 19th century. Navigation structures, filling and diking in the lower river and estuary have decreased the tidal prism by - 15%, increased sediment residence time and shoaling, simplified the channel network. and concentrated flow in the navigation channel. In addition to sediment, temperature, organic matter, nutrients, pollutants, and biotic influxes at the estuarine interface, changes in river discharge regime have modified estuarine stratification, mixing, and residence time. Such modifications have had profound effects on sensitive estuarine processes such as those that occur in the estuarine turbidity maximum (ETM), where trapping of suspended material occurs. organic matter is incorporated in the dynamic microbial loop, and important food web linkages to higher level consumers occur.

Note: Excellent reference that provides a synopsis for dynamics/factors/alterations affecting the physical/chemical and biological processes of the Columbia river estuary/tidal river since the latter part of the 19th century to present.

REFERENCE # 104

Hamilton, Peter. 1990. *Modelling salinity and circulation for the Columbia river estuary*. Prog. Ocean. 25: 113-156. 551.4605 PR, Fish and Ocean Library, U of W.

Annotation Author provides information regarding mathematical simulations of the time & density dependent salinity and current fields of the Columbia river estuary, using a multi-channel, laterally averaged estuary model.

REFERENCE # 105

Simenstad, C.A., and J.R. Cordell. 1985. *Structural dynamics of epibenthic zooplankton in the Columbia River delta*. Verh. Int. Verein. Limnol. 22:2 173-218. 570.0 1 IN 8 1 V, Fish and Ocean Library, U of W.

Comment Future candidate for acquisition. review. and annotation.

REFERENCE # 106

Simenstad, C.A., L.F. Small and C.D. McIntire. 1990. *Consumption processes and food web structure in the Columbia River Estuary*. Progress in Oceanography. 25, 271-298. 55 1.4605 PR. Fish and Ocean Library, U of W.

Comment Future candidate for acquisition. review, and annotation.

REFERENCE # 107

Bonneville Power Administration. 1981. *Columbia river power for the people: a history of policies of the Bonneville Power Administration*. U.S. Department of Energy, Bonneville Power Administration. Portland, Oregon: 338 p. TK1423.7.C647 1981, Fish & Ocean Library, U of W: or PNL-I 07. Battelle Pacific Northwest Laboratory. Richland, WA.

Annotation Reference provides a comprehensive history of the Bonneville Power Administration and its activities. Includes an extensive literature cited list, legislative acts cited, and historical chronology of events. Note: Very little information regarding the Columbia river estuary included: some aerial photographs (2) of the Bonneville Dam and the Columbia river mouth (view of the north and south jetties) are included.

REFERENCE # 108

Sims, C.W., and C.J. Cederholm. 1970. *Temperature, dissolved oxygen, total alkalinity, and biochemical oxygen demand in the Columbia River estuary 1966-67*. U.S. Fish Wildl. Serv. Data Rep. 43. 34 p. MB 291. Microfiche Files. Fish and Ocean Library, U of W.

Comment Future candidate for acquisition. review. and annotation.

REFERENCE # 109

Small, L.F. and H. Curl. 1972. *Effect of Columbia River discharge on Chlorophyll a and light attenuation in the sea*. In A.T. Pruter and D.L. Alverson (editors). *The Columbia River Estuary and adjacent ocean waters*. p. 203-218. Univ. Washington Press, Seattle., WA. TD 427. R3 C64, Fish and Ocean Library U of W.

Annotation Authors discuss and correlate the seasonal effects and relationship of the Columbia river discharge (plume) on the Chlorophyll a and light attenuation in coastal waters of Oregon and Washington.

REFERENCE # 110

Small, L., CD. McIntire, K.B. McDonald, J.R. Lara-Lara, B.E. Frey, M.C. Amspoker, and T. Winfield. 1990. *Primary production, plant and detrital biomass, and particle transport in the Columbia River Estuary*. Progress in Oceanography, 25, 175-210. 55 1.4605 PR, Fish and Ocean Library, U of W.

Annotation Authors provide information on the dynamics of primary production and particulate detritus cycling in the Columbia river estuary, in terms of mechanisms/ processes that effect patterns within the water column, on the tidal flats, and in the adjacent wetlands. Reference includes the following sections: Floristic Patterns (phytoplankton, benthic algae, & vascular plants), Plant Biomass (phytoplankton, benthic algae, & vascular plants), Primary Production (phytoplankton, benthic algae, vascular plants & annual dynamics in the estuary), Import and Export of Living Plant Biomass, and Detrital Transport.

REFERENCE # 111

Stefansson. U., and F.A. Richards. 1963. *Processes contributing to the nutrient distributions off the Columbia River and Strait Of Juan de Fuca*. Limnol. Oceanogr. 9:394-410. 591.9205 LI, Fish and Ocean Library, U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 112

Thomas, D.W. 1983. *Changes in the Columbia River estuary habitat types over the past century*. Columbia River Estuary Data Development Program, Astoria, Oregon. 51 p. QH541.5. E8 T46 1983, Fish and Ocean Library, U of W; or PNL-112, Battelle Pacific Northwest Laboratory, Richland, WA.

Annotation The author provides and compares information for habitat of the Columbia river from the period predating most human interventions (circa 1870) to the present day (1980). Qualitative and quantitative changes in various estuarine habitat are described and illustrated (figures & tables) according to:

- (1) Area- river mouth, mixing zone, Youngs Bay, Baker Bay, Grays Bay, Cathlamet Bay, Upper Estuary, and Estuary;
- (2) Habitat type- deep water, medium depth, shallows/ flats, tidal marshes, tidal swamps, developed floodplain, uplands (natural & filled), non-estuarine swamp, and non-estuarine water;
- (3) Acreage by period- 1870 and present;
- (4) Change- acreage (plus or minus) and percentage;
- (5) 1870 acreage. Present estuarine acreage, estuarine area removed, and non-estuarine wetlands added.

Includes appendices providing information regarding:

- (1) Excerpts from Annual Reports of Superintendent of the U.S. Coast Survey concerning the Columbia river survey for 1868- 1873;
- (2) Verification of the U.S. Coast Survey charts;
- (3) An explanation of the boundaries of the historical subarea map;
- (4) Subarea reports for the River Mouth, Mixing Zone, Youngs Bay, Baker Bay, Grays Bay, Cathlamet Bay, and Upper Estuary;

(5) The nineteen intertidal vegetation communities of the Columbia river. with tables showing their present acreage per subarea and their former acreage and importance (Thomas, 1980).
Note: Excellent reference.

REFERENCE # 113

Engineering News-Record. 1921. **Properly constructed jetties**. Engineering News-Record. volume 86, No. 3. March 1. 1921. page 138. 620.5ENG v.9.5. Kane Hall Auxiliary Stacks. U of W.

Annotation Reference notes that prior to emplacement of jetties at the mouth of the Columbia river it was difficult to main a depth of 20 feet across the bar. and that the channel was irregular and shifting.

REFERENCE # 114 U.S. Army. Corps of Engineers. Portland District 1975 Columbia and lower \Villamette River maintenance and completion of the 40 foot navigation channel downstream of Vancouver, Washington. and Portland. Oregon Environmental Impact Statement. Portland, Oregon. 77 pp. Note: Future candidate for researching call number & location. acquisition. review, and annotation.

REFERENCE # 115

U.S. Army Corps of Engineers. 1983. *Columbia River at the mouth Oregon and Washington* Navigation Channel Improvement Draft Environmental Impact Statement. U.S. Army Corps of Engineers. Portland District. 35 pp + appendices.

Comment Future candidate for researching call number & location. acquisition. review, and annotation.

REFERENCE # 116

George C. Anderson. et al. 1961. *The Columbia River discharge area of the northeast Pacific Ocean: a literature survey* University of Washington. Dept. of Oceanography. Seattle. Wash. .Z6004.P6 C655 1961. Fish and Ocean Library. U of W. Note: Reference for library use only.

Comment Future candidate for acquisition. review. and annotation.

REFERENCE # 117

Blahm. Theodore H.. Robert J. McConnell. 1979. Impact of flow-lane *disposal at Dobelbower Bur*. Northwest and Alaska Fisheries Center. Coastal Zone and Estuarine Studies Division, Seattle. Wash.. Processed Report. TC 187 .B53 1979. Fish and Ocean Library, U of W.

Comment Future candidate for acquisition. review. and annotation.

REFERENCE # 118

Sherwood, C. R. 1980. *An annotated bibliography for modern sedimentary geology of the Columbia river estuary*. Submitted as part of the Columbia River Estuary Development Program Literature Search. March 1980. PNL-28-t. Battelle Pacific Northwest Laboratory, Richland. WA.

Annotation Author provides a comprehensive listing and annotations of published and unpublished literature, written on topics of or research associated with the sedimentary geology of the Columbia river estuary; includes works on sediment transport. processes of sedimentation.

sedimentary environments, sediment characteristics, stratigraphy, geochemistry and environmental geology.

REFERENCE # 119

Earl M. Dawley et al. 1980. *A study to define the migration characteristics of chinook and coho salmon and steelhead in the Columbia River estuary.. annual report-1 979.* Coastal Zone and Estuarine Studies Division, Northwest and Alaska Fisheries Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Seattle, Wash. QL639.5 .S78 1980. Fish and Ocean Library, U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 120

Earl M. Dawley et al. 198 1. *A study to define the migrational characteristics of chinook and coho salmon in the Columbia River Estuary and associated marine waters.* Coastal Zone and Estuarine Studies Division, Northwest and Alaska Fisheries Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Seattle, Wash. QL638.S2 S784 198 1, Fish and Ocean Library, U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 121

Earl M. Dawley et al. 1984. *Migrational characteristics and survival of juvenile salmonids entering the Columbia River Estuary in 1983.* Coastal Zone and Estuarine Studies Division, Northwest and Alaska Fisheries Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Seattle, Wash. QL638.S2 M475 1984, Fish and Ocean Library, U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 122

Earl M. Dawley et al. 1984. *Migrational characteristics and survival of juvenile salmonids entering the Columbia River Estuary during 1982: annual report Of research.* Coastal Zone and Estuarine Studies Division, Northwest and Alaska Fisheries Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Seattle, Wash. QL638.S2 M4755 1984, Fish and Ocean Library, U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 123

Dodge, Douglas P. 1989. *Proceedings Of the International Large River Symposium (LARS).* Proceedings of the International Large River Symposium (LARS) Honey Harbour, Ontario, Canada, September 14-21,1986. GB561 .I57 1986, Fish and Ocean Library, U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 124

Fox, David. 1984. *Abstracts of major CREDDP publications*. Columbia River Estuary Data Development Program, Astoria, OR. QH541.5.E8 A39 1984, Fish and Ocean Library, U of W; or PNL-124. Battelle Pacific Northwest Laboratory, Richland. WA.

Annotation Author provides: (a) abstracts of major CREDDP publications (section 2); (b) an annotated bibliography of other CREDDP publications. maps. etc.(section 3): and (c) sampling site maps of CREDDP research projects (appendix).

REFERENCE # 125

Tom Gaumer, Darrell Demory (and) Laimons Osis. 1973. *1971 Columbia River Estuarine estuary resource use study*. Fish Commission of Oregon, Division of Management and Research. Portland. SH539 .G379. Fish and Ocean Library, U of W.

Annotation Authors provide information regarding fish species (invertebrate and vertebrate) harvested and observed in the recreation harvest from the seaward end of the south jetty upstream to the area adjacent to Jetty Sands parking lot. from 1 March through 31 October 1971. Figures and tables temporally and spatially illustrate the species and catch statistics for this harvest.

REFERENCE # 126

Alan Jay. 1987. *Residual circulation in shallow, stratified estuaries*. Thesis.-Department of Oceanography. University of Washington, Seattle, WA. GC 7 Th345 15, Fish and Ocean Library. U of W.

Annotation Author examines the residual flow of the Columbia River estuary, by relating residual flow to the vertical exchange mechanism causing the mixing of salt and freshwater. and to external parameters (tides. river flow. and baroclinic forcing). Verifies models successfully that predict tidal and residual density and velocity fields and the tidal ranges at which neap-spring and spring-neap transitions occur.

REFERENCE # 127

Michael R. Landry and Barbara M. Hickey. 1989. *Coastal oceanography of Washington and Oregon*. Elsevier Science Pub Co.. Amsterdam; New York : Elsevier. GC856 .C62 1989. Fish and Ocean Library, U of W. Annotation Authors present a comprehensive treatment of the physical processes. biological. chemical and physical interactions along the coast of Washington and Oregon and within & adjacent to the Columbia river estuary Chapter 10 addresses riverine chemical inputs of the Columbia river sediments.

REFERENCE # 128

James K. Lewis and Peter Hamilton. 1980. *A review of numerical models of the Columbia River estuary*, Prepared by Simulation Contractor B-1 .2. Science Applications, Inc.: for the Pacific Northwest River Basins Commission. GC856 .L484 1980. Fish and Ocean Library, U of W.

Annotation Authors provide a review of hydrodynamic models that have been applied in simulating physical characteristics (e.g tidal/flow dynamics. salinity intrusion. etc.) of the Columbia river estuary. The models are described and conclusions are presented.

REFERENCE # 129

McCabe, G.T., S.A. Hinton, R.L. Emmett, and R.J. McConnell. 1990. *Benthic invertebrates, sediment characteristics, and demersal fishes off Cottonwood Island, Columbia River, before and after rock groin construction, 1987-1988*. Northwest and Alaska Fisheries Center, Seattle, Coastal Zone & Estuarine Studies; Processed Report. 18 p. + Appendices. QH104.4.N6 B46 1990, Fish and Ocean Library, U of W. Comment candidate for acquisition, review, and annotation.

REFERENCE # 130

McCabe, Jr., G.T, and Robert J. McConnell. 1989. *Abundance and size-class structure of Dungeness crabs in or near frequently-dredged areas in the Columbia River Estuary*. Northwest and Alaska Fisheries Center, Seattle, Coastal Zone & Estuarine Studies; Processed Report. QL444.M33 M23 1989, Fish and Ocean Library, U of W. Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 131

McConnell, R.J. 1979. *Concentration, extent, and duration of salinity intrusion into the Columbia River Estuary, September-October, 1977-1978: final report*. Northwest and Alaska Fisheries Center, Seattle, Coastal Zone & Estuarine Studies; Final Report of Research Funded by U.S. Army Corps of Engineers, 32 p. GC97.8.C6 M36 1979, Fish and Ocean Library, U of W. Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 132

McGary, Noel B. 1971. *An atlas of the Columbia River effluent and its distribution at sea*. Special Report No. 47. University of Washington, Dept. of Oceanography, Seattle, Wash; U.S. Atomic Energy Commission Contract No. AT (45-D-2225, September 1971. G 1466.C7 M35 1971, Fish and Ocean Library, U of W. Annotation Author provides introduction describing the data collection process and various sets of illustrative presentations of the Columbia effluent and its distribution at sea in terms of abiotic attributes of the water quality and the atmospheric environment during the spring, summer, autumn and winter seasons for the period from January 1961 through December 1963. The abiotic information includes: 1) monthly direction and velocity of winds, 2) direction and magnitude of monthly Ekman transports, 3) water temperature, salinity, density, and oxygen.

REFERENCE # 133

Mercier, Howard T. 1984. *Index to CREDDP data*. Columbia River Estuary Data Development Program. Astoria, OR. QH541.5.E8 152 1984. Fish and Ocean Library, U of W; or PNL-133. Battelle Pacific Northwest Laboratory, Richland, WA. Annotation Author provides an index for Columbia river estuary-related categories/types of raw data developed by work unit researchers and collected in a magnetic tape archive, established by CREDDP at the U.S. Army Corps of Engineers North Pacific Division Data Processing Center (Portland, OR). Also describes and locates data sets which were not adaptable to computer storage.

REFERENCE # 134

Morgan, Cheryl A. 1983. *Sink or swim?: copepod population maintenance in the Columbia River estuarine turbidity maxima region*. MS Theses. School of Fisheries, University of Washington, Seattle. WA. SH19.Th41984, Fish and Ocean Library. U of W.

Annotation Author provides extensive information on the calanoid copepods. *Eurytermora affinis* (an epibenthic calanoid) and *Coullanna candadensis* (harpacticoid calanoid) based on sampling during three different hydrological seasons between 1990 - 1992. Sampling was focused on zooplankton in the estuarine turbidity maxima (ETM) region of the Columbia river estuary; copepods were numerically dominant, comprising 88-95% of the total zooplankton assemblage. Concurrent measurement of physical variables (tidal stage, current velocity, turbidity, temperature, and conductivity) and zooplankton samples were conducted in order to directly compare copepod densities and physical characteristics in the estuary.

REFERENCE # 135

Neal, Victor Thomas. 1965. *A calculation of flushing times and pollution distribution for the Columbia River estuary*. PhD Thesis Submitted to Oregon State University. Corvallis, OR.. June 1965. GC 1556 .N42 1965. Fish and Ocean Library, U of W.

Annotation Author discusses probable pollution distribution and flushing times, varying river flow, resulting saltwater intrusion, and semi-diurnal tidal range for the Columbia river estuary, based on U.S Corps of Engineers' current measurement program of 1959.

REFERENCE # 136

Nehsen, W., G. Blomberg, and S. Bell. 1984. *Guide to the use of CREDDP information for environmental assessments*. Columbia River Estuary Data Development Program. Astoria, OR, 49 pp. QH54 I.5.E8G82 1984, Fish and Ocean Library, U of W; or PNL-136. Battelle Pacific Northwest Laboratory. Richland, WA.

Annotation Authors provide an extensive guide that explains the principles on which environmental assessments are based and that presents some necessary background for people who need to understand the effects (physical, chemical and biological) of proposed development projects (e.g. construction, diking, filling, dredging, etc.) on the Columbia river estuary.

REFERENCE # 137

U.S. Army Corps of Engineers. 1949. *Columbia river and tributaries below the Yakima river. report on flood of May-June, 1948*. Report Prepared By Portland District, Corps of Engineers. Dated July 1, 1949; 167pp. 627.4Un3c. Natural Sciences Library. U of W.

Annotation Report provides comprehensive hydrological and meteorological information and data regarding the Columbia river flood of 1948. Report appendices contains tables and figures related to the flood plain of the lower Columbia river estuarine region. Columbia river estuarine area related information is:

1) Location and description of existing flood control projects-Table 19; and 2) Illustration of Flood district boundaries, levees constructed or rehabilitated by the Corps, existing levees constructed by local interests, authorized or constructed bank protection, existing bank protection

constructed by local interest, lands inundated by 1948 flood, etc. of the lower Columbia estuary area- Plates 19-24.

REFERENCE # 138

Morgan, John B., Linda M. Marston and Robert L. Holton. 1979. *An annotated bibliography of the Columbia River estuary*. Oregon Estuarine Research Council; Oregon Sea Grant Publication ORESU-L-79-002.26005.C6A5, Fish and Ocean Library, U of W; Note: Library Use Only- Document was reviewed for contents, and a personal copy from Sea Grant, Oregon State University was requested for a comprehensive review

Comment Important Source Document- Future candidate for acquisition, review: and annotation.

REFERENCE # 139

Seaman, Margaret H. 1977. *Columbia River estuary inventory of physical, biological and cultural characteristics*. Columbia River Estuary Study Taskforce. GC860.C6 1977, Fish and Ocean Library, U of W. Annotation Author provides a document containing a compilation of work contributions by various experts for the Columbia river basin, with respect to physical characteristics (e.g. climate, freshwater, estuarine tides, etc.); biological characteristics (e.g. tidal marshes, shoreline habitat, plankton, fishes, etc.); and cultural characteristics (e.g. land & water uses, recreation, etc.).

REFERENCE # 140

Engineering News-Record. 1923. *Drainage project on the Columbia adjoining Portland, Ore.* Engineering News-Record, volume 90, Vol. 9, March 1, 1923, pages 395-397. 620.5ENG v.95, Kane Hall Auxiliary Stacks, U of W.

Annotation Reference discusses a drainage project on the Columbia river that encompasses the use of levees and a pumping plant for reclamation of 8,478 acres of low land in Multnomah County Drainage District No. 1 (near Portland, Oregon). The project affects the habitat characteristics of Columbia Slough and adjacent lands. An eleven mile levee borders and is set back 50-100 ft from the river; a fringe of willows and cottonwoods lies between the river and levee. The enlargement of the slough is considered for use as a dilution vehicle for municipal sewage. Includes a map illustrating the Columbia Slough/project area and its orientation with the Columbia river reach adjacent to the Vancouver/Portland area.

REFERENCE # 141

U. S. Army Corps of Engineers. 1960. *Interim report on 1959 current measurement program. Columbia River at mouth, Oregon and Washington, Volumes I, II, III, & IV*. U.S. Army Engineer District, Portland, Corps of Engineers. GB 1227.C7 v. 1-2, GB 1227.C7 v.3, GB 1227.C7 v.4, Fish and Ocean Library, U of W.

Annotation Author provides detail results on water velocity, current direction, salinity, and tide gauge measurements at 23 stations in the lower 52 miles of the Columbia river. Measurements were taken in 9-day periods during intermediate, high and low upland discharges in May, June and September 1959, respectively. Study of scouring and shoaling in the dredged areas from available hydrographic surveys of the entrance channel from 1945 to 1959 is presented. Information on bed-material samples at each of 22 stations and other selected points are

included. Extensive illustrations of data/information are presented in graphical and tabular formats.

REFERENCE # 142

U.S. Geological Survey. 1953- 198 1. *Current discharge at selected stations in Pacific Northwest*. NW Water Resources Data Center. Water Resources Division. Portland. OR. 55 1.57 Un35c. Kane Hall Auxiliary Stacks. U of W.

Comment Future candidate for acquisition. review, and annotation.

REFERENCE # 143

Walter. Stephen R. 1980. *Mineralogy of sediments of the Columbia River estuary: the discover of a distinctive coastal mineral.. special report*. Dept. of Oceanography. University of Washington. Seattle. Wash. QE375.W3 1980.Fish and Ocean Library. U of W.

Annotation Author provides information on the mineralogy and composition of inorganic sediments materials in the Columbia river estuary and nearshore of its mouth. States that lamellar pyroxene concentration in Clatsop Spit suggests that coastal sediments comprised a greater proportion of beach and estuary sediments prior to river entrance improvements which produced a prograding of Clatsop Spit.

REFERENCE # 144

Galay. V.J.. D.B. Tutt. and R. Kellerhals. 1983. *The meandering distributary channels of the upper Columbia River*. In *River Meandering: Proceedings of the Conference Waterway Rivers '83*. p. 1 13-125. American Society of Civil Engineers, Waterway. Port, Coastal and Ocean Division.

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 145

Allen, R.L. 1977. *Status of the upper Columbia River salmon and steelhead runs*. In E. Schweibert (ed.) *Columbia River salmon and steelhead*. p. 23-30. Am. Fish. Soc. Spec. Publ. 10. Wash., D.C. SH221.5C64 1976. Fish & Ocean Library: U of W.

Annotation Author provides a general synopsis of the status of salmon and steelhead runs in the upper Columbia river: uses figures and tables to illustrate their status. Status of these runs is based on statistical information/data from 1947-1 975.

REFERENCE # 146

Gunsolus, R.T. 1977. *Status of the salmon and steelhead runs entering the Columbia River* In E. Schwiebert (ed.) *Columbia River salmon and steelhead*. p. 21-22. Am. Fish. Soc. Spec. Publ. 10. Wash., D.C. SH221.5C64 1976. Fish & Ocean Library. U of W.

Annotation Author provides a general synopsis of the status of salmon and steelhead runs in the Columbia river uses figures and tables to illustrate their status. Status of these runs is based on statistical information/data from 1947- 1975.

REFERENCE # 147

Budinger, T.F., L.K. Coachman and C.A. Barnes. 1964. *Columbia River effluent in the northeast Pacific Ocean, 1961, 1962: selected aspects of physical oceanography*. Univ. of Washington, Dept. of Oceanogr., Tech. Rep. No. 99,78 pp. 55 1.46065 W279t, Fish & Oceans Library, U of W.

Annotation Based on 12 oceanographic surveys during 1961- 1962, the authors explain and describe temporally and spatially the dynamics and processes of the dispersion (lateral and vertical) of Columbia river effluent water in the northeast Pacific ocean off the Washington-Oregon coast, in terms of salinity gradients.

REFERENCE # 148

Anderson, G.C. 1972. *Aspects of marine phytoplankton studies near the Columbia River, with special reference to a subsurface chlorophyll maximum*. In A.T. Pruter and D.L. Alverson (eds.), *The Columbia River Estuary and adjacent ocean water: Bioenvironmental Studies*, p. 2 19-240. Univ. of Washington Press, Seattle, Wa. TD 427.R3C64, Fish and Ocean Library, U of W.

Annotation Author discusses the dynamic and processes associated with marine **phytoplankton** populations and their production in waters off the Oregon and Washington coast, with respect to the effects of the Columbia river plume. Provides information on the species composition, distribution, and annual production of phytoplankton.

REFERENCE # 149

Morse, B.A., M.G. Gross and C.A. Barnes. 1968. *Movement of seabed drifters near the Columbia River*. J.Waterways Harbors Div., Am. Soc. Civil Eng., 94:93-103. TCI A4 v.94, Engineering Library, U of W.

Annotation Authors present the results and conclusion of a study to determine the movement of seabed drifter devices released in the area within 50 km of the mouth of the Columbia river, during the autumn to spring period. Results were presented regarding the effect of wind and wave factors on the movement of these drifter devices.

REFERENCE # 150

Park, P. K., C.L Osterberg. and W.O. Forster. 1972. *Chemical budget of the Columbia river*. In A..T. Pruter and D.L. Alverson (editors), *The Columbia River estuary and adjacent ocean waters*. p. 123-134. Univ.Washington Press, Seattle. TD 427. R3 C64, Fish and Ocean Library, U of W.

Annotation Authors generally describe the Water Budget, Chemical Budget, Average Chemical Concentration, Biological Alteration of Water Quality, and Nutrient Ratio of the Columbia river estuary (near Astoria) and its ocean plume.

REFERENCE # 15 1

Conomos, T.J. and M.G. Gross. 1972. *River-ocean suspended particulate matter relations in summer*. In A.T. Pruter and D.L. Alverson (eds.), *The Columbia River Estuary and Adjacent Ocean Waters: Bioenvironmental Studies*, p. 176-202. Univ. of Washington Press, Seattle, Wa. TD427.R3C64, Fish & Ocean Library, U of W. Annotation Authors discuss the processes effecting the input, concentration, spatial and temporal distribution/ circulation of suspended particulate materials (lithogenous and biogenous) in the Columbia river plume during the

summer season. Excellent figures illustrating the dynamics and processes associated with spatial, temporal movement and circulation of suspended particulates in the river, estuarine and ocean plume regions.

REFERENCE # 152

Dahm, C.N., S.V. Gregory and P.K. Park. 1981. *Organic carbon transport in the Columbia River*. Est. Coast. Shelf Sci., 13: 645-658. GC96E89 v. 13. Fish and Ocean Library, U of W. Annotation Authors discuss the monthly measurements of total organic carbon (TOC) and dissolved organic carbon (DOC) in the Columbia river, based on sampling behind the Bonneville dam spillway and at Kalama. Washington (128 km above the mouth) during May 1973 - December 1974. They estimate total dissolved and particulate organic carbon output from the Columbia river into the northeastern Pacific ocean. Discuss diel and monthly variations in TOC and DOC, and their correlations with oxygen saturation and river discharge. Correlate particulate organic carbon (POC) with instream primary productivity per pH and oxygen saturation.

REFERENCE # 153

McManus, D.A. 1972. *Bottom topography and sediment texture near the Columbia River mouth*. In A.T. Pruter and D.L. Alverson (eds.), *The Columbia River Estuary and Adjacent Ocean Waters: Bioenvironmental Studies*. p. 251-253. Univ. of Washington Press. Seattle. Wa. TD427.R3C64. Fish & Ocean Library, U of W. Annotation Author provides a synopsis of the topography and sediment texture (vertical and lateral distribution / percent composition). of the Columbia river mouth and adjacent areas within the region of the Columbia river plume.

REFERENCE # 154

O'Brien, M.R. 1936. *Mouth of the Columbia river- beach erosion investigations*. Tech. Mem. No. 20. Berkeley, CA: U.S. Tidal Model Laboratory.

Comment Future candidate for researching call number & location. acquisition. review. and annotation.

REFERENCE # 155

Shuman, F.R. 1978. *The fate of phytoplankton chlorophyll in the euphotic zone-Washington coastal waters*. Ph.D. Diss., Dept. of Oceanogr., Univ. of Washington. Seattle, Wa.. 243 pp. GC7.Th26441, Fish and Ocean, Library, U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 156

Engineering News. 1910. *A 30 year record of flow for the Columbia River*. *Engineering News*, June 30, 1910. 620.5ENG, Suzzallo Library, Auxiliary Stacks, U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 157

Smith, K.L. 1910. *The great river of the northwest*. *Scientific American Supplement* No. 1824, December 17, 1910: p. 392-394.605SC, Natural Sciences Library, U of W.

Annotation Author provides a very general information for the Columbia river with respect to its history and general description of its commerce and scenic qualities. Includes photographs of various reaches/vistas of the Columbia river.

Note: Reference has minimal value for PTA parameters.

REFERENCE # 158

Harts, William W. 1911. *Harbor improvement of the Pacific coast of the United States U.S. Corps of Engineers*. Professional memoirs, 3 (12), 6 18-64 1.620.5 PR Kane Hall Auxiliary Stacks, U of W.

Annotation Author discusses the dynamics (environmental, hydraulic, hydrologic, and tidal) that effect the physical characteristics of the Columbia river bar. Provides physiographic illustrations of the Columbia river estuary in the vicinity of Bakers Bay and Clatsop Spit in 1839, 1874. 188 1, 1895, 1902 and 1908- pp. 622-626.

REFERENCE # 159

Lukesh, G.R. 1930. *The Columbia river system*. Military Engineer, 22 (124), 328-335. 623.05 M. Kane Hall Auxiliary, U of W.

Annotation Author provides an excellent historical, geographical, hydraulic (gradient, navigability, etc.) synopsis of the Columbia river system (and the Snake river basin) from its sources to the mouth. Discusses the potential for power (includes tables illustrating Streams, Condition of Flow, Kilowatts Available, and Installed Capacity, etc.) and irrigation developments in the Columbia river system- pp. 328-335.

REFERENCE # 160

Weaver, Theron D. 1939. *The Columbia river between Vancouver and The Dalles*. Military Engineer, 3 1(176) 91-95.623.05 M, Kane Hall Auxiliary Stacks, U of W.

Annotation Author provides brief introductory history of the Columbia river and its developments (commerce, navigation) at the time of the Bonneville dam and The Dalles channel improvement projects. Mentions that in 1935 the Portland District of the Corps of Engineers constructed six permeable dikes (three on each river bank) between Vancouver and a point 3.5 miles above that city- p. 91. Describes the river channel in terms of physical and hydraulic characteristics and navigability for the sections of Vancouver to Bonneville, at Bonneville (discussion/description of the lock facilities), and Bonneville to The Dalles. Includes illustrations of 1) The Columbia River from its mouth to The Dalles, and 2) The Bonneville Dam project; and photographs of 1) Columbia river and Cascade Lock, 2) Floating Mooring Bit (at Bonneville dam), 3) The Bridge of The Gods, 4) The Hood River-White Salmon Bridge, and 5) View (aerial) of the site of the Bonneville project prior to start of operations-pp. 9 1-95.

REFERENCE # 161

Moore, Cecil R. 1939. *The Willamette river project*. Military Engineer, 3 1(177), 208-2 11. 623.05 M, Kane Hall Auxiliary Stacks, U of W

Annotation Author provides a brief history. and geophysical. hydrologic, climatologic description of the Willamette river basin. Discusses and describes the Willamette basin plan that will includes 1) navigation improvement from the mouth to upstream of Willamette Falls. 2)

irrigation (seven storage projects of 335,000 acre ft) and stream purification projects. Mentions loss and mitigation of fish habitat and mitigating factors for this loss in terms of improved water flows and quality. Provides illustrative tables for reservoir projects and project costs- pp. 208-211.

REFERENCE # 162

Weaver, Theron D. 1939. *The upper Columbia and Snake rivers*. Military Engineer, 3 1(178), 254-257.623.05 M, Kane Hall Auxiliary Stacks, U of W.

Annotation Author discusses the Columbia and Snake river in terms of navigation and its existing and future-proposed projects. Mentions the deep water channel of the Columbia river from the ocean to The Dalles at the foot of Five Mile Rapids (Big Eddy) about 3 miles above the town of The Dalles- pp. 254. Also discusses The Dalles-Celilo Canal project, in terms of its history, construction, physical characteristics, and operation. Describes the Celilo to Snake river section of the Columbia river, and the Snake river, with respect to their physical/hydraulic and navigational characteristics. Discusses the future development of the upper Columbia and Snake river region in terms of hydropower and navigation development- pp. 254-257.

REFERENCE # 163

Duxbury, A.C., B. Morse and N. McGary. 1966. *The Columbia river effluent and its distribution at sea*. 1961-1963. Univ. of Washington, Dept. of Oceanogr., Tech. Rep. No. 156, 105 pp. 55 1.46065W279t. Fish & Oceans Library. U of W.

Annotation Authors use information derived during Washington-Oregon coastal surveys, from 1961-1963, to illustrate and delineate the extent of influence of the Columbia river effluent in the Northeast Pacific both horizontally by distance and vertically by depth through use of salinity distributions, over four distinct seasonal patterns. A method is described for the prediction of the salinity distribution of the effluent from surface wind data. Reference includes numerous figures illustrating the area of study, salinity distribution, surface winds and Columbia effluent water transport, and water particle transport.

REFERENCE # 164

Engineering News-Record. 1923. *Converting Columbia slough into sewage outlet*. Engineering News-Record, volume 90. Vol. 9. March 1, 1923. pages 397-399. 620.5ENG v.95, Kane Hall Auxiliary Stacks. U of W.

Annotation Reference discusses a project to enlarge/convert Columbia Slough (lying between the Willamette and Columbia river- area locally known as the peninsula) to sewage drainage outlet. Discussed the project design and construction methods. Notes the actual water flow/velocity of the Slough for-the year 1921 as follows:

- (1) high water- with 33 ft depth= 4 ft/sec; and
 - (2) low water (varying with tidal stage)-minimum velocity= 0.5 Wsec. and flow= 223 cfs-97 cfs.
- Includes photograph of a section of Columbia Slough and -the dredging operation.

REFERENCE # 165

Kidby, H A., and John G. Oliver. 1965. *Erosion and accretion along Clatsop spit*. Report of U.S. Army Engineer District, Portland Corps of Engineers, Portland, Oregon. 7 pp. PNL- 165, Battelle Pacific Northwest Laboratory, Richland, WA

Annotation Authors present information/graphics on the Clatsop Beach area (lying between the Columbia river south jetty and Tillamook Head) with respect to physical changes (including man-made changes such as jetty construction which was initiated in 1885) that have occurred in the area since 1792. Theories based on an analysis of the very complex joint function of sand supply and incident wind, oceanographic, and estuarine forces are proposed as to the cause of erosion and accretion over the long-time span.

REFERENCE # 166

U.S. Army, Corps of Engineers. 19?? *Mouth of Columbia current survey, 1932-1933*. Report No. MCR 100/5.288. War Department, Office of the District Engineer, Portland, Oregon. PNL-166, Battelle Pacific Northwest Laboratory, Richland, WA.

Annotation Reference comprehensively presents information regarding the history, physical oceanography, hydrology and alterations (past and current) of the Columbia river mouth related to maintenance of the navigation channel. Bathymetry charts of the Columbia river mouth for the years 1876,1882, 1895. 1917,1929,1932,1938,1941,1944,1947,and 1949 are included.

REFERENCE # 167

Callaway, R.J.. K.V. Byram, and G.R. Ditsworth. 1969. *Mathematical model of the Columbia river from the Pacific ocean to Bonneville dam, part I theory, program notes and programs*. United States Department of Interior, Federal Water Pollution Control Administration, Northwest Region, Pacific Northwest Water Laboratory, 200 S. 35 th Street, Corvallis, OR 97330, November 1969. GB 1227 C7 C35 pt. 1, Fish & Oceans Library, U of W.

Annotation Authors describe a model for simulating the dynamics of the Columbia river estuary, in the vicinity of the mouth to Bonneville dam (area of the tidal river- affected by tidal influences). with respect to predicting pollution problems/water quality. Includes sections describing mathematical methods, heat budget terms, and schematization.

REFERENCE # 168

Callaway, R.J. and K.V. Byram. 1970. *Mathematical model of the Columbia river from the Pacific ocean to Bonneville dam, part II input-output and initial verification procedures*. Environmental Protection Agency, Water Quality Office, Northwest Region, Pacific Northwest Water Laboratory. 200 S. 35 th Street, Corvallis, OR. 97330, December 1970. GB 1227 C7 C35 pt. 2, Fish & Oceans Library, U of W.

Annotation Authors apply mathematical simulation model to generate **input-output on test cases** for hydraulic and water quality programs used to approximate dynamics of the Columbia river estuary, in the vicinity of the mouth to Bonneville dam (area of the tidal river- affected by tidal influences). with respect to predicting pollution problems/water quality. Provide Columbia river data results (river hydraulic and water quality outputs) used for comparison and verification with actual data/information.

REFERENCE # 169

Evergreen. 1993. *The mighty Columbia lam life*. Evergreen, March/April 1993,23 p. SH 384M53 1993, Fish & Oceans Library, U of W.

Annotation Author provides a concise history and chronology of events/activities (early 19 th century to present) in the Columbia basin, with respect to exploration & settlement and development of commerce & exploitation of natural resources in the basin. Many references and comments regarding the fisheries resources of the basin are provided.

Chronology of events/activities:

- (1) 1859- the first large scale irrigation project is completed in the Wyalla W'alla river valley; P. 3
- (2) 1880- between 1880 and 19 10, loggers build more than 100 splash dams in the Columbia river basin. in order to transport logs: p. 3
- (3) 1915- the Columbia Gorge Highway is completed on the Oregon side of the Columbia river: p. 3
- (4) 1939- the Bonneville Power Administration signs its first industrial sales contract. with the Aluminum Company of America: ALCOA constructs a smelter on the Columbia. a few miles downstream of Vancouver: p. 3
- (5) 1941- September 28 th. Grand Coulee Dam begins operation: p. 4
- (6) Congress authorizes construction of Hungry Horse Dam. on the South Fork of the Flathead River in Montana; this dam was the first of many upstream dams to control summer and winter flows for maximum power generation by downstream dams: p. 3
- (7) 1945- the U.S. Congress authorizes construction of five dams: McNary. Ice Harbor. Lower Monumental. Little Goose. and Lower Granite: p. 4
- (8) 1946- the U.S. Congress authorizes construction of Chief Joseph Dam: p. 4
- (9) 1950- the U.S. Congress ratified the River and Harbor Flood Control Act. authorizing four more dams: The Dalles and John Day on the mainstem Columbia: Albeni Falls and Pend Oreille in northeast Washington; and Libby Dam on the Kootenai in northwest Montana: p. 4:
- (10)1955- the Federal Power Commission grants Idaho Power Company a 50 year license to build three dams in Hells Canyon on the middle Snake River: p. 4 and
- (11)1968- construction begins on eight hatcheries to compensate for chinook and steelhead losses from four federal darns on the lower Snake River: p. 4

REFERENCE # 170

Hansen, D.V. 1965. *Currents and mixing in the Columbia river estuary*. Ocean Sci and Ocean Eng 1965. Vol. 2. p. 943-955; Marine Technology Society. American Society of Limnology & Oceanography, Transactions of the Joint Conference & Exhibit. 14- 17 June 1965. W'ashington D.C. GC2023 1965 v.2, Engineering Library U of W.

Annotation Author provides a brief discussion regarding 1) the general features. such as tides, river discharge, and salinity; 2) salinity & current patterns. and 3) mixing parameters. for the Columbia river estuary/mouth.

REFERENCE # 171

Hughes, F.W. and M. Rattray Jr. 1980. *Salt flux and mixing in the Columbia river estuary*. Est Coast Mar Sci 10: 479-493. GC96E89 v.10, Fish and Ocean Library, U of W.

Annotation Authors figuratively and mathematically illustrate and describe the Clatsop spit section of the Columbia river estuary with respect to: 1) the current and salinity patterns; 2) sectional distribution of the longitudinal salt flux; and 3) components of the net longitudinal salt flux.

REFERENCE # 172

Columbia Basin Inter-Agency Committee. 1962. *River mile index main stem Columbia river*. Hydrology Subcommittee, Columbia Basin Inter-Agency Committee; 17 pp.

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 173

Robe, R.Q. 1968. *Salt flux in and classification of the Columbia river estuary during high and low discharge*. M.S Thesis, University of Washington.

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 174

U.S. Geological Survey. 1958. *Compilation of records of surface waters of the United States through 1950, part 14: Pacific slope basins in Oregon and lower Columbia basin*. Water Supply Paper 13 18. Washington D.C.

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 175

Pacific Northwest River Basins Commission. 1980. *The effects of the Mount St. Helens eruption on water resources*. A Forum Held June 12, 1980 Vancouver, WA; Conducted by Pacific Northwest River Basins Commission, Vancouver, WA. PNL-175, Battelle Pacific Northwest Laboratory, Richland, WA.

Annotation Reference presents a series of papers regarding the effects of the Mount St. Helens eruption with respect to the current and long-term effects of the eruption on regional water and land-related resources. Includes papers regarding the effects on estuarine and marine related activities and resources of the Columbia river and adjacent Pacific Ocean waters.

REFERENCE # 176

U.S. Army Corps of Engineers. 1943. *Columbia river-Puget Sound waterway; report on the intercoastal waterway from the mouth of the Columbia river to Puget Sound*. Letter and Attached Review Report from the U.S. Secretary of War to the Speaker of the U.S. House of Representatives, 02 June 1943; Document CE 800.921 (Columbia River - Puget Sound) SPEKH. TC624. W2A65, Engineering Library, U of W.

Annotation Reference includes letters and a review report (by the Chief of Engineer, U.S. Army) regarding the project to construct a 120 mile long waterway, with a series of locks, to navigate shipping from Bakers Bay (mouth of the Columbia) via Willapa Bay via Chehalis-Black Rivers to Lower Puget Sound (at Olympia, Washington). The review report includes section discussing the Existing Project (p. 12), that provides general information regarding the depth/characteristics of the navigational channel of the Columbia river (mouth to Portland, and above Portland) and the Willamette river.

REFERENCE # 177

Jewett, Henry C.. 1946. *History of Corps of Engineers to 1915*. Military Engineer, 38(250),340-346. 623.05M. Kane Hall Auxiliary Stacks, U of W.

Annotation Author provides a synopsis for the history of the U.S. Army Corps of Engineers. Provides a brief history of the Corps' duties and activities/projects, under the Rivers and Harbors Improvements, such as the navigational improvement on the Columbia river and the Dallas-Celilo Canal-p. 345

REFERENCE # 178

Robins, Thomas M.. 1940. *The River and Harbor functions of the Corps of Engineers*. Military Engineer. 32(185).323-33 1. 623.05 M.Kane Hall Auxiliary Stacks, U of W.

Annotation Author provides an early history. organization/hierarchy and various functions & activities of the Corps of Engineers. The U.S. Congress created the U.S. Army Corps of Engineers under an act on 16 March 1802; in 1820 the Corps of Engineers was called to function in the conservation and development of streams for navigation.

REFERENCE # 179

Hickson, R.E.. 1937. *C'olwnhia river South Jetty terminal*. Military Engineer. 29(164).135-138. 623.05 M. Kane Hall Auxiliary Stacks. U of W.

Annotation Author provides a short historical background for the jetty projects (south and north) at the mouth of the Columbia river; describes in detail the project for construction of asphaltic-concrete terminal end of the South Jetty. Includes a diagrammatic map of the Columbia river mouth. and plan & section engineering drawings of the South Jetty terminal.

- (1) The South Jetty project (7 miles in length) was started in 1885 and completed in 1913- p. 135
- (2) The North Jetty project (2.5 miles in length) was started in 1913 and completed in 1917- p. 135.

REFERENCE # 180

Gorlinski, J.S. 1935. *The Bonneville dam*. Military Engineer. 27(153).2 1 O-21 3. 623.05 M, Kane Hall Auxiliary Stacks. U of W.

Annotation Author discusses the construction of Bonneville dam project. With respect to: the spillway dam. cofferdam. power installation, navigation locks. railroad and highway relocation-and fishways. A photographic view of the river reach is provided at the Bonneville project (during construction) looking southeast from the Washington shore- p. 2 13.

REFERENCE # 181

Engineering News-Record. 1925. *Channel-dredging project at Portland, Oregon*. Engineering News-Record, volume 95. December 17, 1925. pages 982-984.620.5ENG v.95. Kane Hall Auxiliary Stacks. U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 182

Hickson, R.E.. 1926. *Performance of dredge Wahkiakum*. Military Engineer. 18(101).387. 623.05 M. Kane Hall Auxiliary Stacks, U of W.

Annotation Author notes the activities of the dredge Wahkiakum on the Columbia river in the vicinity of Vancouver and Portland during the month of October 1925. Mentions that the dredge excavated a 300 ft wide and 25 ft deep (at low water) channel in the Columbia river below Vancouver. Washington: also excavated a 350 ft wide and 33 ft deep (at low water) channel below Portland. Oregon. States pumping rates and cost per hour of dredging activity.

REFERENCE # 183

Engineering Record. 1914. *Dredging progress on the Columbia bar*. Engineering Record. October 3, 1914. 620.5ENG. Kane Hall Auxiliary Stacks, U of W.

Comment Future candidate for acquisition. review, and annotation.

REFERENCE # 184

Howard. W.J. 1914. *Erecting the Snake River viaduct*. Engineering News, November 19, 1914. 620.5ENG. Kane Hall Auxiliary Stacks, U of W.

Comment Future candidate for acquisition. review, and annotation.

REFERENCE # 185

Moore. A. M. 1968 *Water temperatures in the lower Columbia river*. Geological Survey Circular 551, U.S. Geological Survey. Department of Interior. 1968. 45 pp. PNL-285, Battelle Pacific Northwest Laboratory, Richland. WA.

Annotation Author provides daily observations of water temperature for 20 sites in the lower Columbia river (estuarine and tidal river zones), in tabular form and in profile form by months for the period August 1941 to July 1942. Also includes a table illustrating monthly maximum, minimum, and mean water temperatures of the Columbia river at Bonneville dam forebay. during the period of 1938-1966.

REFERENCE # 186

Professional Memoirs. 1914. *Notes on river and harbor works*, Professional Memoirs. Vol VI. No. 26, March-April 1914. Corps of Engineers, United States Army. and Engineer Department at Large. 620.5 PR V6. Kane Hall. Auxiliary Stacks. U of W.

Annotation Notes the physical characteristics and location of Cascades of the Columbia River. with reference to the Cascades Canal project; p. 246. A photograph of the Cascades Canal and Locks and the surrounding area are presented in figure 3; p. 249

REFERENCE # 187

Bixby, William H. 1912. *Rivers and harbors improvement: progress and needs in the United States*. I91 I. Professional Memoirs. Vol IV. No. 13. January-February 1912. Corps of Engineers. United States Army. and Engineer Department at Large: pp. 114-128. 620.5 PR V6. Kane Hall. Auxiliary Stacks. U of W.

Annotation Author notes the General Dam Act of June 23, 1910, which recognized the fact that ownership of power developed by dams constructed wholly at private expense is a matter for control by individual states and not by the federal government. In accordance with this Act, which must be complied with before riparian owners can build dams in navigable waters... the U.S. is empowered to require the dam owner to furnish the U.S. free of cost such water and such locks, log sluices, fishways, and other auxiliary constructions as are necessary in the interest of navigation and the fisheries...p. 125-126.

REFERENCE # 188

Hamilton, P. 1984. *Hydrodynamic modeling in the Columbia river estuary*. Columbia River Data Development Program. Astoria, OR. Two Volumes, 411 p. QH541.5E8H92 1984. Fish & Ocean Library. U of W.

Annotation Author presents 1) the results of applying a two-dimensional tidal-storm surge model to the Columbia river estuary (volume 1), and 2) the results of from a multi-channel model (volume 2).

The tidal-storm surge model was used to determine the possible effects of wind surge on the non-tidal flow.

The multi-channel model was used to:

- 1) simulate low flow (October 1980) and high flow (May and June 1981);
- 2) predict the circulation and salinity intrusion for a constant river flow (2,000 m³ per second).
- 3) predict the circulation that existed for the bathymetry of 1868; three runs for river flows of 12,000, 4,000, and 2,000 m³/s.

REFERENCE # 189

Hodge, Edwin T. 1934. *The geology of the beach and the petrography of its sands*. Letter of Transmittal and Report to Thomas M. Robbins. Lt. Colonel, Corps of Engineers. Pacific Division Engineer. San Francisco, California. PNL- 189, Battelle Pacific Northwest Laboratory. Richland, WA.

Annotation Author provides information on the geologic history and characteristics of various points of headlands (e.g. North Head, McKenzie Head, Tillamook Head, etc.) and beaches of Columbia river mouth and adjacent area. Presents analytic determinations of beach sands sampled from various areas. Describes water currents (river and littoral), wind velocities & directions, effects of wind & water currents, and effects of wood debris with respect to beaches of the Columbia river mouth.

REFERENCE # 190

Duxbury, Alyn C. 1965. *The union of the Columbia river and the Pacific ocean- general features*. Ocean Sci and Ocean Eng 1965. Vol. 2, p. 914-923; Marine Technology Society.

American Society of Limnology & Oceanography, Transactions of the Joint Conference & Exhibit. 14- 17 June 1965, Washington D.C. GC2023 1965 v.2, Engineering Library, U of W
Annotation Author provides a brief synopsis for 1) features of the Columbia river, regarding its discharge, and 2) the seasonal variation of the Columbia river effluent. regarding its movement in the coastal waters of Washington and Oregon. Briefly describes the processes (e.g.. mixing)/factors (e.g. salinity. temperature) related to seasonal distribution of the effluent.

REFERENCE # 191

McConnel. R.J.. G.R. Snyder, J.T. Durkin. and T.H. Blahm. 1979. *Concentration, extent. and duration Of salinity intrusion into the Columbia river estuary September-October 1977-1978*. Final Report of Research Financed by U.S. Army Corps of Engineers. and U.S. Dept. Commer.. Natl. Oceanic Atmos. Admin., Natl. Mar. Fish. Serv., Northwest and Alaska Fish. Cent.. Seattle. WA.. December 1979.37 p. GC97.8C6M36 1979, Fish & Oceans Library, U of W.
Annotation Authors provide information regarding the extent and duration of salinity intrusion in the Columbia river estuary; salinity was measured simultaneously during maximum (spring) and minimum (neap) tidal cycles at Tongue Point, Grays Point, Cathlamet Bay, and Harrington Point. during the period of September and October of 1977 and 1978.

REFERENCE # 192

Northwest Cartography, Inc. 1980. *Summary of contemporary bathymetry for the Columbia river estuary*. Columbia River Estuary Data Development Program, Asroria, OR. 9 p.
Comment Future candidate for researching call number & location. acquisition, review, and annotation.

REFERENCE #193

Columbia River Estuary Data Development Program. 1984. *Abstracts of major CREDDP publications*. Columbia River Estuary Data Development Program, 45 pp. QH541.5E8 A391 984, Fish & Oceans Library, U of W
Annotation Reference prefaces background information regarding the formation. mission and activities of the Columbia River Estuary Data Development Program. Provides 1) abstracts of major CREDDP publications, 2) a list of references and associated annotations associated with the CREDDP, and 3) an appendix containing sampling sites of CREDDP research projects.

REFERENCE # 194

Pacific Fisherman. 1904. *Sand Island controversy* Pacific Fisherman. Vol II, No. 9, p. 17. Seattle, Wash., September 1904.639.205PA, Fish & Oceans Library, U of W; or PNL-194, Battelle Pacific Northwest Laboratory, Richland, WA.
Annotation Reference briefly notes the controversy of ownership of Sand Island in the Columbia river estuary, which had been set aside as a federal government reserve. and has been used as valuable fishing and fish trapping ground. B.F. Heuston of Tacoma, Washington recently applied for purchase of the tide lands on this island and Desdemonia sands in the Columbia river.

REFERENCE # 195

Beyer, D.; Zamber, D.; Lawley, G. 1980. *Literature review of reptiles and amphibians in the Columbia River Estuary* Pacific Northwest River Basins Commission. Vancouver. WA: 15 pages.

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 196

Beyer, D.; Zamber, D.; Lawley, G. 1980. *Literature review of seed production in the Columbia River Estuary*. Pacific Northwest River Basins Commission. Vancouver, WA: 11 pages.

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 197

Brzezinski, M.A.; Holton, R.L. 1980. *Appendix A. Key species report: harpacticoid copepods*. Pacific Northwest River Basins Commission, Vancouver, WA: 40 pages.

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 198

Butts, J.E.; Kadeg, R.D.; Kingsbury, P.A.; Duncan, P. 1980. *Columbia River Estuary Data Development Program: Task B 3.1-2, characterization of water quality, 2 volumes*. Pacific Northwest River Basins Commission, Vancouver, WA: 845 pages.

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 199

Cardwell, R.; Zamber, D.; Lawley, G. 1980. *Literature review of terrestrial insects of the Columbia river estuary*. Pacific Northwest River Basins Commission, Vancouver, WA: 22 pages.

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 200

DeLapa, M.D.; Damron, J.; Fox, D.S.; Thomas, D. 1982. *Plan of study for the completion of the Columbia River Estuary Data Development Program*. Columbia River Estuary Study Taskforce, Astoria, OR; 136 pages.

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 201

Durkin, J.T.; Blahm, T.; McCabe, G.; Coley, T.; McConnell, R.; Emmett, R.; Muir, W. 1981. *Salmonid and non-salmonid fish work unity (September 1979 to September 1981). It includes summaries of fish catch data for the period from February 1980 to July 1981 and growth and*

feeding data for selected fish species. Columbia River Estuary Data Development Program. Astoria. OR.

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 202

Lawley, G.; Zamber, D. 1980. *Literature review of nitrogen fixation in the Columbia River Estuary.* Pacific Northwest River Basins Commission. Vancouver, WA: 14 pages.

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 203

Llewellyn, J.G.; Holton, R.L. 1980. *Appendix B. key species report: Macoma balthica (Bivalvia).* Pacific Northwest River Basins Commission. Vancouver, WA: 15 pages.

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 204

Loch, J.J. 1982. *Juvenile and adult steelhead and sea-run cutthroat trout within the Columbia River Estuary, 1980.* Washington Department of Game. Olympia, WA: 84 pages

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 205

McConnell, R.; Blahm, T.; McCabe, G. Jr.; Clocksin, T.; Coley, T.; Durkin, J.; Emmett, R.; Muir, W. 1983. *Columbia River Estuary Data Development Program data report: Salmonid and non-salmonidfish, 4 volumes.* Columbia River Estuary Data Development Program. Astoria. OR: Vol. 1 - 105 pages; Vol. 2 - 88 pages; Vol. 3 - 10,000 pages; Vol. 4 - 18 pages.

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 206

McIntire, C.D. 1982. *The diatom flora as a salinity indicator in the Columbia River Estuary.* Oregon State University, Corvallis, OR: 150 pages.

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 207

Merker, C. 1984. *Key mammals of the Columbia River Estuary - density, food consumption, and limiting factors.* Columbia River Estuary Data Development Program, Astoria. OR.. 70 pages. PNL-207. Battelle Pacific Northwest Laboratory, Richland. WA

Annotation Author provides extensive information about seven key mammalian species (muskrat, nutria, beaver, river otter, raccoon, Columbia white-tailed deer, and the Black-tailed deer) occurring the Columbia river estuary, with respect to their density, food consumption and

limiting factors. Extensive tables are provide to illustrate spatial and temporal occurrence and inhabitation of key mammals within the low marsh. high marsh. and swamp habitats of Columbia river estuarine zone.

REFERENCE # 208

Richter. J.D.; Holton. R.L. 1980. *Appendix D. Key species report: Corphium sp (Amphipoda)*. Pacific Northwest River Basins Commission. Vancouver, WA: 15 pages.
Comment Future candidate for researching call number & location. acquisition. review, and annotation.

REFERENCE # 209

Show. I.T. 1980. *Literature review and unnotuted bibliography of historic and contemporary research on modeling estuarine processes*. Pacific Northwest River Basin Commission. Vancouver. WA: 34 pages.
Comment Future candidate for researching call number & location. acquisition. review. and annotation.

REFERENCE # 210

Thomas. D.W. 1980. *Study of the intertidal wgetation of the C'olumbiu River Estuary*. Pacific Northwest River Basins Commission. Vancouver. WA: 17 pages.
Comment Future candidate for researching call number & location. acquisition. review. and annotation1

REFERENCE # 211

Thomas, D.W. In press. *The vascular flora of the C'olumbiu River Estuary* Wassman Journal of Biology. 20 pages.
Comment Future candidate for researching call number & location. acquisition. review. and annotation.

REFERENCE # 212

Wilson, S.L.; Holton. R.L. 1980. *.Appendix C. Key species report: Neanthes limnicola (Polychaeta)*. Pacific Northwest River Basins Commission. Vancouver, WA: 11 pages.
Comment Future candidate for researching call number & location. acquisition. review. and annotation.

REFERENCE # 213

Wilson, S.L.; Jones. K.K.; Higley. D.L.; Holton. R.L. 1982. *Seasonal changes in community structure of benthic infauna at six stations in the Columbia River Estuary*. Oregon State University. Corvallis, OR: 95 pages.
Comment Future candidate for researching call number & location. acquisition. review. and annotation.

REFERENCE # 2 14

Cordell, J.R., C.A. Morgan and C.A. Simenstad. 1992. *Occurrence of the Asian calanoid copepod Pseudodiaptomus inopinus in the zooplankton of the Columbia River Estuary*. J. Crust. Biol. 12(2):260-269. QL435AIJ6 v. 12, Fish & Oceans Library, U of W.

Annotation Authors discussed the discovery and occurrence of an exotic calanoid **copepod** *Pseudodiaptomus inopinus* in the zooplankton of the Columbia River Estuary, during September 1990 sampling activities. Noted that this Asian calanoid copepod (*Pseudodiaptomus inopinus*) was established in the estuarine turbidity maximum (ETM) region, and coexists with extensive populations of another calanoid copepod, *Eurytemora affinis*, and a harpacticoid copepod, *Scottoluna canadensis*. The establishment of this species may have resulted from the synergism between increased ballast dumping, decrease in maximum river flows, and the attenuation of extreme low temperatures in the Columbia estuary during the last decade.

REFERENCE # 215

Haertel, L.S. and C. Osterberg. 1967. *Ecology: of zooplankton, benthos and fishes in the Columbia River Estuary*. Ecology. 48:459-472. 570.5EC, Fish & Ocean Library, U of W.

Annotation Author presents temporal and spatial information regarding certain **physical** parameters (salinity, temperature, DO), census of organisms present, food habits of common fishes, and ecological relationships in the Columbia river estuary. Provides data on 1) seasonal occurrence/abundance of common zooplankton at various sampling stations in the estuary. 2) distribution of invertebrates according to season and salinity, 3) fish species collected & their distribution according to salinity (includes chinook salmon).

REFERENCE # 2 16

Hubbell, D.W., J.L. Glenn and H.H. Stevens Jr. 1971. *Studies of sediment transport in the Columbia River Estuary*. Technical Conference on Estuaries in the Pacific Northwest. Proc. Circ. 42, Engineering Experiment Station, Corvallis, Oregon. Pp. 190-226. PNL-2 16, Battelle Pacific Northwest Laboratory, Richland, WA.

Annotation Authors provide information regarding sediment transport and deposition in the Columbia river estuary. Results of flow measurements and water sediment samples showed that temporal and spatial variation in suspended sediment concentrations and in suspended sediment discharges are large and are affected significantly by a turbidity maximum that develops and migrates longitudinally in the estuary.

REFERENCE # 2 I7

Lyman, William D. 1917. *The Columbia river: its history, its myths, its scenery, its commerce*. C.P. Putnam's Sons. New York and London, The Knickerbocker Press, 1917; 418 pp.

979.5L989c3. Suzzallo Library, General Stacks, U of W.

Annotation Author provides (in Chapter VI, "The Lower River and Ocean Tides") extraneous descriptions for the topography and scenery- as viewed in the early 1900's- of the lower Columbia river from Rooster Rock to the mouth. Descriptions are:

- 1) "Below Rooster Rock, the River expands to a width of one to two miles . . . grassy islands and shores thick with fir or cottonwood."-p.385;

- 2) Reference to the area of the confluence of the Willamette and Columbia rivers: “The Willamette steals shyly and coquettishly through green islands to fall into the strong arms of the Columbia.” “The western arm of the Willamette, commonly called the “Slough”. joins the Columbia eighteen miles below..“-p.388;
- 3) Reference to Sauvie’s Island (also known as Wapatoo Island) “In the ponds grew the plant called wapatoo. an onion-like root, very nutritious and palatable... The wapatoo still grows in the ponds and lagoons of the island. These ponds formerly abounded in ducks and geese and cranes and swans.“-p.388;
- 4) Reference to lower Columbia below the Gorge: "... while down-river the sinuous and hazy lines of low-lying shore betoken the nearer proximity of the ocean.“-p.389;
- 5) Reference to the riparian and uplands areas of the Columbia between the mouth of the Willamette to the ocean: "... the continuance of the same low, oozy, and verdant banks. the same timbered hills on either side in the middle distance...“-p.397;
- 6) “After passing the ingress of the Cowlitz, we find the River widening to yet grander proportions. Islands become numerous.“-p.397; and
- 7) Author alludes to time of his observations in the lower Columbia by mentioning his observation of the Federal Government in the course of constructing the great jetty in the area between "... long sand spit of Point Adams lies on the south, and the bold rock-promontory of Cape Hancock on the north..." and generally describes the jetty project-p.404.

REFERENCE # 218

Conomos, Tasso J. 1968. *Processes affecting suspended particulate matter in the Columbia river-efluent system, 1965-1966*. Doctoral Thesis, Department of Oceanography, University of Washington, Seattle; 141 p. GC7.THI7174, Fish & Ocean Library, U of W.

Annotation Author offers information regarding the processes/dynamics that affect the spatial. temporal movement (lateral and vertical) of suspended lithogenous particles (e.g. sediment) and biogenous particles (e.g. phytoplankton and zooplankton) within the Columbia river estuary.

REFERENCE # 219

U.S. Army. Chief of Engineers. 1933. *Columbia and lower Willamette rivers, between Portland, Oreg. and the sea*. Committee on Rivers and Harbors, U.S. House of Representatives, 73d Congress. 1st Session. Document No. 6: 20 p.. 627.1Un3co, Natural Sciences Library. U of W.

Annotation Chief of Engineers provides a series of letters to Congress requesting project approval/re-authorization for alteration projects (dredging to widen & deepen) to the channel of the Columbia river from its mouth to the vicinity of Vancouver/Portland, and to the channel of the Willamette river from the mouth to Ross Island. Includes map illustrating the proposed dredging & spoils dumping areas, channel configuration & depth soundings on the lower Willamette river.

REFERENCE # 220

Secretary of War. 1933. *Columbia river and minor tributaries*. U.S. House of Representatives, 73d Congress, 1st Session, House Document No. 103. 627.1 Un3c v. 1, Natural Sciences Library, U of W.

Annotation Reference provides various statements regarding the Columbia river estuary in terms of navigation and the history of navigation & river commerce related activities on the Columbia river (p. 23-34). Mentions the following:

- 1) prior to man-made alterations the entrance of the Columbia was obstructed by a shoal across which there were one or more unstable channels with unstable depths up to about 20 feet at mean lower low water-p.23;
- 2) originally the Columbia river from its mouth to river mile 105 (Vancouver) was obstructed by numerous sand bars, through which the channel or channels were narrow, with depths varying from 10- 15 feet at low water-p.23;
- 3) the head of tidewater (influence) was at river mile 143 (the foot of Cascade Gorge-Bonneville Dam location), with a controlling depth of 8 feet-p.23;
- 4) in 1884. the original jetty project was adopted to deepen a channel to 30 ft. at MLL water and obtain a 4.5 mile south jetty, and construction occurred during the period of April 1885 to October 1895-p.25;
- 5) all the jetty work (south and north jetties) was completed in 1918-p.25;
- 6) As early as 1866 relief dredging was done at various bars in the river above the mouth and below Portland and Vancouver to aid sea-going traffic-p.25;
- 7) the original regular project for improvements below Portland was approved in 1877. and the first project contemplated a depth of 20 ft. at low water to be obtained by means of dikes and revetments: 1892 depth was modified to 25 ft, 1912 depth was increased to 30 ft., and 1930 a 35 ft depth and 500 ft wide channel project was adopted-p.25; and
- 8) Note that at time of this reference (1933) project improvement had never been done between river mile 104.5 and river mile 143 (head of tidewater)-p.26.

REFERENCE # 22 1

Simenstad. C.A., D.A. Jay and C.R. Sherwood 1992. *Impacts of watershed management on land-margin ecosystems: the Columbia River estuary*. In R.J. Naiman (ed.), *Watershed Management: balancing sustainability and environmental change*. Pp. 266-306. Springer-Verlag, New York, NY. 543 pp. TC423.7W38 1992, Fish & Oceans Library, U of W.

Annotation Authors describe the pattern of land use development, changes in estuarine dynamics/process, and habitat alterations of the Columbia river estuary, with respect to river flow, physical properties, and discharge of sediments. State a reduction in 1) mean river flow by -20%, 2) spring freshet discharge by -50% of natural flow, 3) sediment inflow by -25%, and 4) tidal prism by - 15% since the 19 th century. Modifications of the estuary have had significant effects on the estuarine processes that occur in the estuarine turbidity maximum (ETM). Subject of headings of reference are: 1) Watershed impacts on land-margin ecosystems, 2) Land margin ecosystems of illustrative of watershed impacts, 3) River characteristics and the influence of watershed alterations, 4) River flow dynamics. 5) Water characteristics and constituents. 6) Historic alterations to the Columbia river from the watershed to the land margin (includes subsections specifying/describing alterations to (a) watershed. (b) river flow frequency spectrum. & (c) sediment transport), 7) Effects of modifications to watershed on land-margin ecosystem processes (ETM, estuarine heat budget, organic input and food web, consumer populations & ecology). Reference contains excellent descriptive tables and figures that illustrate estuarine

alterations, historical trends of specific physical/hydrologic factors in the estuary, and historical trends in anadromous salmon landings in the Columbia river.

REFERENCE # 222

Maser. Chris. and James R. Sedell. 1994. *From the forest to the sea: ecology. of wood in streams. rivers, estuaries, and oceans.* Delray Beach. FL: St. Lucie Press. 1994. QH54 1 .5.W3.M365 1994. Fish & Oceans Library. U of W.

Comment Future candidate for acquisition. review. and annotation.

REFERENCE # 223

Anderson. George C. 1963. *Columbia river effluent in the northeast Pacific ocean, 1961, 1962: selected aspects of phytoplankton distribution and production* Univ. of Washington, Dept. of Oceanogr.. Tech. Rep. No. 96. 77 pp. 55 1.46065W279t. Fish & Oceans Library, U of W.

Annotation Author describes the distribution of chlorophyll a and phytoplankton productivity of the Washington and Oregon coasts. during 1961 - 1962. with respect to the surface waters in the area covered by the Columbia river effluent. Notes that these surface water (Columbia river effluent area) generally contain more phytoplankton and had a higher rate of photosynthesis than ambient waters. Describes the rate of productivity and standing crop for phytoplankton on a seasonal basis. Reference contains figures illustrating hydrography of Columbia river effluent off the Washington-Oregon coast. nutrient chemistry. and seasonal distribution and annual production of chlorophyll a and primary production.

REFERENCE # 224

Ballard. Ronald L. 1964. *Distribution of beach sediment near the Columbia river.* Univ. of Washington. Dept. of Oceanogr.. Tech. Rep. No. 98. 82 pp. 55 1.46065W279t. Fish & Oceans Library, U of W.

Annotation Author explains and describes the distribution/movement of beach sediments (derived from the Columbia river and other sources) along the Washington-Oregon coast. Notes that the net direction of beach sediment movement near the Columbia river appears to be northward. Describes the derivation. texture and composition of sediments. and processes/dynamics of materials movement adjacent to the Columbia river along the Washington-Oregon coast. Reference contains figures illustrating 1) sampling stations within the Columbia river estuary and beach zones along the Washington-Oregon coast. and 2) spatial and temporal distribution of materials (types & grain size).

REFERENCE # 225

Hodge, E.T. 1938. *The geology of the lower Columbia river.* Bull. Geol. Soc. Am.. 49: 83 1-930.

Comment Future candidate for researching call number & location. acquisition. review. and annotation.

REFERENCE # 226

U.S. Army Engineers. 1875. *Report of the chief of engineers .* Appendix GG, pp. 730-759.

Comment Future candidate for researching call number & location. acquisition, review, and annotation.

REFERENCE # 227

U.S. Army Corps of Engineers. 1938. *Mouth Of the Columbia river, Oregon and Washington*. Corps of Engineers. US Army, Portland. Oregon. District. 15 pp. PNL-227, Battelle Pacific Northwest Laboratory, Richland, WA.

Annotation Reference provides a concise history of and description prior to and after improvements/ alterations (channelization, jetties, and dredging) to the mouth and lower part of Columbia river estuary, since the mid- 19th century. Describes the original physiography of, and natural changes to the river mouth, its channels, sand bars, islands, and bays. Includes bathymetry charts of the mouth of the Columbia river for the years 1851, 1885, 1913, and 1937.

REFERENCE # 228

U.S. Tidal Model Laboratory. 1936. *Mouth Of the Columbia river, beach erosion investigations, summary Of observations and results*. U.S. Tidal Model Laboratory, Berkeley, California. Tech. Memo.. 20. 29 pp.

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 229

Hobson, Louis A. 1964. *Some influences Of the Columbia river effluent on marine phytoplankton during January, 1961*. Univ. of Washington, Dept. of Oceanogr.. Tech. Rep. No. 100, 6 pp. 55 1.46065W279t, Fish & Oceans Library, U of W; or PNL-229, Battelle Pacific Northwest Laboratory, Richland, WA.'

Annotation Author explains and describes the influence of the Columbia river effluent on standing crop of marine phytoplankton species along the Washington-Oregon coasts. Describes the processes effecting the standing crop of marine phytoplankton, in terms of distribution, freshwater influences, photosynthetic rates, grazing, sinking, and stability & nutrient content.

REFERENCE # 230

Barnes, C.A., and C.M. Love. 1963. *Physical, chemical and biological data from the northeast Pacific ocean: Columbia river effluent area, January-June 1961*. Univ. of Washington, Dept. of Oceanogr., Tech. Rep. No. 86.405 pp. 55 1.46065W279t. Fish & Oceans Library. U of W.

Annotation Authors provide information regarding gross features (physical, chemical and biological) of the movement and dispersion of Columbia river effluent water in the open sea of the mouth of the river and along the adjacent coast, during the period July-August 1961. Includes extensive tables and graphics for illustrating data/characteristics.

REFERENCE # 231

Gross, M.G., J.S. Creager, and D.A. McManus. 1963. *Preliminary report on the sediments and radioactivity* in the vicinity Of the Columbia river effluent*. Univ. of Washington, Dept. of Oceanogr., Tech. Rep. No. 84.32 pp. 55 1.46065W279t, Fish & Oceans Library, U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 232

Reid, J.L., Jr. 1960. *Oceanography Of the northeastern Pacific ocean during the last ten years.* California Cooperative Oceanographic Fisheries Investigations Report, Vol. VII. 77 p.

SHI 1 .C3c43a, Fish & Oceans Library, U of W

Annotation Author discusses oceanography of the northeastern Pacific during past ten years. in terms of currents, temperature. salinity and oxygen characteristics. Notes the effects of a thin layer of freshwater from the Columbia river on the salinity within in the O(surface)- 10 meter layer (p. 79 and 82).

REFERENCE # 233

Richards. F.A.. and U. Stefansson. 1963. *Silicate-salinity relationships in the Columbia river effluent.* Trans. Am. Geophys. Union (abstract) 44 (1): 2 13. 55 1.06Am3t. Fish & Oceans Library. U of W.

Comment Future candidate for acquisition. review. and annotation.

REFERENCE # 234

Love. C.M. 1964. *Phy:sical. chemical and biological data from the northeast Pacific ocean: Columbia river effluent area. .July-August 1961.* Univ. of Washington. Dept. of Oceanogr.. Tech. Rep. No. 112.261 pp. PNL-286. Battelle Pacific Northwest Laboratory, Richland. WA.

Annotation Author provides information regarding gross features (physical. chemical and biological) of the movement and dispersion of Columbia river effluent water in the open sea of the mouth of the river and along the adjacent coast. during the period July-August 1961. Includes extensive tables and graphics for illustrating data/characteristics.

REFERENCE # 235

Sylvester, R.O., and D.A. Carlson. 1961. *Lower Columbia river basic water quality data analysis.for the year f960.* Dept. Civil Engineering, University of Washington.. 628.1 W27111. Engineering Libra?. U of W.

Annotation Authors present a cover letter. figures illustrating location & river cross-sectional data of 11 sampling stations. rivrer discharge. and water quality data (e.g. temperature. pH. NH₃N, NO₂N, etc.) in the lower Columbia river within the Columbia river estuary/tidal river areas (Bonneville dam to Tenasillahe Is.). Information is presented in tabular format.

REFERENCE # 236

Westrheim, Sigurd J. 1955. *Migrations Of starry flounder (Platichthys stellatus) tagged in the Columbia river.* Fish. Comm. Oregon Res. Briefs 6 (1): 33-37. 639.2or3r, Fish & Oceans Library, U of W.

Comment Future candidate for acquisition. review. and annotation.

REFERENCE # 237

Burtm W.V.. and W>B. AcAlister. 1959. *Recent studies in the hydrography Of Oregon estuaries.* Fish. Comm. Oregon Res. Briefs 7 (1): 168-1 84. 639.2or3r. Fish & Oceans Library, U of W.

Comment Future candidate for acquisition. review. and annotation.

REFERENCE # 238

U.S. Army Corps of Engineers. 1960. *Interim report on 1959 current measurement program Columbia river at mouth Oregon and Washington*. Report prepared by the U.S. Army Engineer District, Portland Corps of Engineers, 1 September 1960. Vol. 1, 2, 3, and 4. GB 1227C7U53. Fish & Ocean Library. U of W: or PNL-238, Battelle Pacific Northwest Laboratory, Richland, WA.

Annotation Report presents in graph and chart form the results of current measurements conducted in the lower 52 miles of the Columbia river estuary during three 9 day periods in May, June, and December 1959. Volumes 2-4 contain the basic data consisting of velocity, current direction, salinity, and tide-gage records. Reference contains numerous illustrations of the aforementioned data collected at 23 stations.

REFERENCE # 239

Robeck, Gordon G., and Ralph C. Palange. 1954. *Water quality studies on the Columbia river*. U.S. Public Health Service, Robert A. Taft Sanitary Engineering Center. Cincinnati. 99 numb. leaves.

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 240

Osterberg, C., J.G. Pattullo, and W. Percy. 1964. /zinc 65 in euphasids as related to Columbia river of the Oregon coast. *Limnol. Oceanog.* 9 (2): 249-257. 591.9205L1, Fish & Oceans Library, U of W.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 241

Craddock, D.R., T.H. Blahm, and W.D. Parente. 1976. *Occurrence and utilization of zooplankton by juvenile chinook salmon in the lower Columbia river*. *Trans. Am. Fish. Soc.* 105 (1): 72-76. 639.2AM, Fish & Oceans Library, U of W.

Comment Future candidate for acquisition, review, and annotation,

REFERENCE # 242

Davis, J.S. 1978. *Diel activity of benthic crustaceans in the Columbia river estuary*. M.S. Thesis, Oregon State University, Corvallis, OR. 170 p.

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 243

Durkin, J.T., S.J. Lipovsky, G.R. Snyder, and M.E. Tuttle. 1977. *Environmental studies of three Columbia river estuarine beaches*. U.S. Dept. Commer., Natl. Oceanic Atmos. Admin., Nat]. Mar. Fish. Serv., Northwest and Alaska Fish. Cent., Seattle, WA. Processed Report. 78 p. TD427.R4C64, NMFS Montlake Library, Northwest Fisheries Science Center. 2725 Montlake Blvd. E., Seattle, WA 98112.

Comment Future candidate for acquisition, review, and annotation.

REFERENCE # 244

Gunsolus, R.T. and H. Wendler (Editors). 1975. Status report Columbia river fish runs and commercial fisheries. 1938-70: 1974 addendum. Fish Comm. Oreg. and Wash. Dep. Fish.. Joint Invest. Rep. 1 (5). 44p. SH073A35, Fish & Oceans Library. U of W.

Comment Future candidate for acquisition. review, and annotation.

REFERENCE # 245

Johnsen, R.C. and C.W. Sims. 1973. *Purse seining for juvenile salmon and trout in the Columbia river estuary*. Trans. Am. Fish. Soc. 102: 341-345. 639.2AM, Fish & Oceans Library, U of W.

Comment Future candidate for acquisition. review, and annotation.

REFERENCE # 246

Wilson, S.L. 1983. *The life history of Corophium salmonis in the Columbia river estuary*. M.S. Thesis. Oregon State University. Conallis. OR. 66 p.

Comment Future candidate for researching call number & location. acquisition. review. and annotation.

REFERENCE # 247

Durkin, J.T. 1973. *A list of crustacean shellfish of the lower C'olunthia river between the mouth and river mile 108. July to October 1973*. Northwest and Alaska Fisheries Center. Seattle, Coastal Zone & Estuarine Studies: Processed Report. 4 p. Reprint File. NMFS Montlake Library. Northwest Fisheries Science Center. 2725 Montlake Blvd. E.. Seattle. WA 981 12.

Comment Future candidate for acquisition. review. and annotation.

REFERENCE # 248

Columbia River Estuary Data Development Program. 1980. A Literature survey of the Columbia River estuary Volume I Summary Pacific Northwest River Basins Commission. Vancouver. WA. Z6005.C6 L57 v. 1. Fish and Ocean Library. U of W.

Annotation Reference summarizes a literature survey of scientific information developed for the Columbia river estuary (defined as the river mouth to river mile 43). but limited to the defined estuarine region. Categories of this survey are: Emergent Plant Production (Task A-2.2): Benthic Primary Production (Task A-2.3); Water Column Primary Production (Task X-2.4): Zooplankton and Larval Fishes (Task A-2.5): Benthic Infauna (Task A-2.6): Epibenthic Organisms (Task A-2.7); Non-Salmon Fishes (Task A-2.8): Salmonid Fishes (Task A-2.9): Avifauna (Task A-2.10): Marine Mammals (Task A-2.11): Wildlife (Task A-2.12): Current Studies (Task A-2.13): and Sedimentation (Task A-2.14).

REFERENCE # 249

Columbia River Estuary Data Development Program. 1980. *A Literature survey of the C'olumbia River estuary, Volume II Annotated Bibliography*, Pacific Northwest River Basins Commission. Vancouver, WA. Z6005C6 L57 v.2. Fish and Ocean Library U of W.

Annotation Reference provides literature references to scientific information developed for the Columbia river estuary (defined as the river mouth to river mile 43). but limited to the defined

estuarine region. Categories of literature references are: Emergent Plant Production (Task A-2.2); Benthic Primary Production (Task A-2.3); Water Column Primary Production (Task A-2.4); Zooplankton and Larval Fishes (Task A-2.5); Benthic **Infauna** (Task A-2.6); Epibenthic Organisms (Task A-2.7); Non-Salmon Fishes (Task A-2.8); **Salmonid** Fishes (Task A-2.9); Avifauna (Task A-2.10); Marine Mammals (Task A-2.11); Wildlife (Task A-2.12); Current Studies (Task B-1.1); and Sedimentation (Task B-2.1). Each reference citation is formatted in the following manner: Reference number, Citation (author, title, date, source), Descriptors (or subject of terms), Annotation, Location of study site **where** investigation occurred. Acquisition source to obtain reference.

Note: Reference is an excellent source of literature citations and annotations regarding investigations in the Columbia river estuary and adjacent areas.

REFERENCE # 250

Small, L. F., and F.A. Cross. 1972. *Effects of the Columbia river plume on tow copepod species*. In A.T. Pruter and D.L. Alverson (editors), *The Columbia River estuary and adjacent ocean waters*, p. 344-350. Univ. Washington Press, Seattle. TD 427. R3C64, Fish and Ocean Library, U of W

Annotation Authors discuss the effects on the Columbia river plume (discharge) on the spatial and temporal distribution of two copepods, *Acartia danae* and *Centropages mcmurricchi*.

REFERENCE # 251

Pruter, A.T., and D.L. Alverson. 1972. *The Columbia river estuary and adjacent ocean waters, bioenvironmental studies*. University of Washington Press, Seattle & London. 868 pp. TD 427. R3C64, Fish and Ocean Library, U of W.

Annotation An extensive collection of papers regarding the Columbia mainstem river (Hanford to the estuary), estuary, plume and adjacent coastal waters of the northeastern Pacific ocean; purpose of this collection is to present a series of stepping stones for defining and solving the ecological problems associated with discharge of radioactive pollutants, originating from the Hanford nuclear facility operations in the Richland, Washington area. Chapters of this book are organized in **five** sections: Background, Columbia River-Ocean Relationships, Composition and Distribution of the Biota of the Marine Environment, Radionuclides in the Ecosystem, and a **Summary**.

Note: Excellent reference that describes the present day dynamics and processes effecting the Columbia river, its estuary, plume, and adjacent coastal waters and associated biological communities (faunal and floral).

REFERENCE # 252

Morse, Betty-Ann, and Noel McGary. 1965. *Graphic representation of the salinity distribution near the Columbia river mouth*. *Ocean Sci and Ocean Eng* 1965, Vol. 2, p. 9923-9942; Marine Technology Society, American Society of Limnology & Oceanography, Transactions of the Joint Conference & Exhibit, 14-17 June 1965, Washington D.C. GC2023 1965 v.2, Engineering Library, U of W.

Annotation Authors provide a brief synopsis for the seasonal distribution (horizontal and vertical) of salinity gradients in the coastal waters of Washington and Oregon, off the mouth of the Columbia river. They use graphs and map charts to illustrate salinity distributions.

REFERENCE # 253

Oregon Historical Society. 1980. *Columbia's gateway: a history of the Columbia river estuary to 1920*. Pacific Northwest River Basins Commission. Vancouver, WA. F953C65, Suzzallo Library. U of W.

Annotation A concise history of the Columbia River estuary and its development is provided from its earliest inhabitants to 1920. This reference includes the history and associated milestones of: 1) Indians, 2) early exploration/discovery, 3) inhabitation by white settlers, and 4) fishing, logging, shipping industries, within the Columbia River estuary. Appendices to the reference include a comprehensive bibliography and a set of maps that depict surveys of the estuary/waterway from the late 1700s to 1915.

REFERENCE # 254

U.S. House of Representatives. 1899. *Document 94*. 56th Congress, 1st Session. 10 pp.

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 255

U.S. House of Representatives. 1928. *Document 195*. 70th Congress, 1st Session. 50 pp.

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 256

U.S. House of Representatives. 1900. *Document 673*. 56th Congress, 1st Session. 16 pp.

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 257

U.S. House of Representatives. 1946. *Document 692*. 79th Congress, 2nd Session. 23 pp.

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 258

U.S. House of Representatives. 1921. *Document 1009*. 66th Congress, 3rd Session. 35 pp.

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 259

U.S. House of Representatives. 1919. *Document 1222*. 65th Congress, 2nd Session. 15 pp.

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 261

U.S. House of Representatives. 1917. *Document 2096*. 64th Congress, 2nd Session. 11 pp.

Comment Future candidate for researching call number
annotation.

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REFERENCE # 262

U.S. House of Representatives. 1906. *Document 3213*. 59th Congress, 1st Session. 12 pp.

Comment Future candidate for researching call number & location, acquisition, review, and
annotation.

REFERENCE # 263

U.S. Senate. 1881. *Document 49*. 46th Congress. 3rd Session. 8 pp.

Comment Future candidate for researching call number & location, acquisition, review, and
annotation.

REFERENCE # 264

U.S. Senate. 1917. *Document 57*. 65th Congress, 1st Session. 5 pp.

Comment Future candidate for researching call number & location, acquisition, review, and
annotation.

REFERENCE # 265

Van Winkle. W. 1914. *Quality of surface waters of Washington*. U.S. Geological Water Supply
Paper 339. PNL-265. Battelle Pacific Northwest Laboratory, Richland, WA.

Annotation Reference provides information regarding general features, character of the water,
and mineral analyses of surface water resources in Washington state. Information regarding
surface waters of the Columbia river basin are provided.

Note: Information is not included for the Columbia river below Cascades Locks.

REFERENCE # 266

Good, James W. 1977. *Columbia river tidal marshes*. In M.H. Seaman (editor), *Columbia River
estuary*, inventory of physical, biological and cultural characteristics, Sect. 302-I to 302-I 9.

Columbia River Estuary Data Development Program. GC860. C6 C66 1977. Fish and Ocean
Library. U of W; or PNL-266, Battelle Pacific Northwest Laboratory, Richland, WA.

Annotation The author identifies, describes, and enumerates the marsh habitat and communities
of the Columbia river estuary. Provides illustrations (figures and tables) describing the location
and area of tidal marsh habitat; and discusses each tidal marsh area with respect to community
structure and alterations/impacts induced by human interventions (dredging, diking, etc.).

Note: Excellent reference for deriving a perspective of the estuarine habitat and associated
communities prior to and after human intervention.

REFERENCE # 267

Good, James W., and George D. Potter. 1977. *Columbia river estuary shoreline habitat and
Wildlife resources*. In M.H. Seaman (editor), *Columbia River estuary*, inventory of physical,

biological and cultural characteristics. Sect. 303-1 to 303-33. Columbia River Estuary Data Development Program. GC860. C6 C66 1977, Fish and Ocean Library, U of W; or PNL-267. Battelle Pacific Northwest Laboratory. Richland. WA.

Annotation The authors identify, describe, and enumerate the shoreline/riparian habitat and wildlife communities (waterfowl, birds, big game, furbearers, small mammals, reptiles, amphibians, and marine mammals) of the Columbia river estuary. Provide illustrations (figures and tables) describing the kinds, location and area of various wildlife and their associated habitat that presently occur within the estuarine zone of the Columbia river.

Note: Excellent reference for deriving a perspective of the estuarine habitat and associated wildlife communities occurring in the shoreline/riparian zone of the Columbia river estuary.

REFERENCE # 268

Buchanan, Kurt. 1977. *Columbia river estuary fishes*. In M.H. Seaman (editor). Columbia River estuary, inventory of physical, biological and cultural characteristics, Sect. 306-I to 306-33. Columbia River Estuary Data Development Program.. GC860. C6 C66 1977, Fish and Ocean Library, U of W; or PNL-268. Battelle Pacific Northwest Laboratory. Richland. WA.

Annotation The author provides information on the types of fishes (salmonid and non-salmonid) and the life histories for selected fishes that occur within the Columbia river estuary. Provides illustrations (figures and tables) that describe timing, distribution (temporal & spatial), and food preferences for salmonids such as chinook, coho, sockeye and chum salmon and steelhead and cutthroat trout.

Note: Good reference for deriving a general perspective of types, distributions (temporal & spatial), and behaviors of salmonid and non-salmonid fish species inhabiting the Columbia river estuary.

REFERENCE # 269

Good, James W. 1977. *Columbia river estuary plankton*. In M.H. Seaman (editor), Columbia River estuary, inventory of physical, biological and cultural characteristics, Sect. 304-1 to 304-12. Columbia River Estuary Data Development Program.. GC860. C6 C66 1977, Fish and Ocean Library. U of W; or PNL-269. Battelle Pacific Northwest Laboratory. Richland, WA.

Annotation Author discusses plankton species (phytoplankton and zooplankton) of the Columbia river estuary, in terms of their presence, abundance, distribution, and limiting factors.

Zooplankton-nutrient-phytoplankton relations and zooplankton food web relationships within the Columbia river estuary are covered.

REFERENCE # 270

Good, James W. 1977. *Columbia river estuary benthic invertebrates*. In M.H. Seaman (editor), Columbia River estuary, inventory of physical, biological and cultural characteristics, Sect. 305-1 to 305-16. Columbia River Estuary Data Development Program.. GC860. C6 C66 1977. Fish and Ocean Library, U of W; or PNL-270. Battelle Pacific Northwest Laboratory. Richland. WA.

Annotation Author discusses the benthic invertebrate species of the Columbia river estuary, with respect to species, physical/chemical factors affecting benthos distribution, and dominant groups of benthic invertebrates (decapod shellfish, mysids, amphipods, polychaetes, oligochaetes, mollusks, nematodes and chironomids).

REFERENCE # 271

Maser, C., R.F. Tarrant, J.M. Trappe, and J.F. Franklin (Editors). 1988. *From Forest to the sea: a story of fallen trees*. U.S. Forest Service General Technical Report PNW-GTR 229, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon, USA.

Comment Future candidate for researching call number & location, acquisition, review, and annotation.

REFERENCE # 272

Deletions Task Force. 1981. *Adjusted streamflow and storage 1928-1978 Columbia river and coastal basins- with listings of historical streamflow storage change, summation of storage change, and adjusted streamflow*. Deletions Task Force of the Columbia River Water Management Group. October 1981. 333 p. PNL-272. Battelle Pacific Northwest Laboratory, Richland, WA.

Annotation Reference provides monthly mean stream flow data for mainstem and tributary streams of the Columbia river and coastal basins during the period of 1928-1978.

Note: No information is provided for the Columbia river below Bonneville.

REFERENCE # 273

Deletions Task Force. 1982. *Appendix to adjusted streamflow and storage 1928-1978 Columbia river and coastal basins- giving procedures for determining historical streamflow*. Deletions Task Force of the Columbia River Water Management Group. February 1982. 190 p. PNL-273. Battelle Pacific Northwest Laboratory, Richland, WA.

Annotation Reference provides underlying information (e.g. procedures, methods, equations, etc.) used in calculating and estimating monthly mean stream flow data for mainstem and tributary streams of the Columbia river and coastal basins during the period of 1928-1978.

Note: No information is provided for the Columbia river below Bonneville.

REFERENCE # 274

Deletions Task Force. 1983. *1980 level modified streamflow 1928-1978 Columbia river and coastal basins- diversion and return flow patterns, summation of depletion adjustments, 1980 level modified streamflow*. Deletions Task Force of the Columbia River Water Management Group. July 1983. 340 p. PNL-274, Battelle Pacific Northwest Laboratory, Richland, WA.

Annotation Reference describes development of modified flows at each of the projects and project sites, of the 1980 level of irrigation development during the period of 1928-1978.

Note: No information is provided for the Columbia river below Bonneville.

REFERENCE # 275

Deletions Task Force. 1983. *Seasonal volumes and statistics 1928-1978 Columbia river basin- 1980 level modified streamflows, computed seasonal volumes, 50 year statistics*. Deletions Task Force of the Columbia River Water Management Group. October 1983. 396 p. PNL-275 Battelle Pacific Northwest Laboratory, Richland, WA.

Annotation Reference provides statistics of seasonal volumes and streamflow for 27 selected sites in the Columbia river basin during the period of 1928- 1978.

Note: No information is provided for the Columbia river below Bonneville.

REFERENCE # 276

U.S. Army Corps of Engineers. 1978. *Atlas of Oregon coastal navigation project hopper dredge operation areas*. U.S. Army Corps of Engineers. Navigation Division, Portland Engineer District. January 1978. 83 pp. PNL-276 Battelle Pacific Northwest Laboratory, Richland. WA. Annotation Reference provides information regarding shoal/bar patterns of the entrance and lower estuary of the Columbia river. with respect to current and future dredging operations (and disposal areas of materials) for maintenance of the navigation channel (page 1- 19). Includes photos. charts. and diagrams of affected areas, plus a bibliography of project studies.

REFERENCE # 277

U.S. Army Corps of Engineers. 1978. *Columbia river downstream of Bonneville dam-maintenance disposal plan*. U.S. Army Corps of Engineers. Portland District. March 1978. 79 pp. PNL-277. Battelle Pacific Northwest Laboratory, Richland, WA. Annotation Reference provides information regarding shoal/bar patterns of the entrance and estuary of the Columbia river to Bonneville dam, with respect to current and future dredging operations (and disposal areas of materials) for maintenance of the navigation channel. Information (past maintenance, present Oregon side disposal. and present Washington side disposal) for each critical bar/reach is provided: each is illustrated using an aerial photograph that is detailed with data & outlines. Note: Photographs provide excellent details of **inriver**, riparian and uplands habitat from an aerial perspective.

REFERENCE # 278

U.S. Army Corps of Engineers. 1984. *Columbia river basin master water control manual*. U.S. Army Corps of Engineers. North Pacific Division, Portland, Oregon. December 1984. 79 pp. PNL-278, Battelle Pacific Northwest Laboratory, Richland, WA. Annotation Reference provides a comprehensive synopsis of general information regarding the Columbia river basin, with respect to 1) basin and river description (e.g. physical characteristics, climate, hydrology. land and fish & wildlife resources); 2) basin development (e.g. legislation. history of multiple purpose development. navigation improvements. fish & wildlife. etc.): 3) principles of system water control: 4) history of reservoir regulation organization and responsibilities; and 5) principal and other coordination organizations (e.g. coordination of streamflow forecasting activities).

REFERENCE # 279

U.S. Army Corps of Engineers. 1977. *Report of Essayons and Biddle hopper dredging operations- mouth of Columbia river Oregon and Washington April - October 1977*. U.S. Army Corps of Engineers. Navigation Division. Portland Engineer District. 30 December 1977. 83 pp. PNL-279, Battelle Pacific Northwest Laboratory, Richland. WA. Annotation Reference discusses the planning. preparation. execution and results of 1977 Hopper Dredge operations at the mouth of the Columbia river. Contains information' maps regarding

areas affected by dredging activities, sediment characteristics, and areas/locations for disposal of dredged materials.

REFERENCE # 280

Kidby, H A., and John G. Oliver. 1965. *Erosion and accretion along Clatsop spit*. American Society of Civil Engineers, Coastal Engineering Conference, Santa Barbara, CA. 1965. pp. 647-671. TC203C58, Engineering Library, U of W; or PNL-280, Battelle Pacific Northwest Laboratory. Richland, WA.

Annotation Authors present a history and description of the physical changes of Clatsop spit/beach area (lying between Columbia river, south jetty and Tillamook Head), including the jetty construction. since 1792. Changes are also graphically presented using bathymetric charts and photographs.

REFERENCE # 281

Johnson, V. G., and N. H. Cutshall. 1975. *Geochemical baseline data Youngs Bay, Oregon, 1974*. Final Report Submitted to Alumax Pacific Aluminum Corporation, School of Oceanography, Oregon State University, Corvallis, Oregon, Reference 75-7, April 1975. PNL-28 1, Battelle Pacific Northwest Laboratory, Richland, WA.

Annotation Authors present information regarding a baseline record for levels of fluoride and selected trace metals in Youngs Bay located in the estuary and near the mouth of the Columbia river.

REFERENCE # 282

Hopkins, Thomas S.. 1971. *Velocity, temperature, and pressure observations from moored meters on the shelf near the Columbia river mouth, 1967-1969*. Special Report No. 45, University of Washington, Department of Oceanography, Seattle, Washington; Reference M7 1-27 RLO-1725-193. May 1971. PNL-282. Battelle Pacific Northwest Laboratory, Richland, WA.

Annotation Author provides the results of time series measurements for horizontal velocity, temperature, and pressure fields recorded from instruments moored off the Washington-Oregon coast at the mouth of the Columbia river. Extensive tables and graphics of data/information are provided.

REFERENCE # 283

U.S. Army Corps of Engineers. 1960. *River & harbor and flood control project & index maps*. U.S. Army Corps of Engineers. Portland Engineer District, 1960. 83 pp. PNL-283, Battelle Pacific Northwest Laboratory. Richland, WA.

Annotation Reference provides extensive and comprehensive information and graphic illustrations of Corps of Engineer navigation and flood control projects/sites at various locations in the Columbia river estuary/tidal river region.

Note: Excellent reference for deriving physiographic information (in-channel and riparian areas) regarding the Columbia river estuary/tidal river.

Annual Reports of Chief of Engineers U.S. Army

Note: Reports for years 1874- 1880 were not available at U of W library; currently being refurbished and will be available at later date.

Comment Future candidates for researching call number & location. acquisition, review. and annotation

REFERENCE # 284

U.S. House of Representatives. 1881. *Annual report of the chief of engineers, U.S. Army, to the Secretary of War for the year 1881 in three parts.* 47th Congress. 1 st Session. Ex. Doc.1, pt 2. vol.II, Washington Government Printing Office 188 1. 623Un3 1 r, Suzzallo Library. Auxiliary Stacks. U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- (1) Mouth of Columbia river- Part 3. p. 2534-2552 (includes historical description of river mouth for physical characteristics and projects since early 1839, and bathymetry maps December 1880 and February 188 1 opposite p.2546 & 2552 respectively);
- (2) Lower Willamette and Columbia rivers from Portland to the sea-Part 1, p. 324-326, Part 3. p. 253 1-2534 (surveys & dredging activities):
- (3) Cowlitz River-Part 1. p.33 1, Part 3. p. 2600-2603 (includes brief historical description of river characteristics and commerce in the valley adjacent to the river): and
- (4) Young's, Lewis & Clark, and Skipanon rivers, tributaries to Young's Bay-Part 1. p.332.

REFERENCE # 285

U.S. House of Representatives. 1882. *Annual report of the chief of engineers, U.S. Army, to the Secretary of War for the year 1882 in three parts.* 47th Congress, 2nd Session, Ex. Doc.1, pt 2, vol.II, Washington Government Printing Office 1882. 623Un3 1r. Suzzallo Library, Auxiliary Stacks. U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- (1) Improvement of lower Willamette and Columbia rivers from Portland, Oregon to the sea, including bar at mouth of Columbia river- Part 3, p. 2643-2654: (a) Operations a Willamette river mouth, Saint Helen's Bar, Willamette Slough Dam (built in 1879), Swan Island Bar,

Columbia river mouth, snagging operations (removal of snags from Willamette, Cowlitz and Columbia river channels), and river surveys/observation activities;

- (2) Improvement of Cowlitz river, Washington Territory-Part 3, p. 2684-2685: project was prepared in 1879 for removal of drift and snags, and moderate scraping of river bars as far as Cowlitz Landing (40 miles upriver of mouth); and
- (3) Examination of Young's, Lewis & Clark and Skipanon rivers entering Young's Bay near mouth of Columbia river-Part 3, p. 2714-27 16: a brief description of these rivers with respect to their physical/hydraulic characteristics and their surrounding area (e.g. "The foothills are generally well timbered. No extensive attempt has been made to clear them for agricultural purposes.").

Note 1: Excellent habitat & riverine description of this area for this period.

Note 2: Part 1 of this reference was not available to review information regarding Lower Columbia and Cowlitz rivers, p.3 18 etc. and p. 323 etc.

Note: Reports for years 1883-1886 were not available at U of W library.

Comment Future candidate for researching call number & location, acquisition, review, and annotation

REFERENCE # 286

U.S. House of Representatives. 1887. *Annual report of the chief of engineers, U.S. Army, to The Secretary of War for the year 1887 in four parts*. 50th Congress, 1 st Session, Ex. **Doc.** 1, pt 2, **vol.II**, Washington Government Printing Office 1887. **623Un3 1 r**, Suzzallo Library. Auxiliary Stacks, U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- (1) Mouth of Columbia river- Part 1, p. 327, Part 3, p. 2470 etc. (not available at U of W library for review);
- (2) Columbia and Willamette rivers below Portland, OR- Part 1, p. 33 1, Part 3, p. 2507 etc. (not available at U of W library for review); and
- (3) Cowlitz river- Part 1, p. 333, Part 3, p. 2524 etc. (not available at U of W library for review).

Note: Reports for years 1888-1890 were not available at U of W library.

Comment Future candidate for researching call number & location, acquisition, review, and annotation

REFERENCE # 287

U.S. House of Representatives. 189 1. *Annual report of the chief of engineers, U.S. Army, to the Secretary of War for the year 1891 in six parts*. 52D Congress, 1 st Session, Ex. **Doc.** 1, pt 2,

vol.II, Washington Government Printing Office 1891. 623Un3 1 r,Suzzallo Library. Auxiliary Stacks, U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- (1) Mouth of Columbia river-Part 1, p. 4 12-413 (channel maintenance and work on low-tide jetty from Fort Stevens to Clatsop Spit). Part 5. p. 33 14-3328 (includes bathymetry map of Columbia mouth for June 1891);
- (2) Columbia and Willamette rivers below Portland. OR- Part 1. p. 416-417. Part 5. p. 3362-3367;
- (3) Cowlitz river- Part 1, p. 418-419
- (4) Willamette river at Swan Island-Part 1, p. 420, Part 5, p.3370-3371;
- (5) Young's Bay (improvement of Young's and Klasskuine rivers) at Columbia river mouth-Part 1, p. 420. Part 5, p.3371-3372 (removal of snags and overhanging trees);
- (6) Deep, Skamakawa, and Crooked rivers-Part 1, p. 420
- (7) Lower Columbia river between Astoria and Woods Landing (snag removal project)-Part 1, p. 420. Part 5, p.3380;
- (8) Lewis and Clarke's river (snag & overhanging trees removal project)-Part 1, p. 42 1. Part 5. p.3384-3385;
- (9) Grays river (sand bar, snag & overhanging trees removal project)-Part 1, p. 42 1, Part 5. p.3386-3387; and
- (10) Deep, Skamakawa, and Crooked rivers-Part 5, p. 3378-3379.

REFERENCE # 288

U.S. House of Representatives. 1892. *Annual report of the chief of engineers, U.S. Army, to the Secretary of War for the year 1892 in four parts and atlas*. 52D Congress, 2d Session, Ex. Doc.1, pt 2. vol.II, Washington Government Printing Office 1892. 623Un3 1r,Suzzallo Library, Auxiliary Stacks. U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- (1) Mouth of Columbia river-Part 1, p. 386-388 (channel maintenance and work on low-tide jetty from Fort Stevens to Clatsop Spit), Part 3. p. 2808-28 18;

- (2) Columbia and Willamette rivlers below Portland, OR- Part 1. p. 389-391. Part 3, p. 2829-2835;
- (3) Cowlitz river- Part 1. p. 392-393, Part 3. p. 2837-2838;
- (4) Young's Bay (improvement of Young's and Klasskuine rivers) at Columbia river mouth-Part 1, p. 393. Part 3. p.2839 (removal of snags and overhanging trees);
- (5) Lower Willamette and Columbia rivers, with view of securing 25 feet a low water from Portland to the mouth of the Columbia-Part 1, p. 394-395. Part 3. p. 285 1-2869; and
- (6) Willamette river at Ross Island-Part 3. p.2842-2844.
- (7) Atlas: Map no. 126- Depth sounding of the Columbia river mouth. 9.10, 11 June 1892; Map no. 127- Showing jetty construction at Columbia river mouth.

REFERENCE # 289

U.S. House of Representatives. 1893. *Annual report of the chiqf'of engineers. U.S. Army, to the Secretary of War for the year 1893 in six parts.* 53D Congress. 2d Session, Ex. Doc. 1. pt 2, vol.II, Washington Government Printing Office 1893. 623Un3 1 r.Suzzallo Library. Auxiliary Stacks. U of W.

Annotation The reference contains **comprehensive** information regarding projects and activities related to the channelization. diking. and **channel/bank** maintenance of the mouth. estuarine. tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie. Cowlitz. Lewis. Skamokawa. Grays. and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area.The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history. costs & results, etc.) are covered:

- (1) Mouth of Columbia river-Part 1, p. 447-449 (channel maintenance and work on low-tide jetty from Fort Stevens to Clatsop Spit). Part 4, p. 3488-3503 (includes bathymetry map of mouth, June 1893 opposite of p. 3496);
- (2) Columbia and Willamette rivers below Portland. OR- Part 1, p. 452-455. Part 4. p. 35 15-3522;;
- (3) Cowlitz river- Part 1. p. 456, Part 4, p. 3526-3527;
- (4) Young's and Klasskuine rivers-Part 1, p. 456-457. Part 4. p.3527-3528 (removal of snags and overhanging trees):
- (5) Lewis river from mouth to Speliah creek-Part 1. p. 458, Part 4. p. 3533-3536; and
- (6) Columbia river between Vancouver. WA and mouth of Willamette river-Part 1, p. 449-450, Part 4. p. 3503-3506.

REFERENCE # 290

U.S. House of Representatives. 1894. *Annual report of the chief of engineers, US. Army, to the Secretary of War for the year 1894 in six parts.* 53D Congress, 3d Session, Ex. Doc.1. pt 2. vol.II, Washington Government Printing Office 1894. 623Un3 1 r.Suzzallo Library. Auxiliary Stacks, U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth. estuarine. tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g.

Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- (1) Mouth of Columbia river-Part 1, p. 4 13-4 14 (channel maintenance and work on low-tide jetty from Fort Stevens to Clatsop Spit). Part 4, p. 263 1-2642 (includes bathymetry map of mouth, June 1894 opposite of p. 2640);
- (2) Columbia and Willamette rivers below Portland, OR- Part 1, p. 416-417. Part 4, p. 2654-2659;
- (3) Cowlitz river- Part 1, p. 417-418. Part 4, p. 2662-2663;
- (4) Young's and Klasskuine rivers-Part 1, p. 418. Part 4, p.2663 (removal of snags and overhanging trees); and
- (5) Columbia river between Vancouver, WA and mouth of Willamette river-Part 1, p. 414-415, Part 4, p. 2643-2645.

REFERENCE # 291

U.S. House of Representatives. 1895. *Annual report of the chief of engineers, U.S. Army, to the Secretary of War for the year 1895 in seven parts*. 54th Congress, 1 st Session. Ex. Doc. 1. pt 2. vol.II. Washington Government Printing Office 1895. 623Un3 1r. Suzzallo Library. Auxiliary Stacks. U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channelbank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- (1) Mouth of Columbia river-Part 1, p. 460-461, Part 5, p. 355 I-3561 (includes bathymetry map of mouth, October-November 1894 opposite of p. 3560);
- (2) Columbia and Willamette rivers below Portland, OR- Part 1, p. 461-462. Part 5, p. 3561-3566;
- (3) Cowlitz river- Part 1, p. 466. Part 5, p. 3594-3595;
- (4) Young's and Klasskuine rivers-Part 1, p. 466. Part 5, p.3595-3596 (removal of snags and overhanging trees);
- (5) Clatskanie river, from mouth to town of Clatskanie-Part 1, p. 467. Part 5, p. 3596-3598 (description of existing conditions prior to project improvements);
- (6) Lewis river from La Center to its mouth-Part 1, p. 467. Part 5, p. 3600-3601;
- (7) South channel of Columbia river (in front of Astoria, OR-Part 1, p. 468. Part 5, p. 3605-3606 (includes bathymetry map of south channel, Tongue Pt to Smith Point, dated November 1894 opposite p. 3608); and
- (8) Columbia river between Vancouver, WA and mouth of Willamette river-Part 1, p. 462-463; Part 5, p. 3566-3568.

REFERENCE # 292

U.S. House of Representatives. 1896. *Annual report of the chief of engineers, U.S. Army, to the Secretary of War for the year 1896 in six parts*. 54th Congress, 2d Session, Ex. Doc. 1, pt 2, vol. II, Washington Government Printing Office 1896. 623Un3 1r, Suzzallo Library, Auxiliary Stacks, U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- (1) Mouth of Columbia river-Part 1, p. 400-401. Part 5, p. 3250-3256 (includes bathymetry map of mouth, October-November 1894 opposite of p. 3560);
- (2) Columbia and Willamette rivers below Portland, OR- Part 1, p. 401-422, Part 5. p. 3257-3262;
- (3) Cowlitz river- Part 1, p. 415, Part 5, p. 3385-3386;
- (4) Young's and Klasskuine rivers-Part 1, p. 405, Part 5, p.3283; and
- (5) South channel of Columbia river (in front of Astoria, OR-Part 1, p. 401. Part 5. p. 3256-3257);
- (6) Columbia river between Vancouver, WA and mouth of Willamette river-Part 1. p. 402-403, Part 5, p. 3263-3266.

REFERENCE # 293

U.S. Army. 1897. *Report of the chief of engineers 1897 in six parts*. Annual Reports, War Department, Fiscal Year Ended June 30, 1897, Washington Government Printing Office. 623Un3 1r, Suzzallo Library, Auxiliary Stacks, U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- (1) Mouth of Columbia river-Part 1, p. 502-503. Part 4, p. 3404-3406;
- (2) Columbia and Willamette rivers below Portland. OR- Part 1, p. 503, Part 4, p. 3407-3414;
- (3) Columbia river between Vancouver, WA and mouth of Willamette river-Part 1. p. 504. Part 4, p. 3414-3416.
- (4) Cowlitz river- Part 1, p. 520, Part 4. p. 3463-3465;
- (5) Young's and Klasskuine rivers-Part 1. p. 466. Part 5, p.3595-3596 (removal of snags and overhanging trees);
- (6) Clatskanie river, from mouth to town of Clatskanic-Part 1, p. 467, Part 4, p. 3596-3598;

- (7) Lewis river (survey)-Part 1. p. 523. Part 4. p. 3469-3478; and
(8) South channel of Columbia river (in front of Astoria. OR-Part 1, p. 468. Part 4. p. 3406-3407.

REFERENCE # 294

U.S. Army. 1898. *Report of the chief of engineers 1898 in six parts*. Annual Reports. War Department, Fiscal Year Ended June 30. 1898, Washington Government Printing Office. 623Un3 1 r. Suzzallo Library, Auxiliary Stacks. U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- (1) Mouth of Columbia river-Part 1. p. 507-508. Part 4, p. 3040;
- (2) Columbia and Willamette rivers below Portland, OR- Part 1, p. 505-506. Part 4, p. 303 1-3038;
- (3) Columbia river between Vancouver, WA and mouth of Willamette river-Part 1, p. 499, Part 4, p. 3414-3416.
- (4) Cowlitz river- Part 1, p. 508-509. Part 4. p. 304 1-3042;
- (5) Willamette Slough (Scappoose Creek/ Bay)- Part 4. p. 3043-3044;
- (6) Clatskanie river. from mouth to town of Clatskanie-Part 1. p. 5 10, Part 4. p. 3049-3050; and
- (7) South channel of Columbia river (in front of Astoria, OR-Part 1. p. 507. Part 4. p. 3039.

REFERENCE # 295

U.S. Army. 1899. *Report of the chief of engineers 1899 in six parts*. Annual Reports. War Department. Fiscal Year Ended June 30. 1899, Washington Government Printing Office. 623Un3 1 r. Suzzallo Library, Auxiliary Stacks. U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- (1) Mouth of Columbia river-Part 1. p. 595 Part 4, p. 3246-3247 (includes bathymetry map, dated June 1899. of mouth):
- (2) Columbia and Willamette rivers below Portland. OR- Part 1, p. 592-593, Part 4, p. 3239-3245.;
- (3) Columbia river between Vancouver, WA and mouth of Willamette river-Part 1, p. 586-588. Part 4. p. 3229-323 1 (includes map of Hayden Slough characteristics & 6 pages of photographs);

- (4) Cowlitz river- Part 1, p. 597-598. Part 4, p. 3249-3250;
- (5) Lewis river-Part 1, p. 596-597, Part 4, p. 3248-3249;
- (6) Clatskanie river-Part 1, p. 595-596, Part 4, p. 3247-3248; and
- (7) Columbia river below Tongue Point-Part 1, p. 594, Part 4, p. 3245-3246.

REFERENCE # 296

U.S. Army. 1900. *Report of the chief of engineers 1900 in nine parts*. Annual Reports. War Department. Fiscal Year Ended June 30. 1900, Washington Government Printing Office. 623Un3 l r, Suzzallo Library, Auxiliary Stacks. U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- (1) Mouth of Columbia river-Part 1, p. 671-672 & p. 676,-Part 6, p. 4361-4362 & p. 4434-4455 (includes bathymetry map, dated June 1900, of mouth);
- (2) Columbia and Willamette rivers below Portland, OR- Part 1, p. 669-670 & p. 676. Part 6, p. 4352-4360 & p. 4416-4433 (includes bar above Tongue Pt, Dobelbower Bar, Walker Is. Bar, Martin Is., Hunters Bar, Martin Is.-Upper Bar, & Pillar Rock Bar);
- (3) Columbia river between Vancouver, WA and mouth of Willamette river-Part 1, p. 661-663. Part 6, p. 4334-4337 (includes map of Hayden Slough characteristics);
- (4) Cowlitz river- Part 1, p. 674-675. Part 6, p. 4366-4367;
- (5) Lewis river-Part 1, p. 673-674. Part 6, p. 4364-4365;
- (6) Clatskanie river-Part 1, p. 672-673, Part 6, p. 4363-4364; and
- (7) Columbia river below Tongue Point-Part 1, p. 670-671, Part 6, p. 4360-4361.

REFERENCE # 297

U.S. Army. 1901. *Report of the chief of engineers 1901 in five parts plus supplement*. Annual Reports, War Department, Fiscal Year Ended June 30, 1901, Washington Government Printing Office. 623Un3 l r, Suzzallo Library, Auxiliary Stacks, U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- (1) Mouth of Columbia river-Part 1, p. 635-637,-Part 5, p. 3567-3570;
- (2) Columbia and Willamette rivers below Portland, OR- Part 1, p. 633-634, Part 5, p. 3557-3565;

- (3) Columbia river between Vancouver, WA and mouth of Willamette river-Part 1, p. 627-628, Part 5, p. 3499-3501;
- (4) Cowlitz river- Part 1, p. 639-640, Part 5. p. 3573-3575;
- (5) Lewis river-Part 1. p. 638-639, Part 5. p. 3572-3573;
- (6) Clatskanie river-Part 1. p. 637-638, Part 5. p. 3571-3572; and
- (7) Columbia river below Tongue Point-Part 1. p. 634-635. Part 5. p. 3565-3567.

REFERENCE # 298

U.S. Army. 1902. *Report of the chief of engineers 1902 in four parts plus supplement*. Annual Reports. War Department, Fiscal Year Ended June 30. 1902. Washington Government Printing Office. 623Un3 1 r. Suzzallo Library, Auxiliary Stacks, U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- (1) Mouth of Columbia river-Part 1, p. 556-558, -Part 3, p. 2400-2402;
- (2) Columbia and Willamette rivers below Portland. OR- Part 1. p. 554-555. Part 3, p. 2393--2398;
- (3) Columbia river between Vancouver, WA and mouth of Willamette river-Part 1. p. 549-550, Part 3. p. 2383-2384;
- (4) Cowlitz river- Part 1, p. 559-560. Part 3. p. 2404-2405;
- (5) Lewis river-Part 1. p. 560-561, Part 3. p. 2406-2407;
- (6) Clatskanie river-Part 1. p. 558-559, Part 3, p. 2403-2404; and
- (7) Columbia river below Tongue Point-Part 1. p. 556-558. Part 3. p. 2398-2400.

REFERENCE # 299

U.S. Army. 1903. *Report of the chief of engineers 1903-Volume 9, Part 1, Volume 10, Part 2, Volume 11, Part 3, Volume 12, Part 4, & Volume 13, Supplement.* Annual Reports. War Department, Fiscal Year Ended June 30. 1903. Washington Government Printing Office. 623Un3 1r, Suzzallo Library. Auxiliary Stacks. U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- (1) Mouth of Columbia river-Part 1. p. 614-616, -Part 3. p. 227 1-23 18 (includes a comprehensive synopsis for the Columbia river entrance, with respect to description, history, physical data.

sand movements, projects such as jetties, dredging, etc, and appendices with historical surveys & bathymetric maps);

- (2) Columbia and Willamette rivers below Portland, OR- Part 1. p. 612-614, Part 3. p. 2263-2270 (includes an index map of the lower Columbia and Willamette rivers, opposite p. 2266);
- (3) Columbia river between Vancouver, WA and mouth of Willamette river-Part 1, p. 608-609, Part 3, p. 2228-2229;
- (4) Cowlitz river- Part 1, p. 616-618, Part 3. p. 2319;
- (5) Lewis river-Part 1, p. 618-619, Part 3, p. 2320-2321 (includes index map of Lewis river);
- (6) Clatskanie river-Part 1, p. 616-617, Part 3. p. 2318; and
- (7) Columbia river below Tongue Point-Part 1, p. 614, Part 3. p. 2398-2400.

Note: Excellent reference that provides the history of the Columbia entrance from late 1700's to present.

REFERENCE # 300

U.S. Army. 1904. *Report of the chief of engineers 1904- Volume 5, Part 1, Volume 6. Part 2, Volume 7, Part 3, Volume 8, Part 1, & Volume 9, Supplement.* Annual Reports, War Department, Fiscal Year Ended June 30, 1904, Washington Government Printing Office. 623Un3 1 r, Suzzallo Library, Auxiliary Stacks, U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- (1) Mouth of Columbia river-Part 1, p. 678-681, -Part 3, p. 3543-3553 (includes a bathymetric map of the Columbia river entrance for June 1904, opposite p. 3548);
- (2) Columbia and Willamette rivers below Portland, OR- Part 1, p. 675--677, Part 3. p. 3534-3542 (includes an index map of the lower Columbia and Willamette rivers. opposite p. 3538);
- (3) Columbia river between Vancouver, WA and mouth of Willamette river-Part 1, p. 670-671. Part 3. p. 3496-3506;
- (4) Cowlitz river- Part 1. p. 682-683, Part 3. p. 3555-3557;
- (5) Lewis river-Part 1, p. 683-685. Part 3. p. 3557-3558 (includes index map of Lewis river);
- (6) Clatskanie river-Part 1, p. 681-682, Part 3, p. 3554-3555; and
- (7) Columbia river below Tongue Point-Part 1, p. 678, Part 3, p. 3543.

REFERENCE # 301

U.S. Army. 1905. *Report of the chief of engineers 1905- Volume 5, Part 1, Volume 6. Part 2, Volume 7, Part 3, Volume 8, Supplement.* Annual Reports, War Department. Fiscal Year Ended June 30, 1905. Washington Government Printing Office. 623Un3 1 r, Suzzallo Library. Auxiliary Stacks, U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine,

tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- (1) Mouth of Columbia river-Part 1, p. 685-687,-Part 3. p. 2484-2492 (includes a bathymetric map of the Columbia river entrance for June 1905, opposite p. 2488);
- (2) Columbia and Willamette rivers below Portland. OR- Part 1. p. 681-684. Part 3. p. 2475-2483 (includes an index map of the lower Columbia and Willamette rivers. opposite p. 2478);
- (3) Columbia river between Vancouver, WA and mouth of Willamette river-Part 1. p. 676-678. Part 3, p. 2467-2468;
- (4) Cowlitz river- Part 1. p. 688-689. Part 3, p. 2493-2494;
- (5) Lewis river-Part 1. p. 689-691. Part 3. p. 2495-2496;
- (6) Clatskanie river-Part 1. p. 687-688, Part 3. p. 2492-2493; and
- (7) Columbia river below Tongue Point-Part 1. p. 684. Part 3, p. 2483-2484.

REFERENCE # 302

U.S. Army. 1906. *Report of the chief of engineers U.S. Army 1906 in two parts*. Annual Reports, War Department, Fiscal Year Ended June 30, 1906, Washington Government Printing Office. 623Un31r, Suzzallo Library, Auxiliary Stacks, U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- (1) Mouth of Columbia river-Part 1, p. 757-760,-Part 2, p. 2012-2017-(includes a bathymetric map of the Columbia river entrance for May-June 1906. opposite p. 2016);
- (2) Columbia and Willamette rivers below Portland, OR- Part 1. p. 754-756, Part 2. p. 2006-2012 -(includes an index map of the lower Columbia and Willamette rivers. opposite p. 2010);
- (3) Columbia river between Vancouver, WA and mouth of Willamette river-Part 1. p. 750-751. Part 2. p. 1998-2000;
- (4) Cowlitz river- Part 1, p. 761-763. Part 2. p. 2018-2019;
- (5) Lewis river-Part 1. p. 763-765. Part 2. p. 2019; and
- (6) Clatskanie river-Part 1. p. 760-761. Part 2. p. 2017-2018.

REFERENCE # 303

U.S. Army. 1907. *Report of the chief of engineers U. S. Army 1907 in three parts*. Annual Reports, War Department, Fiscal Year Ended June 30, 1907, Washington Government Printing Office. 623Un31r, Suzzallo Library, Auxiliary Stacks, U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie. Cowlitz. Lewis, Skamokawa. Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- 1) Columbia river- mouth to mouth of Willamette river-Part 1, p. 767-768;
- 2) Columbia and lower Willamette rivers below Portland- Part 1. p.771-772;
- 3) Mouth of Columbia river- Part 1, p. 773-774, Part 3, p. 2 196-2203;
- 4) Dredge for improving lower Willamette and Columbia rivers- Part 2, p. 1105-1 106. Part 3. p. 2 190-2 196;
- 5) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part 1, p. 775-776, Part 3, p. 2203-2204;
- 6) Lewis river (empties into Columbia 26 miles below Portland, stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1. p. 777-778. Part 3. p. 2204-2207;
- 7) Cowlitz river (empties into Columbia river 45 mi. below Portland; tidal to 9 miles above mouth)- Part 1, p. 776-777. Part 3. p. 2204-2207; and
- 8) Grays river (empties into Grays Bay at mouth; tidal in lower 8 mi.)- Part 1. p. 779. Part 3, p. 2207.

REFERENCE # 304

U.S. Army. 1908. *Report of the chief of engineers U.S. Army 1908 in three parts*. Annual Reports, War Department. Fiscal Year Ended June 30, 1908. Washington Government Printing Office. 623Un3 Ir. Suzzallo Library, Auxiliary Stacks, U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie. Cowlitz. Lewis. Skamokawa. Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- 1) Columbia and lower Willamette rivers below Portland- Part 1. p.820-822, Part 3. p.2264-2270;
- 2) Mouth of the Columbia river- Part 1. p. 822-825, Part 3, p. 2270-2274 (Note: opposite page 2272 is survey map of Columbia river entrance for the year 1908);
- 3) Dredge for improving lower Willamette and Columbia rivers- Part 1, p. 1 143-1 144;
- 4) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part 1, p. 825-826, Part 3, p. 2274-2275;
- 5) Lewis river (empties into Columbia 26 miles below Portland. stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1, p. 827-829. Part 3, p. 2277-2278;

- 6) Cowlitz river (empties into Columbia river 45 mi. below Portland; tidal to 9 miles above mouth)- Part 1, p. 826-8277. Part 3, p. 2275-2277; and
- 7) Grays river (empties into Grays Bay at mouth; tidal in lower 8 mi.)- Part 1, p. 829-830, Part 3, p. 2278-2279.

REFERENCE # 305

U.S. Army. 1909. *Report of the chief of engineers U.S. Army 1909 in three parts*. Annual Reports, War Department. Fiscal Year Ended June 30. 1909. Washington Government Printing Office. 623Un31r, Suzzallo Library, Auxiliary Stacks, U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- 1) Columbia and lower Willamette rivers below Portland- Part 1, p. 859-982. Part 3, p. 2230-2236;
- 2) Mouth of the Columbia river- Part 1, p.862-864, Part 3, p. 2236-2239;
- 3) Dredge for improving lower Willamette and Columbia rivers- Part 1, p. 1153 (Note: opposite page 2238 is survey map of Columbia river entrance for the year 1909):
- 4) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part 1, p. 865-866. Part 3, p. 2239-2240:
- 5) Lewis river (empties into Columbia 26 miles below Portland, stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1, p. 867-869. Part 3, p. 2241-2242:
- 6) Cowlitz river (empties into Columbia river 45 mi. below Portland; tidal to 9 miles above mouth)- Part 1, p. 866-867. Part 3, p. 2240-2241; and
- 7) Grays river (empties into Grays Bay at mouth: tidal in lower 8 mi.)- Part 1, p. 869-870, Part 3, p. 2242-2243.

REFERENCE # 306

U.S. Army. 1913. *Report of the chief of engineers U.S. Army 1913 in three parts*. Annual Reports, War Department. Fiscal Year Ended June 30. 1913. Washington Government Printing Office. 623Un31r, Suzzallo Library, Auxiliary Stacks, U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- 1) Oregon Slough (part of the former channel of the Columbia river which separates Hayden Island from the Oregon mainland)- Part 1, p. 1338-1 340 (Note: Includes table of references to examination or **survey** reports or maps not in the project documents for years 1892. 1896, 1904, & 1912), Part 3, p. 3083-3084;
- 2) Columbia and lower Willamette rivers below Portland- Part 1, p. 1350-1354 (Note: Includes table of references to examination or survey reports or maps including the project documents for years 1877, 1891. 1892, & 1900), Part 3. p. 3092-3 100;
- 3) Mouth of the Columbia river- Part 1, p. 1354-1359, Part 3, p. 3 100-3 108 (Note: opposite page 3 104 is survey map of Columbia river entrance for the year 1913);
- 4) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part 1, p. 1359-1361 & p. 1367-1368 (Note: Snag removal projects), Part 3. p. 3 108-3 109 & p. 3 115 (Note: Snag removal projects);
- 5) Lewis river (empties into Columbia 26 miles below Portland, stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1, p. 1364-1367 & p. 1367-1368 (Note: Snag removal projects), Part 3, p. 3 113-3 114 & p. 3 115 (Note: Snag removal projects);
- 6) Cowlitz river (empties into Columbia river 45 mi. below Portland; tidal to 9 miles above mouth)- Part 1, p. 1362-1364 & p. 1367-1368 (Note: Snag removal projects), Part 3, p. 3 1 10-3 112 & p. 3 115 (Note: Snag removal projects); and
- 7) Grays river (empties into Grays Bay at mouth; tidal in lower 8 mi.)- Part 1, p. 1368- 1369, **Part 3, p. 3115-3116.**

REFERENCE # 307

U.S. Army. 1914. *Report of the chief of engineers U.S. Army 1914 in three parts.* Annual Reports, War Department, Fiscal Year Ended June 30, 19 14, Washington Government Printing Office. 623Un3 1 r, Suzzallo Library, Auxiliary Stacks, U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth. estuarine. tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- 1) Oregon Slough (part of the former channel of the Columbia river which separates Hayden Island from the Oregon mainland)- Part 1, p. 1387-1 389 (Note: Includes table of references to examination or survey reports or maps not in the project documents for years 1892, 1896, 1904, & 1912),
- 2) Columbia and lower Willamette rivers below Portland- Part 1, p. 1400-1 403 (Note: Includes table of references to examination or survey reports or maps including the project documents for years 1877, 1891, 1892, & 1900).
- 3) Mouth of the Columbia river- Part 1, p. 1403- 1409 (Note: Includes (1) Table of references to examination or survey reports or maps including the project documents for years 1879, 1880, 1883, 1886, 1890, 1893, 1895, 1900 & 1903, and (2) Information on the amount of stone used for the 1884 and 1903 jetty projects);

- 4) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part 1, p. 1409- 14 11 & p. 14 17- 14 18 (Note: Dredge & snag removal projects). Part 3, p. 3239-3240 & p. 3245 (Note: Dredge & snag removal projects);
- 5) Lewis river (empties into Columbia 26 miles below Portland, stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1, p. 1414-1417 & p. 1417-1418 (Note: Dredge & snag removal projects), Part 3. p. 3243-3444 & p. 3455 (Note: Dredge & snag removal projects);
- 6) Cowlitz river (empties into Columbia river 45 mi. below Portland; tidal to 9 miles above mouth)- Part 1. p. 14 11- 14 14 & p. 14 17- 14 18 (Note: Dredge & snag removal projects). Part 3, p. 3240-3243 & p. 3455 (Note: Dredge & snag removal projects); and
- 7) Grays river (empties into Grays Bay at mouth; tidal in lower 8 mi.)- Part 1. p. 14 18- 1419. Part 3. p. 3245-3246.

REFERENCE # 308

U.S. Army. 1915. *Report of the chief of engineers U.S. Army 1915 in three parts*. Annual Reports. War Department. Fiscal Year Ended June 30, 1915, Washington Government Printing Office. 623Un3 1 r, Suzzallo Library. Auxiliary Stacks. U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- 1) The Columbia river between Vancouver, WA and the mouth of the Willamette river- Part 1, p. 1513-1 15;
- 2) Oregon Slough (part of the former channel of the Columbia river which separates Hayden Island from the Oregon mainland)- Part 1, p. 15 15-1518, Part 3, p. 3389-3390;
- 3) Columbia and lower Willamette rivers below Portland- Part 1, p. 1527-1532, Part 2, p. 1998-1999, Part 3, p. 3397-3404;
- 4) Mouth of the Columbia river- Part 1. p. 1533-1538, Part 2, p. 1999-2000, Part 3. p. 3404-3414 (Note: opposite page 3408 are survey maps of Columbia river entrance for the September and December 19 14, and March and June 19 15);
- 5) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part 1. p. 1538-1 540 & p. 1546-1 547 (Note: Dredge & snag removal projects). Part 2. p. 2000. Part 3. p. 3414-3415 & p. 3418-3419 (Note: Dredge & snag removal projects);
- 6) Lewis river (empties into Columbia 26 miles below Portland, stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1, p. 1543-1 546 & p. 1546-1 547 (Note: Dredge & snag removal projects), Part 2. 2001) Part 3, p. 3417--3418 & p. 34 18-3419 (Note: Dredge & snag removal projects);
- 7) Cowlitz river (empties into Columbia river 45 mi. below Portland; tidal to 9 miles above mouth)- Part 1, p. 1540- 1542 & p. 1546- 1547 (Note: Dredge & snag removal projects), Part

2. p. 2000, Part 3p. 34 15-3417 & p. 34 18-3419 (Note: Dredge & snag removal projects); and
- 8) Grays river (empties into Grays Bay at mouth; tidal in lower 8 mi.)- Part 1, p. 1547- 1549, Part 3, p3245-3246.

REFERENCE # 309

U.S. Army. 19 16. *Report of the chief of engineers U.S. Army 191 6 in three parts*. Annual Reports, War Department, Fiscal Year Ended June 30. 1916, Washington Government Printing Office. 623Un3 1 r. Suzzallo Library. Auxiliary Stacks, U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channelbank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowhitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results. etc.) are covered:

- 1) Columbia and lower Willamette rivers below Portland- Part 1, p. 1649-1 655. Part 3. p.3227-3233;
- 2) Mouth of the Columbia river- Part 1. p. 1655-1658, Part 3, p. 3233-3238 (Note: opposite page 3408 is survey map of Columbia river entrance for the June 1916).
- 3) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part 1, p. 1658-1661 & p. 1668 (Note: Dredge & snag removal projects). Part 3, p. 3239-3240 & p. 3244-3245 (Note: Dredge & snag removal projects);
- 4) Lewis river (empties into Columbia 26 miles below Portland, stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1, p. 1663- 1667 & p. 1668 (Note: Dredge & snag removal projects), Part 3, p. 3242--3244 & p. 3244-3245 (Note: Dredge & snag removal projects);
- 5) Cowlitz river (empties into Columbia river 45 mi. below Portland; tidal to 9 miles above mouth)- Part 1, p. 166 1- 1663 & p. 1668 (Note: Dredge & snag removal projects), Part 3. p. 3240-3242 & p. 3244-3245 (Note: Dredge & snag removal projects); and
- 6) Grays river (empties into Grays Bay at mouth; tidal in lower 8 mi.)- Part 1, p. 1668-1 670, Part 3. p. 3245-3246.

REFERENCE # 3 10

U.S. Army. 1917. *Report of the chief of engineers U.S. Army 1917 in three parts*. Annual Reports, War Department, Fiscal Year Ended June 30, 1917, Washington Government Printing Office. 623Un3 1 r, Suzzallo Library, Auxiliary Stacks, U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following

estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- 1) Mouth of the Columbia river- Part 1, p. 1716-1719, Part 2, p. 3329-3333;
- 2) Columbia and lower Willamette rivers below Vancouver and Portland- Part 1, p. 1719-1726. Part 2, p. 3333-3340;
- 3) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part 1. p. 1726-1729, Part 2. p. 3340-3342;
- 4) Lewis river (empties into Columbia 26 miles below Portland. stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1, p. 1735-1739. Part 2. p. 3345--3347;
- 5) Cowlitz river (empties into Columbia river 45 mi. below Portland: tidal to 9 miles above mouth)- Part 1. p. 1739-1741, Part 2. p. 3347-3349; and
- 6) Grays river (empties into Grays Bay at mouth; tidal in lower 8 mi.)- Part 1, p. 1742-1744, Part 2, p. 3349-3350.

REFERENCE # 3 11

U.S. Army. 1918. *Report of the chief of engineers U.S. Army 1918 in three parts*. Annual Reports. War Department. Fiscal Year Ended June 30. 1918. Washington Government Printing Office. 623Un3 1 r, Suzzallo Library, Auxiliary Stacks. U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section's surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- 1) Mouth of the Columbia river- Part 1. p. 1763-1766. Part 3. p. 3377-3380 (Note: opposite page 3378 is survey map of Columbia river entrance for the June 1918).;
- 2) Columbia and lower Willamette rivers below Vancouver and Portland- Part 1, p. 1766-1772, Part 3. p. 3381-3388;
- 3) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part I, p. 1773-1775, Part 3, p. 3389-3390;
- 4) Lewis river (empties into Columbia 26 miles below Portland, stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1, p. 1782-1786. Part 3. p. 3394--3395;
- 5) Cowlitz river (empties into Columbia river 45 mi. below Portland: tidal to 9 miles above mouth)- Part 1, p. 1786-1789, Part 3, p. 3395-3397; and
- 6) Grays river (empties into Grays Bay at mouth; tidal in lower 8 mi.)- Part 1. p. 1789-1791, Part 3, p. 3397-3398.

REFERENCE # 3 12

U.S. Army. 1919. *Report of the chief of engineers U.S. Army 1919 in three parts*. Annual Reports, War Department, Fiscal Year Ended June 30. 1919, Washington Government Printing Office. 623Un3 1 r, Suzzallo Library, Auxiliary Stacks. U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the **channelization**, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following **estuarine/tidal** river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- 1) Mouth of the Columbia river- Part 1, p. 1857-1 861, Part 3, p. 3433-3437 (Note: opposite page 3434 is survey map of Columbia river entrance for the June 1919).;
- 2) Columbia and lower Willamette rivers below Vancouver and Portland- Part 1. p. 186 1- 1867. Part 3, p. 3437-3445.
- 3) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part 1, p. 1867-1 870. Part 3, p.3445-3446 ;
- 4) Lewis river (empties into Columbia 26 miles below Portland. stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1, p. 1877-1 880. Part 2, p. 3450-345 1;
- 5) Cowlitz river (empties into Columbia river 45 mi. below Portland; tidal to 9 miles above mouth)- Part 1, p. 1881-1 883, Part 3, p. 3452-3453;
- 6) Skamokawa Creek (empties into Columbia river at RM 34, lower 1.5 mi. tidal)- Part 1. p. 1883- 1885, Part 3, p. 3453-3454; and
- 7) Grays river (empties into Grays Bay at mouth; tidal in lower 8 mi.)- Part 1. p. 1885-1 888. Part 3, p. 3454-3455.

REFERENCE # 3 13

U.S. Army. 1920. *Report of the chief of engineers U.S. Army 1920 in three parts*. Annual Reports, War Department, Fiscal Year Ended June 30, 1920. Washington Government Printing Office. 623Un3 1 r, Suzzallo Library, Auxiliary Stacks. U of W.

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- 1) Mouth of the Columbia river- Part 1, p. 1851-1 854, Part 2, p. 2935-2937 (Note: opposite page 2936 is survey map of Columbia river entrance for the June 1920);
- 2) Columbia and lower Willamette rivers below Vancouver and Portland- Part 1, p. 1854-1 861. Part 2. p. 2937-2940;
- 3) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part 1, p. 1861-1863, Part 2. p.2941 ;
- 4) Lewis river (empties into Columbia 26 miles below Portland, stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1, p. 1870-1873, Part 2. p. 2943-2944;

- 5) Cowlitz river (empties into Columbia river 45 mi. below Portland; tidal to 9 miles above mouth)- Part 1, p. 1874-I 876, Part 2. p. 2944;
- 6) Skamokawa Creek (empties into Columbia river at RM 34. lower 1.5 mi. tidal)- Part 1, p. 1876-I 878, Part 2. p. 2945; and
- 7) Grays river (empties into Grays Bay at mouth; tidal in lower 8 mi.)- Part 1, p. 1878- 188 1, Part 2, p. 2945.

REFERENCE # 3 14

U.S. Army. 192 1. *Report of the chief of engineers U.S. Army 1921 in two parts*. Annual Reports, War Department, Fiscal Year Ended June 30, 192 1. Washington Government Printing Office. 623Un3 Ir. Suzzallo Library. Auxiliary Stacks, U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking. and channel/bank maintenance of the mouth, estuarine. tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys. project history, costs & results, etc.) are covered:

- 1) Mouth of the Columbia river- Part 1. p. 1867-I 870 (Note: opposite page 1868 is survey map of Columbia river entrance for the June 192 1);
- 2) Columbia and lower Willamette rivers below Vancouver and Portland- Part 1, p. 1870-I 877;
- 3) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part 1, p. 1877-I 880;
- 4) Lewis river (empties into Columbia 26 miles below Portland, stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1, p. 1886-I 889;
- 5) Cowlitz river (empties into Columbia river 45 mi. below Portland; tidal to 9 miles above mouth)- Part 1, p. 1889-I 892;
- 6) Skamokawa Creek (empties into Columbia river at RM 34, lower 1.5 mi. tidal)- Part 1. p. 1892- 1894; and
- 7) Grays river (empties into Grays Bay at mouth; tidal in lower 8 mi.)- Part 1. p. 1894-I 897.

REFERENCE # 3 15

U.S. Army. 1922. *Report of the chief of engineers U.S. Army 1922 in two parts*. Annual Reports, War Department, Fiscal Year Ended June 30. 1922, Washington Government Printing Office. 623Un3 1r, Suzzallo Library. Auxiliary Stacks. U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channehzation, diking. and channel/bank maintenance of the mouth. estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie. Cowlitz, Lewis. Skamokawa. Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys. project **history**, costs & results, etc.) are covered:

- 1) Mouth of the Columbia river- Part 1, p. 1887-J 889;
- 2) Columbia and lower Willamette rivers below Vancouver and Portland- Part 1, p. 1890- 1897;
- 3) Willamette Slough (also known as Multnomah Channel- 21 miles in length, flowing in northerly direction. connecting the Willamette and Columbia rivers at St. Helens, OR)- Part 1, p. 1897-1 899 (Note: a new project in the fiscal year 1922);
- 4) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part 1, p. 1900- 1902;
- 5) Lewis river (empties into Columbia 26 miles below Portland. stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1, p. 1909- 19 12;
- 6) Cowlitz river (empties into Columbia river 45 mi. below Portland: tidal to 9 miles above mouth)- Part I, p. 1912-1914;
- 7) Skamokawa Creek (empties into Columbia river at RM 34, lower 1.5 mi. tidal)- Part 1, p. 1915-1916; and
- 8) Grays river (empties into Grays Bay at mouth: tidal in lower 8 mi.)- Part 1. p. 1916-1919.

REFERENCE # 3 16

U.S. Army. 1923. *Report of the chief of engineers U.S. Army 1923 in three parts*. Annual Reports. War Department. Fiscal Year Ended June 30. 1923. Washington Government Printing Office. 623Un3 1 r. Suzzallo Library, Auxiliary Stacks. U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and **channel/bank** maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following **estuarine/tidal** river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- 1) Mouth of the Columbia river- Part 1, p. 1743-11746;
- 2) Columbia and lower Willamette **rivers** below Vancouver and Portland- Part 1, p. 1746-1 754;
- 3) Willamette Slough (also known as Multnomah Channel- 21 miles in length, flowing in northerly direction. connecting the Willamette and Columbia rivers at St. Helens, OR)- Part 1, p. 1754-1756;
- 4) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part 1. p. 1756- 1759;
- 5) Lewis river (empties into Columbia 26 miles below Portland, stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1, p. 1764-I 767;
- 6) Cowlitz river (empties into Columbia river 45 mi. below Portland; tidal to 9 miles above mouth)- Part 1. p. 1767-1 769;
- 7) Skamokawa Creek (empties into Columbia river at RM 34, lower 1.5 mi. tidal)- Part 1, p. 1769-1771: and
- 8) Grays river (empties into Grays Bay at mouth; tidal in lower 8 mi.)- Part 1. p. 1772-I 774.

REFERENCE # 3 17

U.S. Army. 1924. *Report of the chief of engineers U.S. Army 1924 in two parts*. Annual Reports. War Department, Fiscal Year Ended June 30. 1924, Washington Government Printing Office. 623Un3 Ir, Suzzallo Library, Auxiliary Stacks, U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth. estuarine. tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie. Cowlitz, Lewis, Skamokawa. Grays. and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys. project history, costs & results. etc.) are covered:

- 1) Mouth of the Columbia river- Part 1. p. 1748- 175 1;
- 2) Columbia and lower Willamette rivers below Vancouver and Portland- Part 1, p.175 1- 1759;
- 3) Willamette Slough (also known as Multnomah Channel- 21 miles in length. flowing in northerly direction. connecting the Willamette and Columbia rivers at St. Helens. OR)- Part 1, p. 1760-I 762;
- 4) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part 1. p. 1762-I 764;
- 5) Lewis river (empties into Columbia 26 miles below Portland. stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1. p. 1769-I 772;
- 6) Cowlitz river (empties into Columbia river 45 mi. below Portland; tidal to 9 miles above mouth)- Part 1. p. 1772- 1774;
- 7) Skamokawa Creek (empties into Columbia river at RM 34. lower 1.5 mi. tidal)- Part 1. p. 1775-I 776; and
- 8) Grays river (empties into Grays Bay at mouth: tidal in lower 8 mi.)- Part 1. p. 1777-1779.

REFERENCE # 3 18

U.S. Army. 1925. *Report of the chief of engineers U.S. Army 1925 in two parts*. Annual Reports. War Department. Fiscal Year Ended June 30. 1925. Washington Government Printing Office. 623Un3 Ir, Suzzallo Library, Auxiliary Stacks. U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization. diking, and channel/bank maintenance of the mouth. estuarine. tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays. and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history. costs & results. etc.) are covered:

- 1) Mouth of the Columbia river- Part 1. p. 1676-I 679;
- 2) Columbia and lower Willamette rivers below Vancouver and Portland- Part 1, p. 1679- 1686;
- 3) Willamette Slough (also known as Multnomah Channel- 21 miles in length, flowing in northerly direction, connecting the Willamette and Columbia rivers at St. Helens, OR)- Part 1, p. 1686-1688;

- 4) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part I, p. 1688- 169 1;
- 5) Lewis river (empties into Columbia 26 miles below Portland, stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1, p. 1699-1 701;
- 6) Cowlitz river (empties into Columbia river 45 mi. below Portland; tidal to 9 miles above mouth)- Part 1, p. 1702- 1704;
- 7) Skamokawa Creek (empties into Columbia river at RM 34. lower 1.5 mi. tidal)- Part 1, p. 1704-1 705;
- 8) Grays river (empties into Grays Bay at mouth; tidal in lower 8 mi.)- Part 1. p. 1706- 1707; and
- 9) Deep river (formerly known as Alamicut river- a tidal slough extending 4 mi. inland from a northerly direction of Grays Bay- Part 1. p. 1708- 1709.

REFERENCE # 3 19

U.S. Army. 1926. *Report of the chief of engineers U.S. Army 1926 in two parts*. Annual Reports, War Department, Fiscal Year Ended June 30, 1926, Washington Government Printing Office. 623Un3 Ir, Suzzallo Library, Auxiliary Stacks, U of W.

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- 1) Mouth of the Columbia river- Part 1, p. 1665- 1668;
- 2) Columbia and lower Willamette rivers below Vancouver and Portland- Part 1, p. 1668-I 677;
- 3) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part 1, p. 1677-1680;
- 4) Lewis river (empties into Columbia 26 miles below Portland, stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1, p. 1688- 169 1;
- 5) Cowlitz river (empties into Columbia river 45 mi. below Portland; tidal to 9 miles above mouth)- Part 1, p. 1691-1694;
- 6) Skamokawa Creek (empties into Columbia river at RM 34, lower 1.5 mi. tidal)- Part 1, p. 1694- 1696;
- 7) Grays river (empties into Grays Bay at mouth; tidal in lower 8 mi.)- Part 1, p. 1696-I 698; and
- 8) Deep river (formerly known as Alamicut river- a tidal slough extending 4 mi. inland from a northerly direction of Grays Bay- Part 1, p. 1698- 1701.

REFERENCE # 320

U.S. Army. 1927. *Report of the chief of engineers U.S. Army 1927 in two parts*. Annual Reports, War Department, Fiscal Year Ended June 30, 1927, Washington Government Printing Office. 623Un3 1 r, Suzzallo Library, Auxiliary Stacks, U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- 1) Mouth of the Columbia river- Part 1, p. 1664- 1667;
- 2) Columbia and lower Willamette rivers below Vancouver and Portland- Part 1, p. 1667-1 675;
- 3) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part 1, p. 1675-1 678;
- 4) Lewis river (empties into Columbia 26 miles below Portland, stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1, p. 1700-1 702;
- 5) Cowlitz river (empties into Columbia river 45 mi. below Portland; tidal to 9 miles above mouth)- Part 1, p. 1702- 1705;
- 6) Skamokawa Creek (empties into Columbia river at RM 34, lower 1.5 mi. tidal)- Part 1, p. 1705-1 707;
- 7) Grays river (empties into Grays Bay at mouth; tidal in lower 8 mi.)- Part 1, p. 1707-1 709; and
- 8) Deep river (formerly known as Alamicut river- a tidal slough extending 4 mi. inland from a northerly direction of Grays Bay- Part 1, p. 1709- 17 11.

REFERENCE # 321

U.S. Army. 1928. *Report Of the chief of engineers U.S. Army 1928 in two parts*. Annual Reports, War Department, Fiscal Year Ended June 30, 1928, Washington Government Printing Office. 623Un3 1 r, Suzzallo Library, Auxiliary Stacks. U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- 1) Mouth of the Columbia river- Part 1, p. 1725- 1728;
- 2) Columbia and lower Willamette rivers below Vancouver and Portland- Part 1, p. 1728-1 736;
- 3) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part 1, p. 1736-1 739;
- 4) Lewis river (empties into Columbia 26 miles below Portland, stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1, p. 176 1 - 1763;
- 5) Cowlitz river (empties into Columbia river 45 mi. below Portland; tidal to 9 miles above mouth)- Part 1, p. 1764-1 766;

- 6) Skamokawa Creek (empties into Columbia river at RM 34. lower 1.5 mi. tidal)- Part 1, p. 1766- 1768;
- 7) Grays river (empties into Grays Bay at mouth; tidal in lower 8 mi.)- Part 1, p. 1769- 1770; and
- 8) Deep river (formerly known as Alamicut river- a tidal slough extending 4 mi. inland from a northerly direction of Grays Bay- Part 1, p. 1771- 1773.

REFERENCE # 322

U.S. Army. 1929. *Report of the chief of engineers U.S. Army 1929 in two parts*. Annual Reports. War Department, Fiscal Year Ended June 30, 1929. Washington Government Printing Office. 623Un3 1 r. Suzzallo Library, Auxiliary Stacks, U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- 1) Mouth of the Columbia river- Part 1, p. 1753-1 756;
- 2) Columbia and lower Willamette rivers below Vancouver and Portland- Part 1, p. 1756-I 764;
- 3) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part 1, p. 1764-I 767;
- 4) Lewis river (empties into Columbia 26 miles below Portland, stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1, p. 1790-I 793;
- 5) Cowlitz river (empties into Columbia river 45 mi. below Portland; tidal to 9 miles above mouth)- Part 1, p. 1793-1796;
- 6) Skamokawa Creek (empties into Columbia river at RM 34, lower 1.5 mi. tidal)- Part 1, p. 1796- 1798;
- 7) Grays river (empties into Grays Bay at mouth; tidal in lower 8 mi.)- Part 1, p. 1798- 1800; and
- 8) Deep river (formerly known as Alamicut river- a tidal slough extending 4 mi. inland from a northerly direction of Grays Bay- Part 1, p. 1800- 1802.

REFERENCE # 323

U.S. Army. 1930. *Report of the chief of engineers U.S. Army 1930 in two parts*. Annual Reports. War Department, Fiscal Year Ended June 30, 1930. Washington Government Printing Office. 623Un3 1 r. Suzzallo Library, Auxiliary Stacks, U of W.

Annotation The reference contains comprehensive information regarding **projects and activities** related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent **area**. The following

estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- 1) Mouth of the Columbia river- Part 1, p. 1844-1 847;
- 2) Columbia and lower Willamette rivers below Vancouver and Portland- Part 1, p. 1849-1 856;
- 3) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part 1, p. 1856- 1859;
- 4) Lewis river (empties into Columbia 26 miles below Portland. stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1, p.1886- 1889;
- 5) Cowlitz river (empties into Columbia river 45 mi. below Portland; tidal to 9 miles above mouth)- Part 1, p. 1889- 1892;
- 6) Skamokawa Creek (empties into Columbia river at RM 34. lower 1.5 mi. tidal)- Part 1, p. 1893-1895;
- 7) Grays river (empties into Grays Bay at mouth; tidal in lower 8 mi.)- Part 1. p. 1895-1 897;
- 8) Deep river (formerly known as Alamicut river- a tidal slough extending 4 mi. inland from a northerly direction of Grays Bay- Part 1, p. 1897-1 900;
- 9) **Skipanon** Channel (located at Warrenton. OR; originally called **Skipanon** river, a narrow crooked stream with -1.8 mi tidal)- Part 1, p. 1847- 1849 (Note: reference provides a short history of the stream & condition);
- 10) Lake river (enters Columbia river near the mouth of the Lewis river)- Part 1, p. 1885- 1886 (Note: a short history of the stream and associated activities/description is provided); and
- 11) Steamboat Slough (also known as Skamokama Slough)- Part 1. p. 1892- 1893.

REFERENCE # 324

U.S. Army. 193 1. *Report of the chief of engineers U.S. Army 1931 in two parts*. Annual Reports. War Department, Fiscal Year Ended June 30. 193 1, Washington Government Printing Office. 623Un3 lr, Suzzallo Library, Auxiliary Stacks. U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and **Willamette** rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project **history**, costs & results, etc.) are covered:

- 1) Mouth of the Columbia river- Part 1. p. 1854-I 857;
- 2) Columbia and lower Willamette rivers below Vancouver and Portland- Part 1, p. 1861- 1869;
- 3) Clatskanie river (empties through **Beaver** and **Wallace** Sloughs into the Columbia river 65 mi below Portland)- Part 1, p. 1869-I 872;
- 4) Lewis river (empties into Columbia 26 miles below Portland, stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1. p. 1899- 190 1;
- 5) Cowlitz river (empties into Columbia river 45 mi. below Portland; tidal to 9 miles above mouth)- Part 1, p. 1901-1905;
- 6) Skamokawa Creek (**empties** into Columbia river at RM 34, lower 1.5 mi. tidal)- Part 1, p. 1906-1910;

- 7) Grays river (empties into Grays Bay at mouth; tidal in lower 8 mi.)- Part 1, p. 1895-1 897;
- 8) Deep river (formerly known as Alamicut river- a tidal slough extending 4 mi. inland from a northerly direction of Grays Bay- Part 1, p. 19 1 1 - 19 13;
- 9) Skipanon Channel (located at Warrenton, OR; originally called Skipanon river, a narrow crooked stream with ~ 1.8 mi tidal)- Part 1, p. 1857-1 860 (Note: reference provides a short history of the stream & condition);
- 10) Lake river (enters Columbia river near the mouth of the Lewis river)- Part 1, p. 1896- 1899 (Note: a short history of the stream and associated activities/description is provided); and
- 11) Steamboat Slough (also known as Skamokama Slough)- Part 1, p. 1905-I 906.

REFERENCE # 325

U.S. Army. 1932. *Report of the chief of engineers U.S. Army 1932 in two parts*. Annual Reports. War Department. Fiscal Year Ended June 30, 1932, Washington Government Printing Office. 623Un3 1 r, Suzzallo Library. Auxiliary Stacks, U of W.

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- 1) Mouth of the Columbia river- Part 1, p. 1756-1 760;
- 2) Columbia and lower Willamette rivers below Vancouver and Portland- Part 1, p. 1762- 177 1;
- 3) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part 1, p. 177 1-1 773;
- 4) Lewis river (empties into Columbia 26 miles below Portland, stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1, p. 1794-1 796;
- 5) Cowlitz river (empties into Columbia river 45 mi. below Portland; tidal to 9 miles above mouth)- Part 1, p. 1796-1 799;
- 6) Skamokawa Creek (empties into Columbia river at RM 34, lower 1.5 mi. tidal)- Part 1, p. 1800- 1802;
- 7) Grays river (empties into Grays Bay at mouth; tidal in lower 8 mi.)- Part 1. p. 1802-1 803;
- 8) Deep river (formerly known as Alamicut river- a tidal slough extending 4 mi. inland from a northerly direction of Grays Bay- Part 1, p. 1803-1 805;
- 9) Lake river (enters Columbia river near the mouth of the Lewis river)- Part 1. p. 1792- 1794 (Note: a short history of the stream and associated activities/description is provided); and
- 10) Steamboat Slough (also known as Skamokama Slough)- Part 1, p. 1799-1 800.

REFERENCE # 326

U.S. Army. 1933. *Report of the chief of engineers U.S. Army 1933 in two parts*. Annual Reports. War Department, Fiscal Year Ended June 30, 1933, Washington Government Printing Office. 623Un3 1r, Suzzallo Library, Auxiliary Stacks, U of W.

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- 1) Mouth of the Columbia river- Part 1. p. 1140- 1143;
- 2) Columbia and lower Willamette rivers below Vancouver and Portland- Part 1, p. 11145- 1150;
- 3) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part 1. p. 1150-I 152;
- 4) Lewis river (empties into Columbia 26 miles below Portland, stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1, p. 1164- 1165;
- 5) Cowlitz river (empties into Columbia river 45 mi. below Portland; tidal to 9 miles above mouth)- Part 1. p. 1166- 1168;
- 6) Skamokawa Creek (empties into Columbia river at RM 34, lower 1.5 mi. tidal)- Part 1, p. 1168-I 169;
- 7) Grays river (empties into Grays Bay at mouth; tidal in lower 8 mi.)- Part 1, p. 1802-1803;
- 8) Deep river (formerly known as Alamicut river- a tidal slough extending 4 mi. inland from a northerly direction of Grays Bay- Part 1, p. 1169- 1170; and
- 9) Skipanon Channel (located at Warrenton, OR; originally called Skipanon river, a narrow crooked stream with -1.8 mi tidal)- Part 1. p. 1143-I 145 (Note: reference provides a short history of the stream & condition).

REFERENCE # 327

U.S. Army. 1934. *Report of the chief of engineers U.S. Army 1934 in two parts*. Annual Reports. War Department, Fiscal Year Ended June 30, 1934. Washington Government Printing Office. 623Un3 1 r. Suzzallo Libra?. Auxiliary Stacks, U of W.

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- 1) Mouth of the Columbia river- Part 1. p.1313-1316;
- 2) Columbia and lower Willamette rivers below Vancouver and Portland- Part 1, p. 13 18-I 325;
- 3) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part 1. p. 1325-1326;
- 4) Lewis river (empties into Columbia 26 miles below Portland, stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1. p. 1343-I 344;

- 5) Cowlitz river (empties into Columbia river 45 mi. below Portland; tidal to 9 miles above mouth)- Part 1, p. 1344-1 347;
- 6) Skamokawa Creek (empties into Columbia river at RM 34, lower 1.5 mi. tidal)- Part 1, p. 1347- 1348;
- 7) Grays river (empties into Grays Bay at mouth; tidal in lower 8 mi.)- Part 1, p. 1348-1 350;
- 8) Deep river (formerly known as Alamicut river- a tidal slough extending 4 mi. inland from a northerly direction of Grays Bay- Part 1, p. 1350-1 35 1;
- 9) Lake river (enters Columbia river near the mouth of the Lewis river)- Part 1, p. 1341-I 343 (Note: a short history of the stream and associated activities/description is provided);
- 10) Columbia river at Bakers Bay- Part 1, p. 135 1-1 352;
- 11) Columbia river at Bonneville-Part 1, p. 1334-1 337; and
- 12) Skipanon Channel (located at Warrenton, OR; originally called Skipanon river, a narrow crooked stream with -1.8 mi tidal)- Part 1. - Part 1. p. 13 16-1 3 18 (Note: reference provides a short history of the stream & condition).

REFERENCE # 328

U.S. Army. 1935. *Report of the chief of engineers U.S. Army 1935 in two parts*. Annual Reports, War Department. Fiscal Year Ended June 30, 1935, Washington Government Printing Office. 623Un3 1 r,Suzzallo Library. Auxiliary Stacks, U of W.

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- 1) Mouth of the Columbia river- Part 1 , p. 1475-1477;
- 2) Columbia and lower Willamette rivers below Vancouver and Portland- Part 1, p. 1479-1487;
- 3) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part 1, p. 1487-1488;
- 4) Lewis river (empties into Columbia 26 miles below Portland, stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1, p. 1499- 150 1;
- 5) Cowlitz river (empties into Columbia river 45 mi. below Portland; tidal to 9 miles above mouth)- Part 1. p. 1501-1503;
- 6) Skamokawa Creek (empties into Columbia river at RM 34. lower 1.5 mi. tidal)- Part 1, p. 1503-1504;
- 7) Grays river (empties into Grays Bay at mouth; tidal in lower 8 mi.)- Part 1. p. 1504-1 505;
- 8) Deep river (formerly known as Alamicut river- a tidal slough extending 4 mi. inland from a northerly direction of Grays Bay- Part 1, p. 1505-1 507;
- 9) Lake river (enters Columbia river near the mouth of the Lewis river)- Part 1, p. 1498- 1499 (Note: a short history of the stream and associated activities/description is provided);
- 10) Columbia river at Bakers Bay- Part 1, p. 1507-1 508;
- 11) Columbia river at Bonneville-Part 1, p. 15 13-1 5 16;

- 12) **Skipanon** Channel (located at Warrenton. OR; originally called **Skipanon** river, a narrow crooked stream with ~1.8 mi tidal)- Part 1, - Part 1, p. 1477-1478 (Note: reference provides a short history of the stream & condition);
- 13) Youngs Bay and Youngs river (lower 8 mi. tidal)-Part 1, p. 1478-1479; and
- 14) Multnomah Channel (also known as Willamette Slough)-Part 1, p. 1489- 1490.

REFERENCE # 329

U.S. Army. 1936. *Report of the chief of engineers U.S. Army 1936 in two parts*. Annual Reports, War Department, Fiscal Year Ended June 30. 1936, Washington Government Printing Office. 623Un3 1 r, Suzzallo Library. Auxiliary Stacks. U of W.

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- 1) Mouth of the Columbia river- Part 1, p. 1476-1478;
- 2) Columbia and lower Willamette rivers below Vancouver and Portland- Part 1, p. 1481- 1487;
- 3) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part 1, p. 1487-1489;
- 4) Lewis river (empties into Columbia 26 miles below Portland, stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1, p. 1500- 1502;
- 5) Cowlitz river (empties into Columbia river 45 mi. below Portland; tidal to 9 miles above mouth)- Part 1, p. 1502- 1504;
- 6) Skamokawa Creek (empties into Columbia river at RM 34, lower 1.5 mi. tidal)- Part 1, p. 1504-I 505;
- 7) Grays river (empties into Grays Bay at mouth: tidal in lower 8 mi.)- Part 1, p. 1505- 1506;
- 8) Deep river (formerly known as Alamicut river- a tidal slough extending 4 mi. inland from a northerly direction of Grays Bay- Part 1, p. 1506-I 507;
- 9) Lake river (enters Columbia river near the mouth of the Lewis river)- Part 1, p. 1499-I 500 (Note: a short history of the stream and associated activities/description is provided);
- 10) Columbia river at Bakers Bay- Part 1, p. 1507-I 508;
- 11) Columbia river at Bonneville-Part 1, p. 1517-I 524;
- 12) **Skipanon** Channel (located at Warrenton. OR; originally called **Skipanon** river, a narrow crooked stream with ~ 1.8 mi tidal)- Part 1, - Part 1, p. 1479- 1480 (Note: reference provides a short history of the stream & condition);
- 13) Youngs Bay and Youngs river (lower 8 mi. tidal)-Part 1, p. 1480;
- 14) Multnomah Channel (also known as Willamette Slough)-Part 1, p. 1489-1490; and
- 15) Oregon Slough (also known as North Portland Harbor)-Part 1, p. 1498- 1499.

REFERENCE # 330

U.S. Army. 1937. *Report of the chief of engineers U.S. Army 1937 in two parts. Annual Reports*, War Department, Fiscal Year Ended June 30, 1937, Washington Government Printing Office. 623Un3 1 r. Suzzallo Library, Auxiliary Stacks, U of W.

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- 1) Mouth of the Columbia river- Part 1, p. 1487-I 489;
- 2) Columbia and lower Willamette rivers below Vancouver and Portland- Part 1, p. 1492- 1498;
- 3) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part 1, p. 1499-I 500;
- 4) Lewis river (empties into Columbia 26 miles below Portland, stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1, p. 1509- 15 10;
- 5) Cowlitz river (empties into Columbia river 45 mi. below Portland; tidal to 9 miles above mouth)- Part 1, p. 1510-1512;
- 6) Skamokawa Creek (empties into Columbia river at RM 34. lower 1.5 mi. tidal)- Part 1. p. 1513-1514;
- 7) Grays river (empties into Grays Bay at mouth; tidal in lower 8 mi.)- Part 1, p. 15 14-I 5 15;
- 8) Deep river (formerly known as Alamicut river- a tidal slough extending 4 mi. inland from a northerly direction of Grays Bay- Part 1, p. 15 15-I 5 16;
- 9) Lake river (enters Columbia river near the mouth of the Lewis river)- Part 1, p. 1508-I 509 (Note: a short history of the stream and associated activities/description is provided);
- 10) Columbia river at Bakers Bay- Part 1, p. 15 16-I 5 17;
- 11) Columbia river at Bonneville-Part 1, p. 1529-I 536;
- 12) **Skipanon** Channel (located at Warrenton, OR; originally called **Skipanon** river, a narrow crooked stream with -1.8 mi tidal)-Part 1, p. 1489-1491 (Note: reference provides a short history of **the** stream **&** condition);
- 13) Youngs Bay and Youngs river (lower 8 mi. tidal)-Part 1, p. 1491-1492;
- 14) Multnomah Channel (also known as Willamette Slough)-Part 1, p. 1500-I 501;
- 15) Oregon Slough (also known as North Portland Harbor)-Part 1, p. 1498- 1499;
- 16) **Westport** Slough (side channel of the Columbia river located 70 mi. below Portland, **OR**)- Part 1. p. 1498-1499;
- 17) Elockomin Slough (3.5 mi. in length, located 75 mi. below Portland)-Part 1, p. 15 12-I 5 13; and
- 18) Columbia river between Vancouver and Bonneville-Part 1, p. 1528-I 529.

REFERENCE # 33 I

U.S. Army. 1938. *Report Of the chief of engineers U.S. Army 1938 in two parts*. Annual Reports, War Department, Fiscal Year Ended June 30, 1938, Washington Government Printing Office. 623Un3 1 r. Suzzallo Library, Auxiliary Stacks, U of W.

Annotation The reference contains comprehensive information regarding projects and activities related to the channelization, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- 1) Mouth of the Columbia river- Part 1, p. 1740- 1742;
- 2) Columbia and lower Willamette rivers below Vancouver and Portland- Part 1, p. 1746-I 750;
- 3) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part 1. p. 1751-1753;
- 4) Lewis river (empties into Columbia 26 miles below Portland, stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1, p. 1762-1763;
- 5) Cowlitz river (empties into Columbia river 45 mi. below Portland; tidal to 9 miles above mouth)- Part 1. p. 1763- 1765;
- 6) Skamokawa Creek (empties into Columbia river at RM 34. lower 1.5 mi. tidal)- Part 1. p. 1766- 1767;
- 7) Grays river (empties into Grays Bay at mouth; tidal in lower 8 mi.)- Part 1, p. 1767-1 768;
- 8) Deep river (formerly known as Alamicut river- a tidal slough extending 4 mi. inland from a northerly direction of Grays Bay- Part 1, p. 1768-1 769;
- 9) Lake river (enters Columbia river near the mouth of the Lewis river)- Part 1, p. 1761-1 762 (Note: a short history of the stream and associated activities/description is provided);
- 10) Columbia river at Bakers Bay- Part 1, p. 1769- 1770;
- 11) Columbia river at Bonneville-Part 1. p. 1829-I 838;
- 12) Skipanon Channel (located at Warrenton, OR; originally called Skipanon river, a narrow crooked stream with -1.8 mi tidal)-Part 1, p. 1742-1 744 (Note: reference provides a short history of the stream & condition);
- 13) Youngs Bay and Youngs river (lower 8 mi. tidal)-Part 1, p. 1745-1746;
- 14) Multnomah Channel (also known as Willamette Slough)-Part 1. p. 1753-I 754;
- 15) Oregon Slough (also known as North Portland Harbor)-Part 1, p. 1498-1499;
- 16) Westport Slough (side channel of the Columbia river located 70 mi. below Portland. OR)- Part 1. p. 1751;
- 17) Elockomin Slough (3.5 mi. in length, located 75 mi. below Portland)-Part 1, p. 1765-1 766;
- 18) Columbia river between Vancouver and Bonneville-Part 1. p. 1828- 1829;
- 19) Columbia river between Chinook, WA and head of Sand Island-Part 1. p. 1770-I 77 1: and
- 20) Information regarding diking & Improving Districts along lower Columbia-Part 1. p. 1774- 1808.

REFERENCE # 332

U.S. Army. 1939. *Report of the chief of engineers U.S. Army 1939 in two parts*. Annual Reports. War Department. Fiscal Year Ended June 30. 1939. Washington Government Printing Office. 623Un3 1 r. Suzzallo Library, Auxiliary Stacks. U of W.

Annotation The reference contains **comprehensive** information regarding projects and activities related to the **channelization**, diking, and channel/bank maintenance of the mouth, estuarine, tidal river zones of the Columbia and Willamette rivers and other tributaries thereof (e.g. Clatskanie, Cowlitz, Lewis, Skamokawa, Grays, and Deep). Includes information regarding original and existing conditions of the river section/surrounding area (may be relative to habitat conditions) and notes commerce & development activities of adjacent area. The following estuarine/tidal river zone (of the lower Columbia region) and associated activities information (e.g. surveys, project history, costs & results, etc.) are covered:

- 1) Mouth of the Columbia river- Part 1, p. 1890-1 893;
- 2) Columbia and lower Willamette rivers below Vancouver and Portland- Part 1, p. 1897-1 903;
- 3) Clatskanie river (empties through Beaver and Wallace Sloughs into the Columbia river 65 mi below Portland)- Part 1, p. 1903-1 904;
- 4) Lewis river (empties into Columbia 26 miles below Portland, stream is tidal to La Center on East Fork and Woodland on the North Fork)- Part 1, p. 1914-1 915;
- 5) Cowlitz river (empties into Columbia river 45 mi. below Portland; tidal to 9 miles above mouth)- Part 1, p. 1915-1917;
- 6) Skamokawa Creek (empties into Columbia river at RM 34, lower 1.5 mi. tidal)- Part 1, p. 1918-1919;
- 7) Grays river (empties into Grays Bay at mouth; tidal in lower 8 mi.)- Part 1, p. 1919- 1920;
- 8) Deep river (formerly known as Alamicut river- a tidal slough extending 4 mi. inland from a northerly direction of Grays Bay- Part 1, p. 1920- 1922;
- 9) Lake river (enters Columbia river near the mouth of the Lewis river)- Part 1, p. 1913- 19 14 (Note: a short history of the stream and associated activities/description is provided);
- 10) Columbia river at Bakers Bay- Part 1, p. 1922- 1923;
- 11) Columbia river at Bonneville-Part 1, p. 2002-20 11;
- 12) Skipanon Channel (located at Warrenton, OR; originally called Skipanon river, a narrow crooked stream with -1.8 mi tidal)-Part 1, p. 1893-1 895 (Note: reference provides a short history of the stream & condition);
- 13) Youngs Bay and Youngs river (lower 8 mi. tidal)-Part 1, p. 1895-1 897;
- 14) Multnomah Channel (also known as Willamette Slough)-Part 1, p. 1904-1 905;
- 15) Oregon Slough (also known as North Portland Harbor)-Part 1, p. 1498-1499;
- 16) Westport Slough (side channel of the Columbia river located 70 mi. below Portland, OR)- Part 1, p. 1751;
- 17) Elockomin Slough (3.5 mi. in length, located 75 mi. below Portland)-Part 1, p. 1917-1 918;
- 18) Columbia river between Vancouver and Bonneville-Part 1, p. 2000-2002;
- 19) Columbia river between Chinook, WA and head of Sand Island-Part 1, p. 1923-1 924; and
- 20) Information regarding diking & Improving Districts along lower Columbia-Part 1, p. 1927-1973.

APPENDIX B

**Matrices Of Reference Indices Identifying Annotated References Of Bibliographic Listing
According To Environ And General Attribute And Information Category For Time
Periods 1 - 6**

Matrix 1. Reference Index Identifying Annotated References of Bibliographic Listing According To Environ and General Attribute And Information Category For Time Period 1: Pre 1830

| Location/ Environ | General Attribute & Information Categories And Related References (#) ¹ | | | | | |
|----------------------|--|--------------------------|--------------------------------|---|-----|----------------------|
| | <i>Abiotic Attributes</i> | <i>Biotic Attributes</i> | <i>Pacific Salmon Specific</i> | <i>General History, Description & Information</i> | | <i>Miscellaneous</i> |
| <i>Ocean</i> | | | | | | |
| <i>Plume</i> | | | | | | |
| <i>Estuary</i> | | | | 165 | 253 | 280 |
| <i>Tidal River</i> | | | | 253 | | |
| <i>Riverine</i> | | | | 253 | | |

¹Reference numbers refer to citations listed in Appendix A of this report.

Matrix 2. Reference Index **Identifying** Annotated References of Bibliographic Listing According To Environ and General Attribute And Information Category For Time Period 2: 1830 - 1888

| Location/ Environ | General Attribute & Information Categories And Related References (#) | | | | | | | | | |
|----------------------|---|------------|------------|--------------------------|-----|--------------------------------|---|---------------------------------|--------------------------|----------------------|
| | <i>Abiotic Attributes</i> | | | <i>Biotic Attributes</i> | | <i>Pacific Salmon Specific</i> | <i>General History, Description & Information</i> | | | <i>Miscellaneous</i> |
| <i>Ocean</i> | | | | | | | | | | |
| <i>Plume</i> | | | | | | | | | | |
| <i>Estuary</i> | 003 096 286 | 006 284 | 082 285 | 006 | 112 | | 003 112 220 380 286 | 006 165 227 284 | 096 165 253 285 | |
| <i>Tidal River</i> | 284 | 285 | 286 | | | | 220 285 | 253 286 | 284 | |
| <i>Riverine</i> | 284 | 285 | 286 | | | | 169 285 | 253 286 | 281 | |

Matrix 3. Reference Index Identifying Annotated References of Bibliographic Listing According To Environ and General Attribute And Information Category For Time Period 3: 1889 - 1922

| Location/ Environ | General Attribute & Information Categories And Related References (#) | | | | | | | | | |
|----------------------|---|-----|-----|--------------------------|-----|--------------------------------|---|------------|------------|----------------------|
| | <i>Abiotic Attributes</i> | | | <i>Biotic Attributes</i> | | <i>Pacific Salmon Specific</i> | <i>General History, Description & Information</i> | | | <i>Miscellaneous</i> |
| <i>Ocean</i> | | | | | | | | | | |
| <i>Plume</i> | | | | | | | | | | |
| <i>Estuary</i> | 003 | 006 | 043 | 006 | 112 | | 003 | 006 | 043 | |
| | 082 | 158 | 287 | | | | 062 | 112 | 113 | |
| | 288 | 289 | 290 | | | | 157 | 158 | 165 | |
| | 291 | 292 | 293 | | | | 165 | 194 | 217 | |
| | 294 | 295 | 296 | | | | 220 | 227 | 253 | |
| | 297 | 298 | 299 | | | | 280 | 287 | 288 | |
| | 300 | 301 | 302 | | | | 289 | 290 | 291 | |
| | 303 | 304 | 305 | | | | 292 | 293 | 294 | |
| | 306 | 307 | 308 | | | | 295 | 296 | 297 | |
| | 309 | 310 | 311 | | | | 298 | 299 | 300 | |
| | 312 | 313 | 314 | | | | 301 | 302 | 303 | |
| | 315 | | | | | | 304 | 305 | 306 | |
| | | | | | | | 307 | 308 | 309 | |
| | | | | | | | 310 | 311 | 312 | |
| | | | | | | | 313 | 314 | 315 | |

| Location/ Environ | General Attribute & Information Categories And Related References (#) | | | | | | | | | | | | | | |
|----------------------|---|-----|-----|--------------------------|--|--|--------------------------------|--|--|---|-----|-----|----------------------|--|--|
| | <i>Abiotic Attributes</i> | | | <i>Biotic Attributes</i> | | | <i>Pacific Salmon Specific</i> | | | <i>General History, Description & Information</i> | | | <i>Miscellaneous</i> | | |
| <i>Tidal River</i> | 287 | 288 | 289 | | | | | | | 062 | 157 | 217 | | | |
| | 290 | 291 | 292 | | | | | | | 220 | 253 | 287 | | | |
| | 293 | 294 | 295 | | | | | | | 288 | 289 | '90 | | | |
| | 296 | 297 | 298 | | | | | | | 291 | 292 | 293 | | | |
| | 299 | 300 | 301 | | | | | | | 294 | 295 | 296 | | | |
| | 302 | 303 | 304 | | | | | | | 297 | 298 | 299 | | | |
| | 305 | 306 | 307 | | | | | | | 300 | 301 | 302 | | | |
| | 308 | 309 | 310 | | | | | | | 303 | 304 | 305 | | | |
| | 311 | 312 | 313 | | | | | | | 306 | 307 | 308 | | | |
| | 314 | 315 | | | | | | | | 309 | 310 | 311 | | | |
| | | | | | | | | | | 312 | 313 | 314 | | | |
| | | | | | | | | | | 315 | | | | | |
| <i>Riverine</i> | 265 | 287 | 288 | | | | 187 | | | 062 | 157 | 169 | | | |
| | 289 | 290 | 291 | | | | | | | 186 | 187 | 217 | | | |
| | 292 | 293 | 294 | | | | | | | 253 | 265 | 287 | | | |
| | 295 | 296 | 297 | | | | | | | 288 | 289 | 390 | | | |
| | 298 | 299 | 300 | | | | | | | 291 | 292 | 293 | | | |
| | 301 | 302 | 303 | | | | | | | 294 | 295 | 296 | | | |
| | 304 | 305 | 306 | | | | | | | 297 | 298 | 299 | | | |
| | 307 | 308 | 309 | | | | | | | 300 | 301 | 302 | | | |
| | 310 | 311 | 312 | | | | | | | 303 | 304 | 305 | | | |
| | 313 | 314 | 315 | | | | | | | 306 | 307 | 308 | | | |
| | | | | | | | | | | 309 | 310 | 311 | | | |
| | | | | | | | | | | 312 | 313 | 314 | | | |
| | | | | | | | | | | 315 | | | | | |

Matrix 4. Reference Index **Identifying** Annotated References of Bibliographic Listing , According To Environ and General Attribute And Information Category For Time Period 4: 1923 - 1938

| Location/ Environ | General Attribute & Information Categories And Related References (#) | | | | | | | | | |
|----------------------|---|------------|------------|--------------------------|-----|--------------------------------|--|------------|------------|----------------------|
| | <i>Abiotic Attributes</i> | | | <i>Biotic Attributes</i> | | <i>Pacific Salmon Specific</i> | <i>General History, Description & Information.</i> | | | <i>Miscellaneous</i> |
| <i>Ocean.</i> | | | | | | | | | | |
| <i>Plume</i> | | | | | | | | | | |
| <i>Estuary</i> | 006 | 044 | 082 | 006 | 112 | | 006 | 096 | 112 | |
| | 096 | 159 | 189 | | | | 159 | 165 | 165 | |
| | 316 | 317 | 318 | | | | 179 | 219 | 220 | |
| | 319 | 320 | 321 | | | | 227 | 280 | 316 | |
| | 322 | 323 | 324 | | | | 317 | 318 | 319 | |
| | 325 | 326 | 327 | | | | 320 | 321 | 322 | |
| | 328 | 329 | 330 | | | | 323 | 324 | 325 | |
| | 331 | | | | | | 326 | 327 | 328 | |
| | | | | | | | 329 | 330 | 331 | |
| <i>Tidal River</i> | 140 | 159 | 160 | | | | 140 | 159 | 160 | |
| | 164 | 316 | 317 | | | | 182 | 219 | 220 | |
| | 318 | 319 | 320 | | | | 316 | 317 | 318 | |
| | 321 | 322 | 323 | | | | 319 | 320 | 321 | |
| | 324 | 325 | 326 | | | | 322 | 323 | 324 | |
| | 327 | 328 | 329 | | | | 325 | 326 | 327 | |
| | 330 | 331 | | | | | 328 | 329 | 330 | |
| | | | | | | | 331 | | | |

| Location/ Environ | General Attribute & Information Categories And Related References (#) | | | | | | | | | | | | | | | | | |
|------------------------------|--|-----|-----|--------------------------|--|--|--------------------------------|-----|-----|---|--|--|----------------------|--|--|--|--|--|
| | <i>Abiotic Attributes</i> | | | <i>Biotic Attributes</i> | | | <i>Pacific Salmon Specific</i> | | | <i>General History, Description & Information</i> | | | <i>Miscellaneous</i> | | | | | |
| <i>Riverine</i> | 159 | 160 | 185 | | | | 159 | 160 | 169 | | | | | | | | | |
| | 272 | 273 | 274 | | | | 180 | 316 | 317 | | | | | | | | | |
| | 275 | 316 | 317 | | | | 318 | 319 | 320 | | | | | | | | | |
| | 318 | 319 | 320 | | | | 321 | 322 | 323 | | | | | | | | | |
| | 321 | 322 | 323 | | | | 324 | 325 | 326 | | | | | | | | | |
| | 324 | 325 | 326 | | | | 327 | 328 | 329 | | | | | | | | | |
| | 327 | 328 | 329 | | | | 330 | 331 | | | | | | | | | | |
| | 330 | 331 | | | | | | | | | | | | | | | | |

Matrix 5. Reference Index Identifying Annotated References of Bibliographic Listing , According To Environ and General Attribute And Information Category For Time Period 5: 1939 - 1958

| Location/ Environ | General Attribute & Information Categories And Related References (#) | | | | | | | | | |
|----------------------|---|-----|-----|--------------------------|-----|--------------------------------|--|-----|-----|----------------------|
| | <i>Abiotic Attributes</i> | | | <i>Biotic Attributes</i> | | <i>Pacific Salmon Specific</i> | <i>General History , Description & Information</i> | | | <i>Miscellaneous</i> |
| <i>Ocean</i> | | | | | | | | | | |
| <i>Plume Estuary</i> | 006 | | | 006 | 112 | 146 | 006 | 047 | 068 | |
| | 137 | 068 | 096 | | | | 082 | 096 | 112 | |
| | | 141 | 162 | | | | 137 | 162 | 165 | |
| | 176 | 185 | 332 | | | | 176 | 177 | 178 | |
| | | | | | | | 280 | 332 | | |
| <i>Tidal River</i> | 068 | 137 | 160 | 161 | | 161 | 068 | 137 | 160 | |
| | 161 | 162 | 176 | | | | 161 | 162 | 332 | |
| | 185 | 332 | | | | | | | | |
| <i>Riverine</i> | 137 | 160 | 161 | 161 | | 161 | 099 | 137 | 160 | |
| | 162 | 185 | 272 | | | | 161 | 162 | 169 | |
| | 273 | 274 | 275 | | | | 332 | | | |
| | 332 | | | | | | | | | |

Matrix 6. Reference Index **Identifying** Annotated References of Bibliographic Listing , According To Environ and General Attribute And Information Category For Time Period 6: Post 1958

| Location/ Environ | General Attribute & Information Categories And Related References (#) | | | | | | | | | | |
|----------------------|---|--|--|--|---------------------------------|--------------------------|--------------------------------|--|------------|---|-----|
| | <i>Abiotic Attributes</i> | | | <i>Biotic Attributes</i> | | | <i>Pacific Salmon Specific</i> | | | <i>General History, Description & Information</i> | |
| <i>Ocean</i> | 002 132 230 251 | 004 147 232 252 | 127 163 234 | 002 234 | 127 251 | 230 | 090 | | | 090 251 | 001 |
| <i>Plume</i> | 002 012 127 148 151 190 229 234 252 | 004 054 132 149 153 223 230 250 282 | 007 109 147 150 163 224 232 251 | 002 057 148 230 251 | 007 109 223 234 | 021 127 229 250 | 007 021 090 | | 090 251 | 001 | |

| Location/ Environ | General Attribute & Information Categories And Related References (#) | | | | | | | | | | | | | | |
|----------------------|---|------------|------------|--------------------------|------------|------------|--------------------------------|------------|-----|--|------------|------------|----------------------|------------|-----|
| | <i>Abiotic Attributes</i> | | | <i>Biotic Attributes</i> | | | <i>Pacific Salmon Specific</i> | | | <i>General History , Description & Information</i> | | | <i>Miscellaneous</i> | | |
| <i>Estuary</i> | 002 | 006 | 007 | 002 | 006 | 007 | 007 | 008 | 021 | 006 | 009 | 010 | 001 | 005 | 014 |
| | 008 | 009 | 010 | 008 | 009 | 011 | 090 | 146 | 215 | 058 | 069 | 075 | 107 | | |
| | 012 | 027 | 038 | 021 | 023 | 040 | 248 | 249 | 268 | 083 | 090 | 101 | | | |
| | 040 | 041 | 053 | 041 | 042 | 057 | | | | 102 | 103 | 112 | | | |
| | 054 | 055 | 069 | 059 | 061 | 073 | | | | 118 | 124 | 133 | | | |
| | 080 | 083 | 091 | 077 | 091 | 100 | | | | 136 | 139 | 165 | | | |
| | 097 | 098 | 102 | 102 | 110 | 112 | | | | 175 | 193 | 221 | | | |
| | 104 | 118 | 126 | 125 | 127 | 134 | | | | 248 | 249 | 251 | | | |
| | 127 | 128 | 134 | 139 | 175 | 207 | | | | 266 | 279 | 280 | | | |
| | 135 | 139 | 141 | 214 | 215 | 218 | | | | | | | | | |
| | 143 | 150 | 151 | 221 | 248 | 249 | | | | | | | | | |
| | 153 | 163 | 165 | 251 | 266 | 267 | | | | | | | | | |
| | 167 | 168 | 170 | 268 | 269 | 270 | | | | | | | | | |
| | 171 | 175 | 188 | | | | | | | | | | | | |
| | 190 | 191 | 216 | | | | | | | | | | | | |
| | 218 | 221 | 224 | | | | | | | | | | | | |
| | 235 | 238 | 248 | | | | | | | | | | | | |
| | 249 | 251 | 266 | | | | | | | | | | | | |
| | 270 | 276 | 277 | | | | | | | | | | | | |
| | 281 | 283 | | | | | | | | | | | | | |
| <i>Tidal River</i> | 009 | 013 | 054 | 009 | 013 | 057 | | | | 009 | 058 | 069 | 107 | | |
| | 069 | 072 | 083 | 251 | 278 | | | | | 083 | 251 | 278 | | | |
| | 152 | 167 | 168 | | | | | | | 283 | | | | | |
| | 235 | 251 | 277 | | | | | | | | | | | | |
| | 278 | 283 | | | | | | | | | | | | | |

| Location/ Environ | General Attribute & Information Categories And Related References (#) | | | | | | | | | | | | |
|----------------------|---|-----|-----|--------------------------|-----|-----|--------------------------------|---|-----|-----|----------------------|-----|-----|
| | <i>Abiotic Attributes</i> | | | <i>Biotic Attributes</i> | | | <i>Pacific Salmon Specific</i> | <i>General History, Description & Information</i> | | | <i>Miscellaneous</i> | | |
| <i>Riverine</i> | 027 | 038 | 054 | 027 | 251 | 278 | 145 | 027 | 058 | 083 | 001 | 005 | 107 |
| | 083 | 127 | 152 | | | | | 169 | 251 | 278 | | | |
| | 185 | 251 | 272 | | | | | 283 | | | | | |
| | 273 | 274 | 275 | | | | | | | | | | |
| | 278 | | | | | | | | | | | | |

APPENDIXC

**Template For Matrices Of Information Preference Sources, Geographic Locations, And
Data Descriptions Relevant To Analytic Evaluations Of Abiotic And Biotic Attributes
Associated With Pacific Salmon Life Histories**

MATRIX 1. INFORMATION (REFERENCE SOURCES, GEOGRAPHIC LOCATIONS, AND DATA DESCRIPTION) RELEVANT TO ANALYTIC VALUATIONS OF ABIOTIC OR BIOTIC ATTRIBUTES ASSOCIATED WITH PACIFIC SALMON LIFE HISTORIES

| WATER ATTRIBUTES | | PHYSIO-MORPHOMETRIC & GEO-MORPHOMETRIC ATTRIBUTES | | |
|---|---|---|---|---|
| Quantity | Quality | Channel | Riparian | Uplands |
| Reference #: Geographic Location Code: Data Description: |
| Reference #: Geographic Location Code: Data Description: |
| Reference #: Geographic Location Code: Data Description: |
| Reference #: Geographic Location Code: Data Description: |
| Reference #: Geographic Location Code: Data Description: |
| Reference #: Geographic Location Code: Data Description: |
| Reference #: Geographic Location Code: Data Description: |
| Reference #: Geographic Location Code: Data Description: |

APPENDIXD

Template For Matrices Of Numerical Values, Geographic Locations, And Reference Numbers Pertinent To Analytic Evaluations Of Abiotic And Biotic Attributes Associated With Pacific Salmon Life Histories

MATRIX 1. NUMERICAL VALUES, GEOGRAPHIC LOCATIONS, AND REFERENCE NOS. PERTINENT TO ANALYTIC EVALUATIONS OF ABIOTIC OR BIOTIC ATTRIBUTES ASSOCIATED WITH PACIFIC SALMON LIFE HISTORIES

| WATER ATTRIBUTES | | PHYSIO-MORPHOMETRIC & GEO-MORPHOMETRIC AT-TRIBUTES | | |
|---|---|--|--|---|
| Quantity | Quality | Channel | Riparian | Uplands |
| Mean: Range: Geographic Location Code: Reference Nos. | Mean: Range: Geographic Location Code: Reference Sos | hlean: Range: Geographic Location Code: Reference Nos | Slean: Range: Geographic Location Code: Reference Sos | Mean: Range: Geographic Location Code: Reference Nos |
| hlean: Range: Geographic Location Code: Reference Nos. | Slean: Range: Geographic Location Code: Reference Nos | Mean: Range: Geographic Location Code: Reference Sos | Mean: Range: Geographic Location Code: Reference Nos | hlean: Range: Geographic Location Code: Reference Sos |
| Mean: Range: Geographic Location Code: Reference Sos. | hlean. Range: Geographic Location Code: Reference Nos | Mean: Range: Geographic Location Code: Reference Sos | Mean: Range: Geographic Location Code: Reference Nos | hlean: Range: Geographic Location Code: Reference Sos |
| hlean: Range: Geographic Location Code: Reference Nos. | Mean: Range: Geographic Location Code: Reference Sos | hlean: Range: Geographic Location Code: Reference Nos | Mean: Range: Geographic Location Code: Reference Nos | hlean: Range: Geographic Location Code: Reference Sos |
| Mean: Range: Geographic Location Code: Reference Sos. | Mean: Range: Geographic Location Code: Reference Sos | Mean: Range: Geographic Location Code: Reference Nos | Mean: Range: Geographic Location Code: Reference Nos | Mean: Range: Geographic Location Code: Reference Sos |
| Mean: Range: Geographic Location Code: Reference Sos. | Slean: Range: Geographic Location Code: Reference Nos | Slean: Range: Geographic Location Code: Reference Nos | hlean: Range: Geographic Location Code: Reference Sos | Mean: Range: Geographic Location Code: Reference Nos |