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ANNOTATED BIBLIOGRAPHY OF THE LAKE WASHINGTON DRAINAGE

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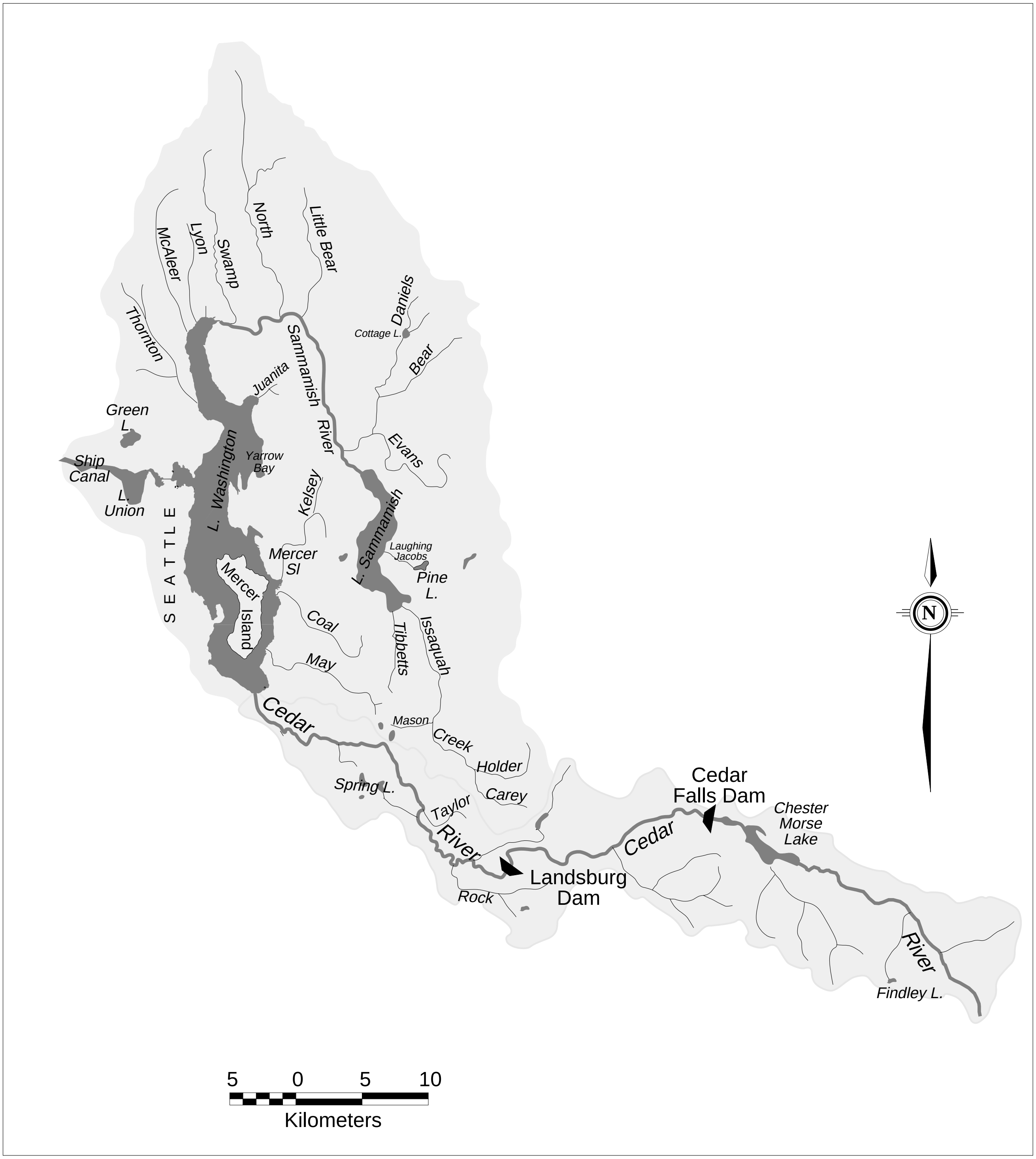

Map of Lake Washington drainage basin.

ACKNOWLEDGMENTS

Construction of this bibliography was made possible by the H. Mason Keeler Endowment for Excellence to the School of Fisheries, University of Washington. Acknowledgment is given to the library staff at the University of Washington College of Oceanography and Fisheries Library for their patience and expertise in locating documents and using the computerized University catalog. Additional thanks go to the librarians at the Metro Library for their help in locating government documents stored in their library. Many others need to be thanked for sharing their bibliographies and copies of documents, including Dr. W. T. Edmondson, Professor Emeritus at the University of Washington; Gino Luchetti of King County Surface Water Management; David Beauchamp of Utah State University; and Bob Pfeifer, Washington Department of Fish and Wildlife.

KEY WORDS

bibliography, Lake Washington, salmon

INTRODUCTION

This bibliography contains annotated references for 693 documents that pertain to the ecology of the Lake Washington drainage basin. Both published and unpublished reports are included, but special care was given to locate and include published scientific papers, university theses, and dissertations relevant to the waters of the drainage. This bibliography does not include all the numerous environmental impact statements prepared as prerequisites to current development projects in the basin although several of these reports are included. Additionally, research on primarily upslope processes such as forestry, geology, and soils was not included.

There are almost 100 years of published research on the Lake Washington drainage basin. The earliest published report in this bibliography is dated 1895, almost 50 years after the founders of modern Seattle built their settlement on the shores of Alki Point. The 1895 report by Seale is a list of nine species of freshwater fish collected from Green Lake and Lake Washington. This was an important time in the history of Lake Washington. Plans were being developed to link Lake Washington with the marine waters of Puget Sound via a canal which was eventually completed in 1917. The construction of the canal also included lowering the level of Lake Washington and controlling its future elevation by diverting the Cedar River to flow into the lake. At the same time the original outlet for the lake, the Black River channel, was abandoned. A good review of the history of the canal and its effects on Lake Washington's morphology and hydrology is provided in Chrzastowski (1983).

A majority of the research on the waters of Lake Washington was prompted by its unique position in time and space. Its location within a relatively recent and rapidly growing metropolitan area during a period of increasing scientific understanding of ecological relationships makes the basin an excellent study site for investigating the effects of urbanization. Additionally, the University of Washington is situated along the shore of Union Bay, creating a convenient outdoor laboratory for researchers. Because of this combination of urban influence and scientific curiosity, the increasing eutrophication of Lake Washington during the mid-1900s was carefully described (Edmondson 1961). The story of the subsequent diversion of sewage and recovery of the lake was recently published as a book (Edmondson 1991) by the lake's foremost authority, Dr. W. T. "Tommy" Edmondson, Emeritus professor at the University of Washington.

Two other milestones in the history of research on the Lake Washington basin included the population explosion of returning adult sockeye salmon to the lake in the 1960s and the International Biological Program in the early 1970s. In 1967, the Washington State Department of Fisheries began to actively manage the sockeye run, collecting data and establishing harvest limits. A recent review of the sockeye population dynamics in the lake was presented at the 1993 North American Lake Management Society symposium (Fresh 1993). Concurrent with the growing interest in the sockeye run, a suite of ecological studies on the basin was initiated by the University of Washington as part of their effort in the federally funded International Biological Program. In 1972 the first annotated bibliography of the entire basin was published as a bulletin of the International Biological Program by Dr. Richard S. Wydoski (Wydoski, 1972). The Wydoski bibliography contained 392 citations of published and unpublished reports, and the authors of this current bibliography are indebted to his earlier efforts. The Wydoski bibliography was an invaluable starting point for this newer bibliography, and many of the references included herein use Wydoski's original annotations. However, some of the references in the Wydoski bibliography, including unpublished reports and memos that could not be located, and documents that focus primarily on terrestrial aspects of the watershed, were not included in this bibliography.

The Computerized Bibliography

This annotated bibliography was constructed on an IBM-PC compatible with the PAPYRUS(TM) Bibliography System, Version 7.0 (Research Software Design, 1992). This database program is a permanent storage for the reference citations, and is capable of quickly searching, sorting, and formatting the citations as needed. This computerized system facilitates easy searches for references by authors, year, and/or key word. It is also easy to add new references or modify existing citations and key words. Other PAPYRUS(TM) users will be able to modify their own copies of this bibliography, tailoring it to their research needs.

For interested persons without the PAPYRUS system, a "read-only" version of this database program is available on diskette. It is capable of searching and outputting the results to the screen, to a disk file, or to a printer. However, it is not possible to make any changes or additions to the database while using this read-only version.

Document Sources

The primary sources of references and documents consulted for this project are as follows: (1) the 1972 Wydoski bibliography (Wydoski, 1972); (2) the University of Washington's computerized library catalog, (LCAT) (BRS Software Products, 1991); and (3) the Metro library. Additionally three compact disc (CD-ROM) bibliographic databases were searched for relevant citations. These databases included the Compact Cambridge® Aquatic Sciences & Fisheries Abstracts (ASFA) (1982-1992) (Cambridge Scientific Abstracts, 1992); and the Compact Cambridge® Selected Water Resources Abstracts (SWRA) (1967-1992) (Cambridge Scientific Abstracts, 1992).

Selection of Key Words and Annotations

Each reference in this bibliography is indexed by one or more key words. The key words were selected to describe each report's topic(s) and study location(s) within the drainage basin. Please keep in mind that the key words were designed for this bibliography as an aid to the reader and may not reflect the principle intent of the author. Some key words are more specific than others, so it is possible to search for references using a general key word, such as "POLLUTION" or a more specific key word, such as "HYDROCARBONS." Because of the size and breath of the bibliography, most of the specific key words refer only to documents of fish and fisheries topics. For example, "GROWTH," "ABUNDANCE," "DISTRIBUTION," "BREED-

ING," and "FECUNDITY" are used as key words only to index studies on fish and were not used to index studies on zooplankton or birds.

The annotations that follow each reference are short summaries of the relevant information contained in the document. For many of the journal articles the full abstract is provided. Some of the summaries are given as initially found in the Wydoski bibliography and the summaries are appropriately cited. The annotations are provided for convenience only and the information provided should not be cited without confirmation with the actual document.

Location of References

Ideally all of the documents referenced in this bibliography would be housed in one location. This would be especially useful for anyone needing the information contained in one of the unpublished or more obscure documents. It is hoped that in the future a repository for all documents pertaining to the Lake Washington drainage basin will be located at the University of Washington's School of Fisheries (UW SOF). In the short term, copies of many of the journal articles, theses, and dissertations generated in the University of Washington are being collected and stored in the office of Dr. Thomas H. Sibley in the UW SOF.

Currently the database and this printed copy of the bibliography contains information on the location of most references. Only the location closest to the UW SOF is given for a reference, even if the document is available in more than one library or personal collection. A table is provided listing the location addresses at which documents can be found.

ANNOTATED BIBLIOGRAPHY

1. Abella, S. E. B. 1988. Effect of the Mt. Mazama ashfall on the planktonic diatom community of Lake Washington. *Limnol. Oceanogr.* 33:1376-1385. Location: UW SOF/THS

L. WASHINGTON, PALEOLIMNOLOGY, PHYTOPLANKTON, SEDIMENTS

Preserved diatom assemblages are found in deep water sediments in Lake Washington above and below an ash layer originating from an eruption of Mt. Mazama 6800 B.P. Total abundance of frustules did not change after the ash event, but a significant shift in community structure occurred. *Melosira italica* var. *subarctica* increased after the ashfall, and *Fragilaria crotonensis* decreased. The changes most likely indicate an increase in the Si:P ratio and decreased light penetration in the eutrophic zone during winter and spring.

2. Adams, D. 1973. The paleoecology of two lakes in western Washington. M.S. Thesis. University of Washington. 58 pp. Location: UW SOF/THS

FINDLEY LAKE, LAND USE, PALEOLIMNOLOGY, SEDIMENTS

Pollen, diatom and sedimentary chlorophyll analysis of two lakes in western Washington (Findley and Angle Lakes) showed distinct relationships between the aquatic and terrestrial environments. Any severe disturbance of the terrestrial environment caused shifts in the aquatic ecosystem. These changes often involved a sequence of changes in the dominant diatom present. Further, the pattern of changes in the aquatic ecosystem seemed to be related to the type of disturbance in the surrounding watershed; human disturbance caused changes in the lake different than those caused by previous nearby forest fires. Sedimentary chlorophyll either did not change significantly or varied in relation to changes in the number of conifer needles in the sediment.

3. Adeniyi, R. O. 1990. Fishway impacts on the population of resident cutthroat trout (*Oncorhynchus clarki*) in Evans Creek, Washington. M.S. Thesis. University of Washington. 198 pp. Location: Fisheries Library

COHO SALMON, CUTTHROAT TROUT, EVANS CREEK, FISH, FLOW, GROWTH, SPAWNING, STREAMS, URBANIZATION

This study examined the impact of fishway installation on the population of resident cutthroat trout in Evans Creek, Washington. Distribution and characteristics of adult spawning migration, spawning, population dynamics, and movement in relation to the fishway were studied before (1984) and after (1985 and 1986) the installation of the fabricated pool and weir fishway with alternating triangular weir slots. The fishway was designed and installed by the Washington Department of Fisheries to eliminate blockage to upstream passage of adult salmon. Results from this study indicate that installation of the fishway altered the salmonid production of Evans Creek. It enhanced coho salmon and searun cutthroat population by opening up an additional 1.8 river miles of spawning and rearing habitat and redistributed coho and searun cutthroat within the watershed. In contrast, it decreased resident cutthroat population in Evans Creek by allowing anadromous fish access to resident cutthroat stream habitats.

4. Ajwani, S. 1956. A review of Lake Washington watershed, historical, biological, and limnological. M.S. Thesis. University of Washington. 148 pp. Location: UW SOF/THS

BEAR CREEK, BIBLIOGRAPHY, CEDAR RIVER, COAL CREEK, FISH, ISSAQUAH CREEK, JUANITA CREEK, L. SAMMAMISH, L. WASHINGTON, LITTLE BEAR CREEK, MANAGEMENT, MAY CREEK, MCALEER CREEK, MERCER SLOUGH, NORTH CREEK, REVIEW, ROCK CREEK, SAMMAMISH R., STOCKING, STREAMS, SWAMP CREEK, THORNTON CREEK

To formulate a sound fishery management program, for an ocean, sea, bay, strait, lake or stream, it was found to be of utmost importance to have adequate information regarding the body of water. This information should include, the sequence of historical events beginning as far back as it is possible. It is often necessary to look into the past to see if answers to present day management problems can be found in history. This thesis is a compilation of such data with regard to the Lake Washington watershed.

5. Allen, G. H. 1956. Migration, distribution and movement of Puget Sound silver salmon. Ph.D. Dissertation. University of Washington. 295 pp. Location: Fisheries Library

COHO SALMON, DISTRIBUTION, FISH, MIGRATION, STOCKING

This is a study of migration, distribution, and homing instinct of five groups of marked silver salmon (*Oncorhynchus kisutch*) that were planted during the spring of 1952 in Puget Sound streams. The two groups (both from the same stock) of 12-month-reared fingerlings were “mass-planted” in the Lake Washington watershed (Wydoski, 1972).

6. Allen, G. H. 1958. Survial through hatching of eggs from silver salmon (*Oncorhynchus kisutch*). *Trans. Am. Fish. Soc.* 87:207-219.

COHO SALMON, FISH, SPAWNING

This report describes survival of eggs that were obtained from 1950-brood-year salmon. These fish were recovered during the 1953/1954 spawning season at the University of Washington College of Fisheries trap (Wydoski, 1972).

7. Allen, G. H. 1959. Growth of marked silver salmon (*Oncorhynchus kisutch*) of the 1950 brood in Puget Sound. *Trans. Am. Fish. Soc.* 88:310-318.

COHO SALMON, FISH, GROWTH, L. WASHINGTON, STOCKING

Two stocks of marked silver salmon (*Oncorhynchus kisutch*) were released into Minter Creek and the Lake Washington watersheds during the spring of 1952. Average lengths of all marked salmon recovered in the Pacific Ocean at the same time and place, and at time of escapement, showed that the Lake Washington salmon were larger than those from Minter Creek (Wydoski, 1972).

8. Allen, G. H. 1959. Behavior of chinook and silver salmon. *Ecology* 40:108-113.

CHINOOK SALMON, COHO SALMON, ESCAPEMENT, FISH, HATCHERIES, SPAWNING

During the escapement of 1953/1954, 83 chinook and 113 silver salmon returned to the University of Washington College of Fisheries hatchery. External stimuli initiated their return to the pond (which is considered analogous to a salmon’s movement onto the spawning beds in natural areas) (Wydoski, 1972).

9. Allen, G. H. 1965. Estimating error associated with ocean recoveries of fin marked coho salmon. *Trans. Am. Fish. Soc.* 94:319-326.

COHO SALMON, FISH, STOCKING

Estimation of error associated with ocean recoveries is reported for coho salmon released into Puget Sound in 1952 from the Lake Washington watershed and Minter Creek. Errors include unauthentic recoveries, duplication of marks, and fin regeneration. Major source of error in ocean fisheries recoveries was attributed to salmon clipped of only one fin (Wydoski, 1972).

10. Allen, G. H. 1966. Ocean migration and distribution of fin-marked coho salmon. *J. Fish. Res. Board Can.* 23:1043-1061.

COHO SALMON, DISTRIBUTION, FISH, MIGRATION, STOCKING

Differences in migration, distribution, and movements of five groups of fin-marked cohos were correlated with time, place, and method of planting. Fish planted in southern Puget Sound remained within Puget Sound to a greater degree than fish planted in middle Puget Sound from the Lake Washington watershed (Wydoski, 1972).

11. Allen, G. H. 1968. Mortality of coho smolts migrating through a lake system. *Ecology* 49:1001-1002.

COHO SALMON, FISH, HATCHERIES, ISSAQUAH CREEK, STOCKING, STREAMS

Two groups of fin-marked 1950-brood coho salmon were planted into Lake Washington drainage in the spring of 1952. One group, with left ventral marks, was planted at the University of Washington, which is 8 km from Puget

Sound. The other group, with right ventral marks, was planted at the Issaquah Creek hatchery, which is 56 km from Puget Sound. The right ventral-marked fish suffered 22% greater mortality than the left-ventral-marked fish (Wydoski, 1972).

12. Allen, G. H. 1969. Catch-to-escapement rates of fin-marked 1950-brood Puget Sound coho salmon. *Trans. Am. Fish. Soc.* 98:599-610.

COHO SALMON, DISTRIBUTION, ESCAPEMENT, FISH, L. WASHINGTON, STOCKING

Catch-to-escapement (C-E) ratios of five groups of fin-marked 1950-brood Puget Sound coho salmon are summarized. For salmon released at Minter Creek the C-E ratio was 4:1, whereas salmon released at Lake Washington had a C-E ratio of 3:1. In contrast, for salmon migrating into the Pacific Ocean (90% of the Lake Washington and 45% of the Minter Creek), the Lake Washington salmon had a C-E ratio ten times greater than the Minter Creek salmon (14:1 versus 1.4:1) (Wydoski, 1972).

13. Ames, J. 1969. Lake Washington sockeye freshwater investigations. *Wash. State Dep. Fish. Ann. Rep.* 79:9-14. Location: UW SOF/THS

CEDAR RIVER, ESCAPEMENT, FISH, L. WASHINGTON, SOCKEYE SALMON, SPAWNING

A freshwater management study of the Cedar River sockeye run obtained information toward a prediction of sockeye escapement needed to utilize the available spawning grounds and maximize the yield. The report covers spawning escapement enumeration; studies on tagging; spawner density prediction; juvenile sockeyes; and suggestions for future work (Wydoski, 1972).

14. Ames, J. 1970. Lake Washington sockeye salmon - 1970 freshwater investigations. *Wash. State Dep. Fish. Ann. Rep.* 80:67-68. Location: Fisheries Library

CEDAR RIVER, ESCAPEMENT, FISH, L. WASHINGTON, SOCKEYE SALMON

Description of the 1970 sockeye salmon in the Lake Washington drainage. The 1970 escapement was estimated at 110,000 spawners in the Cedar River, 11,000 in other tributaries, and 3000 lake beach spawners (Wydoski, 1972).

15. Ames, J. 1983. Lake Washington sockeye: An example of a low productivity salmon stock. In: Lake Washington Symposium, (Ed.) A. Adams. Trout Unlimited. Mercer Island (WA). Location: UW SOF/THS

CEDAR RIVER, ESCAPEMENT, FISH, L. WASHINGTON, SOCKEYE SALMON

This report discusses the questions 1) why can't more Lake Washington sockeye salmon be harvested, and 2) is an escapement goal of 350,000 spawners justified? Data tables on escapement from brood years 1964-1983 are provided.

16. Ames, J. J. 1991. Lake Washington sockeye. Washington Department of Fisheries data presented in Vancouver, British Columbia - June 4 and 5. Location: UW SOF/THS

CEDAR RIVER, ESCAPEMENT, FISH, L. WASHINGTON, MANAGEMENT, SOCKEYE SALMON, STOCKING

This report consists of figures and tables only. Data are presented on: sockeye catches and escapement from 1967-1990; freshwater survival; Lake Washington trawl catches; salmon and trout stocking records; and other related data.

17. Ames, J. J., and P. Bucknell. 1981. Puget Sound river mile index: supplement to a catalog of Washington streams and salmon utilization, Vol. 1 - Puget Sound. Washington State Department of Fisheries. Olympia (WA). Location: Fisheries Library

STREAMS

This supplement provides a table of streams draining into Lake Washington. The tables include the stream name, river miles of key road and railroad crossings, and the stream length and drainage area.

18. Amos, K. H., K. A. Hopper, and L. LeVander. 1989. Absence of infectious hematopoietic necrosis virus in adult sockeye salmon. *J. Aquat. Anim. Health.* 1:281-283.

CEDAR RIVER, DISEASE, FISH, SOCKEYE SALMON

Adult sockeye salmon *Oncorhynchus nerka*, captured as they exited saltwater during their spawning migration and subsequently held in pathogen-free water until sexual maturation, were assayed for the presence of infectious hematopoietic necrosis virus (IHNV). The virus was not isolated from any of the test fish. Sockeye salmon allowed to migrate naturally to spawning grounds on the Cedar River, Washington, had IHNV prevalences of 90 to 100%. The data suggest that the high prevalence of IHNV in the natural spawners is primarily the result of horizontal virus transmission in the Cedar River and not of the reappearance of virus in fish harboring a life-long latent infection.

19. Anderson, C. W. 1991. Response of Pine Lake, Washington, to diversion of wetland inflow. M.S.E. Thesis. University of Washington. 173 pp. Location: Engineering Library

FLOW, NUTRIENTS, PHYTOPLANKTON, PINE LAKE, SMALL LAKES, ZOOPLANKTON

The Pine Lake wetland diversion was intended to improve lake quality by elimination of spring blooms, reduction of lake total phophorus, and elimination of hypolimnetic anoxia. The project was successful at acheiving some of the more important stated improvements in lake quality.

20. Anderson, D., R. N. Brenner, and A. W. Johnson. 1984. Coal Creek stream resource inventory; technical input to the King County and City of Bellevue Coal Creek basin plan. Metro. Seattle. Location: METRO Library

COAL CREEK, STREAMS

This report is provided as technical input to King County's basin plan for Coal Creek. Provided are summaries of physical, chemical, and biological data on Coal Creek.

21. Anderson, D., A. Johnson, and D. Wilson. 1984. Proposal for critical drainage designation for the Bear Evans Creek drainage basin; technical memorandum. Metro. Seattle. Location: METRO Library

BEAR CREEK, EVANS CREEK, STREAMS

This is a proposal for designating selected stream reaches and drainage areas within the Bear-Evans Creek drainage basin as critical flood, drainage and/or erosion areas.

22. Anderson, G. C. 1954. A limnological study of the seasonal variation of phytoplankton population. Ph.D. Dissertation. University of Washington. 268 pp. Location: Allen Library

CHEM. LIMNOLOGY, L. WASHINGTON, NUTRIENTS, PHYTOPLANKTON, TEMPERATURE

Physical and chemical conditions influencing growth and distribution of phytoplankton were studied in Lake Washington, a soft-water lake relatively low in dissolved nutrients. On the basis of hypolimnetic oxygen deficit, the lake was in the early stages of eutrophy. The heat budget was moderately high for a large, deep lake. The phytoplankton population was varied and showed a spring and a late summer bloom. The dominant groups were Chyrsophyta and Pyrrophyta. Phytoplankton population consisted of 49 species, 23 species fewer than were reported in 1933 (Wydoski, 1972).

23. Anderson, G. C. 1961. Recent changes in the trophic nature of Lake Washington - A review. In: Algae and metropolitan wastes; transactions. 1960 Seminar on algae and metropolitan wastes Cincinnati. U.S. Department of Health, Education, and Welfare. Cincinnati (OH). (Tech. Rep. W61-3) pp. 27-33 Location: Fisheries Library

L. WASHINGTON, NUTRIENTS, REVIEW, SEWAGE

This report provides background history and reviews the limnological changes that occurred in Lake Washington (Wydoski, 1972).

24. Anon. 1970. Special Flood Hazard Information: Bear and Evans Creeks, Redmond and Vicinity, Washington. City of Redmond. Redmond. (prepared by Army Engineer District, Seattle) Location: METRO Library

BEAR CREEK, EVANS CREEK, FLOW, LAND USE, STREAMS, URBANIZATION

Bear Creek and its two principal tributaries, Evans and Cottage Lake Creeks, have well-defined channels through the study reach near Redmond, Washington, except in the extreme upper reach of Evans Creek. Moderately rolling semiforested side hills border the irregular valleys. The lower section of the Bear Creek-Evans Creek valley is used primarily for farming. Further upstream principal development is residential. Because of the area's proximity to Seattle, future expansion pressures are certain to prevail throughout the basin. Flood season is from October to March. Melting snow may augment rainstorm flooding. There are 43 bridges in the study area where debris may collect and increase extent of flooding. The largest recorded streamflow at the gaging station at Bear Creek occurred in March, 1950, at 654 cfs; at Evans Creek in January, 1965, at 146 cfs; and at Cottage Lake creeks in January, 1956, at 132 cfs. Intermediate regional flood (IRF) discharges were determined from an analysis of past floods and include an adjustment to reflect anticipated future, 40% development of Bear Creek basin. At the confluence of Bear and Evans Creeks, IRF peak discharge would be 1450 cfs. Flood occurrences greater than the IRF were not investigated.

25. Anon. 1970. Crawfish farm is being tried. *Fish. Hunting News, West. Wash.*:10. (on microfilm) Location: Suzzallo Library

INVERTEBRATES, L. UNION, L. WASHINGTON, SHIP CANAL

The Washington State Department of Fisheries issued a permit to Hoviland Seafood Co., Kirkland, to take 454 kg of crawfish from Lakes Union and Washington and the Lake Washington Ship Canal. These were to be reared in a small lake near Bellevue. The permit allowed experiments in the culture, growth, and breeding of crawfish, but no sale or commercial use. The permit was valid until December 31, 1970 and experiments were to be closely monitored by fisheries shellfish biologists (Wydoski, 1972).

26. Anon. 1972. Studies of the Lake Washington watershed by the Washington Cooperative Fishery Unit. WA Coop. Fish. Unit, University of Washington. Seattle. (unpublished) Location: UW SOF/THS

BIBLIOGRAPHY

List of WA Cooperative Fishery Unit studies on Lake Washington between 1969 and 1972. Many of the reports are unpublished and their locations are unkown.

27. Anon. 1974. Bibliography of the Coniferous Forest Biome Investigations: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle. (unpublished) Location: UW SOF/THS

BIBLIOGRAPHY

This is a bibliography of reports published and unpublished that were generated from the Biome investigations. This consists of nine typewritten pages stapled together.

28. Anon. 1974. Environmental planning for the metropolitan area Cedar-Green River Basins, Washington. Part II. Urban drainage study. Appendix C:Storm water monitoring program. National Technical Information Service. Springfield (VA). (NTIS AD-A042 168)

CEDAR RIVER, FLOW, HYDROCARBONS, LAND USE, MANAGEMENT, METALS, NUTRIENTS, POLLUTION, STORMWATER, URBANIZATION

These results were part of an integrated study of water and waste management sponsored by the City of Seattle. The study was designed to provide a drainage management plan for use in development of an integrated environmental management plan for the Green and Cedar River Basins. This appendix reports the results of a seven-month stormwater runoff study of the Seattle metropolitan area. Both quantity and quality of the runoff is assayed. Quantity was continuously measured by monitoring stormwater runoff and rainfall volume and intensity.

Quality measurements were made for 29 parameters at specified intervals over six months. Rainfall runoff factors were low—ranging from 5% for low density residential areas to 64% for commercial areas—probably due to light rainfall intensity during the testing period. Pollutant washoff increased by land use, ranging from the lowest recordings for single family residential to new commercial to industrial to multiple residential to the highest recordings for old commercial areas. Major pollutants were solids, BOD, COD and oil. Nutrient and heavy metal loadings were low; coliform recordings in a sanitary sense were insignificant. Recommendations include extending the monitoring program, establishing a more complete rain gauge network, sampling higher intensity storms, studying street pollutant buildups, improving calibration methods, using automatic sampling equipment and better analysis of the data.

29. Antipa, R. G. 1973. Investigations into the ecology of the bass tapeworm (*Proteocephalus amloplitis*) with special reference to control of infestations in lake dwelling fishes. WA Cooperative Fishery Unit, University of Washington. Seattle. (unpublished) Location: UW SOF/THS

FISH, L. WASHINGTON, LARGEMOUTH BASS, PARASITE

This investigation studied the dynamics of infection of rainbow trout, cutthroat trout, and coho salmon, in addition to largemouth bass and prickly sculpin. In Lake Washington, however, only largemouth bass were sampled.

30. Baca, R. G., A. F. Gasperino, A. Brandstetter, and A. S. Myhres. 1977. Water quality models for municipal water supply reservoirs. Part 2. Model formulation, calibration and verification. National Technical Information Service. Springfield (VA). (NTIS PB-275 913)

L. WASHINGTON, MODELLING, NUTRIENTS

This report describes formulations, calibration, and verification of a eutrophication model and a limnological model for predicting and simulating water quality changes in municipal water supply reservoirs of Adelaide, Australia. These computer models apply to both shallow and deep lakes and reservoirs. The eutrophication model incorporates inflows and outflows, fluctuations of the thermocline, nutrient fixation and mineralization, and sediment-water interactions to simulate monthly changes of four eutrophication indicators: (1) soluble phosphorus, (2) total phosphorus, (3) chlorophyll-*a*, and (4) Secchi disc depth. The limnological model is based on dynamics of heat and mass transport, hydromechanics, and chemical and biological transformations. The model simulates daily vertical and horizontal variations of: (1) water flow and temperature, (2) phytoplankton and zooplankton biomass, (3) nitrogen and phosphorus forms, (4) BOD, (5) DO, (6) total dissolved solids, and (7) suspended sediments. The eutrophication model was verified with data from Lake Washington (Washington) for 1933-72, which showed its ability to predict changes in lake trophic state, and the limnological model was tested with data from Mt. Bold Reservoir near Adelaide for 1973-75 with good results, except for suspended sediment for which data were insufficient. Three other volumes provide a summary of the project, a user's manual, and Mt. Bold Reservoir data acquisition and evaluation.

31. Bagley, C. B. 1916. History of Seattle from the earliset settlement to the present time, Vol 1. S. J. Clarke Publishing Co. Chicago. Location: Suzzallo Library

REVIEW

This account includes a description of the unsuccessful earliest attempt to make a canal between Lake Washington and Lake Union.

32. Bagley, C. B. 1929. History of King County, Vol. 2-4. S. J. Clarke Publishing Co. Chicago. Location: Suzzallo Library

FISH, LAND USE

This book offers an account of King County covering historical beginnings, pioneers, growth of industries, Native Americans, education, Asian Americans, public departments, newspapers, financial institutions, roads, politics, King County Port Commission, fish and fisheries, grades and regrades, waterways, and individual communities (Wydoski, 1972).

33. Baier, R. W., and M. L. Healy. 1977. Partitioning and transport of lead in Lake Washington. *J. Environ. Qual.* 6:291-296.

L. WASHINGTON, METALS, SEDIMENTS, STORMWATER, URBANIZATION

Input of lead to Lake Washington appears to result from the settling of airborne Pb onto surface waters and the washing of terrestrial accumulations to the lake as runoff. Some of the Pb received by the lake is associated with particles that sink, while the remainder leaves the lake with the overflow. The range in Pb concentration during 2 years of sampling was 0.04 to 6.6 ppb. The path of Pb to the sediments is not direct but involves cycling through both liquid and solid phases. Over 70% of the total Pb entering the lake is retained by sediment. Lead in top layers of sediment ranged from 242 ppm near a heavily used bridge to 4 ppm near the major tributary of the lake. A simple compartment model accounts for some of the interchanges between dissolved and particulate forms of Pb through the processes of adsorption, absorption, and complexation. The time required to achieve steady-state conditions for the model is comparable to the yearly flushing period. Large shifts in the annual timing of flushing and mixing are encountered because of meteorological changes.

34. Bailey, R. E., and L. Margolis. 1987. Comparison of parasite fauna of juvenile sockeye salmon (*Oncorhynchus nerka*) from southern British Columbian and Washington State lakes. *Can. J. Zool./J. Can. Zool.* 65:420-431.

FISH, L. WASHINGTON, PARASITE, SOCKEYE SALMON

Sixteen species and juveniles of four taxa of parasites (Myxosporea, 4; Monogenea, 1; Trematoda, 5; Cestoda, 4; Nematoda, 2; Acanthocephala, 2; Copepoda, 2) were encountered in 1550 sockeye salmon (*Oncorhynchus nerka*) smolts and presmolts examined from 15 Fraser lakes, Nimpkish Lake on Vancouver Island, and Lake Washington, Washington State, U.S.A. The most common taxa were *Diphyllobothrium* sp. (spp.?) pleroceroids, *Philonema agubernaculum*, *Eubothrium* sp., and *Proteocephalus* sp. K-nearest neighbour analysis demonstrated that considerable overlap existed among many of the studied lakes, whereas little overlap occurred among other lakes. Cluster analyses revealed similar faunas among some lakes within biogeoclimatic zones and lakes of similar trophic status.

35. Bailey, R. E., L. Margolis, and C. Groot. 1988. Estimating stock composition of migrating juvenile Fraser River (British Columbia) sockeye salmon, *Oncorhynchus nerka*, using parasites as natural tags. *Can. J. Fish. Aquat. Sci.* 45:586-591. Location: UW SOF/THS

FISH, L. WASHINGTON, MIGRATION, PARASITE, SOCKEYE SALMON

Simulated mixtures of juvenile sockeye salmon (*Oncorhynchus nerka*) were constructed using parasite data to represent proportionally the major component stocks of Fraser River and Lake Washington sockeye migrating within the Strait of Georgia, British Columbia, in 1982-84. Sample mixture estimates correctly identified the dominant stock for each year-class, although for 1984 the dominant group was determined as a complex of three stocks because the individual stocks were not distinguishable. The results indicate that it is feasible to use parasites as natural tags to estimate stock compositions of migrating juvenile sockeye salmon in the Strait of Georgia.

36. Bain, R. C., Jr. 1977. Summary of Draft 201 Facility Plan for upgrading Metro Puget Sound plants. Municipality of Metropolitan Seattle. Seattle. Location: METRO Library

L. WASHINGTON, SEWAGE

The Metropolitan Seattle area was required by federal law to institute secondary sewage treatment by 1983. This report addresses the four major issues, viz, the specifications of the federal law, economic impact, environmental impact, and water quality. Eight alternative plans are presented.

37. Barnes, R. S., and W. R. Schell. 1972. Physical transport of trace metals in the Lake Washington watershed. In: Cycling and control of metals: proceedings of an environmental resources conference, (Eds.) M. G. Curry, and G. M. Gigliotti. National Environmental Research Center. Cincinnati (OH) pp. 45-53 Location: UW SOF/THS

L. WASHINGTON, METALS, SEDIMENTS,URBANIZATION

In the Lake Washington drainage, trace metal enrichment appears to be correlated with the cultural development of the region, and is brought into the local hydrosphere principally by advective atmospheric transport. Fluvial processes are of considerable significance, but appear to be reflected in the sediments primarily on the basis of the suspended load.

38. Barnes, R. S. 1976. A trace element survey of selected waters, sediments, and biota of the Lake Washington drainage. M.S. Thesis. University of Washington. 169 pp. Location: UW SOF/THS

CHESTER MORSE RES., FINDLEY LAKE, FISH, L. SAMMAMISH, L. WASHINGTON, METALS, SEDIMENTS, SHIP CANAL, SQUAWFISH

Concentrations of mercury were determined in biota and sediments. The squawfish was the only species examined that had mercury levels above 0.5 mg/kg. The present levels of mercury in all the lake sediments appear to be derived primarily from aeolian transport of mercury from antropogenic sources. In Lake Washington sediment core mercury, lead, zinc, copper, chromium, arsenic, and antimony all showed substantial enrichment over pre-1916 levels.

39. Barrick, R. C., E. T. Furlong, and R. Carpenter. 1983. Hydrocarbon and azaarene markers of coal transport to aquatic sediments. National Technical Information Service. Springfield (VA).

HYDROCARBONS, L. WASHINGTON, POLLUTION, SEWAGE, STORMWATER

Hydrocarbons and azaarene concentrations and compositions vary systematically in sixteen western Washington coal samples ranging in rank from lignite to anthracite. Coals generate an overall lipid signal distinct from other fossil sources including street runoff and municipal sewage discharges. These molecular markers demonstrate the transport of specific local coals to aquatic sediments in adjacent drainage basins resulting from erosion and mining activity.

40. Bartoo, N. W., R. G. Hanson, and R. S. Wydoski. 1972. A portable vertical gill-net system: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal report 42. (unpublished) Location: UW SOF/THS

DISTRIBUTION, FISH

This report details the specific gear design used for handling gill nets for sampling a vertical water column.

41. Bartoo, N. W. 1972. The vertical and horizontal distributions of northern squawfish (*Ptychocheilus oregonesis*), peamouth (*Mylocheilus caurinus*), yellow perch (*Perca flavescens*), and adult sockeye salmon (*Oncorhynchus nerka*) in Lake Washington. M.S. Thesis. University of Washington. 60 pp. Location: UW SOF/THS

DISTRIBUTION, FISH, L. WASHINGTON, PEAMOUTH, SOCKEYE SALMON, SQUAWFISH, TEMPERATURE, YELLOW PERCH

Vertical gill nets were operated from January 1971 to June 1972. The nets caught 15 species, principally northern squawfish, peamouth, yellow perch, and adult sockeye salmon (when available). Catchability and distribution are presented for each species by season. Vertical distributions of each species except sockeye were governed primarily by temperature.

42. Bartoo, N. W. 1977. Population parameter estimates and energy budgets for peamouth, northern squawfish, and yellow perch in Lake Washington. Ph.D Thesis. University of Washington. 144 pp. Location: UW SOF/THS

ABUNDANCE, DIET, FISH, L. WASHINGTON, PEAMOUTH, SQUAWFISH, YELLOW PERCH

Population estimates and mortality rates for three species of Lake Washington benthic fish were determined using gill net samples compensated for selectivity effects. Relative abundance and mortality rate estimates provide relative population sizes which are scaled by the use of a hydroacoustic population estimate on one species. Values for routine metabolism and excretion are taken from the literature. Seasonal growth profiles are estimated from data and expected food consumption rates are estimated. Seasonal food webs are presented for each species.

43. Bates, C. L. 1976. Analysis of time series modeling errors with application to the Lake Sammamish hydrologic system. M.S. Thesis. University of Washington. 112 pp. Location: UW SOF/THS

L. SAMMAMISH, MODELLING, WATER BUDGET

In this investigation two major topics were examined (1) an analysis of time series modelling with respect to how errors in modelling efforts can be identified and partially removed, and (2) an analysis leading to the development of a model of the Lake Sammamish hydrologic system.

44. Bauer, D. H. 1971. Carbon and nitrogen in the sediments of selected lakes in the Lake Washington drainage. M.S. Thesis. University of Washington. 91 pp. Location: UW SOF/THS

CARBON, CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, L. WASHINGTON, NUTRIENTS, SEDIMENTS

Quantification of the nutrient budget in lakes requires delineation of the role of sediments in controlling the nutrient status of the lake. In the case of Lake Washington and Lake Sammamish, comparison of the nutrient budgets before and after diversion will provide means to measure sediment nutrient response to the decrease in the surface nutrient inflow to the lakes following sewage diversion. The purpose of this study was the investigation of the C and N composition in the surface sediments of the four lakes, Lake Washington, Lake Sammamish, Chester Morse Reservoir, and Findley Lake.

45. Beauchamp, D. A. 1982. Lake trout (*Salvinelinus namaycush*) - feasibility of introduction into Lake Washington. WA Cooperative Fishery Research Unit, University of Washington. Seattle. (unpublished) Location: UW SOF/THS

FISH, L. WASHINGTON, STOCKING

The biological benefits from introducing lake trout in Lake Washington are addressed by comparing the life history characteristics and requirements of lake trout with the habitat present in Lake Washington.

46. Beauchamp, D. A. 1990. Seasonal and diel food habits of rainbow trout stocked as juveniles in Lake Washington. *Trans. Am. Fish. Soc.* 119:475-482. Location: UW SOF/THS

DIET, FISH, L. WASHINGTON, RAINBOW TROUT, SCULPIN, SMELT, YELLOW PERCH, ZOOPLANKTON

The author examined food habits of rainbow trout *Oncorhynchus mykiss* in Lake Washington, Washington, for relationships to the spatial and temporal distribution of their prey. Rainbow trout smaller than 250 mm (fork length) ate primarily *Daphnia pulicaria* during summer and autumn; larger fish were piscivorous throughout the year. Longfin smelt, *Spirinchus thaleichthys*, made up the largest fraction of fish prey in the diet of rainbow trout from the nearshore zone during autumn and winter, whereas prickly sculpin *Cottus asper* (in 1984) and yellow perch *Perca flavescens* (in 1985) were most important in spring and summer. Rainbow trout in the offshore zone (> 15 m deep) ate mostly longfin smelt in spring and summer. Longfin smelt exhibited a 2-year cycle of abundance that appeared to influence the feeding habits of rainbow trout. During 1984, the adult longfin smelt population was large and provided the major prey of rainbow trout. When adult longfin smelt were less abundant during the 1985 winter, the fish fraction of the rainbow trout diet and the apparent ration size were roughly half the levels observed the previous winter.

47. Beauchamp, D. A. 1993. A comparison of squawfish abundance, distribution, and ecology in Lake Washington between 1970's and 1980's: implications for juvenile sockeye survival. Utah Cooperative Fish and Wildlife Research Unit. Logan (UT). Location: UW SOF/THS

FISH, L. WASHINGTON, SOCKEYE SALMON, SQUAWFISH

This internal report synthezes the information on the abundance, seasonal distribution, and ecology of northern squawfish to make a framework for 1) assessing the feasibility of a squawfish removal program, and 2) predicting the costs and benefits of such a program.

48. Beauchamp, D. A. 1993. Spatial and temporal dynamics of piscivory: implications for foodweb stability and transparency of Lake Washington. Presented at the 13th International Symposium of the North American Lake Management Society: November 30 - December 4, 1993. Seattle (WA). Location: UW SOF/THS

CUTTHROAT TROUT, DIET, FISH, L. WASHINGTON, RAINBOW TROUT, SMELT, SOCKEYE SALMON, SQUAWFISH, STICKLEBACK

A rainbow trout, *Oncorhynchus mykiss* , stocking program in Lake Washington altered the predator and prey populations, disrupted pelagic food web dynamics, and has been implicated in the decline of juvevile sockeye salmon, *0. nerka*. In this paper, the author explores the temporal-spatial dynamics of predation by three piscivores: the native northern squawfish, *Ptychicheilus oregonensis*, and cutthroat trout, *O. clarki*, and hatchery rainbow trout, on the major planktivorous fishes (longfin smelt, *Spirinchus thaleichthys*, juvenile sockeye salmon, and threespine sticklebacks, *Gasteroseus aculeatus*), and how these interactions influence the link between sport fish productivity and water quality.

49. Beauchamp, D. A., D. J. Stewart, and G. L. Thomas. 1989. Corroboration of a bioenergetics model for sockeye salmon. *Trans. Am. Fish. Soc.* 118:597-607. Location: UW SOF/THS

FISH, MODELLING, SOCKEYE SALMON

The authors constructed a bioenergetics model for sockeye salmon *Oncorhynchus nerka* and evaluated its sensitivity to parameter error. When used to predict annual growth, the model was most sensitive, in declining order of importance, to changes in the intercept of the dependence of consumption on body weight, the proportion of maximum consumption, the energy density of prey, low temperature and its associated proportion of maximum consumption in the temperature-dependence function, the intercept of the energy density relationship to predator weight, and the intercept of the relationship between body weight and respiration. Estimates of consumption from the model, when consumption was constrained by fixed growth, were quite insensitive to perturbation of all parameters except the energy density of prey.

50. Beauchamp, D. A., S. A. Vecht, and G. L. Thomas. 1992. Temporal, spatial, and size-related foraging of wild cutthroat trout in Lake Washington. *Northwest Sci.* 66:149-159. Location: UW SOF/THS

CUTTHROAT TROUT, DIET, FISH, L. WASHINGTON, SMELT, SOCKEYE SALMON

The feeding behavior of wild cutthroat trout *Oncorhynchus clarki*, a major piscivore, was documented prior to planned enhancement of juvenile sockeye salmon, *O. nerka*, a potential prey species in Lake Washington. Food habits of cutthroat trout changed with body size, season, and time of day. Cutthroat trout ate invertebrates until they reached a large enough size to capture small fishes. Seasonal changes in the distribution of cutthroat trout corresponded with that of their primary prey, the longfin smelt, *Spirinchus thaleichthys*, when it was available. Juvenile sockeye salmon was a relatively minor constituent of the diet. Cutthroat trout appear to feed primarily in the littoral and upper limnetic zones and respond to the diel and seasonal differences in accessibility of prey in these zones. This suggests that predation on juvenile sockeye salmon by cutthroat trout might increase in response to enhancement measures or to declimes in the longfin smelt population.

51. Beauchamp, D. A. 1987. Ecological relationships of hatchery rainbow trout in Lake Washington. Ph.D. Diss. Washington Univ., Seattle (USA). 252 pp. Location: Fisheries Library

CEDAR RIVER, DIET, DISTRIBUTION, FISH, GROWTH, L. WASHINGTON, RAINBOW TROUT, SCULPIN, SMELT, SOCKEYE SALMON, STOCKING, ZOOPLANKTON

Rainbow trout stocked as fingerlings occupied a relatively broad niche in Lake Washington, overlapping the feeding guild of facultative planktivores and piscivores. Trout released in late May or June were planktivorous upon entering the lake, feeding heavily on *Daphnia*, but became mostly piscivorous by mid- to late fall at sizes greater than or equal to 250 mm. Prickly sculpin entered the diet briefly in the fall and represented only a minor portion of the diet while longfin smelt constituted the largest fraction of the fish species eaten. Other prey included yellow perch, cyprinids, and juvenile sockeye salmon. The heaviest predation by the hatchery origin rainbow trout on the sockeye salmon occurred off the mouth of the Cedar River as the salmon fry entered the lake. Rainbow trout predation accounted for an estimated loss of 81,000 sockeye smolt equivalents in 1984 (1983 brood year) and 184,000 smolt equivalents in 1985 (1984 brood year). This corresponds to a 7% and a 2% loss in sockeye smolt production in 1984 and 1985, respectively.

52. Becker, C. D. 1964. The parasite-vector-host relationship of the hemoflaellate *Cryptobia salmositica* Katz, the leech *Piscicola salmositica* Meyer, and certain freshwater teleosts. Ph.D. Dissertation. University of Washington. 200 pp. Location: Fisheries Library

CEDAR RIVER, CHINOOK SALMON, COHO SALMON, FISH, ISSAQUAH CREEK, L. WASHINGTON, PARASITE, SCULPIN, SHIP CANAL, SOCKEYE SALMON, STREAMS

This report reviews the literature and summarizes the life history of *Cryptobia*. The parasite was found in the coastrange sculpin, and coho, chinook, and sockeye salmon in the Lake Washington drainage, including the Univeristy of Washington ponds, Hiram M. Chittenden Locks, Cedar River, and Issaquah Creek. (Wydoski, 1972)

53. Becker, C. D., and M. Katz. 1965. Distribution, ecology, and biology of the salmonid leech *Piscicola salmositica* (Rhynchobdellae: Piscicolidae). *J. Fish. Res. Board Can.* 22:1175-1195.

CHINOOK SALMON, COHO SALMON, FISH, PARASITE, SOCKEYE SALMON

This report describes the life history of this leech that was collected from chinook, coho, and sockeye salmon in the Lake Washington drainage (Wydoski, 1972).

54. Becker, C. D., and M. Katz. 1965. Infections of the hemoflagellate, *Cryptobia salmositica* Katz, 1951, in freshwater teleosts of the Pacific Coast. *Trans. Am. Fish. Soc.* 94:327-333.

FISH, PARASITE

Infections of the hemoflagellate *Cryptobia salmositica* occurred in 16 species of teleosts from southern British Columbia to northern California. *C. salmositica* was found in the blood of teleosts where the leech vector *Piscicola salmositica* occurred, an environment characterized by streams of low temperature, graveled beds, and moderate to swift currents. Specific information is given on infections of fish in the Lake Washington drainage (Wydoski, 1972).

55. Benndorf, J. 1988. Objectives and unsolved problems in ecotechnology and biomanipulation: A preface. *Limnol.* 19:5-8. Location: UW SOF/THS

L. WASHINGTON, NUTRIENTS, POLLUTION, REVIEW

The two different strategies to control water quality in freshwater are described as (1) the strategy of reducing the external load of nutrients, toxic substances, organic matter or acid precipitation and (2) the strategy of controlling internal ecological processes (ecotechnology). The first strategy will provide acceptable solutions with respect to toxic substances, organic wastes, and acid precipitation. As far as eutrophication of lakes and reservoirs is concerned, a combination of both strategies leads to better water quality and, consequently, to a lower cost/benefit ratio in the management of the water resource compared with the application of the first strategy alone. One of the most impressive case studies showing the success of this cooperation of external load reduction and internal ecological mechanisms is Lake Washington. There are water bodies to which the first strategy cannot be applied for economic, political or technological reasons. In these cases, the second strategy offers a possibility to minimize the consequences of eutrophication or acidification and, therefore, it guarantees water use which otherwise would not be possible with the given external load.

56. Benson, W. W. 1967. A study of the periphyton of Lake Washington. M.S. Thesis. University of Washington. 87 pp. Location: UW SOF/THS

L. WASHINGTON, NUTRIENTS, PERIPHYTON, PHYTOPLANKTON, PRODUCTIVITY

The annual production cycle of the periphyton of Lake Washington parallels the changes in the plankton and closely reflects environmental conditions in the lake. The major algal taxa comprising the phytoplankton and periphyton follow the same seasonal cycles, indicating a similarity in trophic requirements which is independent of their respective habitats. The factors that affect plankton production are also of paramount importance in the growth of the periphyton.

57. Berggren, T. J., and R. L. Burgner. 1973. Dynamics of limnetic feeding fish, II. Lake Sammamish: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 151. (unpublished) Location: UW SOF/THS

ABUNDANCE, DIET, DISTRIBUTION, FISH, GROWTH, L. SAMMAMISH, SOCKEYE SALMON

This report provides analysis of data collected from February 1972 through March 1973 in order to answer the following objectives (1) seasonal vertical and horizontal distribution of 1971 year class sockeye, (2) seasonal abundance, growth, mortality, biomass, and production estimates of 1971 year class of sockeye, and (3) feeding ecology of sockeye.

58. Berggren, T. J. 1974. Seasonal changes in the abundance, biomass, production, distribution, and feeding of the 1971 year class of sockeye salmon in Lake Sammamish. M.S. Thesis. University of Washington. 80 pp. Location: UW SOF/THS

ABUNDANCE, DIET, DISTRIBUTION, FISH, L. SAMMAMISH, L. WASHINGTON, SOCKEYE SALMON

The purpose of this study was to observe and quantify the seasonal changes in abundance, biomass, and production of the 1971 year class of sockeye salmon in Lake Sammamish and to compare them with those found in Lake Washington to determine the magnitude of utilization per hectare of Lake Sammamish by sockeye salmon. Other objectives included determining the seasonal changes in spatial distribution with respect to the hypolimnic oxygen deficiency and the food utilization of the pelagic fish community.

59. Birch, P. B., and D. E. Spyridakis. 1981. Nitrogen and phosphorus recycling in Lake Sammamish, a temperate mesotrophic lake. *Hydrobiol.* 80:129-138.

L. SAMMAMISH, NUTRIENTS, SEDIMENTATION

This paper presents nitrogen and phosphorus budgets for spring and summer for the trophogenic (0-9 m) and tropholytic (9-27 m) zones of Lake Sammamish. The objective of constructing the budgets was to evaluate the efficiency of nutrient recycling and increase knowledge of the overall nutrient dynamics. The budgets reveal that uptake and solubilization are the dominant fluxes and the nutrient recycling is generally efficient, with the possible exception of early spring during the diatom bloom. This leads to greater reductions in the dissolved N and P pools in spring than summer. Sedimentation is greater in spring because of a pulse immediately following the diatom bloom. Solubilization of particulates is much less in the tropholytic zone than the trophogenic zone. This is due to slower decomposition rates there and to the efficiency of solubilization in the overlying trophogenic zone which results in a relatively small particulate influx. Turnover times for the N and P pools are therefore much faster in the trophogenic zone than in the tropholytic zone. In the trophogenic zone, however, the dissolved N pools turns over much more slowly than the dissolved P pool because of its larger size relative to algal growth requirements. Overall there is a net loss of N and P from the water column in spring primarily due to sedimentation and denitrification whilst in summer there is a small net gain because of sediment release and a slight excess of inflow over outflow.

60. Birch, P. B. 1974. Sedimentation in lakes of the Lake Washington drainage basin. M.S. Thesis. University of Washington. 163 pp. Location: UW SOF/THS

CARBON, CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, L. WASHINGTON, NUTRIENTS, SEDIMENTATION, SEDIMENTS

Collection of tripton in sediment traps in four Lake Washington drainage basin lakes of constrasting morphometry and differing trophic states were analyzed for organic carbon, nitrogen, total phosphorous and iron. Flux of organic tripton in three of the lakes was mainly settling plankton detritus, but in the fourth lake (Findley Lake) it was a mixture of planktondetritus and forest litter. Most of the forest litter entered the lake on the completion of snow and ice melt. Most of the settling plankton detritus mineralized before it reached the bottom sediments, where further mineralization occured.

61. Birch, P. B. 1976. The relationship of sedimentation and nutrient cycling to the trophic status of four lakes in the Lake Washington drainage basin. Ph.D. Thesis. University of Washington. 200 pp. Location: UW SOF/THS

CARBON, CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, L. WASHINGTON, NUTRIENTS, SEDIMENTATION, SEDIMENTS

This research defined the relationship between sedimentation, nutrient cycling, and biological production in four lakes which differ in their physical features and trophic state. The four study lakes were Lakes Findley, Chester Morse, Sammamish, and Washington. The former two lakes were oligotrophic, while Lakes Sammamish and Washington were classified as mesotrophic. Particular reference in the study was given to Lake Sammamish, the only lake in which the hypolimnion goes anaerobic.

62. Bissonnette, P., and F. B. Taub. 1973. Benthic macroinvertebrate production: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 147. (unpublished) Location: UW SOF/THS

BENTHIC, CHESTER MORSE RES., FINDLEY LAKE, INVERTEBRATES, L. SAMMAMISH, L. WASHINGTON

Macrobenthos populations of the IBP lakes were sampled from March to October 1973 on a regular basis. Biomass and production of chironimids, oligichaetes, sphaerids, and amphipods are presented.

63. Bissonnette, P., and F. B. Taub. 1972. Estimates of biomass of detritus food chain: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 87. (unpublished) Location: UW SOF/THS

BENTHIC, CHESTER MORSE RES., FINDLEY LAKE, INVERTEBRATES, L. SAMMAMISH, L. WASHINGTON

Macrobenthos populations of the IBP lakes were sampled during October and November 1972. Analysis of the samples revealed dominance of chironomids and oligochaetes in both littoral and profundal regions for at least this time of year. Due to sampling difficulties the oligochaete material was not used for chemical analyses. Biomass per square meter was determined for the chironomids. From these data, literature values were used to estimate calories, carbohydrate, fat, and protein per square meter.

64. Bissonnette, P. A. 1974. Extent of mercury and lead uptake from lake sediments by Chironmidae. M.S. Thesis. University of Washington. 96 pp. Location: UW SOF/THS

BENTHIC, CHESTER MORSE RES., FINDLEY LAKE, FISH, INVERTEBRATES, L. SAMMAMISH, L. WASHINGTON, METALS, POLLUTION, SEDIMENTS, SQUAWFISH, URBANIZATION

Four lakes in the Lake Washington drainage were chosen to study mercury and lead uptake from sediments by members of the Chironomidae. Analysis of mercury and lead in sediments revealed an increasing input since the 1920's. Comparison of the lakes shows a general increase in contamination with proximity to urban centers.

65. Bodhaine, G. L., B. L. Foxworthy, J. F. Santos, and J. E. Cummans. 1963. The role of water in shaping the economy of the Pacific Northwest. U.S. Dep. Inter., Geol. Surv. Tacoma (WA). Location: Forestry Library

FLOW, URBANIZATION

This report describes the geographic and hydrologic environment; and summaries of the surface water, groundwater, and relation of ground and surface water are provided for the Lake Washington basin under Power Supply Area 43. Also summarizes the historic, present, and future uses of water, quantities required, supplies available, water resources versus current and prospective uses, and potential growth of the Pacific Northwest (Wydoski, 1972).

66. Bodznick, D. 1978. Water source preference and lakeward migration of sockeye salmon fry *Oncorhynchus nerka*. *J. Comp. Physiol.* 127:139-146.

DISTRIBUTION, FISH, L. WASHINGTON, MIGRATION, SOCKEYE SALMON

The water source preference behavior of sockeye fry and fingerlings of 2 different populations was observed in a 2-choice Y-trough with Lake Washington water (lake) and well water (non-lake) as the alternate choices. Experiments with fry that had been hatched and reared entirely in either Lake Washington water or well water or had not previously experienced either water source demonstrated that preference behavior was a result of 2 separate factors: an apparently innate preference for lake water as compared to non-lake waters as proposed by Brannon (1972); and an attraction for the recently experienced water source over foreign waters. The strong lake water preference of fry that had recently experienced Lake Washington water was eliminated by olfactory occlusion. Water source preference is believed to play an important role in the guidance of sockeye fry migration from their incubation stream to a nurse lake.

67. Bolstridge, J. C. 1982. Green Lake: physical, chemical and biological analysis in preparation for lake restoration. M.S.E. Thesis. University of Washington. 92 pp. Location: Engineering Library

GREEN LAKE, NUTRIENTS, PHYTOPLANKTON, SMALL LAKES

This study was designed to provide a basis for sound management decisions in regard to the effects of potential restoration methods. A phosphorus budget for green Lake with emphasis on determination of the relative magnitude of external and internal nutrient sources was developed, and the temporal variations in nutrient sources to the lake were described.

68. Born, S. M. 1979. Lake rehabilitation: A status report. *Environ. Manage.* 3:145-153.

L. WASHINGTON, NUTRIENTS, POLLUTION, REVIEW, SEDIMENTATION, URBANIZATION

The most prevalent lake degradation problems are the result of eutrophication and sedimentation; other problems are due to the addition of toxic substances and radio-activity and by man-made alterations. Lake rehabilitation activities have been centered in developed and populous countries in lake-rich parts of the world, particularly in Western Europe, Canada, and the United States. In the U.S. lake rehabilitation has been provided for by the Clean Lakes Act (Sec. 314, PL 92-500). There are two general approaches to rehabilitating lakes: (1) restricting the input of undesirable materials, and (2) employing in-lake controls for the removal or inactivation of undesirable materials. In-lake techniques that can be used to hasten the recovery of degraded lakes include dredging, nutrient inactivation/precipitation, and aeration and/or circulation. The Lake Washington, Seattle (WA) case represents one of the most conclusive and best documented lake rehabilitation experiences. The lake underwent rapid eutrophication due to the influx of sewage effluent beginning in 1941. Concern led to creation of a municipal sewerage authority in 1958; by 1972 the lake had been rehabilitated to pre-eutrophication conditions and it has continued to experience improved water quality. The most outstanding illustration of the potential for employing in-lake techniques in a comprehensive lake rehabilitation strategy is the restoration of Lake Trummen in Sweden. Most of the lake rehabilitation activities to date have dealt with eutrophication problems and have emphasized reducing nutrient loading, particularly phosphorous.

69. Bortleson, G. C., N. P. Dion, J. B. McConnell, and L. M. Nelson. 1976. Reconnaissance data on lakes in Washington, Vol. 2 - King and Snohomish Counties. USGS Water Supply Bulletin 43. Location: Fisheries Library

SMALL LAKES

A total of 156 lakes in two counties was sampled using helicopter or boat to obtain information on their physical, cultural, and water-quality conditions.

70. Borton, W., L. Bucher, C. Dyckman, A. Johnson, and B. Way. 1982. Clean water, streams and fish; a holistic view of watersheds: elementary curriculum. Metro. Seattle. Location: METRO Library

FISH, STREAMS

This document is intended to help youth and adults act responsibly towards their life support system: water. It is also intended to round out the curricular offerings on salmon (see Dyckman and Garrod 1978) by emphasizing the fresh water habitat phase of salmon life history.

71. Boughner, R. C. 1954. An investigation of subsurface water currents in Lake Washington around Mercer Island including design of suitable floats. M.S. Thesis. University of Washington. 34 pp. Location: Engineering Library

CIRCULATION, FLOW, L. WASHINGTON, SEWAGE, WATER BUDGET

The goal of this study of lake currents was to enable the placing of new sewage treatment plant effluent into areas so as to have little possibility of polluting water supplies. The object of the investigation was to determine the existence of residual currents in Lake Washington and the effect of wind induced currents.

72. Boule, M. E. 1982. Analysis of wetlands regulation and the Corp of Engineer's Section 404 program in western Washington. National Technical Information Service. Springfield (VA).

L. WASHINGTON, MANAGEMENT, WETLANDS

This report was one of ten regional case studies prepared for OTA for use in its study: Wetlands: Their use and regulation. The study identified wetland trends, use factors and institutional structures before and after Federal and State legislation aimed at preserving and protecting wetlands were passed.

73. Braaten, D. O. 1970. Characteristics and angling desires of Western Washington trout anglers, and a simulation of the fishery-management system so as to optimize angler enjoyment. Ph.D. Dissertation. University of Washington. 155 pp. Location: Fisheries Library

CUTTHROAT TROUT, FISH, HATCHERIES, MANAGEMENT, RAINBOW TROUT, RECREATION, STOCKING

The objectives of this study were to describe quantitatively trout fishing participation and catch in Washington lakes by King County anglers (near the urban center of the State), to establish on the basis of user opinions some parameters of quality fishing experience, and then to develop a stocking policy for catchable trout to optimize these factors.

74. Bradbury, A. 1983. Trout enhancement on Lake Washington. In: Lake Washington Symposium, (Ed.) A. Adams. Trout Unlimited. Mercer Island (WA). Location: UW SOF/THS

FISH, HATCHERIES, L. WASHINGTON, RAINBOW TROUT, REVIEW, STOCKING

This paper reviews the history of trout enhancement in Lake Washington.

75. Brandstetter, A., R. G. Baca, A. F. Gasperino, and A. S. Myhers. 1977. Water quality models for municipal water supply reservoirs, Part I. Summary. National Technical Information Service. Springfield (VA). (NTIS PB-275 912)

L. WASHINGTON, MODELLING, NUTRIENTS

This volume summarizes a project to develop a eutrophication model and a limnological model to predict and simulate eutrophication and other water quality changes in the municipal water supply reservoirs of Adelaide,

Australia, and to evaluate the effectiveness of lake restoration schemes. Three other volumes cover: (1) model formulation, calibration, and verification; (2) user's manual; and (3) Mt. Bold Reservoir data acquisition and evaluation. The detailed limnological model predicts daily changes of all important water quality phenomena, including thermal stratification, dissolved oxygen, nutrient cycling, and algal growth and decay, over several seasons (less than 10 years). The eutrophication model, which requires minimal data, can predict monthly changes in key trophic indicators over many years (10 or more). Two models together provide the information necessary for assessing detailed short-term water quality fluctuations and general long-term eutrophication trends resulting from alternative land use and lake management plans. The eutrophication model was tested with data from Lake Washington (Washington) for 1933-72, with good agreement. The limnological model was tested with data from Mt. Bold Reservoir near Adelaide for 1973-75, with good results for all parameters except suspended sediment, for which there was not sufficient data. The models were programmed in Fortran IV.

76. Brannon, E., S. Mathews, H. Seen, J. Youngren, and R. Antipa. 1988. Salmon enhancement in Washington State: Report to the Senate Environmental and Natural Resources Committee. Committee for Salmon Enhancement. Olympia (WA). Location: UW SOF/THS

FISH, HATCHERIES, MANAGEMENT

This report was guided by the Engrossed Senate Bill 6647, enacted into law in 1988. The emphasis of this bill was to double statewide salmon harvest by the year 2000. This report focuses on the Washington coastal area, the Strait of Juan de Fuca, and Puget Sound. The University of Washington's salmon hatchery is provided as an example of small project which makes significant contributions to the salmon resource.

77. Brannon, E. L. 1983. Management alternatives. In: Lake Washington symposium, (Ed.) A. Adams. Trout Unlimited. Mercer Island (WA). Location: UW SOF/THS

FISH, L. WASHINGTON, MANAGEMENT, REVIEW

This paper reviews the management alternatives for the Lake Washington fishery.

78. Brannon, J. M., D. Gunnison, R. M. Smart, and R. L. Chen. 1984. Effects of added organic matter on iron and manganese redox systems in sediment. *Geomicrobiol. J.* 3:319-341.

CARBON, L. WASHINGTON, METALS, SEDIMENTS

Addition of five types of organic matter to Lake Washington sediments resulted in release of high concentrations of iron, organic carbon, and manganese into the interstitial water, and caused an increase in observed sediment oxygen consumption rates. The depressed electrode potentials (E_h < -150 mV) that should accompany such reduction processes did not occur, indicating that E_h was being poised by redox systems present in the sediment. Iron redox systems ($Fe(OH)_3$-Fe^{2+}, $Fe_3(OH)_8$-Fe^{2+}, and $Fe(OH)_3$-$Fe_3(OH)_8$ were shown to be poising the E_h of control sediments throughout 13 weeks of incubation and dominating the potential of several of the organically amended sediments following the first three weeks of incubation.

79. Brengle, M. J., and K. B. Katsaros. 1980. Development of a microcomputer program for data collection and processing in field experiments. National Technical Information Service. Springfield (VA).

L. WASHINGTON

The Atmospheric Sciences Department at the Univerity of Washington established an experimental site on Lake Washington, where turbulent fluxes, wave height, and other air-sea interaction related measurements are obtained. The configuration consists of a mast, positioned 30 m from shore, on which a variety of meteorological instruments are mounted. The instrument analog signals are sent back to shore via lines and are digitized and recorded on audio tape with a frequency shift keying system.

80. Brenner, R. N., D. Anderson, B. Morrice, A. Johnson, and T. Prodan. 1983. Annual report to the Water Quality Monitoring Review Board; streams and rivers program. Municipality of Metropolitan Seattle. Seattle. Location: METRO Library

CHEM. LIMNOLOGY, FISH, REVIEW, SMALL LAKES, SPAWNING, STREAMS

This is an annual report of 44 sites in the sample network for the streams and lakes routine survey. All samples are analysed for 22 parameters. Additionally the results of fish spawning surveys are presented.

81. Brenner, R. N., and D. E. Anderson. 1980. Small streams survey report for 1980. Municipality of Metropolitan Seattle. Seattle. Location: METRO Library

BEAR CREEK, BENTHIC, CHEM. LIMNOLOGY, COAL CREEK, EVANS CREEK, INVERTEBRATES, ISSAQUAH CREEK, JUANITA CREEK, KELSEY CREEK, LITTLE BEAR CREEK, LYON CREEK, MAY CREEK, MCALEER CREEK, NORTH CREEK, STREAMS, SWAMP CREEK, THORNTON CREEK, YARROW BAY

Data are presented for water samples taken once each month from 64 sites on 24 western King County streams during 1980. In addition the benthos populations were evaluated.

82. Brenner, R. N., and J. Davis. 1983-1989. Status of water quality in small lakes Seattle-King county region: 1985 survey: Volunteer and METRO staff monitoring. Municipality of Metropolitan Seattle. Seattle. Location: UW SOF/THS

LAND USE, MANAGEMENT, PINE LAKE, REVIEW, SMALL LAKES, SPRING LAKE, URBANIZATION

These annual reports are part of a long-term trend monitoring program for lakes that have public access and are 20 acres or larger.

83. Brenner, R. N., and R. Morrice. 1977. Routine streams survey interim report. Municipality of Metropolitan Seattle. Seattle. Location: METRO Library

BEAR CREEK, EVANS CREEK, LITTLE BEAR CREEK, LYON CREEK, MCALEER CREEK, NORTH CREEK, STREAMS, SWAMP CREEK, THORNTON CREEK

Presents data from 19 sampling stations on eight streams for 1976-1977.

84. Brenner, R. N., R. Morrice, and R. Swartz. 1978. Effects of stormwater runoff on the Juanita Creek drainage system, a baseline study. Metro. Seattle. Location: METRO Library

JUANITA CREEK, POLLUTION, STORMWATER, STREAMS, URBANIZATION

The runoff from three storms was sampled and the resultant data were applied to a computer model to estimate annual pollutant loads. Solids loading to the stream resulting from urbanization was considered to be the primary problem.

85. Brenner, R. N., R. J. Morrice, and R. G. Swartz. 1977. An intensive water quality survey of 8 selected lakes in the Green River and Cedar River drainage basins (1975-1976). Municipality of Metropolitan Seattle. Seattle. Location: METRO Library

SMALL LAKES

The water quality of eight small lakes in the Green and Cedar River drainage basins was studied during 1975 and 1976. Biological, physical, and chemical observations indicated eutrophication as the basic problem in all of the lakes.

86. Bretz, J. H. 1910. Glacial lakes of Puget Sound. *J. Geology* 18:448-458.

GEOLOGY

Topography of Puget Sound at the advance of the Vashon Glaciation was closed on the east and west by mountain ranges, open to the south by a low gravel plain, and open to the north from where the glacier came. When the ice sheet retreated, water accumulated at the ice front to the south and spread across the land forming many glacial lakes (Wydoski, 1972).

87. Brown and Caldwell. 1958. Metropolitan Seattle sewerage and drainage survey: A report for the City of Seattle, King County, State of Washington. City of Seattle. Seattle. Location: Fisheries Library

SEWAGE

This is a report of a survey covering the following: major sewage and drainage problems then confronting the metropolitan Seattle area; the objectives, scope and procedures of the survey; a chronological history of sewerage development and events; physical and economic factors as they relate to future growth and development; a description of the existing facilities; the characteristics of the sewage to be dealt with; and environmental and economic effects of then current deficiencies. Alternatives and recommendations are provided (Wydoski, 1972).

88. Bryant, M. D. 1976. Lake Washington sockeye salmon: biological production, and a simulated harvest by three fisheries. Ph.D. Dissertation. University of Washington. 159 pp. Location: Fisheries Library

FISH, L. WASHINGTON, MODELLING, SOCKEYE SALMON

The productive capacity of the Lake Washington sockeye salmon system was examined using data from biological studies of the Lake Washington sockeye. Mortality rates during major life history stages were estimated and used in a series of spawner-recruit models. A provisional minimum escapement was suggested as a reference point for analysis of harvest strategies imposed on a series of simulated recruitment levels.

89. Bryant, M. D., and S. B. Mathews. 1977. The Lake Washington sockeye salmon sport fishery: catch, fishing effort, and economic evaluation, 1973. Fisheries Research Institute, University of Washington. Seattle. Location: Fisheries Library

FISH, L. WASHINGTON, RECREATION, SOCKEYE SALMON

The 1973 sport fishery for Lake Washington sockeye was monitored for catch, effort, and economic information. Sport catch was estimated as 23,000 sockeye in about 55,000 angler trips. Approximately 6,900 individual fishermen participated in the fishery.

90. Buchannan, K. D. 1977. Comparison of total mercury in recent and museum specimens of fishes from Lake Washington. M.S. Thesis. University of Washington. 66 pp. Location: Fisheries Library

FISH, L. WASHINGTON, METALS, PEAMOUTH, POLLUTION, SQUAWFISH, SUCKER, YELLOW PERCH

A positive semi-logarithmic relationship was found between the amount of mercury in muscle and the standard length for three species of fish - northern squawfish, yellow perch, and largescale sucker collected from Lake Washington, 1973-1974. No such relationship was observed for peamouth collected from Lake Washington. The total mercury concentrations in axial muscle of northern squawfish ranged from 0.037 to 1.4 ppm (wet wt) for fish 100 to 500 mm standard length (SL); yellow perch, 0.020 to 0.43 ppm for fish 80 to 290 SL; peamouth, 0.040 to 0.28 ppm for fish 170 to 280 mm SL; and for largescale sucker, 0.025 to 0.25 ppm for fish 185 to 430 mm SL. Statistical analysis of museum specimens of these four species indicates that fishes collected in the period 1935-1941 had significantly greater mercury concentrations in muscle than did fishes in 1973-1974.

91. Buckley, R. M. 1964. Incidence of beach spawning sockeye salmon in Lake Washington and Lake Sammamish. *Wash. State Dep. Fish. Ann. Rep.* 75:28-29. Location: Fisheries Library

FISH, L. SAMMAMISH, L. WASHINGTON, SHORELINE, SOCKEYE SALMON, SPAWNING

Small gravel substrate indicated favorable spawning habitat for sockeye salmon along east and west shorelines of Lake Sammamish and the east shoreline of Lake Washington at Pleasure Point, Bellevue, Enatai Beach, and Juanita Point. Spawning activity was in the first meter of water (Wydoski, 1972).

92. Buckridge, T. N. 1956. A study of hybridization of cutthroat trout (*Salmo clarkii*) as a management practice. M.S. Thesis. University of Washington. 50 pp. Location: Fisheries Library

BREEDING, CUTTHROAT TROUT, FISH, MANAGEMENT, STREAMS, THORNTON CREEK

This study was part of a long-range hybrid program of cutthroat trout from Lake Whatcom and University of Washington stocks. The university stock originated from trout collected in Thornton (Matthews) Creek, a western tributary to Lake Washington. (Wydoski, 1972)

93. Buffo, J. 1979. Early warning system (section 1-3). Metro. Seattle. Location: METRO Library

LAND USE, POLLUTION, STORMWATER

These reports were prepared to provide planners in the Seattle region with a “first cut” estimate of stormwater contribution for select pollutants from a wide range of land use types.

94. Burbank, P. 1983. Inventory of beneficial uses of selected waters in the Seattle/King County region. Metro. Seattle. Location: METRO Library

L. UNION

This document determined what the selected waters in the region were used for including fish and shellfish, water contact sports, viewing, boating and navigation, wildlife, water supply, and waste disposal.

95. Burgner, R. L., and O. A. Mathisen. 1972. Survey of population magnitude and species composition of limnetic feeding fish: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 33. (unpublished) Location: UW SOF/THS

ABUNDANCE, CHESTER MORSE RES., FISH, GROWTH, L. SAMMAMISH, L. WASHINGTON

This is a progress report on estimating seasonal abundance, growth, mortality, and biomass of planktivore fish by species and age groups in Lakes Washington and Sammamish, and in Chester Morse Reservoir.

96. Campbell, M. S. 1943. Sources and extent of Lake Washington pollution. Washington State Pollution Control Commission. Pollution Ser. Bull. 29. Location: Fisheries Library

BACTERIA, L. WASHINGTON

Washington State Department of Health’s findings from bacteriological analysis showed that Lake Washington was contaminated in areas at the north and south end and on the east shore, and was unsafe for domestic use without adequate treatment (Wydoski, 1972).

97. Casne, E. W. 1973. Kinetic growth and nutrient uptake characteristics of natural algal populations. M.S. Thesis. University of Washington. 86 pp. Location: UW SOF/THS

FINDLEY LAKE, L. SAMMAMISH, NUTRIENTS, PHYTOPLANKTON, PRODUCTIVITY

The purpose of this study was to determine and compare the kinetic growth and nutrient uptake characteristics of natural phytoplankton populations in Lake Sammamish (eutrophic) and Findley Lake (oligotrophic). Water samples were collected from the lakes during the peak of the spring algal bloom; and incubated in growth flasks containing various concentrations of nitrate and phosphate. Daily measurements were taken of ^{14}C uptake and nutrient availablility during the eight day incubation period.

98. Casne, S. R., and Q. J. Stober. 1973. Preliminary study of the fish populations: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 157. (unpublished) Location: UW SOF/THS

CEDAR RIVER, CHINOOK SALMON, COHO SALMON, CUTTHROAT TROUT, DACE, DOLLY VARDEN, FISH, LAMPREY, MOUNTAIN WHITEFISH, RAINBOW TROUT, SCULPIN, SOCKEYE SALMON, SUCKER

This report detailed the preliminary investigations of the fish populations in the Cedar River which began in June 1973.

99. Casne, S. R. 1975. Production and food of salmonid populations in three sections of the Cedar River, Washington. M.S. Thesis. University of Washington. 53 pp. Location: UW SOF/THS

ABUNDANCE, BLUEGILL, CEDAR RIVER, CHINOOK SALMON, COHO SALMON, CUTTHROAT TROUT, DACE, DIET, DOLLY VARDEN, FISH, GROWTH, INVERTEBRATES, LAMPREY, MOUNTAIN WHITEFISH, RAINBOW TROUT, SCULPIN, SOCKEYE SALMON, STEELHEAD, SUCKER

Comparisons of salmonid populations within three sections of the Cedar River were made. The three sections were above the storage dam, above the diversion dam at Landsburg, and below the diversion dam to the mouth of the river at Lake Washington. The objectives were to compare population estimates of salmonid species in each section, to compare estimates of growth rates of salmonids between sections, to compare biomass and production estimates in each section, and to summarize the food resources utilized (stomach contents) by salmonids in each section.

100. CH2M Hill. 1974. Water resources management study (Vol I - Vol VII). Municipality of Metropolitan Seattle. Seattle. Location: METRO Library

MODELLING

This seven-volume document includes: Vol I, The main report; Vol. II, Appendixes to the main report; Vol III, User's manual: Computer operations; Vol IV, User's manual: the Hydrocomp simulation program for hydrology; Vol V,User's manual: the Hydrocomp simulation program for water quality; Vol VI, User's manual: The river yield model; Vol VII, User's manual: The upper Duwamish estuary model.

101. CH2M Hill. 1975. Water circulation studies of Lake Washington. Municipality of Metropolitan Seattle. Seattle. Location: METRO Library

CIRCULATION, FLOW, L. UNION, L. WASHINGTON

This is a report of a circulation study on Lake Washington to understand how water masses are transported and dispersed within the Lake Washington-Lake Union system. The observed water circulation system was found to be highly variable and influenced by several factors.

102. Chapra, S. C., and K. H. Reckhow. 1983. Comment on "The effect of changes in the nutrient income on the condition of Lake Washington" (Edmondson and Lehman). *Limnol. Oceanogr.* 28:792-795. Location: UW SOF/THS

L. WASHINGTON, MODELLING, NUTRIENTS

This comment suggests that Lehman and Edmondson's article (1981) is an oversimplification of Vollenweider's phosphorus budget model and that their supporting evidence is insufficient.

103. Chasan, D. J. 1971. The Seattle area wouldn't allow the death of its lake. *Smithsonian* 2:6-13.

L. WASHINGTON, NUTRIENTS, SEWAGE

This is a popular historical review of changing the eutrophic condition of Lake Washington. It discusses how concerned citizens took up the politics of antipollution and succeeded in cleaning up the lake (Wydoski, 1972).

104. Chase, M. 1921. Monthly and yearly summaries of hydrometric data in the State of Washington: 1878-1920. Wash. State Dep. Conserv. Dev., Div. Water Resour. Water Supply Bulletin 1. Location: Allen Library

FLOW, STREAMS

This report provides a summation of all official records pertaining to streamflow in the State of Washington, kept by the USGS, U.S. Reclamation Service, U.S. Weather Bureau, U.S. Forest Service, U.S. Office of Indian Affairs, and private irrigation and power companies prior to the establishment of the Department of Conservation and Development in 1921. Provided is good coverage of streamflows in the Puget Sound drainage prior to the diversion of the Cedar River from the Duwamish River (Wydoski, 1972).

105. Chigbu, P., and T. H. Sibley. 1993. Predation by *Neomysis mercedis*: effects of temperature, *Daphnia magna* size and prey density on ingestion rate and size selectivity. *Fresh. Ecol.* (in press). Location: UW SOF/THS

L. WASHINGTON, TEMPERATURE, ZOOPLANKTON

Neomysis mercedis predation rates on *D. magna* were determined under laboratory conditions. There were generally no consistent differences between the number of *Daphnia* ingested at 10°C and 14°C. At each temperature, the number of prey consumed increased with mysid size and decreased with *Daphnia* size. For small prey the relationship between ingestion rate and prey density represented a Type II functional response. However, for larger prey there was no significant relationship between density of prey and consumption by mysids.

106. Chigbu, P. 1993. Trophic role of longfin smelt in Lake Washington. Ph.D. Dissertation. University of Washington. 224 pp. Location: UW SOF/THS

FISH, L. WASHINGTON, SMELT, SOCKEYE SALMON, ZOOPLANKTON

During the two decades since the ecology of longfin smelt was last studied in Lake Washington, significant changes in the physico-chemical conditions and zooplankton composition have occurred in the lake. The diet of juvenile sockeye salmon has changed from one dominated by copepod species and *Diaphanosoma* in the late 1960's and early 1970's to one dominated by *Daphnia*. There is an increase in diet overlap between smelt and juvenile sockeye salmon from the level reported previously. That, coupled with the fact that both species select large *Daphnia* indicate a high potential for competition between smelt and juvenile sockeye salmon, especially during odd years. The spatial distribution of smelt and mysids overlapped substantially; both species exhibited a reciprocal relationship in their population abundance suggesting that smelt control mysid abundance in the lake. Similarly, from 1988 to 1991, an inverse relationship in the population abundance of 1+ smelt and *Daphnia pulicaria* was observed indicating that smelt may also affect the abundance of *D. pulicaria* in Lake Washington.

107. Chigbu, P., and T. H. Sibley. 1993. Diet and growth of longfin smelt and juvenile sockeye salmon in Lake Washington. *Verh. Int. Ver. Theor. Angew. Limnol.* (. (in press) Location: UW SOF/THS

FISH, L. WASHINGTON, SMELT, SOCKEYE SALMON, ZOOPLANKTON

In Lake Washington longfin smelt (*Spirinchus thaleichthys*) and juvenile sockeye salmon (*Oncorhynchus nerka*) are generally the most abundant planktivorous species. In this article the feeding habits and growth of longfin smelt and sockeye salmon are described and the potential for competition between the two species is assessed.

108. Chrzastowski, M. J. 1983. Historical changes to Lake Washington and route of the Lake Washington Ship Canal, King County, Washington. USGS Water-Resources Investigation Report 81-1182. Seattle. Location: UW SOF/THS

CEDAR RIVER, L. UNION, L. WASHINGTON, LAND USE, SAMMAMISH R., SHIP CANAL, SHORELINE, URBANIZATION, WETLANDS

Historical shoreline changes to hydrologic characteristics were studied for Lake Washington and the route of Lake Washington Ship Canal. The study is based on comparison of maps made during the period 1875-1907 and modern topographic maps, supplemented with historical documents that describe the once-natural setting of the lakes and streams in the Lake Washington drainage basin. The observed shoreline changes range from minor to substantial. The water-surface area has been historically reduced by about 6 km^2, and total shoreline has been reduced by 20 km. Approximately 4 km^2 of the historical wetland area has been eliminated, or about 93 % of the natural wetland extent. The changes have resulted from construction of the Lake Washington Ship Canal and accompanying water-level adjustments, shoreline modification from urban growth of the area, and limited natural processes. The map comparison documents (1) extent of shoreline changes (2) historical loss of wetlands area, (3) loss of small streams that historically entered the lakes and bays, and (4) historical vegetation and land-use patterns around the lakeshore and canal route. The identification of historical shorelines, wetlands, and small streams that have no expression on today's landscape is information of value to land-use planning and local engineering activities. References include several historical documents not included in this bibliography.

109. City of Bellevue. 1986. Coal Creek basin plan and draft environmental impact statement. City of Bellevue. Bellevue, Washington. Location: King County Surface Water Management

COAL CREEK, LAND USE, MANAGEMENT, STREAMS, URBANIZATION

This document is a combined basin plan and draft environmental impact statement.

110. City of Bellevue. 1989. Streamside revegetation enhancement criteria. City of Bellevue Storm & Surface Water Utility. Washington. Location: UW SOF/THS

PLANTS, SHORELINE, STREAMS

This document is intended to provide property owners with the information necessary to easily develop a streamside revegetation plan that conforms to the City of Bellevue's revegetation criteria.

111. City of Seattle. 1988. Lake Union and Ship Canal water quality management program interim action plan. City of Seattle, Office for Long-range Planning. Seattle. Location: GOVERNMENT LIBRARY

HYDROCARBONS, L. UNION, POLLUTION, SHIP CANAL, STORMWATER

The Lake Union and Ship Canal Water Quality Management Program involves coordination with: combined sewer overflow reduction planning; drainage planning, and storm drain sediment sampling and analysis; and the Gas Works Park groundwater analysis program and preparation of a remedial action plan.

112. Clark, T. J., R. J. Morrice, R. I. Matsuda, and R. S. Domenowske. 1972. Cedar Hills landfill study, Municipality of Metropolitan Seattle, February 1 to June 21, 1972. Metro. Seattle. Location: METRO Library

ISSAQUAH CREEK, LAND USE, MASON CREEK, POLLUTION, STORMWATER, STREAMS

From February through June of 1972, the Municipality of Metropolitan Seattle conducted a short-term sampling program to study the effects of leachate drainage from King County's Cedar Hills Landfill site on the water quality of Mason and Issaquah Creeks.

113. Clark, T. J., R. J. Morrice, and R. I. Matsuda. 1971. A brief study of the Sammamish River. Municipality of Metropolitan Seattle. Seattle. Location: METRO Library

CHEM. LIMNOLOGY, INVERTEBRATES, SAMMAMISH R.

On May 5, 1971, The Ecology Section of Metro made a chemical, physical, and biological survey of the Sammamish River from its source, at Lake Sammamish, to its mouth, at Lake Washington.

114. Clarke, E. 1967. How Seattle is beating water pollution. *Harper's* 234:91-95.

L. WASHINGTON, POLLUTION, SEWAGE

The creation of Metro (Municipality of Metropolitan Seattle) was Seattle's solution to water pollution. Solutions and failures of 1958 and 1967 are discussed as well as plans for new sewage facilities (Wydoski, 1972).

115. Cole, D. W., G. V. Wolfe, and P. S. Homann. 1988. Cedar River watershed research, 1961-1988. College of Forest Resources, University of Washington. Seattle. Location: Forestry Library

BIBLIOGRAPHY, LAND USE, MAMMALS, NUTRIENTS, PLANTS

Since 1961 the Cedar River Watershed has provided the scientific community with an unusual opportunity to investigate the ecology, productivity, and nutrient dynamics of forest ecosystems. This report documents the research of 79 scientific articles, 16 master's theses, 22 Ph.D. dissertations, 31 book (or proceedings) chapters, and 6 bulletins. Aquatic research is not included.

116. Collias, E. E., and G. R. Seckel. 1954. Lake Washington Ship Canal data. Dept. of Oceanography. Univ. of Washington. (Spec. Rep. 2) Location: SUZALLO LIBRARY

CHEM. LIMNOLOGY, CIRCULATION, L. UNION, L. WASHINGTON, SHIP CANAL

This report provides physical and chemical data that were collected by the Department of Oceanography on Lakes Union and Washington and Salmon Bay in the ship canal from 29 November 1950 through 22 December 1953 (Wydoski, 1972).

117. Collings, M. R., R. W. Smith, and G. T. Higgins. 1968. The hydrology of four streams in Western Washington as related to several Pacific salmon species, Geological Survey Water-Supply Paper. U.S. Government Printing Office. Washington, D.C. Location: METRO Library

CEDAR RIVER, FISH, FLOW, SPAWNING

Enhancement- or possibly even preservation- of the Pacific salmon hinges on the careful planning and proper management of the streamflow upon which they depend for spawning. This report is the first of a series and is used to present the method of determining preferred salmon spawning conditions and results of the investigation of 129 measurements in 14 study reaches of the Dewatto, Cedar, Kalama, and North Fork Nooksack Rivers.

118. Comis, J. G. 1972. Watershed ecology, phase II; an interdisciplinary study of Kelsey and Coal Creeks, Washington State. Department of Civil Engineering, University of Washington. Seattle. Location: METRO Library

COAL CREEK, KELSEY CREEK, MODELLING, STREAMS, URBANIZATION

The Watershed Ecology Study Phase II was an interdisciplinary student originated study funded by the NSF and City of Bellevue, Washington. The focus of the study was two drainage basins, the Mercer Creek System and the Coal Creek System. The goal of the study was to identify and measure the associated problems inherent with urban development in small stream watersheds.

119. Comis, J. G., and Students. 1971. Stream ecology study: An interdisciplinary watershed study of Kelsey and Coal Creeks, King County, Washington. Water Air Resour. Div., Dept. Civil Eng. University of Washington, Seattle. Location: Fisheries Library

COAL CREEK, KELSEY CREEK, STREAMS, URBANIZATION

This study summarized an intensive effort for 15 weeks by 28 students from various disciplines. The study was organized into four major section, physical, biological, water quality, and applied, with an overall objective of studying the problems of urbanization on small watersheds (Wydoski, 1972).

120. Comita, G. W., and G. C. Anderson. 1959. The seasonal development of a population of *Diaptomus ashlandi* Marsh and related phytoplankton cycles in Lake Washington. *Limnol. Oceanogr.* 4:37-52.

L. WASHINGTON, PHYTOPLANKTON, ZOOPLANKTON

The results of a study of a *Diaptomus ashlandi* population and the simultaneous phytoplankton cycles in Lake Washington were reported (Wydoski, 1972).

121. Comita, G. W. 1953. A limnological study of planktonic copepod populations. Ph.D. Thesis. University of Washington. 195 pp. Location: UW SOF/THS

L. WASHINGTON, ZOOPLANKTON

The dominant calanoid copepod populations of three Washington lakes and one artic lake were studied. The following features received particular attention: the developmental history of each species, their egg production, the time of maximum occurence and duration of each larval instar, the size of animals in each of the instars through the entire time of their existence, and the sex ratios.

122. Communication Design. 1980. Pine Lake restoration study; survey of residents and park visitors. Metro. Seattle. Location: METRO Library

PINE LAKE, RECREATION, SEWAGE, SMALL LAKES

One hundred and fifty one residents of the Pine Lake Basin were interviewed to determine their attitudes towards water quality at Pine Lake. Fifty eight visitors to the park were also surveyed.

123. Coney, B. 1969. Sockeye abound in Lake Washington but forget it, sportsmen, they don't bite. *Pacific Search* 3:(unnumbered). Location: Allen Library

FISH, L. WASHINGTON, RECREATION, SOCKEYE SALMON

This is a popular article on the growing sockeye salmon population in the lake and the potential for sport and commercial fisheries (Wydoski, 1972).

124. Conley, J. W., Jr. 1974. Urban storm water management in Kelsey Creek drainage basin. M.S. Thesis. University of Washington. 119 pp. Location: Engineering Library

KELSEY CREEK, STORMWATER, STREAMS, URBANIZATION

This thesis provides a literature review on the impact of urban development on small drainage basins and on what measures might offer a reasonable starting point for control of urban stormwater runoff. A qualitative survey of Kelsey Creek and its tributaries located sources of pollution and signs of increased flow. Additionally an evaluation was made of the City of Bellevue's approach toward stormwater management.

125. Cook, R. C., and I. Guthrie. 1987. In-season stock identification of sockeye salmon (*Oncorhynchus nerka*) using scale pattern recognition. In: Sockeye Salmon (*Oncorhynchus nerka*) Population Biology and Future Management: Can. Spec. Publ. Fish. Aquat. Sci, no. 96, (Eds.) H. D. Smith, L. Margolis, and C. C. Wood. Department of Fisheries and Oceans, Ottawa. Ont. pp. 327-334

FISH, L. WASHINGTON, MANAGEMENT, SOCKEYE SALMON

Automated video digitization of sockeye salmon (*Oncorhynchus nerka*) scales was investigated as a technique to help meet the logistic requirements of in-season stock identification for the Fraser River. A microcomputer-based system with a television camera interface was used to make 64,000 luminance measurements on each scale in 6 seconds. The resulting data were converted to circuli spacing information for use in stock identification. Algorithms were established to allow for rapid discriminant analysis and stock composition estimation for any possible combination of Fraser River and Lake Washington stocks. The results of this feasibility study were then evaluated in the context of the management problem and the rapid advances in image processing technology.

126. Costa, H. H. 1973. The food and feeding chronology of yellow perch (*Perca flavescens*) in Lake Washington: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 155. (unpublished) Location: UW SOF/THS

DIET, FISH, L. WASHINGTON, YELLOW PERCH

The food habits of yellow perch in Lake Washington were studied over a period of nine months. Altogether, 549 yellow perch were examined for the stomach contents. The food consisted mainly of cottids, mysid shrimp, and

chironomid pupae and larvae; the predominant food item being the mysid shrimp. There was no difference in the food consumed between the different sexes and between the different size groups. However, a considerable seasonal variation in the consumption of different food items was seen. Maximum feeding by perch during the day was observed just before dusk, and the daily ration was calculated to be about 0.014 grams per gram of body weight.

127. Costa, H. H. 1979. The food and feeding chronology of yellow perch (*Perca flavescens*) in Lake Washington. *Int. Rev. Gesamt. Hydrobiol.* 64:783-793.

DIET, FISH, L. WASHINGTON, YELLOW PERCH

The food habits of yellow perch (*Perca flavescens*) in Lake Washington, Seattle were studied over a period of nine months. Altogether 549 yellow perch were examined for stomach contents. The daily activity pattern of the yellow perch in Lake Washington appears to correspond roughly with the feeding pattern. The maximum numbers of perch caught by the nets during 24 hour study periods correspond well with degree of fullness of stomachs noted for the different times of the day. The food consisted mainly of cottids, mysid shrimps (*Acanthomysis awatchensis*) and chironomid pupae and larvae. There was no difference in the food consumed between the different sexes and between the different size groups. Maximum feeding by perch during the day was observed just before dark and the daily ration was calculated to be about 1.4% of their wet body weight.

128. Craddock, D. R., J. G. Parker, C. A. Spjut, and G. F. Slusser. 1978. Effect of Lake Washington sediment from the Sand Point dredging site on coho salmon (*Oncorhynchus kisutch*) fingerlings, Interim Report to GSA. U.S. Department of Commerce, NOAA. Seattle (WA).

BIOASSAY, COHO SALMON, FISH, L. WASHINGTON, SEDIMENTS

High concentrations of Lake Washington sediment did not cause mortalities of coho salmon fingerlings approaching LC_{50} even after 192 hour exposure,

129. Crecelius, E. A. 1974. The geochemistry of arsenic and antimony in Puget Sound and Lake Washington. Ph.D. Dissertation. University of Washington. 133 pp. Location: Fisheries Library

L. WASHINGTON, LAND USE, METALS, SEDIMENTS, STORMWATER

In Lake Washington abnormally high arsenic concentration (>100 ppm dry weight) were found in the surface sediments and were attributed to the following processes: (1) Atmospheric input of partially soluable arsenic rich dust from the copper smelter located 35 km upwind, and (2) Removal of dissolved arsenic from the lake water by a bacteria or inorganic reaction during the summer and fall. An arsenic budget for the lake indicated equal amounts were brought in by the atmosphere and by rivers. The contributions from storm water runoff and sewage were minor.

130. Dalseg, R. D., and B. Burrow. 1973. Freshwater lakes and streams survey, phase V, I-90 corridor studies. Metro. Seattle. Location: METRO Library

ISSAQUAH CREEK, SMALL LAKES, STREAMS

This is a report of a water quality survey of lakes and streams along the I-90 corridor between East Issaquah and Tanner.

131. Dalseg, R. D., and R. J. Hansen. 1969. Bacteriological and nutrient budget of the Sammamish River; study period March 1967-February 1969. Municipality of Metropolitan Seattle. Seattle. Location: METRO Library

BACTERIA, NUTRIENTS, SAMMAMISH R., STREAMS

It was estimated that 36% of total P and 28% of the total nitrate-nitrogen load entering Lake Washington enters from the Sammamish River. Data are provided on the nutrient contribution (ammonia, nitrates, phosphates) from the origin of the Sammamish River, Swamp Creek, North Creek, Bear Creek, Evans Creek, and at the mouth of the Sammamish River. Monthly averages are also given for ammonia, nitrates, and nitrites and phosphates from June 1967 until February 1969 and total and fecal coliform counts are summarized (Wydoski, 1972).

132. Dalseg, R. D., G. W. Issac, and R. I. Matsuda. 1966. A survey of stream conditions in Issaquah Creek, Water Quality Series No. 3. Municipality of Metropolitan Seattle. Seattle. Location: METRO Library

ISSAQUAH CREEK, L. SAMMAMISH, NUTRIENTS, STREAMS

Lake Sammamish was undergoing eutrophication. The major cause was the contribution of nutrients from its major tributary, Issaquah Creek (Wydoski, 1972).

133. Dart, J. D. 1952. The changing hydrologic pattern of the Renton-Sumner Lowland, Washington. *Yearb. Assoc. Pac. Coast Geogr.* 14:19-23. Location: Suzzallo Library

CEDAR RIVER, FLOW

This report follows changes that made the Cedar River the major inlet into Lake Washington (Wydoski, 1972).

134. Davis, J. I., and R. G. Swartz. 1981. Investigation of fifteen lakes in King County with projections of future quality. Metro. Seattle. Location: METRO Library

L. SAMMAMISH, L. UNION, NUTRIENTS, SMALL LAKES

Fifteen lakes in the Metro planning area were sampled every other month from May 1979 through March 1980 to assess changes caused by nonpoint sources of pollution since the lakes had last been evaluated at some time between 1972 and 1976.

135. Davis, M. B. 1973. Pollen evidence of changing land use around the shores of Lake Washington. *Northwest Sci.* 47:133-148. Location: UW SOF/THS

L. WASHINGTON, LAND USE, PALEOLIMNOLOGY, SEDIMENTS

Eutrophication of Lake Washington caused by the growth of Seattle is recorded in the upper layers of the sediments. Human disturbance of vegetation has also left a pollen record in the sediments of Lake Washington. The pollen changes are quite different from those observed elsewhere, reflecting the unique vegetation and the unique history of land use in the Pacific Northwest.

136. Dawson, J. J., and R. E. Thorne. 1975. Lake Washington sockeye salmon studies 1974-1975: final report for the period July 1, 1974-June 30, 1975. Fisheries Research Institute, University of Washington. Seattle. Location: Fisheries Library

FISH, L. WASHINGTON, SOCKEYE SALMON

This report contains results of surveys of Lake Washington sockeye salmon. The results of population studies of both adults and juveniles are provided.

137. Dawson, J. J., and R. E. Thorne. 1978. Lake Washington sockeye salmon studies, 1977-1978. Fisheries Research Institute, University of Washington. Seattle. Location: Fisheries Library

FISH, L. WASHINGTON, SOCKEYE SALMON

This report contains survey results for Lake Washington sockeye salmon during November 1977 and February 1978. The population was estimated between 5.8 and 4.0 million.

138. Dawson, J. J., and R. E. Thorne. 1980. Lake Washington sockeye salmon presmolt studies, 1980. Fisheries Research Institute, University of Washington. Seattle. Location: Fisheries Library

FISH, L. WASHINGTON, SOCKEYE SALMON

This report contains the survey results of juvenile sockeye salmon in Lake Washington during March 1980. The population was estimated between 6.6 and 7.0 million fish.

139. Dawson, J. J. 1972. Determination of seasonal distribution of juvenile sockeye salmon in Lake Washington by means of acoustics. M.S. Thesis. University of Washington. 112 pp. Location: UW SOF/THS

ABUNDANCE, DISTRIBUTION, FISH, L. WASHINGTON, SOCKEYE SALMON

Factors that affect sockeye salmon run size include quantity and quality of spawning areas and the rearing capability of the nursery lake. The latter factor is dependent on how the lake is utilized by the juveniles. Woodey (1972) observed reduced growth rates of young sockeye in some areas of Lake Washington apparently due to crowding. Mechanisms causing this crowding and those controlling horizontal movements through the lake are not well known. This study explores these mechanisms by (1) quantifying the distribution of young salmon population periodically through its residency and (2) comparing the resulting distributions with various environmental parameters measured periodically.

140. DeLacy, A. C., and B. Doble. 1972. Feeding ecology and food habits of limnetic feeding fish: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 91. (unpublished) Location: UW SOF/THS

DIET, FISH, L. WASHINGTON, SOCKEYE SALMON

This is a short summary of progress made in quantifying the amount of food consumed by juvenile sockeye at selected times during their 14 month lacustrine residence in Lake Washington.

141. DeLacy, A. C., L. R. Donaldson, and E. L. Brannon. 1969. Homing behavior of chinook salmon. *UW Fisheries Contribution* 300:59-60. Location: UW SOF/THS

CHINOOK SALMON, FISH, MIGRATION

The role of olfaction in the homing of chinook salmon was studied using fish from the UW holding pond.

142. Dell, M. B. 1974. Tag return and movement of rainbow trout (*Salmo gairdneri*) and rainbow-steelhead trout released in the Lake Washington system. *Trans. Am. Fish. Soc.* 103:250-254. Location: UW SOF/THS

DISTRIBUTION, FISH, HATCHERIES, L. UNION, L. WASHINGTON, MIGRATION, RAINBOW TROUT, STEELHEAD, UNION BAY

Similar patterns of dispersion were observed over 90-day periods among hatchery-reared rainbow trout and rainbow-steelhead hybrid trout released in the Lake Washington system in 1966 and 1967. In both experiments 90 % of recaptures were within 3.2 km if the release site. Returns were generally the same for the three tags tested. Of the total fish released in 1966, 47.3% were recovered, and of those in 1967, only 40.5%. A reward was offered in the 1966 experiment. Loosening and loss of tags and infection of tag wounds appeared minimal.

143. Devol, A. H., and T. T. Packard. 1978. Seasonal changes in respiratory enzyme activity and productivity in Lake Washington microplankton. *Limnol. Oceanogr.* 23:104-111. Location: UW SOF/THS

CARBON, L. WASHINGTON, NUTRIENTS, PHYTOPLANKTON, PRODUCTIVITY

Calculations of cyclical seasonal respiration from direct measurements of electron transport system (ETS) activity in natural phytoplankton assemblages are presented for Lake Washington (WA) for January-December 1974. During the first few months of the year minimum ETS activity (4.2 mg 0_{eq} m^{-2} hr^{-1}), carbon-14 uptake (84 mg C m^{-2} day^{-1}), and chlorophyll (10.1 mg m^{-2}), coincided with minimum temperature (about 6.2C) and maximum nutrient concentrations (phosphate, 250 mg m^{-2}; nitrate, 3.5 g m^{-2}). Maximum ETS activity (109.8 mg 0_{eq} m^{-2} hr^{-1}), carbon-14 uptake (2126 mg C m^{-2} day^{-1}), and chlorophyll (121.7 mg m^{-2}) occurred during spring bloom. During the fall period of thermal stratification and nutrient depletion, values were intermediate. Respiration rates were used to calculate production:respiration ratios (P:R), which were low in late summer and fall and high in winter. The percentage of primary production oxidized during a 12-hr dark period varied from 7-100%, with high percentages in summer, low in late winter. Dark respiration should be considered in any study of the fate of photosynthetically fixed carbon; 10-40% of carbon-14 carbon incorporated by marine algae can be lost in a four-hour dark period. The P:R rate has been considered the major single measure of the physiological state of phytoplankton populations.

144. Devol, A. H., and T. T. Packard. 1973. Respiratory electron transport system activity measurements from four lakes in the Lake Washington drainage: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 141. (unpublished) Location: UW SOF/THS

BACTERIA, CARBON, CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, L. WASHINGTON, PHYTOPLANKTON, PRODUCTIVITY, ZOOPLANKTON

The respiratory electron transport system activity (ETS) distribution was monitored in four lakes to answer the questions (1) what is the relative importance of the phytoplankton, zooplankton, and bacterial respiration, (2) how much of the primary productivity of the phytoplankton community is oxidized by that community in order to meet cellular energy requirements, (3) which is more important in the cycling of nutrients, bacteria or zooplankton, (4) what are the relationships between ETS activity an ^{14}C-uptake, and (5) what are the cycles of ETS activity?

145. Dobbin, C. N. 1933. Fresh water Ostracoda of Washington. M.S. Thesis. University of Washington. 57 pp. Location: Allen Library

L. WASHINGTON, ZOOPLANKTON

A key to the freshwater Ostracoda found in Washington is provided, together with descriptions of the genera and brief descriptions and drawings of the species (Wydoski, 1972).

146. Doble, B. D., and A. C. DeLacy. 1973. Feeding ecology and food habits of limnetic feeding fish: Coniferous Forest Biome. Ecosysten Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 153. (unpublished) Location: UW SOF/THS

DIET, FISH, L. WASHINGTON, SOCKEYE SALMON, ZOOPLANKTON

The diel feeding periodicity of the juvenile sockeye was established for all successful sampling dates in 1972 and 1973. Estimates of the instantaneous rate of gastric evacuation and daily ration by size of fish were completed. An examination of diet and selectivity in feeding by size of fish was completed.

147. Doble, B. D., and D. M. Eggers. 1978. Diel feeding chronology, rate of gastric evacuation, daily ration, and prey selectivity in Lake Washington juvenile sockeye salmon (*Oncorhynchus nerka*). *Trans. Am. Fish. Soc.* 107:36-45.

DIET, FISH, L. WASHINGTON, SOCKEYE SALMON, ZOOPLANKTON

Patterns of diel feeding chronology, rate of gastric evacuation, daily ration, and prey selectivity were determined by season and by fish length groups for Lake Washington juvenile sockeye salmon. In summer and fall, sockeye fed intensely during the afternoon to dusk. During the winter a high percentage of the population did not feed. Those fish that fed did so at a much lower rate than observed in summer and fall. No feeding occurred in the hours of darkness at any time of the year. Rates of gastric evacuation decreased with fish body size and increased with water temperature. The daily meal (total intake) generally increased while the daily ration decreased (daily meal/fish body weight) with increasing body size. During the winter the daily meal and daily ration were considerably lower than those observed in the summer and fall. Juvenile sockeye salmon in Lake Washington showed size-selective predation that had marked seasonal trends as well as marked trends among fish size groups. These patterns suggested that sockeye optimally forage by ignoring small zooplankton forms upon encounter.

148. Doble, B. D. 1974. Diel feeding periodicity, instantaneous rate of gastric evacuation and daily zooplankton ration of juvenile sockeye salmon (*Oncorhynchus nerka*) in Lake Washington. M.S. Thesis. University of Washington. 79 pp. Location: UW SOF/THS

DIET, FISH, L. WASHINGTON, SOCKEYE SALMON, ZOOPLANKTON

The availability of year-round logistic support and the capability of capturing large numbers of specimens at periodic intervals provided an opportunity for attempting bimonthly field estimates of the instantaneous rate of gastric evacuation and daily ration for juvenile sockeye salmon (*Oncorhychus nerka*) in Lake Washington. Specific objectives included (1) establishing the diel feeding periodicity of the juvenile sockeye, (2) estimating *in situ* the instantaneous rate of gastric evacuation and the daily ration, and (3) determining the relative importance of the dominant zooplankters in Lake Washington to the daily ration of the juvenile sockeye. The principle parameters examined in reference to each of these objectives were size of fish and time of year.

149. Donaldson, L. R. 1970. Selective breeding of salmonid fishes. In: Marine aquaculture, (Ed.) W. J. McNeil. Oregon State Univ. Press. Corvallis (OR). pp. 65-74 Location: Fisheries Library

BREEDING, CHINOOK SALMON, FECUNDITY, FISH, GROWTH, RAINBOW TROUT

This report summarizes data on the selective breeding of chinook salmon and rainbow trout at the University of Washington with an emphasis on growth and fecundity. Both species have been liberated in the Lake Washington drainage (Wydoski, 1972).

150. Donaldson, L. R., and G. H. Allen. 1958. Return of silver salmon, *Oncorhynchus kisutch* (Walbaum), to point of release. *Trans. Am. Fish. Soc.* 87:13-22.

COHO SALMON, FISH, HATCHERIES, ISSAQUAH CREEK, MIGRATION, STOCKING

Siver salmon were transferred after a year of rearing at the Soos Creek Hatchery to the Lake Washington watershed where 36,833 were reared for two months at the Issaquah Hatchery (right ventral mark) and 34,405 were reared for two months at the University of Washington hatchery (left ventral mark) before they were released. Returning salmon were recovered at their point of release rather than their native stream (Wydoski, 1972).

151. Donaldson, L. R., D. D. Hansler, and T. N. Buckridge. 1957. Interracial hybridization of cutthroat trout, *Salmo clarkii* and its use in fisheries management. *Trans. Am. Fish. Soc.* 86:350-360.

BREEDING, CUTTHROAT TROUT, FISH, MANAGEMENT, THORNTON CREEK

Initial stock for experiments at the University of Washington were obtained in 1933 from Thornton (Matthews) Creek, which is a northeastern tributary of Lake Washington. Field testing was made in Echo Lake, northeast of Seattle (Wydoski, 1972).

152. Donaldson, L. R., and D. Menasveta. 1961. Selective breeding chinook salmon. *Trans. Am. Fish. Soc.* 90:160-164.

BREEDING, CHINOOK SALMON, FISH, HATCHERIES, L. UNION, STOCKING

Fish for the initial experiments were obtained from the Soos Creek hatchery. The progeny of these fish were planted in Lake Union and later returned to the ponds at the University of Washington where selective breeding, since 1949, has produced stocks of chinook salmon that are more resistant to high temperature and disease, mature earlier and have a higher survival rate than non-selected stocks (Wydoski, 1972).

153. Donaldson, L. R., and P. R. Olson. 1957. Development of rainbow trout brood stock by selective breeding. *Trans. Am. Fish. Soc.* 85:93-101.

BREEDING, FISH, L. WASHINGTON, RAINBOW TROUT, STOCKING

This report describes the selective breeding of rainbow trout at the University of Washington for over 23 years. Gives data on age, length-weight relationships, and fecundity. Releases of these fish have been made in Lake Washington (Wydoski, 1972).

154. Donaldson, L. R. 1983. Lake Washington history and present status. In: Lake Washington Symposium, (Ed.) A. Adams. Trout Unlimited. Mercer Island (WA). Location: UW SOF/THS

L. WASHINGTON, REVIEW

This short report provides a summary of the history of Lake Washington.

155. Drew, A. W., and R. E. Thorne. 1979. Lake washington sockeye salmon studies, 1979:final report for the period Jan. 1, 1979-June 30, 1979. Fisheries Research Institute, University of Washington. Seattle. Location: Fisheries Library

FISH, L. WASHINGTON, SOCKEYE SALMON

This report contains the 1977 survey results for Lake Washington sockeye salmon. The population was estimated between 1.28 and 3.11 million.

156. Driggers, V. W. 1964. Tracer dye studies of Lake Union and Bellingham Bay. M.S. Thesis. University of Washington. 73 pp. Location: Fisheries Library

FLOW, L. UNION

Rhodamine B dye was used to examine the transport phenomenon in Lake Union and Bellingham Bay (Wydoski, 1972).

157. Dryfoos, R. L. 1965. The life history and ecology of the longfin smelt in Lake Washington. Ph.D. Thesis. University of Washington. 229 pp. Location: UW SOF/THS

ABUNDANCE, DIET, DISTRIBUTION, FECUNDITY, FISH, GROWTH, L. WASHINGTON, SMELT

The objectives of this study were to (1) describe the life history and ecology of the longfin smelt, *Spirinchus thaleichthys* (Ayres), in Lake Washington, (2) determine the relationship between the Lake Washington population and populations of longfin smelt from other areas, and (3) define the role of the smelt in the Lake Washington ecosystem.

158. Duncan, A. 1985. Body carbon in daphnids as an indicator of the food concentration available in the field. *Ergeb. Limnol.* 21:81-90.

CARBON, L. WASHINGTON, PHYTOPLANKTON, ZOOPLANKTON

Daphnia pulicaria and *D. thorata* from Lake Washington were reared for a whole generation at three temperatures and 4-6 concentrations of a good algal food. Carbon weight-body length regressions were calculated for all but one food concentration-temperature combination and proved to be statistically significant. Covariance analysis showed that within one temperature, regressions could be grouped into 2 statistically different groups that fell into food levels above and below 0.125 mg C L^{-1} the elevation of the food-limited pooled regression being lower than that for the higher food levels. By comparison with the regressions derived experimentally under defined conditions of food and temperature, it proved possible to identify periods of food limitation for the daphnid populations in Lake Washington and to indicate the food levels at which the daphnid populations were operating during these periods of food limitation.

159. Dunstan, W. A. 1956. Copper sulfate treatment of the Cedar River and tributaries. In: Progress report: Puget Sound stream studies 1956, (Eds.) W. E. Bostick, W. A. Dunstan, and W. H. Rees. State of Washington Department of Fisheries. Olympia (WA). pp. 6-15 Location: Fisheries Library

CEDAR RIVER, FISH, INVERTEBRATES, MANAGEMENT, METALS, PERIPHYTON

For many years it has been the practice of the Seattle City Water Department to destroy all algae growth in the Cedar River in order to maintain a high standard of water quality. This algae control was accomplished by the addition of copper sulfate crytals to the river and its tributaries during the warm spring and summer months. This study concluded: 1) at least three miles of main river channel were covered with sufficient copper and over a long enough period of time to kill salmon; and 2) an additional five miles were covered with sufficient copper to kill most forms of algae and insects.

160. Dyckman, C., and S. Garrod. 1978. Small streams and salmonid: a handbook for water quality studies. Metro. Seattle. Location: METRO Library

FISH, STREAMS

This manual is written as a handbook for teachers to teach about the local environment and to carry out stream rehabilitation, water quality, and salmonid enhancement programs.

161. Dyckman, C., A. W. Way, and P. Kelly. 1981. Clean water, streams and fish; a holistic view of watersheds. secondary curriculum. Metro. Seattle. Location: METRO Library

FISH, STREAMS

This document is intended to help youth and adults act responsibly towards their life support system: water. It is also intended to round out the curricular offerings on salmon (see Dyckman and Garrod 1978) by emphasizing the freshwater habitat phase of salmon life cycle.

162. Dykeman, R. G. 1980. An investigation of the young of the year and age I fish population in southern Lake Washington. M.S. Thesis. University of Washington. 297 pp. Location: Fisheries Library

ABUNDANCE, CHINOOK SALMON, COHO SALMON, CRAPPIE, DISTRIBUTION, FISH, GROWTH, L. WASHINGTON, LARGEMOUTH BASS, PEAMOUTH, PUMPKINSEED, RAINBOW TROUT, SCULPIN, SMELT, SOCKEYE SALMON, SQUAWFISH, STICKLEBACK, SUCKER, YELLOW PERCH

Age 0 and 1 fish were sampled at the southern tip of Lake Washington between March and October 1976 prior to the operation of the Shuffleton Power Plant. Potential impacts of power generation on these fishes were estimated based on abundance, growth, and distribution.

163. Edmondson, W. T. 1956. Biological aspects of the problem. *In* A new critical phase of the Lake Washington pollution problems by R.O. Sylvester, W.T. Edmondson, and R.H. Bogan. *Trend. Eng.* 8:8-14. Location: UW SOF/THS

L. WASHINGTON, MANAGEMENT, NUTRIENTS, SEWAGE

Aspects of the Lake Washington pollution are presented by university authorities: 1) the history and (then) present aspects of the problem along with several alternative solutions to the problem, 2) the biological changes and the effects increased fertilization would have on the lake, and 3) the sanitary chemistry involved in the conversion of domestic wastes to aquatic fertilizers and possible means of removing these fertilizers (Wydoski, 1972).

164. Edmondson, W. T. 1961. Changes in Lake Washington following an increase in the nutrient income. *Verh. Int. Ver. Theor. Angew. Limnol.* 14:167-175. Location: UW SOF/THS

L. WASHINGTON, NUTRIENTS, SEWAGE

This article described the eutrophication of Lake Washington (Wydoski, 1972).

165. Edmondson, W. T. 1963. Pacific Coast and Great Basin. In: Limnology in North America, (Ed.) D. E. Frey. Univ. Wisconsin Press. Madison (WI). pp. 371-392 Location: Fisheries Library

BIBLIOGRAPHY, L. WASHINGTON, NUTRIENTS, REVIEW, SEWAGE

This is a limnological review of Lake Washington, covering signs of eutrophication, sewage disposal in the lake, proposed action to divert sewage to Puget Sound and properties of the lake associated with increased productivity. Bibliography is extensive (Wydoski, 1972).

166. Edmondson, W. T. 1966. Changes in the oxygen deficit of Lake Washington. *Verh. Int. Ver. Theor. Angew. Limnol.* 16:153-158. Location: UW SOF/THS

CHEM. LIMNOLOGY, L. WASHINGTON, NUTRIENTS

This report describes the effect of eutrophication on dissolved oxygen in Lake Washington (Wydoski, 1972).

167. Edmondson, W. T. 1968. Water quality management and lake eutrophication: The Lake Washington case. In: Water resources management and public policy, (Eds.) T. H. Campbell, and R. O. Sylvester. Univ. Washington Press. Seattle (WA). pp. 139-178 Location: UW SOF/THS

L. WASHINGTON, NUTRIENTS, REVIEW

The biological aspects of the pollution problem in Lake Washington are explained, and a review of the limnological background of other lakes is provided (Wydoski, 1972).

168. Edmondson, W. T. 1969. Cultural eutrophication with special reference to Lake Washington. *Comm. Internat. Verein. Limnol.* 17:19-32. Location: UW SOF/THS

L. WASHINGTON, LAND USE, NUTRIENTS, PALEOLIMNOLOGY, REVIEW, SEDIMENTS, URBANIZATION

This paper reports on the beginning of a study of the sediments of Lake Washington and how it will contribute to the development of paleolimnology.

169. Edmondson, W. T. 1969. Eutrophication in North America. In: Eutrophication, causes, consequences, correctives. National Academy of Sciences. NAS-NRC Publ. 1700. Washington D.C. pp. 124-149 Location: UW SOF/THS

L. WASHINGTON, MANAGEMENT, NUTRIENTS, SEWAGE

This chapter emphasizes individual lakes affected by artificial enrichment and their consequent changes in productivity and abundance of organisms.

170. Edmondson, W. T. 1970. Phosphorous, nitrogen, and algae in Lake Washington after diversion of sewage. *Science* 169:690-691.

L. WASHINGTON, NUTRIENTS, PHYTOPLANKTON, SEWAGE

After diversion of sewage effluent of Lake Washington, winter concentration of phosphate and nitrate decreased at different rates. The amount of phytoplanktonic chlorophyll in the summer was very closely related to the mean winter concentration of phosphate, but not to that of nitrate or carbon dioxide (Wydoski, 1972).

171. Edmondson, W. T. 1972. The present condition of Lake Washington. *Verh. Int. Ver. Theor. Angew. Limnol.* 18:284-291. Location: UW SOF/THS

CHEM. LIMNOLOGY, L. WASHINGTON, NUTRIENTS, REVIEW, SEWAGE, URBANIZATION

During the period of 1941-1963 Lake Washington received increasing amounts of effluent from secondary sewage treatment plants. During 1963-1968 the sewage was diverted step-wise, and after February 1968 the effluents were halted. The lake's condition improved rapidly and sensitively with the changes in nutrient input. In the summer of 1971, the transparency exceeded that observed in 1950, and the hypolimnetic oxygen concentrations toward the end of summer 1969 were close to those of 1950. Thus lake has conformed to predictions. Nevertheless, the lake's condition is not yet identical to that of 1950; in particular plankton has not yet returned to its 1950 condition and appears to be still in transition. Since 1950 the watersheds have changed considerably—large areas have been deforested for urbanization with resultant environmental modifications. Nitrate and alkalinity are now higher than in 1950. However, the lake showed that it was able to accept a rather large increase in nutrients before it deteriorated, and that it could rapidly revert when relieved of that stress.

172. Edmondson, W. T. 1972. Nutrients and phytoplankton in Lake Washington. In: Nutrients and eutrophication: The limiting-nutrient controversy, (Ed.) G. E. Likens. American Society of Limnology and Oceanography. Lawrence (KA). pp. 172-193 Location: UW SOF/THS

CARBON, L. WASHINGTON, NUTRIENTS, PHYTOPLANKTON, SEWAGE

Lake Washington was enriched with increasing volumes of effluent from secondary sewage treatment plants in the period 1941-1963. It responded with increased production, and the abundance of algae increased severalfold. The winter phosphate concentration increased proportionally much more than did nitrate or carbon dioxide. After diversion of effluent, starting in 1963, winter phosphate decreased about as much, but nitrate and carbon dioxide flucuated from year to year at relatively high values. Thus the major change following sewage diversion was in phosphorous and phytoplankton, but not in nitrate or carbon dioxide. Similarly, the concentration of phosphate in the hypolimnion at the end of the summer changed much more than did that of nitrate and carbon dioxide.

173. Edmondson, W. T. 1973. Lake Washington. In: Environmental quality and water development, (Eds.) C. R. Goldman, and J. McEvoy. W.H. Freeman and Company. USA. pp. 281-298 Location: UW SOF/THS

L. WASHINGTON, NUTRIENTS, POLLUTION, SEWAGE

This paper discusses both the scientific and the political aspects of a water pollution problem in Lake Washington and Puget Sound. This paper describes the participation of the public in the cleanup of Lake Washington, and shows how a concerned and motivated citizenry can accomplish a major improvement on its own initiative.

174. Edmondson, W. T. 1974. The sedimentary record of the eutrophication of Lake Washington. *Proc. Natl. Acad. Sci.* 71:5093-5095. Location: UW SOF/THS

L. WASHINGTON, PALEOLIMNOLOGY, SEDIMENTS

Lake Washington changed in productivity, abundance of organisms, and chemical character as a result of enrichment with sewage effluent and subsequent diversion of the effluent. A record of many of the changes is left in the sediments in the form of concentrations of specific elements or compounds and recognizable remains of organisms, especially diatoms. The vertical distribution of diatoms in dried cores of sediment can be determined with considerable precision with scanning electron microscopy. Such data provide information about the character of the lake before limnological studies were made.

175. Edmondson, W. T. 1975. Microstratification of Lake Washington sediments. *Verh. Int. Ver. Theor. Angew. Limnol.* 19:770-775. Location: UW SOF/THS

L. WASHINGTON, PALEOLIMNOLOGY, SEDIMENTATION

The microstratification of recent Lake Washington sediments were determined using scanning electron microscopy.

176. Edmondson, W. T. 1977. Trophic equilibrium of Lake Washington: Ecological Research Series. Corvallis Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency. Corvallis; EPA-600/3-77-087. Location: UW SOF/THS

L. WASHINGTON, NUTRIENTS, PHYTOPLANKTON, ZOOPLANKTON

The purpose of this study was to help establish a description of chemical condition of Lake Washington during 1973-1976 after recovery from diversion of sewage effluent. The condition during this period is compared with some of the results of extensive earlier studies. The hypothesis was that the lake would enter into a steady state in equilibrium with the new conditions in the watershed. Sewage effluent was diverted progressively from the lake during 1963-1968, and the chemical conditions changed in close relation to the amount of sewage entering. The total P content of the lake decreased rapidly to 1971 after which year it varied around a value of about 50,000 kg (=17 μg/l) with a slight decreasing trend. The lake has retained about 56 % of the P that entered during 1971-1975. Winter means of nitrate and the annual mean total content of Kjeldahl N has decreased at a slow rate during the entire period. Phytoplankton as measured by chlorophyll in the epilimnion during summer dropped to a low value in close proportion to P during diversion, but has decreased faster than P during 1971-1976. A large increase in transparency occured in 1976. A major change is taking place in the character of the zooplankton of Lake Washington in that *Daphnia* became very abundant in 1976. This event is probably not directly related to recovery from eutrophication, so the lake is entering a new phase.

177. Edmondson, W. T. 1977. Lake Washington. In: North Americal Project - A Study of U.S. Water Bodies, (Eds.) L. Seyb, and K. Randolph. Environmental Protection Agency. Corvalis (OR). (Publication No. EPA-600/3-77-086) pp. 288-300 Location: UW SOF/THS

BENTHIC, L. WASHINGTON, NUTRIENTS, PHYTOPLANKTON, REVIEW, SEWAGE, ZOOPLANKTON

Basic data for Lake Washington (WA) on geography, limnology, and nutrient budget are given, primarily for the years 1957-76. In the 1890's Lake Washington was connected to Lake Union, and in 1916 a canal was opened between Lake Union and Puget Sound. In the 1940's and 1950's a transitory layer of very dilute seawater formed in the deepest parts of Lake Washington. The lake has characteristically had a spring diatom bloom dominated by *Stephanodiscus*, *Fragilaria*, *Melosira*, and *Asterionella*. In 1933 and 1950 the summer population was mostly a mixture of chlorophyte species and some flagellates. During the period of eutrophication this basic pattern had superimposed on it a dense population of cyanophytes in the summer, including *Oscillatoria rubescens*, *O. agardhii*, *Microcystis*, *Anabaena*, and *Aphanizomenon*. Most abundant zooplankton are *Diaptomus ashlandi*, *Epischura lacustris*, *Cyclops*, *Diaphanosoma leuchtenbergianum*, *Bosmina longirostris* and the rotifers *Keratella cochlearis* and *Kellicottia longispina*. Bottom fauna is dominated by chironomids, with lesser numbers of tubificids and small mollusks (Pisidium). Maximum input of treated secondary effluent was in 1962, and in March 1963 diversion was begun. Sewage was decreased from about 76,000 m^3 per day (20 million gal); the project was completed in 1968. Nutrient inputs have varied greatly with the increase in sewage, and then with diversion. Data are presented by year on nutrient income and loading.

178. Edmondson, W. T. 1977. Recovery of Lake Washington from eutrophication. In: Recovery and restoration of damaged ecosystems, (Eds.) J. Cairns, K. L. Dickson, and E. E. Herricks. University Press of Virginia. Charlottesville (VA). pp. 102-109 Location: Fisheries Library

L. WASHINGTON, NUTRIENTS, SEWAGE

Changes in the condition of Lake Washington have promptly accompanied changes in the input of nutrients. In the period 1941-63 the lake received increasing amounts of treated sewage effluent. The abundance of algae increased and the population changed character, most notably with the appearance of *Oscillatoria rubescens* in 1955. Sewage was diverted during the period 1963-68, during which time the proportion of blue-green algae began to decrease. By 1974 the lake seemed to be finishing its response to the diversion of sewage.

179. Edmondson, W. T. 1979. Lake Washington and the predictability of limnological events. *Ergeb. Limnol.* 13:234-241. Location: UW SOF/THS

L. WASHINGTON, NUTRIENTS, PHYTOPLANKTON, SEWAGE

Lake Washington responded to major changes in nutrient income with changes in several conditions related to production of phytoplankton. Diversion of treated sewage effluent from the lake was followed by predicted changes in transparency and other conditions related to nutrient income. The phosphorus content of the lake, the abundance of phytoplankton and the transparency promptly started to change with the beginning of diversion. The lake seemed to be coming into equilibrium with the new nutritional conditions during 1971-1975. Unexpected changes took place later, mainly the establishment in 1976 of a large population of *Daphnia*, a genus that had been present only sporadically for more than two decades before.

180. Edmondson, W. T. 1983. Productivity and plankton in Lake Washington. In: Lake Washington Symposium, (Ed.) A. Adams. Trout Unlimited. Mercer Island (WA). Location: UW SOF/THS

L. WASHINGTON, PHYTOPLANKTON, PRODUCTIVITY, REVIEW, ZOOPLANKTON

This paper outlines the history of water quality in Lake Washington following the diversion of sewage effluent.

181. Edmondson, W. T. 1985. Recovery of Lake Washington from eutrophication. In: Lakes pollution and recovery:European water pollution control association international congress, Rome, 15th-18th April, 1985. Proceedings—Preprints. European Water Pollution Control Assoc. London. pp. 228-234 Location: UW SOF/THS

L. WASHINGTON, NUTRIENTS, SEWAGE, ZOOPLANKTON

Lake Washington showed clear evidence of deterioration during an episode of enrichment with secondary sewage effluent. An early warning by the appearance of *Oscillatoria rubescens* is 1955 permitted a detailed study to be initiated before the condition of the lake had deteriorated seriously, relative to advanced cases of eutrophication. Sewage effluent was diverted from the lake. With the first partial diversion, in 1963, deterioration stopped, as shown by the fact that the Secchi disc transparency in summer remained about the same for several years. Then, with further diversion, the lake improved and established an equilibrium with its new nutrient supply. An unexpected population explosion of *Daphnia* in 1976 resulted in further improvement, with the summer transparency being about twice that before *Daphnia* appeared.

182. Edmondson, W. T. 1985. Reciprocal changes in abundance of *Diaptomus* and *Daphnia* in Lake Washington. *Ergeb. Limnol.* 21:475-481. Location: UW SOF/THS

L. WASHINGTON, NUTRIENTS, PHYTOPLANKTON, ZOOPLANKTON

When *Daphnia* increased in abundance in 1976-1978, the general abundance of phytoplankton in summer decreased. *Diaptomus* also decreased, suggesting an effect of exploitative competition. This explanation is not supported by the activity of the *Diaptomus* population; the animals in the smaller populations were producing eggs at a faster rate, making somewhat larger clutches, and growing a larger adult size than in previous years when the population was larger. These are not characteristics of a population responding to a reduction in food supply. Since 1978 there have been further weakly reciprocal changes in abundance and changes in reproduction. A full analysis of these changes will require a close examination of phytoplankton species known to be used by the animals and study of the death rates.

183. Edmondson, W. T. 1987. Environmental problem-solving and ecological research. Videorecording of Jessie & John Danz lecture series. Location: Odegaard Library

L. WASHINGTON, NUTRIENTS, SEWAGE

This is a collection of three videocassettes of taped lectures including 1) What happened to Lake Washington: how and why; 2) Lessons from Lake Washington: Puget Sound and other problems; and 3) Long term environmental; research: why and how.

184. Edmondson, W. T. 1988. The present status of zooplankton in Lake Washington. *Verh. Int. Ver. Theor. Angew. Limnol.* 23:306. (Abstract only)

DIET, FISH, L. WASHINGTON, PHYTOPLANKTON, SMELT, SOCKEYE SALMON, ZOOPLANKTON

In 1976, the abundance of *Daphnia* abruptly increased in Lake Washington. Several lines of evidence suggest that it probably had been suppressed before that time by two conditions, predation by *Neomysis mercedis* and interference with feeding by *Oscillatoria* species. Both operated together between approximately 1955 and 1967. *Neomysis* was abundant before 1967, and *Oscillatoria* was present between 1955 and 1975. The decrease of *Oscillatoria* can be understood as a clear result of the diversion of sewage effluent from the lake. The reason for the decrease of *Neomysis* was not so obvious. It is suggestive that two species of fish that spawn in the Cedar River became abundant in the mid-1960s, the sockeye salmon (*Onchorhynchus nerka*) and the longfin smelt (*Thaleichthyes spirinchus*). In 1960 dredging was discontinued, and in the early 1960's an extensive program was carried out to reduce the damaging consequences of flooding; i.e., erosion and slumping of banks.

185. Edmondson, W. T. 1988. On the modest success of *Daphnia* in Lake Washington in 1965. In: Algae and the aquatic environment, (Ed.) F. Round. Biopress. Papers in honor of J.W.G. Lund. pp. 225-243 Location: UW SOF/THS

L. WASHINGTON, PHYTOPLANKTON, TEMPERATURE, ZOOPLANKTON

Until 1976, *Dapnia* was present sporadically in Lake Washington in small numbers. In 1965 it was present continuously for several months, although it remained scarce. The record of conditions known to affect *Daphnia* was examined in search of a possible explanation of the modest success of *Daphnia* in 1965.

186. Edmondson, W. T. 1990. Lake Washington entered a new state in 1988. *Verh. Int. Ver. Theor. Angew. Limnol.* 24:428-430. Location: UW SOF/THS

CHEM. LIMNOLOGY, L. WASHINGTON, PHYTOPLANKTON, URBANIZATION, ZOOPLANKTON

During the summer of 1988, the alkalinity of the epilimnion of Lake Washington achieved the highest value ever observed, a mean of 0.80 meq l^{-1} during July through September, 9% higher than one year before. The biological condition of Lake Washington is still the center of attention. A distinct change in the phytoplankton was the first indication of lake alteration in 1988. Lake Washington receives about 90% of its inflow from two inlets, the Cedar River which originates in melting snow in the Cascade Mountains and the Sammamish, a lowland lake near Lake Washington. The recent rise in alkalinity is hypothesized to result largely from accelerating land development in parts of the drainage area. Forests have been clearcut, bulldozed, and replaced by housing developments with paved streets and concrete stormwater drains. Chemical parameters measured include major cations and anions, nutrients, alkalinity and conductivity. Lake Washington had two previous episodes of increasing alkalinity. Early values were 0.56 meq l^{-1} in 1933 and 0.54 meq l^{-1} in 1957. During 1963 to 1969 the alkalinity increased from 0.58 mg l^{-1}, levelling off at 0.66 meq l^{-1}. The first increase coincided with diversion of sewage effluent from the lake, the second with a major change in the composition of the phytoplankton after a population explosion of *Daphnia*. The real significance of the conditions in 1988 cannot be assessed until more time has passed. Alkalinity can be expected either to level off at a new elevated level, as in the two earlier episodes of increase or perhaps to decrease as disturbed areas become stabilized and input decreases. In the meantime, the plankton community will have been making continued internal adjustments to the shifting chemical environment.

187. Edmondson, W. T. 1991. The uses of ecology: Lake Washington and beyond. University of Washington Press. Seattle (WA). Location: UW SOF/THS

L. WASHINGTON, REVIEW, UNION BAY

This book builds on a case study of the pollution and recovery of Lake Washington to develop a broad perspective on environmental problems and the role of basic scientific research. The book advocates long-term scientific research as a key to help us to avoid environmental disasters. Written for a diverse audience, the book explores issues of ecology, public opinion, and the role of government.

188. Edmondson, W. T. 1991. Sedimentary record of changes in the condition of Lake Washington. *Limnol. Oceanogr.* 36:1031-1044. Location: UW SOF/THS

L. WASHINGTON, PALEOLIMNOLOGY, SEDIMENTS

Variations with depth in properties of the sediment of Lake Washington are compared with known conditions in the lake. Annual changes of depostion form pairs of cryptic layers, dominated respectively by diatoms and mineral particles, that are revealed by X-radiography. A period of eutrophication is recorded by sediment rich in phosphorus. Two later peaks of P can be attributed to deposition of eroded material during floods. The relative importance of diatom species observed in the cores is also discussed.

189. Edmondson, W. T. 1993. Experiments and quasi-experiments in limnology. *Bull. Marine Sci.* 53:65-83. Location: UW SOF/THS

L. WASHINGTON, PHYTOPLANKTON, ZOOPLANKTON

True replication and control are not available for whole-lake experiments, even when the investigator can manipulate the system. Many lakes have been subjected to deliberate or inadvertant disturbance and provide excellent opportunities for research when one can find substitutes for replication and control. Such studies require extensive quantitative description of relevant conditions in the lake. The population explosions of *Oscillatoria* and *Daphnia* in Lake Washington are taken as examples. One of the relevant properties of a zooplankton population for such an analysis is the rate of reproduction, or egg production. The present state of the uses of data on eggs is described against the background of development of the uses of such information.

190. Edmondson, W. T., and S. E. B. Abella. 1988. Unplanned biomanipulation in Lake Washington. *Limnol.* 19:73-79. Location: UW SOF/THS

CEDAR RIVER, L. WASHINGTON, NUTRIENTS, PHYTOPLANKTON, SMELT, SQUAWFISH, ZOOPLANKTON

The concept of biomanipulation has been developed to include a group of techniques for the management or protection of lakes against eutrophication as an alternative to techniques that involve manipulating the chemical control system. Techniques of biomanipulation change the interactions among species in such a way as to improve the condition of the lake. Because *Daphnia* is able to increase the clarity of lakes by consuming small algae, it is an effective tool in biomanipulation of eutrophic lakes. Lake Washington became more transparent after an unexpected outbreak of Daphnia in 1976 than it had been before. The data suggest that Daphnia had previously been suppressed by two conditions: a relatively abundant population of the selective predator *Neomysis* and an abundance of the alga *Oscillatoria* which interferes with the feeding mechanism of *Daphnia*. Diversion of sewage effluent was responsible for the decrease in *Oscillatoria*. The reduction in *Neomysis* was correlated with an increased abundance of the longfin smelt, a fish that feeds selectively on *Neomysis*. The increase of smelt was probably facilitated by improvements in the physical conditions of the Cedar River that promoted spawning and survival. There is also a possibility that growth of the smelt population was aided by a decrease in the predatory northern squawfish. This experience suggests that desirable predators may be increased by manipulating the physical conditions that increase reproductive success. For a manipulation of physical conditions to be successful, the biological relationships of the species present must be considered. Techniques of biomanipulation can be broadened to include alteration of conditions in the watershed designed to improve the success of keystone species in the lake.

191. Edmondson, W. T., and D. E. Allison. 1970. Recording densitometry of X-radiographs for the study of cryptic laminations in the sediment of Lake Washington. *Limnol. Oceanogr.* 15:138-144. Location: UW SOF/THS

L. WASHINGTON, PALEOLIMNOLOGY, SEDIMENTATION, SEDIMENTS

X-radiographs of sediment cores from Lake Washington revealed prominant laminations that are not visible to the eye. A band occurring at a depth of about 16 cm in the central part of the lake is attributed to the lowering of the lake level in 1916. Therefore the mean rate of deposition has been about 3.1 mm per year (Wydoski, 1972).

192. Edmondson, W. T., G. C. Anderson, and D. R. Peterson. 1956. Artificial eutrophication of Lake Washington. *Limnol. Oceanogr.* 1:47-53. Location: UW SOF/THS

L. WASHINGTON, NUTRIENTS, PHYTOPLANKTON, SEWAGE

Lake Washington has been receiving increasing amounts of treated sewage, and appears to be responding by changes in kind and quantity of biota. In 1933 and 1950 the dominant phytoplankton organisms were *Anabaena* and various diatoms and dinoflagellates, but in 1955, apparently for the first time, there was a large population of the blue-green alga, *Oscillatoria rubescens*, a species which makes nuisance blooms in a number of lakes.

193. Edmondson, W. T., G. W. Comita, and G. C. Anderson. 1962. Reproduction rate of copepods in nature and its relation to phytoplankton populations. *Ecology* 43:625-634.

CHESTER MORSE RES., L. WASHINGTON, ZOOPLANKTON

A summary of the reproductive rate in copepods in Lakes Washington, Chase, and Lenore are provided (Wydoski, 1972).

194. Edmondson, W. T., and J. T. Lehman. 1981. The effect of changes in the nutrient income on the condition of Lake Washington. *Limnol. Oceanogr.* 26:1-29. Location: UW SOF/THS

L. WASHINGTON, NUTRIENTS, SEDIMENTS, SEWAGE

Variations in nutrient income resulting from alterations in sewage arrangements have had a significant effect on the condition of Lake Washington. Between 1941 and 1963, the lake received increasing amounts of secondary sewage effluent from the Seattle, Washington, metropolitan area, with resultant changes in the amount of nutrients in the water and in the kind and quantity of phytoplankton. The lake responded quickly to declining inputs of effluent between 1963 and 1968, when almost all discharges to the lake were discontinued. The amount of nutrients, the quantity of phytoplankton, and the proportion of blue-green algae all decreased during this period. By 1975, the lake could be regarded as having recovered from eutrophication. Calculations of phosphorus and nitrogen income sewage to the lake had much more effect on the phosphorus regime than on the nitrogen regime. Total phosphorus input varied from a high of 204,200 kilograms per year in 1964 to a low of 42,900 in 1973 and 1976, with sewage contributing about 72 percent of the total in 1962. Variation in total nitrogen ranged from a high of 1,419,000 kilograms per year in 1964 to 734,000 in 1976. Seasonal differences were found in the deposition of phosphorus to and release from the sediments. On the average, the sediments retained about 57 percent of the income over the long term. After diversion of the sewage effluent from the lake, there was a slight increase in the proportion of incoming phosphorus lost to the sediments. The amount of phosphorus lost permanently to the sediments during a year was found to be more closely related to the annual income than to the mean concentration in water.

195. Edmondson, W. T., and A. H. Litt. 1982. Daphnia in Lake Washington. *Limnol. Oceanogr.* 27:272-293. Location: UW SOF/THS

L. WASHINGTON, PHYTOPLANKTON, ZOOPLANKTON

Daphnia suddenly became dominant in Lake Washington in 1976. At this time the mean summer transparency of the lake doubled. The major cause of the increase in Daphnia was a decrease of the predator *Neomysis mercidis* in the mid-1960's. The input of sewage effluent into the lake had reached a peak of 75,700 m^3 per day in 1962-64 and had been totally discontinued by 1968. The 10-year lapse between the decrease in *Neomysis* and the resurgence in *Daphnia* was not attributable to decreases in nutrient input from sewage effluent, lack of individuals to serve as an inoculum, changes in planktivorous fish populations, increases in edible food organisms, or decreases in competing zooplankton. The presence of *Oscillatoria*, a filamentous alga, may have been a delaying factor. Although *Daphnia* eat *Oscillatoria*, they reject the filaments accumulated in their feeding systems, thus reducing the efficiency of food intake. *Oscillatoria* were abundant until 1972, when the population began a progressive decline. By 1976 *Oscillatoria* absolute abundance and proportion of the total phytoplankton had decreased to very low values. Eight *Daphnia* species have been observed in the lake, but only *D. pulicaria*, *D. galeata mendotae*, and *D. thorata* are abundant. The population dynamics of the plankton are described in detail.

196. Edmondson, W. T., and A. H. Litt. 1987. *Conochilus* in Lake Washington. *Hydrobiol.* 147:157-162. Location: UW SOF/THS

L. WASHINGTON, ZOOPLANKTON

The rotifer *Conochilus unicornis* appeared in Lake Washington sporadically and ususally in small numbers during a total of 28 years of observation since 1933. *C. hippocrepis* was present even less frequently until the 3 year period 1977-1979, when it became extraordinarily abundant. The abundances of food organisms and known predators are examined.

197. Edmondson, W. T., and P. Murtaugh. 1980. Selective predation by mysids in lake restoration by biomanipulation. National Technical Information Service. Springfield (VA). (NTIS PB81-170359)

L. WASHINGTON, PHYTOPLANKTON, ZOOPLANKTON

After decades of scarcity or absence, members of the crustacean genus *Daphnia* have become very abundant in Lake Washington in recent years. One hypothesis to explain the recent success of *Daphnia* is a decline in the abundance of the predatory crustacean *Neomysis mercedis*, apparently caused by changes in fish predation. This study focuses on the selection of prey by *Neomysis* and its relevance to the Lake Washington zooplankton community. In feeding experiments in small containers, clearance rates of *Neomysis* on *Daphnia* were roughly two to four times higher than those on the copepod *Diaptomus*. The 'preference' for *Daphnia* deduced by comparing gut contents to prey densities in the plankton is much more pronounced, and the cladocerans are consistently selected over all other prey species found in the lake. Small mysids select the smallest *Daphnia* available, but adult mysids can consume cladocerans as large as 3.0 mm. The pattern of selectivity over the manageable size range of prey is variable for large *Neomysis*, suggesting that mysids may alter their feeding behavior in response to changing availability of prey. Since mysids reproduce seasonally in Lake Washington, their size-frequency distribution is alternately dominated by large and small individuals. Size-related differences in feeding rate and prey selection by the mysids therefore imply that the intensity and character of predation on *Daphnia* will vary seasonally as well.

198. Eggers, D. M. 1978. Limnetic feeding behavior of juvenile sockeye salmon in Lake Washington and predator avoidance. *Limnol. Oceanogr.* 23:1114-1125.

DIET, DISTRIBUTION, FISH, L. WASHINGTON, SOCKEYE SALMON, SQUAWFISH

Patterns of limnetic feeding behaviour (vertical movement, schooling, diel feeding chronology, zooplankton prey selectivity) of Lake Washington juvenile sockeye salmon (*Oncorhynchus nerka*) are described. A general hypothesis to explain the relative fitness of alternative behavioural decisions is presented. The limnetic feeding behaviour of the salmon appears to minimize their vulnerability to predation by the visual piscivore, northern squawfish. Seasonal variation indicates that sockeye feeding behaviour is a short term optimization process involving foraging success and encounters with northern squawfish. Lake Washington sockeye salmon can afford to spend a large amount of their time engaged in antipredator behaviour at the expense of foraging success because Lake Washington is comparatively zooplankton-rich and the energy demands of the fish can be met in short foraging periods. Sockeye in other less productive systems show a more aggressive exploitation of the zooplankton.

199. Eggers, D. M. 1980. Feeding ecology of Lake Washington juvenile sockeye salmon and the salmon enhancement problem. In: Proceedings of a Symposium On Salmonid Ecosystems of the North Pacific Ocean, (Eds.) W. J. McNeil, and D. C. Himsworth. Oregon State Univ. Corvallis. (Washington Univ., College of Fisheries Contrib. No. 525.) pp. 165-170 (Washington Univ., College of Fisheries Contrib. No. 525.)

DIET, FISH, L. WASHINGTON, SOCKEYE SALMON, SQUAWFISH

Some potential fallacies in enhancement from the perspective of a recently developed hypothesis regarding the limnetic feeding behavior and predator avoidance of sockeye salmon (*Oncorhynchus nerka*) in Lake Washington is discussed. Their feeding repertoire is described and their behavior relative to the hypothesis is assessed. The hypothesis suggests that salmon feeding behavior is a dynamic and finely tuned response to ambient conditions that trade off the competing necessities of obtaining food and avoiding predators. Factors in the limnetic environment include seasonal and vertical gradients of prey abundance, prey species composition, light intensity and temperature. In addition, a sizeable population of northern squawfish (*Ptychocheilus oregonensis*) preys on juvenile sockeye.

200. Eggers, D. M. 1982. Planktivore preference by prey size. *Ecology* 63:381-390.

DIET, FISH, L. WASHINGTON, SOCKEYE SALMON, ZOOPLANKTON

The reactive field volume model of prey encounter was shown to give a close approximation to the apparent size model of prey encounter rate for prey size distributions consisting of many prey types. The two models of prey encounter give almost identical predictions for the Lake Washington zooplankton community. The prey encounter models do not account for observed patterns of prey selection by Lake Washington juvenile sockeye salmon (*Oncorhynchus nerka*). This suggests an active preference for large nonevasive prey. This preference is dynamic. Small, as well as evasive prey, are pursued and eaten at times of the year when the large nonevasive prey are rare or absent from the water column.

201. Eggers, D. M., H. W. Bartoo, M. A. Rickard, R. E. Nelson, and R. C. Wissman. 1978. The Lake Washington ecosystem: The perspective from the fish community production and forage base. *J. Fish. Res. Board Can.* 35:1553-1571. Location: UW SOF/THS

ABUNDANCE, BENTHIC, FISH, L. WASHINGTON, PHYTOPLANKTON, REVIEW, SCULPIN, SOCKEYE SALMON, SQUAWFISH, YELLOW PERCH, ZOOPLANKTON

In Lake Washington, fish production through detritus-based food chains is substantially greater than fish production through the grazing food chain. The lack of significant grazing by fish on the zooplankton is a consequence of both piscivore predation and conditions in the planktivore spawning environment. At low planktivore abundance, squawfish may switch to benthos feeding, exploiting the abundant prickly sculpin. At high planktivore abundance, squawfish feed more heavily on planktivores. Thus, even when reproductive success of planktivores is good, swamping of the squawfish population does not occur and depensatory mortality due to squawfish predation prevents planktivore abundance from increasing to the point where zooplankton resource depletion would occur. Benthic-littoral species are vulnerable to predation essentially only as larva and juveniles. They avoid predation by occupying littoral and epibenthic refugia. Recruitment to the adult population from these refugia may be sufficient to account for the greater rate of benthos exploitation by fish relative to the rate of zooplankton exploitation by fish. *Neomysis* is an important component of the Lake Washington fish production, since potentially *Neomysis* is a regulating agent on the zooplankton, and reduction in *Neomysis* predation on zooplankton, due to decreasing abundance and a deeper vertical distribution, may be partly responsible for the recent reappearance of *Daphnia*. The response of the fish community to trophic changes in Lake Washington has been slight. No consistent trends in the growth of fish utilizing zooplankton were observed.

202. Eggers, D. M., and L. M. Male. 1972. The modeling process relating to questions about coniferous lake ecosystems. In: Research on Coniferous Forest Ecosystems: First Year Progress in the Coniferous Forest Biome, US/IBP, (Ed.) J. F. Franklin, L. J. Dempster, and R. H. Waring. Pacific Northwest Forest and Range Experiment Station, U.S. Department of Agriculture. Portland. pp. 33-36 Location: UW SOF/THS

MODELLING

The role of sound conceptualization and meaningful questions in the modelling process is discussed. The salient features of lake communities are reviewed.

203. Eggers, D. M. 1975. A synthesis of the feeding behavior and growth of juvenile sockeye salmon in the limnetic environment. Ph.D. Thesis. University of Washington. 217 pp. Location: UW SOF/THS

DIET, FISH, GROWTH, L. WASHINGTON, MODELLING, SOCKEYE SALMON

The objective of this work was to formulate a viable set of hypotheses relating to how the limnetic environment affects the growth and feeding behavior of juvenile sockeye salmon. The set of hypotheses was defined so that the construction of a computer model which simulates the growth and feeding behavior based upon the ambient environment is possible. The synthesis had four major areas of process development, (1) predator-prey, (2) metabolism and growth, (3) schooling, and (4) behavioral.

204. Eldridge, E. F. 1956. A biennium and status report of the Washington Pollution Control Commission to November 1, 1956. Report to the Governor and Wash. State Poll. Control. Comm. Oylmpia (WA). Location: Fisheries Library

L. WASHINGTON, SEWAGE

This report provides a summary of water quality objectives and minimum treatment requirements. Provides a listing of cities, institutions, and installations having sewage treatment plants, type of treatment, and population served. Also gives a listing of industrial waste permits by city. Includes information on these topics for the cities surrounding the Lake Washington drainage (Wydoski, 1972).

205. Eldridge, E. F., and W. W. Bergerson. 1948. The Seattle sewage treatment problem with comments on the Wolman report. Wash. State Pollut. Control Comm. Olympia (WA). Location: Suzzallo Library

L. WASHINGTON, SEWAGE

The sewage treatment problem in Seattle is reviewes, and the Wolman report on the problem is critized as inconclusive (Wydoski, 1972).

206. Emery, R. M. 1972. Initial responses of phytoplankton and related factors in Lake Sammamish following nutrient diversion. Ph.D. Thesis. University of Washington. 222 pp. Location: UW SOF/THS

L. SAMMAMISH, L. WASHINGTON, NUTRIENTS, PHYTOPLANKTON, SEWAGE

A two-year study on Lake Sammamish was carried out to evaluate the responses of phytoplankton and related factors to a sewage diversion project completed in September, 1968. Trophic indices of pre-diversion years in Lake Sammamish were compared to those in nearby Lake Washington to determine the relative extent of eutrophication in Lake Sammamish. Lake Washington was found to be in a more advanced stage of eutrophication than Lake Sammamish, prior to diversion. Post-diversion trophic indices in Lake Sammamish were compared to those of pre-diversion years to determine the extent of recovery. In addition, post-diversion changes of indices in Lake Sammamish were also compared to those in Lake Washington, a lake with an established pattern of response to diversion.

207. Entranco Engineers, I. 1981. Lyon Creek watershed comprehensive drainage plan for Mountlake Terrace and Lake Forest Park. Entranco Engineers. Bellevue (WA). Location: METRO Library

LAND USE, LYON CREEK, STREAMS, URBANIZATION

This report outlines the existing condition of the Lyon Creek watershed and proposes implementation of recommended design improvements to alleviate flooding in the watershed and to enhance fisheries habitat.

208. Entranco Engineers Inc. 1984. Lake management handbook. Municipality of Metropolitan Seattle. Seattle; Prepared for Metro.

L. SAMMAMISH, L. UNION, L. WASHINGTON, LAND USE, MANAGEMENT, REVIEW, URBANIZATION

This handbook on lake management was prepared to provide guidance to local lake communities about measures they can take to protect and enhance their valuable lake resources.

209. Erickson, K. A. 1982. An interactive simulation model for the Cedar/Tolt water supply system. M.S.E. Thesis. University of Washington. Location: Engineering Library

CEDAR RIVER, FLOW, L. UNION, MANAGEMENT, URBANIZATION, WATER BUDGET

Interactive simulation models represent an alternative management technique. Yield analyses performed with the weekly Cedar/Tolt simulation model showed that the present system can reliably provide M & I supplies up to approximately 1.3 times the current base demand of 2.8 acre-feet/week. With the City Light Plan in effect and a diversion dam on the North Fork Tolt, the system could reliably provide the year 2025 demand of 5.08 acre-feet/week.

211. Erickson, R. C., and R. R. Whitney. 1972. Lake Washington thermal study, July 1971: Coniferous Forest Biome. Ecosystem analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 35. (unpublished) Location: UW SOF/THS

L. WASHINGTON, TEMPERATURE

Depth-temperature profiles were made at selected stations in Lake Washington. Because of the potential source of heat from the Shuffleton generating plant, effort was concentrated in time and space at the south end of the lake, but data were collected over the entire lake.

212. Evermann, B. W., and S. E. Meek. 1897. Salmon investigations in the Columbia River basin and elsewhere on the Pacific Coast in 1896. *Bull. U.S. Fish. Comm.* 17:15-84. Location: Fisheries Library

FISH, L. SAMMAMISH, L. WASHINGTON, UNION BAY

Ten regions were investigated including the Puget Sound tributaries and Lakes Sammamish, Union, and Washington (Wydoski, 1972).

213. Farris, G. D., J. M. Buffo, K. L. Clark, D. S. Sturgill, and R. I. Matsuda. 1979. Urban drainage stormwater monitoring program. Metro. Seattle.

FLOW, LAND USE, STORMWATER, URBANIZATION

This report documents an urban stormwater runoff quantity and quality study conducted in the Seattle metropolitan area. Three land use types - industrial, commercial, and residential - were surveyed, with samples collected over a broad range of conditions.

214. Felmy, A. R. 1981. Manganese chemistry in Lake Sammamish. M.S. Thesis. University of Washington. 132 pp. Location: Engineering Library

L. SAMMAMISH, METALS, SEDIMENTATION, SEDIMENTS

The chemistry and cycling patterns of manganese in Lake Sammamish were evaluated over a three year period utilizing sediment traps, sediment cores, water column samples and inlet-outlet samples.

215. Ferguson, C. H. 1965. Reproductive rate of *Diaptomus ashlandi* in Lake Washington, an enriched lake. M.S. Thesis. University of Washington. 38 pp. Location: Allen Library

L. SAMMAMISH, L. WASHINGTON, ZOOPLANKTON

This report describes the reproductive rate of this zooplankter when the lake was undergoing increased productivity. Preserved samples from 1949/1950, 1957/1958, and 1962/1964 were used for the study. Also provides some data on the reproductive rate of this zooplankter from Lake Sammamish for 1964/1965 (Wydoski, 1972).

216. Field, R., and R. E. Pitt. 1990. Urban storm-induced discharge impacts: US Environmental Protection Agency Research program review. *Water Sci. Technol.* 22:1-7.

FISH, FLOW, L. WASHINGTON, METALS, POLLUTION, SEDIMENTATION, SEDIMENTS, STORMWATER, STREAMS, URBANIZATION

The effects of storm-induced discharges on receiving water aquatic organisms or other beneficial uses is very site specific. Two West Coast studies sponsored by the Storm and Combined Sewer program of the US Environmental Protection Agency both found significant aquatic life beneficial use impairments in urban creeks, but the possible causes were quite different. The Coyote Creek (San Jose, CA) study found major accumulations of toxic sediments in the urban reaches of the creek, while the Bellevue (WA) study found very little toxic material in the sediments. The Bellevue urban creek had a very large carrying capacity for sediment and high flow rates which apparently flushed the toxic sediments through the creek and into Lake Washington. Fish kill were observed in Bellevue, but they were associated with illigal storm drain discharges during dry weather. The long-term aquatic life effects of urban runoff are probably more important than short-term effects associated with specific events and are probably related to the deposition and resuspension of toxic sediments, or the inability of the aquatic organisms to adjust to repeated exposures to high concentrations of toxic materials or high flow rates. Long-term effects may only be expressed at great distances downstream from discharge locations, or in accumulating areas (lakes).

217. Fiscus, G. 1967. Lake Washington sockeye. *Wash. State Dep. Fish. Ann. Rep.* 77:19-20. Location: Fisheries Library

FISH, L. WASHINGTON, SOCKEYE SALMON

This report provides a summary of the 1967 run of sockeye salmon into Lake Washington (Wydoski, 1972).

218. Fish, E. R. 1967. The past and present in Issaquah, Washington. Kingsport Press. Kingsport (TN). Location: Suzzallo Library

LAND USE, REVIEW

This is a historical look at Issaquah: coal mining, logging, recreation, transportation by water and land, and civic growth, (Wydoski, 1972).

219. Flaherty, D. C. 1980. Saving the lakes. WSWRC. Pullman, Wa. Location: GOVERNMENT LIBRARY

BIBLIOGRAPHY, L. SAMMAMISH, L. WASHINGTON, NUTRIENTS, REVIEW

Washington freshwater lakes had earlier been receiving nutrients and other pollutants that threatened their pristine condition and has placed several lakes on the verge of eutrophication. Significant developments have since occurred that have enabled significant progress in rehabilitating Washington freshwater lakes. Research studies had involved Liberty Lake, Lake Coeur d' Alene, Lake Washington, Lake Sammamish, Moses Lake, Long Lake, and Newman and Williams Lakes. Lake research is continuing. This document covers separate reports on each of the major Washington lakes with a bibliography of the resulting technical literature following the discussion of each lake project.

220. Fletcher, D. 1983. Spiny ray enhancement. In: Lake Washington Symposium, (Ed.) A. Adams. Trout Unlimited. Mercer Island (WA). Location: UW SOF/THS

FISH, L. WASHINGTON, LARGEMOUTH BASS, RECREATION, REVIEW, SMALLMOUTH BASS, STOCKING

This paper reviews the history of bass planting and sportfishing in Lake Washington.

221. Flint, T. 1977. Juvenile coho population estimates determined by electrofishing in 12 Puget Sound streams, August - October 1976. State of Washington Department of Fisheries. Progress Report No. 32. Olympia (WA). Location: Fisheries Library

ABUNDANCE, COHO SALMON, FISH, ROCK CREEK, STREAMS

Rock Creek, a tributary to the Cedar River, was sampled for juvenile coho abundance in 1976. The number of coho was estimated as approximately 2 coho per square meter.

222. Foster, R. F. 1943. Sources of pollution in Lake Washington Canal and Lake Union. Wash. State Poll. Control Commission. Seattle. (Pollut. Ser. Bull. 28) Location: METRO Library

L. UNION, POLLUTION, SHIP CANAL, STOCKING

This is a report on 65 sources of pollution in the Lake Washington Ship Canal and Lake Union (Wydoski, 1972).

223. Fraser, J. 1971. Lake Washington temperature studies. WA Cooperative Fishery Unit, University of Washington. Seattle. (unpublished) Location: UW SOF/THS

L. WASHINGTON, TEMPERATURE

Between December 1970 and March 1971 a survey was conducted to measure lake temperature at the south end of Lake Washington. This period is before the Shuffleton plant was in operation.

224. Fresh, K. L. 1993. Lake Washington fisheries: a historical perspective. Presented at the 13th International Symposium of the North American Lake Management Society. November 30 - December 4, 1993. Seattle (WA). Location: UW SOF/THS

CHINOOK SALMON, COHO SALMON, CUTTHROAT TROUT, FISH, L. WASHINGTON, REVIEW, SOCKEYE SALMON, STEELHEAD

In this paper, a brief historical perspective on several of the most important fisheries in Lake Washington is provided. The focus is primarily on salmon and trout species, particularly sockeye salmon, because these are the most important species economically.

225. Furlong, E. T. 1987. Sediment geochemistry of photosynthetic pigments in oxic and anoxic marine and lacustrine sediments: Dabob Bay, Saanich Inlet, and Lake Washington. Ph.D. Diss. Washington Univ., Seattle (USA). 237 pp.

L. WASHINGTON, PALEOLIMNOLOGY, SEDIMENTS

Chlorophyll derivatives were measured in oxic and anoxic marine and lacustrine sediments to determine preservation, degradation and alteration of these phytoplanktonic biomarkers over time periods of 10's-10,000 years.

Particulate pheopigment water column fluxes are >90% remineralized before accumulating in sediments. Remineralization was slightly less severe in coastal marine and lacustrine anoxic sediments.

226. Galvin, D. V., and R. K. Moore. 1982. Toxicants in urban runoff, Metro toxicant program report #2. Municipality of Metropolitan Seattle. Seattle. Location: METRO Library

LAND USE, POLLUTION, STORMWATER, URBANIZATION

This is a study of the toxic substances in urban stormwater runoff and its potential adverse effects in the aquatic environment. The project included collection and analysis of samples, a comprehensive literature review, and a summary of potential control measures.

227. Gaufin, A. R. 1972. Dynamics and productivity of aquatic invertebrates in the Cedar River: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 94. (unpublished) Location: UW SOF/THS

CEDAR RIVER, INVERTEBRATES

This summary provides a list of the Plecoptera species collected from each station on the Cedar River.

228. Geist, D. 1983. Salmon sport potential in Lake Washington fishery (Where sockeye is known as the King Salmon). In: Lake Washington Symposium, (Ed.) A. Adams. Trout Unlimited. Mercer Island (WA). Location: UW SOF/ THS

CHINOOK SALMON, COHO SALMON, FISH, L. WASHINGTON, REVIEW, SOCKEYE SALMON

This paper reviews the salmon fisheries in Lake Washington.

229. Gibbons, R. 1989. Steelhead investigations in Washington: July 1, 1988 - June 30, 1989. Washington Department of Wildlife, Fisheries Management Division. Olympia (WA). (Progress Report, Project No. F-75-R) Location: Fisheries Library

CEDAR RIVER, ESCAPEMENT, FISH, STEELHEAD

The 1989 steelhead spawning escapement estimate for the Lake Washington basin was estimated as 686 and 1,600 wild steelhead and wild winter steelhead, respectively. Two steelhead were projected to be caught from the Cedar River during 1989.

230. Gibbs, C. V. 1968. Receiving-water monitoring: Key to Seattle METRO pollution-abatement program. In: Water resources management and public policy, (Eds.) T. H. Campbell, and R. O. Sylvester. Univ. Washington Press. Seattle (WA). pp. 179-186

MANAGEMENT, POLLUTION

The water Quality Control Division of Seattle’s Metro monitors the water-disposal receiving waters (Wydoski, 1972).

231. Gladwell, J. A., and A. C. Mueller. 1967. Sammamish-Cedar River watershed #8. In: An initial study of the water resources of the State of Washington, Vol.II, Water resources atlas of the State of Washington. Section IX, Water Subdivision, WA State Water Resour. Cent. Pullman (WA). pp. 33-38

ATLAS, CEDAR RIVER, L. SAMMAMISH, L. WASHINGTON

This presents a broad view of the physical aspects of the water resources of the Lake Washington drainage basin (Wydoski, 1972).

232. Glass, M. W. 1982. Analysis of fishery management options for a small urban lake. M.S. Thesis. University of Washington. 181 pp. Location: Fisheries Library

FISH, GREEN LAKE, MANAGEMENT, RECREATION, SMALL LAKES

This study combines concepts and techniques from the field of sociology with those of biology to evaluate management options for a small urban lake, Green Lake. The physical and biological characteristics of the lake and the sociological characteristics of the anglers indicate that the maximum sociological benifits will be realized by a management plan that places primary emphasis on warm water species that will provide satisfactory oportunities for juvenile anglers. As a secondary objective, periodic plantings of legal sized trout will provide suitable opportunities for older anglers.

233. Goad, J. A. 1982. Biomanipulation and its potential in the restoration of Green Lake. M.S.E. Thesis. University of Washington. 55 pp. Location: Engineering Library

GREEN LAKE, SMALL LAKES

234. Goldstein, L. S. 1982. Sammamish River resource inventory technical report. Municipality of Metropolitan Seattle. Seattle. Location: METRO Library

REVIEW, SAMMAMISH R.

This report synthesizes available information on the condition of the river and evaluates the suitability of the river to support various uses.

235. Goldstein, L. S. 1982. Swamp Creek stream resource inventory technical report. Municipality of Metropolitan Seattle. Seattle. Location: METRO Library

REVIEW, STREAMS, SWAMP CREEK

This report synthesizes available information on the condition and use of Swamp Creek and evaluates the suitablity of the creek to support various uses.

236. Goldstein, L. S. 1982. Little Bear Creek stream resource inventory technical report. Municipality of Metropolitan Seattle. Seattle. Location: METRO Library

LITTLE BEAR CREEK, REVIEW, STREAMS

This report synthesizes available information on the condition of Little Bear Creek and evaluates the suitability of the creek to support various uses.

237. Gomez, A., and T. McLean. 1991. Swamp Creek sanitary survey report. Seattle-King County Department of Public Health; Environmental Health Division. Seattle.

SEWAGE, STREAMS, SWAMP CREEK

This report was intended to identify potential problem areas which receive untreated sewage from undersized or otherwise inadequate sewage disposal systems.

238. Goodpasture, L. M., R. N. Brenner, B. K. Uchida, and R. G. Swartz. 1976. Baseline survey of aquatic plants in selected lakes of King County. Metro. Seattle. Location: METRO Library

PLANTS, SMALL LAKES

Twenty four small lakes were surveyed for aquatic macrophyte growth. Generally, aquatic vegetation was observed to be increasing and is considered a nuisance by most lakeside residents.

239. Goodpasture, L. M. 1986. The effects of anthropogenic disturbances on benthic faunal communities in Thornton and Coal Creek, King County, Washington. M.S. Thesis. University of Washington. 110 pp. Location: Forestry Library

BENTHIC, COAL CREEK, INVERTEBRATES, STREAMS, THORNTON CREEK

This study compared the numbers and composition of benthic faunal communities in an urban stream, Thornton Creek, and a nonurban stream, Coal Creek.

240. Gould, H. R., and R. F. Budinger. 1958. Control of sedimentation and bottom configuration by convection currents, Lake Washington, Washington. *J. Mar. Res.* 17:183-198. Location: UW SOF/THS

CIRCULATION, FLOW, GEOLOGY, L. WASHINGTON, SEDIMENTATION

This article describes how Lake Washington was formed into a W-shaped trough by the Vashon ice sheet (Wydoski, 1972).

241. Grafius, E., and N. H. Anderson. 1973. Literature review of foods of aquatic insects: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 129. (unpublished) Location: UW SOF/THS

BIBLIOGRAPHY, INVERTEBRATES, REVIEW

This report provides a table from published feeding records up to 1972, of selected aquatic insects with some interpretive comments.

242. Gray, P. L. 1965. Fecundity of the chinook salmon (*Oncorhyncus tshawytscha*) related to size, age, and egg diameter. M.S. Thesis. University of Washington. 65 pp. Location: Fisheries Library

BREEDING, CHINOOK SALMON, FECUNDITY, FISH

This study summarizes a selective breeding experiment for fish that returned during 1960/1963 to the holding pond at the University of Washington. (Wydoski, 1972)

243. Graybill, J. P. 1974. Effects of discharge in the Cedar River on sockeye salmon spawning area. M.S. Thesis. University of Washington. 60 pp. Location: Suzzallo Thesis Stacks

CEDAR RIVER, FISH, SOCKEYE SALMON, SPAWNING

For this thesis, hydraulic and biological investigations on the Cedar River were designed to determine depths and velocities preferred by spawning Cedar River sockeye salmon and to provide an understanding of the effects of discharge on spawning sockeye during low flow periods.

244. Green, S. B., and T. H. Campbell. 1967. Current usage and pricing, Appendix A. In: An initial study of the water resources of the State of Washington, Vol. I, A first estimate of future demands for water in the State of Washington. WA Water Resour. Cent. Pullman (WA). p. 63

FLOW, MANAGEMENT

This report summarizes community uses of water such as rates of use, variation in rates of use, and prices. Good summarizes of time-rates of demand are provided for Seattle. Also includes industrial water uses (Wydoski, 1972).

245. Gregory, E., R. S. Perry, and J. T. Staley. 1980. Characterization, distribution, and significance of metallogenium in Lake Washington. *Microb. Ecol.* 6:125-140.

BACTERIA, L. WASHINGTON, METALS, PHYTOPLANKTON

During summer stratification, *Metallogenium personatum* was found exclusively in the hypolimnion of Lake Washington where the oxygen tension was below 8 ppm. Numbers of the organism decreased in the lake immediately following turnover in October. Significant concentrations of *Metallogenium* microcolonies did not recur until spring, after the lake had stratified. During stratification the distribution of particulate manganese closely followed the distribution of *Metallogenium* . EDAX analysis, confirmed by electron microprobe analyses of the encrustation, showed that the primary component was manganese. Iron and some trace elements were also precipitated on the organism but to a lesser degree. In addition, phosphate, the primary substance limiting phytoplankton growth in Lake Washington, was found in the encrustation, indicating *Metallogenium* may be important in limiting algal blooms in the lake. Attempts to grow *Metallogenium* in the laboratory were unsuccessful. This inability, combined with the negative results of thin-sectioning and acridine orange staining of Metallogenium microcolonies, suggests that the microcolonial structures seen in Lake Washington are not a living form of an organism.

246. Gregory, E., and J. T. Staley. 1982. Widespread distribution of ability to oxidize manganese among freshwater bacteria. *Appl. Environ. Microbiol.* 44:509-511.

BACTERIA, L. WASHINGTON, METALS, SEDIMENTS

Manganese-oxidizing heterotrophic bacteria were found to comprise a significant proportion of the bacterial community of Lake Washington (Seattle, WA) and Lake Virginia (Winter Park, FL). Identification of these freshwater bacteria showed that members of a variety of genera are capable of oxidizing manganese. Isolates maintained in the laboratory spontaneously lost the ability to oxidize manganese. A direct correlation was found between the presence of plasmid DNA and the ability of the organism to oxidize manganese.

247. Gregory, E. 1979. Microbiological studies of Lake Washington. Ph.D. Dissertation. University of Washington. 108 pp. Location: Health Sciences Library

BACTERIA, L. WASHINGTON

The abundance and distribution of the heterotrophic bacteria of Lake Washington was investigated over a period of three years. Three enumeration techniques were compared. The seasonal and vertical distribution of bacteria varied with each enumeration technique, but all three methods showed that during the period of stratification increases in bacterial numbers were limited to the epilimnion with the exception of *Caulobacter* spp. Bacteria capable of oxidizing maganese were also studied and their role in nutrient cycling was investigated.

248. Griffiths, M., and W. T. Edmondson. 1975. Burial of *Oscillaxanthin* in the sediment of Lake Washington. *Limnol. Oceanogr.* 20:945-952.

L. WASHINGTON, PALEOLIMNOLOGY, PHYTOPLANKTON, SEDIMENTATION, SEDIMENTS

The distribution of oscillaxanthin in new cores is different from that of cores taken earlier from the same regions. The present paucity of surface oscillaxanthin reflects the diminution of *Oscillatoria* in the lake resulting from the diversion of sewage.

249. Griffiths, M., P. A. Perrott, and W. T. Edmondson. 1969. Oscillaxanthin in the sediment of Lake Washington. *Limnol. Oceanogr.* 14:317-326. Location: UW SOF/THS

L. WASHINGTON, NUTRIENTS, PALEOLIMNOLOGY, PHYTOPLANKTON, SEDIMENTS, SEWAGE

Oscillaxanthin was determined quantitatively from portions of five sediment cores. Oscillaxanthin is produced by *Oscillatoria rubescens* and *O. agardhii*, both of which have been abundant in Lake Washington since 1955. Therefore the first appearance of oscillaxanthin (before 1950) probably came early in the sewage enrichment of the lake (Wydoski, 1972).

250. Griswold, C. A. 1983. Cedar River watershed interpretive master plan. M.S. Thesis. University of Washington. Location: Forestry Library

LAND USE, MANAGEMENT, RECREATION

This document is a conceptual master plan for the development of interpretive resources within the City of Seattle's Cedar River watershed. It is meant to supply information and direction to field interpreters and watershed managers. Twenty one sites are described with recommendations for interpretive development.

251. Grondal, B. L. 1945. Relation of runoff and water quality to land and forest use in Cedar River watershed. *J. Am. Water Assoc.* 37:15-20.

CEDAR RIVER, LAND USE, STORMWATER

The Seattle City Council appointed a commission to study the Cedar River watershed to determine future logging policies. This commission recommended a continuation of logging on a controlled, sustained-yield basis, and the rationale of the conclusion is outlined (Wydoski, 1972).

252. Guluka, L. B. T. 1979. Harvest allocation of Lake Washington sockeye salmon (*Oncorhynchus nerka*): a goal programming approach. M.S. Thesis. University of Washington. 106 pp. Location: Fisheries Library

FISH, MANAGEMENT, SOCKEYE SALMON

This study developed an analytical tool to generate allocation alternatives. The management objectives were, 1) to limit excess harvest, 2) to maximize harvest value, 3) to minimize harvest cost, 4) to maintain or create jobs, and 5) to maintain half of the total allowable catch to treaty Indian fishermen.

253. Guttormsen, S. A. 1974. A comprehensive nitrogen study of Lake Sammamish. M.S. Thesis. University of Washington. 136 pp. Location: UW SOF/THS

ISSAQUAH CREEK, L. SAMMAMISH, LAUGHING JACOBS CREEK, NUTRIENTS, SAMMAMISH R., STREAMS

This study describes the forms, amounts and seasonal distribution of nitrogen species in Lake Sammamish, its main surface tributaries and outlet. Research involving sample nitrogen preservation and studies on ultraviolet combustion for the analysis of organic nitrogen were also performed.

254. Hahnel, G. B. 1982. Incidence of *Aeromonas liquefaciens* in brown bullhead (*Ictalurus nebulosus*) in Lake Washington, Washington. College of Fisheries, University of Washington. Seattle. (unpublished) Location: UW SOF/THS

BULLHEAD, DISEASE, FISH, UNION BAY

Bullhead were sampled from Union Bay and examined for disease. The incidence of infection in the population was determined.

255. Hansen, G., G. Carter, W. Towne, and G. O'Neal. 1971. Log storage and rafting in public waters. Pac. Northwest Pollut. Control council. Task Force Rep. Location: Suzzallo Library

L. UNION, L. WASHINGTON, LOG STORAGE

This is a review of log storage in the Northwest and recommendations for implementing improved log handling practices that will benefit water quality. The Seattle harbor area including Commencement and Salmon Bays, Lake Union, Lake Washington, and Lake Washington Ship Canal handled approximately 100,000 to 1 million tons of rafted logs annually (Wydoski, 1972).

256. Hansen, R. 1970. Some fish species available from benthic gill nets in Pontiac Bay, Lake Washington. Class report, unpublished. University of Washington. Location: UW SOF/THS

FISH, L. WASHINGTON

A two month sampling program obtained preliminary data on the species, distribution, and relative abundance of fish in Pontiac Bay on Lake Washington.

257. Hansen, R. G. 1974. Effect of different filament diameters on the selective action of monofilament gill nets. *Trans. Am. Fish. Soc.* 103:386-387. Location: UW SOF/THS

FISH, L. WASHINGTON, PEAMOUTH, YELLOW PERCH

This short note discusses the comparison of two filament diameters with the same mesh size of 38.1 mm for catches of peamouth and yellow perch. In both cases, the smaller filament diameter captured larger fish.

258. Hansen, R. G. 1972. The selectivity of vertical and horizontal monofilament gill nets for peamouth, yellow perch, and northern squawfish in Lake Washington. M.S. Thesis. University of Washington. 87 pp. Location: UW SOF/THS

FISH, L. WASHINGTON, PEAMOUTH, SQUAWFISH, YELLOW PERCH

Two types of gills nets were used to sample the fish populations of Lake Washington. Horizontal gill nets were used to sample the benthic and littoral zones and vertical gill nets were used to sample all zones. This study compares the selectivity of the nets for peamouth, yellow perch, and northern squawfish, the three species that were readily caught by multi-mesh vertical and horizontal monofilament gill nets.

259. Hansler, D. D. 1958. Some effects of artifical selection upon a stock cutthroat trout, *Salmo clarkii clarkii*, with related hybrization studies. M.S. Thesis. University of Washington. 102 pp. Location: Fisheries Library

BREEDING, CUTTHROAT TROUT, FISH, STREAMS, THORNTON CREEK

University of Washington stock of cutthroat trout that were originally obtained from Thornton (Matthews) Creek, a western tributary to Lake Washington, were used in breeding experiments. (Wydoski, 1972)

260. Hanson, H. A. 1957. More land for industry - a story of flood control in the Green River valley. *Pac. Northwest Q.* 48:1-7. Location: Suzzallo Library

FLOW, LAND USE, STREAMS

This is a brief look into the changes in the flow patterns of the tributaries and streams of Lake Washington (Wydoski, 1972).

261. Hardy, F. J. 1984. Responses of naturally-derived aquatic microcosms to selective chemical stress. Ph.D. Dissertation. University of Washington. 276 pp. Location: Fisheries Library

GREEN LAKE, L. WASHINGTON, PHYTOPLANKTON, PRODUCTIVITY, ZOOPLANKTON

Microcosms, aquatic laboratory ecosystems that demonstrate ecosystem level behaviors similar to those in natural systems, may be naturally occurring (intact) or laboratory cultured (synthetic). As a test type of secondary effects of toxicants, laboratory microcosms were suitable for evaluating environmental hazards for several reasons, including replicability and standardization. This study explores the relationship between a synthetic microcosm, the Standardized Aquatic Microcosm (SAM), and naturally-derived microcosms. Additionally, several factors hypothesized to effect chemical stressors, such as microcosm size and culture condition, annual variability, and source community structure were investigated using naturally-derived microcosms. A selective algicide, streptomycin sulfate, was the test chemical and Lake Washington the source community used for all but one (Green Lake) naturally derived experiment.

262. Harper-Owes. 1979. Cedar River temperature study. Municipality of Metropolitan Seattle. Seattle. Location: METRO Library

CEDAR RIVER, FLOW, TEMPERATURE

This study assessed the impact of flow changes on water temperature of the the Cedar River at Renton.

263. Harper-Owes. 1981. Development and evaluation of a predictive capability to assess water quality impacts from urbanization in King County streams and rivers. Metro. Seattle. Location: METRO Library

BENTHIC, CHEM. LIMNOLOGY, FISH, FLOW, INVERTEBRATES, LAND USE, URBANIZATION

The purpose of this report was to develop a methodology for use in predicting problems in flowing waters of the region. Different water quality indices were compared including Metro's Water Quality Index and its components.

264. Harper-Owes. 1981. Pine Lake restoration analysis; draft report, draft and final environmental impact statements. Metro. Seattle. Location: METRO Library

NUTRIENTS, PINE LAKE, SEWAGE, SMALL LAKES

This report diagnosed the causes of water quality problems in Pine Lake and and recommended alternatives for improving lake conditions.

265. Harper-Owes. 1982. Cedar River resource inventory technical report. Municipality of Metropolitan Seattle. Seattle. Location: METRO Library

CEDAR RIVER, INVERTEBRATES

This report provides a synthesis of the available information on the condition of the river and serves as a technical document for developing basin plans.

266. Hartmann, H. J. 1983. Control of algal dominance through changes in zooplankton grazing, Lake Washington: Phase I. National Technical Information Service. Springfield (VA). (NTIS PB83-226878)

L. WASHINGTON, NUTRIENTS, PHYTOPLANKTON, ZOOPLANKTON

Mechanisms by which selective grazing and phosphorus recycling regulate phytoplankton abundance and succession were investigated. Food preferences of a cladoceran (*Daphina*) and a copepod (*Diaptomus*) on paired mixtures of a centric diatom (*Stephanodiscus*), a green (*Ankistrodesmus*) and a filamentous blue-green alga (*Oscillatoria*) were compared in double-isotope (^{32}P/^{33}P) feeding studies; phosphorus-limited growth and nutrient uptake of the algae were compared in batch-culture experiments. Zooplankton food selectivity and algal phosphorus uptake were size- and species-specific: Single-cell ingestion rates of small *Daphina* and adult copepods were similar, while large *Daphnia* ingested 1.6 times more cells/weight than *Diaptomus*. *Daphina* selected diatoms over green algae over a wide cell-concentration range (50 to 50,000 cells/ml). Selectivity was more significant in small than in large *Daphnia*. *Diaptomus* and large *Daphnia* rejected blue-green filaments against single cells, while small *Daphnia* could not reject filaments. *Ankistrodesmus* removed phosphate faster from the environment, grew faster and depleted internal phosphorus quicker than *Stephanodiscus* or *Oscillatoria*. Zooplankton changes in Lake Washington would be expected to influence dominance of centric diatoms, green, and similar single-celled algae, but are unlikely to affect abundance of filamentous blue-green algae.

267. Hartmann, H. J. 1984. Control of algal dominance through changes in zooplankton grazing, Lake Washington: Phase II. National Technical Information Service. Springfield (VA). (NTIS PB85-215119/AS)

L. WASHINGTON, NUTRIENTS, PHYTOPLANKTON, ZOOPLANKTON

Food gathering and selective grazing behavior of the calanoid copepod *Diaptomus ashlandi* and the cladoceran *Pulicaria* from Lake Washington were compared as part of a larger study that examines the grazing and phosphorus-recycling roles of pelagic lacustrine zooplankton in relation to phytoplankton abundance and species succession. Proportionally mixed double-isotope (^{32}P-^{33}P) labeled pairs of a diatom (*Stephanodiscus hantzschii*), a green alga (*Ankistrodesmus* sp.) and a filamentous blue-green bacterium (*Oscillatoria aghardii*) were fed to *Diaptomus* copepodites to measure clearance and ingestion rates and examine selectivity behavior. Both grazers preferred *Stephanodiscus* over *Ankistrodesmus*, but the feeding niches were separated along boundaries determined by total algal biomass and the relative abundance of each alga. When algal density was great (>1000 cells/ml), *Diaptomus* selected for *Stephanodiscus* to a greater extent than *Daphnia*. With lower algal density (< 1000 cells/ml), or when *Stephanodiscus* were relatively common (>60% of total algal biomass), *Daphnia* selected the diatom more consistently than *Diaptomus*. *Oscillatoria* strands interfered with the feeding of small neonate *Daphnia*, but not with larger adult *Daphnia* or *Diaptomus*. The divergent feeding behavior patterns were interpreted through scanning microscope examination of the animals' feeding morphologies.

268. Hasler, A. D. 1969. Cultural eutrophication is reversible. *Bioscience* 19:425-532.

L. WASHINGTON, NUTRIENTS

Historical background and development in the cultural eutrophication of waters was described. The author used Lake Washington as an example of the control of eutrophication (Wydoski, 1972).

269. Haw, F., and R. M. Buckley. 1962. Prolonged freshwater residence of juvenile fall chinook salmon. *Wash. State Dep. Fish. Ann. Rep.* 72:25-26. Location: Fisheries Library

CHINOOK SALMON, FISH, MIGRATION, STREAMS

Scale analysis of spent chinook carcasses from the major spawning streams of the Lake Washington system revealed that 12% were in their third year when they entered saltwater, 18% were in their second year of life, and 66% were in thier first year of life (Wydoski, 1972).

270. Haw, F., H. O. Wendler, and G. Deschamps. 1967. Development of Washington salmon sport fishery through 1964. *Wash. State Dep. Fish. Ann. Rep.* 7:55-56. Location: Fisheries Library

CHINOOK SALMON, COHO SALMON, FISH, L. WASHINGTON, RECREATION

This report provides a short description of the salmon sport fishery in Lake Washington. Since 1952 the annual catch estimates for chinook salmon varied from 15 to 134 while the annual catch estimates for coho salmon ranged from 155 to 2196.

271. Hedges, J. I., J. R. Ertel, and E. B. Leopold. 1982. Lignin geochemistry of a Late Quaternary sediment core from Lake Washington. *Geochim. Cosmochim. Acta* 46:1869-1877.

CARBON, L. WASHINGTON, PALEOLIMNOLOGY, SEDIMENTS

Long term lignin stability and paleovegetation patterns were studied using CuO oxidation products of sediments from an 11 m core of Late Quaternary sediment collected from the mid-basin of Lake Washington, Washington State. Relatively constant yields of lingin-derived phenols from the entire core indicate minimal *in situ* lignin degradation over the last 13,000 years. Compositional patterns within the phenolic suite and increased corresponding yields from base extracted sediments indicate that sedimentary lignins are present predominantly as well preserved plant tissue fragments. Abundance patterns of vanillyl, syringyl, and cinnamyl phenols record four distinct sequences within the core, characterized by: high concentrations of gymnosperm wood in basal horizon of glacial flour, 11-10 m; an essentially pure mixture of nonwoody angiosperm tissues in late Pleistocene sediments, 10-8 m; relatively high concentrations of angiosperm woods in the bottom half of a limnic peat sequence deposited approximately 10,000-7,000 years B.P., 8-4 m; and a progressive enrichment in gymnosperm woods at the expense of angiosperm woods over the last 7,000 years in the upper limnic peat, 4-0 m. Vascular plant tissues account for less than half the total sedimentary organic carbon throughout the core.

272. Hettick, O. C. 1979. Flood profiles along the Cedar River, King County, Washington. Geological Survey Water-Resources Investigations 78-84. (open-file report).

CEDAR RIVER, FLOW

Flood profiles on the Cedar River, King County were developed from 21.1 to 33.65 miles upstream from the mouth for the flood of December 3-4, 1975, and for a 100-year flood. Estimated water-surface elevations during a 100-year flood indicate virtually all the flow would be contained in the river channel. Since 1914, Cedar River flows have been affected by impoundment and release of storage from Chester Morse Lake at river mile 35.6, and since 1901 by diversion for water supply at river mile 21.6. Flood-frequency analysis, based on 62 years of regulated flows (period 1915-76), indicate the 100-year flood would have a discharge of 8,600 cubic feet per second at river mile 23.4 and 6,870 cubic feet per second at river mile 33.2. The highest flood since regulation began occurred December 3 and 4, 1975, and was 7,930 cubic feet per second at river mile 23.4 and 6,860 cubic feet per second at river mile 33.2. Recurrence interval of this flood is about 70 years at river mile 23.4 and about 100 years at mile 33.2 under present conditions of storage and regulation.

273. Heun, T. 1982. Lake Washington northern squawfish: life history, control methods, and impact on other species with an emphasis on salmonids: Final review. WA Cooperative Fishery Unit, University of Washington. Seattle. (unpublished) Location: UW SOF/THS

FISH, L. WASHINGTON, REVIEW, SQUAWFISH

This report is a review of the available literature on squawfish.

274. Highsmith, R. M. 1953. Atlas of the Pacific Northwest - resources and development. Dep. Nat. Resour., Oreg. State Univ. Corvallis (OR).

ATLAS, REVIEW

This atlas provides a general review and summary of landforms, climate, farming, electric power facilites, transportation, manufacturing development, retail and wholesale trade, population, and resources including water, rail, forest, fishery, mineral, and recreation (Wydoski, 1972).

275. Higman, H. W. 1951. Union Bay-Life of city marsh. University of Washington Press. Seattle.

UNION BAY, WETLANDS

This book describes the harmonious living of animals and plants with humans in the City of Seattle at a marsh along the eastern portion of the University of Washington campus where the sounds of automobile traffic, the activities of a university, a ship canal, a commercial district, and a community of homes are always present (Wydoski, 1972).

276. Hockett, C. A. 1976. Urbanization and shoreline development of Lake Washington. Master of Urban Planning Thesis. University of Washington. 210 pp. Location: UW SOF/THS

L. WASHINGTON, LAND USE, PIERS, SHORELINE, URBANIZATION

This thesis examined some of the aspects of urbanization which have major participants in the interactions between the lake's aquatic life and the urban development of the lake region and the shoreline. Considerable quantifiable data relating to the aspects of urbanization are presented. The study was concerned with the following areas (1) the physical characteristics of Lake Washington, (2) the lake's historical background, and the factors which contributed to the impact of urbanization upon aquatic life, (3) the extent of urbanization within a specified region around the lake, (4) the changes which have occurred in the configuration of the lakeshore, and (5) the extent of piers and overwater structures.

277. Hoppe, G. N. 1934. Plecoptera of the State of Washington. M.S. Thesis. University of Washington. 57 pp. Location: Allen Library

INVERTEBRATES

Keys are given for the families and species of these aquatic insects. Some of the collections were from the Lake Washington drainage. (Wydoski, 1972)

278. Horne, A. J. 1979. Management of lakes containing N_2-fixing blue-green algae. *Ergeb. Limnol.* 13:133-144.

L. WASHINGTON, MANAGEMENT, NUTRIENTS, PHYTOPLANKTON, POLLUTION

In Lake Washington, the most frequently quoted successful restoration of a polluted lake, sewage diversion quickly reduced chlorophyll *a* and increased transparency to former levels, but the phytoplankton composition was not restored. In contrast, both the polluted and restored lake phytoplankton were dominated by colonial blue-green algae although these changed to N_2-fixing forms after waste diversion. Possibly there is an irreducible minimum level of blue-green algae which may be anticipated in totally restored lakes. There are certainly a large number of water bodies where feasible restoration is partial or where natural levels of blue-green algae are a nuisance. However, the algae tend to be N_2-fixing species which is odd if the major pollutant was phosphorus. This paper discusses some reasons why N_2-fixing blue-green algae occur in restored or naturally eutrophic water bodies and how they can be managed over the next decade.

279. Horner, R. R., E. B. Welch, S. R. Butkus, and D. E. Spyridakis. 1987. Management significance of bioavailable phosphorus in urban runoff. National Technical Information Service. Springfield (VA). (NTIS PB89-101950/AS)

BIOASSAY, ISSAQUAH CREEK, L. SAMMAMISH, LAND USE, MANAGEMENT, NUTRIENTS, PHYTOPLANKTON, STORMWATER, STREAMS, URBANIZATION

Biologically available phosphorus (BAP) was determined in Lake Sammamish at two depths and in its main tributary, Issaquah Creek, by an algal growth potential bioassay technique. BAP was more closely related to soluble reactive phosphorus (SRP) than to total phosphorus. Relationships between BAP and SRP plus sodium hydroxide-extractable phosphorus were derived to permit BAP estimation from chemical measurements in the future. A previously developed nonsteady-state, mass balance model for Lake Sammamish was reformulated in terms of BAP, calibrated, and verified. A linear relationship was also dervived to predict phytoplankton biomass as chlorophyll *a* and Secchi depth transparancy for future cases of watershed development and storm runoff pollution control. Significant change in trophic state indicators is expected without controls, while state-of-the-art retention facilities, vegetated overland flow treatment, and soil infiltration of runoff could maintain the current state. The analysis led to the generation of a series of management strategies to protect Lake Sammamish water quality.

280. Horton, M. A. 1972. The role of the sediments in the phosphorous cycle of Lake Sammamish. M.S. Thesis. University of Washington. 220 pp. Location: UW SOF/THS

CHEM. LIMNOLOGY, L. SAMMAMISH, METALS, NUTRIENTS, SEDIMENTS

Levels of oxygen, iron, and phophorous are found to be intimately related in Lake Sammamish. Oxygen controls the solubility of Fe from the sediments,and Fe solubility dictates the solubility of the closely associated P. Under stratified conditions, release of Fe and P is apparent, however, P release appears to be limited by sorption onto reoxidized Fe compounds (probably ferric hydroxides), returning it to the sediments.

281. Howard, E. D. 1983. Concepts of an urban lake sportfishing plan. In: Lake Washington Symposium, (Ed.) A. Adams. Trout Unlimited. Mercer Island (WA). Location: UW SOF/THS

FISH, L. WASHINGTON, MANAGEMENT, RECREATION, REVIEW

This paper discusses the goals and objectives of the Lake Washington Gamefish Operating Committee.

282. Howe, R. C. 1979. The effect of stormwater runoff on nearshore areas of Lake Sammamish. M.S. Thesis. University of Washington. 178 pp. Location: Engineering Library

L. SAMMAMISH, METALS, NUTRIENTS, PERIPHYTON, PHYTOPLANKTON, POLLUTION, STORMWATER, URBANIZATION

Accumulations of periphytic algae were stimulated by stormwater in localized areas 60-85 m2 around the mouths of the storm drains in Lake Sammamish. Stability of substrates imparted a larger influence on the amounts of peripyton accumulations than did stormwater nutrient loadings. Zinc toxicity may serve as an explanation for limited periphyton growth and the absence of *Cladophora*.

283. Human Resources Planning Institute. 1975. Lake Washington-Lake Union social impact study. National Commission on Water Quality. Washington, D.C. Location: METRO Library

L. UNION, L. WASHINGTON, LAND USE, RECREATION, SEWAGE

This study illuminates some of the social impacts that were associated with the water pollution clean-up of Lake Washington and Lake Union, such as changes in social characteristics, land use patterns and recreational changes.

284. Ikusemiju, K. 1967. The life history of *Cottus* sp in Lake Washington. M.S. Thesis. University of Washington. 90 pp. Location: UW SOF/THS

DIET, DISTRIBUTION, FECUNDITY, FISH, GROWTH, L. WASHINGTON, SCULPIN, SPAWNING

The sculpin, *Cottus* sp, is an undescribed fish which is adapted to a pelagic existence in Lake Washington. This study was conducted to investigate the biology of an undescribed species and to make a contribution to the study of a resident fish in the lake. The specific objectives were to describe the life history and ecology of *Cottus* sp with emphasis on (1) the distribution in the lake, (2) the food and feeding in relation to size and maturity of individuals and other factors influencing food eaten, (3) the growth rate with details of age, length, weight, and length-weight relationships, and (4) the reproduction with reference to spawning period and fecundity.

285. Ikuswmiju, K. 1975. Aspects of the ecology and life history of the sculpin, *Cottus aleuticus* (Gilbert), in Lake Washington. *J Fish Biol.* 7:235-245. Location: UW SOF/THS

DIET, DISTRIBUTION, FECUNDITY, FISH, GROWTH, L. WASHINGTON, SCULPIN

Aspects of the ecology and life history of the sculpin, *Cottus aleuticus* (Gilbert) were investigated. The fish exhibited a diurnal vertical migration towards the surface at night and towards the bottom during the day. It grew to a total length of 54 mm and attained this size at an age of about two years. The growth pattern was the same irrespective of season. It fed mainly on ostracods and chironomid larvae. Fecundity varied from 114-298 eggs.

286. Imamura, K. K. 1975. Life history of the brown bullhead, *Ictalurus nebulosus* (Lesueur), in Lake Washington. M.S. Thesis. University of Washington. 78 pp. Location: UW SOF/THS

ABUNDANCE, BULLHEAD, DIET, DISTRIBUTION, FECUNDITY, FISH, GROWTH, L. WASHINGTON

The life history of the brown bullhead, *Ictalurus nebulosus* (Lesueur), was studied from data collected primarily between February and October, 1971 and periodically during 1972. The principal sampling gear used was frame nets. A boat-mounted electroshocker and hand-held dip nets were also used. Results are presented for habitat locations, abundance, movement, age and growth, diet and the timing of spawning.

287. Imboden, D. M., and R. Gachter. 1978. A dynamic lake model for trophic state prediction. *Eco. Modelling* 4:77-98.

L. WASHINGTON, MODELLING, NUTRIENTS, PRODUCTIVITY

A dynamic, one-dimensional vertical model for phosphate and particulate phosphrous simulates the relationship between phosphrous loading and primary production per unit lake area, as a measure of a lake's trophic state. Primary production per unit lake area is described by a nonlinear function of phosphate and particulate phosphorus which accounts for Michaelis-Menten saturation and algal self-shading. The model includes lake morphometry, hydraulic loading, respiration rate, sedimentation, vertical eddy diffusion, thermocline depth, and phosphorus exchange at the sediment-water interface. The model was applied to Alpnachersee and Greifensee in Switzerland and Lake Washington in Washington state, and good agreement was found between observation and the calculation of phosphorus variations as a function of time and depth. The calibrated model predicted the effectiveness of various eutrophication control measures, such as reduction of phosphrous loading, discharge of hypolimnetic water, hypolimnion aeration, and destratification. For Greifensee, with a mean residence time of 1.2 years, reduction in phosphorus loading to 20% current level is needed to achieve permanent aerobic conditions throughout the lake; other measures result in only minor improvements. The model simulates well the observed recovery of Lake Washington following sewage diversion 1963-67.

288. Infante, A., and S. E. B. Abella. 1985. Inhibition of *Daphnia* by *Oscillatoria* in Lake Washington. *Limnol. Oceanogr.* 30:1046-1052. Location: UW SOF/THS

L. WASHINGTON, PHYTOPLANKTON, ZOOPLANKTON

The hypothesis of Edmondson and Litt concerning the inhibition of *Daphnia* by *Oscillatoria* in Lake Washington was tested in experiments with cultures. Growth and reproduction of *Daphnia pulicaria* and *Daphnia thorata* were reduced by increasing concentrations of *Oscillatoria agardhii* from 0 to 400 filaments per ml in the presence of adequate amounts of *Cryptomonas* as food. *Cryptomonas* reproduction also was inhibited by *Oscillatoria*, by an undetermined mechanism. The results are consistent with the idea that the scarcity of *Daphnia* in Lake Washington during the 10-year period before 1976 was related to high concentrations of *O. agardhii*.

289. Infante, A., and W. T. Edmondson. 1985. Edible phytoplankton and herbivorous zooplankton in Lake Washington. *Ergeb. Limnol.* 21:161-171. Location: UW SOF/THS

L. WASHINGTON, PHYTOPLANKTON, ZOOPLANKTON

The annual succession of *Daphnia pulicaria*, *D. thorata*, *D. galeata*, *Diaphanosoma leuchtenbergianum* and *Diaptomus ashlandi*: and the relationships with edible phytoplankton in Lake Washington between 1976 and 1982 were examined. Direct determinations of gut contents revealed interspecific differences in the number of algal species ingested. A group of ten algal food species was used by all daphnids implying a potential for interspecific competition. The general dominance of *D. pulicaria* may be attributable to the wider spectrum of food species which it ingests.

290. Infante, A., and A. H. Litt. 1985. Differences between two species of *Daphnia* in the use of 10 species of algae in Lake Washington. *Limnol. Oceanogr.* 30:1053-1059. Location: UW SOF/THS

L. WASHINGTON, PHYTOPLANKTON, ZOOPLANKTON

The ability of *Daphnia publicaria* and *Daphnia thorata* to grow and reproduce when given the same concentrations of single species of algae was compared. The 10 algae selected included some of those most frequently found in the guts of *Daphnia* in Lake Washington. Clearing rates were determined and consumption of food expressed as number of cells ingested per day, cell volume, and carbon content. *Cryptomonas erosa* and *Stephanodiscus hantzschii* supported the highest egg production and increase in biomass.

291. Isaksson, A. 1970. Discrimination of Fraser River and Lake Washington sockeye salmon by means of scale characters. M.S. Thesis. University of Washington. 94 pp. Location: Fisheries Library

FISH, L. WASHINGTON, SOCKEYE SALMON

A comparative study of the scales of Lake Washington sockeye salmon of the 1960/1966 brood years and the scales of Fraser River sockeye of corresponding brood years. Lake Washington sockeye from the 1960/1964 brood years could be separated from Fraser River stock by a false annulus on the scales, but this prominent characteristic was not present in the 1965 and 1966 brood years.

292. Issac, G. W., R. I. Matsuda, and J. R. Welker. 1966. Limnological investigation of water quality conditions in Lake Sammamish. Municipality of Metropolitan Seattle. Seattle. (Seattle Water Qual. Ser. 2) Location: METRO Library

CHEM. LIMNOLOGY, L. SAMMAMISH

Water quality in Lake Sammamish affects Lake Washington's water quality because they are directly connected. A 1964/1965 study of Lake Sammamish indicated that it was in the early stages of eutrophication and was in worse condition than Lake Washington was in 1950 (Wydoski, 1972).

293. Jewell, E. D. 1965. Research and management: Puget Sound commercial salmon fisheries. *Wash. State Dep. Fish. Ann. Rep.* 75:9-10. Location: Fisheries Library

ESCAPEMENT, FISH, L. WASHINGTON, SOCKEYE SALMON

The total sockeye escapement to the Lake Washington system was estimated to be in excess of 40,000 fish. No commercial net fishery was permitted in 1965 (Wydoski, 1972).

294. Jewell, E. D. 1965. Status of marine research on Puget Sound salmon runs. *Wash. State Dep. Fish. Ann. Rep.* 75:11-14. Location: Fisheries Library

CEDAR RIVER, ESCAPEMENT, FISH, SOCKEYE SALMON

Summarizes escapement of sockeye salmon to the Cedar River. Research has been limited to monitoring returns on the spawning grounds (Wydoski, 1972).

295. Jewell, E. D. 1966. Research and Management: Puget Sound commercial salmon fisheries. *Wash. State Dep. Fish. Ann. Rep.* 76:119-120. Location: Fisheries Library

ESCAPEMENT, FISH, L. WASHINGTON, SOCKEYE SALMON

Estimated escapements of Lake Washington sockeye since 1960 had ranged widely, but an overall increase was apparent. The Department of Fisheries indicated concern about damaging effects of over-escapement. Test fishing was to commence in 1968 (Wydoski, 1972).

296. Jewell, E. D., and G. I. Fiscus. 1969. 1969 Lake Washington sockeye run. *Wash. State Dep. Fish. Ann. Rep.* 79:15-19. Location: Fisheries Library

FISH, L. WASHINGTON, SOCKEYE SALMON

Describes the commercial fishery for Lake Washington sockeye in Puget Sound and the test fishery in Lake Washington. Several figures show the distribution of commercial gill net and purse seine fishing in Puget Sound with the species composition of the catch by area. Another figure shows the timing of the sockeye run that is based on catches by all gear (Wydoski, 1972).

297. Jewell, E. D., and G. I. Fiscus. 1969. Strait of Juan de Fuca perserve test fishery. *Wash. State Dep. Fish. Ann. Rep.* 79:20-26. Location: UW SOF/THS

FISH, L. WASHINGTON, SOCKEYE SALMON

Four tables summarize the commercial and test fishing for Lake Washington sockeye during 1960. Catches are listed by the area in Puget Sound and by gear. Several photographs of Lake Washington sockeye are included (Wydoski, 1972).

298. Jewell, E. D., and G. I. Fiscus. 1969. Management and research: Puget Sound commercial salmon fisheries. *Wash. State Dep. Fish. Ann. Rep.* 79:27-29. Location: Fisheries Library

FISH, L. WASHINGTON, SOCKEYE SALMON

Discusses improvement in sockeye catches during 1969 over 1968 with emphasis on the Lake Washington stock (Wydoski, 1972).

299. Jewell, E. D., G. I. Fiscus, and C. Pratt. 1971. Management and research: Puget Sound commercial salmon fisheries. *Wash. State Dep. Fish. Ann. Rep.* 80:9-14. Location: Fisheries Library

FISH, L. WASHINGTON, SOCKEYE SALMON

A description of the commercial fishery and gill net test fishery are provided for the Lake Washington sockeye salmon in 1970 (Wydoski, 1972).

300. Jewell, E. D. F., G. I. Pratt, and D. C. Washington. 1969. A review of the 1969 Lake Washington sockeye run: special report. Washington Department of Fisheries. Olympia. (Copy imperfect: 6th page of plates missing.) Location: Fisheries Library

FISH, L. WASHINGTON, SOCKEYE SALMON

In view of the large sockeye runs expected back to Lake Washington in 1971, the Washington Department of Fisheries carried out an extensive test fishery in 1969, the results of which are provided in this report.

301. Johnson, A. W., and R. J. Morrice. 1983. Brief examination of nutrients and suspended solids in portions of Juanita Creek and Bay. Metro. Seattle. Location: METRO Library

JUANITA CREEK, NUTRIENTS, POLLUTION, STREAMS, WETLANDS

This project was undertaken to identify some of the sources and effects of nonpoint pollution in Juanita Creek and Bay. It is divided into two portions, one evaluating water quality of the creek in the vicinity of the McDonalds wetland; the other, an investigation of water quality in Juanita Bay.

302. Johnson, A. 1982. Effectiveness of Timberline Reclamation, Inc's "Silt Sucker" in cleaning the stream substrate of Juanita Creek. Metro. Seattle. Location: METRO Library

BENTHIC, JUANITA CREEK, MANAGEMENT, SEDIMENTS, STREAMS

This memorandum is an report on the evaluation of a portable stream substrate cleaning machine.

303. Johnson, A. W., and J. M. Stypula. 1993. Guidelines for bank stabilization projects in the riverine environments of King County. Surface Water Management Division, King County Department of Public Works. Seattle (WA). (Draft) Location: UW SOF/THS

GEOLOGY, ISSAQUAH CREEK, MANAGEMENT, PLANTS, STREAMS, URBANIZATION

In recent years, numerous river scientists and public works experts have questioned the traditional view of how bank stabilization projects should be built and maintained. As a result of their efforts, new approaches are emerging. These new approaches include biotechnical bank stabilization techniques, which use soil, vegetation, and rock. This report contains information on: 1) the geology and ecology of local streams and rivers; 2) modes and causes of bank failures; 3) methods for conducting a preliminary site investigation; 4) a discussion of relevant government regulation, permit requirements, and policy issues; 5) the role and use of vegetation in bank stabilization; 6) design alternatives; 7) construction procedures; and, 8) guidelines for monitoring and maintenance.

304. Johnson, R. 1968. Sonar counter investigations. *Wash. State Dep. Fish. Ann. Rep.* 78:30. Location: UW SOF/THS

ABUNDANCE, CEDAR RIVER, FISH, SOCKEYE SALMON

Initial trials to count salmon were made in the Cedar River with a sonar device developed by the Bendix Corporation and the State of Alaska (Wydoski, 1972).

305. Jones, B. J. 1978. Water quality and related problems in the Lake Union watershed. City of Seattle, Department of Engineering. Seattle. Location: METRO Library

L. UNION, POLLUTION

This report documented the water characteristics and the water quality and quantity problems in the Lake Union sub-basin. The main water quality problem was from combined sewer overflows which deliver nutrients, pathogens, and heavy metals to Lake Union.

306. Jones, B. J. 1978. Water quality and related problems in the Thornton Creek watershed. City of Seattle, Department of Engineering. Seattle. Location: METRO Library

STREAMS, THORNTON CREEK, URBANIZATION

This report documents the existing and projected water characteristics of Thornton Creek and the water quality and and quantity problems within the watershed. A review of data gathered during other studies and an analysis of data gathered during this study are included.

307. Joyner, T. 1959. The exchange of zinc between catfish and environmental solutions. M.S. Thesis. University of Washington. 40 pp. Location: Fisheries Library

BIOASSAY,CATFISH, FISH, METALS, UNION BAY

A radioactive tracer technique was used to study the exchange of zinc between catfish *Ameiurus nebulosus* and environmental solutions of zinc chloride. These fish were collected from Union Bay (Wydoski, 1972).

308. Karlin, R. E., and S. E. B. Abella. 1992. Paleoearthquakes in the Puget Sound region recorded in sediments from Lake Washington, U.S.A. *Science* 258:1617. Location: Fisheries Library

GEOLOGY, L. WASHINGTON, PALEOLIMNOLOGY

Holocene sediments in Lake Washington contain a series of turbidites that were episodically deposited throughout the lake. The magnetic signatures of these terrigenous layers are temporally and areally correlatable. Large earthquakes appear to have triggered slumping on the steep basin walls and landslides in the drainage area, resulting in turbidite deposition. One prominant turbidite appears to have been deposited about 1100 years ago as the reult of a large earthquake. Downcore susceptibility patterns suggest that near-simultaneous slumping occurred in at least three separate locations, two of which now contain submerged forests. Several other large earthquakes may have occurred in the last 3000 years.

309. Katz, M. 1951. Two new hemoflagellates (genus *Cryptobia*) from some western Washington teleosts. *J. Parasitol.* 37:245-250.

COHO SALMON, FISH, PARASITE, SCULPIN, STREAM, SWAMP CREEK

Two new species of hemoflagellates are described. *Cryptobia salmositica* Katz was discovered in coho salmon, and *C. lynchi* Katz was discovered in the coastrange sculpin, from Swamp Creek, a northern tributary to Lake Washington (Wydoski, 1972).

310. Katz, M., J. C. Woodey, C. D. Becker, T. K. Woo, and J. R. Adams. 1966. Records of *Cryptobia salmositica* from sockeye salmon from the Fraser River drainage and from the State of Washington. *J. Fish. Res. Board Can.* 23:1965-1966.

CEDAR RIVER, FISH, PARASITE, SOCKEYE SALMON

This flagellate was recorded for the first time in sockeye salmon. Some sockeye from the Cedar River were found to contain the organism (Wydoski, 1972).

311. Kaufer, P. 1983. A sportman's perspective of the past. In: Lake Washington Symposium, (Ed.) A. Adams. Trout Unlimited. Mercer Island(WA). Location: UW SOF/THS

FISH, L. WASHINGTON, RECREATION

This paper highlights twenty-six years of fishing experience on Lake Washington.

312. Kemmerer, G., J. R. Bovard, and W. R. Boorman. 1924. Northwestern lakes of the United States: biological and chemical studies with reference to possibilities in production of fish. *Bull. U.S. Bur. Fish.* 39:51-140.

CHEM. LIMNOLOGY, L. SAMMAMISH, L. WASHINGTON

This report details a study of northwestern lakes including Lakes Washington and Sammamish, during the summers of 1911, 1912, and 1913. Depth, temperature, dissolved gases, and transparency af water is given for each lake. Other information includes maps and data on soundings, water samples, net plankton samples, fish in small lakes, and fish food (Wydoski, 1972).

313. Kemper, N. M. 1975. An *in situ* study of the nitrogen system in Lake Sammamish. M.S. Thesis. University of Washington. 120 pp. Location: UW SOF/THS

ISSAQUAH CREEK, L. SAMMAMISH, NUTRIENTS, SEDIMENTS, STREAMS

The objective of this study was to characterize and quantify the nitrogen release from the sediment and determine whether it is a significant source of nitrogen to the lake.

314. Kenney, B. C. 1990. Lake dynamics and the effects of flooding on total phosphorus. *Can. J. Fish. Aquat. Sci.* 47:480-485.

L. WASHINGTON, MODELLING, NUTRIENTS, SEDIMENTATION, URBANIZATION, WATER BUDGET

The concentration of total phosphorus in Lake Washington before and after the sewage diversion project was simulated using first-order linear dynamics. Fluctuation in total phosphorus in the lake occurred as a forced response to changes in inflow phosphorus concentration. The dynamics of total phosphorus in Lake Washington was adequately represented by two independent time scales based on water renewal and sedimentation. The water renewal time scale was modeled as a time dependent process. Sedimentation of total phosphorus, on the other hand, appeared constant over the 16-year period that data were available. A marked increase of total phosphorus in the lake occurred during two flood periods when high concentrations of total phosphorus corresponded to small values of the water renewal time scale (i.e., high flows). At other times, peak concentrations of total phosphorus in the inflow coincided with large values of the water renewal time scale and the lake was dynamically unable to respond to these peaks.

315. Kerfoot, W. C. 1977. Competition in cladoceran communities: The cost of evolving defenses against copepod predation. *Ecology* 58:303-313.

L. WASHINGTON, UNION BAY, ZOOPLANKTON

An intimate relationship is apparent between fecundity and predator resistance in clones of the parthenogenic cladoceran *Bosmina longirostris*. Young of certain clones possess spines, slightly larger bodies, and thicker carapaces, all of which frustrate the handling tactics of predatory copepods. During periods of abundant resources, the resistance is purchased at considerable cost, since eggs and developing young are carried in a restricted space, a special brood chamber formed from the dorsal portion of the carapace. The energy used in the development of protective defenses comes from the egg yolk supply, leading to larger eggs and smaller broods. During the spring algal bloom in Union Bay, Lake Washington, long-featured lines carry few large eggs, while short-featured lines fill their pouches with many small eggs. The resulting differences in birth rate account for much of the rapid replacement of long-featured lines in the inshore regions after fishes remove predatory copepods.

316. Kerfoot, W. C., and R. A. Pastorok. 1978. Survival versus competition: Evolutionary compromises and diversity in the zooplankton. *Verh. Int. Ver. Theor. Angew. Limnol.* 20:362-374.

FISH, L. WASHINGTON, ZOOPLANKTON

Field experiments in Tuck Lake (Washington) and laboratory experiments with samples from Lake Washington (Washington) to study survival and competition among several common zooplankton species showed that compensatory defenses developed by prey of larger zooplankters result in inferior ability to compete with species of similar size. The energy costs of developing such defenses as production of spines, gelatinous sheaths, or larger eggs and neonates, or reduction of pigment to increase transparency (with resultant higher susceptibility to blue-light death) have significant effects on competitive ability and consequent effects on diversity. Predation by fish further intensifies such effects. Zooplankters investigated included *Daphnia pulex v. minnihaha* and *D. schoedleri*; *Bosmina* short- and long-featured ‘morphs’; and *Daphnia pulex*, *Diaphanosoma leuchtenbergianum*, *Bosmina longirostris*, and *Chydorus sphaericus*. Experiments showed: (1) Lake Washington *Bosmina* ‘morphs’ with longer features and protective characteristics (such as thicker exoskeletons) survive in nature more because of resistance to predation than because of ability to compete for shared resources. (2) *Daphnia* and other Tuck Lake zooplankton persist in backwater not because they are better competitors but because of larger size and thicker carapace. It is concluded that selective predation may serve to stabilize species associations in homogeneous open-water environments.

317. Kersnar, F. J. 1961. Small plants in metropolitan Seattle. *J. Wat. Pol. Con. Fed.* 33:909-913.

MANAGEMENT, SEWAGE

In the metropolitan Seattle area, several small sewage treatment plants designed to serve small urban developments and topographically isolated from the remainder of the area were found to be more economical than transmission of sewage flow to a major treatment and disposal site (Wydoski, 1972).

318. King County. 1973. Lake Washington and Lake Sammamish shoreline inventory, unincorporated areas. King County. Seattle.

BEAR CREEK, EVANS CREEK, FISH, GEOLOGY, ISSAQUAH CREEK, LAND USE, NORTH CREEK, SAMMAMISH R., SHORELINE, STEELHEAD, STREAMS, SWAMP CREEK, TIBBETTS CREEK

This document provides a summary of land use, ownership, geology, soils, vegetation, slope and shoreline classification, wildlife, and history of the unincorporated areas.

319. King County. 1977. Juanita Creek your stream's future. King County Resource Planning Section. Seattle.

JUANITA CREEK, STREAMS

This is a brief pamphlet outlining the Juanita Creek basin plan.

320. King County. 1980. May Creek basin plan: a multiple purpose surface water management program. King County Planning Department. Washington. Location: METRO Library

LAND USE, MANAGEMENT, MAY CREEK, SMALL LAKES, STREAMS

This plan addresses existing as well as future surface water problems based on present and recommended land use patterns in the May Creek Basin.

321. King County. 1982. East Sammamish community plan and area zoning. King County Planning Division. Washington. Location: King County Surface Water Management

EVANS CREEK, L. SAMMAMISH, LAND USE, SMALL LAKES, STREAMS, WETLANDS

This planning document includes references on land use, transportation, water quality, and wetlands.

322. King County. 1987. King County basin plan reconnaissance program: program summary, Vol. 1-3. King County. Washington. Location: King County Surface Water Management

FLOW, LAND USE, MANAGEMENT, STREAMS

There are 29 basin reports contained in a three-folder set. Each basin report describes the conditions of the basin and conclusions of the field reconnaissance team. A basin map shows problem locations and recommended capital improvement projects are outlined.

323. King County. 1990. Sensitive areas map folio. King County, Department of Parks, Planning and Resources. Washington. Location: King County Surface Water Management

ATLAS, GEOLOGY, SMALL LAKES, STREAMS, WETLANDS

This collection of maps displays the locations of environmentally sensitive areas in unincorporated western King County. Lands are identified that are subject to natural hazards and lands that support unique, fragile, or valuable natural features. Sensitive areas included are: wetlands, streams, flood hazards, erosion hazards, landslide hazards, seismic hazards, and coal mine hazards.

324. King County. 1990. King County wetlands inventory, Vol. 1-3. King County Environmental Division. Washington. Location: King County Surface Water Management

ATLAS, WETLANDS

This three volume set contains the 1990 updated inventory of wetlands in King County. Each wetland is described with two pages which include an aerial photograph and location as well as summaries of 12 parameters such as acreage, significant habitat features, and its wetland rating.

325. King County. 1991. Issaquah Creek basin current/future conditions and source identification report. King County Surface Water Management. Washington. Location: King County Surface Water Management

CAREY CREEK, FLOW, HOLDER CREEK, ISSAQUAH CREEK, LAND USE, MANAGEMENT, STREAMS, WETLANDS

This report documents the conditions of surface waters in the Issaquah Creek basin planning area. The report assesses current and future problems in the basin's streams, wetlands, and to a lesser extent, lakes. The report also predicts how surface water conditions may change in the area as changes in land use occur, particularly if those changes are allowed to take place in the absence of corrective actions.

326. King County. 1993. Cedar River current and future conditions report. King County Surface Water Management. Seattle. Location: UW SOF/THS

CEDAR RIVER, LAND USE, MANAGEMENT, ROCK CREEK, SMALL LAKES, STREAMS, TAYLOR CREEK, WETLANDS

This report provides a comprehensive assessment of the current conditions and predicts future trends in the Cedar River basin. Its primary purpose is to identify significant conditions and issues to be addressed in the Cedar River Basin/Action Plan. The Basin/Action Plan will recommend solution and management programs for the significant, often interrelated problems related to flooding, erosion and deposition, water quality, and aquatic habitat.

327. King County, and Municipality of Metropolitan Seattle. 1977. Juanita Creek Basin plan, a multiple purpose surface water management program. King County and Metro. Seattle. Location: METRO Library

INVERTEBRATES, JUANITA CREEK, MANAGEMENT, STREAMS

The basin plan is an attempt to accomodate the urbanization of the basin with the existing natural drainage system. This reports lists several recommendations to maintain and remediate the stability of the system.

328. King County Neighborhood Youth Corps. 1972. The H.A.S.T.E.N. water quality and animal ecology survey. King County. Seattle, WA. Location: METRO Library

BEAR CREEK, BENTHIC, COTTAGE L., DANIELS CREEK, LITTLE BEAR CREEK, MARTIN CREEK, SAMMAMISH R., STREAMS

Between July 3 and August 25, 1972, Project H.A.S.T.E.N., a summer project of the King County Neighborhood Youth Corps, conducted a water quality and ecological study of the Sammamish River drainage system. Weekly tests were run to determine air temperature, water temperature, and DO. Other water constituents (pH, turbidity, bacteria, phosphates, and discharge) were checked periodically. Most of the results met with the Class A, Excellent, water quality standard established for the Sammamish River by the Water Pollution Control Commission. Phosphate concentrations were high, however, and the total coliform bacteria level was far beyond the Class A maximum. An inventory of the stream fauna indicated a fair diversity of animals within the ecosystem. With the exception of the Sammamish Slough itself, the creeks sheltered primarily animals indicative of good water quality.

329. King County Planning Department. 1973. Summary shoreline inventory, King County. King County. Seattle. Location: METRO Library

LAND USE, SHORELINE

This document is a summary of the inventory of King County shorelines conducted by the King County Department of Planning in compliance with Section 8(1) of the Shoreline Management Act of 1971. Land use and ownership types are tabled in "front feet."

330. King County Planning Division. 1980. King County streams - a disappearing resource. King County. Seattle. Location: METRO Library

STREAMS

This is a popular pamphlet describing the state of King County streams.

331. King County Planning Division. 1982. Bear Creek : Community plan : Profile. King County. Seattle.

BEAR CREEK, LAND USE, STREAMS

This document gives an overview of the Bear Creek watershed land use including a map of known wildlife resource areas.

332. Kirkpatrick, L. W. 1967. A preliminary investigation of the projected effects of urbanization upon water resources within the Lake Sammamish watershed. M.S. Thesis. University of Washington. 84 pp. Location: Engineering Library

L. SAMMAMISH, NUTRIENTS, SEWAGE, URBANIZATION, WATER BUDGET

This study was done to determine if Lake Sammamish was faced with the same degradation of water quality from excessive nutrient enrichment as occurred in nearby Lake Washington. The study period extended from March through May of 1967.

333. Kittle, L. J., and A. A. Jensen. 1973. Total benthic oxygen uptake in four lakes of the Lake Washington drainage basin: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 149. (unpublished) Location: UW SOF/THS

BENTHIC, CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, L. WASHINGTON, SEDIMENTS, TEMPERATURE

This study relates oxygen uptake by sediments to *in situ* temperature for the four lakes within the Lake Washington drainage system

334. Kolb, R. 1971. A review of Lake Washington sockeye (*Oncorhynchus nerka*) age and racial characteristics as determined by scale analysis. Wash. State Dep. Fish. Supp;. Prog. Rep. Location: Fisheries Library

FISH, L. WASHINGTON, SOCKEYE SALMON

Circuli counts of sockeye salmon scales are provided that can be used to separate stocks that are returning to Lake Washington and to Stuart Lake of the Fraser river system. Also presents a table that summarizes the history of the Lake Washington sockeye runs (Wydoski, 1972).

335. Kosmerchock, M. K. 1972. The effect of zooplankton grazing determined *in situ* in two lakes of the Cedar River watershed. M.S. Thesis. University of Washington. 85 pp. Location: UW SOF/THS

CHESTER MORSE RES., L. SAMMAMISH, PHYTOPLANKTON, ZOOPLANKTON

Experiments were conducted in Chester Morse Reservoir and Lake Sammamish, Washington, from July through September of 1971 to determine the effect that the zooplankton grazing has on the standing crop of phytoplankton. Plexiglass columns were constructed as a means to conduct the experiments *in situ*. Filtering rates, from cell

concentrations and chlorophyll *a* concentrations, were calculated using two methods which were fairly consistant. The grazing rate, which ranged from 0.566-7.92 ml/animal/day was found to be similar in the two lakes of different phytoplankton levels of productivity. The zooplankton from the less productive lake, Chester Morse, were found to be consuming per animal, approximately one third that of Lake Sammimish. No feeding selectivity was observed. Blue green algae did not have an inhibiting effect on the zooplankton grazing rate.

336. Kramer Chin & Mayo. 1990. Report on review of Mayor's plan for restoration of Green Lake. City of Seattle. Seattle. Location: GOVERNMENT LIBRARY

GREEN LAKE, MANAGEMENT, NUTRIENTS, SMALL LAKES

This is an independent review of Mayor Rice's plan to control phosphorous concentrations in Green Lake through water treatment, dilution, and alum additions.

337. Kubo, M. M. 1983. Emergency closure system and flood control regulation gate for Hiram M. Chittenden Locks at Lake Washington Ship Canal. Hydrualic model investigation. Technical report, May 81 -April 82. National Technical Information Service. Springfield (VA).

FLOW, MODELLING, SHIP CANAL, WATER BUDGET

A 1:50 scale model was used to evalute the proposed emergency closure system (ECS) for the large lock at the Lake Washington Ship Canal project. The model was also used to evaluate the acceptibility of using the large lock chamber as an auxiliary spillway with the ECS functioning as a regulating gate.

338. Kuivila, K. M., and J. W. Murray. 1984. Organic matter diagenesis in freshwater sediments: The alkalinity and total CO_2 balance and methane production in the sediments of Lake Washington. *Limnol. Oceanogr.* 29:1218-1230.

CARBON, CHEM. LIMNOLOGY, L. WASHINGTON, SEDIMENTATION, SEDIMENTS

The interstitial water chemistry of Lake Washington (Washington) sediments collected with an *in situ* sampler was studied. Lake Washington is mesotrophic, 87 km^2 in area with a maximum depth of 65 m. The depth where the sulfate concentration reaches a low background value appears to delineate a transition within the sediments above and below which profiles of total carbon dioxide, alkalinity, methane, and ammonium are linear, suggesting zones dominated by diffusion separated by a narrow zone of reaction. The increase of alkalinity with depth in the interstitial waters was identified by a stoichiometric model. The largest contribution to this increase was made by ammonium production, followed by iron reduction. The C:N ratio of the decomposing organic matter increases systematically, from 3.9 at 5 cm to over 14 ar 50 cm. The organic matter being decomposed becomes nitrogen-poor with age. About a fourth of the detrital rain of carbon is recycled to the lake as a diffusive flux of carbon dioxide and methane.

339. Kuivila, K. M., J. W. Murray, A. H. Devol, M. E. Lidstrom, and C. E. Reimers. 1988. Methane cycling in the sediments of Lake Washington. *Limnol. Oceanogr.* 33:571-581.

CARBON, L. WASHINGTON, SEDIMENTS

The importance and ultimate fate of methane in the carbon cycle of Lake Washington was examined. Aerobic oxidation is important in the cycling of methane in the sediments. About half of the methane flux from depth is oxidized to CO_2 in the upper 0.7 cm of the sediments and the remainder escapes into the water column. In terms of the total carbon budget of the lake, the upward flux of methane is insignificant with only about 2% of the carbon fixed by primary production being returned as methane. The upward flux of methane, however, does represent about 20% of the organic carbon decomposed within the sediments. In addition, methane oxidation consumes 7-10% of the total oxygen flux into the sediments. Measured kinetic parameters suggest that methane oxidation is restricted to the top 6-7 mm of sediment where oxygen is present and that the rate of this process is probably controlled by the concentration of methane.

340. Kuivila, K. M., J. W. Murray, A. H. Devol, and P. C. Novelli. 1989. Methane production, sulfate reduction and competition for substrates in the sediments of Lake Washington. *Geochim. Cosmochim. Acta* 53:409-416.

CARBON, L. WASHINGTON, SEDIMENTS

Rates of methane production (both acetate fermentation and CO_2 reduction) and sulfate reduction were directly measured as a function of depth in the sediments of Lake Washington. Although methanogenesis was the primary mode of anaerobic respiration (63%), the major zone of methane production existed only below the sulfate reduction zone (16 cm). Acetate fermentation accounted for 61 to 85% of the total methane production, which is consistent with other low sulfate environments. The observed spatial separation of methane production and sulfate reduction is attributed to competition between the methane-producing and sulfate-reducing bacteria for acetate and hydrogen. This hypothesis is supported by the strong correlation between the measured distributions of acetate and hydrogen and the rates of methane produced from these two precursors in Lake Washington sediments. Acetate concentrations increased rapidly once the sulfate concentration decreased below 30 µM and methane production via acetate fermentation began. A similar trend was observed for hydrogen concentrations, which increased from 7 to 22 nM up to 40 to 55 nM, at the onset of methanogenesis from CO_2 and H_2 (sulfate concentrations of 35-40 µM). These results show, for the first time in a freshwater lake, the separation of methane production and sulfate reduction and the corresponding changes in acetate and hydrogen concentrations.

341. Kuivila, K. M. 1986. Methane production and cycling in marine and freshwater sediments. Ph.D. Dissertation. University of Washington. 170 pp. Location: Fisheries Library

CARBON, L. WASHINGTON, SEDIMENTS

The purpose of this research was to examine the interactions between methanogenesis and other organic carbon oxidation processes in marine and freshwater sediments. The majority of the methane flux into the aerobic layer of Lake Washington (66 %) was oxidized to CO_2 while only 34 % escaped into the hypolimnion.

342. Kuntz, D. R., and T. T. Packard. 1972. Interim progress 1972: Water column respiration: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 84. (unpublished) Location: UW SOF/THS

CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, L. WASHINGTON, PHYTOPLANKTON, ZOOPLANKTON

Research was begun to measure the respiratory metabolism of zooplankton and phytoplankton in four lakes in the Lake Washington drainage. This was done using an enzyme assay for the activity of the electron transport system.

343. Kuntz, E. 1942. The Rotatoria of Washington. M.S. Thesis. University of Washington. 161 pp. Location: Allen Library

ZOOPLANKTON

This thesis provides keys for the order, family, and genus of rotifers from Washington State. Descriptions of species are provided under the section on genera. Some collections were taken from the Lake Washington drainage (Wydoski, 1972).

344. Lampman, B. H. 1946. The coming of the pond fishes. Benford and Mort Pupl. Portland (OR).

FISH, REVIEW, STOCKING

Provides a history of the introduction of some spiny-rayed and exotic fishes into the Columbia river region and Pacific coast waters (Wydoski, 1972).

345. Lang, G. A., and D. Scavia. 1986. Calculation of vertical diffusivity in Lake Washington based on long-term simulation of thermal structure: Noaa Tech. Memo. NOAA Environmental Research Labs. Ann Arbor (MI). (NTIS Order No.: PB86-205515/GAR.)

CIRCULATION, L. WASHINGTON, MODELLING, TEMPERATURE

A one-dimensional vertical heat-diffusion model, empirically parameterized in terms of the gradient Richardson number and the Brunt-Vaisala frequency, is described. Comparison of observed and simulated vertical thermal structure and total heat content in Lake Washington for the period 1963-1976 demonstrates that the model produces a good parameterization of bulk vertical mixing processes. Fourteen years of daily-averaged, model-calculated eddy diffusion coefficients (k) are presented.

346. Lanich, J. S. 1972. Mineralogy and cation exchange capacity of surface sediments from selected lakes of Lake Washington drainage. M.S. Thesis. University of Washington. 104 pp. Location: UW SOF/THS

CHEM. LIMNOLOGY, CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, L. WASHINGTON, SEDIMENTS

This study is concerned with some of the physical and mineralogical properties of the surface sediments from Lakes Washington and Sammamish, Chester Morse Reservoir, and Findley Lake.

347. Lanphere, H. G. 1936. The aquatic and semi-aquatic Heteroptera of western Washington. M.S. Thesis. University of Washington. 61 pp. Location: Allen Library

INVERTEBRATES

This thesis describes all families, genera, and species of these insects that were found in western Washington until 1936. Many localities are given as Seattle area. Some are found in all of the freshwaters in the Seattle area, including the Lake Washington watershed (Wydoski, 1972).

348. Larrison, E. J. 1947. Field guide to the birds of King County, Washington, The trail side series. Seattle Audubon Society. Washington.

BIRD

This book provides a biotic description of King County, methodology of observing birds, and a description of characteristics, habitats, and location of each bird found in the county (Wydoski, 1972).

349. Larson, K. W. 1972. The systematics of a population of sculpins (*Cottus*) in Lake Washington. M.S. Thesis. University of Washington. 76 pp. Location: UW SOF/THS

DISTRIBUTION, ELECTROPHORESIS, FISH, L. WASHINGTON, SCULPIN

The species of the genus *Cottus* in western Washington comprise an interesting but confusing mosaic of forms. The species appear to have diverged and/or converged into the variety of forms that are adapted to the many habitats of the coastal streams and lakes of the Pacific Northwest. One of the more interesting adaptations of a form of *Cottus* is its pelagic existence in Lake Washington. This population of sculpins occupies the deep benthic areas of the lake during the daylight hours and migrates off the bottom at night and apparently swims pelagically until dawn. This study compares the lake population with *Cottus aleuticus* from the Lake Washington drainage. The comparison is made in order that (1) the systematics of the lake population can be described in relation to the systematics of a phenotypically similar stream cottid, and (2) the specific status of the lake population can be investigated.

350. Larson, S. B. 1975. The history of the Lake Washington Ship Canal. King County Arts Commission. Seattle (WA). Location: METRO Library

SHIP CANAL

This report is on the history of the Lake Washington Ship Canal. A slide presentation with taped narrative resulted as a finished product of this report.

351. Lazoff, S. B. 1980. Deposition of diatoms and biogenic silica as indicators of Lake Sammamish productivity. M.S. Thesis. University of Washington. 128 pp. Location: Engineering Library

L. SAMMAMISH, PALEOLIMNOLOGY, PHYTOPLANKTON, PRODUCTIVITY, SEDIMENTS

Changes in the past diaton productivity of Lake Sammamish were evaluated from paleoecological data and changes in the yearly deposition rate of biogenic silica. It appears that the net yearly diatom productivity has approximately doubled since the settlement of Europeans in the watershed, c. 1870.

352. Legear, C. E. 1950. United States atlases: A list of national, state, county, city, and regional atlases in the Library of Congress. The Library of Congress, Ref. Dep. Washington, D.C.

ATLAS

Lists atlases of Seattle and vincinity under King County, Washington. A supplement of 301 pages was published in 1953 as Volume 2 (Wydoski, 1972).

353. Lehman, J. T. 1986. Control of eutrophication in Lake Washington. In: Ecological knowledge and environmental problem-solving. National Academy Press. Washington,D.C. pp. 301-316 Location: UW SOF/THS

FISH, L. WASHINGTON, MANAGEMENT, NUTRIENTS, REVIEW, SOCKEYE SALMON

This chapter describes Lake Washington as a case study of creative interaction between the scientific community and the political arena in the development and execution of a plan that resulted in water quality improvement in the lake.

354. Lehman, J. T. 1988. Hypolimnetic metabolism in Lake Washington: Relative effects of nutrient load and food web structure on lake productivity. *Limnol. Oceanogr.* 33(6 part 1):1334-1347. Location: UW SOF/THS

CARBON, L. WASHINGTON, NUTRIENTS, PHYTOPLANKTON, PRODUCTIVITY, SEDIMENTS

The general metabolism of carbon, oxygen, phosphate, nitrate and silicate in the hypolimnion of Lake Washington is examined from 23 years of record. Magnitudes of net consumptive and regenerative processes in the water column and sediments are identified and stoichiometries of regeneration *in situ* are calculated. Aerobic respiration appears to be almost equally divided between the water column and sediment surface. Net nitrification is more rapid in the water column, and silicate regeneration is confined to the sediment surface. Nutrients do not accumulate on average at the Redfield ratio. Rates of hypolimnetic oxygen consumption are compared to production rates inferred independently from ^{14}C and oxygen bottle assays. A third of all gross primary production is respired in the hypolimnion during spring and summer, but the proportion was significantly lower during an episode of cultural eutrophication in the 1960’s. Rates of primary production and hypolimnetic processes decreased in response to changes in nutrient income when effluents from waste treatment plants were diverted from the lake. After a period of recovery from eutrophication, Lake Washington experienced a second basinwide perturbation involving alteration of the planktonic herbivore community. The change in food web structure failed to produce a response comparable to that of altered nutrient loading. Despite inferred changes in algal growth rates and in species composition, total primary productivity and rates of hypolimnetic metabolism did not change.

355. Lehman, J. T., and W. T. Edmondson. 1983. The seasonality of phosphorus deposition in Lake Washington. *Limnol. Oceanogr.* 28:796-800. Location: UW SOF/THS

L. WASHINGTON, MODELLING, NUTRIENTS, SEDIMENTATION

This paper provides observations on actual and modelled phosphorus deposition in Lake Washington as a rebuttal to comments expressed in Chapra and Reckhow (1983).

356. Leon, K. A. 1970. Some aspects of the comparative biology of an interracial hybrid rainbow trout and the two parental stocks. Ph.D. Dissertation. University of Washington. 111 pp. Location: Fisheries Library

BREEDING, FISH, RAINBOW TROUT, STOCKING

The planting of rainbow, hybrid, and steelhead trout into Portage Bay in the Lake Washington drainage are described, as well as returns of these fish to the hatchery pond at the University of Washington (Wydoski, 1972).

357. Leopold, E. B., R. Nickmann, J. I. Hedges, and J. R. Ertel. 1982. Pollen and lignin records of late Quaternary vegetation, Lake Washington. *Science (Wash.).* 218:1305-1306.

L. WASHINGTON, PALEOLIMNOLOGY, SEDIMENTS

Analyses of lignin oxidation products and pollen for an 11-meter core from Lake Washington provide independent but similar reconstructions of the late Quaternary vegetation in the Puget Lowland. An exception is in sediments of the late Pleistocene where pollen percentages and influx values suggest conifer forest whereas lignin compositions suggest a treeless source region. This dissimilarity appears to result from different major provenances: eolian transport of pollen to the lake from adjacent or downstream drainage basins as opposed to fluvial transport of lignified plant debris only from the Lake Washington drainage basin.

358. Lettenmaier, D. P., and S. J. Burges. 1982. Validation of synthetic streamflow models. In: Time series methods in hydrosciences. Proceedings of an international conference held at Canada Centre for Inland Waters, October 6-8, 1981, Burlington, Ontario: Developments in Water Science, No. 17. Elsevier Scientific Publishing Co. New York. pp. 424-444

CEDAR RIVER, FLOW, MODELLING

The use of graphical techniques for validation of multivariate synthetic streamflow models is advocated. Two general types of validation measures are suggested: statistical and performance-based. Although preservation of low order moments, particularly the mean, will often be a necessary condition for model acceptance, biasing of higher order moment estimators complicates their use for validation purposes. Although moment estimators may be corrected for bias, this does not necessarily result in improvement of a stochastic model from a performance standpoint. Therefore, performance-based model validation measures, particularly sequent peak storage, may be more significant for operational validation. Application of the techniques suggested to three two-site, three season models of the Cedar and North Fork Snoqualmie River, Washington indicated possible inadequacies in the seasonal distribution of flows, as well as differences related to long term persistence structure. The graphical results also pointed out a tradeoff in the multivariate long term persistence models between cross-site correlations and autocorrelations at the individual sites. Empirical distributions of moments and auto- and cross-correlations at the seasonal level were useful in validating the multi-site disaggregation model, while the sequent peak algorithm was most useful for overyear validation. The latter indicator is, however, sensitive to the demand pattern imposed. Critical extraction rate and crossing distributions were less useful model validation measures.

359. Lidstrom, M. E., and L. Somers. 1984. Seasonal study of methane oxidation in Lake Washington. *Appl. Environ. Microbiol.* 27:1255-1260.

BACTERIA, CARBON, L. WASHINGTON, SEDIMENTS

The distribution of methane and methane-oxidizing bacteria in the water column of Lake Washington was determined monthly for 1 year. The methane profiles were relatively constant, with little stratification and low concentrations (0.05 to 0.5 μM). The number of methane-oxidizing bacteria detected by a filter-plating method was routinely < 1/ml throughout the water column, and no incorporation or oxidation of methane was detected by radioisotopic labeling, even after methane was added. However, samples taken from the sediment-water interface contained as much as 3 μM methane and 50 CFU of methane-oxidizing bacteria per ml and showed significant rates of methane oxidation and incorporation. To define the region of maximum activity more precisely, vertical profiles of the sediment were examined. The concentration of methane increased with depth to a maximum of 150 to 325 μM at 2.5 cm, and significant rates of methane oxidation were found within the top 2.5 cm. The apparent Kms for methane and oxygen were determined for samples from the top 1.0 cm of the sediment and found to be ca. 10 and 20 μM, respectively. Projected values for methane oxidation rates suggested that maximum methane oxidation occurred in the top 0.5 cm of the sediment.

360. Lighthart, B., and J. Bollinger. 1972. Carbon flux in the water column: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 82. (unpublished) Location: UW SOF/THS

BACTERIA, CARBON, CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, L. WASHINGTON, PHYTOPLANKTON, ZOOPLANKTON

This paper provides the methods developed for estimating gross carbon uptakes by autotrophs, biophages and saprophages in the water columns of four lakes in the Lake Washington drainage.

361. Lighthart, B. 1972. A simple aquatic carbon cycle model: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 83. (unpublished) Location: UW SOF/THS

CARBON, L. WASHINGTON, MODELLING

The biological components within a lake may be modelled in terms of carbon fluxes between delineated carbon-containing compartments or pools. This paper presents the results of a model run using measurements from Lake Washington. The carbon pools and fluxes between the pools are given.

362. Lighthart, B., and P. E. Tiegs. 1972. Exploring the aquatic carbon web. In: Research on Coniferous Forest Ecosystems: First Year Progress in the Coniferous Forest Biome, US/IBP, (Ed.) J. F. Franklin, L. J. Dempster, and R. H. Waring. Pacific Northwest Forest and Range Experiment Station, U.S. Department of Agriculture. Portland. pp. 289-300

BACTERIA, CARBON, CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, L. WASHINGTON, PHYTOPLANKTON, ZOOPLANKTON

An aquatic carbon web containing the six compartments dissolved inorganic carbon (DIC), phytoplankton, zooplankton, dissolved organic carbon (DOC), detritus, and chemoorganotrophic bacteria is discussed.

363. Loucks, O. L., W. E. Odum, N. M. Johnson, J. S. Eaton, J. E. Richey, G. E. Likens, R. T. Prentki, and A. H. Devol. 1978. Analysis of five North American lake ecosystems. 1. A strategy for comparison. *Verh. Int. Ver. Theor. Angew. Limnol.* 20:556-608. Location: Fisheries Library

FINDLEY LAKE, PRODUCTIVITY, REVIEW

The ecosystems of five North American lakes were compared. One study describes the basic parameters to enable a comparison, such as lake morphology, geology, vegetation cover, physicochemical properties etc. Another paper includes the energy milieu and circulation patterns of the lakes. The sources and the cycling of nitrogen and phosphorus and the magnitude and importance of allochthonous carbon for the lake ecosystems were further themes. The primary production in dependence of physical and chemical properties, the partitioning of the production among the producer communities and the influence of primary production upon consumer communities are described. Check lists are given for aquatic invertebrates and fish with hints to their habitat preferences. For fish abundance, habitat and feeding behavior are summarized in a table. Besides chemical reactions in the sediment-water interface, CO_2/O_2 budgets in the benthos with the corresponding trophic categories had been investigated.

364. Lynch, J. E. 1936. New species of *Neoechnorhynchus* from the western sucker, *Catostomus macrocheilus* Girard. *Trans. Am. Microsc. Soc.* 55:21-43.

FISH, PARASITE, STREAMS, SUCKER

This article describes two new species of Acanthocephala from fish that were collected in an unnamed tributary of Lake Washington (Wydoski, 1972).

365. Maki, J. S., B. M. Tebo, F. E. Palmer, K. H. Nealson, and J. T. Staley. 1987. The abundance and biological activity of manganese-oxidizing bacteria and Metallogenium-like morphotypes in Lake Washington, USA. *Fems Microbiol. Ecol.* 45:21-29.

BACTERIA, L. WASHINGTON, METALS

The distribution of bacteria, ATP, Metallogenium morphotypes and manganese-oxidizing activities were studied in Lake Washington, WA. In accordance with earlier studies, the authors found that Metallogenium morphotypes show a stable seasonal distribution in Lake Washington. The authors used ^{54}Mn(II) tracer studies coupled with poisoned and no-oxygen controls to demonstrate that biological manganese oxidation was not linked to the numbers of Metallogenium morphotypes. The data suggest that these morphotypes do not contribute significantly to the biological oxidation of manganese in Lake Washington.

366. Male, L. 1971. Aquatic production model: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 39. (unpublished) Location: UW SOF/THS

FISH, MODELLING, PHYTOPLANKTON, PRODUCTIVITY, SOCKEYE SALMON, ZOOPLANKTON

This report summarizes the philosophy and assumptions implicit in the aquatic production model's development. Details are provides on the phytoplankton, zooplankton, and sockeye salmon submodels.

367. Male, L. M. 1972. A temporal-spatial model for studying nutrient cycling dynamics of a phytoplankton production system: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. Univeristy of Washington. Seattle; Internal Report 95. (unpublished) Location: UW SOF/THS

L. SAMMAMISH, L. WASHINGTON, MODELLING, NUTRIENTS, PHYTOPLANKTON, PRODUCTIVITY

This report describes the development of a system model for studying the processes of phytoplankton production and nutrient cycling in a freshwater lake and describes how the model may be used to increase our understanding of the dynamics of the system and how it can be useful in guiding research efforts.

368. Malick, J. G., and Q. J. Stober. 1973. Secondary production in the Cedar River: Macroinvertebrate and related studies: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 156. (unpublished) Location: UW SOF/THS

BENTHIC, CEDAR RIVER, INVERTEBRATES

This report is a summary of work completed in the first three years of the project. The project objectives were to determine the general ecology and dynamics of the invertebrate riffle communities at six stations in the Cedar River, determine the community relationship to some of the assumed more important environmental factors, both terrestrial and aquatic, and to model the invertebrate riffle community of the Cedar River from available literature data and data accumulated.

369. Malick, J. G. 1977. Ecology of benthic insects of the Cedar River, Washington. Ph.D. Thesis. University of Washington. 188 pp. Location: UW SOF/THS

BENTHIC, CARBON, CEDAR RIVER, INVERTEBRATES

Benthic insect investigations were conducted at six sites in the Cedar River, Washington. Study sites were established in rhithron habitats that represented natural stream sections and stream affected by agriculture, urbanization and a small lake-reservoir complex. Detrital material was collected and insect production determined.

370. Malone, F., S. Bowles, J. Grenney, and P. Windham. 1979. Stochastic analysis for water quality. National Technical Information Service. Springfield (VA). (NTIS PB-295 392)

L. WASHINGTON, MODELLING, NUTRIENTS

This report demonstrates the feasibility of applying stochastic techniques to linear water quality models. The Monte Carlo, first order analysis, and generation of moment equation techniques are applied to a long term phosphorus model of Lake Washington. The effect of uncertainty of the phosphorus loading term on simulated phosphorus levels is analyzed. All three stochastic techniques produced the same results. The simulated concentrations of phosphorus in the water column are very responsive to uncertainty in annual phosphorus loading, the sediment concentration relatively insensitive. The Monte Carlo technique requires the most computation time of the three stochastic techniques applied. The First Order and Generation of Moment Equation techniques are precise and efficient methods of stochastic analysis. In this application they required less than one thousandth the computation time of the Monte Carlo technique. The Generation of Moment Equations technique is also applied to a steady state salinity model of the Colorado River system. Two sources of uncertainty are considered: (1) the estimation of 'steady state' values of salinity loading from a limited historic data base and (2) the estimation of salinity loading from irrigated land by a semi-empirical approach. Six stochastic simulations of the Colorado River system are presented. Coefficients of variations of simulated salinities at Imperial Dam vary from 5.7 to 10.3 percent. The major source of uncertainty in all simulations is the estimation of the steady state salinity loading with the agricultural loading term becoming important in some simulated management alternatives.

371. Malone, R., D. S. Bowles, M. P. Windham, and W. J. Grenney. 1983. Comparison of techniques for assessing effects of loading uncertainty upon a long term phosphorus model. *Appl. Math. Modelling.* 7:11-18.

L. WASHINGTON, MODELLING, NUTRIENTS

This paper compares the feasibility of applying three stochastic techniques to a linear water quality model. The Monte Carlo, first order analysis, and generation of moment equation techniques are applied to a long term phosphorus model of Lake Washington. The effect of uncertainty of the phosphorus loading term on simulated phosphorus levels is analysed. The simulated concentrations of phosphorus in the water column are very responsive to uncertainty in annual phosphorus loading, but the sediment concentrations are relatively insensitive. All three stochastic techniques produced identical results, but the level of preparatory and computational effort required varies considerably. The Monte Carlo technique requires the most computation time of the three stochastic techniques examined.

372. Manley, N. J. 1976. Influence of elk and beaver on the bacterial water quality in the Cedar River watershed, Washington. M.S. Thesis. University of Washington. 52 pp. Location: Engineering Library

BACTERIA, CEDAR RIVER, MAMMALS

Coliform, fecal coliform, and fecal streptococcus were measured in water in the Cedar River watershed. It was found that animals associated with a beaver pond noticably affected the bacterial water quality. It was also found that along the Cedar River the concentration of bacteria increased with the distance downstream and with the number of animals.

373. Marshall, W. A. 1989. The effect of stormdrain runoff on algal growth in nearshore areas of Lake Sammamish. M.S. Thesis. University of Washington. 112 pp. Location: Engineering Library

BIOASSAY, L. SAMMAMISH, METALS, NUTRIENTS, PHYTOPLANKTON, STORMWATER, URBANIZATION

Six algal growth-potential bioassays conducted in 1979 using water from two urban stormdrains showed that storm water produced both stimulatory and inhibitory effects in localized areas near the stormdrain outlets. Algal biomass attained with full strength stormwater ranged from 55 to 95 percent less than that expected based on growth in lake water containing equivalent levels of stormwater nutrients. The inhibitory effect was probably caused in part by one or a combination of heavy metals.

374. Martin, S. G. 1965. Environmental factors influencing the entry of chinook salmon and silver salmon into the University of Washington holding pond. M.S. Thesis. University of Washington. 70 pp. Location: Fisheries Library

BREEDING, CHINOOK SALMON, COHO SALMON, FISH

This study was a part of Dr. Lauren Donaldson's selective breeding program at the University of Washington. (Wydoski, 1972)

375. Martinsen, G. R. 1981. Creel survey and descriptive analysis of the sport fisheries of Lake Washington, 1981-1982, Progress report. WA Cooperative Fishery Unit, University of Washington. Seattle. (unpublished) Location: UW SOF/THS

FISH, L. WASHINGTON, MANAGEMENT, RECREATION

This is a progress report of a creel survey project. Included is a copy of the survey data form.

376. Matches, J. R., and M. M. Wekell. 1972. Degradation of organic compounds in freshwater sediments by bacteria: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 88. (unpublished) Location: UW SOF/THS

BACTERIA, CARBON, CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, L. WASHINGTON, SEDIMENTS

The rates of glucose mineralization by indigenous bacteria were collected and analyzed from the four IBP lakes.

377. Matches, J. R., and M. M. Wekell. 1973. Degradation of organic compounds in freshwater sediments by bacteria: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 146. (unpublished) Location: UW SOF/THS

BACTERIA, CARBON, CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, L. WASHINGTON, SEDIMENTS

This report discusses the mineralization of glucose to CO_2 as a measure of the activity of bacterial populations found in lake sediments. These measurements give information on the numbers of bacteria present and their activity rates.

378. Mathews, S. B., E. D. Jewell, and F. Haw. 1971. Incidental catch of chinook, coho, and steelhead during the 1971 Lake Washington sockeye salmon season. WA Dept. of Fisheries. Olympia. Location: Fisheries Library

CHINOOK SALMON, COHO SALMON, FISH, L. WASHINGTON, SOCKEYE SALMON, STEELHEAD

Onboard checks and fish landing tickets were used to investigate incidental catch from commercial purse seine and gillnetting harvest of Lake Washington sockeye in central Puget Sound.

379. McConnaha, W. E. 1978. Factors affecting the distribution of benthic macroinvertebrates around Sand Point, Lake Washington. M.S. Thesis. University of Washington. 116 pp. Location: Fisheries Library

BENTHIC, INVERTEBRATES, L. WASHINGTON, SEDIMENTS

This study examined the effects of sediment on the distribution and abundance of benthic macroinvertebrate around Sand Point, Lake Washington. Both chironomid larvae and oligochaetes were found to be relatively insensitive to large changes in sediment composition. The effect of sediment apparently changed with depth. No sediment parameter accounted for more than 10% of the variation in organism abundance.

380. McDonald, L. S. 1979. The Lake Washington story: a pictorial history. Superior Publishing Co. Seattle. Location: Suzzallo Library

L. WASHINGTON

This is a popular history of Lake Washington and the surrounding landscape.

381. McDonnell, J. C. 1975. *In situ* phosphorous release rates from anaerobic lake sediments. M.S. Thesis. University of Washington. 158 pp. Location: UW SOF/THS

L. SAMMAMISH, NUTRIENTS, SEDIMENTS

This study was initiated to scrutinize the contribution of sediments to the phosphorous budget of Lake Sammamish. By employing *in situ* cylindrical microcosms planted into the sediments, these investigations examine (1) the

rates of release of reduced constituents including P, Fe, and Mn during anoxia, (2) the interactions between P release and the oxygen conditions and (3) the effect of increased surface P loading upon the equilibrium values under anaerobic conditions.

382. Mcgreevy, R. 1973. Seattle Shoreline Environment. City of Seattle, Department of Community Development. Seattle, Washington.

BIBLIOGRAPHY, BIRD, FISH, GEOLOGY, L. UNION, L. WASHINGTON, LAND USE, MAMMALS, PLANTS, REVIEW, SHORELINE, UNION BAY, URBANIZATION

This booklet identifies the shoreline environment within the City of Seattle. Included are descriptions of the lakefront parks, birds, wildlife, plants, geology, and fish associated with these areas. An annotated map of shoreline property (streams and reservoirs) outside if the city limits is provided. Addditionally a useful bibliography is provided.

383. McLaughlin, P. J. 1961. Some observations on encystment of a protistan ectocommensal on Cladocera. M.S. Thesis. University of Washington. 56 pp. Location: Allen Library

PARASITE, UNION BAY, ZOOPLANKTON

Some of the samples used in this study were collected from Union Bay and ponds in the Seattle area. (Wydoski, 1972)

384. McManus, D. A. 1963. Postglacial sediments in Union Bay, Lake Washington, Seattle, Washington. *Northwest Sci.* 37:61-73. Location: UW SOF/THS

L. WASHINGTON, SEDIMENTS, UNION BAY

Sediment profile in Union Bay from Foster Island to Lake Washington (Wydoski, 1972).

385. Melder, F. E. 1938. History of the discoveries and physical development of the coal industry in the State of Washington. *Wash. Hist. Q.* 29:151-165.

LAND USE, REVIEW

Brief insight into the role of the Lake Washington watershed in the growth of the coal industry in the area for about 100 years, beginning in 1833 (Wydoski, 1972).

386. Merriman, D. S. 1935. The effect of temperature on the development of the eggs and larvae of the cutthroat trout (*Salmo clarkii clarkii* Richardson). *J. Exp. Biol.* 12:297-305.

CUTTHROAT TROUT, FISH, GROWTH, STREAMS, TEMPERATURE, THORNTON CREEK

This article describes a laboratory experiment of the effect of temperature (6.35, 8.25, and 11.3 degrees C) on the growth of cutthroat trout embryos and larvae. The trout were collected in Thornton Creek (Wydoski, 1972).

387. Mesner, N., and J. Davis. 1985. Annual report to the Water Quality Monitoring Review Board, lakes program. Metro. Seattle.

CHEM. LIMNOLOGY, L. SAMMAMISH, L. UNION, L. WASHINGTON, MILFOIL, PHYTOPLANKTON

This reports details results from the monitoring program of Lakes Washington, Sammamish, and Union. Chemical and physical parameters were measured as well as surveys of phytoplankton and aquatic macrophytes.

388. Mesner, N. O. 1984. The feeding ecology of *Epischura nevadensis* in Lake Washington. M.S. Thesis. University of Washington. 80 pp. Location: Suzzallo Thesis Stacks

L. WASHINGTON, ZOOPLANKTON

Epischura nevadensis is one of three predatory copepods found in Lake Washington. This study used laboratory feeding trials to determine functional responses of *E. nevadensis* predation on several common zooplankton and algal prey found in the lake. Additionally animals were collected from the lake and fecal pellets produced were examined microscopically for prey types.

389. Miller, D. W., J. J. Geraghty, and R. S. Collins. 1962. Water atlas of the United States. Water Information Center, Inc. Port Washington, Long Island (NY). Location: Fisheries Library

ATLAS, CLIMATE, TEMPERATURE

The atlas portrays by maps many aspects of water resources, including areas of water surplus and deficiency, rivers and principal drainage basins, mean annual lake evaporation, average temperature of groundwater, groundwater use, total withdrawal of water by state, population distribution, per capita water use, and per capita water consumption (Wydoski, 1972).

390. Miller, J. F. 1909. The City of Seattle. *Coast* 18:129-334.

LAND USE, REVIEW

This is an entire magazine containing articles about the city of Seattle - history, buildings, parks, land, transportation, shipping, public utilities, public schools, etc (Wydoski, 1972).

391. Miller, J. W. 1976. The effects of minimum and peak Cedar River streamflows on fish production and water supply. M.S. Thesis. University of Washington. 85 pp. Location: Engineering Library

CEDAR RIVER, FISH, FLOW, SOCKEYE SALMON

In order to assess the relationship between the Cedar River discharge and sockeye salmon production in the Cedar River, a spawner-recruit relationship was formulated which included a factor for instantaneous flood peaks and spawning discharge levels. Results indicated that spawning flows have a relatively small effect on fish production unless they are reduced to very low levels, but that flood flows have a very significant effect on fish production.

392. Miller, S. 1970. Small mammal populations in a Douglass-fir forest: Cedar River, Washington. M.S. Thesis. University of Washington. 102 pp.

CEDAR RIVER, MAMMALS

Summary of population and biomass estimates of small mammals on the Thompson Research Center on the lower Cedar River watershed. Also provides appendices with a species list of mammals for the Cedar River watershed, vegetation analysis of the study areas, biology of selected species, and assumptions used in calculating energy flows (Wydoski, 1972).

393. Miller, S., C. W. Erickson, R. D. Taber, and C. H. Nellis. 1972. Small mammal and bird populations on Thompson site, Cedar River: Parameters for modeling. In: Proceedings - Research on coniferous forest ecosystems - A symposium, (Eds.) J. F. Franklin, L. J. Dempster, and R. H. Waring. USDA For. Serv. Portland (OR). pp. 199-207

BIRD, CEDAR RIVER, MAMMALS

Summary of preliminary estimates of small-mammal and bird populations that were made on the Cedar River watershed. Also provides an estimate of biomass for the most abundant birds and mammals. A list of the birds and mammals on the Thompson site is presented with a summary of the foraging strata and consumer role by species (Wydoski, 1972).

394. Minden, R. V., and F. C. Ugolini. 1974. Findley Lake lysimeter leachate, precipitation inflow, outflow, and throughfall data, June 1973-January 1974: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 159. (unpublished) Location: UW SOF/THS

FINDLEY LAKE, WATER BUDGET

This report contains data on soil leachate at three sites and four depths, throughfall, precipitation, and lake inflow and outflow. Chemical analysis included nitrogen, iron, pH, conductivity and phosphorous.

395. Monahan, F. C. 1974. An *in situ* study of sediment nutrient release on Lake Sammamish. M.S. Thesis. University of Washington. 131 pp. Location: UW SOF/THS

L. SAMMAMISH, NUTRIENTS, SEDIMENTS

Sediment nutrient release at the sediment-water interface in enclosed *in situ* Lake Sammamish sediment-water columns appears to parallel the chemical element release measured in the lake hypolimnion during lake stratification and oxygen depletion. Comparison of *in situ* lake column studies to comparable laboratory experiments indicate that it will be possible to extrapolate laboratory data to lake systems.

396. Moon, C. E. 1973. The effect of waste water diversion on the nutrient budget of Lake Sammamish. M.S. Thesis. University of Washington. 104 pp. Location: UW SOF/THS

BIOASSAY, ISSAQUAH CREEK, L. SAMMAMISH, NUTRIENTS, SEWAGE, STREAMS, WATER BUDGET

The objective of this research was to develop a post-diversion nutrient budget, and to determine the effects of urbanization on that budget. In addition, a simple mathematical model is used to calculate a water budget to illustrate the relative importance of the input sources in the nutrient budget. The horizontal and vertical movement of Issaquah Creek waters within Lake Sammamish is also discussed.

397. Moulton, L. L. 1974. Abundance, growth, and spawning of the longfin smelt in Lake Washington. *Trans. Am. Fish. Soc.* 103:46-52. Location: UW SOF/THS

ABUNDANCE, CEDAR RIVER, FISH, GROWTH, L. WASHINGTON, SMELT, SPAWNING

Abundance and growth data indicated a 2-yr life cycle for longfin smelt with even-numbered year-classes being more abundant and showing a lower growth rate than the odd. The Cedar River was the major spawning area. The peak of the spawning run occurred during mid-March in 1970 and mid-February in 1971. The average size of spawning adults decreased as the spawning runs progressed. Males were consistently larger than females and dominated in numbers throughout the runs by a 3:2 ratio. The time of the spawning migration was related to body size; larger adults of the odd year-class spawn earlier in the year than the smaller adults of the even year-class.

398. Moulton, L. L. 1970. The longfin smelt spawning run in Lake Washington with notes on egg development and changes in the population since 1964. M.S. Thesis. University of Washington. 84 pp. Location: UW SOF/THS

ABUNDANCE, FISH, L. WASHINGTON, SMELT, SPAWNING

The primary objectives of this study were to describe (1) spawning areas and time of spawning for the longfin smelt in Lake Washington, (2) movements of the smelt during the spawning run, (3) development of the smelt eggs, and (4) changes in the population since Dryfoos' study.

399. Mulcahy, D., R. J. Pascho, and C. K. Jenes. 1983. Titre distribution patterns of infectious haematopoietic necrosis virus in ovarian fluids of hatchery and feral salmon populations. *J. Fish Dis.* 6:183-188.

CHINOOK SALMON, DISEASE, FISH, HATCHERIES, L. WASHINGTON, SOCKEYE SALMON

The success of natural populations of salmon in which infectious haematopoietic necrosis virus (IHNV) is enzootic, and the recurrent outbreaks of the disease in hatchery fish, led to a comparison of IHNV prevalence rates and mean titres in the two groups. Samples of overian fluid were taken from seven salmon populations over a period of 1-3 years. Three populations were of sockeye salmon, *Oncorhynchus nerka* (Walbaum), two of these feral Alaskan, one from a population introduced into Lake Washington. Four populations were hatchery-supported chinook salmon, *O. tshawytscha* (Walbaum). The feral population had an average of 25% of titres exceeding 10^5 p.f.u./ml.; the introduced population 43%, and the hatchery-supported populations 32%. The success of the feral populations may be due to the occurrence of levels of viral titer sufficient to maintain the virus in the host population but not sufficiently high for the transmission of lethal doses through eggs. Outbreaks of acute disease in hatcheries may be due to the mixing of eggs from many females. Lack of genetic selection for resistance may also account for IHNV associated mortality.

400. Municipality of Metropolitan Seattle. 1975-1981. Water quality monitoring review board biannual reports. Metro. Seattle.

REVIEW

These biannual reports contain the review of the water quality monitoring data and updates of the status of the water quality monitoring projects carried out by the Water Quality Division of Metro.

401. Municipality of Metropolitan Seattle. 1976. Aquatic plant control in Lake Washington's Union Bay. Municipality of Metropolitan Seattle. Seattle. Location: Fisheries Library

L. UNION, MILFOIL, PLANTS

This report details alternatives for aquatic vegetation removal throughout Union Bay and the existing legal and management structure involved.

402. Municipality of Metropolitan Seattle. 1977-1980. Progress report for the areawide water quality plan. Metro. Seattle. Location: METRO Library

REVIEW

These documents identify problems in water quality and potential solutions for Lake Washington drainage and the nearshore areas of Puget sound.

403. Municipality of Metropolitan Seattle. 1977. A small streams guide for western King County. Metro. Seattle.

MANAGEMENT, STREAMS

This tabloid discusses issues relevant to stream management and briefly describes some of the local streams

404. Municipality of Metropolitan Seattle. 1980. Union Bay demonstration project: Metro staff analysis. Municipality of Metropolitan Seattle. Seattle. Location: METRO Library

MILFOIL, UNION BAY

This report includes a description of the macrophytes in Union Bay and control programs implemented by the Corps of Engineers and Metro.

405. Municipality of Metropolitan Seattle. 1981-1991. Annual milfoil harvesting report. Municipality of Metropolitan Seattle. Seattle. Location: UW SOF/THS

L. SAMMAMISH, L. WASHINGTON, MANAGEMENT, MILFOIL

The Municipality of Metropolitan Seattle has conducted an aquatic plant harvesting program for twelve years to control the growth of Eurasion water milfoil in public use areas. This report details activities in 1991 as well as costs of the previous years' programs (1980-1990)

406. Municipality of Metropolitan Seattle. 1982. Issaquah Creek stream resource inventory technical report. Municipality of Metropolitan Seattle. Seattle. (Tech. Report WR-82-3) Location: UW SOF/THS

ISSAQUAH CREEK, MANAGEMENT, REVIEW, STREAMS

This report provides a synthesis of the available information on the present condition of the Issaquah Creek's physical, biological and chemical features. Specifically, this document is intended to serve as a technical resource document for developing basin specific water quality management plans.

407. Municipality of Metropolitan Seattle. 1982. Bear-Evans Creek stream resource inventory. Municipality of Metropolitan Seattle. Seattle. (Tech. Report WR-82-2) Location: UW SOF/THS

BEAR CREEK, EVANS CREEK, MANAGEMENT, REVIEW, STREAMS

This report provides a synthesis of the available information on the present condition of the Bear-Evans Creek's physical, biological, and chemical features. This document is intended to serve as a technical resource document for developing basin specific water quality management plans.

408. Municipality of Metropolitan Seattle. 1982. Sammamish River resource inventory. Municipality of Metropolitan Seattle. Seattle. (Tech. Report WR-82-6) Location: UW SOF/THS

MANAGEMENT, REVIEW, SAMMAMISH R.

The purpose of this report is to synthesize the available information on the present condition and use of Sammamish River and to evaluate the suitability of the river to support various uses. This report is intended to serve as a technical resource for the development of water quality management plans.

409. Municipality of Metropolitan Seattle. 1982. North Creek stream resource inventory. Municipality of Metropolitan Seattle. Seattle. (Tech. Report WR-82-1) Location: UW SOF/THS

MANAGEMENT, NORTH CREEK, REVIEW, STREAMS

The purpose of this report is to provide a synthesis of the available information on the present condition of North Creek's physical, biological, and chemical features. This document is intended to serve as a technical resource document for developing basin specific water quality management plans.

410. Municipality of Metropolitan Seattle. 1982. Swamp Creek stream resource inventory. Municipality of Metropolitan Seattle. Seattle. (Tech. Report WR-82-5) Location: UW SOF/THS

MANAGEMENT, REVIEW, STREAMS, SWAMP CREEK

This report provides a synthesis of the available information on the present condition and use of Swamp Creek and evaluates the suitability of the creek to support various uses. This report is intended to serve as a technical resource for the development of water quality management plans.

411. Municipality of Metropolitan Seattle. 1982. Little Bear Creek stream resource inventory. Municipality of Metropolitan Seattle. Seattle. (Tech. Report WR-82-4) Location: UW SOF/THS

LITTLE BEAR CREEK, MANAGEMENT, REVIEW, STREAMS

This report provides a synthesis of the available information on the present condition and use of Little Bear Creek and evaluates the suitability of the creek to support various uses. This report is intended to serve as a technical resource aid for management plans.

412. Municipality of Metropolitan Seattle. 1987. Status of the waters 1987: A report on the water quality in the Seattle/King County region. Municipality of Metropolitan Seattle. Seattle. Location: UW SOF/THS

L. SAMMAMISH, L. UNION, L. WASHINGTON, LAND USE, MILFOIL, URBANIZATION

This brief report summarizes Metro's work to improve and protect the regional waters. Included is a summary of local water conditions and a summary of local water quality programs.

413. Municipality of Metropolitan Seattle. 1987. Union Bay milfoil fragment cleanup: pilot project. Municipality of Metropolitan Seattle. Seattle. Location: METRO Library

MANAGEMENT, MILFOIL, STREAMS, UNION BAY

A pilot project to assess the feasibility of mechanically cleaning up accumulation of milfoil fragments in the nearshore areas of the north and east shores of Union Bay was conducted during the summer of 1987.

414. Municipality of Metropolitan Seattle. 1987. Priorities for water quality: update of the areawide water quality plan for the Cedar-Green River basins. Metro. Seattle. Location: METRO Library

CEDAR RIVER, MANAGEMENT, STREAMS

This document is an update of the original areawide plan prepared in 1978. The plan's purpose is to assess in a comprehensive manner the priority water quality problems within the region, develop possible solutions to these problems and identify ways to implement the recommended solutions.

415. Municipality of Metropolitan Seattle. 1988. Guide to water quality data and technical information, 10th Edition. Municipality of Metropolitan Seattle. Seattle. (Section 6 (biblio) in UW SOF/THS) Location: METRO Library

BIBLIOGRAPHY, REVIEW

This 10th Edition represents projects, programs, and reports generated over the last 25 years.

416. Municipality of Metropolitan Seattle. 1988. Quality of local lakes and streams. Municipality of Metropolitan Seattle. Seattle. (Pub. 167) Location: UW SOF/THS

BEAR CREEK, CEDAR RIVER, COAL CREEK, EVANS CREEK, ISSAQUAH CREEK, JUANITA CREEK, KELSEY CREEK, L. SAMMAMISH, L. UNION, L. WASHINGTON, LITTLE BEAR CREEK, LYON CREEK, MANAGEMENT, MAY CREEK, MCALEER CREEK, NORTH CREEK, REVIEW, SAMMAMISH R., STREAMS, SWAMP CREEK, THORNTON CREEK, YARROW BAY

The goals of Metro's freshwater assessment program are to provide information about local surface waters in the Seattle Metropolitan area in support of programs that protect water quality and abate nonpoint pollution. This report determines the present quality and identifies short- and long-term trends existing or potential problems, and suggests corrective measures.

417. Municipality of Metropolitan Seattle. 1990. Lake Sammamish water quality management project: Final environmntal impact statement. Metro. Seattle. Location: METRO Library

BEAR CREEK, L. SAMMAMISH, NUTRIENTS, STORMWATER, STREAMS

This project addresses stormwater runoff quality management controls to protect the water quality of Lake Sammamish.

418. Municipality of Metropolitan Seattle. 1991. Stormwater quality management bibliography: Pacific Northwest edition. Municipality of Metropolitan Seattle. Seattle. Location: UW SOF/THS

BACTERIA, BIBLIOGRAPHY, FLOW, LAND USE, NUTRIENTS, POLLUTION, SEDIMENTS, STORMWATER, URBANIZATION

This bibiliography focuses in key data sources and studies of stormwater quality, state-of-the-art approaches to stormwater quality control, and methods to prevent and resolve the water quality problems generated by the discharge of stormwater to surface and groundwater of the state.

419. Municipality of Metropolitan Seattle. 1991. Quality of local lakes and streams: 1989-1990 update. Municipality of Metropolitan Seattle. Seattle. Location: UW SOF/THS

BEAR CREEK, CEDAR RIVER, COAL CREEK, EVANS CREEK, ISSAQUAH CREEK, JUANITA CREEK, KELSEY CREEK, L. SAMMAMISH, L. UNION, L. WASHINGTON, LITTLE BEAR CREEK, LYON CREEK, MANAGEMENT, MAY CREEK, MCALEER CREEK, MERCER SLOUGH, NORTH CREEK, REVIEW, SAMMAMISH R., SHIP CANAL, STREAMS, SWAMP CREEK, THORNTON CREEK, YARROW BAY

This report is an update of water quality in the region for the 1989-1990 water year. Detailed descriptions of all of the watersheds sampled by Metro are available in *Quality of Local Lakes and Streams 1988-1989 Status Report*.

420. Munn, J. H. 1965. Chinook salmon returns to the University of Washington during the year 1953 through 1961. M.S. Thesis. University of Washington. 156 pp. Location: Fisheries Library

CHINOOK SALMON, ESCAPEMENT, FECUNDITY, FISH

A study of chinook salmon returns at the University of Washington from 1953 to 1961. Sex, mark, fork length, and date of arrival are recorded for each fish. In addition, after 1959, records of body weight, fecundity, and average egg size were kept. (Wydoski, 1972)

421. Murray, J. W. 1987. Mechanisms controlling the distribution of trace elements in oceans and lakes. In: Sources and Fates of Aquatic Pollutants. American Chemical Society. Washington DC. pp. 153-184

L. WASHINGTON, NUTRIENTS, SEDIMENTS, STOCKING

Many of the same mechanisms that control the distribution of trace elements in the ocean are also important in lakes. Specifically, these include nutrient-like biological recycling, sediment fluxes, oxidation-reduction cycling, and scavenging by particles. The influence of each of these mechanisms can be seen in the trace element profiles of lakes despite the fact that lakes are intrinsically much more difficult to study than oceans. This difficulty arises because: (1) lakes are not at steady state, and the magnitude of the controlling mechanisms varies with time; and (2) the large sediment-to-water-volume (sediment-volume) ratios, together with rapid horizontal mixing, result in sediment fluxes that tend to mask the other processes. Nevertheless, lakes are more accessible and in most cases easier to sample than the ocean. Because of the wide variety in types of lakes, isolating variables is possible by choosing the lake with the right properties. Examples of different processes are illustrated by using new trace element data from Lake Zurich and Lake Washington.

422. Murtaugh, P. A. 1981. Inferring properties of mysid predation from injuries to *Daphnia*. *Limnol. Oceanogr.* 26:811-821.

L. WASHINGTON, ZOOPLANKTON

Daphnia from Lake Washington occasionally have injured tail spines; laboratory observations suggest that such injuries are caused by handling by the crustacean predator *Neomysis mercedis*. A short-lived, brown “scar” that forms shortly after the tail spine is amputated provides the basis for a simple model for interpreting injury data. When combined with laboratory estimates of the duration of tail spine “scars,” the model is used to infer some properties of mysid predation: the dependence of ingestion efficiency on prey size, vertical variation in predation intensity, and the absolute *in situ* feeding rate of *Neomysis* are estimated from injury frequencies in the plankton.

423. Murtaugh, P. A. 1981. Selective predation by *Neomysis mercedis* in Lake Washington. *Limnol. Oceanogr.* 26:445-453.

L. WASHINGTON, ZOOPLANKTON

Feeding experiments and examination of gut contents show that *N. mercedis* is an effective predator on zooplankton in Lake Washington. *Daphnia* is consistently preferred to other prey; *Diaptomus* and *Cyclops copepodids* and nauplii are always underrepresented in mysid diets. This pattern of selectivity is consistent with the hypothesis that a large population of *Neomysis* formerly excluded *Daphnia* from the lake.

424. Murtaugh, P. A. 1981. Size-selective predation on *Daphnia* by *Neomysis mercedis*. *Ecology* 62:894-900.

L. WASHINGTON, ZOOPLANKTON

Predation on different sized *Daphnia* by the crustacean *Neomysis mercedis* was examined in the laboratory and in Lake Washington.

425. Murtaugh, P. A. 1981. The feeding ecology of *Neomysis mercedis* in Lake Washington. Ph.D. Dissertation. University of Washington. 98 pp. Location: Suzzallo Thesis Stacks

L. WASHINGTON, ZOOPLANKTON

This study was designed to assess the potential impact of mysid predation on populations of zooplankton. The abundance and distribution of *Neomysis mercedis* in Lake Washington is described as well as the selection of zooplankton prey by the mysid both among and within prey species. A discussion is provided on the way that the life history of *Neomysis* influences both the quantity and character of the predation pressure exerted on populations of herbivorous zooplankton.

426. Murtaugh, P. A. 1983. Mysid life history and seasonal variation in predation pressure on zooplankton. *Can. J. Fish. Aquat. Sci.* 40:1968-1974.

L. WASHINGTON, ZOOPLANKTON

The bivoltine life history of *Neomysis mercedis* in Lake Washington, Seattle, results in seasonal variation in populations size structure that influences the amount and quality of predation suffered by its zooplankton prey. Population densities and size-frequency data for *Neomysis* are combined with information on the influence of body size on feeding rate and composition of the diet to predict relative predation intensity on five classes of *Daphnia* over a 27-month period. An imperfect relationship between mysid numbers and expected predation intensity and seasonal fluctuations in the relative vulnerability of different-sized prey are two consequences of the mysid's pattern of life history.

427. Murtaugh, P. A. 1984. Variable gut residence time: problems in inferring feeding rate from stomach fullness of a mysid crustacean. *Can. J. Fish. Aquat. Sci.* 41:1287-1293. Location: UW SOF/THS

L. WASHINGTON, ZOOPLANKTON

The gut residence time of the mysid crustacean, *Neomysis mercedis* is extremely variable and is negatively correlated with ingestion rate. In two experiments in which mysids were fed copepod meals followed by continous exposure to *Daphnia*, passage times varied from less than 1 to more than 13 hours, and there were significant negative correlations of both copepod and daphinid passage times with the average feeding rate on *Daphnia*. In a third experiment starved mysids retained significant amounts of meterial in the stomach for more than 13 days. This dependence of evacuation rate on feeding activity may invalidate attempts to infer absolute or relative ingestion rate from the stomach fullness of field-caught animals.

428. Murtaugh, P. A. 1989. Fecundity of *Neomysis mercedis* Holmes in Lake Washington (Mysidacea). *Crustaceana.* 57:194-200.

L. WASHINGTON, ZOOPLANKTON

The mysid crustacean *Neomysis mercedis*, is an important predator on zooplankton in Lake Washington, Seattle and a resident of other lakes and estuaries on the west coast of North America. The author describes the effects of female body size, season, and year on the fecundity of *N. mercedis* in Lake Washington and considers the possibility that embryo numbers are related to standing stocks of zooplankton in the lake.

429. Muto, M., and J. Shefler. 1983. Game fish distribution in selected streams within the Lake Washington drainage basin. Wash. Dept. Game, Fish Management Division. Olympia. Location: METRO Library

ABUNDANCE, DISTRIBUTION, FISH, MANAGEMENT, STREAMS

Upstream limits of game fish distribution were determined for selected tributaries of the Lake Washington drainage basin. The streams were chosen on the basis of their importance to resource management agencies and overall community use. Biological data obtained included species composition of the populations sampled, and age and growth characteristics of selected subsamples. Information was gathered on selected physical parameters at each survey site to characterize stream condition, and subjective evaluations were made of habitat quality and abundance.

430. Narita, R. E. 1978. Effects of discharge on sockeye salmon egg and alevin survival in the Cedar River, Washington. M.S. Thesis. University of Washington. 95 pp. Location: Fisheries Library

CEDAR RIVER, FISH, FLOW, SOCKEYE SALMON

In 1975 and 1975 the effect of a minimum streamflow regime on density-dependent egg and alevin mortality due to redd superimposition was investigated on selected sockeye salmon spawning reaches of differing hydraulic characteristics.

431. Nece, R. E., and R. P. Vilker. 1980. Field tests to verify equations for predicting lateral velocity distributions in rivers. National Technical Information Service. Springfield (VA). (NTIS PB81-103038)

CEDAR RIVER, FLOW, MODELLING

Three models proposed by Milhous for predicting the lateral distribution of depth-averaged velocities in rivers were tested. Each model requires a different level of input data; all, however, assume that the stage-discharge relationship is known at that river station where the velocities are to be predicted. Two of the models incorporate Manning's equation for uniform flow as applied to sub-elements of the stream cross-section, and the third applies the 'hydraulic geometry' concept to the sub-elements. Field studies were carried out in the Cedar River and the Deschutes River, in Western Washington. The experimental results apply to gravel bed rivers. Some modification in calculation procedure were suggested. The principal application of the models is in the quantitative evaluation of reaches of rivers as fish habitats.

432. Nelson, R. E., Jr. 1977. Life history of the yellow perch *Perca flavescens* (Mitchill). M.S. Thesis. University of Washington. 83 pp. Location: Fisheries Library

ABUNDANCE, DIET, DISTRIBUTION, FECUNDITY, FISH, GROWTH, L. WASHINGTON, YELLOW PERCH

This study provided a detailed description of the life history of the yellow perch, *Perca flavescens*, in western Washington. Results are presented on abundance, distribution, growth rates for both male and female yellow perch, fecundity, and diet.

433. Nishimoto, M. L. 1973. Life history of the peamouth (*Mylocheilus caurinus*) in Lake Washington. M.S. Thesis. University of Washington. 73 pp. Location: UW SOF/THS

ABUNDANCE, DIET, DISTRIBUTION, FECUNDITY, FISH, GROWTH, L. WASHINGTON, PEAMOUTH

The life history of the peamouth (*Mylocheilus caurinus*) in Lake Washington was studied from fish collected between January 1970 and December 1972. Experimental gill nets with nine mesh sizes ranging from 1 to 5-inch (stretched) by 1/2-inch increments were generally used. Samples of small fish were also taken by electrofishing along the shoreline. Peamouth were found in deep water during the fall-winter period (October-mid-March), but mature fish began to migrate inshore be spring (late March-June) and were later followed by immature fish in the summer (July-September). Age determination was made by the scale method. Peamouth from Lake Washington, a mesotrophic lake with a long growing season, exhibited the fastest growth rate recorded for this species. Females lived longer (to age 8) than males (to age 6) and also grew at a faster rate after the third year of life. Peamouth growth was best when Lake Washington was eutrophic but declined with lower primary productivity after sewage was diverted from the lake. Most males first matured at age 3, while females first matured at age 4. Peamouth spawned from May to June, usually along the shoreline. Peamouth fecundity was related to fish length and ranged from 5,657 for a 215 mm (total length) female to 34,841 for a 330 mm female.

434. Noah, C. M. 1976. A multiparametric model of the nitrogen system in Lake Sammamish. M.S. Thesis. University of Washington. 248 pp. Location: UW SOF/THS

L. SAMMAMISH, MODELLING, NUTRIENTS, PHYTOPLANKTON, ZOOPLANKTON

A mathematical model of Lake Sammamish was developed by Tang (1974) at the University of Washington which described the mixing and stratification processes through the use of the density profile and the wind sheer. This was then linked to an ecosystem model which determined the concentrations and interactions of four state variables: phytoplankton biomass, orthophosphate concentration, zooplankton biomass, and detritus. The assumption was that phosphorus was the nutrient most likely to limit the growth of the phytoplankton. This work is concerned with the effects of nitrogen on this system and a model has been developed which attaches to the Tang ecosytem and mixing models.

435. Oblas, V. C. 1973. Pollution potential of storm runoff from a drainage basin on Mercer Island, Washington. M.S. Thesis. University of Washington. 114 pp. Location: Engineering Library

BACTERIA, L. WASHINGTON, NUTRIENTS, STORMWATER

The water quality of runoff from a drainage basin on Mercer Island was found to be comparable to water quality of runoff reported in the literature for other communities.

436. Oglesby, R. T., and W. T. Edmondson. 1966. Control of eutrophication. *J. Wat. Pol. Con. Fed.* 28:1452-1460.

L. WASHINGTON, NUTRIENTS, SEWAGE

Dilution and diversion of nutrients show success toward decreasing eutrophication. Lake Washington was used as an example of nutrient diversion for control of eutrophication (Wydoski, 1972).

437. Olander, D. 1973. Sportfishing in Lake Washington, Seattle. WA Cooperative Fishery Unit, University of Washington. Seattle. (unpublished, class report) Location: UW SOF/THS

FISH, L. WASHINGTON, RECREATION

This report uses thesis-level research work, personal communications, and undergraduate research projects on fish species in Lake Washington.

438. Oldfield, F., C. Barnosky, E. B. Leopold, and J. P. Smith. 1983. Mineral magnetic studies of lake sediments. *Hydrobiol.* 103:33-44.

L. WASHINGTON, METALS, SEDIMENTS

This review outlines the origin and environmental significance of magnetic minerals in lake sediments. Attention is drawn to situations where the patterns of mineral magnetic variation is a reflection of processes other than changing erosion rates and fire incidence. In many cases simple variations in the concentration of primary magnetic minerals in allocthonous catchment-derived materials do not provide an adequate model of mineral magnetic variations in lake sediments. Depending on the environmental context, mineral magnetic variations can be used to aid the elucidation of a diversity of problems. The use of mineral magnetic techniques in sediment source tracing, paleoclimatic studies and the reconstruction of particulate pollution history is illustrated by means of case studies from Britain and North America. The value of magnetic susceptibility as an on-site core logging technique is shown by reference to data from Lake Washington.

439. Olney, F. E. 1975. Life history and ecology of the northern squawfish *Ptychocheilus oregonensis* (Richardson) in Lake Washington. M.S. Thesis. University of Washington. 73 pp. Location: UW SOF/THS

DIET, DISTRIBUTION, FECUNDITY, FISH, GROWTH, L. WASHINGTON, SQUAWFISH

A study of the life history and ecology of the northern squawfish was conducted in Lake Washington from September, 1971 to June 1973. Parameters investigated included distribution, age and growth, diet, and reproductive biology.

440. Olson, P. R., D. W. Cole, and R. R. Whitney. 1972. Findley Lake - the study of a terrestrial-aquatic interface. In: Research on Coniferous Forest Ecosystems: First Year Progress in the Coniferous Forest Biome, US/IBP, (Eds.) J. F. Franklin, L. J. Dempster, and R. H. Waring. Pacific Northwest Forest and Range Experiment Station, U.S. Department of Agriculture. Portland. pp. 15-20

FINDLEY LAKE

The linkage of the aquatic properties of a small lake to the terrestrial landscape was examined in the Findley Lake Basin of the Cedar River watershed. This pristine, 10 ha, oligotrophic lake is situated at 1,128 m elevation in a 162 ha watershed. For the initial year of investigation, this research program and the long-term objectives are discussed.

441. Olson, P. R. 1983. Contribution of the Cedar River. In: Lake Washington Symposium, (Ed.) A. Adams. Trout Unlimited. Mercer Island (WA). Location: UW SOF/THS

CEDAR RIVER, FLOW, LAND USE, MANAGEMENT, REVIEW

This paper discusses the Cedar River and the Cedar River watershed and the Seattle Water Department's management role.

442. O'Neill, K. 1991. Ravenna Creek: past, present, and ? future?: report to the working group on the daylighting of Ravenna Creek. K. O'Neill. Seattle (WA). Location: UW SOF/THS

GREEN LAKE, RAVENNA CREEK, STREAMS, UNION BAY

Ravenna Creek once flowed between Green Lake and Union Bay. It is now cut off from it's orignal source at Green Lake and from its original outlet at Union Bay. This report is a proposal to reconnect the stream with Union Bay, resurrecting the creek so that it flows on the surface. The potential values of the restored creek are described as aesthetic, economical, and environmental.

443. Orlob, G. T. 1977. Mathematical modeling of surface water impoundments, Volume: I, and II. National Technical Information Service. Springfield (VA). (NTIS PB-293 204)

L. WASHINGTON, MODELLING, REVIEW

A review of the state-of-the-art of mathematical modelling of surface water impoundments was conducted. Models reviewed included one-dimensional models for simulation of temperature and water quality in stratified reservoirs, two-dimensional circulation and water quality in shallow lakes, two-dimensional stratified flow, circulation in multi-layer large lakes, and eutrophication and ecological responses in lake systems. Model for simulation/optimization of single reservoir and multiple reservoir systems were also reviewed, including LP, DP, explicit and implicit stochastic methods, and simulation techniques. Recommendations are made for the formation of a 'national register' of software for water resource planning and management, with functions of facilitating technology transfer, standardizing documentation procedures, and disseminating information on mathematical models to potential users.

444. Pacific Northwest River Basins Commission. 1970-1971. Comprehensive study of water and related land resources: Puget Sound and adjacent waters. Puget Sound Task Force, Pac. Northwest River Basins Comm. Vancouver (WA). Location: Fisheries Library

FISH, FLOW, MAMMALS, MANAGEMENT, RECREATION

The contents were published as separate appendixes: 1) Digest of public hearings; 2) Political and legislative environment; 3) Hydrology and natural environment; 4) Economic environment; 5) Water related land resources; 6) Municipal and industrial water supply; 7) Irrigation; 8) Navigation; 9) Power; 10) Recreation; 11) Fish and wildlife; 12) Flood control; 13) Water quality control; 14) Watershed management; 15) Plan formulation. Each appendix is a detailed report on one of the various components of water and land resources of Puget Sound. These reports were prepared by the task force, established in 1969, consisting of ten members representing major state and federal agencies. Information pertinent to the Lake Washington drainage is included under the section of the appendixes entitled "Cedar-Green River Basins" (Wydoski, 1972).

445. Pamatmat, M. M., and A. M. Bhagwat. 1972. Anaerobic metabolism in Lake Washington sediments: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 89. (unpublished) Location: UW SOF/THS

L. WASHINGTON, SEDIMENTS

A method of measuring the dehydrogenase activity of sediments at 10°C was calibrated by direct microcalorimetry at the same temperature. Field measurements of dehydrogenase activity of sediments in Lake Washington were converted to rates if metabolic heat release by means of the significant regression of dehydrogenase activity on metabolic heat release. Simultaneous field measurements at 10°C of oxygen uptake by undisturbed sediment cores were converted to rates of metabolic heat release by the factor 4.8 cal liberated per ml of oxygen consumed.

446. Parametrix Inc. 1988. Cedar River watershed : Secondary use analysis. Draft environmental impact statement. Seattle Water Deptartment. Seattle. Location: METRO Library

CEDAR RIVER, LAND USE, MANAGEMENT, RECREATION

The purpose of the proposed project was to implement management guidelines on the use of the Cedar River Watershed for purposes other than the supply of high-quality municipal water. Secondary uses considered by this document include timber resources, wildlife and botanical resources, fisheries resources, education, recreation, and cultural resources.

447. Parametrix Inc. 1992. Lake Union capping feasibility study. City of Seattle. Seattle. Location: GOVERNMENT LIBRARY

HYDROCARBONS, L. UNION, POLLUTION, SEDIMENTS

This report concluded that a pilot capping project in Lake Union is most suitable at the Gas Works Park location.

448. Parker, M. 1977. Vitamin B_{12} in Lake Washington, USA: concentration and rate of uptake. *Limnol. Oceanogr.* 22:527-538.

BACTERIA, BIOASSAY, L. WASHINGTON, NUTRIENTS, PHYTOPLANKTON

The concentration of vitamin B_{12} in the surface water of Lake Washington was measured by bioassays and the rate of vitamin uptake by adding ^{57}Co-labeled B_{12} to samples of surface waters. The concentration of vitamin B_{12} in the lake water decreased by 60% from late winter to summer, while the rate of uptake increased 16-fold and turnover time decreased from 50 days to 1 day. The uptake process could be described by the Michaelis-Menten equation. Regression analyses suggested that the standing crops of blue-green algae and detritus were most important in affecting the concentration of vitamin B_{12}, but that the standing crops of diatoms and 'other' algae affected the rate of uptake most. A hypothesis formulated to explain the necessary coincident variation in rates of vitamin B_{12} input and output assumes indirect coupling, via detritus, between algal utilization and bacterial production of vitamin B_{12}; it was tested against data from this and other studies.

449. Patten, B. G. 1971. Spawning and fecundity of seven species of Northwest American *Cottus*. *Am. Midl. Nat.* 85:493-506.

FECUNDITY, FISH, SCULPIN, SPAWNING, STREAMS, SWAMP CREEK

This report documents the spawning and fecundity of sculpins in Washington State. Records the occurrence and reproduction of *Cottus confusus* from Swamp Creek, a tributary to the Sammamish River (Wydoski, 1972).

450. Pautzke, C. F. 1938. Studies on the effects of coal washings on steelhead and cutthroat trout. *Trans. Am. Fish. Soc.* 67:232-233.

CEDAR RIVER, CUTTHROAT TROUT, FISH, LAND USE, POLLUTION, STEELHEAD

Describes a single field experiment to determine the effects of coal washings on steelhead trout. Experiment was done in the Cedar River because of the debris from coal mining that was going into the river (Wydoski, 1972).

451. Pedersen, E. R. 1981. The use of benthic invertebrate data for evaluating impacts of urban stormwater runoff. M.S. Thesis. University of Washington. 106 pp. Location: Engineering Library

BEAR CREEK, BENTHIC, INVERTEBRATES, KELSEY CREEK, STORMWATER, STREAMS, URBANIZATION

The benthic macroinvertebrate community of Kelsey Creek was compared to rural Bear Creek in order to evaluate the influence of urban stormwater runoff. Study sites were selected to obtain between station comparisons and upstream, downstream comparisons within each stream. Sampling sites of the hyporheal and streambed surface invertebrate communities were located in comparable riffle areas for all stations. Sampling was performed from April 1979 to March, 1980.

452. Pederson, G. L. 1974. Plankton secondary production and biomass; seasonality and relation to trophic state in three lakes. Ph.D. Thesis. University of Washington. 106 pp. Location: UW SOF/THS

CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, NUTRIENTS, ZOOPLANKTON

The population cycles, abundance, biomass and production of the most important species of zooplankton were followed during 1972 and 1973 for three lakes of varying trophic status in the Lake Washington watershed. Trophic states of lakes Findley and Chester Morse were considered to be oligotrophic; while most characteristics indicated Lake Sammamish to be mesotrophic.

453. Pelletier, G., J. I. Davis, A. Johnson, and W. Prodan. 1983. Trends in Lake Sammamish water quality 1964-1982. Municipality of Metropolitan Seattle. Seattle. Location: METRO Library

L. SAMMAMISH, NUTRIENTS

This is a report on the state of Lake Sammamish with concern to eutrophication. A summary is available as "Long term trends in Lake Sammamish, a summary," 1983

454. Pelletier, G. J. 1985. The phosphorus loading budget and sedimentation history for Pine Lake, Washington. M.S.E. Thesis. University of Washington. 114 pp. Location: Engineering Library

LAND USE, NUTRIENTS, PINE LAKE, PLANTS, POLLUTION, SEDIMENTATION

The present P sedimentation rate in Pine Lake is approximately double the rate estimated for pre-development natural conditions. The geochronology of sedimentation indicates a rapid increase in sedimentation at the time when logging of the watershed occurred in the late 19th century. The sedimentation rate declined to approximately pre-logging levels then increased again during the mid-20th century to the present. Likewise, historical changes in phosporous loading have probably followed a similar chronology, since sedimentation represents a major loss of phosphorous.

455. Perkins, M. A., H. L. Boston, and E. F. Curren. 1980. The use of fiberglass screens for control of Eurasian watermilfoil. *J. Aquat. Plant Manage.* 18:13-19.

L. WASHINGTON, MILFOIL

Vinyl coated fiberglass mesh (64 apertures/cm^2) screening material was placed upon 216 m^2 test plots within an embayment of Lake Washington infested with Eurasian watermilfoil (*Myriophyllum spicatum*). The screens were immediately effective in providing a plant-free water column. Coverage for 1, 2 and 3 month periods resulted in substantial reductions in plant dry weight biomass relative to untreated control areas. Optimum coverage time was 2 months which resulted in a 75% reduction in biomass with only limited regrowth after panel removal. The screens appear to be well suited for the enhancement of localized areas suffering from nuisance growths of aquatic plants.

456. Perkins, M. A., and M. D. Sytsma. 1987. Harvesting and carbohydrate accumulation in Eurasian watermilfoil. *J. Aquat. Plant Manage.* 25:57-62.

L. WASHINGTON, MILFOIL

The effectiveness of a multiple cut harvesting program in controlling nuisance growth of Eurasian watermilfoil (*Myriophyllum spicatum* L.) in Lake Washington was evaluated. A single cut in July provided only a brief reduction in nuisance standing crop biomass. A two cut program provided an additional 36% reduction in standing crop and reduced the peak summer standing crop by half in the year of treatment. Harvesting did interrupt the accumulation of nonstructural carbohydrates in milfoil root tissues during the growing season but observed reduction were negated by overwinter accumulation.

457. Perkins, M. A. 1980. Evaluations of selected non-chemical alternatives for aquatic plant management. University of Washington. Seattle. (Prepared for Municipality of Metropolitan Seattle)

MANAGEMENT, MILFOIL, UNION BAY

This report evaluates the use of fiberglass screening and harvesting as methods of controlling milfoil in Union Bay.

458. Peterson, D. R. 1955. An investigation of pollutional effects in Lake Washington. Washington State Pollution Control Commission. Technical Bulletin 18.

L. WASHINGTON, NUTRIENTS, PHYTOPLANKTON, SEWAGE

This study of algal growths in Lake Washington from June 1952 to July 1953 showed the lake to be in early stages of eutrophication. During periods of precipitation 32 overflow structures discharged storm water and raw sewage into the lake. Treated and untreated sewage was also introduced into the lake by individual household disposal systems. Algae bloom was maximum in May with increased amounts of nitrates, phosphates, and light.

459. Peterson, D. R., K. R. Jones, and G. T. Orlob. 1952. An investigation of pollution in Lake Washington. Washington Pollution Control Commission. Technical Bulletin No. 14.

CEDAR RIVER, COAL CREEK, JUANITA CREEK, KENMORE CREEK, L. WASHINGTON, LYON CREEK, MAY CREEK, MCALEER CREEK, POLLUTION, SAMMAMISH R., SEWAGE, STREAMS, THORNTON CREEK

This is a summary of a pollution study of Lake Washington watershed from May 6 to August 26, 1952 by the Washington Pollution Control Commission (Wydoski, 1972).

460. Pfeifer, B. 1983. Game fish production in Lake Washington 1981 - 1983. In: Lake Washington Symposium, (Ed.) A. Adams. Trout Unlimited. Mercer Island (WA). Location: UW SOF/THS

BULLHEAD, CRAPPIE, CUTTHROAT TROUT, FISH, L. WASHINGTON, LARGEMOUTH BASS, RAINBOW TROUT, RECREATION, REVIEW, SMALLMOUTH BASS, YELLOW PERCH

Enhancement of rainbow has raised the species from an incidental catch to the major game fishery in the lake. Yellow perch provide the second most important fishery, potentially rivalling the rainbow. Brown bullheads provide an important fishery in the spring in selected areas of the lake. Bass are not numerically significant, and there is virtually no harvest of black crappie. Comparisons of yield for the various species are made with data from other large lakes in Washington.

461. Pflug, D. E., and G. B. Pauley. 1983. The movement and homing of smallmouth bass, *Micropterus dolomieui*, in Lake Sammamish, Washington. *Calif. Fish Game.* 69:207-216.

DISTRIBUTION, FISH, L. SAMMAMISH, SMALLMOUTH BASS

Smallmouth bass were tagged and released at new locations between 0.8 to 11.3 km away from the initial capture location on the lake. The recaptured bass showed a homing tendency with 41% returning to the site of capture, 38% were apparently on their way back to the point of capture, and only 21% showed a sedentary response by staying in the new release area. Smallmouth tagged and released at the site of capture showed a definite affinity for a home area, with 81% recaptured in the area of capture and release. Of the 19% that moved out of this area, 4.8 km was the farthest distance any fish moved. The home range tendency of smallmouth bass has potential management implications when considering expanding a smallmouth fishery within a large lake, when stocking a lake for the first time with smallmouth bass, or when evaluating bass tournament release procedures.

462. Pflug, D. E., and G. B. Pauley. 1984. Biology of smallmouth bass (*Micropterus dolomieui*) in Lake Sammamish, Washington. *Northwest Sci.* 58:118-130.

DIET, FISH, GROWTH, L. SAMMAMISH, SMALLMOUTH BASS

Smallmouth bass (*M. dolomieui*) grew very rapidly in Lake Sammamish, with mean averages of 10.1 cm (1-year), 18.5 cm (2-year), 26.0 cm (3-year), 31,4 cm (4-year), 35,7 cm (5-year), 38.3 cm (6-year) and 41.4 cm (7-year). Most of the fish were 2- and 3-year-old bass, representing 39 and 24 percent of the total population respectively. Incremental growth was greatest between the ages of 1 and 3 and progressively decreased between the ages of 4 and 7. While crayfish (*Pasifastacus leniusculus*) and sculpins (*Cottus* sp.) made up a major part of the diet in most months, migratory salmon (*Oncorhynchus* sp.) were the most important prey item in the month of May, at the peak of the salmonid outmigration. Evidence is presented to support the theory that smallmouth bass do not selectively feed on salmon but are random feeders, eating whatever prey item is available.

463. Pflug, D. E. 1981. Smallmouth bass (*Micropterus dolomieui*) of Lake Sammamish: A study of their age and growth, food and feeding habits, population size, movement and homing tendencies, and comparative interactions with largemouth bass. M.S. Thesis. Univerisity of Washington. 80 pp. Location: Fisheries Library

ABUNDANCE, DIET, DISTRIBUTION, FISH, GROWTH, L. SAMMAMISH, LARGEMOUTH BASS, SMALLMOUTH BASS

This study investigated the interspecies relationship between smallmouth and largemouth bass in Lake Sammamish. Additionally the life history of smallmouth bass was described.

464. Pitts, M. P. 1903. The legend of Lake Washington. *Overland Monthly* 41:339-345. Location: Suzzallo Library

L. WASHINGTON

This article is a narrative of a trip to Lake Washington and a legend of why the lake claims the bodies of its dead.

465. Pratt, D. 1968. Research and management: Puget Sound commercial salmon fisheries. *Wash. State Dep. Fish. Ann. Rep.* 78:9-11. Location: UW SOF/THS

CEDAR RIVER, ESCAPEMENT, FISH, L. WASHINGTON, SOCKEYE SALMON

The estimated total catch of 25,200 Lake Washington sockeye by all fisheries left an escapement of approximately 160,000 in the Cedar River and 3000 throughout the remainder of the system (Wydoski, 1972) (Note: Wydoski referenced this as authored by Jewell, E.D.).

466. Pratt, D. C., and E. D. Jewell. 1972. The 1971 Lake Washington sockeye tagging study: final report. WA Dept of Fisheries. Olympia. Location: Fisheries Library

FISH, L. WASHINGTON, MIGRATION, SOCKEYE SALMON

During June and July of 1971, 3,709 sockeye salmon were tagged in the area from Discovery Bay to Seattle, Washington. Tagging was carried out to gain additional information on the speed of migration, commercial harvest rates, migration routes, and the timing of various spawning segments of Lake Washington sockeye migrating through lower Puget Sound.

467. Preston Thorgrimson Ellis & Holman. 1980. Long term aquatic plant control in Union Bay: legal opinion on sponsoring agency. Preston Thorgrimson Ellis & Holman. Seattle. Location: METRO Library

MILFOIL, UNION BAY

This memorandum analyzes the legal authority of the City of Seattle and Metro to act as the sponsoring agency for a long-term aquatic plant control program for Union Bay and to enter into certain agreements which may be required for the funding and implementation of such a program.

468. Purvis, N. H. 1934. History of Lake Washington Canal, Washington. *Wash. Hist. Q.* 25:114-127. (25(3):210-213)

SHIP CANAL

A history of the ship canal covers the Seattle and Lake Washington region: the building, history, location controveresty, costs, hydrualics, features of the two locks and dam, saltwater intrusion, and the salt water basin (Wydoski, 1972).

469. Quay, P. D., S. R. Emerson, B. M. Quay, and A. H. Devol. 1986. Carbon cycle for Lake Washington - A stable isotope study. *Limnol. Oceanogr.* 31:596-611.

CARBON, L. WASHINGTON, SEDIMENTATION

The carbon cycle in Lake Washington for the year 1980 was studied using monthly measurements of dissolved inorganic carbon (DIC) and its ^{13}C:^{12}C isotopic composition. Between 24 June and 13 August, the calculated CO_2 gas invasion rate of 800000 moles C per day nearly equaled the river DIC inflow rate. The calculated epilimnetic net organic carbon production rate was 680000 moles C per day, about 20-30% of primary productivity estimated from ^{14}C-fixation experiments and electron transport system-derived respiration rates. Metalimnetic and hypolimnetic DIC increase rates and porewater DIC gradients in hypolimnetic sediments indicated that remineralization of particulate organic carbon (POC) previously deposited sediments is a major source of DIC in the lake during summer. Summertime CO_2 gas invasion balanced wintertime CO_2 gas evasion and DIC and POC outflow balanced DIC and POC inflow rates, implying no net carbon burial in the sediments during 1980. This contrasts with the measured long-term sedimentation-rate-derived carbon burial rate of 800000 mole C per day. Year-to-year variability in summer primary production rates largely determines net gains or losses of C via CO_2 gas exchange and sedimentation.

470. Rahman, A. H. M. M. 1964. A study of the movement of elements from tree crowns by natural litterfall, stemflow and leaf wash. M.F. Thesis. University of Washington. 118 pp. Location: Forestry Library

CEDAR RIVER, LAND USE, NUTRIENTS, PLANTS

Collections were made on a monthly basis from both red alder and Douglas-fir stands at the Cedar River and from plots under various species and treatments at Pack Forest. Stemflow, leaf wash, and the individual components of litterfall (leaves, twigs, branches, and flowers) were analysed for percentage of N, P, K, Ca, and Mg. Soils from the study plots were analysed for their chemical and physical properties (Wydoski, 1972).

471. Rattray, M., Jr., G. R. Seckel, and G. A. Barnes. 1954. Salt budget in the Lake Washington Ship Canal system. *J. Mar. Res.* 13:263-275.

CIRCULATION, FLOW, L. UNION, L. WASHINGTON, SHIP CANAL, WATER BUDGET

Saltwater enters and accumulates in the freshwater system of Lake Washington, Montlake Canal, Lake Union, Fremont Canal, and Salmon Bay during the summer when heavy lock operation and small runoff occurr. Lake Union is flushed corresponding to the rates of flow during periods of high runoff; Lake Washington is flushed only during the winter overturn. Stagnation may occur with increased chlorinity since the water may be so dense that overturn and flushing may not occur. Approximately 25% of the saltwater is flushed from Lake Washington annually (Wydoski, 1972).

472. Rau, G. 1978. Carbon-13 depletion in a subalpine lake: carbon flow implications. *Science (Wash.)*. 201:901-902.

CARBON, FINDLEY LAKE, NUTRIENTS

Plankton (>76 micron) taken from an undisturbed oligotrophic lake was found to have delta ^{13}C values (= $^{13}C/^{12}C$ relative to the Pee Dee belemnite standard) ranging from -44 to -47 per ml. This extraordinary ^{13}C depletion, together with characteristics of the inorganic carbon pool, indicates that lake respiration as well as surrounding soil respiration provide important carbon sources for plankton production in this lake.

473. Rau, G., and R. Gara. 1973. Allochthonous material income and decomposition in Findley Lake: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 148. (unpublished) Location: UW SOF/THS

CARBON, FINDLEY LAKE

The objectives of this study were to (1) identify the various sources and pathways of foriegn substances entering Findley Lake, (2) develop and employ techniques of sampling allochtonous income for the purposes of qualitatively and quantitatively describing its characteristics, and (3) monitor weight loss, chemical change, and decomposer successsion on a dominant litter type (conifer needles) entering the lake.

474. Rau, G. H. 1978. Conifer needle processing in a subalpine lake. *Limnol. Oceanogr.* 23:356-358.

CARBON, FINDLEY LAKE

Fir and hemlock needles lost an average of 80-90% of their initial dry weight after a 1-year incubation on a littoral benthic site in Findley Lake, Washington. Considerably less mean weight was lost from needles in fine and coarse mesh bags. In all treatments there was little change in mean needle weight during the seond year of the experiment.

475. Rau, G. H. 1979. Carbon sources for aquatic insect production in a subalpine lake. Ph.D. Dissertation. University of Washington. 59 pp. Location: Forestry Library

CARBON, FINDLEY LAKE, INVERTEBRATES

Based on four years of quantitative sampling, an average of 0.9 g (dry wt.) of aquatic insects per square meter was estimated to emerge annually from Findley Lake. Relative carbon-13 concentrations were found to be significantly different among the three potential food sources for the production of this adult insect biomass. These three food sources were conifer tree detritus, periphyton, and plankton. At least 30% of the insect organic carbon annually emerging from this lake was calculated to originate from terrestrial plant sources.

476. Rau, G. H. 1980. Carbon-13/carbon-12 variation in subalpine lake aquatic insects: food source implications. *Can. J. Fish. Aquat. Sci.* 37:742-746.

CARBON, FINDLEY LAKE, INVERTEBRATES, PERIPHYTON

Relative ^{14}C concentrations were found to be significantly different among the three primary organic carbon sources for aquatic insect production within Findley Lake, WA. These three carbon sources were conifer tree detritus (mean ^{12}C = -27.3 per mil), periphyton (-34.6 per mil), and plankton (-45.9 per mil). Correspondingly, the ^{13}C of the adults of assumed autochthonous carbon feeders, *Paraleptophlebia* sp. (Ephemeroptera: Leptophlebiidae) and *Chaoborus trivittatus* (Diptera: Chaoboridae), well approximated the ^{13}C of periphyton and plankton, respectively. The remainder of the adult insect emergence, mostly Limnelphilidae and Chironomidae, exhibited ^{13}C values intermediate between the terrestrial and periphyton carbon. Approximately 38% of the 51 kg C of insect biomass annually emerging from this lake was conservatively estimated to originate from terrestrial plant sources.

477. Rau, G. H. 1974. The natural dispersal of plant and insect litter into and around a subalpine lake. M.S. Thesis. University of Washington. 78 pp. Location: UW SOF/THS

FINDLEY LAKE, INVERTEBRATES, PLANTS

The objectives of this study were to investigate the quantity, quality, and the seasonal and spatial nature of plant and insect material dispersing into and around Findley Lake. This study was accomplished by (1) the identification and enumeration of debris collected periodically from litter traps positioned on and around the lake, (2) the periodic measurement of suspended organic drift carried to the lake by surface inflows, and (3) the use of this information to construct models estimating the total dispersal to and from the lake. In addition, the aquatic decompostion and utilization of conifer needles was examined.

478. Rees, W. H. 1956. A review of aerial surveying in Puget Sound streams. In: Progress report:Puget Sound stream studies 1956, (Eds.) W. E. Bostick, W. A. Dunstan, and W. H. Rees. State of Washington Department of Fisheries. Olympia (WA). pp. 37-40 Location: Fisheries Library

CEDAR RIVER, FISH, SPAWNING

During the fall of 1956 surveys were made of the Sauk river, Wallace, Tolt, Sultan, Cedar, and Green rivers as well as other rivers surveyed since 1952. It was concluded that the Wallace, Raging, Cedar, and Green rivers were, for the most part, too narrow and with too much overhanging vegetation to make extremely accurate counts.

479. Rees, W. H. 1959. Effects of stream dredging on young silver salmon (*Oncorhynchus kisutch*) and bottom fauna. *Wash. State Dep. Fish. Ann. Rep.* 2:52-65. Location: Fisheries Library

BENTHIC, COHO SALMON, DIET, FISH, INVERTEBRATES, LITTLE BEAR CREEK, MANAGEMENT, STREAMS

This was a study of the biological changes which occurred from rechanneling about 1.6 km of Little Bear Creek, a tributary to the Sammamish River. Following channelization a drastic reduction in the bottom fauna and fish population resulted, but both groups of organisms recovered within one year (Wydoski, 1972).

480. Richey, J. E., D. P. Lettenmaier, and F. S. Sanders. 1982. Construct for analysis of ecosystem perturbations based on input/output analysis. National Technical Information Service. Springfield (VA).

CARBON, FINDLEY LAKE, L. WASHINGTON, MODELLING

One primary concern of ecological assessment is to determine how the integrity of an ecosystem as a whole has been affected by perturbation. A construct is developed here, based on the material flow characteristics of systems, that is an alternative or complement to the traditional methods of inventory and simulation. Leontief input/output analysis is adapted to the assessment of material budgets (including intrasystem flows). The theory and principles of the methodology are developed and then a preliminary feasibility study is conducted by testing the construct on case histories of Lake Washington and Findley Lake.

481. Richey, J. E., and R. C. Wissmar. 1979. Sources and influences of allochthonous inputs on the productivity of a subalpine lake. *Ecology* 60:318-328.

CARBON, FINDLEY LAKE, NUTRIENTS, SEDIMENTATION

Allochthonous and autochthonous inputs of soluble reactive phosphate, dissolved organic P, particulate P, dissolved inorganic N, total N, dissolved organic C, and particulate organic C were measured seasonally over a 2-yr period in a subalpine lake of a coniferous forest. Nutrient budgets were constructed and analyzed for patterns and relative importance of material flow pathways. Of total annual particulate organic C inputs to the water column of 15.9 g/m^2, 83% was allochthonous, mainly from fluvial and snowpack inputs in the spring and litter inputs in the fall.Annual allochthonous inputs of soluble reactive P and dissolved inorganic N averaged 0.12 g/m^2 and 2.24 g/m^2, respectively; spring fluvial sources provided 33%-50% of these annual incomes. Zooplankton excretion of soluble reactive phosphate was comparable to allochthonous inputs of soluble reactive phosphate, and 18% of total inputs of dissolved inorganic N was autochthonous. Particulate losses were assignable to both fluvial and sedimentation processes, whereas 70% of soluble reactive phosphate and dissolved inorganic N incomes were lost through the outflow and the rest to uptake. Allochthonous dissolved organic carbon inputs (68 g/m^2) and allochthonous dissolved organic P inputs (0.21 g/m^2) were mostly fluvial and 100% were lost fluvially. These data are related to those of other lakes, and patterns and apparent anomalies are discussed. These results suggest that terrestrial inputs to the sediments, and the subsequent cycling of nutrients in the sediments, have a major influence on biological activity in both benthic and water-column environments during most of the growing season.

482. Richey, J. S. 1982. Effects of urbanization on a lowland stream in Western Washington. Ph.D. Dissertation. University of Washington. 249 pp. Location: Engineering Library

BEAR CREEK, BENTHIC, BIOASSAY, CARBON, FLOW, INVERTEBRATES, KELSEY CREEK, POLLUTION, SEDIMENTS, STORMWATER, STREAMS, URBANIZATION

The effects of nonpoint source pollution due to urbanization and stormwater runoff on the structure and function of an urban stream, Kelsey Creek, were investigated in comparison to a nearby, control stream, Bear Creek. The results of this study indicated that changes in stream hydrology and geomorphology were the critical agents in causing alterations in the ecological structure of the stream.

483. Rickard, N. A. 1980. Life history and population characteristics of the prickly sculpin (*Cottus asper* Richardson) in Lake Washington. M.S. Thesis. University of Washington. 148 pp. Location: Fisheries Library

ABUNDANCE, DIET, DISTRIBUTION, FECUNDITY, FISH, GROWTH, L. WASHINGTON, SCULPIN

The objectives of this study were the description of the life history of *Cottus asper* in Lake Washington and the assessment of its contribution to the fish community in terms of competitive interactions and as a forage base. Life history aspects studied included benthic distribution, age and growth, reproductive biology, and food habits. Additional emphasis was placed on estimating population size.

484. Roberson, K. 1967. An occurrance of chinook salmon beach spawning in Lake Washington. *Trans. Am. Fish. Soc.* 96:423-424.

CHINOOK SALMON, FISH, L. WASHINGTON, SPAWNING

In 1965, 50 chinook salmon spawned on three Lake Washington beaches, Juanita, Windermere, and Seward Park, where there was gravel, sand, and groundwater seepage. Spawning occurred in 15 to 91 cm of water. No lake spawning of chinook occurred in 1964 in 1966 (Wydoski, 1972).

485. Rock, C. A. 1974. The trophic status of Lake Sammamish and its relationship to nutrient income. Ph.D. Thesis. University of Washington. 130 pp. Location: UW SOF/THS

L. SAMMAMISH, NUTRIENTS, PALEOLIMNOLOGY

The general objective of this research was to quantify the changes in the trophic status of Lake Sammamish in relation to both a modern-day nutrient diversion project and to the long-term historical change in nutrient income. The sewage diversion project coupled with the limnological data collected over the past decade provided a classic opportunity to contribute valuable insight into the mechanisms of lake response to sudden nutrient perturbations. The utilization of paleolimnogical techniques coupled with a turn-of-the-century limnological survey provided an opportunity to contribute to the knowledge of determing the effect of a long-term nutrient change on the trophic status of the lake. A corollary objective was to evaluate the information gathered from the Lake Sammamish sewage diversion project and apply it to the universal problem of accurately assessing the effectiveness of anticipated lake restoration projects prior to initiation.

486. Royal, L. A., and A. Seymour. 1940. Puget Sound sockeye plantings show varying degrees of success. *Prog. Fish-Cult.* 52:1-7.

BEAR CREEK, CEDAR RIVER, FISH, ISSAQUAH CREEK, SOCKEYE SALMON, STOCKING, STREAMS

Prior to 1940, only an occasional sockeye salmon was reported south of the Skagit River. Documents the introduction of sockeye fry into the Cedar River, Bear Creek, and Issaquah Creek during 1937 and the first spawning of the fish that returned from this year class in 1940 (Wydoski, 1972).

487. Scattergood, L. W. 1948. Autumn census of Lake Washington waterfowl in 1937. *Murrelet* 29:5-8.

BIRD, L. WASHINGTON

An October 1937 census determined the numbers and species of ducks present at two areas on Lake Washington. At Kenmore and at Andrews Bay, respectively, there were 93% and 99% mallards, baldpates, and coots. The amount of food present was a major factor in the large concentrations of ducks in these two areas. A table lists the species and numbers of waterfowl counted (Wydoski, 1972).

488. Scheffer, V. B. 1936. The plankton of Lake Washington. Ph.D. Dissertation. University of Washington. 110 pp. Location: Allen Library

CHEM. LIMNOLOGY, L. WASHINGTON, PHYTOPLANKTON

This dissertation provides a general description of the plankton of Lake Washington, the relationship of the plankton to that of other United States lakes, and a comparison of the physics and chemistry of the water and the plankton of the lake to environmental conditions. Concluded that Lake Washington was a temperate lake with all the principal characteristics of an oligotrophic lake with a phytoplankton population typical to those conditions (Wydoski, 1972).

489. Scheffer, V. B., and R. J. Robinson. 1939. A limnological study of Lake Washington. *Eco. Monographs* 9(1):96-143. (Contribution No. 80, Oceanographic Laboratories, University of Washington)

BENTHIC, CHEM. LIMNOLOGY, L. WASHINGTON, NUTRIENTS, PHYTOPLANKTON, ZOOPLANKTON

This is an historical monograph on the general limnology of Lake Washington that includes an historical account of the lake. In addition this paper describes the physical and chemical characteristics of the water as well as the quantity and species composition of the plankton.

490. Schell, W. R., J. R. Swanson, and L. A. Currier. 1983. Anthropogenic changes in organic carbon and trace metal input to Lake Washington. Final report. *Radiocarbon* 25:621-628.

CARBON, L. WASHINGTON, METALS, PALEOLIMNOLOGY, POLLUTION, SEDIMENTS

An example of how man's contaminants are introduced, deposited and retained in sediments giving a chronological record of events has been developed for Lake Washington. Introduction of significant amounts of both inorganic and organic compounds into the environment have been identified as originating from fossil fuel sources - such as power plants and motor vechicles. However, many organic compounds are introduced from contempory biogenic materials. Through the application of the combined carbon isotope analysis technique (CCIA), the authors distinguished between fossil and contempory carbon source classes (using ^{14}C), and they identified certain sources within each of these classes (using ^{13}C).

491. Schneider, R. L. 1971. A comparison of tetracycline marks with pectoral fin clips in returning chinook salmon males. M.S. Thesis. University of Washington. 70 pp. Location: Fisheries Library

CHINOOK SALMON, ESCAPEMENT, FISH

This thesis describes the successful marking of chinook salmon with tetracycline (TM-50) that was placed in the food mixture for fry. Returning salmon were checked for marks at the University of Washington pond (Wydoski, 1972).

492. Schultz, L. P. 1930. Miscellaneous observations on fishes in Washington. *Copeia* 1930:137-140. Location: UW SOF/THS

CRAPPIE, DISTRIBUTION, FISH, L. UNION, L. WASHINGTON, LAMPREY, STREAMS

The western brook lamprey was reported as abundant in all the lowland streams in the vicinity of Lake Washington. Also reported a single adult specimen of the river lamprey from Lake Washington. Spot checking in the suitable spawning areas did not reveal any additional lampreys. The black crappie was also reported as abundant in Lakes Washington and Union (Wydoski, 1972).

493. Schultz, L. P. 1930. The life history of *Lampetra planeri* Block, with a statistical analysis of the rate of growth of the larvae from western Washington. University of Michigan, Mus. Zool. Occasional Paper 221. Ann Arbor (MI). Location: Allen Library

EVANS CREEK, FISH, LAMPREY, STREAMS

This report provides life history notes on the western brook lamprey. Two year classes in the larvae can be distinquished definitely. Some evidence exists that lampreys are about four years old at spawning. Larvae are abundant in eddies with rich deposits of silt mixed with a little sand. Collections were made in Evans Creek, a tributary to the Sammamish River (Wydoski, 1972).

494. Schultz, L. P. 1934. Species of salmon and trout in northwestern United States. *Proc. Fifth Pac. Sci. Cong.*:3777-3782. Location: Fisheries Library

FISH

A key to the species of Salmonidae in northwestern United States is provided. A short discussion of their characteristics, along with a discussion of problems in identification and classification is given (Wydoski, 1972).

495. Schultz, L. P. 1935. The spawning habits of the chub, *Mylocheilus caurinus*, a forage fish of some value. *Trans. Am. Fish. Soc.* 65:143-147.

FISH, L. WASHINGTON, PEAMOUTH, SPAWNING

First description of the spawning behavior of peamouth. The fish were observed spawning along specific beaches of Lake Washington (Wydoski, 1972).

496. Schultz, L. P. 1937. The breeding habits of salmon and trout. *Annual Report of the Smithsonian Institute* 1937:365-376.

FISH, SOCKEYE SALMON, SPAWNING, STREAMS, SWAMP CREEK

Describes the spawning habits of kokanee (*O. nerka*) from Swamp Creek, a tributary to the Sammamish River. Much of the information from Schultz and Students (1935) is repeated (Wydoski, 1972).

497. Schultz, L. P., and A. C. Delacy. 1935/1936. Fishes of the American Northwest: A catalogue of fishes of Washington and Oregon with distributional records and a bibliography. Journal of the Pan-Pacific Research Institute. . Location: Fisheries Library

BIBLIOGRAPHY, DISTRIBUTION, FISH

This article summarizes distribution records of fishes, including the Lake Washington drainage (Wydoski, 1972).

498. Schultz, L. P., and Students. 1935. The breeding activities of the little redfish, a landlocked form of the sockeye salmon, *Onchorynchus nerka*. *J. Pan-Pac. Res. Inst.* 10:67-77.

FISH, SOCKEYE SALMON, SPAWNING, STREAMS, SWAMP CREEK

A detailed description of spawning behavior of landlocked salmon in Swamp Creek was provided (Wydoski, 1972).

499. Scott, J. B., C. R. Steward, and Q. J. Stober. 1982. Impacts of urban runoff on fish population in Kelsey Creek, Washington. Fisheries Research Institute. University of Washington. (FRI-UW-8204) Location: Fisheries Library

BEAR CREEK, BIOASSAY, COHO SALMON, CUTTHROAT TROUT, DISTRIBUTION, FISH, FLOW, GROWTH, KELSEY CREEK, LAND USE, MIGRATION, STORMWATER, STREAMS, URBANIZATION

A three-year study was conducted to assess the impact of urban development upon the fisheries resources of Kelsey Creek. Streambed scour was significantly greater than in a control stream during periods of stormwater runoff, but the resultant mortality of coho salmon and cutthroat trout embryos was estimated to average less than 15 percent in the years 1978-1981. Composition of the streambed was observed and instream bioassays were performed. Biomass, growth, and migration were also studied.

500. Scott, J. B., C. R. Steward, and Q. J. Stober. 1986. Effects of urban development of fish population dynamics in Kelsey Creek, Washington. *Trans. Am. Fish. Soc.* 115:555-567.

COHO SALMON, CUTTHROAT TROUT, FISH, KELSEY CREEK, STORMWATER, STREAMS, URBANIZATION

A 30-month study of the comparative dynamics of the fish populations inhabiting Kelsey Creek, located in the City of Bellevue, Washington, and a nearby pristine control stream suggest that urban development has resulted in a restructuring of the fish community. Environmental perturbations, including habitat alteration, increased nutrient loading, and degradation of the intragravel environment appeared to have a greater impact on coho salmon *Oncorhynchus kisutch* and non-salmonid fish species than on cutthroat trout *Salmo clarki* . Although the total biomass (g/m^2) of fish in each stream was similar, its composition differed markedly. Ages 0 and I cutthroat trout were the majority of the fish community inhabiting Kelsey Creek, whereas the control stream supported a diverse assemblage of salmonids of various ages and numerous non-salmonids.

501. Seale, A. 1895. List of freshwater fishes collected in the vicinity of Seattle, Washington by Edwin C. Starks. *Proc. Calif. Acad. Sci.* 5:852-854. (Supplement to D.S. Starr and E.C. Starks, p. 785-852) Location: UW SOF/THS

FISH, L. WASHINGTON

This supplement lists 9 species of freshwater fishes collected in Green Lake and Lake Washington.

502. Seattle and Lake Washington Waterway Company. 1895? Guide map of Seattle showing tide lands to be filled and canal to be constructed by the Seattle and Lake Washington Waterway Company [map]. Seattle and Lake Washington Waterway Company. Seattle. Location: Suzzallo Library

SHIP CANAL

Map of proposed southern canal through Beacon Hill. Library's copy is mounted on linen, hand colored. Scale [ca. 1:30,000] (W 1222606 - W 1221616/N 474221 - N 473059). Base map is cadastral map also shows waterfront businesses and tract names, 1889, by O.P. Anderson. Insets: Steamship and railroad routes from Seattle. Profile of the highland section of the Seattle and Lake Washington waterway.

503. Seattle and Lake Washington Waterway Company. 1902. History and advantages of the canal and harbor improvement project now being executed by the Seattle and Lake Washington Water Company. Seattle and Lake Washington Waterway Company. Seattle (WA). Location: Suzzallo Library

REVIEW, SHIP CANAL

The history of the Lake Washington Ship Canal and Harbor Improvement Project up to 1895 is discussed. It includes an appendix with pertinent historical documents that helped to determine future decisions on location and advantages of the canal (Wydoski, 1972).

504. Seattle Chamber of Commerce. 1903. The government canal connecting Lake Washington with Puget Sound: copies of documents. Seattle Chamber of Commerce. Seattle. Location: Suzzallo Library

SHIP CANAL

This report contains retyped copies of documents regarding the proposed Lake Washington Ship Canal.

505. Seattle Engineering Department. 1978. Seattle drainage management program, proposed. Areawide waste treatment management planning Section 208 - P.L.92-500. Metro. Seattle. Location: METRO Library

L. UNION, POLLUTION, SEWAGE, STREAMS, THORNTON CREEK, URBANIZATION

Recognizing that the City of Seattle faces a long term, expensive and major undertaking to bring drainage under control, staff recomendations were developed for a phased implementation program.

506. Seattle Engineering Dept., and Kennedy/Jenks/Chilton. 1987. Lake Union and Ship Canal sampling and analysis program. Seattle Engineering Dept. Office for Planning. Seattle.

L. UNION, POLLUTION, SHIP CANAL, STORMWATER, URBANIZATION

This report provides background data on storm drains which empty into Lake Union and Ship Canal.

507. Seckel, G. R. 1953. Salt intrusion and flushing of Lake Washington Ship Canal. M.S. Thesis. University of Washington. 97 pp. Location: Fisheries Library

CIRCULATION, FLOW, L. UNION, L. WASHINGTON, SHIP CANAL, WATER BUDGET

A siphon on the freshwater side of the Hiram M. Chittenden Locks was designed as the major saltwater catch basin. Salmon Bay and Lake Union are deeper than Fremont Canal and Montlake Canal and act as additional catch basins. Computed volumes of saltwater intrusion show the siphon and Salmon Bay to be inadequate in preventing lake contamination on the basis of volume capacity. Only 25% of the chlorinity flushes out of Lake Washington annually during the period of overturn. Tables of chlorinity and water discharge are provided for 1951, 1952, and 1953. (Wydoski, 1972)

508. Seckel, G. R., and M. Rattay Jr. 1953. Studies on Lake Washington Ship Canal. University of Washington, Dept. of Oceanography. Seattle. (Technical Report No. 15) Location: Engineering Library

CHEM. LIMNOLOGY, CIRCULATION, FLOW, SHIP CANAL

Salt water enters the freshwater system of Lake Washington through the U.S. Government Locks at Ballard. The salt water siphon and the Salmon Bay basin are inadequate to prevent salt water intrusion on the basis of volume capacity, and also because the salt water flowing lakeward out of the locks travels esstentially as a jet and spills over into Lake Union where it is no longer available to the siphon's flushing action.

509. Semple, E. 1902. Comparison between the Seattle Canal and The Ballard Canal, both designed to connect Lakes Washington and Union with Puget Sound, State of Washington. 11 p. Location: Suzzallo Library

SHIP CANAL

A letter from Eugene Semple, president of Seattle and Lake Washington Waterway Co. to T.E. Burton, chairman of Rivers and Harbors Committe, House of Representatives.

510. Senn, H. 1970. Final progress report: Evaluation of 1965 brood coho released from ten Puget Sound and three coastal hatcheries. State of Washington Department of Fisheries, Hatchery Division. Olympia (WA). Location: Fisheries Library

COHO SALMON, FISH, HATCHERIES, ISSAQUAH CREEK, STREAMS

During the second year of a 3-year fin-marking experiment at Puget Sound and coastal hatcheries 1,312,316 marked smolt coho were released. The total survival (catch plus escapement) to adults from Puget Sound hatcheries ranged from 4.55% to 11.07 %.

511. Senn, H. 1970. Final progress report: Evaluation of 1964 brood coho released from ten Puget Sound and one coastal hatchery. State of Washington Department of Fisheries, Hatchery Division. Olympia (WA). Location: Fisheries Library

COHO SALMON, FISH, HATCHERIES, ISSAQUAH CREEK, STREAMS

During the first year of a 3-year, fin-marking experiment 1,042,613 marked smolt coho were released from 10 Puget Sound hatcheries and 402,700 released from one coastal station. The total survival (catch plus escapement) to adults from Puget Sound hatcheries ranged from 2.87% to 5.59%.

512. Senn, H. 1971. Final progress report: Evaluation of 1966 brood coho released from eleven Puget Sound and two coastal hatcheries. State of Washington Department of Fisheries, Hatchery Division. Olympia (WA). Location: Fisheries Library

COHO SALMON, FISH, HATCHERIES, ISSAQUAH CREEK, STREAMS

This report covers the final year of a 3-year, fin-marking experiment to evaluate the artificial production of coho salmon. In the final year, 1,475,486 fin-marked smolt coho were released from 11 Puget Sound and 2 coastal hatcheries. The total survival (catch plus escapement) to adults from Puget Sound hatcheries ranged from 0.7% to 8.2%.

513. Setter, A. 1983. Squawfish control. In: Lake Washington Symposium, (Ed.) A. Adams. Trout Unlimited. Mercer Island (WA). Location: UW SOF/THS

FISH, L. WASHINGTON, MANAGEMENT, REVIEW, SQUAWFISH

This paper reviews the life history of squawfish in Lake Washington and methods of controlling their population.

514. Shanbhogue, S. L. 1981. Daily activity pattern of peamouth (*Mylocheilus caurinus*) in Lake Washington. *Mysore J. Agric. Sci.* 15:126-132.

DIET, DISTRIBUTION, FISH, L. WASHINGTON, PEAMOUTH

The peamouth (*Mylocheilus caurinus*) is the dominant species of fish in Lake Washington, WA. Studies were carried out from 1973 to 1975 on the daily activity pattern of this species to understand the role played by it in the

lake ecosystem. Horizontal gill nets were used for this study. Results indicated that in early spring peamouth are only active after dusk and during the night. During late spring little activity was observed during day light hours but most activity seems to be at night. In early summer they are active during most part of the day with intensive movement at night and early morning hours. During late summer, two activity peaks are noticed, one just after dusk and the other just before dawn. Peamouth during fall are active only at night.

515. Shanbhogue, S. L. 1981. Feeding periodicity of peamouth (*Mylocheilus caurinus*) in Lake Washington. *Mysore J. Agric. Sci.* 15:120-126.

DIET, FISH, L. WASHINGTON, PEAMOUTH

Feeding periodicity of peamouth (*M. caurinus*) was studied for fish feeding naturally in the lake by two methods, namely mean per cent fullness of guts and mean weights of gut contents per gram of body weight. Results seem to indicate intensive feeding activity from 1900 to 0500 hours during early spring and from noon to well after dusk during late spring. Considerable feeding activity during most hours of day in the summer was noticed. Peamouth seem to actively feed only at night during the fall.

516. Shanbhoque, S. L. 1976. Studies on food and feeding habits of peamouth (*Mylocheilus caurinus*) in Lake Washington. Ph.D. Dissertation. University of Washington. 114 pp. Location: Fisheries Library

DIET, FISH, L. WASHINGTON, PEAMOUTH

The objective of this research was to describe the food and feeding habits of peamouth and its daily activity pattern in Lake Washington. Diel feeding activity was determined from degree fullness of guts and from analysis of gut contents.

517. Shapiro, J. 1960. The cause of a metalimnetic minimun of dissolved oxygen. *Limnol. Oceanogr.* 5:216-227.

CHEM. LIMNOLOGY, L. WASHINGTON, NUTRIENTS, ZOOPLANKTON

Lake Washington, which was undergoing eutrophication, was showing an increase in the magnitude of a metalimnetic depletion of dissolved oxygen. This increase was due to the respiration of a metalimnetic population of nonmigrating copepods, which were increasing in numbers. Chemical properties of the metalimnetic depletion are compared with those of a hypolimnetic depletion due to morphometric causes (Wydoski, 1972).

518. Shapiro, J., W. T. Edmondson, and D. E. Allison. 1971. Changes in the chemical composition of sediments in Lake Washington, 1959-1970. *Limnol. Oceanogr.* 16:437-452. Location: UW SOF/THS

L. WASHINGTON, NUTRIENTS, PALEOLIMNOLOGY, SEDIMENTS

Comparisons were made among three cores taken in deep water in different parts of Lake Washington in 1958 and 1959, and two cores taken at one of these locations in 1968 and 1970. During the interval between the two sets of cores, the sewage effluent that had been causing eutrophication of the lake was diverted and the lake began to return to a relatively unproductive condition. Because the lake was in a state of rapid change, this paper documents the transition between two quite different conditions (Wydoski, 1972).

519. Shepard, M. F. 1975. Fishes sampled in the Pontiac Bay-Sand Point area of Lake Washington. WA Cooperative Fishery Research Unit, University of Washington. Seattle. (unpublished) Location: UW SOF/THS

BULLHEAD, CHINOOK SALMON, COHO SALMON, CRAPPIE, CUTTHROAT TROUT, FISH, L. WASHINGTON, LARGEMOUTH BASS, PEAMOUTH, PIERS, RAINBOW TROUT, SCULPIN, SHORELINE, SMELT, SOCKEYE SALMON, SQUAWFISH, SUCKER, YELLOW PERCH

This survey of fish was an attempt to predict some of the effects of proposed pier construction and dredging activities. Inshore and offshore movements of the fish as well as rearing and spawning habitat were evaluated.

520. Shepard, M. F. 1978. Comparisons of benthic biota in areas affected by sewage effluent in Lake Washington. WA Cooperative Fishery Research Unit, University of Washington. Seattle. (unpublished) Location: UW SOF/THS

BENTHIC, INVERTEBRATES, L. WASHINGTON, SEWAGE

In November 1977, Metro and the University of Washington began a coordinated benthic study in areas affected by sewage effluent in Lake Washington. This report discusses the results found during the prestudy and field operations and analyses for the February 1978 sampling period.

521. Shepard, M. F. 1979. A preliminary physical and biological survey of the East Fork of Issaquah Creek near Issaquah, Washington with emphasis on the coho salmon and cutthroat trout populations. WA Cooperative Fishery Research Unit, University of Washington. Seattle. (unpublished) Location: UW SOF/THS

COHO SALMON, CUTTHROAT TROUT, FISH, ISSAQUAH CREEK, STREAMS

During construction on Interstate 90 portions of the East Fork of Issaquah Creek were provided with artificial concrete pools. In the summer months, low flow resulted in a dry stream bed with fish trapped within the pools. This study examined the consequences of these structures and suggests potential enhancements for fish habitat.

522. Shepard, M. F. 1982. Walleye (*Stizostedion vitreum vitreum*) - feasibility of introduction into Lake Washington. WA Cooperative Fishery Research Unit, University of Washington. Seattle. (unpublished) Location: UW SOF/THS

FISH, L. WASHINGTON, MANAGEMENT, RECREATION, STOCKING, WALLEYE

This paper reviews and summarizes research on walleye and discusses the feasibility of successfully introducing and managing a fishable population of walleye in Lake Washington.

523. Shepard, M. F. 1982. The management value of data presently available for five species of warmwater fish in Lake Washington, 1982. WA Cooperative Fishery Research Unit, University of Washington. Seattle. (unpublished) Location: UW SOF/THS

BULLHEAD, CRAPPIE, FISH, L. SAMMAMISH, L. WASHINGTON, LARGEMOUTH BASS, MANAGEMENT, SMALLMOUTH BASS, YELLOW PERCH

This report reviews and summarizes thesis studies and others dealing with warmwater fishes in Lake Washington and Lake Sammamish and assesses their adequacy in determining the abundance, distribution, food habits, growth, spawning requirements, and general habitat requirements of those fishes in the system.

524. Shepard, M. F., and J. C. Hoeman. 1979. Some comparisons of the benthic biota in control areas and areas affected by sewage effluent in Lake Washington, 1977-1978. WA Cooperative Fishery Research Unit, University of Washington. Seattle. (unpublished Final Report) Location: UW COOP Files

BENTHIC, INVERTEBRATES, L. WASHINGTON, POLLUTION, SEWAGE, STORMWATER

The purpose of this study was to describe the numerical abundance, biomass, and types of benthic organisms in control areas and areas affected by pipe storm drains and combined sewer overflows in Lake Washington.

525. Shepard, M. F., and R. G. Dykeman. 1977. A study of the aquatic biota and some physical parameters of Lake Washington in the vicinity of the Shuffleton Power Plant, Renton, Washington 1975-1976. Washington Cooperative Fishery Research Unit. University of Washington. (For Puget Sound Power and Light Company) Location: Fisheries Library

BENTHIC, BULLHEAD, CARP, CATFISH, CHINOOK SALMON, COHO SALMON, CRAPPIE, CUTTHROAT TROUT, DISTRIBUTION, DOLLY VARDEN, FISH, INVERTEBRATES, L. WASHINGTON, LARGEMOUTH BASS, MOUNTAIN WHITEFISH, PARK CREEK, PEAMOUTH, PERIPHYTON, PHYTOPLANKTON, PUMPKINSEED, RAINBOW TROUT, SCULPIN, SMELT, SOCKEYE SALMON, SQUAWFISH, STEELHEAD, STICKLEBACK, SUCKER, TENCH, YELLOW PERCH, ZOOPLANKTON

In 1974 the Washington State Department of Ecology issued the Puget Sound Power and Light Company a National Pollution Discharge Elimination System Waste Discharge Permit to operate the Shuffleton Power Plant in the south end of Lake Washington during 1975-1976. This study evaluated whether certain methods of operation might be desirable to ensure the protection and propagation of a balanced indigenous population of fish in Lake Washington that might be affected by the Shuffleton Power Plant. This study was designed to increase the base line data.

526. Sherk, T. E., and D. R. Paulson. 1972. A progress report on insect emergence at Findley Lake during 1972: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 71. (unpublished) Location: UW SOF/THS

BENTHIC, FINDLEY LAKE, INVERTEBRATES

The preliminary results of a study of the insect emergence at Findley Lake in the Cascade Mountains of Washington during 1972 are presented. Bottom samples were taken from different regions of the lake to compare the insect emergence at the surface, the physical conditions of the bottom, and the biological communities within the bottom sediments. Those insects that have both an aquatic larval stage and an adult flying stage in their life cycles were collected when they emerged from the lake by ten floating and ten shore-emergence traps.

527. Sherk, T. E., and D. R. Paulson. 1973. A progress report on insect emergences at Findley Lake during 1972: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./Internationa Biological Program. University of Washington. Seattle; Internal Report 71. (unpublished) Location: UW SOF/THS

BENTHIC, FINDLEY LAKE, INVERTEBRATES

This report presents the preliminary results of a study of the insect emergence at Findley Lake during 1972. The insects were identified to family, then counted, dried, weighed, and the total biomass that emerged was determined.

528. Shuster, J. I. 1985. The effect of past and present phosphorus loading on the water quality of Lake Sammamish. M.S.E. Thesis. University of Washington. 116 pp. Location: Engineering Library

L. SAMMAMISH, MODELLING, NUTRIENTS

Lake Sammamish has recently shown convincing signs of recovery from the 1968 sewage diversion project, exhibiting a mean whole lake total P concentration, since 1981, of 18 µg/L, summer chl *a* of 2.5 µg/L, and Secchi depth of 4.9 m. This state is in contrast to prediversion values of 33 µg/L, 5.0 µg/L, and 3.3 m for TP, chl *a* and Secchi transparency, respectively.

529. Sibley, T. H., and P. Chigbu. 1993. Feeding behavior of longfin smelt (*Spirinchus thaleichthys*) may affect water quality and salmon production in Lake Washington. Presented at the 13th International Symposium of the North American Lake Management Society: November 30 - December 4, 1993. Seattle (WA). Location: UW SOF/THS

DIET, FISH, L. WASHINGTON, SMELT, SOCKEYE SALMON

Recently, the population of sockeye salmon in Lake Washington have declined and longfin smelt populations have increased dramatically. This paper presents research conducted to determine if the increased abundance of smelt has altered the trophic dynamics of Lake Washington.

530. Sloane-Richey, J., M. A. Perkins, and K. W. Malueg. 1981. The effects of urbanization and stormwater runoff on the food quality in two salmonid streams. *Verh. Int. Ver. Theor. Angew. Limnol.* 21:812-818.

BENTHIC, CARBON, FISH, KELSEY CREEK, POLLUTION, STORMWATER, STREAMS, URBANIZATION

The effect of physical and chemical changes on stream biota caused by urbanization had been studied on two salmonid streams in the State of Washington. The amount and the chemical composition of the particulate organic matter on natural rock surfaces was investigated as the primary food base. The results show that the food quality and the temporal availability of particulate organic matter are significantly lower in the stream near urban settings which receives storm water runoff from the urban areas. Causes are the rapid physical changes, the decreasing allochthonous input, and the high concentrations of suspended solids which limit the survival of many organisms.

531. Smith, E. V. 1921. Report on the little red fish, locally known as the silver trout. *State Game Warden* 7th and 8th Annual Report:18-20. Location: Fisheries Library

FISH, L. SAMMAMISH, L. WASHINGTON, SOCKEYE SALMON

The silver trout of Lake Washington and Lake Sammamish is a small variety of the sockeye salmon (kokanee) which does not migrate out to saltwater (Wydoski, 1972).

532. Smith, E. V., and T. G. Thompson. 1925. The control of sea water flowing into Lake Washington Ship Canal. *Ind. Eng. Chem.* 17:1084-1087.

CIRCULATION, FLOW, L. UNION, L. WASHINGTON, SHIP CANAL

After the completion of the Lake Washington Ship Canal in 1917, seawater invaded Lake Union to the extent that its waters were unfit for industrial purposes. A study that was undertaken concluded: 1) the concentration of seawater in the freshwater is dependent on rainfall, number of lockages, the saltwater drain, and surplus water disposal, 2) the volume of saltwater in the freshwater could be lessened by conducting surplus water through the lock valves instead of letting it run over the spillway, draining surplus water during the dry season instead of during the period of surplus gain, and enlarging the saltwater basin, 3) Lake Union serves as a secondary basin, thus preventing saltwater from entering Lake Washington (Wydoski, 1972).

533. Smith, E. V., and T. G. Thompson. 1927. Occurence of hydrogen sulfide in the Lake Washington Ship Canal. *Ind. Eng. Chem.* 19:822-826.

BACTERIA, CIRCULATION, SHIP CANAL

In 1925 hydrogen sulfide was noted in the deeper portions of the Lake Washington Ship Canal where quantities of brackish water had accumulated. The hydrogen sulfide was caused by bacteria (Wydoski, 1972).

534. Smith, E. V., and T. G. Thompson. 1927. Salinity of the Lake Washington Ship Canal; a study of conditions affecting the flow of sea water into the canal system. University of Washington. Seattle. (Engineering Experimental Station bulletin No. 41) Location: Fisheries Library

CHEM. LIMNOLOGY, CIRCULATION, FLOW, L. UNION, SHIP CANAL

This bulletin reports on the extent and permanency of the influx of sea water into Lake Union and the canal and the efficiency of the method uses for controlling it. Results are provided from a ten year study period 1917-1927.

535. Spyridakis, D., P. Birch, and B. Barnes. 1973. Sedimemt and nutrient fluxes of lakes in the Lake Washington drainage basin: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 144. (unpublished) Location: UW SOF/THS

CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, L. WASHINGTON, NUTRIENTS, SEDIMENTS

Sediment patterns were measured in the four lakes of the Lake Washington drainage basin. More extensive treatment of sediment fluxes were made in Findley Lake and sediment nutrient regeneration from *in situ* Lake Sammamish experiments.

536. Spyridakis, D. E., and R. S. Barnes. 1976. The effects of waste water diversion on heavy metal levels in the sediments of a large urban lake. Department of Civil Engineering, University of Washington. Seattle. Location: GOVERNMENT LIBRARY

L. WASHINGTON, METALS, SEDIMENTS, SEWAGE

The effects of wastewater diversion on the levels of lead, copper, and zinc in the profundal sediments of Lake Washington were examined using sediment cores and sedimentaion rates based on ^{210}Pb dating. Copper and zinc levels were found to respond promptly to the diversion, however the increases in lead discharges to the lake from general sources more than offset any decrease in lead resulting from the diversion.

537. Spyridakis, D. E., and E. B. Welch. 1972. Nutrient budgets in the lakes of the Cedar River watershed: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 85. (unpublished) Location: UW SOF/THS

CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, L. WASHINGTON, NUTRIENTS, SEDIMENTS

Aquatic mineral measurements and sediment characterization of the Cedar River basin lakes and streams reveals two largely distinct physical and chemical environments. Near the headwaters of the Cedar River watershed the composition of lakes and streams reflect adjacent rocks but the effects of forest and agriculture practices and of processes ocurring downstream very quickly alter the composition to a type largely responsive to the urbanization in the lower reaches of the watershed.

538. Staley, J. T., A. E. Konopka, and J. P. Dalmasso. 1987. Spatial and temporal distribution of *Caulobacter* spp. in two mesotrophic lakes. *Fems Microbiol. Ecol.* 45:1-6.

BACTERIA, L. WASHINGTON, PHYTOPLANKTON

The seasonal distribution of *Caulobacter* spp. has been determined in the water column of two mesotrophic lakes using most probable number (MPN) viable counting techniques from April, 1972 to March, 1973. Concentrations in Lake Washington, a monomictic lake, peaked at 1000-3300 per ml in the epilimnion during the late spring and summer and reached lows in October of less than 2 per ml prior to fall turnover. The populations of *Caulobacter* spp. reached maximum numbers at the approximate times and depths at which algal biomass would be expected to be greatest.

539. Staley, J. T., and F. Taub. 1973. Nitrogen transformation: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 143. (unpublished) Location: UW SOF/THS

CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, L. WASHINGTON, NUTRIENTS, PHYTOPLANKTON

Nitrogen fixation rates were determined periodically by the acetylene reduction technique at three depths in each of the lakes. Fixation began in June in Lakes Washington and Sammamish and peaked during July and August. Chester Morse and Findley Lakes did not exhibit acetylene reduction activity until August and rates encountered were much lower than in the other two lakes. Nitrogen fixation in the lakes correlates closely with the concentration of blue-greens.

540. Stansbury, M. J. 1976. Insect drift in the Cedar River, Washington. M.S. Thesis. University of Washington. 110 pp. Location: Fisheries Library

BENTHIC, CARBON, CEDAR RIVER, FLOW, INVERTEBRATES

This study related insect drift to benthic insects in the Cedar River, Washington. Adjusted production values from insect drift were estimated at 94.5% of the estimates from the benthos. This suggests that drifting insects may be directly related to benthic density and production in the Cedar River. No apparent relationship of CPOM:FPOM to insect production was noted. Insect drift rates and densities were independent of river discharge and velocity. Discussion includes information on carbon pathways, probable insect trophic levels and association of benthos and drift to resident salmonid populations.

541. State of Washington. 1975. Water quality assessment report: Volume I. State of Washington. 75-8. Location: UW SOF/THS4

REVIEW

This is the State's section 305(b) report that assesses the existing water quality in Washington State, and outlines the water quality management program presently employed to improve water quality.

542. State of Washington Department of Fisheries. 1983. 1983 status of Puget Sound sockeye salmon and recommendations for management. Harvest Management Division. State of Washington Department of Fisheries. Location: Fisheries Library

CEDAR RIVER, ESCAPEMENT, FISH, L. WASHINGTON, MANAGEMENT, MODELLING, SOCKEYE SALMON

Predictions of the Lake Washington sockeye run have been prepared for the past 15 years. There are now ten brood years of pre-smolt and adult return data given in this report. The projected 1983 return was 301,600 fish entering the Strait of Juan de Fuca. This report recommended that no fishery be directed at Lake Washington sockeye in 1983 because the forecast is below the 350,000 escapement goal.

543. Stein, J. N. 1970. A study of the largemouth bass population in Lake Washington. M.S. Thesis. University of Washington. 69 pp. Location: UW SOF/THS

ABUNDANCE, DIET, DISTRIBUTION, FECUNDITY, FISH, GROWTH, L. WASHINGTON, LARGEMOUTH BASS

The objectives of this study included (1) an analysis of the food habits of bass greater and less than 100 mm in length, (2) an estimation of fecundity, (3) an examination of bass growth rates, (4) an examination of the types and amounts of bass habitat on the lake, and their relative importance to bass, and (5) a study of bass movement in Lake Washington and the formulation of a population estimate.

544. Stevens Thompson and Runyan Inc. 1974. RIBCO: Conclusion of the WQMS and WRMS concerning future water quality in Lake Washington and Lake Sammamish. Metro. Seattle. Location: METRO Library

L. SAMMAMISH, L. WASHINGTON, NUTRIENTS, SEWAGE

This study was designed to assess water quality conditions in Lakes Washington and Sammamish for the year 2000. Both lakes have been polluted as a result of receiving direct discharge of municipal wastewater for many years.

545. Steward, C. R., III. 1983. Salmonid populations in an urban stream environment: Kelsey Creek, Washington. M.S. Thesis. University of Washington. 247 pp. Location: Fisheries Library

BEAR CREEK, COHO SALMON, CUTTHROAT TROUT, DACE, FISH, FLOW, GROWTH, KELSEY CREEK, SCULPIN, SEDIMENTS, STORMWATER, STREAMS, URBANIZATION

The salmonid populations, spawning habitat, and intergravel water quality of Kelsey Creek, an urban stream located within the City of Bellevue, were studied in relation to the physical perturbations which have resulted from urban development. Bear Creek, which drains a nearby undeveloped watershed of comparable size, served as a control stream.

546. Stinson, M. D., and D. L. Eaton. 1983. Concentrations of lead, cadmium, mercury, and copper in the crayfish (*Pacifasticus leniusculus*) obtained from a lake receiving urban runoff. *Arch. Environ. Contam. Toxicol.* 12:693-700.

BIOASSAY, INVERTEBRATES, L. WASHINGTON, METALS, POLLUTION, URBANIZATION

Commercially caught crayfish (*Pacifasticus leniusculus*) were placed in a municipal lake below a combined sewer overflow outfall and a storm drain outfall associated with elevated sediment metal concentrations. Abdominal muscle, viscera, and exoskeleton from each crayfish were analyzed for mercury, cadmium, lead, and copper. Results indicated that mercury accumulated in muscle tissue, highest cadmium concentrations were in the viscera, and highest lead concentrations were in the exoskeleton; uptake of copper is well-regulated by the organism at nontoxic water concentrations; viscera concentrations of cadmium, lead, and copper tended to be higher and more variable than in muscle tissue.

547. Stober, J., R. E. Narita, and A. H. Hamalainen. 1978. Instream flow and the reproductive efficiency of sockeye salmon. National Technical Information Service. Springfield (VA). (NTIS PB-286 071)

CEDAR RIVER, FISH, FLOW, GROWTH, SOCKEYE SALMON, SPAWNING

The factors controlling reproduction and early development of sockeye salmon included the effects of augmented low flows, uncontrolled floods and density-dependent mortality. Density-dependent mortality due to redd superimposition occurred on a static spawning area where about 50% of the potential eggs were deposited. A higher egg deposition efficiency of about 80 and 100% occurred on reaches where spawning area accumulated with an increase in discharge. Substrate scouring due to a flood (249.3 X 10^3 m/sec) reduced egg/alevin densities by 50.6 and 96.6% on two reach types sampled. The presmolt-to-spawner ratio ranged from 5.8 following the flood to 20.2 following augmented low flow and no flood. Fry production in 1976 and 1977 was 1.75 X 10^6 respectively, representing survival rates of 0.81 and 8.1%. A sustained flood loss of 42% of the spawning habitat coupled with a 22% increase in escapement appears to have increased the density-dependent mortality and reduced the contribution of the early spawners to the total fry production. These results should help to establish an efficient escapement goal for the Cedar River sockeye and find application on salmon streams affected by hydroelectric or diversion projects where stream discharge can be managed to maximize spawning area to benefit fish production.

548. Stober, Q. J., S. Crumley, and R. S. McComas. 1978. Prespawning mortality and the reproductive efficiency of Cedar River sockeye salmon (Supplemental report). National Technical Information Service. Springfield (VA). (NTIS PB-286 055)

CEDAR RIVER, ESCAPEMENT, FISH, FLOW, PARASITE, SOCKEYE SALMON, SPAWNING

An escapement of 410,000 sockeye salmon was monitored during fall 1977 in the Cedar River. A large prespawning mortality apparently due to infestation of the fish with the parasitic copepod, *Salmincola*, was observed. This resulted in an estimated differential mortality of about 119,813 females and an effective survival of 117,987 females. The total maximum effective escapement was estimated at 290,187 sockeye. The amount of area spawned in the 28.8 km of river below Landsburg remained about the same in 1976 and 1977 at 60,000 m^2, while the total escapement increased about three times. This strongly indicated a sustained reduction in the spawning habitat following a severe (249.3 X 10^3 m/sec) December 1975 flood. Reduction of the spawning habitat as a result of major floods may necessitate an adjustment in the escapement goal. Extensive mass spawning and a large prespawning mortality prevented reliable estimates of the potential egg densities on the spawning reaches where hydraulic egg samples were collected. For these reasons the efficiency of egg deposition could not be adequately determined. Intragravel mortality occurred at similar times and levels as found during the 1976 spawning season. Flood losses of 49 and 86% of the egg-alevins were found on two reaches following a discharge of 116 X 10^3 m/s in December 1977.

549. Stober, Q. J., and J. P. Graybill. 1973. Preliminary assessment of the Cedar River discharge and the effects on spawning sockeye salmon. Fisheries Research Institute. University of Washington. (FRI-UW-7308) Location: Fisheries Library

CEDAR RIVER, FISH, FLOW, SOCKEYE SALMON, SPAWNING

This study was designed to 1) determine the depths and velocities "preferred" by spawning sockeye salmon in the Cedar River, 2) develop the relationships between spawnable area and discharge, 3) formulate the relationship between actual spawner use and empirical calculations of spawnable area within river reaches, and 4) assess the timing of the run, general population dynamics, and impact of predicted minimum discharge levels during times of low water suppy on future salmon runs.

550. Stober, Q. J., and J. P. Graybill. 1974. Effects of discharge in the Cedar River on sockeye salmon spawning area. Fisheries Research Institute. University of Washington. (FRI-UW-7407) Location: Fisheries Library

CEDAR RIVER, FISH, FLOW, SOCKEYE SALMON, SPAWNING

Hydrualic and biological investigations conducted at eleven study reaches on the Cedar River were designed to determine depths and velocities preferred by spawning Cedar River sockeye salmon and to provide an understanding of the effects of discharge on spawning sockeye during low flow periods.

551. Stober, Q. J., and A. H. Hamalainen. 1979. Cedar River sockeye salmon fry emigration, January 1979 - September 1979. Fisheries Research Institute. University of Washington. (FRI-UW-7917) Location: Fisheries Library

CEDAR RIVER, ESCAPEMENT, FISH, FLOW, SOCKEYE SALMON, SPAWNING

The estimated escapement of 277,801 sockeye salmon in 1978 was the fourth largest recorded in the Cedar River. Sockeye eggs were not subjected to discharges greater than 47.6 m^3/s during the 1978-79 incubation period. The emigration of fry in 1979 was estimated at 25.5 x 10^6 which included the unknown survival from 9.5 x 10^6 fry artifically produced in the WDF incubation facility at Landsburg.

552. Stober, Q. J., and A. H. Hamalainen. 1980. Cedar River sockeye salmon production, 1980. Washington Univ. Seattle.

ABUNDANCE, CEDAR RIVER, DISEASE, ESCAPEMENT, FISH, FLOW, SOCKEYE SALMON, SPAWNING

The 1979 Cedar River escapement of sockeye salmon (*Oncorhynchus nerka*) was estimated at 185,300 spawners that were the progeny of the 1975 brood year that had been impacted by the maximum flood on record. River discharge during the 1979 spawning seasons was regulated along the critical year flow curve, due to extant drought conditions. National egg survival was probably reduced by a moderate flood in mid-December. Fry estimated to have entered Lake Washington totalled 13,900,000. The egg-to-fry survival rate for the entire run was 4.0%. The infection rate due to hematopoetic necrosis viral disease declined to low level after all fry emigrated from the enchancement facilities. The 1976 and 1978 brood years were comparable, but 1978 escapement was doubled. Egg-to-fry survival was 8.1, 4.5, and 4.0 for the 1976, 1978, and 1979 brood years, respectively. The number of pre-emergent fry has increased with enhancement production.

553. Stober, Q. J., and J. G. Malick. 1972. Aquatic production in a sockeye salmon-producing river: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 93. (unpublished) Location: UW SOF/THS

BENTHIC, CEDAR RIVER, FISH, INVERTEBRATES, SOCKEYE SALMON

This report summarizes the work completed in the first two years of the study of benthic invertebrates and sockeye salmon production in the Cedar River.

554. Stober, Q. J., R. E. Narita, A. H. Hamalainen, and S. L. Marshall. 1976. Preliminary analysis of the effects of instream flow level on the reproductive efficiency of Cedar River sockeye salmon, Annual progress report July 1975 - June 1976. University of Washington. Seattle. Location: METRO Library

CEDAR RIVER, ESCAPEMENT, FISH, FLOW, SOCKEYE SALMON, SPAWNING

The escapement of spawning sockeye salmon was monitored on 11 reaches of the Cedar River (see Stober, Narita, and Hamalainen, 1978).

555. Stockdale, E. C. 1986. Viability of freshwater wetlands for urban surface water management and nonpoint pollution control : An annotated bibliography. Resource Planning Section, King County Dept. of Planning and Community Development. Seattle, WA. Location: METRO Library

BIBLIOGRAPHY, POLLUTION, SEWAGE, STORMWATER, WETLANDS

This is an annotated bibliography that pertains to the use of wetlands for urban stormwater management and nonpoint pollution control. Most of the literature included relates to the use of wetlands for the treatment of secondary sewage effluent. Regional references on nonpoint pollution are also provided.

556. Stockner, J. G., and W. Benson. 1967. The succession of diatom assemblages in the recent sediments of Lake Washington. *Limnol. Oceanogr.* 12:513-532.

L. WASHINGTON, NUTRIENTS, PALEOLIMNOLOGY, PHYTOPLANKTON, SEDIMENTS

Diatom remains in the recent sediment of Lake Washington reveal correlations with the pattern of sewage enrichment over the past 80 years. In the deeper sediment deposited prior to cultural enrichment, the relative composition of the diatoms was constant. The considerable change in species ranking, diversity, and redundancy values in the upper 30 cm if sediment is the result of cultural enrichment. The percentages of Araphidinae and Centrales seemed to be more reliable indicators than independent species (Wydoski, 1972).

557. Stoll, R. K. 1973. Size selective algal grazing of zooplankton using a radioisotope tracer. M.S. Thesis. University of Washington. 57 pp. Location: UW SOF/THS

CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, PHYTOPLANKTON, ZOOPLANKTON

Zooplankton grazing experiments were conducted in three lakes of contrasting trophic status. Algae were tagged with ^{14}C and zooplankton were allowed to graze upon them for a fixed period of time in dark bottles. Light bottle experiments were also conducted.

558. Sturtevant, P. 1974. Growth rate parameters and biomass measurement ratios for natural algal populations. M.S. Thesis. University of Washington. Location: UW SOF/THS

FINDLEY LAKE, L. SAMMAMISH, L. WASHINGTON, NUTRIENTS, PHYTOPLANKTON

This work explored the interaction of nitrate and phosphate in stimulating the growth rate of natural populations of phytoplankton. Lake water used was from the mixed upper layer of Lakes Washington, Sammamish, and Findley Lake during the summer of 1974.

559. Swanson, J. R. 1980. Carbon isotope analysis of carbonaceous compounds in Puget Sound and Lake Washington. Ph.D. Dissertation. University of Washington. 230 pp.

CARBON, HYDROCARBONS, L. WASHINGTON, POLLUTION, SEDIMENTS

A new method was developed and tested for determining chronological profiles of organic pollutants. This method, Carbon Isotope Analysis (CIA), involves measurement of ^{12}C, ^{13}C and ^{14}C in carbonaceous compounds found in layers of sediment. Lipids, total aliphatic hydrocarbons (TAHs) and polycyclic aromatic hydrocarbons (PAHs) are separated from kg quantities of sediment. The basic principle of Carbon Isotope Analysis is the fact that natural isotopic differences present in organic compounds are due to their respective sources. Carbon Isotope Analysis uses three levels of ^{14}C in organic compounds to develop a chronological profile of the anthropogenic impact on sedimentary organic compounds. The overall impact of organic pollutants on a given region often cannot be determined by compound identification alone. Most sophisticated analytical instruments often confuse compounds derived from petroleum and coal dust with natural organic degradation products. By using Carbon Isotope Analysis, additional insight to pollution can be obtained and the impact of chronic levels of toxicants can be identified. This investigation reviewed carbon isotopic data and carbon cycling and analyzes organic pollution in two limited ecosystems (Puget Sound and Lake Washington).

560. Swartz, R. G. 1983. Metro's water quality enhancement programs (Lake Washington non-point source issues). In: Lake Washington Symposium, (Ed.) A. Adams. Trout Unlimited. Mercer Island(WA). Location: UW SOF/THS

L. WASHINGTON, MANAGEMENT, REVIEW, URBANIZATION

The history of Metro's water quality enhancement programs in Lake Washington was reviewed in this paper.

561. Swartzman, G. L., and D. A. Beauchamp. 1990. Simulation of the effect of rainbow trout introduction in Lake Washington. *Trans. Am. Fish. Soc.* 119:122-134. Location: UW SOF/THS

FISH, MODELLING, RAINBOW TROUT, SMELT, SOCKEYE SALMON, STOCKING

A simulation model was developed based on energetics, habitat selection, feeding selectivity, and population dynamics to examine the effect of introductions of rainbow trout (*Oncorhynchus mykiss*) on parr of sockeye salmon (*O. nerka*) and longfin smelt (*Spirinchus thaleichthys*) resident in Lake Washington. The authors modeled growth and population dynamics of rainbow trout cohorts introduced between 1981 and 1984, and compared results with length-at-age data obtained from marked released fish and with data on diets. Graphical comparisons indicated a reasonable fit to the growth data over the 150-400 mm size range. The model gave a close prediction

of the size at which rainbow trout begin to eat fish, these results being sensitive to a size-selective feeding function. Simulation experiments examined the effect of altered rainbow trout enhancement, fishing pressure, prey vulnerability, and prey abundance and species composition on prey fish survival.

562. Swift, C. H., III. 1976. Estimation of stream discharges preferred by steelhead trout for spawning and rearing in western Washington, Open-file report 75-155. U.S.Geological Survey. Tacoma,WA.

BEAR CREEK, CEDAR RIVER, FISH, FLOW, ISSAQUAH CREEK, SPAWNING, STEELHEAD, STREAMS

Determined during the study of 54 stream reaches on 18 streams were 1) stream discharges that cover the greatest areas of the streambeds with water at both the depths and the velocities preferred by spawning steelheads; 2) discharges that cover selectively reduced streambed areas with water at both the depths and velocities preferred by spawning steelhead; 3) discharges that cover the greatest streambed areas with water at velocities preferred by spawning steelhead; 4) rearing discharges that cover the streambed, but not the banks of the channel, with water; and 5) average wetted perimeters of the channels at water stages corresponding to the rearing discharges.

563. Swift, C. H., III. 1979. Preferred stream discharges for salmon spawning and rearing in Washington, Open-file report 77-422. U.S. Geological Survey. Tacoma, WA.

BEAR CREEK, CEDAR RIVER, CHINOOK SALMON, CHUM SALMON, COHO SALMON, FISH, FLOW, ISSAQUAH CREEK, SOCKEYE SALMON, SPAWNING, STREAMS

Stream discharge preferred by salmon for spawning were determined from relationships between discharge and spawnable area at 84 study reaches on 28 streams in Washington.

564. Syck, J. M. 1964. Thermal convection in Lake Washington, winter 1962-1963. M.S. Thesis. University of Washington. 32 pp. Location: UW SOF/THS

CIRCULATION, L. WASHINGTON, TEMPERATURE

The purpose of this study was to describe convection in Lake Washington associated with winter cooling under conditions of low wind and large cooling rates. It was necessary to (1) define the vertical and horizontal temperature structure of the lake, (2) compute the heat budget of the lake during the period of winter cooling, (3) compute the vertical transport and associated velocities required for bottom water replacement by convection currents.

565. Sylvester, R. O. 1952. The sewage disposal problem in the Seattle metropolitan area: A study and recommendations. Wash. State Pollut. Control Comm. Tech Bull. 13. Location: Engineering Library

L. WASHINGTON, SEWAGE, URBANIZATION

This bulletin outlines sewerage problems (1950/1951), facilities, natural drainage basin boundaries, then current and predicted population data, the need for sewer districts, and a suggested districting of the suburban area. Data presented in tables and plates (Wydoski, 1972).

566. Sylvester, R. O. 1961. Nutrient content of drainage of water from forested, urban, and agricultural areas. In: Algae and metropolitan wastes; transactions. 1960 Seminar on Algae and Metropolitan Wastes Cincinnati. U.S. Department of Health,Education,and Welfare. Cincinnati. pp. 80-87 Location: Fisheries Library

NUTRIENTS, STREAMS, THORNTON CREEK

This report provides some values for nitrogen and phosphorus from Thornton Creek, an eastern tributary of Lake Washington (Wydoski, 1972).

567. Sylvester, R. O., G. T. Orlob, A. Young, W. Montgomery, and L. C. Orlob. 1949. A survey of pollution, Seattle metropolitan area. Washington State Poolut. Control Comm. Olympia (WA). Location: GOVERNMENT LIBRARY

BACTERIA, FISH, L. WASHINGTON, MIGRATION, NUTRIENTS, POLLUTION, SEWAGE, STORMWATER

Describes fish migration and navigation in the ship canal, and sewage disposal of the combined storm and sanitary type that is primarily discharge into Lake Washington. The contamination of beaches was determined by coliform counts, evidence of sewage, and proximity of sewers. Lists sources of sewage (Wydoski, 1972).

568. Taub, F. B., and F. Palmer. 1972. Nitrogen transformations: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 86. (unpublished) Location: UW SOF/THS

BACTERIA, CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, L. WASHINGTON, NUTRIENTS

This study's prime objective of the 1972 year was to evaluate the feasibility of measuring the magnitude of various nitrogen transformations. The abundance of nitrogen transforming bacteria was estimated periodically in the four lakes: Lakes Washington and Sammamish, Findley Lake and Chester Morse Reservoir.

569. Taub, F. B., R. L. Burgner, E. B. Welch, and D. E. Syridakis. 1972. A comparitive study of four lakes. In: Research on Coniferous Forest Ecosystems: First Year Progress in the Coniferous Forest Biome, US/IBP, (Eds.) J. F. Franklin, L. J. Dempster, and R. H. Waring. Pacific Northwest Forest and Range Experiment Station, U.S. Department of Agriculture. Portland. pp. 21-32

CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, L. WASHINGTON

Lakes Washington, Sammamish, Findley Lake, and Chester Morse Reservoir studied together generated sufficient understanding to predict the impact of various perturbations on the general lake community structure and production.

570. Taub, F. B. 1973. Relationships between inorganic nutrient input, algal density, herbivore density, and residual inorganic nutrient: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program.University of Washington. Seattle; Internal report 59. (unpublished) Location: UW SOF/THS

MODELLING, NUTRIENTS, PHYTOPLANKTON, ZOOPLANKTON

An exploration of the relationships between inorganic nutrient supply and the first two trophic levels was accomplished by the use of a mathematical model based on experimental data from a pair of two-stage continous cultures.

571. Thompson, A. E. 1948. A city guards its water. *Am. For.* 54:248-251.

CEDAR RIVER, LAND USE, MANAGEMENT

Forestry was shown to be good and profitable watershed management. The Cedar River supplies over half a million people in the area with domestic water. Controlled use of power resources and timber resources has also been developed. The history of the Cedar River watershed is covered from 1856 (Wydoski, 1972).

572. Thorne, R. E. 1970. Investigations into the use of an echo integrator for measuring pelagic fish abundance. Ph.D. Dissertation. University of Washington. 117 pp. Location: Fisheries Library

ABUNDANCE, FISH, L. WASHINGTON, SOCKEYE SALMON

This dissertation estimates the population of presmolt sockeye salmon in Lake Washington by use of an echo integrator (Wydoski, 1972).

573. Thorne, R. E. 1971. Investigations into the relation between integrated echo voltage and fish density. *J. Fish. Res. Board Can.* 28:1269-1273.

ABUNDANCE, FISH, L. WASHINGTON, SOCKEYE SALMON

This article summarizes the relation between integrated echo voltage and density of juvenile sockeye salmon in Lake Washington (Wydoski, 1972).

574. Thorne, R. E. 1973. Population studies on juvenile sockeye salmon in Lake Washington. Fisheries Research Institute, University of Washington. Seattle. Location: Fisheries Library

FISH, L. WASHINGTON, SOCKEYE SALMON

This report contains the survey results of Lake Washington sockeye salmon for the years 1971 and 1972. The population estimates were 3.8 and 2.5 million fish, respectively.

575. Thorne, R. E. 1979. Hydroacoustic estimates of adult sockeye salmon (*Oncorhynchus nerka*) in Lake Washington, 1972-1975. *J. Fish. Res. Board Can.* 36:1145-1149.

CEDAR RIVER, ESCAPEMENT, FISH, SHIP CANAL, SOCKEYE SALMON

Hydroacoustic techniques were used on Lake Washington from 1972 to 1975 to estimate the potential escapement of *O. nerka* . Target strength measurements were used to establish a threshold which would separate the larger adult sockeye salmon from smaller resident fish. The acoustic estimates of escapement were very similar to those obtained from visual observations at the Hiram M. Chittenden Ship Canal locks, observations on the Cedar River, and spawning ground surveys.

576. Thorne, R. E. 1982. Lake Washington sockeye salmon presmolt studies in 1981: final report for the period Feb. 15, 1981-June 30, 1981. Fisheries Research Institute, University of Washington. Seattle. Location: Fisheries Library

FISH, L. WASHINGTON, SOCKEYE SALMON

This report contains the results of hydroacoustic surveys of Lake Washington sockeye salmon during 1981. Population was estimated as 3.64 million.

577. Thorne, R. E. 1983. Application of hydroacoustic assessment techniques to three lakes with contrasting fish distributions. In: Symposium On Fisheries Acoustics. Selected Papers of the Ices/Fao Symposium On Fisheries Acoustics, Bergen, Norway, 21-24 June 1982: Fao Fish. Rep, no. 300, (Eds.) O. Nakken, and S. C. Venema. Fao. Rome. pp. 269-277

ABUNDANCE, FISH, L. WASHINGTON, SOCKEYE SALMON

Since 1969, the Fisheries Research Institute of the University of Washington has conducted over 200 hydroacoustic surveys on 25 different lakes using echo integration and echo counting techniques. This paper describes results of surveys on 3 lakes which typify the variety of these applications: Washington, Tustumena, and Twin Lakes. Nearly 100 hydroacoustic surveys have been conducted on Lake Washington including estimates of presmolt sockeye salmon (*Oncorhynchus nerka*) for 12 years. These results have been used in the management of the sockeye salmon fishery and for evaluation of factors affecting productivity. Hydroacoustic estimates have compared well with estimates from midwater trawling.

578. Thorne, R. E., and J. J. Ames. 1987. A note on variability of marine survival of sockeye salmon (*Oncorhynchus nerka*) and effects of flooding on spawning success. *Can. J. Fish. Aquat. Sci.* 44:1791-1795.

FISH, FLOW, L. WASHINGTON, SOCKEYE SALMON

Most of the annual variability in sockeye salmon (*Oncorhynchus nerka*) survival has been assumed to be associated with freshwater stages, while marine survival has been assumed to be very consistent from year to year. Data from Lake Washington sockeye salmon stock, including hydroacoustic surveys of presmolt populations, indicate that marine survival may vary on the order of 4-20%. However, the data also show that river flow conditions during spawning and gravel incubation have a major effect on production for this stock.

579. Thorne, R. E., and J. J. Dawson. 1974. Lake Washington sockeye salmon studies: final report. Fisheries Research Institute, University of Washington. Seattle. Location: Fisheries Library

ABUNDANCE, FISH, L. WASHINGTON, SOCKEYE SALMON

This report contains results of eight surveys of adult sockeye salmon and five surveys of juvenile sockeye salmon in Lake Washington during 1973 and 1974.

580. Thorne, R. E., and J. J. Dawson. 1976. Lake Washington sockeye salmon studies, 1975-1976: final report for the period July 1, 1975-June 30, 1976. Fisheries Research Institute, University of Washington. Seattle. Location: Fisheries Library

ABUNDANCE, FISH, L. WASHINGTON, SOCKEYE SALMON

This report contains results of the 1975 acoustic surveys of sockeye salmon in Lake Washington. The acoustic estimate for the whole lake was 763,625 presmolts and the corresponding net estimate was 849,070.

581. Thorne, R. E., and J. J. Dawson. 1977. Lake Washington sockeye salmon studies, 1976-1977: final report for the period July 1, 1976-June 30, 1977. Fisheries Research Institute, University of Washington. Seattle. Location: Fisheries Library

ABUNDANCE, FISH, L. WASHINGTON, SOCKEYE SALMON

This report contains results of surveys of sockeye salmon in Lake Washington during the summer of 1976 and spring of 1977.

582. Thorne, R. E., and J. C. Woodey. 1970. Stock assessment by echo integration and its application to juvenile sockeye salmon in Lake Washington, Circular No. 70-2. Washington Sea Grant Publication No. 70-2. University of Washington. Location: UW SOF/THS

ABUNDANCE, FISH, L. WASHINGTON, SOCKEYE SALMON

This report contains the results of the first practical application of the acoustical integrator in the enumeration of the stock of pre-smolt sockeye salmon in Lake Washington

583. Thorne, R. E. 1972. Hydroacoustic assessment of limnetic-feeding fishes. In: Research on Coniferous Forest Ecosystems: First Year Progress in the Coniferous Forest Biome, US/IBP, (Eds.) J. F. Franklin, L. J. Dempster, and R. H. Waring. Pacific Northwest Forest and Range Experiment Station, U.S. Department of Agriculture. Portland. pp. 317-322

ABUNDANCE, FISH, L. WASHINGTON

Hydroacoustic techniques have been applied at the University of Washington to determine the number and biomass of limnetic fishes in order to evaluate their role in the productivity of lake systems. The lakes were surveyed with high frequency, high resolution portable echo sounders.

584. Thut, R. N. 1966. A study of the profundal bottom fauna of Lake Washington. M.S. Thesis. University of Washington. 145 pp. Location: Allen Library

BENTHIC, INVERTEBRATES, L. WASHINGTON

This thesis summarizes the benthic macrofauna of the profundal zone of Lake Washington; 24 species were recognized and 13 were Chironomidae. The Oligochaeta comprised 45% of the bottom fauna and 33% of the total biomass. The weighted mean dry weight was 8.03 kg/ha, which shows the benthic productivity of Lake Washington to be above average. The large presence of Oligochaeta is typical of other lakes that have undergone cultural eutrophication (Wydoski, 1972).

585. Tilley, J. N., and S. B. Semb. 1938. A study of the waters of the Lake Washington Ship Canal. B.S. Thesis. University of Washington. 65 pp. Location: Suzzallo Library

CHEM. LIMNOLOGY, FLOW, POLLUTION, SHIP CANAL

Physical and chemical analysis of the waters of the Lake Washington Ship Canal are recorded. The flushing action is noted, and the effect of industrial pollution is discussed. (Wydoski, 1972)

586. Tison, D. L., F. E. Palmer, and J. T. Staley. 1977. Nitrogen fixation in lakes of the Lake Washington drainage basin. *Water Res.* 11:843-847.

BACTERIA, CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, L. WASHINGTON, NUTRIENTS, PHYTOPLANKTON

Measurements of biological nitrogen fixation rates using the acetylene reduction technique in epilimnetic waters of four lakes near Seattle, Washington support the hypothesis that rates are directly related to a lake's trophic status. Lower rates were measured in Lakes Findley and Chester Morse, considered oligotrophic, than in Lakes Washington and Sammamish, which are mesotrophic. It should be noted that algal blooms in eutrophic lakes may be dominated by species which do not fix nitrogen, and in nutrient-poor lakes cyanophytes may fix nitrogen at

rates which are low but significant in proportion to the nitrogen cycling of the community. On an annual basis, epilemnetic biological nitrogen fixation is not a major source of fixed nitrogen for any of the four lakes investigated, though it may be important in summer when inorganic forms of nitrogen have been depleted from the epilimnion. The contribution of fixed nitrogen in these lakes, all of which are in the Lake Washington basin, is estimated at less than 1% of the total annual nitrogen input from other sources. Nitrogen fixation was detected regularly during the summer in the two mesotrophic lakes, but only occasionally in the oligotrophic lakes. Comparisons are made with the Great Lakes, and with lakes in California, Alaska, and Wisconsin. Measurements used in this study were made between June 1973 and October 1974.

587. Tomlinson, R. D., and S. H. Aubert. 1978. Baseline water quality study for May creek. Municipality of Metropolitan Seattle. Seattle. Location: METRO Library

FLOW, MAY CREEK, STORMWATER, STREAMS

This report is a summary of the results of an analysis of the flow and pollutant loading characteristics observed in May Creek during a rainstorm beginning May 10, 1978. Contains 6 pages of text and 24 pages of tables and figures.

588. Tomlinson, R. D., B. N. Bebee, M. F. Shepard, R. G. Swartz, and R. R. Whitney. 1979. An assessment of biological impacts of combined sewer and storm drain effluent entering Lake Washington: workshop presentation. University of Washington. Seattle. (unpublished) Location: UW SOF/THS

BENTHIC, INVERTEBRATES, L. WASHINGTON, SEWAGE, STORMWATER

This report details studies of the effect of combined sewer outfalls and storm drains on the benthic infauna in the lake.

589. Tomlinson, R. D., B. N. Bebee, R. G. Swartz, S. Lazoff, and D. E. Spyridakis. 1980. The distribution of sediments and particulate contaminants from combined sewer and storm drain overflows in Seattle's nearshore waters. In: Urban Stormwater and Combined Sewer Overflow Impact on Receiving Water Bodies, Proceedings of the National Conference, Orlando, Florida, Nov 26-28, 1979, (Eds.) EPA Report. National Technical Information Service. Springfield (VA). (NTIS PB81-155426) pp. 115-146 (NTIS PB81-155426)

HYDROCARBONS, L. WASHINGTON, METALS, POLLUTION, SEDIMENTS, SEWAGE, STORMWATER, URBANIZATION

The locations and dimensions of the sewer outfalls in Lake Washington, Washington were mapped and measured. The map includes 23 emergency outfalls, 34 combined sewer outfalls (CSO's), 56 pump stations, and 240 storm drains (SD's). The analyses of sediments collected near 10 CSO's and 10 SD's revealed their widespread enrichment with heavy metals, chlorinated hydrocarbons and organic wastes. This was particularly true of the western nearshore region where all of the CSO's were located. Intensive comparative studies were carried out at one representative CSO and one SD having similar drainage basins and rainfall. Pollutant loading estimates indicated that, whereas mean storm concentrations for most parameters were greater for the CSO, the total annual loading was greater in most instances for the SD, due to its continuous and therefore greater volume of discharge. Effluent turbidity patterns and metals concentration ratios for effluent solids, settling particulates and sediments demonstrated significant local deposition of wastewater particles. The different effects of near-bottom, offshore transport and longshore advection cause different particulate dispersion patterns at the two sites.

590. Tomlinson, R. D., R. J. Morrice Jr., E. C. S. Duffield, and R. I. Matsuda. 1977. A baseline study of the water quality,sediments,and biota of Lake Union. Municipality of Metropolitan Seattle. Seattle. Location: UW SOF/THS

BENTHIC, FISH, L. UNION, METALS, NUTRIENTS, PHYTOPLANKTON, SEDIMENTS, ZOOPLANKTON

This Metro report focuses on the following questions (1) what is the present quality of the water and sediments, (2) what is the present condition of the phytoplankton and benthic communities, (3) what is the present trophic state of the lake, (4) what is the effect of the saltwater intrusion (from the Hiram M. Chittenden Locks) on all of the above, and (5) how do the sediment conditions of Lake Union compare with those of other local bodies of water.

591. Traynor, J. J., R. J. Berggren, R. L. Burgner, and R. E. Thorne. 1972. Dynamics of limnetic feeding fish in Lakes Washington and Sammamish: Annual report, 1972: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 90. (unpublished) Location: UW SOF/THS

ABUNDANCE, FISH, L. SAMMAMISH, L. WASHINGTON

This study was designed to investigate the population parameters of the pelagic fish populations. The specific objectives were to (1) estimate population abundance and biomass at specific time intervals for each pelagic species, and (2) estimate production, mortality, and growth rate for each pelagic species during the intervals bound by the sampling dates.

592. Traynor, J. J., R. E. Thorne, and R. L. Burgner. 1973. Dynamics of limnetic feeding fish; I. Lake Washington: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 150. (unpublished) Location: UW SOF/THS

ABUNDANCE, FISH, L. WASHINGTON, SMELT, SOCKEYE SALMON

Acoustical population estimation methods in conjunction with biological information obtained by net sampling were used to obtain point estimates of abundance and biomass, and interval estimates of growth rate and production of the pelagic fish species in Lake Washington.

593. Traynor, J. J. 1973. Seasonal changes in the abundance, size, biomass, production, and distribution of the pelagic fish species in Lake Washington. M.S. Thesis. University of Washington. 91 pp. Location: UW SOF/THS

ABUNDANCE, DISTRIBUTION, FISH, GROWTH, L. WASHINGTON, SMELT, SOCKEYE SALMON, STICKLEBACK

A study of seasonal changes in the abundance, size, mortality, biomass, production, and distribution of the pelagic fish species in Lake Washington was conducted from March 1972 to February 1973. Collections of specimens stratified by depth were made at bimonthly intervals with a high speed midwater trawl in five areas of the lake. Acoustic surveys of the fish in the lake at approximately the same time as net sampling supplied abundance data.

594. Trepanier, T. W. 1974. The use of growth kinetics models to predict phytoplankton growth rates. M.S. Thesis. University of Washington. 71 pp. Location: UW SOF/THS

FINDLEY LAKE, MODELLING, PHYTOPLANKTON

During the period 7 June 1973 to 16 July 1973, Findley Lake was intensively sampled to determine which of several growth kinetics models with experimentally determined parameters best fit the observed growth rates. The models tested included (1) phosphorous only as the limiting factor, (2) nitrogen only limiting, (3) nitrogen and phosphorous limiting together, (4) an exponential light model, and (5) all three factors limiting together. The models were then compared with observed growth rates measured *in situ* at various depths throughout the study period using the P/B ratio or photosynthetic index on days when nutrient samples were collected.

595. Uchida, B. K., C. M. Whitmore, E. C. S. Duffield, J. F. Condon, R. R. Brenner, R. I. Matsuda, and G. D. Farris. 1976. An intensive water quality survey of 16 lakes selected in the Lake Washington and Green River basins (1973-1974). Metro. Seattle.

SMALL LAKES

A general summary of the biological, chemical, and physical characteristics are presented and discussed by parameter. The basic water quality problem viewed in many small suburban lakes is eutrophication.

596. Uchida, B. K. 1978. Profile of water quality in the Cedar-Green River basins. Municipality of Metropolitan Seattle. Seattle. Location: METRO Library

BEAR CREEK, CEDAR RIVER, COAL CREEK, EVANS CREEK, ISSAQUAH CREEK, JUANITA CREEK, KELSEY CREEK, L. SAMMAMISH, L. UNION, L. WASHINGTON, LITTLE BEAR CREEK, LYON CREEK, MAY CREEK, MCALEER CREEK, MERCER SLOUGH, NORTH CREEK, REVIEW, SAMMAMISH R., STREAMS, SWAMP CREEK, THORNTON CREEK

This report defines the existing water conditions and problems and the impact of these conditions on existing instream water uses so that decisions regarding the design and implementation of effective water quality management systems can be made by the public and agencies.

597. Uhte, W. R. 1964. Metropolitan Seattle's Renton treatment plant. *J. Wat. Pol. Con. Fed.* 36:475-494.

MANAGEMENT, SEWAGE, URBANIZATION

The Renton treatment plant, located at the south end of Lake Washington adjacent to the Green River, is one of the two major plants in Metro. It serves the east side of Lake Washington drainage basin, the Lake Sammamish basin, and the Green River basin. Includes information on the growing population, disposal of waste solids, site development, hydraulic design, equipment design, and operation design. A map of the area and drawings of different aspects of plant design are included (Wydoski, 1972).

598. United States. Works Progress Administration. 1938. Report on Green Lake algae control: W.P. Project #667-#4110-#5638: The sanitary survey. Joshua H. Vogel Library. Seattle. Location: Suzzallo Library

GREEN LAKE, PHYTOPLANKTON, SEWAGE, SMALL LAKES

This report is on the algae growth in Green Lake and the procedure used for its chemical purification. A total amount of 3,800 pounds of copper sulfate was added to the lake.

599. U.S. Army Corps of Engineers. 1973. Urban runoff and basin drainage study, Cedar River/Lake Washington & Green River basins: Potential demonstration areas. U.S.Army Corps of Engineers, River Basin Coordinating Committee. Seattle. Location: METRO Library

CEDAR RIVER, ISSAQUAH CREEK, L. WASHINGTON, LAND USE, MODELLING, STORMWATER, STREAMS, URBANIZATION

This report details the rating used to select five small watersheds to demonstrate the design capabilities of an urban runoff computer model.

600. U.S. Army. Corps of Engineers. 1979. State of Washington aquatic plant management program: Final environmental impact statement. U.S. Army Corps of Engineers, Seattle District. Seattle. Location: METRO Library

MANAGEMENT, MILFOIL

A program for the management of the nonnative aquatic plant Eurasian milfoil (*Myriophyllum spicatum* L.) is proposed for waters within the State of Washington.

601. U.S. Army. Corps of Engineers. 1979. State of Washington aquatic plant management program: Public brochure. U.S. Army Corps of Engineers, Seattle District. Seattle. Location: METRO Library

MANAGEMENT, MILFOIL

This brochure updates the planning that has taken place since the public workshops, provides the tentative COE's recommendations for the Aquatic Plant Management Program, presents the framework for implementation of the program, and compares the alternative methods of aquatic plant control and prevention.

602. U.S. Army. Corps of Engineers. 1980. Kenmore Navigation Channel, Kenmore, King County, Washington: Final detailed project report. U.S. Army Corps of Engineers, Seattle District. Seattle. Location: METRO Library

L. WASHINGTON, SAMMAMISH R.

This report examines the economic, technical, and environmental feasibility of a plan for Federal improvement and maintenance of a navigation channel to serve the Kenmore industrial park. The area was served by an inadequately sized, privately developed and maintained navigation channel.

603. U.S. Army Corps of Engineers. 1991. State of Washington aquatic plant management program. U.S. Army Corps of Engineers, Seattle District. Seattle. Location: METRO Library

MANAGEMENT, MILFOIL

The purpose of this supplement to the EIS (1979) for the Aquatic Plant Management Program for the State of Washington is to review and update both geographic and treatment-related program elements in light of nearly 12 years of experience.

604. U.S. Coast and Geodetic Survey. 1905. Lake Washington, Washington [map] Coast and Geodetic Survey. The Survey. Washington, D.C. Location: Suzzallo Library

L. WASHINGTON

Library's copy is mounted on linen. Scale 1:40,000 (W 1222641 - W 1220700/N 474704 - N472756). Contains corrections from surveys by the Corps of Engineers. Relief shown by contours and spot heights; depths shown by sounding in feet.

605. U.S. Department of Agriculture. 1941. Climate and man. U.S. Dept. Agric. Yearb. Agric.

CLIMATE

Provides 40-year averages of temperature, dates of killing frost, growing season, and precipitation. A summary for stations throughout the State of Washington is given on pages 1170-1181. Data for Seattle are summarized under King County on page 1171 (Wydoski, 1972).

606. U.S. Department of Agriculture, S. C. S. 1970. Outdoor recreation potential in Washington. Wash. State Soil Water Conserv. Comm. Olympia (WA). Location: Suzzallo Library

RECREATION

Reported is an appraisal of the potential for outdoor recreation in Washington State. Maps are provided that summarize various outdoor recreational activities as to high, medium, or low potential for each county (Wydoski, 1972).

607. U.S. Department of Commerce, E. D. S. 1975. Weather atlas of the United States. U.S. Dept. of Commer. Washington, D.C. Location: Fisheries Library

ATLAS, CLIMATE

Comprehensive summary of climatic maps showing the national distribution of mean, normal, and/or extreme values of temperature, precipitation, wind, barometric pressure, relative humidity, dew point, sunshine, sky cover, heating degree days, solar radiation, and evaporation (Wydoski, 1972).

608. U.S. Department of Commerce, E. D. S. 1898-present. Climatological data - Washington. U.S. Department of Commerce, Natl. Oceanic Atmos. Adm., Environ. Data Serv. Ashville (NC). (Allen library (Natural Sciences) has volumes from 1914- present)) Location: Allen Library

CLIMATE

Provides daily information on temperature, precipitation, total snowfall, and number of days with 2.5 cm or more of snow on the ground. See stations for the University of Washington, Seattle, and Seattle-Tacoma International

Airport. Supplemental data for the airport station include windspeed and direction, average relative humidity, percentage of possible sunshine, and average sky cover. Volumes from March 1898 to June 1965 issued by U.S. Weather Bureau; volumes from July 1965 to present issued by U.S. Environmental Data Service (Wydoski, 1972).

609. U.S. Department of Commerce, E. D. S. 1951-present. Climatological data: National summary. U.S. Depart. Commer., Natl. Oceanic Atmos. Adm., Environ. Data Serv. Ashville (NC). Location: Fisheries Library

CLIMATE

Monthly summaries of barometric pressure, temperature, precipitation, wind, cloud cover, percentage of possible sunshine, heating and cooling in degree days, and storms are provided. Climitological data are given in both metric and English units (Wydoski, 1972).

610. U.S. Department of Commerce, E. D. S. 1961. Climatic guide for Seattle, Washington, and adjacent Puget Sound area/ U.S. Department of Commerce, Weather Bureau. In: Climatography of the the United States, No. 40-45. U.S. Dep. Commer. Weather Bureau. Location: Allen Library

CLIMATE

Data in this publication were compiled primarily during 1959/1960 and in general include observations for the period of record through 1959. “Normal” values given in the reference are for the 30-year period of 1921-1950. Includes stations at the Federal Office Building in Seattle, at Boeing Field, and at the Seattle-Tacoma International Airport (Wydoski, 1972).

611. U.S. Department of Health Education and Welfare. 1969. Summary report of the northwest watershed project; pre-print. U.S. Dep. Health, Educ., Welfare, Public Health Serv., Bur. Water Hyg. Cincinnati (OH). Location: Engineering Library

BACTERIA, CEDAR RIVER, LAND USE, MAMMALS, URBANIZATION

This is a summary of microbiological water quality of three streams with different human population levels on the watersheds. Estimates the increase in human population densities, game animal population densities, and fecal coliform bacterial densities for the Cedar River watershed (Wydoski, 1972).

612. U.S. Department of Interior. 1970. The national atlas of the United States. USGS. Washington D.C. Location: Odegaard Library

ATLAS

This comprehensive atlas was designed to present the principal characteristics of the country, in cartographic format, including the physical features, historical evolution, economic activities, sociocultural conditions, administrative subdivisions, and place in world affairs (Wydoski, 1972).

613. U.S. Department of Interior. 1955. Monthly and yearly summaries of hydrographic data in the State of Washington to September 1953. USGS. Water Supply Bulletin.

FLOW

Provided are mean freshwater discharges in all the streams of Washington State river basins from the start of monitoring to September 1953 (Wydoski, 1972).

614. U.S. Department of Interior. 1956. Report on surface water investigations in Lake Washington basin and adjacent basins. USGS. Tacoma. Location: Fisheries Library

FLOW, L. WASHINGTON, STREAMS

This document contains flow data only on stream investigations. Drainage areas are given for many streams. Discharge measurements are provided for a subset of these streams.

615. U.S. Department of Interior. 1961-present. Water resources data for Washington. Part I. Surface water records. USGS, Water Resources Division. Tacoma (WA).

FLOW

Provided are data collected at USGS stations for various locations in the Lake Washington basin (Wydoski, 1972).

616. U.S. Department of Interior. 1961-present. Water resources data for Washington. Part 2. Water quality records. USGS, Water Resources Division. Tacoma (WA).

CHEM. LIMNOLOGY

617. U.S. Department of Interior., and F. F. Henshaw. 1913. Water powers of the Cascade Range: Part 2 Cowlitz, Nisqually, Puyallup, White, Green, and Cedar drainage basins. U.S. Geological Survey. Water Supply Pap. 313. Location: Suzzallo Library

CEDAR RIVER, FLOW

The Cedar River drainage basin encompasses 528 km^2, and was formed through glaciation. Gage reading records for monthly estimates of discharge and runoff are maintained at Vaughn Bridge near North Bend, Cedar Lake near North Bend, Ravensdale, and Renton. The power possibilities of Cedar Lake are described (Wydoski, 1972).

618. U.S. Department of Interior. (various years). Surface water supply of United States, Pacific slope basins in Washington and upper Columbia River basin. USGS. Water Supply Paper.

FLOW

For each drainage basin, a general description is given covering area, source, tributaries, topography, geology, forestation, rainflow, irrigation, storage, power, etc. At each gaging station data collected are as follows: a list of discharge measurements; a table of daily gage heights; a table of daily, monthly, and yearly discharges; runoff; and the relation of gage height to discharge with respect to ice, logging, shifting channels, and backwater (Wydoski, 1972).

619. Van Winkle, W. 1914. Quality of the surface waters of Washington. U.S. Geol. Surv. Water Supply Paper 339. Location: Suzzallo Library

CEDAR RIVER, CHEM. LIMNOLOGY

Mineral analysis, color, and alkalinity determinations were made in the Cedar River at Ravensdale, 1910/1911. Results are summarized in tables (Wydoski, 1972).

620. Waddle, T. J. 1979. Continous snowmelt runoff simulation of the Cedar River watershed, Washington. M.S. Thesis. University of Washington. 79 pp. Location: Engineering Library

CEDAR RIVER, FLOW, MODELLING

A continous simulation of watershed snowmelt and runoff developed for California watersheds could not be successfully calibrated for the Cedar River.

621. Wakeham, S. G. 1977. Hydrocarbon budgets for Lake Washington. *Limnol. Oceanogr.* 22:952-957.

HYDROCARBONS, L. WASHINGTON, POLLUTION, SEDIMENTATION, STORMWATER, URBANIZATION

Fluxes of hydrocarbons through Lake Washington show that urban stormwater runoff and river runoff are the major sources of petroleum hydrocarbons to the lake. Sedimentation is the primary removal process for these hydrocarbons.

622. Wakeham, S. G., and J. W. Farrington. 1980. Hydrocarbons in contemperary aquatic sediments. In: Fate and Transport, Case Studies, Modeling, Toxicity: Contaminants and Sediments, VOLUME 1, Vol. 1, (Ed.) R. A. Baker. Ann Arbor Science Publishers Inc. Ann Arbor, MI. pp. 3-32

HYDROCARBONS, L. WASHINGTON, MODELLING, POLLUTION, SEDIMENTS

The results of numerous investigations worldwide are summarized pointing out significant features. Then several representative areas illustrate the understanding of the biogeochemistry of hydrocarbons in contemporary sediments. The locations are: the western North Atlantic continental margin and abyssal plain; Southwest Africa's continental shelf and slope; Buzzards Bay, Massachusetts; Narragansett Bay, Rhode Island; Lake Washington, Washington; Lake Constance; Lake Lucerne, Lake Zurich and Greifensee, Switzerland; and the Pettaquamscutt River, Rhode Island. Qualitative and quantitative distributions of alkane, alkene and aromatic hydrocarbons in these sediments are discussed in terms of sources, chemical and biochemical reactions, and biological and geochemical transport processes. Attention is focused primarily on compounds in the molecular weight range between n-C_{14} and n-C_{31}, naphthalenes to five-ring aromatics.

623. Wakeham, S. G., C. Schaffner, and W. Giger. 1980. Polycyclic aromatic hydrocarbons in recent lake sediments. 1. Compounds having anthropogenic origins. *Geochim. Cosmochim. Acta* 44:403-413.

HYDROCARBONS, L. WASHINGTON, POLLUTION, SEDIMENTS, URBANIZATION

Polycyclic aromatic hydrocarbons (PAH) in sediment cores from Lake Lucerne, Lake Zurich, and Greifensee, Switzerland, and Lake Washington, northwest USA, have been isolated, identified and quantified by glass capillary gas chromatography and gas chromatography/mass spectrometry. Surface sediment layers are greatly enriched in PAH - up to 40 times - compared to deeper layers. In addition, concentration increases in upper sediments generally correspond to increasing industrialization and urbanization in the catchment basins of the lakes. Few PAH could be detected in pre-industrial revolution sediments, indicating that background levels for most PAH in aquatic sediments are extremely low. These results are consistent with an anthropogenic source for most of the aromatic hydrocarbons present in the modern sediments. A comparison of PAH distributions in the sediments and in possible source materials shows that urban runoff of street dust may be the most important PAH input to these lacustrine sediments. There is evidence that a significant contribution to the PAH content of street dust comes from material associated with asphalt.

624. Wakeham, S. G., C. Schaffner, and W. Giger. 1980. Polycyclic aromatic hydrocarbons in recent lake sediments. Compounds derived from biogenic precursors during early diagenesis. *Geochim. Cosmochim. Acta* 44:415-429.

BACTERIA, HYDROCARBONS, L. WASHINGTON, SEDIMENTS

Five groups of polycyclic aromatic hydrocarbons (PAH) thought to be derived by early-diagenetic transformations of biogenic precursors are apparently present in recent sediments of four lakes (Lake Lucerne, Lake Zurich, and Greifensee, Switzerland, and Lake Washington, northwest U.S.A.). These natural PAH include: (1) perylene, (2) an extended series of phenanthrene homologs, (3) retene and pimanthrene derived from diterpenes, (4) a series of tetra- and pentacyclic PAH derived from pentacyclic triterpenes of the amyrin-type, and (5) tetra- and pentacyclic PAH formed from pentacyclic triterpenes with five-membered E-rings. Since these PAH are abundant in very young sediment layers, the transformation reactions involved appear to be faster than previously thought and may be microbially mediated. There is no evidence that anthropogenic or petrogenic sources can account for the distributions of these groups of PAH in cores of recent lake sediments.

625. Wakeham, S. G. 1976. The geochemistry of hydrocarbons in Lake Washington. Ph.D. Dissertation. University of Washington. 191 pp. Location: Suzzallo Thesis Stacks

HYDROCARBONS, L. WASHINGTON

The purposes of this investigation were as follows: 1) to establish a laboratory capable of performing trace hydrocarbon analysis on environmental samples, 2) to determine the distribution of aliphatic hydrocarbons in the sediments of Lake Washington, 3) to use radiocarbon dating and stable carbon isotope mass spectrometry to provide information as to the sources of these hydrocarbons, and 4) to determine hydrocarbon levels in the most likely sources and sinks and to use this distribution data to establish a hydrocarbon budget for Lake Washington.

626. Waldron, K. D. 1953. A new subspecies of *Pontoporeia affinis* in Lake Washington, with a discussion of morphology and life cycle. M.S. Thesis. University of Washington. 78 pp. Location: UW SOF/THS

L. WASHINGTON, ZOOPLANKTON

The purposes of this paper were to (1) determine the taxonomic status of the *Pontoporeia* present in Lake Washington, and (2) present a general description of its life history.

627. Walters, R. A. 1980. A time- and depth-dependent model for physical, chemical and biological cycles in temperate lakes. *Eco. Modelling* 8:79-96.

L. WASHINGTON, MODELLING, NUTRIENTS, PHYTOPLANKTON, TEMPERATURE

A model was developed in which eddy diffusion of algal cells and dissolved nutrients is consistent with mixing processes which influence the thermal structure of the lake. Using standard modelling formulations for net production, respiration and nutrient uptake, results show that chlorophyll-*a* and nutrient distributions are controlled to a large extent by turbulent mixing processes considered in the thermal model. The thermal model follows the general approach of Sundaram and Rehm which leads to a physically realistic description of temperature structure, particularly around the start of stratification in spring. The general biological model considers dependent variables as continuous in space and time, and details nutrient movements within lakes. The biological production model is formulated in terms of paired, coupled, nonlinear partial differential equations governing chlorophyll-*a* and dissolved phosphorus distributions. The equations are solved by finite differences and iteration techniques. A number of formulations for eddy diffusivity in the epilimnion and hypolimnion were evaluated and the results are compared with 1963 data for Lake Washington, Washington. Simulation results compare favorably with measured distributions in Lake Washington. It concludes that a close relationship can exist between the stratification cycle and algal-nutrient distributions. The numerical model was developed to study complex relationships between physical, chemical and biological processes occurring in many deep, stratified temperate lakes.

628. Wang, Fing-H. 1955. Recent sediments in Puget Sound and portions of Washington Sound and Lake Washington. Ph.D. Dissertation. University of Washington. 160 pp. Location: Fisheries Library

L. WASHINGTON, SEDIMENTS

Reviewed here are the bottom characteristics, sediment distribution, analytic properties of the sediments, and related concepts of Puget Sound, parts of the San Juan Islands, and the central-northern part of Lake Washington. (Wydoski, 1972)

629. Warner, E. J. 1990. The horizontal and vertical movement patterns of rainbow trout (*Oncorhynchus mykiss*) in Lake Washington. M.S. Thesis. University of Washington. 75 pp. Location: Fisheries Library

DIET, DISTRIBUTION, FISH, L. WASHINGTON, RAINBOW TROUT

Six rainbow trout were captured in Lake Washington, outfitted with ultrasonic transmitters, released back into the lake, and tracked for an average of 55 hours each. The trout remained close to shore during the day, travelling back and forth along the shore with an average velocity of 18 cm/s. Five of the six fish made one relatively quick excursion across the lake. Distribution and movement of the fish suggests that these fish are feeding on *Daphnia* during most of daylight hours, supplementing this with sculpins and, to a lesser extent, juvenile yellow perch and other nearshore juvenile fishes.

630. Washington Department of Fisheries. 1931. Outline of biological survey for the season 1929 and 1930. *Wash. State Dep. Fish. Ann. Rep.* 40-41(1929-1930):141. Location: Fisheries Library

CHINOOK SALMON, CHUM SALMON, COHO SALMON, FISH, PINK SALMON, SOCKEYE SALMON, STEELHEAD

This report lists the six main tributaries of the Lake Washington watershed and gives the migration distance of salmon. Shows chum and sockeye to be absent; chinook, pink, and steelhead were present in all streams. The silver was scarce in all streams (Wydoski, 1972).

631. Washington Department of Fisheries. 1956. Freshwater research - Puget Sound salmon escapement. *Wash. State Dep. Fish. Ann. Rep.* 66(1956):22. Location: Fisheries Library

CHINOOK SALMON, ESCAPEMENT, FISH

During 1956 the salmon escapement varied from very high to very low depending on the species. Escapement of fall chinook salmon in the Cedar River was very high (Wydoski, 1972).

632. Washington Department of Fisheries. 1958. Report on the salmon escapement in the State of Washington, 1958. *Wash. State Dep. Fish. Ann. Rep.* 68(1958):67-70. Location: Fisheries Library

CHINOOK SALMON, ESCAPEMENT, FISH, SOCKEYE SALMON

This report refers to chinook and sockeye salmon (Wydoski, 1972).

633. Washington Department of Fisheries. 1967. Sockeye salmon to Cedar River record size this year. *Washington State Department of Fisheries Newletter* 66:2-3.

CEDAR RIVER, FISH, SOCKEYE SALMON, STOCKING

This is a short review of sockeye salmon plantings in the Cedar River in the 1930s. The experiment was considered unsuccessful until 1960, when the return was 12,000; 1964 was 50,000-70,000; 1966 was 60,000; and 1967 was expected to be over 100,000 (Wydoski, 1972).

634. Washington Department of Fisheries. 1968. Lake Washington sockeye salmon investigation. *Washington State Department of Fisheries Newletter* 69:1-2.

ESCAPEMENT, FISH, SOCKEYE SALMON

This is a report on the test fishing net at the Hiram M. Chittenden Locks to monitor escapement and gather biological data on Lake Washington sockeye salmon (Wydoski, 1972).

635. Washington Department of Fisheries. 1968. Lake Washington sockeye fishery. *Washington State Department of Fisheries Newletter* 71:1.

CHINOOK SALMON, FISH, SOCKEYE SALMON

The first season of fishing for Lake Washington sockeye salmon in Puget Sound ended in July 1968; 26,000 out of a total run of 100,000 to 125,000 fish were caught. Incidental catch of maturing chinook and coho salmon was less than 8 percent (Wydoski, 1972).

636. Washington Department of Fisheries. (various years). Stream improvemnt and hydraulics. Washington State Dep. Fish. Ann. Rep. (59(1949):12; 63(1953):53; 67(1957):31; 72(1962):60; 73(1963):60; 74(1964):68; 75(1965):55-56; 76(1966):184; 77(1967):85-86; 78(1968):83; 79(1969):119; 80(1970):84-85.) Location: Fisheries Library

STREAMS

Lists stream clearance, improvements, surveys, and miles of stream cleaned for streams in the Lake Washington basin (Wydoski, 1972).

637. Washington Department of Fisheries. (various years). Information about Washington State hatcheries. Wash. State Dep. Ann. Rep. (58(1948):75; 64(1954):20; 67(1957):23; 68(1958):107-108.) Location: Fisheries Library

HATCHERIES

Lists various hatchery information such as history, location, operations, statistics on total fecundity, hatching capacity, and rearing pond capacity (Wydoski, 1972).

638. Washington Department of Fisheries. (various years). Construction projects. Washington State Dep. Fish. Ann. Rep. (58(1948):78-79; 67(1957):30, 61; 68(1958):24, 193; 69(1959):65, 130; 71(1961):109; 72(1962):31, 87; 73(1963):75, 123; 74(1964):141; 77(1967):71; 78(1968):136; 79(1969):111; 80(1970):97-98.)

STREAMS

Provided are lists of various construction projects in the Lake Washington basin (Wydoski, 1972).

639. Washington Department of Fisheries. (various years). Fish planted from state salmon hatcheries during various years. Wash. State Dep. Fish. Ann. Rep. (58(1948):73; 59(1949):52; 60(1950):62; 62(1951,1952):90-91; 64(1954):53-56; 67(1957):50-53; 68(1958):200, 204; 69(1959):138; 71(1961):89; 72(1962):102; 73(1963):105; 74(1964):124; 75(1965):95; 76(1966):202; 77(1967):120; 78(1968):126; 79(1969):153; 80(1970):127.)

FISH, STOCKING

Provides data on fish stocking (Wydoski, 1972).

640. Washington Department of Fisheries. (various years). Egg take of individual hatcheries of various brood years. Wash. State Dep. Ann. Rep. (58(1948):72; 59(1949):51; 60(1950):63; 62(1951,1952):88; 64(1953):61, 62; 64(1954):56; 67(1957):49; 68(1958):194; 69(1959):132; 71(1961):83; 72(1962):96; 73(1963):98; 74(1965):88; 76(1966):95; 77(1967):113; 78(1968):119; 79(1969):145; 80(1970):119.)

FISH, HATCHERIES

Provides lists of egg takes (Wydoski, 1972).

641. Washington Department of Fisheries. (various years). Plantings of salmon by major watersheds. Wash. State Dep. Fish. Ann. Rep. (67(1957):54; 68(1958):206; 69(1959):143; 70(1960):131; 71(1961):95; 72(1962):110; 73(1963):113; 74(1964):132; 75(1965):103; 76(1966):211; 77(1967):127; 78(1968):133; 79(1969):163; 80(1970):135.)

FISH, STOCKING

Lists numbers of salmon planted (Wydoski, 1972).

642. Washington Department of Fisheries. (various years). Escapement to hatchery racks. Wash. State Dep. Fish. Ann. Rep. (59(1949):68-69; 60(1950):61-66; 62(1951,1952):92; 63(1953):63; 64(1954):57; 68(1958):195-197; 69(1959):133-135; 71(1961):84-86; 72(1962):97-99; 73(1963):100-102; 74(1964):118-120; 75(1965):90-92; 76(1966):197-199; 77(1967):115-117; 78(1968):121, 123; 79(1969):148, 150; 80(1970):122.)

ESCAPEMENT, FISH

Provides data on escapement (Wydoski, 1972).

643. Washington Department of Fisheries. (various years). Report on the salmon escapement in the State of Washington. Wash. State Dep. Fish. Ann. Rep. (1965(1964):7, 10, 15; 1966(1965):9, 12, 16; 1968(1967):8, 10, 14; 1969(1968):8, 10, 14; 1970(1969)PS-2, PS-4, PS-7.)

ESCAPEMENT, FISH

These reports provide yearly index counts for salmon in the Lake Washington basin (Wydoski, 1972).

644. Washington Department of Fisheries, Washington Department of Wildlife, and Western Washington Treaty Indian Tribes. 1993. 1992 Washington State salmon and steelhead stock inventory (SASSI). Washington Department of Fisheries. Olympis (WA). Location: UW SOF/THS

CEDAR RIVER, CHINOOK SALMON, CHUM SALMON, COHO SALMON, FISH, ISSAQUAH CREEK, L. SAMMAMISH, L. WASHINGTON, MANAGEMENT, SOCKEYE SALMON, STEELHEAD

This inventory is a compilation of all wild stocks, and a scientific determination of each stock's status. This report forms the basis for measuring future actions to restore stocks to a healthy, fishable status, and is a starting point

that will be modified as new information is obtained. The intent is for SASSI to be a living document regularly updated and revised as new information is available.

645. Washington State Department of Fish and Game. 1903-1904. Statement of fish and eggs furnished the State of Washington by the U.S. Bureau of Fisheries for the years 1895-1904, inclusive. *Wash. State Dep. Fish. Ann. Rep.* 14-15:72-77. Location: Fisheries Library

FISH, STOCKING, STREAMS

Provided is a list of waters stocked, point of deposit, species, and numbers planted (Wydoski, 1972).

646. Washington State Department of Fish and Game. 1929-1930. Summary of stream surveys for bienium 1929-1930. *Wash. State Dep. Fish. Ann. Rep.* 40-41:141-145. Location: Fisheries Library

FISH, STOCKING, STREAMS

647. Washington State University. 1968. Washington climate for these counties: King, Kitsap, Mason, Pierce. Coop. Ext. Serv., Coll. Agric. Wash. State Univ. Pullman (WA). Location: Fisheries Library

CLIMATE

This document provides information on temperature, precipitation, snow depth, and water content by month for various stations in the Lake Washington drainage (see King County). Also provides hourly and daily average of solar radiation (in langleys) by month and hourly averages of wind by month, as well as readings of sky cover and relative humidity at varying intervals at the Seattle-Tacoma International Airport (Wydoski, 1972).

648. Water Resources Engineers Inc. 1968. Applications of mathematical models for prediction of the thermal and quality behavior of Lake Washington. Washington Pollution Control Commission. Olympia.

L. WASHINGTON, MODELLING, TEMPERATURE

Lake Washington is representative of the benefits, problems, and confusion that come with the development and use of large lakes in proximity to population centers. The dominant characteristics and problems of Lake Washington can be described by five major elements: Lakes Washington and Sammamish, Sammamish and Cedar Rivers, and the Ship Canal. All the elements reveal an involved and highly interdependent hydrologic and water quality situation. The system's response to any action will depend on many interrelated factors. This paper tries to determine the subtle responses of the system, quality and temperature techniques and tools are demonstrated and developed for comprehensive investigations and management of the aquatic resources (Wydoski, 1972).

649. Wekell, M. M. B. 1975. Glucose mineralization and chitin hydrolysis by bacteria associated with the sediment in four lakes in the Lake Washington drainage basin. Ph.D. Thesis. University of Washington. 307 pp. Location: UW SOF/THS

BACTERIA, CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, L. WASHINGTON, SEDIMENTS

Glucose mineralization rates of heterotrophic bacteria associated with sediment were measured seasonally in four lakes of varying trophic state in the Lake Washington drainage basin. Higher glucose mineralization rates and bacterial plate counts were found in sediment collected from the littoral than from benthic stations, with the exception of Lake Sammamish when the hypolimnion was anaerobic. Glucose mineralization showed seasonal variations, with higher rates in summer than in winter months. The greatest seasonal flucuations were observed for the oligotrophic lakes, Chester Morse and Findley.

650. Welander, A. D. 1940. A study of the development of the scale of the chinook salmon (*Onchorhynchus tschawytscha*). M.S. Thesis. Univeresity of Washington. 59 pp. Location: Fisheries Library

CHINOOK SALMON, FISH, GROWTH

The scales of chinook salmon up to 108 mm in length were studied in relation to growth at the University of Washington (Wydoski, 1972).

651. Welch, E. B., G. R. Hendrey, A. Litt, and C. A. Rock. 1973. Phytoplankton productivity and growth rate kinetics in the Cedar River watershed: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 140. (unpublished) Location: UW SOF/THS

CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, NUTRIENTS, PHYTOPLANKTON, PRODUCTIVITY

Lakes Findley, Chester Morse, and Sammamish are characterized by one major outburst of phytoplankton productivity and biomass (mainly diatoms) with usually no or low fall activity. Vernal outbursts were often delayed in the monomictic lakes by inadequate light because of unfavorable climate and/or a lack of thermal stratification.

652. Welch, E. B., G. R. Hendrey, A. Litt, and C. A. Rock. 1973. Phytoplankton productivity and growth rate kinetics in the Cedar River lakes: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal report 70. (unpublished) Location: UW SOF/THS

CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, PHYTOPLANKTON, PRODUCTIVITY

This progress report provides a table of the sampling schedule in the three lakes.

653. Welch, E. B., G. R. Hendrey, and C. A. Rock. 1972. Phytoplankton productivity and response to altered nutrient content in lakes of constrasting trophic state: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle, Internal Report 80. (unpublished) Location: UW SOF/THS

CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, PHYTOPLANKTON, PRODUCTIVITY

Lakes Findely, Chester Morse and Sammamish are characterized by one major outburst of phytoplankton productivity and biomass (mainly diatoms) with usually no or low fall activity. Vernal outbursts were often delayed in some lakes and years probably by unfavorable climate.

654. Welch, E. B., A. Litt, and G. L. Pederson. 1973. Zooplankton production and feeding in lakes of the Cedar River: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal report 69. (unpublished) Location: UW SOF/THS

CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, ZOOPLANKTON

This report details the progress of a study of zooplankton production and feeding in Lake Sammamish, Findley Lake and Chester Morse Reservoir.

655. Welch, E. B., G. L. Pederson, and R. K. Stoll. 1972. Grazing and production by zooplankton in lakes of constrasting trophic status - A progress report: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 81. (unpublished) Location: UW SOF/THS

CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, ZOOPLANKTON

Grazing and density of the crustacean zooplankton were measured in Findley and Chester Morse Lakes and Lake Sammamish. Sample analysis is incomplete, thus estimates of production from examination of life stage biomass changes were not possible.

656. Welch, E. B., G. L. Pederson, and R. K. Stoll. 1973. Grazing and production by zooplankton in lakes of the Cedar River watershed: Coniferious Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 139. (unpublished)

CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, ZOOPLANKTON

Zooplankton grazing rates and life history stage densities for secondary production estimates were determined in three lakes: Lakes Sammamish and Findley, and Chester Morse Reservoir.

657. Welch, E. B., C. A. Rock, R. C. Howe, and M. A. Perkins. 1980. Lake Sammamish response to wastewater diversion and increasing urban runoff. *Water Res.* 14:821-828.

L. SAMMAMISH, NUTRIENTS, PHYTOPLANKTON, SEWAGE, STORMWATER, URBANIZATION

Lake Sammamish has shown a decrease in its mean annual concentration of phosphorus following diversion of about one-third of the external loading in 1968. During 1971-1975 the P concentration averaged 27 micrograms/l, in contrast to the prediversion (1964-1966) concentration of 33 micrograms/1, and may be equilibrating near the predicted steady-state concentration of 22 micrograms/l. Neither phytoplankton biomass or Secchi visibility has changed following diversion; however, the blue-green component of the phytoplankton decreased by nearly 50%. The failure of biomass and visibility to improve is probably a result of similar pre- and postdiverson winter-spring epilimnetic P concentrations. The marked reduction in P since diversion occurred during and prior to fall overturn and may have represented a supply or P for later summer early fall blue-green algal populations that declined after diversion. Runoff from a rapidly developing westside portion (18%) of the watershed is contributing substantially to P loading of the lake. Development to a density of about ten dwellings/ha has increased loadin possibly on the order of 14%. Future development of the eastside portion (26% of watershed) may increase loading by 20% and be equivalent to nearly one-half of the P previously diverted in 1968.

658. Welch, E. B., D. E. Spyridakis, and R. F. Christman. 1972. Geochemical equilbria and primary productivity in natural lakes: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal report 30. (unpublished) Location: UW SOF/THS

CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, L. WASHINGTON, NUTRIENTS, PHYTOPLANKTON, SEDIMENTS

This paper reports on the first year of gathering existing information, initiation of monitoring water quality, evaluation of analytical methods and procedures for measuring nutrient regeneration in the sediment-water interface, and the study of growth-environment correlations in Findley Lake, Chester Morse Reservoir, and Lakes Sammamish and Washington.

659. Welch, E. B., D. E. Spyridakis, J. I. Shuster, and R. R. Horner. 1986. Declining lake sediment phosphorus release and oxygen deficit following wastewater diversion. *J. Wat. Pol. Con. Fed.* 58:92-96.

L. SAMMAMISH, NUTRIENTS, SEDIMENTS, SEWAGE

Sediment phosphorus release rates were determined *in vitro* from cores obtained in Lake Sammamish, Washington, and these data and sediment P content results were compared with results from the early 1970's. In addition, a P mass balance model was used to independently evaluate sediment release. Lake Sammamish failed to show a predictable response after P loading was reduced by one-third through wastewater diversion in 1968. Over the past 5 years, however, P concentrations, summer chlorophyll a, and transparency have improved markedly. This dramatic improvement has been largely the result of a decrease in the anaerobic sediment P release rate during summer and fall. The decrease in sediment P release, as determined recently by the rate of hypolimnetic buildup of P, was substantiated by sediment content of interstitial P and by rate of P release in anaerobic columns, but not by total P content in the sediment. Decreased P release rate was also verified by mass balance model. The observed trend of a decreasing rate of hypolimnetic P buildup following diversion may have been caused by a gradual removal of flocculent particulate material, and hence the decreased oxygen demand, at rates much less than the flushing rate.

660. Welch, E. B., T. Wiederholm, D. E. Spyridakis, and C. A. Rock. 1975. Nutrient loading and trophic state of Lake Sammamish, Washington. Department of Civil Engineering, Water and Air Resources Division, University of Washington. Seattle. (Additional tables not published are with the report)

FISH, L. SAMMAMISH, MODELLING, NUTRIENTS, PHYTOPLANKTON, SEDIMENTS, ZOOPLANKTON

This report provides the results of continous monitoring of limnological characteristics from late 1969 to 1975. Included are studies of secondary production (zooplankton and fish), nutrient exchange rates between sediment and water, phytoplankton uptake of nutrients, feeding rates of zooplankton, profundial bottom fauna, and a dynamic modelling of the phosphorous cycle, as well as an evaluation of the nutrient (particularlly P) income.

661. Welch, E. B., T. Wiederholm, D. E. Spyridakis, and C. A. Rock. 1977. Nutrient loading and trophic state of Lake Sammamish, Washington. In: North American Project—A Study of U.S. Water Bodies. EPA Report. EPA. Publication No. EPA-600/3-77-086. pp. 301-320

L. SAMMAMISH, NUTRIENTS, PHYTOPLANKTON, SEDIMENTS, SEWAGE

Lake Sammamish, Washington maintains its mesotrophic status, despite eutrophic levels of nutrient loading, through an internal iron-controlled sediment-water interchange mechanism which regulates incoming phosphorus available to phytoplankton. Total iron correlates closely with total phosphorus as oxygen is exhausted in the hypolimnion during August-October; the oxygen deficit rate is consistently high, about 0.05 mg/cm^2/day. Although phosphorus increases in surface waters following lake turnover in late November, phosphorus is rapidly complexed—probably by ferric hydroxides. Much of the released phosphorus is thereby resedimented and rendered unavailable to the phytoplankton when light is adequate in April and May. Lake Sammamish has been mesotrophic for over 100 years, according to sediment core analysis. The lake has been continuously monitored since 1969. Because of early signs of eutrophication, secondary effluent from the town of Issaquah and dairy processing wastes were diverted in 1968, amounting to one-third of the lake's phosphorus loading. The internal control mechanism can resist phosphorus loading changes over a range of at least 0.66-1.0 g P/m^2/yr; stability is not likely to persist over a much greater range. Maximum total phosphorus is at overturn, reaching 40 micrograms/l (which, before diversion, exceeded 100). Total phosphorus loading is 0.66 g/m^2/yr and total nitrogen is 13 g/m^2/yr. Phytoplankton biomass, primary productivity, and benthic communities all indicate mesotrophy.

662. Welch, E. B. 1977. Nutrient diversion: Resulting lake trophic state and phosphorus dynamics. US Environmental Protection Agency. Corvallis (OR). (EPA-600/3-77-003) Location: UW SOF/THS

L. SAMMAMISH, NUTRIENTS, SEWAGE

Lake Sammamish was studied during 1970-75 to determine the response to wastewater diversion in 1968. The results were compared with a pre-diversion study by Seattle Metro in 1964-65. Diversion reduced the P loading by about one third - from 1.02 to 0.67 g P/m^2-yr and about 119 to 68 µg/L in the inflow.

663. Welch, E. B., M. A. Perkins, and R. R. Zisette. 1981. Trophic state and phosphorus budget of Pine Lake, Washington. Municipality of Metropolitan Seattle. Seattle. Location: METRO Library

NUTRIENTS, PINE LAKE, SMALL LAKES

Pine Lake has shown the consequences of increased eutrophication over the past years and, as a result, has been the subject of several restoration proposals. This report contains two sections; 1) a definition of the trophic state of Pine Lake and description of temporal variations in selected lake characteristics relative to that state and; 2) a phosphorus budget for the lake calculated on both a monthly and annual basis.

664. Welch, E. B., D. E. Spyridakis, and R. F. Christman. 1971. Geochemical equilibria and primary productivity in natural lakes: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 30. (unpublished) Location: UW SOF/THS

CHESTER MORSE RES., FINDLEY LAKE, L. SAMMAMISH, L. WASHINGTON, NUTRIENTS, PHYTOPLANKTON, PRODUCTIVITY, SEDIMENTS

Preliminary data indicate that 3 years after the major portion of phosphorous was diverted from Lake Sammamish, the chemical and biological characters are showing only slight and probably insignificant changes compared to what has been observed in Lake Washington. The chemical and biological characteristics of the lakes reveal a graded sequence in chemical composition and productivity. A 4- to 20-fold increase in concentration is observed with most chemical and biological parameters when Findley and Chester Morse Lakes are compared to Lake Washington.

665. Welch, E. B., and D. E. Syridakis. 1972. Dynamics of nutrient supply and primary production in Lake Sammamish, Washington. In: Research on Coniferous Forest Ecosystems: First Year Progress in the Coniferous Forest Biome, US/IBP, (Eds.) J. F. Franklin, L. J. Dempster, and R. H. Waring. Pacific Northwest Forest and Range Experiment Station, U.S. Department of Agriculture. Portland. pp. 301-316

L. SAMMAMISH, NUTRIENTS, PRODUCTIVITY, SEDIMENTS

Annual nutrient budgets suggest a reduction in sedimented P since diversion but little change in the quantity of P relesed from anaerobic sediment. P availability in the water column (winter mean content) appears to be controlled by Fe precipitation to a greater extent than in Lake Washington. Experiments in situ show that N and P are equally limiting to summer phytoplankton productivity, but as found in Lake Washington, P may be of more long-term significance.

666. Wells, M. E. 1930. A study of western Washington Trichoptera. M.S. Thesis. University of Washington. 73 pp.

INVERTEBRATES

A key to the genera of the Limnephilidae and descriptions of all species that are known from Western Washington are provided. The locations of many species are given as Seattle, and presumably some were collected from Lake Washington drainage (Wydoski, 1972).

667. Whetten, J. T. 1966. Lake Washington's third dimension. *Pac. Search* 1:5-6.

L. WASHINGTON, PALEOLIMNOLOGY

The seismic profile shows the original basin and the older sediment to be of glacial origin. The last glacier was 14,000 years ago, but 13,5000 years ago organic material began to be deposited. Since then organic deposition has continued slowly, punctuated 6700 years ago by volcanic ash from the eruption of Mount Mazam (Crater Lake) (Wydoski, 1972).

668. White, S. T. 1975. The influence of piers and bulkheads on the aquatic organisms in Lake Washington. M.S. Thesis. University of Washington. 132 pp. Location: UW SOF/THS

BENTHIC, L. WASHINGTON, PERIPHYTON, PIERS, SHORELINE

The study objectives were to (1) obtain greater insight into the influences of shoreline development and its related physical and biological factors which may stress the fish and fish food organisms in Lake Washington, (2) identify and peruse residential, commercial, and industrial pressures which have intensified in recent years, (3) document and evaluate wetlands and other shallow water habitats damaged and/or destroyed due to unregulated developmnet, and (4) obtain biological data to assist in developing assessment of the magnitude of the impact associated with piers, fills, and bulkheads.

669. White, S. T., and D. J. Martin. 1976. A baseline study of the benthic community in small streams. Municipality of Metropolitan Seattle. Seattle. Location: Fisheries Library

BEAR CREEK, BENTHIC, CAREY CREEK, COAL CREEK, EVANS CREEK, INVERTEBRATES, ISSAQUAH CREEK, JUANITA CREEK, KELSEY CREEK, LITTLE BEAR CREEK, MAY CREEK, MCALEER CREEK, NORTH CREEK, STREAMS, SWAMP CREEK, THORNTON CREEK, YARROW BAY

This study's primary objectives were to 1) establish baseline information on the benthic macroinvertebrates in the majority of the small stremas located in the Lake Washington and Green River drainage basins, 2) identify present problem areas in streams for planning, 3) compile a library of major invertebrate organisms commonly encountered in the streams, and 4) establish a sampling plan that can be followed in future stream surveys.

670. Whitmore, C. M. 1978. Quality of seven streams in the Lake Washington drainage basin Nov 1972-Dec 1974. Metro. Seattle. Location: METRO Library

BEAR CREEK, EVANS CREEK, LITTLE BEAR CREEK, LYON CREEK, MCALEER CREEK, NORTH CREEK, STREAMS, SWAMP CREEK, THORNTON CREEK

671. Whitney, R. R., and N. W. Bartoo. 1973. Standing crop, production, and population dynamics of selected benthic and littoral fishes in the lakes of the Lake Washington drainage: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle, Internal Report 154. (unpublished) Location: UW SOF/THS

BENTHIC, BULLHEAD, FISH, L. SAMMAMISH, L. WASHINGTON, MODELLING, PEAMOUTH, SQUAWFISH, SUCKER

This paper introduces a benthic and littoral submodel that is compatible with the aquatic modelling effort (IBP) and will allow investigations of environmental and population changes on the fish populations.

672. Wiederholm, T. 1979. Chironomid remains in recent sediments of Lake Washington. *Northwest Sci.* 53:251-257. Location: UW SOF/THS

INVERTEBRATES, L. WASHINGTON, PALEOLIMNOLOGY, SEDIMENTS

The verticle distribution of chironomid remains in the sediment of Lake Washington was determined in each centimeter of core 35 cm long taken from a depth of 63 m in 1975. The time covered is nearly 100 years, and thus includes the period of eutrophication and recovery. More than 900 individuals representing 51 taxa were found, most of them of littoral and sublittoral origin. Results show that the bottom fauna did not respond to eutrophication with major changes in species composition.

673. Williams, J. R., and S. A. Riis. 1989. Miscellaneous streamflow measurements in the State of Washington, January 1961 to September 1985. USGS Open File Report 89-380. Olympia. Location: Fisheries Library

FLOW, STREAMS

This report is a compilation of previously published miscellaneous streamflow measurements. In general, the sites for which data are given in this report are not at gaging stations, however, some data are given for gaging station sites when the data were gathered outside the period of operation of the gage. Some reported flows are from dates earlier than 1961.

674. Williams, R. W., R. M. Laramie, and J. J. Ames. 1975. A catalog of Washington streams and salmon utilization, Vol. 1 - Puget Sound. Washington Department of Fisheries. Olympia (WA). Location: Fisheries Library

FISH, STREAMS

This catalog describes both basin and individual stream reach characteristics. The stream reach discussion describes the physical characteristics of the stream and adjacent tributaries and details salmon use, limiting factors, beneficial developments, and habitat needs.

675. Winkenwerder, H. A., and A. E. Thompson. 1924. Reforestation of Cedar River watershed. Seattle Water Department. Seattle.

CEDAR RIVER, LAND USE

This is a detailed report of the upper Cedar River watershed, which includes a description, importance of reforestation for watershed protection, the fire protection program, the reforestation situation, the planting program, and cost analysis. An appendix includes 10 maps and figures on standing timber (Wydoski, 1972).

676. Winter, D. F., and G. A. Pechuzal. 1973. Modelling annual phytoplankton-phosphate cycles in Lake Washington: A feasibility study: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal report 68. (unpublished) Location: UW SOF/THS

L. WASHINGTON, MODELLING, NUTRIENTS, PHYTOPLANKTON

This paper discusses the results of a "demonstration" numerical model of the annual cycles of algal and phosphate concentrations in Lake Washington.

677. Wissmar, R. C., J. E. Richey, and D. E. Spyridakis. 1977. The importance of allochthonous particulate carbon pathways in a subalpine lake. *J. Fish. Res. Board Can.* 34:1410-1418.

CARBON, FINDLEY LAKE, INVERTEBRATES, ZOOPLANKTON

Particulate carbon pathways in subalpine Findley Lake were examined to assess the dependence of invertebrate consumer production upon allochthonous and autochthonous carbon. Results suggest that allochthonous carbon provides a food base for insect production (6.5 kg C. ha^{-1}) and autochthonous production of carbon appears to maintain zooplankton production (5.0 kg C. ha^{-1}). Annual inputs of allochthonous carbon from snow, fluvial, and litter sources amounted to 75 kg C. ha^{-1}. Autochthonous production totalled 51 kg C. ha^{-1}. Most of the allochthonous inputs were lost through sedimentation and fluvial output. In constrast, most of the autochthonous carbon losses through grazing and respiration were retained in the water column.

678. Wolcott, E. E. 1961. Lakes of Washington. Vol. 1 - Western Washington, 1st Ed. Wash. State Dep. Conserv. Water Supply Bull 14. Location: Fisheries Library

L. SAMMAMISH, L. WASHINGTON, SMALL LAKES

This document provides elevation, area, maximum depth, use, and location of western Washington lakes. Lakes in the Lake Washington drainage are listed under King County (Wydoski, 1972). A 1973 third edition is also available.

679. Wolman, A., C. E. Green, and B. L. Grondal. 1944. Report on the water supply and the Cedar River watershed of the City of Seattle, Washington. Cedar River Watershed Commission, City of Seattle, Washington. Location: Forestry Library

CEDAR RIVER, LAND USE, REVIEW

A report to the mayor and city council of Seattle on the water supply of Seattle and Cedar River watershed. Provides information on the history of the watershed, quality of the water, ownership and use of the watershed, effect of logging on the water supply, and the proposed policy and program for control of water quality and watershed land use (Wydoski, 1972)

680. Wood, K. G. 1990. pH is just a two-letter word. *Verh. Int. Ver. Theor. Angew. Limnol.* 24:166-168.

CARBON, CHEM. LIMNOLOGY, L. WASHINGTON

During 1978, the carbon dioxide system was studied in 37 bodies of water from the St. Lawrence Great Lakes westward to Lake Washington, WA, by measuring the carbon dioxide difference between the sum of carbon dioxide levels in water at air-equilibrium minus the sum of carbon dioxide levels for the undisturbed water (D-carbon dioxide). The hydrogen ion concentration of freshwater is overestimated by pH measurements in the pH 8 region. The error is correlated with calcium, magnesium, or other ions. The varied chemistry of freshwater rules out any easy correction, although a relationship was found with (calcium + magnesium). However, D-carbon dioxide depends on differences, and is less affected by the sigma pH.

681. Woodey, J. C. 1966. Sockeye salmon spawning grounds and adult returns in Lake Washington watershed, 1965. M.S. Thesis. University of Washington. 101 pp. Location: UW SOF/THS

CEDAR RIVER, FISH, L. WASHINGTON, SOCKEYE SALMON, SPAWNING

A study was made of the sockeye salmon occupying spawning grounds in the Cedar River and along the shore of Lake Washington. Physical and chemical properties of the various spawning environments were described. Biological features of the sockeye involved were measured in an attempt to find those characteristics which would serve to rapidly identify adults of the two stocks. Within Lake Washington, two types of littoral spawning areas are occupied by sockeye. The first is characterized by having upwelling ground water, observed by temperature variations, and a high percentage of fines. The second featured an exposed beach with large gravel and an apparent lack of ground water. Cedar River sockeye differed significantly from the lake spawners in their spawning environment, length, egg size, time of migration and spawning, and cyclic abundance. Most apparent were the greater mean length for river spawners of both sexes and the much earlier spawning time. It was concluded that the two stocks were discrete and independent.

682. Woodey, J. C. 1972. Distribution, feeding, and growth of juvenile sockeye salmon in Lake Washington. Ph.D. Thesis. University of Washington. 208 pp. Location: UW SOF/THS

DIET, DISTRIBUTION, FISH, GROWTH, L. WASHINGTON, NUTRIENTS, SOCKEYE SALMON

The juvenile sockeye salmon (*Oncorhynchus nerka*) population residing in Lake Washington presented the possibility of studying this species under conditions of cultural eutrophication. This species has been studied in its typical oligotrophic environments, but data on sockeye ecology in more eutrophic lake environments are limited because of the scarcity of cases. The present study was designed to produced a broad base of information on life history and ecology of juvenile sockeye in Lake Washington. The distribution, food habits, and length and growth of four year classes, 1966 to 1969, were examined from September 1967 to October 1970, as each, in turn, was present for one year in Lake Washington.

683. Wright, S. 1983. Fishery management of Lake Washington. In: Lake Washington Symposium, (Ed.) A. Adams. Trout Unlimited. Mercer Island (WA). Location: UW SOF/THS

FISH, L. WASHINGTON, MANAGEMENT, RECREATION, REVIEW

This paper discusses the Washington Department of Game's management plan for the Lake Washington fishery.

684. Wydoski, R. S., and R. R. Whitney. 1972. Role of benthic and littoral fish in the productivity and ecology of the Lake Washigton drainage: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 92. (unpublished) Location: UW SOF/THS

BENTHIC, CHESTER MORSE RES., FINDLEY LAKE, FISH, L. SAMMAMISH, L. WASHINGTON

This is a progress report summarizing what has been accomplished on several projects related to benthic and littoral fish communities in the four IBP lakes.

685. Wydoski, R. S., and R. R. Whitney. 1972. Development of a systematic sampling scheme for the Lake Washington drainage: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 32. (unpublished) Location: UW SOF/THS

FISH, L. WASHINGTON

This is a progress report of the group effort to determine the productivity of fish in Lake Washington.

686. Wydoski, R. S., and R. R. Whitney. 1979. Inland fishes of Washington. University of Washington Press. Seattle, WA. Location: Fisheries Library

FISH

This book provides color pictures and a key to the inland fishes of Washington State. Descriptions of each species include their distribution and habitat as well as remarks on life history and distinguishing characteristics. Several of the pictures are of fish from the Lake Washington drainage.

687. Wydoski, R. S. 1971. Checklist of fishes in the Lake Washington drainage: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 34. (unpublished) Location: UW SOF/THS

ABUNDANCE, FISH, L. WASHINGTON

Thirty-five species occur in the drainage at present - 24 species are native to the area and 11 other species have been introduced. Two native species, the chum and pink salmon, are included as of doubtful occurance in the checklist. Neither of these species is common, and only an occasional fish may enter the drainage. This list is a modification of Ajwani's (1956).

688. Wydoski, R. S. 1972. A thermal study of the south end of the Lake Washington during operation of the Shuffleton Power Plant in January and December 1972: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 125. (unpublished) Location: UW SOF/THS

L. WASHINGTON, TEMPERATURE

The thermal plume from the Shuffleton Power Plant was monitored during December 5-19, 1972 and January 11, 1973. This paper provides a summary of water temperatures in the south end of Lake Washington during this period, estimates of the area of the thermal plume, and results of experimental gill netting in the vincinity of the plant.

689. Wydoski, R. S. 1972. Annotated bibliography on the ecology of the Lake Washington drainage: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Bulletin No. 1. Location: UW SOF/THS

BIBLIOGRAPHY, L. WASHINGTON, REVIEW

This annotated bibliography contains 392 published and unpublished references that pertain to the natural resources in the Lake Washington watershed, with particular emphasis on the aquatic environment. All references are indexed by key words.

690. Wydoski, R. S., and R. R. Whitney. 1971. Development of a systematic sampling scheme for the Lake Washington drainage: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 32. (unpublished) Location: UW SOF/THS

ABUNDANCE, FISH, L. WASHINGTON

This proposal details the development of a sampling scheme that will enable estimates of the relative abundance of the key species, or perhaps all 35 species, of fish that inhabit the drainage and to expand these estimates into terms of biomass or energy.

691. Wyman, K. 1973. Dynamics of limnetic feeding fish: III Lake Chester Morse: Coniferous Forest Biome. Ecosystem Analysis Studies, U.S./International Biological Program. University of Washington. Seattle; Internal Report 152. (unpublished) Location: UW SOF/THS

CHESTER MORSE RES., DOLLY VARDEN, FISH, RAINBOW TROUT

The objectives of this study were to determine the population sizes, age and growths, length-weight relationships, fecundity, sex ratios, mortality rates, and feeding habits. Biomass and production of the two species will be estimated from this information.

692. Wyman, K. H., Jr. 1975. Two unfished salmonid populations in Lake Chester Morse. M.S. Thesis. University. 53 pp. Location: UW SOF/THS

ABUNDANCE, CHESTER MORSE RES., DIET, DOLLY VARDEN, FISH, GROWTH, RAINBOW TROUT

This study was of two salmonid population, rainbow trout, *Salmo gairderi* (Richardson) and Dolly Varden, *Salvelinus malma* (Walbaum), Chester Morse Reservoir. These populations are unique because of the lack of fishing and the relative simplicity of the system. Only two other fish species inhabit the lake, pygmy whitefish, *Prosopium coulterie* (Eigenmann and Eigenmann) and a cottid, *Cottus* sp.

693. Zardorojny, C. 1971. Chemical water quality of Lake Sammamish. M.S. Thesis. University of Washington. 94 pp. Location: UW SOF/THS

CHEM. LIMNOLOGY, L. SAMMAMISH, NUTRIENTS

The primary purpose of this study was to investigate the chemical quality of the Lake Sammamish proper as it is influenced by the chemical quality of the inflows and outflow waters.

ADDRESSES OF DOCUMENT LOCATIONS

Most citations are followed by a location where the document can be found. this location may not be the only place the document is stored, but it is the most convenient location to the University of Washington, School of Fisheries. The following is description list of specific locations.

Personal Collections

UW SOF/THS	Dr. Thomas H. Sibley, School of Fisheries, WH-10 University of Washington, Seattle, Washington 98195 (206) 543-4257
UW COOP Files	Cooperative Fish and Wildlife Research Unit, WH-10 University of Washington, Seattle, Washington 98195 (206) 543-6475

University of Washington, Seattle Campus Libraries

Allen Library	Natural Sciences Library, FM-25 University of Washington, Seattle, Washington 98195 (206) 543-1243
Engineering Library	Engineering Library Building, FH-15 University of Washington, Seattle, Washington 98195 (206) 543-0741
Fisheries Library	Fisheries-Oceanography Library, WB-30 University of Washington, Seattle, Washington 98195 (206) 543-4279
Forestry Library	Forest Resources Library, AQ-15 University of Washington, Seattle, Washington 98195 (206) 543-2758
Government Library	Government Publications Division, FM-25 University of Washington, Seattle, Washington 98195 (206) 543-1937
Health Sciences Library	Health Sciences Library and Information Center, SB-55 University of Washington, Seattle, Washington 98195 (206) 543-5530
Odegaard Library	Odegaard Undergraduate Library, DF-10 University of Washington, Seattle, Washington 98195 (206) 543-1947
Suzzallo Library	Pacific Northwest Collection, FM-25 University of Washington, Seattle, Washington 98195 (206) 543-1929
Suzzallo Thesis Stacks	Suzzallo Library Circulation, FM-25 University of Washington, Seattle, Washington 98195 (206) 543-2553

Other Libraries

Metro Library	Municipality of Metropolitan Seattle Library 821 Second Avenue, Seattle, Washington 98104 (206) 684-2100
King County Surface Water Management	King County Surface Water Management 700 Fifth Avenue, Suite 2200 Seattle, Washington 98104-5027 (206) 296-6519

ABBREVIATIONS

^{14}C	carbon isotope
^{32}P	phosphorous isotope
^{210}Pb	lead isotope
AF/wk	acre feet per week
C	carbon or Celsius
Ca	calcium
ca. or c.	approximately
Cal	calorie
cfs	cubic feet per second
Chl *a*	chlorophyll *a*
cm	centimeter (10^{-2} meter)
Co	cobalt
CO_2	carbon dioxide
COD	chemical oxygen demand
COE	U.S. Army Corps of Engineers
Cu	copper
d	day
DIC	dissolved inorganic carbon
DO	dissolved oxygen
EIS	environmental impact statement
Fe	iron
FRI	Fisheries Research Institute in the School of Fisheries, University of Washington
g	gram
h	hour
IBP	International Biological Program
IHNV	infectious hematopoietic necrosis virus
K	potassium
kg	kilogram (10^6 gram)
km	Kilometer (10^6 meter)
L or l	liter
LC_{50}	lethal concentration for 50 percent of the population
M or m	meter
m^2	square meter
m^3	cubic meter
meq	milliequivalent
METRO	Municipality of Metropolitan Seattle
Mg	magnesium
mg	milligram (10^{-3} gram)
mm	millimeter (10^{-3} meter)
Mn	manganese
mo	month
mV	millivolt
N	nitrogen
nm	nanometer (10^{-9} meter)
NSF	National Science Foundation
O	oxygen
O_2	oxygen gas
O_{eq}	oxygen equivalent
P	phosphorous
P/B	productivity/biomass
P:R	productivity:respiration
PAH	polycyclic aromatic hydrocarbon
Pb	lead
POC	particulate organic carbon
ppb	parts per billion (e.g., $\mu g\ L^{-1}$)
ppm	parts per million (e.g., $mg\ L^{-1}$)
s	second
Si	silica
sq km	square kilometer
sq m	square meter
TP	total phosphorous
USGS	United States Geological Survey
WA	Washington State
WDF	Washington State Department of Fisheries
wet wt	wet weight
yr	year
µg	microgram (10^{-6} gram)
µM	micromole (10^{-6} Mole)
µm	micron (10^{-6} meter)

INDEX TO KEY WORDS

This index is an alphabetical list of the key words used in the bibliography followed by the sequential number(s) of the relevant citation(s).