Superseded by BNWL-1734

BNWL-1543
UC-48

[redacted]

# A BIBLIOGRAPHY OF ECOLOGICAL PUBLICATIONS SUPPORTED BY THE ATOMIC ENERGY COMMISSION RELATED TO COLUMBIA RIVER THERMAL EFFECTS STUDIES

March 1971

[redacted]

AEC RESEARCH & DEVELOPMENT REPORT

BATTELLE NORTHWEST
BATTELLE MEMORIAL INSTITUTE PACIFIC NORTHWEST LABORATORIES
3000 STEVENS DRIVE, P. O. BOX 999, RICHLAND, WASHINGTON 99352

PACIFIC NORTHWEST LABORATORY
RICHLAND, WASHINGTON
operated by
BATTELLE MEMORIAL INSTITUTE
for the
UNITED STATES ATOMIC ENERGY COMMISSION UNDER CONTRACT AT(45-1)-1830

BNWL-1543
UC-48
Biology and Medicine

# A BIBLIOGRAPHY OF ECOLOGICAL PUBLICATIONS SUPPORTED BY THE ATOMIC ENERGY COMMISSION RELATED TO COLUMBIA RIVER THERMAL EFFECTS STUDIES[1]

William L. Templeton
Charles C. Coutant[2]

1 March 1971

Ecosystems Department
Battelle Memorial Institute
Pacific Northwest Laboratories
Richland, Washington 99352

[1]Compiled under U.S. Atomic Energy Commission Contract AT(45-1)-1830 with Battelle Memorial Institute.

[2]Present address: Ecological Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830.

# INTRODUCTION

This bibliography lists Hanford publications from 1946 through 1970 that are relevant to thermal effects questions. Many reports listed are annual reports or special laboratory reports that are available either from the clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia, or from the Librarian, Biology Library, Battelle-Northwest, P.O. Box 999, Richland, Washington. Others are articles published in the open literature. The reports offer a chronicle of relevant environmental studies that can be matched by few industrial enterprises in this country.

The ecological effects of Columbia River temperatures have been studied in the field and laboratory at Hanford for nearly 25 years. Ecological research in the first two decades centered on the consequences of releasing radioactive materials in reactor cooling water discharges. The nearly complete paucity of radiological information necessitated this emphasis. However, the effects of temperature increases and chemical toxicity of effluents were also studied as significant aspects of the total environment.

Thermal studies were expanded in 1966 coincident with rising national concern for environmental effects of electric power production and development of waterways as cooling water sources. The Hanford complex of nuclear reactors was seen as a useful prototype for studying many of the ecological effects anticipated from nuclear power plants. In addition,

proposed development of the Columbia's apparent cooling water potential exposed serious concern over the capacity of this river to absorb heat, both additional and that already eminating from Hanford. Difficulties inherent in establishing temperature criteria for the Columbia led in 1968 to a cooperative, interagency Columbia River Thermal Effects Study with the AEC, the FWQA (now Environmental Protection Agency) and the Bureau of Commercial Fisheries (now National Marine Fisheries Service), as research participants, with other federal, state, and industrial interests serving on an Advisory Committee. This Thermal Effects Study has further stimulated research efforts.

This bibliography which was first prepared informally in 1968, has been updated and is presented for the benefit of interested technical personnel. Some reports are now in the final stages of preparation and should become available in early 1971.

Those references with an asterisk were reprinted in Annual Progress Reports on Biological Effects of Thermal Discharges 1967 and 1968 issued under the same BNWL number.

Becker, C. D. 1969. The food and feeding of juvenile chinook salmon in the Columbia River at Hanford. pp. 2.45-2.49. In: Pacific Northwest Laboratory Annual Report for 1968 to the USAEC Division of Biology and Medicine, Vol. I Life Sciences, Part 2, Ecological Sciences, (BNWL-1050). Battelle-Northwest, Richland, Washington.

Becker, C. D. 1970. Feeding bionomics of juvenile chinook salmon in the central Columbia River. Northwest Science. 44(2):75-81.

Becker, C. D. 1970. Temperature, timing and seaward migration of juvenile chinook salmon from the central Columbia River. Battelle-Northwest report. USAEC R&D Report (BNWL-1472). Battelle-Northwest, Richland, Washington.

Becker, C. D. 1970. Food and Feeding of juvenile chinook salmon in the central Columbia River in relation to thermal discharges and other environmental features. USAEC R&D Report (BNWL-1528). Battelle-Northwest, Richland, Washington.

Becker, C. D. and C. C. Coutant. 1970. Experimental drifts of juvenile chinook salmon through effluent at Hanford in 1968. USAEC R&D Report (BNWL-1499). Battelle-Northwest, Richland, Washington.

Becker, C. D., C. C. Coutant and E. F. Prentice. 1971. Experimental drifts of juvenile chinook salmon through effluent discharges at Hanford in 1969. USAEC R&D Report (BNWL-1527). Battelle-Northwest, Richland, Washington.

Becker, C. D. 1970. Parasites of Columbia River Fishes. In: Annual Report for 1969 to the USAEC Division of Biology and Medicine, Vol. 1, Life Sciences, Part 2, Ecological Sciences, p. 3.6. (BNWL-1306). Battelle-Northwest, Richland, Washington.

Becker, C. D. 1970. Plume drifts with juvenile salmon. In: Annual Report for 1969 to the USAEC Division of Biology and Medicine, Vol. 1, Life Sciences, Part 2, Ecological Sciences, p. 3.18. (BNWL-1306). Battelle-Northwest, Richland, Washington.

Berlin, J. D. and J. M. Dean. 1966. Ultrastructural changes in fish livers associated with temperature acclimation, p. 115-117. In: Pacific Northwest Laboratory Annual Report for 1965. (BNWL-280). Battelle-Northwest, Richland, Washington.

Berlin, J. D. 1967. Temperature-induced differences in acid phosphatase levels of rainbow trout, p. 157-159. In: Pacific Northwest Laboratory Annual Report for 1966. (BNWL-480). Battelle-Northwest, Richland, Washington.

Berlin, J. D. and J. M. Dean. 1967. Temperature-induced laterations in hepatocyte structure of rainbow trout (Salmo gairdneri). J. of Exptl. Zool., 164(1):117-132.

Caldwell, R. S. 1968. Effect of acclimation temperature on mitochondrial enzymes in fish. p. 7.23. In: Thompson, R. C., P. Teal and E. G. Swezea (eds.), Pacific Northwest Laboratory Ann. Report 1967 to the USAEC Division of

Biology and Medicine, Vol. 1, Biological Sciences, (BNWL-714), Battelle-Northwest, Richland, Washington.

Coutant, C. C. 1968. Thermal pollution-biological effects. In: A Review of the Literature of 1967 on wastewater and water pollution control. J. Water Poll. Cont. Fed. 40(6):1047-1052.

Coutant, C. C. 1968. Behavior of adult salmon and steelhead trout migrating past Hanford thermal discharges. p. 9.10. In: Thompson, R. C., P. Teal and E. G. Swezea (eds.), Pacific Northwest Laboratory Ann. Report, 1967 to USAEC Division of Biology and Medicine, Vol. 1, Biological Sciences, (BNWL-714), Battelle-Northwest, Richland, Washington.

Coutant, C. C. 1968. Effect of temperature on the development rate of bottom organisms. p. 9.13. In: Thompson, R. C., P. Teal and E. G. Swezea (eds.), Pacific Northwest Laboratory Annual Report 1967 to USAEC Division of Biology and Medicine, Vol. 1, Biological Sciences, (BNWL-714), Battelle-Northwest, Richland, Washington.

Coutant, C. C. 1969. Responses of salmonid fishes to acute thermal shock. p. 2.19-2.26. In: Pacific Northwest Laboratory Annual Report for 1968 to the USAEC Division of Biology and Medicine, Vol. 1, Life Sciences, Part 2, Ecological Sciences, (BNWL-1050). Battelle-Northwest, Richland, Washington.

Coutant, C. C., C. D. Becker and E. F. Prentice. 1969. Passage of downstream migrants. p. 2.27-2.30. In: Pacific Northwest Laboratory Annual Report for 1968 to the USAEC Division of Biology and Medicine, Vol. 1, Life Sciences, Part 2, Ecological Sciences, (BNWL-1050). Battelle-Northwest, Richland, Washington.

Coutant, C. C. 1969. Effects of thermal loading: the Columbia River story. pp. 34-39. In: Nuclear Power and Environment: An Inquiry. Conservation Society of Southern Vermont, Bondville, Vermont.

Coutant, C. C. 1969. Thermal pollution-Biological effects. A review of the literature of 1968. Battelle-Northwest, Richland, Washington, AEC Doc. No. (BNWL-SA-2376), J. Water Poll. Cont. Fed. 41(6):1036-1053.

Coutant, C. C. 1969. Behavior of sonic-tagged chinook salmon and steelhead trout migrating past Hanford thermal discharges. pp. 2.39-2.44. In: Pacific Northwest Laboratory Annual Report for 1968 to the USAEC Division of Biology and Medicine, Vol. 1, Life Sciences, Part 2, Ecological Sciences, BNWL-1050. Battelle-Northwest, Richland, Washington.

Coutant, C. C. 1969. Temperature, reproduction and behavior. Chesapeake Sci., 10(3&4):261-274.

Coutant, C. C. 1970. Thermal resistance of adult coho and jack chinook salmon and steelhead trout from the Columbia River. Battelle-Northwest report. USAEC R&D Report

(BNWL-1508). Battelle-Northwest, Richland, Washington.

Coutant, C. C. 1970. Relative vulnerability of thermally shocked salmonids to predation. In: Annual Report for 1969 to the USAEC Division of Biology and Medicine, Vol. 1, Life Sciences, Part 2, Ecological Sciences, p. 3.11. (BNWL-1306). Battelle-Northwest, Richland, Washington.

Coutant, C. C. 1970. Behavior of sonic-tagged chinook salmon and steelhead trout migrating past Hanford thermal discharges 1967. USAEC R&D Report (BNWL-1531). Battelle-Northwest, Richland, Washington.

Coutant, C. C. 1970. Exploratory studies of the interactions of gas supersaturation and temperature on mortality of juvenile salmonids. USAEC R&D Report (BNWL-1529). Battelle-Northwest, Richland, Washington.

Coutant, C. C. 1970. Effect of thermal shock on vulnerability to predation of juvenile salmonids I. Single shock temperature. USAEC R&D Report (BNWL-1521). Battelle-Northwest, Richland, Washington.

Coutant, C. C. 1970. Effect of thermal shock on vulnerability to predation in juveniles salmonids. II. A dose response in rainbow trout. USAEC R&D Report (BNWL-1519). Battelle-Northwest, Richland, Washington.

Coutant, C. C. and C. D. Becker. 1970. Effects of thermal increments on invertebrate populations of the Central

Columbia River. Annual Report for 1969, to the USAEC Division of Biology and Medicine, Vol. 1, Life Sciences, Part 2, Ecological Sciences, p. 3.8. (BNWL-1306). Battelle-Northwest, Richland, Washington.

Coutant, C. C. and C. D. Becker. 1970. Growth of Columbia River limpets, Fisherola nuttalli (Haldeman), in normal and reactor-warmed water. USAEC R&D Report (BNWL-1537). Battelle-Northwest, Richland, Washington.

Coutant, C. C. 1970. Thermal pollution - biological effects. A review of the literature of 1969. Battelle-Northwest, Richland, Washington, Doc. No. (BNWL-SA-3255), J. Water Poll. Cont. Fed. 42(6):1025-1057.

Coutant, C. C., J. M. Dean and C. R. Cole. 1970. Modelling thermal death of fishes in fluctuating lethal temperatures. In: Annual Report for 1969 to the USAEC, Division of Biology and Medicine, Vol. 1, Life Sciences, Part 2, Ecological Sciences, p. 3.9. (BNWL-1306). Battelle-Northwest, Richland, Washington.

Coutant, C. C. and J. M. Dean. 1970. Equilibrium loss and death as responses of juvenile salmonids to thermal shock. USAEC R&D Report (BNWL-1520). Battelle-Northwest, Richland, Washington.

Coutant, C. C. 1970. Thermal resistance studies on salmonid fish. In: Annual Report for 1969 to the USAEC Division of Biology and Medicine, Vol. 1, Life Sciences, Part 2, Ecological Sciences, p. 3.19. (BNWL-1306). Battelle-

Northwest, Richland, Washington.

Cross, F. A., J. M. Dean and R. E. Nakatani. 1966. Metabolism of zinc in a marine benthic amphipod, p. 118-120. In: Pacific Northwest Laboratory Annual Report for 1965. (BNWL-280). Battelle-Northwest, Richland, Washington.

Cushing, C. E. 1963. Plankton-water chemistry cycles in the Columbia River, p. 227-231. In: Biology Research Annual Report for 1962. HW-7600 (Hanford Laboratories, Richland, Washington).

Davis, J. J., R. W. Coopey, D. G. Watson, C. C. Palmiter and C. L. Cooper. 1951. The radioactivity and ecology of aquatic organisms of the Columbia River. p. 19-29. In: Biology Research Annual Report for 1951. HW-25021 (Radiological Sciences Department, Richland, Washington).

Davis, J. J., R. W. Coopey, D. G. Watson and C. C. Palmiter. 1952. Radiobiological survey of the Columbia River. p. 8-13. In: Biology Research Annual Report for 1952. HW-29636 (Radiological Sciences Department, Richland, Washington).

Davis, J. J., D. G. Watson, C. C. Palmiter and R. W. Coopey. 1953. 1953 Radiobiological survey of the Columbia River. p. 8. In: Biology Research Annual Report for 1953. HW-30437. (Radiological Sciences Department, Richland, Washington).

Davis, J. J., D. G. Watson and C. C. Palmiter. 1954. Radiobiological Survey of the Columbia River-1954, p. 6. In: Biology Research Annual Report for 1954. HW-35917. (Radiological Sciences Department, Richland, Washington).

Dean, J. M. and J. D. Berlin. 1965. The effect of temperature acclimation on the tissues of Salmo gairdnerii (rainbow trout). Amer. Zoologist 5(4):696. (Abstract).

Dean, J. M. and R. E. Nakatani. 1966. Temperature effects on cesium metabolism in trout, p. 112-113. In: Pacific Northwest Laboratory Annual Report for 1965. (BNWL-280). Battelle-Northwest, Richland, Washington.

Dean, J. M. 1966. Temperature effects on energy reserves in trout, p. 113-115. In: Pacific Northwest Laboratory Annual Report for 1965. (BNWL-280). Battelle-Northwest, Richland, Washington.

Dean, J. M. 1967. Metabolism of acetate and palmitate by tissues of warm and cold adapted trout, p. 155-157. In: Pacific Northwest Laboratory Annual Report for 1966. (BNWL-480). Battelle-Northwest, Richland, Washington.

Dean, J. M. 1967. Temperature of tissues of freshwater fishes, p. 162-163. In: Pacific Northwest Laboratory Annual Report for 1966. (BNWL-480). Battelle-Northwest, Richland, Washington.

Dean, J. M. 1968. Metabolism of acetate by trout tissues at high temperatures., p. 7.21. In: Thompson, R. C., P. Teal and E. G. Swezea (eds.), Pacific Northwest

Laboratory Annual Report for 1967 to USAEC Division of Biology and Medicine, Vol. 1, Biological Sciences, (BNWL-714), Richland, Washington.

Dean, J. M. and C. C. Coutant. 1968. Lethal temperature relations of juvenile Columbia River chinook salmon. p. 9.5. In: Thompson, R. C., P. Teal and E. G. Swezea (eds.), Pacific Northwest Laboratory Annual Report for 1967 to USAEC Division of Biology and Medicine, Vol. 1, Biology Sciences, (BNWL-714), Richland, Washington.

Dean, J. M. 1969. The response of juvenile salmonids to acute thermal shock. In: Pacific Northwest Laboratory Annual Report for 1968 to the USAEC Division of Biology and Medicine, Vol. 1 Life Sciences, Part 1, Biological Sciences, (BNWL-1050). Battelle-Northwest, Richland, Washington.

Dean, J. M. 1969. The metabolism of tissues of thermal acclimated trout (Salmo gairdneri). Comp. Biochem. Physiol. 29:185-196.

Dean, J. M. and J. D. Berlin. 1969. Alterations in hepatocyte function of thermal, acclimated rainbow trout (Salmo gairdneri) Comp. Biochem. Physiol., 29:307-312 .

Dean, J. M. and J. D. Berlin. 1969. Alterations in hepatocyte function of thermally acclimated rainbow trout (Salmo gairdneri). In: Pacific Northwest Laboratory Annual Report for 1968 to the USAEC Division of Biology and Medicine, Vol. 1, Life Sciences, Part I, Biological

Sciences. (BNWL-1050). Battelle-Northwest, Richland, Washington.

Foster, R. F. Biological problems associated with the discharge of pile effluent into the Columbia River, p. 11-13. In: Biology Research Annual Report for 1951. HW-25021. (Radiological Science Department, Richland, Washington).

Foster, R. F., and P. A. Olson, Jr. 1953. Effect of reactor effluent water on young silver salmon, p. 31-38. In: Biology Research Annual Report for 1952. HW-28636 (Radiological Sciences Department, Richland, Washington).

Foster, R. F. and P. A. Olson. 1959. Water temperatures for the Columbia River above the Hanford reactors, September, 1946 through December, 1958. HW-60028. 53 pp.

Fujihara, M. P. and P. A. Olson. 1961. Studies on the fish disease Chrondrococcus columnaris, p. 160-165. In: Biology Research Annual Report for 1960. HW-69500 (Hanford Laboratories, Richland, Washington).

Fujihara, M. P. and P. A. Olson. 1962. Incedence and virulence of columnaris, p. 151-155. In: Biology Research Annual Report for 1961. HW-72500 (Hanford Laboratories, Richland, Washington).

Fujihara, M. P., P. A. Olson and R. F. Foster. 1960. Mutation and temperature effects in C. columnaris, p. 188-193. In: Biology Research Annual Report for 1959. HW-65500 (Hanford Laboratories, Richland, Washington).

Fujihara, M. P., P. A. Olson and R. E. Nakatani. 1964. Incidence and virulence of columnaris-III, p. 195-202. In: Biology Research Annual Report for 1963. HW-80500 (Hanford Laboratories, Richland, Washington).

Fujihara, M. P., P. A. Olson and R. E. Nakatani. 1965. Antibody production and immune response to fish to C. columnaris, p. 194-196. In: Pacific Northwest Laboratory Annual Report for 1964. (BNWL-122). Battelle-Northwest, Richland, Washington.

Fujihara, M. P. 1966. Columnaris disease in Columbia River fishes. p. 127-130. In: Pacific Northwest Laboratory Annual Report for 1965. (BNWL-280). Battelle-Northwest, Richland, Washington.

Fujihara, M. P. 1967. Immune response of salmonids and exposure of river fishes to Chondrococcus columnaris, p. 183-185. In: Pacific Northwest Laboratory Annual Report for 1966. (BNWL-480). Battelle-Northwest, Richland, Washington.

Fujihara, M. P. 1968. Columnaris exposure and antibody production in seaward and upstream migrant sockeye salmon. p. 9.16. In: Thompson, R. C., P. Teal and E. G. Swezea (eds.), Pacific Northwest Laboratory Annual Report for 1967 to USAEC Division of Biology and Medicine, Vol. 1, Biological Sciences, (BNWL-714), Richland, Washington.

Fujihara, M. P. 1969. Oral immunization of juvenile coho salmon against Chondrococcus columnaris. In: Pacific Northwest Laboratory Annual Report for 1968 to the USAEC Division of Biology and Medicine Vol. 1, Life Sciences, Part 1. Biological Sciences, BNWL-1050. Battelle-Northwest, Richland, Washington.

Fujihara, M. P. and F. P. Hungate. 1970. Seasonal distribution of Chondrococcus columnaris disease in river fishes; A procedure using antibody synthesis in fishes on a survey technique. (BNWL-SA-3563). Battelle-Northwest, Richland, Washington.

Fujihara, M. P. and R. E. Nakatani. 1970. Antibody production and minimal response of rainbow trout and coho salmon to Chondrococcus columnaris. (BNWL-SA-3542). Battelle-Northwest, Richland, Washington.

Fujihara, M. P. and F. P. Hungate. 1970. Chondrococcus columnaris disease of fishes: influence of Columbia River fish ladders. USAEC R&D Report (BNWL-3649). Battelle-Northwest, Richland, Washington.

Fujihara, M. P. 1970. Temperature and fish disease. Pacific Northwest Annual Report for 1969 to USAEC Division of Biology and Medicine, p. 3.22 (BNWL-1306). Battelle-Northwest, Richland, Washington.

Jaske, R. T., W. L. Templeton and C. C. Coutant. 1969. Thermal death models, Industrial Water Engineering. Oct.

Jaske, R. T., W. L. Templeton and C. C. Coutant. 1970. Methods for evaluating effects of transient conditions in heavily loaded and extensively loaded streams. Proc. 1969 (ASME/AICHE Stream Pollution Abatement Conf.), Rutgers University. In Water 1970. November 1970, AICHE New York, N.Y.

Jaske, R. T., W. L. Templeton and J. C. Sonnichsen. 1971. Improved methods for placing of thermal discharges before site acquisition with a specific core example on the Columbia River. SM-146/46. In: Symp. on Environmental Aspects of Nuclear Power Stations, 10-14 August 1970, N.Y., I.A.E.A. Vienna, 731-755.

Nakatani, R. E. and D. H. W. Liu. 1964. Swimming performance of chinook salmon reared in reactor effluent-II, p. 205-208. In: Biology Research Annual Report for 1963. HW-80500, (Hanford Laboratories, Richland, Washington).

Nakatani, R. E. and R. F. Foster. 1966. Hanford temperature effects on Columbia River fishes. (BNWL-CC-591) Battelle-Northwest, Richland, Washington.

Nakatani, R. E. 1969. Effects of heated discharges on anadromous fishes. p. 294-317. In: Biological Aspects of Thermal Pollution, Krenkel, P. A. and F. L. Parker, (eds.), Vanderbilt University Press, Nashville, Tenn.

Olson, P. A., Jr. 1952. Observations on the Transfer of pile effluent radioactivity to trout, p. 30-40. In: Biology Research Annual Report for 1951. HW-25021,

(Radiological Sciences Department, Richland, Washington).

Olson, P. A., Jr. and R. F. Foster. 1952. Effect of pile effluent water on fish, p. 41-52. In: Biology Research Annual Report for 1951. HW-25021 (Radiological Sciences Department, Richland, Washington).

Olson, P. A., Jr. and R. F. Foster. 1953. Extended retention of rainbow trout in dilute reactor effluent, p. 20-30. In: Biology Research Annual Report for 1952. HW-28636 (Radiological Sciences Department, Richland, Washington).

Olson, P. A., Jr. and R. F. Foster. 1954. Reactor effluent monitoring with young chinook salmon, p. 24-35. In: Biology Research Annual Report for 1953. HW-30437 (Radiological Sciences Department, Richland, Washington).

Olson, P. A. and R. F. Foster. 1955. Reactor effluent monitoring with young chinook salmon 1954, p. 11-18. In: Biology Research Annual Report for 1954. HW-35917 (Radiological Sciences Department, Richland, Washington).

Olson, P. A. and R. F. Foster. 1955. Effect of reactor area effluent water on chinook salmon fingerlings, p. 19-23. In: Biology Research Annual Report for 1954. HW-35917, (Radiological Sciences Department, Richland, Washington).

Olson, P. A. and R. F. Foster. 1955. Effect of reactor area effluent water on migrant juvenile blueback salmon, p. 24-27. In: Biology Research Annual Report for 1954. HW-35917 (Radiological Sciences Department, Richland, Washington).

Corrected page for insertion in:
"A Bibliography of Ecological Publications Supported by the Atomic Energy Commission Related to Columbia River Thermal Effects Studies", by: W.L. Templeton and C.C. Coutant ---- BNWL-1543

(Radiological Sciences Department, Richland, Washington).

Olson, P. A., Jr. and R. F. Foster. 1952. Effect of pile effluent water on fish, p. 41-52. In: Biology Research Annual Report for 1951. HW-25021 (Radiological Sciences Department, Richland, Washington).

Olson, P. A., Jr. and R. F. Foster. 1953. Extended retention of rainbow trout in dilute reactor effluent, p. 20-30. In: Biology Research Annual Report for 1952. HW-28636 (Radiological Sciences Department, Richland, Washington).

Olson, P. A., Jr. and R. F. Foster. 1954. Reactor effluent monitoring with young chinook salmon, p. 24-35. In: Biology Research Annual Report for 1953. HW-30437 (Radiological Sciences Department, Richland, Washington).

Olson, P. A. and R. F. Foster. 1955. Reactor effluent monitoring with young chinook salmon 1954, p. 11-18. In: Biology Research Annual Report for 1954. HW-35917 (Radiological Sciences Department, Richland, Washington).

Olson, P. A. and R. F. Foster. 1955. Effect of reactor area effluent water on chinook salmon fingerlings, p. 19-23. In: Biology Research Annual Report for 1954. HW-35917, (Radiological Sciences Department, Richland, Washington).

Olson, P. A. and R. F. Foster. 1955. Effect of reactor area effluent water on migrant juvenile blueback salmon, p. 24-27. In: Biology Research Annual Report for 1954. HW-35917 (Radiological Sciences Department, Richland, Washington).

Olson, P. A. and R. F. Folster. 1956. Effect of chronic exposure to sodium dichromate on young chinook salmon and rainbow trout, p. 35-47. In: Biology Research Annual Report for 1955. HW-41500 (Radiological Sciences Department, Richland, Washington).

Olson, P. A. and R. F. Foster. 1957. Further studies on the effect of sodium dichromate on juvenile chinook salmon, p. 214-224. In: Biology Research Annual Report for 1956. HW-47500 (Hanford Laboratories, Richland, Washington).

Olson, P. A. and R. F. Foster. 1957. Temperature tolerance of eggs and young of Columbia River chinook salmon. Trans. Amer. Fish. Soc. 85(1955):203-207.

Olson, P. A. 1958. Temperature tolerance of eggs and young of Columbia River fish, p. 211-214. In: Biology Research Annual Report for 1957 HW-53500 (Hanford Laboratories, Richland, Washington).

Olson, P. A. 1959. Effects of variable river flow on the toxicity of reactor effluent, p. 135-137. In: Biology Research Annual Report for 1958. HW-59500 (Hanford Laboratories, Richland, Washington).

Olson, P. A. and R. E. Nakatani. 1962. Reactor effluent monitoring with salmon, 1960-1961, p. 144-147. In: Biology Research Annual Report for 1961. HW-72500 (Hanford Laboratories, Richland, Washington).

Olson, P. A. and M. P. Fujihara. 1963. Incidence and virulence of columnaris-II, p. 223-226. In: Biology Research Annual Report for 1962. HW-7600 (Hanford Laboratories, Richland, Washington).

Olson, P. A. and R. E. Nakatani. 1963. Reactor effluent monitoring 1962, p. 211-214. In: Biology Research Annual Report for 1962. HW-7600 (Hanford Laboratories, Richland, Washington).

Olson, P. A. and R. E. Nakatani. 1965. Reactor effluent monitoring 1964, p. 198-201. In: Biology Research Annual Report for 1964. (BNWL-122). (Pacific Northwest Laboratory, Richland, Washington).

Olson, P. A. 1966. Reactor effluent monitoring 1965, p. 132-133. In: Pacific Northwest Laboratory Annual Report for 1965. (BNWL-280).

Olson, P. A. 1967. Reactor effluent monitoring: Comparison of Puget Sound and Priest Rapids chinook salmon, p. 180-181. In: Pacific Northwest Laboratory Annual Report for 1966. (BNWL-480).

Olson, P. A. and R. E. Nakatani. 1968. Effect of elevated temperatures on mortality and growth of young chinook salmon. p. 9.3. In: Thompson, R. C., P. Teal and E. G. Swezea (eds.), Pacific Northwest Laboratory Annual Report for 1967 to USAEC Division of Biology and Medicine, Vol. 1, Biological Sciences, BNWL-714, Richland, Washington.

Olson, P. A. and R. E. Nakatani. 1969. Effects of chronic variable water temperatures on survival and growth of young chinook salmon. p. 2.35-2.38. In: Pacific Northwest Laboratory Annual Report for 1968 to the USAEC Division of Biology and Medicine, Vol. 1, Life Sciences, Part 2, Ecological Sciences, (BNWL-1050). Battelle-Northwest, Richland, Washington.

Olson, P. A., R. E. Nakatani, and T. Meekin. 1970. Effects of thermal increments on eggs and young of Columbia River fall chinook. USAEC R&D Report (BNWL-1538). Battelle-Northwest, Richland, Washington.

Olson, P. A. 1970. Effects of temperature increments on juvenile steelhead. In: Pacific Northwest Laboratories Annual Report for 1969 to the USAEC Division of Biology and Medicine, Vol. 1, Life Sciences, Part 2, Ecological Sciences, p. 3.16. (BNWL-1306). Battelle-Northwest, Richland, Washington.

Prentice, E. F. 1969. Gull predation in a reactor discharge plume. p. 2.33-2.34. In: Pacific Northwest Laboratory Annual Report for 1968 to the USAEC Division of Biology and Medicine, Vol. I. Life Sciences, Part 2, Ecological Sciences, (BNWL-1050). Battelle-Northwest, Richland, Washington

Schneider, M .J. 1970. Physiology of gas bubble disease. In: Pacific Northwest Laboratory Annual Report to USAEC Division of Biology and Medicine, Vol. 1, Life Sciences,

Part 2, Ecological Sciences, p. 3.24, (BNWL-1306). Battelle-Northwest, Richland, Washington.

Sonnichsen, J. C., D. A. Kottwitz and R. T. Jaske. 1970. Dispersion characteristics of the Columbia River between river sites 383 and 355. USAEC R&D Report (BNWL-1477). Battelle-Northwest, Richland, Washington.

Templeton, W. L. and C. C. Coutant. 1971. Studies on the biological effects of thermal discharges from nuclear reactors to the Columbia River at Hanford. In: Environmental Aspects of Nuclear Power Stations. Paper SM 146/33 International Atomic Energy Agency. Vienna, 591-614.

Watson, D. G. 1951. Observations of spawning and migration of chinook salmon, Oncorhynchus tshawytscha (Walbaum) in the Columbia River in the vicinity of Hanford Works. p. 14-18. In: Biology Research Annual Report for 1951. HW-25021 (Radiological Sciences Department, Richland, Washington.

Watson, D. G. 1956. Chinook salmon spawning in the vicinity of Hanford 1947-1955. In: Biology Research Annual Report for 1955. HW-41500 (Radiological Sciences Department, Richland,Washington).

Watson, D. G. 1957. Chinook salmon spawning in the vicinity of Hanford-1956, p. 225. In: Biology Research Annual Report for 1956. HW-47500 (Hanford Laboratories, Richland, Washington).

Watson, D. G. 1958. Chinook salmon spawning in the vicinity of Hanford-1957. HW-53500 (Hanford Laboratories, Richland, Washington).

Watson, D. G. 1959. Chinook Salmon spawning in the vicinity of Hanford-1958. HW-59500 (Hanford Laboratories, Richland, Washington), p. 132.

Watson, D. G. 1960. Salmon spawning in the vicinity of HAPO, 156-159. In: Biology Research Annual Report for 1960. HW-69500 (Hanford Laboratories, Richland, Washington).

Watson, D. G. 1960. Chinook salmon spawning in the vicinity of Hanford-1959. p. 180-182. In: Biology Research Annual Report for 1959. HW-65500 (Hanford Laboratories, Richland, Washington).

Watson, D. G. 1962. Chinook salmon spawning in the Columbia River, p. 148-150. In: Biology Research Annual Report for 1961. HW-72500 (Hanford Laboratories, Richland, Washington).

Watson, D. G. 1963. Chinook salmon spawning near Hanford-1962, p. 215-218. In: Biology Research Annual Report for 1962. HW-7600 (Hanford Laboratories, Richland, Washington).

Watson, D. G. 1964. Chinook salmon spawning near Hanford-1963. p. 203-205. In: Biology Research Annual Report for 1963. HW-80500 (Hanford Laboratories, Richland, Washington).

Watson, D. G. 1965. Chinook salmon spawning near Hanford-1964, In: Biology Research Annual Report for 1964. P. 198-201. (BNWL-122) Pacific Northwest Laboratory, Richland, Washington.

Watson, D. G. 1966. Migration of Columbia River fish, p. 123-125. In: Pacific Northwest Laboratory Annual Report for 1965. (BNWL-280) Pacific Northwest Laboratory, Richland, Washington.

Watson, D. G. 1966. Columbia River Chinook salmon spawning near Hanford. p. 131-132. In: Pacific Northwest Laboratory Annual Report for 1965. (BNWL-280) Pacific Northwest Laboratory, Richland, Washington.

Watson, D. G. 1966. Chinook salmon spawning near Hanford. p. 181-182. In: Thompson, R. C., P. Teal and E. G. Swezea (eds.), Pacific Northwest Laboratory Annual Report 1967 to USAEC Division of Biology and Medicine, Vol. 1, Biological Sciences, (BNWL-714). Richland, Washington.

Watson, D. G. 1969. Chinook salmon spawning near Hanford-1968. 1968. p. 2.31-2.32. In: Pacific Northwest Laboratory Annual Report for 1968 to the USAEC Division of Biology and Medicine, Vol. I, Life Sciences, Part 2, Ecological Sciences, (BNWL-1050). Battelle-Northwest, Richland, Washington.

Watson, D. G. 1970. Salmon population studies. In Pacific Northwest Annual Report for 1969 to USAEC Division of Biology and Medicine, Vol. I, Life Sciences, Part 2,

Ecological Sciences, p. 3.20 (BNWL-1306). Battelle-Northwest, Richland, Washington.

Watson, D. G. 1970. Fall chinook salmon spawning in the Columbia River near Hanford 1947-1969. USAEC R&D Report (BNWL-1515). Battelle-Northwest, Richland, Washington.

# DISTRIBUTION

No. of Copies

OFFSITE

1 AEC Chicago Patent Group

G. H. Lee

201 AEC Division of Technical Information Extension

ONSITE - HANFORD

1 AEC Chicago Patent Group

R. M. Poteat

2. AEC Richland Operations Office

M. R. Schneller
C. R. Qualheim
M. W. Tiernan

239 Battelle-Northwest

F. W. Albaugh
E. L. Alpen
W. J. Bair
C. D. Becker
C. E. Cushing
G. M. Dalen
L. L. Eberhardt
S. J. Farmer
R. F. Foster
J. J. Fuquay
R. D. Harr
W. T. Hinds
R. T. Jaske
J. W. Lichatowich
E. W. Lusty
J. M. Nielsen
T. P. O'Farrell
B. B. Owen
R. S. Paul
D. W. Pearce
K. R. Price
W. H. Rickard
M. J. Schneider
A. J. Scott
C. L. Simpson
J. A. Strand (50)
W. H. Swift
W. L. Templeton (150)
C. J. Touhill
B. E. Vaughan
D. G. Watson
R. E. Wildung
Biology Library (2)
Technical Information (5)
Technical Publications (2)