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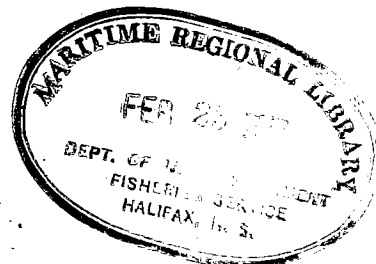
# Fisheries and Ecology of Saint John River, New Brunswick: A Partial Bibliography

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by  
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Freshwater and Anadromous Division  
Resource Branch  
Maritimes Region



FISHERIES AND ECOLOGY OF  
SAINT JOHN RIVER, NEW BRUNSWICK: A  
PARTIAL BIBLIOGRAPHY

J.R. SEMPLE

SEPTEMBER, 1976

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FRESHWATER AND ANADROMOUS DIVISION  
RESOURCE BRANCH  
FISHERIES AND MARINE SERVICE  
DEPARTMENT OF FISHERIES AND THE ENVIRONMENT

HALIFAX, NOVA SCOTIA

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## INTRODUCTION

A new hydroelectric development, known as the Dickey-Lincoln School Project, has been proposed by the United States Corps of Engineers for the upper Saint John River in northeastern Maine. As a result, the Dickey-Lincoln School Technical Committee, which is considering the environmental implications of the project in the Canadian portion of the river drainage, decided to make a compilation of reports dealing with water-related aspects of the river basin to aid it in defining and interpreting possible environmental effects.

The following bibliography is an attempt to summarize available information pertaining to the fisheries and ecology of the river. It represents a submission for a more comprehensive bibliography by the Technical Committee which will include hydrology, pollution, atmospheric environment and socioeconomic information sources.

One hundred and seventy-eight different reports are listed—57 for the lower basin (mouth of river to Mactaquac Dam), 42 for the middle basin (Mactaquac to Grand Falls), 41 for the upper basin (Grand Falls to headwaters) and 54 of a more general or unspecified nature. Some of the reports are annotated or abstracted.

The comprehensive Saint John River Basin Study, initiated in 1971, has resulted in a voluminous amount of current information on fish (102, 103, 104, 106, 107, 108, 110, 111), phytoplankton (157, 161), zooplankton (39, 40), macrobenthos (41, 42), toxic pollution (81, 82, 83), pollution indicators (172, 173) and general aspects of headpond ecology and water use (109, 168, 170, 171). Much of the emphasis in this study was focused on the hydroelectric headponds; however, fisheries investigations were geographically more encompassing.

Studies published in 1976 by the Huntsman Marine Laboratory (65, 66, 67) describe the "living resource potential" of the estuary.

The report by Smith (136) gives a good review of fisheries information for the Saint John River up to 1969 and a Montreal Engineering report (112) presents an overview of water use, pollution, geography, fisheries and other aspects of the water resources within the basin.

In reference to the possible implications and effects of a hydroelectric development in the Dickey-Lincoln School area of the river, the reports by Warner (156), the United States Corps of Engineers (149, 150, 151) and Meta Systems (99, 100, 101) should be consulted.

Other more specific problems—such as turbine mortalities of fish (85, 93), nitrogen gas supersaturation (90) and adult salmon migration through the river's hydroelectric headponds (97)—have also been studied in past years.

## METHODS

Information sources used during the course of this review included the current indexes of the Transactions of the American Fisheries Society, the Fisheries Research Board of Canada and Environment Canada's Maritimes Regional Library. Citations and abstracts were also sought in a computerized search of Saint John River titles using Saint John River, its tributaries and names of hydroelectric dams as key words. The computer search was conducted by the Water Resources Document Reference Centre (WATDOC), using a terminal in the Maritimes Regional Library. The data bases examined were ENV (abstracts of research reports and other documents compiled by the Inland Waters Directorate of Environment Canada to April, 1976) and PAB (pollution abstracts, 1970-75).

In many cases the reference sections of the reports themselves were scrutinized for further pertinent references.

This bibliography represents a collection of report titles and abstracts accumulated in a relatively short period of time and is not intended to be a complete review of the available literature. Where time permitted, annotations and abstracts were acquired. This information immediately follows the reference.

References in the bibliography are arranged in alphabetical order and are consecutively numbered. They are also indexed by pertinent geographical area.

## REPORTS BY GEOGRAPHIC AREA

Lower Basin (Mactaquac Dam to river mouth) Total = 57	1, 7, 8, 9, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 28, 29, 30, 31, 33, 34, 35, 44, 51, 53, 54, 55, 57, 58, 65, 66, 67, 70, 86, 89, 90, 92, 94, 97, 102, 103, 104, 110, 117, 123, 124, 126, 130, 131, 132, 139, 143, 144, 145, 146, 147, 174, 178.
Middle Basin (Mactaquac Dam to Grand Falls) Total = 42	2, 5, 9, 11, 12, 27, 35, 38, 39, 40, 41, 42, 71, 72, 73, 74, 75, 76, 77, 78, 85, 93, 95, 97, 98, 105, 106, 107, 111, 116, 118, 128, 130, 133, 134, 135, 138, 165, 166, 167, 169, 177, 179.
Upper Basin (Grand Falls to headwaters) Total = 41	6, 27, 39, 40, 41, 42, 46, 60, 69, 96, 99, 100, 101, 105, 106, 107, 111, 115, 119, 120, 125, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 169.

General  
Total = 54

3, 4, 10, 13, 24, 26, 32, 36, 37, 43,  
45, 46, 47, 48, 49, 50, 52, 56, 59, 61,  
62, 63, 64, 68, 79, 80, 81, 82, 83, 84,  
88, 91, 105, 108, 109, 112, 113, 114,  
121, 127, 129, 136, 137, 140, 141, 142,  
148, 168, 170, 171, 172, 173, 175, 176.

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*This paper summarizes, by statistical district, gear type, year and month, the number and weight of commercially captured Atlantic salmon from 1949 to 1965 inclusive.*

2. Anonymous. 1894. Aroostook River for sportsmen. Maine Sportsman, 1(9):1-4.
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4. Bailey, L.W. 1839. Notes on *Diatomacea* from the Saint John River. Communicated by the Natural History Society of New Brunswick. From the Canadian Naturalist and Geologist, April, 1863, Montreal.
5. Bair, S.H., H.A. Lynch and G.A. Rounsefell. 1951. Interim report on salmon restoration on the St. Croix, Aroostook and Saint John rivers. Typewritten MS Rept., Atlantic Salmon Investigations, 24 p + 5 figs.
6. Bond, L.H. and F. DeRoche. 1950. A preliminary survey of man-made obstructions and logging practices in relation to certain salmonid fishes of northern Maine. Maine Dept. Inland Fish. and Game, Augusta, Maine, 47 p.

*Preliminary survey to determine the extent and location of man-made obstructions in the headwaters of the river systems of northern Maine. Observations were also made of logging practices and their effect on the habitat of salmon and trout.*

7. Can. Dept. Env. (Fisheries Service) Annual Reports.

*Federal fisheries annual reports, as far back as 1869, contain narrative descriptions and, more recently, statistics on the fisheries in the Saint John River. Res. Devel. Br., Halifax, N.S.*

8. Can. Dept. Env. 1975. Mactaquac and the Saint John River salmon. Fish. and Mar. Serv., Resource Development Branch, Halifax, N.S. Information Publication No. MAR/N-75-1.

*A public relations publication describing the history of the river, dam sites, Mactaquac fish collection facilities, Mactaquac Fish Culture Station, tags and salmon life cycle.*

9. Can. Dept. Fish. 1955. Survey reports, Atlantic salmon rivers, Maritimes Area. Pt. I, Res. Devel. Br., Halifax, N.S. MS Rept. No. 55-6.

*In relation to the Saint John River, reports are presented on salmon surveys in the Kennebecasis and Tobique river tributaries.*

10. Can. Dept. Nat. Health and Welfare. 1961. Survey report: Effects of pollution, Saint John River, New Brunswick and Maine, 1960. Public Health and Eng. Div., Fredericton, N.B. MS Rept., 105 p.
11. Can. Dept. Nat. Health and Welfare. 1966. Survey report: Presquile River, New Brunswick, 1965 baseline water quality. Public Health and Eng. Div., Fredericton, N.B. MS Rept.
12. Can. Dept. Nat. Health and Welfare. 1969. Water quality data 1968-69, Aroostook River, New Brunswick, Public Health and Eng. Div., Fredericton, N.B. MS Rept.
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*Reviews history of dams on the Saint John River and reasons for building Mactaquac Hatchery. Discusses selective breeding programs at Mactaquac Hatchery.*

16. Carey, T.G. 1971. Summary of Saint John River hatchery stocking program - 1971. Can. Dept. Env., Res. Devel. Br., Halifax, N.S. MS Rept. No. 71-8, 19 p.
17. Carscadden, J.E. 1971. A study of the ecology and population characteristics of American shad (*Alosa sapidissima*) in major Atlantic coast rivers. MS Rept. to Can. Dept. Env., Res. Devel. Br., Halifax, N.S.

*Discusses the state of the shad population in the Saint John and Miramichi river systems. Indicates that repeat spawners important in both systems and recommends immediate estimate of population required in both systems. Harvest should be regulated to maintain relatively high levels of repeat spawners.*

*Recommends better marketing practices, resulting in higher return to the fishermen and immediate steps to correct negative impact of Mactaquac Dam on the Saint John River system.*

18. Carscadden, J.E. 1972. Ecology and population characteristics of American shad in Canadian Atlantic coast rivers. MS Rept. for Can. Dept. Env., Res. Devel. Br., Halifax, N.S., 82 p.
19. Carscadden, J.E. 1975. Studies on the American shad (*Alosa sapidissima*, Wilson) in the Saint John River and Miramichi River, New Brunswick, with special reference to homing and r-k selection. Ph.D. Thesis, McGill Univ., Montreal, Quebec, 143 p.
20. Carscadden, J.E. and W.C. Leggett. 1973. Ecology and population characteristics of American shad in rivers of New Brunswick. Prepared for Can. Dept. Env., Res. Devel. Br., Halifax, N.S. MS Rept., 121 p.
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Univariate and multivariate analyses were performed on five meristic characters of American shad (*Alosa sapidissima*), spawning in the Miramichi, Saint John, Connecticut, and Hudson rivers. In 71% of the comparisons, significant differences in mean numbers of meristic characters existed between river populations and between tributaries within the Saint John River system. Comparisons of populations using multivariate techniques revealed that percentage of overlap of meristic characters was low (<1% in most comparisons). It is suggested that shad not only home to their natal river but also to their natal tributary. The results suggest that in shad meristic counts are strongly influenced by a genetic component.

22. Carscadden, J.E. and W.C. Leggett. 1975b. Ecology and population characteristics of American shad (*Alosa sapidissima*) in the Saint John and Miramichi rivers, New Brunswick, with notes on their management. Final MS Rept. for Can. Dept. Env., Res. Devel. Br., Halifax, N.S., 105 p.

Results of a study on the systematics of shad collected in different areas, both by biochemical and meristic methods and life history (reproductive biology, age and growth of shad) in both rivers.

23. Carscadden, J.E. and W.C. Leggett. 1975c. Life history variations in populations of American shad, *Alosa sapidissima* (Wilson), spawning in tributaries of the Saint John River, New Brunswick. J. Fish. Biol. 7:595-609.

Shad were sampled at four locations in the Saint John

River area, New Brunswick — Saint John Harbour, Kennebecasis River, Washademoak Lake and Mactaquac Dam. The effect of the Saint John Harbour fishery on upstream spawning populations was minimal. Mactaquac Dam began operation in 1967 and since that time the populations of shad arriving at that facility have been in a state of flux. When shad populations from Kennebecasis River and Washademoak Lake were compared, the Washademoak Lake population exhibited higher relative fecundity, lower mean age at maturity and possessed a lower proportion of repeat spawners. The combinations of reproductive characteristics occurring in the populations of the Saint John River were the same as those occurring over the Atlantic coast range of shad. The possible environmental factors influencing the variations in reproductive characteristics are discussed.

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25. Catt, J. 1950. Some notes on brown trout with particular reference to their status in New Brunswick and Nova Scotia. *Can. Fish-Cult.* 7:25-27.
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*Gives results of bioassays with speckled trout fingerlings at the Irving Refinery, Atlantic Sugar Refinery, Ste. Anne Nackawic Pulp and Paper Co., Kimberly Clark Ltd., MacMillan Rothesay Pulp and Paper Co., Irving Pulp and Paper Co.*
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*Water quality study of Mactaquac, Beechwood, Tobique and Grand Falls headponds to provide a base study for indication of changes in fertility.*

33. Dadswell, M.J. 1976. Mercury, DDT and PCB content of fishes from the Saint John River estuary. Trans. Can. Soc. Env. Biol., Atl. Chap. Proc.
34. Dixon, W.A. 1954. Electrifying, New Brunswick. Can. Geog. J., May 1954, 14 p.
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*Deterioration of water quality as a result of the disposal of untreated organic and toxic wastes into the Saint John River Basin began when the river was first settled in 1604, and the amount of waste entering the river has increased substantially over the past two decades. Hydropower developments constructed on the main stem during this recent period have added to the problem by reducing the biological assimilative capacity of the river.*

*The significance of these cultural influences for Atlantic salmon (Salmo salar) in the river has been to reduce the quality of its migration route to and from the sea, to eliminate some of its freshwater spawning and rearing areas, and to cause direct mortality of adult and juvenile salmon. As a consequence, the total salmon stock in the Saint John River has declined by approximately 40% over the last two decades.*

*Forest spraying with DDT to control the spruce budworm had a serious direct impact on the salmon resource. Salmon mortalities have also resulted from release of agricultural pesticides directly into streams and from nitrogen supersaturation of the water below Mactaquac hydroelectric power installation. The effect on salmon of generally deteriorating water quality in the main stem has been less obvious, except in cases where fish have been trapped because of low flow in areas where dissolved oxygen has been severely depleted.*

*At present, an approach involving water pollution abatement, together with scientific regulation of the salmon fishery and large-scale artificial propagation, indicates an optimistic future for this valuable natural resource.*

36. Dominy, C.L. (ed.) 1972. A position paper on the inland fisheries of New Brunswick (MS Rept. prepared for the New Brunswick Forest Resource Study). Can. Dept. Env., Res. Devel. Br., Halifax, N.S. MS Rept., 41 p + append.

*Regarding the Saint John River, the report gives an estimate of salmon potential, reviews angling catch and effort in five-year segments from 1951 to 1970 for salmon, and gives some figures on commercial fishery values. It also gives facts on other sport fisheries in the river.*

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*Hydroelectric power developments and deterioration in water quality have led to a decline in salmon abundance of approximately 40% in the salmon stocks of the Saint John River over the past two decades.*

*The future prospects for conserving this valuable natural resource in the river are moderately bright in view of current activities in water pollution abatement, effective regulation of the salmon fisheries and large-scale artificial propagation.*

38. Ducharme, L.J.A. 1963. Electronic fish counting project at the Beechwood Dam. Can. Dept. Fish., Res. Devel. Br., Halifax, N.S. MS Rept. No. 63-4, 6 p + table + illus.
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*A detailed systematic account of zooplankton in the Saint John River headponds.*

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*A systematic account of the species and distribution of zooplankton in the Saint John River headponds (Tobique, Grand Falls, Beechwood and Mactaquac) and Glazier Lake.*

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*A systematic study of the species and distribution of macrobenthos in Saint John River headponds and Glazier Lake.*

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*Detailed catalogue of the macroenthos of Saint John River headponds (Tobique, Grand Falls, Beechwood and Mactaquac) and Glazier Lake.*

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*This is the first of a series of yearly summaries of Atlantic salmon sportfishing statistics. The numbers and weights of salmon and grilse (bright and black) angled in each Maritime river is given by individual month, along with the monthly and annual totals.*

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*Mathematical models and discussion pertaining to water pollution and water quality.*

46. Edwards, H. 1952. Angling surveys, Madawaska Co., N.B., Summer 1952. Can. Dept. Fish., Res. Devel. Br., Halifax, N.S. MS Rept. No. 52-1, 29 p.

*Discusses flowage site investigations in conjunction with angling surveys of Green, Quisibis, Iroquois, Grand and Siegas rivers, in the headwaters of the Saint John River, and related protection issues.*

47. Elson, P.F. 1967. Effects on wild young salmon of spraying DDT over New Brunswick forests. J. Fish. Res. Bd. Canada, 24:751-767.

*When DDT-in-oil was sprayed over large tracts of New Brunswick forest, some of the spray got into drainage systems lying in the spray zones. As a result, many young salmon were killed and stocks were endangered.*

*Most New Brunswick salmon spend three years in rivers before migrating to sea as smolts. The young fish can*

conveniently be divided into three size-groups, which are roughly comparable to each year of age. The groups are: underyearlings, small parr (over 1 year old but 10 cm and under from tip of snout to tip of extended tail fin), and large parr.

Wild young salmon in unsprayed and sprayed streams were assessed for numbers in each age-group, abundance being expressed as population index = average number per 100 square yards of stream bottom.

DDT at 1/2 lb per acre. After such spraying, young salmon of all size-groups were found in noticeably low numbers as compared with unsprayed situations. Underyearlings were only 2%-10% as abundant (index reduced from 24 in places not affected by spray to less than 1 in most sprayed places), small parr only 30% (index reduced from 20 to 6), and large parr only 50% (index reduced from 12 to 6) as abundant.

DDT at 1/4 lb per acre. After spraying at this dosage, underyearlings were only about 50% as abundant as with no spraying; small parr were about 80% as abundant and large parr were affected hardly at all.

DDT at 1/4 per acre applied twice. This was followed by low numbers of underyearlings, similar to those observed with a single application at 1/2 lb per acre. No equivalent data for parr are available, but other information indicates effects similar to a single spraying with 1/2 lb DDT per acre.

Downstream transport of the DDT-in-oil mixture was an important factor in extending the harmful effects 30 or more miles below spray zones.

Delayed mortality followed 4-6 months after the early mortality described above. It was associated with the onset of winter cold. It may have removed a large proportion of parr which survived early mortality, but quantitative measurements of this factor were not made on wild populations.

Reductions in numbers of young salmon were followed by declines in numbers of adults taken in fisheries and returning as spawners.

With no spraying in subsequent years, promptness of recovery of young salmon populations depended primarily on abundance of parent stock.

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An index of lake surveys completed through 1965, some of which are on lakes in the Saint John River basin.

50. Everhart, W.H. 1966. Fishes of Maine, 3rd ed. Maine Dept. Inland Fish. and Game, Augusta, Me., 96 p.
- Taxonomic keys to fish species of Maine, with information on their biology and notes on distribution.*
51. Foda, A. 1971. Investigation results of study of blood physiology parameters related to stress in juvenile Atlantic salmon (*Salmo salar*) at Mactaquac Fish Culture Station. Report No. 1, Can. Dept. Env., Res. Devel. Br., Halifax, N.S. MS Rept No. 71-5, 7 p.
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- Water quality tests done from mid-February to mid-March, 1971, covering Grand Falls, Tobique, Beechwood and Mactaquac headponds and the lower Saint John.*
53. Gillis, G. 1973. An ecological survey of the Saint John estuary. Saint John River Basin Board, Fredericton, N.B. Rept. 15H, 64 p.
54. Gorham, S.W. 1965. Notes on fishes from the Brown's Flat area, Kings County, New Brunswick. Can. Field Nat. 79(2): 137-142.
55. Gorham, S.W. and D.E. McAllister. 1974. The shortnose sturgeon, *Acipenser brevirostrum*, in the Saint John River, New Brunswick, Canada, a rare and possibly endangered species. Nat. Mus. Natl. Sci. (Ottawa). Syl. 5, 18 p.
56. Grasberg, E. 1956. Economic benefits of the Atlantic salmon to the province of New Brunswick. New Brunswick Dept. Lands Mines, Fredericton, N.B. MS Rept., 14 p.
57. Gray, R.W. 1973. Floating Atlantic salmon smolts, *Salmo salar*, to the mouth of the Saint John River: a method for improving fishery contributions. Can. Dept. Env., Res. Devel. Br., Halifax, N.S. MS Rept. No. 73-5, 20 p.
- A total of 16,318 tagged Atlantic salmon smolts were floated from Mactaquac to the Reversing Falls, Saint John, N.B., from May 30 to June 6, 1972. The behaviour, stress, and mortalities associated with the experiment were determined; and data on costs and manpower requirements for floating smolts to salt water were collected. Adult tag returns and spawning escapement will be obtained in 1973 and 1974 and, at this time, a final assessment of the experiment will be made.*
58. Hachey, B.H. 1969. Hydrographic features of Saint John Harbour. J. Fish. Res. Bd. Canada 4(5):424-440.

The salinity distribution of Saint John Harbour water varies greatly with the phase of the tide. After a dry summer, with comparatively small discharge from the river, the salinity at any phase of the tide did not fall below 22.0 ‰, and salinities greater than 32.00 ‰ penetrated the harbour at the greater depths. At times of spring freshets, the harbour was thoroughly bathed, at certain phases of the tide, with waters of a salinity less than 5.0 ‰. At other phases of the tide, salinities greater than 30.00 ‰ penetrated into the harbour. Formulae have been derived to express the annual variation of water temperatures, and the relationship between harbour salinities and river discharge.

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61. H.G. Acres, Ltd. 1971. Water quality management methodology and its application to the Saint John River. Appendix C. Hydraulics of the Saint John River Basin. Appendix D. Aquatic ecology of the Saint John River Basin. Appendix E. Water quality treatment plants and pollution in the Saint John River Basin. Prepared for the Policy Planning Directorate, Can. Dept. Env., Ottawa, by H.G. Acres, Ltd., Niagara Falls, Ont.

This document consists of three appendices to the main report of the Water Quality Management Study of the Saint John River. The first considers certain aspects of the hydraulics and hydrology of the river, particularly during low flow periods. The physical parameters are pollutant and dissolved oxygen concentrations and the significant hydraulic parameters are volumetric flow pattern and travel time between waste sources and points of water quality interest. There are six tables and two plates. The second appendix contains a review of available data on fish species, plankton and fauna on the river and examines the effects of various attributes of the river basin on pollutant loading reuse and in a man-made structure sense. There are 17 tables and 5 plates. The third appendix contains information obtained on waste sources, waste treatment and water quality. There are 7 tables and 12 plates.

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64. Huntsman, A.G. 1931. The Maritime salmon of Canada. Bull. Fish. Res. Bd. Canada, No. 21, 99 p.
65. Huntsman Mar. Lab. 1976a. Baseline survey and living resource potential study of the Saint John River estuary. Vol. I. Physics and chemistry. St. Andrews, N.B. MS Rept.

*Introduces the "living resource potential study" and reports on the results of the determination of selected chemical-physical parameters in the estuary.*

66. Huntsman Mar. Lab. 1976b. Baseline survey and living resource potential study of the Saint John River estuary. Vol. II. Plankton and benthos. St. Andrews, N.B. MS Rept.

*Gives results of chlorophyll A and phytoplankton studies, and benthos and eipbenthos studies in the Saint John River estuary.*

67. Huntsman Mar. Lab. 1976c. Baseline survey and living resource potential study of the Saint John River estuary. Vol. III. Fish and fisheries. St. Andrews, N.B. MS Rept.

*Reports on the biology of shortnose sturgeon (Acipenser brevirostrum), striped bass (Morone saxatilis) and whitefish (Coregonus clupeaformis) in the Saint John River estuary.*

68. Hyatt, R.A. 1969. Fish population density estimates, 1969, Fredericton District. Can. Dept. Fish. & Forest., Res. Devel. Br., Halifax, N.S. MS Rept. No. 70-15, 15 p + tables + figs.

*Gives fish population densities in various middle and lower Saint John River tributaries.*

69. Hyatt, R.A. 1970. A biological survey of Baker Lake, N.B. Can. Dept. Fish. & Forest., Res. Devel. Br., Halifax, N.S. MS Rept., 13 p + figs.

70. Hyatt, R.A. 1971. The effects of density and feeding rates on the disease quality of Atlantic salmon reared at Mactaquac Fish Culture Station, Saint John River, New Brunswick. Can. Dept. Env., Res. Devel. Br., Halifax, N.S. MS Rept. No. 71-10.

*Fingerling Atlantic salmon were placed into 18 test ponds at Mactaquac Fish Culture Station during the summer of 1970 at three loading densities. Each density was*

tested at three feeding rates. Each treatment was replicated once.

Groups that were loaded at 35.0 fish per sq ft and fed at 5% body weight per day until Oct 20/70 and then at 25% until May 18/71 had a lower fin-rot index accumulation than did those at higher densities or those at the same density but fed at either of the two other feeding rates. These results suggest that full feeding may be a logical practice.

71. Ingram, J.H. 1960. Fish photography, Beechwood fishway, 1960a. Can. Dept. Fish., Res. Devel. Br., Halifax, N.S. MS Rept. No. 60-4, 4 p + illus.

*Tests to see if fish counts are possible using photographic methods.*

72. Ingram, J.H. 1960b. Atlantic salmon investigation, Beechwood power dam - Saint John River, N.B., fishway and area. Can. Dept. Fish., Res. Devel. Br., Halifax, N.S. MS Rept. No. 60-1, 66 p + tables + fig.

*A review of work in 1960, dealing with fishway problems at Beechwood, salmon angling, spawning checks, smolt in Beechwood forebays, flowage studies, fish fallback and Tobique Narrows fishway operation.*

73. Ingram, J.H. 1961a. Abstract of salmon investigation, Beechwood area. Can. Dept. Fish., Res. Devel. Br., Halifax, N.S. MS Rept. No. 61-3, 13 p.

74. Ingram, J.H. 1961b. Atlantic salmon investigation, Beechwood power dam - Saint John River, N.B., fishway and area. Can. Dept. Fish., Res. Devel. Br., Halifax, N.S. MS Rept. No. 61-1, 62 p.

*Summary of numbers of fish ascending Beechwood fishway. Discussion of problems, such as attraction water, shape of fishway entrances, salmon fallback, smolt tests, etc.*

*Salmon spawning and population estimates were determined.*

75. Ingram, J.H. 1962a. Summary of salmon investigation in upper Saint John River (Beechwood and Tobique fishways). Can. Dept. Fish., Res. Devel. Br., Halifax, N.S. MS Rept. No. 62-1, 17 p.

76. Ingram, J.H. 1962b. Salmon investigation - Saint John River, Beechwood fishway and other related activities. Can. Dept. Fish., Res. Devel. Br., Halifax, N.S. MS Rept. No. 62-4, 30 p + tables + figs.

*Lists of fish counts for year, along with observations on fish behaviour below dam. Discusses possible reasons for recent declines in salmon runs. Describes preliminary work with a Rockwell fish counter and underwater camera.*

77. Ingram, J.H. 1963. Atlantic salmon investigation Beechwood and Tobique power dam fishways, Saint John River - New Brunswick. Can. Dept. Fish., Res. Devel. Br., Halifax, N.S. MS Rept. No. 63-3, 37 p + figs.

*Summary of numbers of different species of fish ascending both fishways. Problems were encountered with auxiliary water supply pump and high tailwater, and delays were observed below the dam due to spillage attracting salmon away from the fishway.*

78. Ingram, J.H. 1964. Atlantic salmon investigations at Beechwood power dam fishway on Saint John River, N.B. and Tobique River, N.B. Can. Dept. Fish., Res. Devel. Br., Halifax, N.S. MS Rept. No. 64-1, 31 p + figs.

*Summary of fish counts, and observations of delay, etc., at both dams. Description of use of fish counter and camera.*

79. Intern. Saint John River Eng. Bd. 1953. Water resources of the Saint John River Basin, Quebec-Maine-New Brunswick. Interim Report to the Intern. Joint Comm. under reference July 7, 1952. Appendices Vol. 1 - Acknowledgements, storage and power investigations. Appendices Vol. 2. Geology, hydrology, power studies - supply and demand. Intern. Joint Comm., Ottawa, 122 p.

80. Jessop, B.M. 1975. A review of the American shad (*Alosa sapidissima*) stocks of the Saint John River, New Brunswick, with particular reference to the adverse effects of hydroelectric dams. Can. Dept. Env., Res. Devel. Br., Halifax, N.S. Tech. Rept. Series No. MAR/T-75-6, 23 p.

*The commercial catch of American shad (Alosa sapidissima) in the Saint John River, New Brunswick, declined from approximately one million pounds to 56,000 pounds between 1953 and 1974. At Mactaquac Dam, the run of shad declined from 38,800 to 2,400 between 1968 and 1974. The relationship between the total shad population of the Saint John River and that portion which spawned above Mactaquac Dam is uncertain, and no satisfactory estimate can be made of the impact of the dam on the total shad population or commercial fishery. There is little doubt that Mactaquac Dam significantly affected the shad stock which formerly migrated beyond.*

*The major factors affecting shad returns to Beechwood and Mactaquac dams apparently are the biology of the population, difficulties in fish passage at the dams and the effect of adverse environmental conditions on reproductive success. Evidence is given for geographically distinct populations of shad differing in mean population fecundity, for substantial adult shad mortality during upstream passage at Mactaquac Dam, for poor attraction conditions at Beechwood Dam and for mortality during downstream migration at both dams.*

*Declining shad returns to Mactaquac Dam probably also reflect mortality of eggs, resulting from adverse water quality in the headponds and reduction in suitable spawning area, as well as predation and mortality of juveniles at the dams during downstream passage.*

*Recommendations are made for the management and rehabilitation of the shad returning to Mactaquac Dam.*

81. Keachie, P.M. 1972. Ecology of the Saint John River Basin VI. Interim report on toxic pollutants. Prepared for Saint John River Basin Bd. by Can. Dept. Env., Res. Devel. Br., Halifax, N.S. MS Rept., 220 p.
82. Keachie, P.M. and R.P. Côté. 1973. Toxic pollutants in the Saint John River Basin. Saint John River Basin Bd., Fredericton, N.B. MS Rept. T16.

*An extensive report on the toxic pollutants in the Saint John River Basin and possible ecological effects.*

83. Keachie, P.M. and R.P. Côté. 1974. Water use and toxic pollutants in the Saint John River Basin. Saint John River Basin Bd., Fredericton, N.B. MS Rept. S16.
84. Leggett, W.C.G. 1969. Studies on the reproductive biology of the American shad (*Alosa sapidissima*, Wilson): a comparison of populations from four rivers of the Atlantic seaboard. Ph.D. Thesis, McGill Univ., Montreal, Quebec, 125 p + tables and figs.
85. Lindroth, A. 1967. Mactaquac Project and Saint John River salmon. Prepared for the New Brunswick Electric Power Commission, Fredericton, N.B. MS Draft Rept., 14 p + append.

*Reviews all aspects of the dam's possible effects on the salmon populations and includes theoretical estimate of turbine mortality for salmon smolts.*

86. Lord, K.N., G.T. Beaulieu and C. Pellerin. 1968. Velocity tests - Mactaquac Fish Culture Station, large and small ponds. Can. Dept. Fish., Res. Devel. Br., Halifax, N.S. MS Rept. No. 68-8, 2 p + append.
87. MacDonald, J.R. 1968. Saint John River smolt project, 1967. Can. Dept. Fish. & Forest., Res. Devel. Br., Halifax, N.S. MS Rept. No. 68-10.
88. MacDonald, R. 1968. A summary report on activities on the Saint John River in 1968. Can. Dept. Fish. & Forest., Res. Devel. Br., Halifax, N.S. MS Rept No. 68-2, 48 p + append.

*A preliminary report covering smolt production above Mactaquac Dam, planting hatchery stock, fry and parr*

populations, river discharge, water quality and fish kills in 1968, and exploitation of salmon.

89. MacDonald, J.R. and R.A. Hyatt. 1969. Air supersaturation in water below Mactaquac turbines. Can. Dept. Fish. & Forest., Res. Devel. Br., Halifax, N.S. MS Rept No. 69-2, 21 p + append.
90. MacDonald, J.R. and R.A. Hyatt. 1973. Supersaturation of nitrogen in water during passage through hydroelectric turbines at Mactaquac Dam. J. Fish. Res. Bd. Canada 30 (9):1392-1394.

*Two fish kills occurred in the Saint John River, New Brunswick, below the Mactaquac hydroelectric station in the summer of 1968. Gas bubbles, commonly associated with nitrogen supersaturation, were observed on dead and dying salmon (Salmo salar) and eels (Anguilla rostrata). Tests showed that the concentrations of dissolved oxygen and nitrogen gases were substantially increased when water passed through the turbine generating system at low generating levels. Concentrations of dissolved nitrogen gas increased by as much as 20% above atmospheric equilibrium.*

91. MacDonald, J.R., R.A. Row and J.R. Machell. 1970. Pollution survey - Saint John River system, 1969. Can. Dept. Fish. & Forest., Res. Devel. Br., Halifax, N.S. MS Rept. No. 70-14, 103 p + append.
92. MacDonald, R.E.H. 1969. Operating features of the Mactaquac Fish Culture Station: a 500,000 Atlantic salmon smolt production unit. Can. Dept. Fish. & Forest., Res. Devel. Br., Halifax, N.S. MS Rept. No. 69-7, 16 p + figs.
93. MacEachern, N.E. 1960. Mortality tests - Tobique Narrows Dam. Can. Dept. Fish., Res. Devel. Br., Halifax, N.S. MS Rept. No. 60-12, 24 p.

*An investigation to evaluate the mortality of hatchery-reared Atlantic salmon yearlings through the turbine at Tobique Narrows hydroelectric dam. Fish were introduced into the penstock entrance, and a sample was recovered in a downstream trap in the turbine. Mortality rates for different size fish are given.*

94. MacLelland, D.C. and J.B. Sprague. 1966. Bottom fauna of Saint John Harbour and estuary as surveyed in 1959 and 1961. Fish. Res. Bd. Canada, St. Andrews Biological Station. MS Rept. 883, 24 p.
95. McMinn, A.M. and C.M. Côté. 1974. Length-weight measurements and stomach contents analysis of juvenile alewives, Saint John River system. Can. Dept. Env., Res. Devel. Br., Halifax, N.S. Data Record Ser. No. MAR/D-74-2, 103 p.

96. M'Gonigle, R.H. 1936. Report of biological surveys of certain streams of Madawaska County, New Brunswick. Fish. Res. Bd. Canada. MS Rept. 243A.

*A cursory inspection of a number of Madawaska County lakes and streams for siting a hatchery.*

97. Marshall, T.L. 1975. Movement of adult salmon of wild and hatchery origin placed in and above Mactaquac headpond. Can. Dept. Env., Res. Devel. Br., Halifax, N.S. Tech. Rept. Ser. No. MAR/T-75-4, 21 p.

*To determine the effects of large Saint John River, New Brunswick, impoundments in delaying the upriver movement of adult salmon of wild and hatchery origin, 1,355 tagged salmon were released from three locations in 1972 and 1973. A significantly greater percentage of salmon of wild origin moved upstream than did salmon of hatchery origin. Of the groups released in the Mactaquac headpond in 1973, 22.3% of the wild salmon and 2.8% of the hatchery salmon were recaptured at Beechwood Dam, 130 km upstream. For groups released 55 km below Beechwood Dam, 26.2% and 11.3% of wild and hatchery salmon, respectively, were recaptured at Beechwood. Although no differences were apparent in the travel times of the experimental "just tagged" hatchery or wild groups of salmon recaptured at Beechwood, they were found to move significantly slower than salmon tagged prior to their arrival at and subsequent release from Mactaquac Dam.*

*In both years, hatchery salmon released just above Mactaquac Dam fell back at significantly greater rates than did salmon of wild origin. Fallback to Mactaquac of fish released at upstream locations was insignificant.*

*No differences could be detected in the angler exploitation of hatchery or wild salmon.*

*Results suggest that most efficient use of hatchery salmon would be achieved by dispatching them above headponds, directly to the areas of intended angler exploitation or egg deposition.*

98. Mason, J.E. 1954. Aroostook Falls and other obstructions to Atlantic salmon rehabilitation on the Aroostook River. Atlantic Sea-Run Salmon Comm., Augusta, Maine. MS Rept., 21 p + 7 append.
99. Meta Systems, Inc. 1975a. Summary of scope of work, environmental impact statement for the Dickey-Lincoln School Lakes project. Prepared for the Corps of Engineers, New England Division, by Meta Systems, Inc., Cambridge, Mass. MS Rept.
100. Meta Systems, Inc. 1975b. Scope of work, environmental impact statement for the Dickey-Lincoln School Lakes project. Prepared for the Corps of Engineers, New England Division, by Meta Systems, Inc., Cambridge, Mass. MS Rept., Vol. 1.

101. Meta Systems, Inc. 1975c. Scope of work, environmental impact statement for the Dickey-Lincoln School Lakes project. Prepared for the Corps of Engineers, New England Division, Cambridge, Mass. MS Rept., Vol. 2.

102. Meth, F.F. 1971a. Ecology of the Saint John River Basin. II. Catalogue of estuary fish species. Prepared for Saint John River Basin Bd. by Can. Dept. Env., Res. Devel. Br., Halifax, N.S. MS Rept. No. 71-28.

*Fishes were sampled in Saint John River between Reversing Falls and head of tide at McKinley Ferry, using gill nets and manually operated shore seines.*

*Results were presented under heading - Family summaries, species accounts and erroneous reports.*

103. Meth, F.F. 1971b. Fishes of the Saint John estuary. Saint John River Basin Bd., Fredericton, N.B. MS Rept. 75A, 57 p.

*This report catalogues the fishes of the Saint John estuary (New Brunswick). The report includes: family summaries, species accounts, erroneous reports, a glossary of terms and a table of catches. Two species were notable by their virtual absence from the catches: the Atlantic salmon, Salmo salar, and the striped bass, Morone saxatilis.*

104. Meth, F.F. 1972. Ecology of the Saint John River Basin. V. Status of estuarine fisheries. Prepared for Saint John River Basin Bd. by Can. Dept. Env., Res. Devel. Br., Halifax, N.S. Prog. Rept. 6, 70 p + 18 tables + 12 figs.

*Discusses present and future commercial and sport fisheries potential of estuarial tributaries under rearing areas for Atlantic salmon, management procedures, mercury content, results of 1971 survey of distribution and species of fish, and recommendations for changes.*

105. Meth, F.F. 1973a. Ecology of the Saint John River Basin. VII. Catalogue of middle and upper basin fish species. Prepared for Saint John River Basin Bd. by Can. Dept. Env., Res. Devel. Br., Halifax, N.S. MS Rept., 45 p + append.

106. Meth, F.F. 1973b. Ecology of the Saint John River Basin. VIII. Status of middle and upper basin fisheries. Prepared for Saint John River Basin Bd. by Can. Dept. Env., Res. Devel. Br., Halifax, N.S. MS Rept., 59 p + tables, figs. and append.

*Discusses past, present and future use of commercial and sport fisheries, management procedures, categories of*

angling water, interagency liaison, effects of forest-based industry, and results of the 1972 survey and mercury contamination.

107. Meth, F.F. 1973c. Fishes of the upper and middle Saint John River. Prepared for Saint John River Basin Bd. by Can. Dept. Env., Res. Devel. Br., Halifax, N.S. MS Rept., 45 p + append.

*This report is the third in a series describing the fisheries resources of the Saint John River Basin, and comprises a catalogue of species which occur in the basin above the estuary (the estuary is here defined as that portion of the basin subject to the ebb and flow of tide, and extends to a point approximately one mile downstream from the Mactaquac Dam). The drainage area of this portion is about 73% of the total basin area; that is, about 15,500 sq mi (39,680 km<sup>2</sup>). Of this, only 31% lies in New Brunswick, while 20% is in Quebec and 49% in Maine. The emphasis of this investigation is on the New Brunswick portion of the basin, although information from the Quebec and Maine portions has been included in a cursory way, where it was available.*

108. Meth, F.F. 1973d. Fishery management in the Saint River Basin. Saint John River Basin Bd., Fredericton, N.B. MS Rept. 7E.

*In-depth survey of fishery management in the basin.*

109. Meth, F.F. 1973e. Water use for fisheries in the Saint John River Basin. Saint John River Basin Bd., Fredericton, N.B. MS Rept. S7.

*Summary of major reports for the Board concerning water use for fisheries.*

110. Meth, F.F. 1974a. Sports and commercial fisheries of the Saint John estuary. Saint John River Basin Bd., Fredericton, N.B. MS Rept. 7B, 63 p + append.

*This report, the second in a series describing the fisheries task of the Saint John River Basin study, is a compilation of relevant information relating to fisheries, both recreational and commercial, within the estuary of the Saint John River. The estuary proper is defined as that portion of the basin which is exposed to the flow and ebb of tide. In the Saint John River, this tidal influence extends to McKinley Ferry, a point several hundred yards downstream from the Mactaquac power development. The entire drainage basin below this point is considered in this report, even though the upstream reaches of the tributaries entering the estuary are not under tidal influence (Fig. 1). The report consists of a review of all existing fisheries and the management procedures which have been applied to*

those fisheries. Using a survey completed during 1971 as a basis, the possibilities of other fisheries are explored. In addition, all major tributaries are assessed as to their potential production of Atlantic salmon. In view of the recent alarm with respect to mercury concentrations in various freshwater fish, samples of fish from the estuary were analysed and the results are presented herein.

111. Meth, F.F. 1974b. Sports and commercial fisheries of the upper and middle Saint John River. Saint John River Basin Bd., Fredericton, N.B. MS Rept. 7D, 60 p + append.

This report is the fourth in a series describing the fisheries resource of the Saint John River Basin, and focuses on that portion of the basin above the estuary. (The estuary extends from the mouth of the river to a point several hundred yards downstream from the Mactaquac Dam.) This portion has been sub-divided for purposes of fisheries analysis, into a middle basin extending from the head of tide to the cataract at Grand Falls, and an upper basin extending from Grand Falls to the headwaters. A more complete description of these portions of the basin and the reason for the sub-division may be found in the previous report entitled "Catalogue of Middle and Upper Basin Fish Species". As was the case in the second report of this series entitled "Status of Estuarine Fisheries", this report reviews all existing fisheries and management of them. A survey of the area under consideration was carried out in 1972, and the availability of unexploited fisheries was investigated. Atlantic salmon investigations are summarized. Heavy metal and pesticide analyses were also carried out, but complete results from these analyses were not available at the time of writing and will be included in the final report of the toxic pollutants task.

112. Montreal Engineering Co. Ltd. 1969. Maritime provinces water resources study. Prepared for the Atlantic Development Bd., Ottawa, Ont. MS Rept., 5 Vols., 13 append.

A broad summary of activities and developments in a number of New Brunswick river basins including the Saint John giving their demands on water and relative economic importance.

113. Morse, N.H. 1971. Study of fisheries of Saint John Basin. Fisheries Research Project, Dept. Econ., Dalhousie University, Halifax, N.S. Interim MS Rept.
114. Morse, N.H. and A.G. DeWolfe. 1973. Economic principles for the management of Atlantic salmon - Saint John River system. Pages 355-364 in M.W. Smith and W.M. Carter, eds. Proceedings of the International

Symposium on the Atlantic salmon. Intern. Atl. Salm. Found., St. Andrews, N.B.

*Management of a fish stock, such as Atlantic salmon, requires that both supplying of the stock (protecting, rearing, etc.) and harvesting of it generate economic information on which to base decisions. Such is generally not now the case, and as a consequence, decisions are made more or less arbitrarily, perhaps on grounds either to conserve the stock or in response to different, often conflicting, interests. There is no way of determining whether this kind of regime will move towards a social optimum or away from it. The amount of tranquility or of hostility which it generates is a very inadequate or ambiguous index by which to judge its success or failure.*

*The position is taken that a critical factor in the development of a management plan consistent with economic principles broadly interpreted is the conditions of access afforded to users of the fish stock. The bulk of the literature tends to neglect this crucial issue which is concerned with institutional arrangements surrounding utilization of the stock in the first instance. Accordingly, attention is focused on the nature of the good, or of the activity in question, in order to explore whether other institutional arrangements, in particular, an explicit form of market structure, would be feasible.*

*It is concluded that the good is such that resort to a market system is technically feasible, although a range of new problems can be anticipated. Unless changes in this direction can be accomplished, it is inferred that management cannot unambiguously claim to have achieved either a first or a second best position and may only reach one that is considerably lower.*

115. New Brunswick Dept. Fish. Env. 1973. A dam on the Green River: environmental and economic considerations. Fredericton, N.B., 28 p.

*An initial environmental impact statement regarding a proposed hydroelectric dam and reservoir near the mouth of Green River in the headwaters of the Saint John River system.*

116. New Brunswick Dept. Nat. Res. 1972. Fishing guide - Tobique River from Saint John River to Big Nictor Lake. Fish and Wildl. Br., Fredericton, N.B.
117. New Brunswick Dept. Nat. Res. 1973. Fishing guide - Nashwaak River - Fredericton to Nashwaak Lake. Fish and Wildl. Br., Fredericton, N.B.
118. New Brunswick Electric Power Comm. 1955. New Brunswick's Beechwood. Fredericton, N.B. MS Rept., 24 p.

119. New England - New York Inter-Agency Committee. 1955. The Gold Book. The resources of the New England-New York region. Pt. 2, Chapt. III, Saint John River Basin, Maine, XIV Sect.
120. Nobbs, P. 1949. The restoration of the St. Francis, Quebec, as a salmon river. Atl. Salmon Assoc. MS Rept. 10.
121. Perley, M.H. 1852. The sea and river fisheries of New Brunswick. Report of Her Majesty's emigration officer at Saint John, New Brunswick. Fredericton, N.B., 294 p.
- A series of reports giving information on the fisheries of the Saint John River and other New Brunswick streams during the mid-1800's.*
122. Riley, D.C. 1970. Engineering aspects of Mactaquac fish handling facilities. Can. Dept. Fish. & Forest., Res. Devel. Br., Halifax, N.S. MS Rept. No. 70-16, 16 p + figs.
123. Robichaud, H.J. 1965. Salmon and the Mactaquac dam. Atl. Advocate, 56:12-14.
124. Rogers, H.M. 1936. The estuary of the Saint John River: its physiography, ecology and fisheries. M.A. Thesis, Univ. of Toronto, 156 p.
125. Row, R. 1970. Pollution survey of the Saint John industrial complex and its effect on the water quality of the Saint John Harbour. Can. Dept. Fish. & Forest., Res. Devel. Br., Halifax, N.S. MS Rept. No. 70-13, 63 p.
126. Ruggles, C.P. and W.D. Watt. Ecological changes due to hydroelectric development on the Saint John River. J. Fish. Res. Bd. Canada, 32(1):161-170.

*Most of the available head of the Saint John River is utilized for hydroelectric development by a series of dams located from the headwaters almost to tidewater. Seven of these hydroelectric dams are described in terms of location, power generation, size of impoundment, operating schedule, and fish passage facilities. Access to upstream spawning areas by Atlantic salmon (Salmo salar) and other anadromous species has been impeded, while ecological changes in the impoundments have favored such species as the alewife (Alosa pseudoharengus) and the white sucker (Catostomus commersoni). Hydroelectric developments on the main stem of the river have reduced the capacity of the river to assimilate organic wastes and have resulted in a reduction of dissolved oxygen content. Fish kills have occurred due to low dissolved oxygen in the headponds and to supersaturation of nitrogen below the lowermost dam. The combination of impoundments and high pollution load results*

*in the heterotrophic food chain dominating the biological carbon flow.*

127. Saunders, D.E. 1969. Water quality studies in the Mactaquac impoundment. M.Sc. Thesis, Univ. of New Brunswick, Fredericton, N.B.
128. Scott, W.B. and E.J. Crossman. 1959. The freshwater fishes of New Brunswick: a checklist with distributional notes. *Contrib. Roy. Ont. Mus., Div. Zool. Palaeont.*, 51, 37 p.
129. Semple, J.R. 1971. Fisheries investigations in the Saint John River system emphasizing juvenile Atlantic salmon, 1970. *Can. Dept. Env., Res. Devel. Br., Halifax, N.S.* MS Rept. No. 71-35, 75 p.

*Distribution and abundance of juvenile salmon and other species in eastern Saint John River tributaries between Fredericton and the Tobique River is given along with results of smolt enumeration studies on the Tobique River.*

130. Smith, K.E.H. 1956a. Nashwaak River salmon survey. *Can. Dept. Fish., Res. Devel. Br., Halifax, N.S.* MS Rept. No. 56-6, 15 p + tables + figs.

*Gives the distribution and abundance of salmon spawning and nursery area, obstructions to fish migration and notes the degree of river pollution.*

131. Smith, K.E.H. 1956b. Keswick River salmon survey. *Can. Dept. Fish., Res. Devel. Br., Halifax, N.S.* MS Rept. No. 56-8, 10 p + tables + fig.

*A survey of obstructions to fish migration and salmon nursery and spawning areas in the system. Comments on extent of pollution.*

132. Smith, K.E.H. 1957. Beechwood salmon investigation. *Can. Dept. Fish., Res. Devel. Br., Halifax, N.S.* MS Rept. No. 57-7, 18 p + tables + figs.

*Conditions at Beechwood power dam were under observation from late April until early December, 1957.*

*Fishway counts are given; holdup of fish below, due to construction work below dam is described, and possible reasons for the decreased run of salmon in 1957 are discussed. Counts of fish for Tobique Narrows fishway are also listed.*

133. Smith, K.E.H. 1958. Atlantic salmon investigation - Beechwood and Tobique Narrows, 1958. *Can. Dept. Fish., Res. Devel. Br., Halifax, N.S.* MS Rept. No. 58-2.

*Salmon investigations were carried out at Beechwood and Tobique Narrows power dams from May to November, 1958. All*

salmon were counted at Beechwood and checked again as they passed the Tobique Narrows Dam. Numbers of fish taken at both locations are given.

134. Smith, K.E.H. 1959. Beechwood and Tobique Narrows Atlantic salmon investigations. Can. Dept. Fish., Res. Devel. Br., Halifax, N.S. MS Rept. No. 59-1, 56 p + tables + figs.

*A summary of activities at the Beechwood and Tobique Narrows fishways in 1959, including numbers of fish ascending, observations and tests on smolt migration at Beechwood Dam and orifice tests. Transfer of salmon by truck to the Tobique River is also covered.*

135. Smith, K.E.H. 1969. Compendium, Saint John River system, N.B. Can. Dept. Fish. & Forest., Res. Devel. Br., Halifax, N.S. MS Rept. No. 69-6, 238 p.

*A summary up to 1969 of all available information in relation to fish populations. Consists primarily of information from unpublished notes and reports.*

136. Smith, K.E.H. 1970. Summary report, Atlantic salmon investigation, Saint John River system, New Brunswick, 1969. Can. Dept. Fish. & Forest., Res. Devel. Br., Halifax, N.S. MS Rept. No. 70-12, 36 p.

*Summarizes data on Saint John Harbour and Westfield sampling and tagging program, operation of fish pass facilities at Mactaquac and Beechwood dams, including species and numbers of fish ascending. Discusses water quality at Mactaquac Dam and recent restrictions on both commercial and angling fisheries on the system.*

137. Smith, K.E.H. 1973. Tobique Narrows fish pass facilities. Can. Dept. Env., Res. Devel. Br., Halifax, N.S. MS Rept. No. 73-7.

138. Smith, K.E.H. and J.H. Ingram. 1954. Atlantic salmon survey - Canaan River, Westmorland and Queens counties, N.B. Can. Dept. Fish. & Forest., Res. Devel. Br., Halifax, N.S. MS Rept. No. 54-5, 10 p.

*A survey report on obstructions to fish migration, salmon spawning and nursery habitat, pollution and predators.*

139. Smith, M.W. 1963. The Atlantic Provinces of Canada. Chapt. 18. Pages 521-534 in D.G. Frey, ed. Limnology in North America. The Univ. of Wisconsin Press, Madison.

140. Smith, M.W. 1942. The small mouth black bass in the Maritime Provinces. Fish. Res. Bd. Canada, Atl. Prog. Rept., 32:3-4.

141. Sprague, J.B. 1964. Chemical surveys of the Saint John River, tributaries, impoundments, and estuary in 1959 and 1960. Fish. Res. Bd. Canada, Biol. Sta., St. Andrews, N.B. MS Rept. 181, 39 p.
142. Squires, W.A. 1967. Detailed account of saltwater fishes found in lower Saint John River. Nature News, New Brunswick Museum, 18(3):1-3.
143. Squires, W.A. and S.W. Gorham. 1966. Redfish (*Sebastes marinus* var. *mentella*) from the Kennebecasis River, N.B. Can. Field-Nat., 80:253-254.
- Fish captured by a fisherman on January 8, 1966, in Kennebecasis River about one-half mile from Millidgeville.*
144. Squires, W.A. and S.W. Gorham. 1967. Silverside (*Menidia menidia*) and northern pipefish (*Syngnathus fuscus*) in the Saint John River, New Brunswick. Can. Field-Nat., 81:280.
- Fifty-two specimens of silverside were taken by seining at Brown's Flat during summer of 1965. Two specimens of northern pipefish were captured in a gaspereau net at Public Landing, about 18 miles from the mouth of the Saint John River.*
145. Sullivan, J. 1963. Salmon tagging project, Saint John area drift net operation. Can. Dept. Fish., Fish. Cult. Devel. Br., Halifax, N.S. MS Rept. No. 63-6.
146. Trites, R.W. 1960. An oceanographical and biological reconnaissance of Kennebecasis Bay and the Saint John River estuary. J. Fish. Res. Bd. Canada, 17(3):377-408.
- A preliminary survey of the oceanographic features of Kennebecasis Bay and the Saint John estuarial system was carried out in 1957-58 as part of the International Passamaquoddy Fisheries Board program.*
- Kennebecasis Bay and Long Reach on the Saint John River are two-layer systems with a brackish surface layer overlying a deep saline layer. Two sills separate and restrict exchange of deep water in Kennebecasis Bay from that of the Bay of Fundy. The initial step in the formation of deep water of Kennebecasis Bay occurs in the gorge area between the two sills where saline water from the Bay of Fundy mixes vigorously with fresh water of the Saint John River. During periods of low river runoff, combined with spring tides, a portion of the mixed water penetrates inward over the sill at the entrance to Kennebecasis Bay.*
- It is concluded that Kennebecasis Bay represents more extreme conditions than those predicted for Passamaquoddy Bay if power dams are constructed.*

147. Turner, G.E., N.E. MacEachern and C.P. Ruggles. 1972. Review of Atlantic salmon stocks in major New Brunswick rivers in 1972. Can. Dept. Env., Res. Devel. Br., Halifax, N.S. MS Rept. No. 72-18, 10 p + tables + figs.

*Discusses the results of the fisheries regulations imposed in 1972 and summarizes the data on juvenile salmon investigations relative to the 1972 fishing closure. About one-third of the report concerns the Saint John River.*

148. U.S. Dept. of the Army, Corps of Eng. 1967. Report on fishery problems related to the Dickey-Lincoln School dam and reservoir project. Waltham, Mass.

149. U.S. Dept. of the Army, Corps of Eng. 1968. Report on fishery problems related to Dickey-Lincoln dam and reservoir project. Waltham, Mass.

150. U.S. Dept. of Int. 1959. Substantiating data for a report on fish and wildlife resources in relation to the Rankin Rapids dam and reservoir, Saint John River, Maine. Fish and Wildl. Serv., 38 p.

*Detailed report assesses the effects of the proposed Rankin Rapids project on the fish and wildlife resources of the upper Saint John River drainage. Report is primarily based on engineering data provided by the U.S. Corps of Engineers on June 27, 1958.*

151. Warner, K. 1953. Preliminary report on the effects of the proposed Eagle Lake storage dam on salmon spawning grounds. Maine Dept. Inland Fish. and Game, Augusta, Me. MS Rept., 7 p.

152. Warner, K. 1956. Aroostook River salmon restoration and fisheries management. Maine Dept. Inland Fish. and Game and Atlantic Sea-Run Salmon Comm., Fish. Res. Bull. 4, 66 p.

*The report summarizes findings concerning obstructions to fish migration and the biological potential of the Aroostook River for Atlantic salmon production. Also gives information on resident fish species, anadromous species and Atlantic salmon runs, as well as the effects of logging practices on the fisheries of the drainage.*

153. Warner, K. 1957. Meduxnekeag River fishery management. Maine Dept. Inland Fish. and Game, Augusta, Me. MS Rept.

*Summary of findings concerning obstructions to fish migration, indigenous fish populations and biological production potential for Atlantic salmon.*

154. Warner, K. 1959. Migration of landlocked salmon in the Fish River Lakes, Maine. *J. Wildl. Mgt.*, 23:17-27.
155. Warner, K. 1960. Preliminary report on the effects of the proposed Rankin Rapids Dam on the fisheries of the upper Saint John River Basin. Maine Dept. Inland Fish. and Game, Augusta, Me. MS Rept., 15 p.
156. Warner, K. 1962a. The landlocked salmon spawning run at Gross Lake thoroughfare, Maine. *Copeia*, 1:131-138.
157. Warner, K. 1962b. Contribution of hatchery-reared salmon to the fishery of the Fish River Lakes, Maine. *Trans. Amer. Fish. Soc.*, 91(1):99-102.
- An examination of the hypothesis that stocking of hatchery-reared salmon is of limited value in lakes with abundant natural reproduction and sizeable natural populations.*
158. Warner, K. 1963. A creel census of three trout ponds in the Red River drainage, Maine. Job. Compl. Rept. DJ Project F-8-R-11 (in part): 6 p, (mimeographed).
159. Warner, K. 1964. Prestile stream fishery management. Maine Dept. Inland Fish. and Game, Augusta, Me. MS Rept.
- A summary concerning obstructions to fish migration and biological potential for Atlantic salmon.*
160. Warner, K. 1965. Fishery management in the Fish River drainage. Maine Dept. Inland Fish. and Game, Augusta, Me. *Fish Res. Bull.* 6, 52 p.
- Report on the fisheries management of lakes and streams in Fish River, giving information on the distribution of major fish species in surveyed lakes. It discusses fish management with respect to brook trout, Atlantic salmon, blueback trout, lake trout, whitefish, smelt, other fishes, DDT spraying, and logging practices and obstructions to fish migration.*
161. Warner, K. 1967. Maine rivers: the Allagash. Maine Dept. Inland Fish. and Game, Augusta, Me., MS Rept., 4 p.
162. Warner, K. and O.C. Federson. 1962. Effects of DDT spraying for forest insects on Maine trout streams. *J. Wildl. Mgt.*, 26(1):86-93.
163. Warner, K. and O.C. Federson. 1963. The salmon and trout fishery of the Fish River lakes, Maine. *Trans. Amer. Fish. Soc.*, 92(3):193-201.

*Partial creel censuses were operated on five of the Fish River lakes in 1957-59 and on one of the lakes in 1954 and*

1961. The salmon and brook trout fishing, in general, compared favourably with other large Maine lakes. Fishing success in Square Lake declined by 62% between 1954 and 1961. The decline is attributed to a reduced growth rate that delayed attainment of legal length. Salmon caught by anglers from all the lakes were primarily ages 3-4. Estimated yield to the angler ranged from 0.13 to 0.68 lb/acre. Brook trout were generally less abundant than salmon in the sport fishery. Trout were shorter lived than salmon and suffered a higher total mortality. The growth rates of salmon in the lakes are compared, and management possibilities are discussed for the different lakes.

164. Watt, W.D. 1971. Ecology of the Saint John River headponds. I. Catalogue of phytoplankton. Prepared for the Saint John River Basin Bd., Can. Dept. Env., Res. Devel. Br., Halifax, N.S. MS Rept No. 71-25, 18 p + figs.

*A systematic account of the species and distributions of phytoplankton in Saint John River headponds with numerous illustrations.*

165. Watt, W.D. 1972a. Summer headpond ecology in the Saint John River Basin. Saint John River Basin Bd., Fredericton, N.B. MS Rept. 15B, 20 p.

*This report is part of an ecological study of the Saint John River Basin (New Brunswick) and presents an examination of summer headpond ecology in the basin. An introduction to ecosystem ecology and effluent ecology precedes the examination of Grand Falls headpond, Beechwood headpond, Mactaquac headpond and Tobique headpond. It is noted that as eutrophication of a lake proceeds, the yellow perch's temperature preferences enable it to take full advantage of the lake's increased productivity, so the first stages of eutrophication entail a reduced trout population and a much increased perch population. From the point of view of estuary ecology, the headponds probably exert a beneficial influence, affording secondary and some tertiary treatment to the industrial effluents that would otherwise destroy the estuary.*

166. Watt, W.D. 1972b. Ecology of the Saint John River Basin. III. General account of summer headpond ecology. Prepared as an aid for the public participation study of the Saint John River Basin Bd. by Can. Dept. Env., Res. Devel. Br., Halifax, N.S. MS Rept. No. 72-5, 20 p + illus.

*A simplified account of ecosystem and effluent ecology, and a brief description of the ecology of four Saint John River headponds (Grand Falls, Beechwood, Mactaquac and Tobique). The report also discusses possible ecological danger to the river estuary and the possible increase of yellow perch in the new headponds.*

167. Watt, W.D. 1973a. Aquatic ecology of the Saint John River, Vol. 1. Background design methods, nutrients, bacteria, phytoplankton and primary production. Saint John River Basin Bd., Fredericton, N.B. MS Rept. 15F.
168. Watt, W.D. 1973b. Phytoplankton of the Saint John River headponds. Saint John River Basin Bd., Fredericton, N.B. MS Rept. 15A.
169. Watt, W.D. and F.C. Duerden. 1973. Aquatic ecology of the Saint John River. Vol. 2. Zooplankton, macrobenthos, anadromous herring and sucker fry - ecosystem models and conclusions. Saint John River Basin Bd., Fredericton, N.B. MS Rept. 15G.
170. Watt, W.D. and F.C. Duerden. 1974. Water use and aquatic ecology in the Saint John River Basin. Saint John River Basin Bd., Fredericton, N.B. MS Rept. S15.
171. Watt, W.D., G.H. Harding, J. Caldwell and A. McMinn. 1973a. Ecology of the Saint John River Basin. VI. Oligochaetes as water pollution indicators. MS Rept. Prepared for the Saint John River Basin Bd. by Can. Dept. Env., Res. Devel. Br., Halifax, N.S. MS Rept., 31 p + 8 tables + 2 figs.
- Gives relationship between oligochaetes and water pollution and discusses density distributions in the river and their significance.*
172. Watt, W.D., G.H. Harding, J. Caldwell and A. McMinn. 1973b. Sludgeworms (Oligochaetes) as indicators of water pollution in the Saint John River. Saint John River Basin Bd., Fredericton, N.B. MS Rept. 15C.
173. Williamson, F.A. 1974. Population studies of striped bass (*Morone saxatilis*) in the Saint John and Annapolis rivers. MS Thesis, Acadia Univ., Wolfville, N.S., 60 p.
174. Wilson, G.A.C. 1957a. Maritime sport fisheries (A compilation of information). Can. Dept. Fish., Res. Devel. Br., Halifax, N.S. MS Rept. No. 57-9, 10 p.
175. Wilson, G.A.C. 1957b. Maritime sport fisheries (A compilation of information). Can. Dept. Fish., Res. Devel. Br., Halifax, N.S. MS Rept. No. 57-3, 13 p.
176. Wilson, G.A.C. 1958. Suggestions for Beechwood fishway improvements. Can. Dept. Fish., Res. Devel. Br., Halifax, N.S. MS Rept. No. 58-4, 3 p.
177. Wykes, C.E. and R.W. Dunfield. 1967. Atlantic salmon commercial catch statistics, Maritimes Region. Can. Dept. Fish., Res. Devel. Br., Halifax, N.S. Data Record Series.

A series of annual reports giving statistical information on commercial salmon landings from various areas, including the Saint John River. There are separate reports for the years 1967-75, inclusive. From 1972 onwards, these reports were authored solely by Dunfield.

178. Zitko, V. 1970. Organic compounds in Mactaquac impoundment. Fish. Res. Bd. Canada. MS Rept. 1040, 31 p.

The concentration of lignosulphonates in the Mactaquac impoundment was 41.7 mg/l in January 1969, dropped to zero after the heavy spring runoff in May 1969, and started to rise in June, reaching 12.0-15.2 mg/l, with higher values occurring at higher runoffs. Carbon-chloroform (CCE) and carbon-ethanol (CEE) extract values ranged from 1.5 to 7.0 and from 2.1 to 10.6 mg/l, respectively. The higher values of the extracts coincided with high concentrations of lignosulphonates. An unidentified non-polar compound, possibly a pesticide, was found in one water sample. Characteristics of compounds present in CCE, CEE, and in two industrial effluents, discharged into the Saint John River above the Mactaquac impoundment, are described. No particular compound could be blamed for the fish kills in the Mactaquac Fish Culture Station in January and March, 1969. The fish kills were probably caused by the generally low water quality in the impoundment at that time.

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## ADDENDUM

The following two manuscript reports were overlooked in the original compilation. These have not yet been allotted catalogue numbers, but copies are available for reference use at the Maritime Regional Library, Fisheries and Marine Service, Halifax, Nova Scotia.

Smith, K.E.H. 1953. Salmon investigation, Salmon River, Queens County, New Brunswick. Fish Culture Development Branch, Dept. of Fisheries, Saint John, New Brunswick. MS Rept., 9 p + 1 illus.

Smith, K.E.H. and J.H. Ingram. 1955. Tobique River salmon survey. Fish Culture Development Branch, Dept. of Fisheries, Saint John, New Brunswick. MS Rept., 28 p + 2 illus. + 9 p of photos.