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# RESOURCE DEVELOPMENT BRANCH

## MANUSCRIPT REPORT

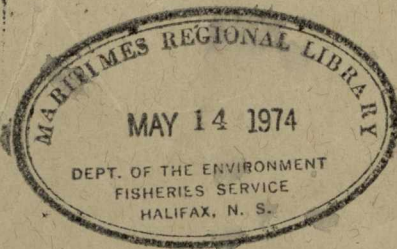
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COMPENDIUM

ST. JOHN RIVER SYSTEM, N.B.

by

K.E.H. Smith



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COMPENDIUM  
ST. JOHN RIVER SYSTEM, N. B.

by

K.E.H. SMITH

1969



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St. John River System, N.B.

Introduction

The following report is primarily an attempt to summarize all available information on the St. John River system, in relation to fish populations.

The histories of power development, pollution and industry are discussed in relation to their effects on environment and fish populations. With the steady increase of power development and industry in the area, scientific management procedures are becoming more important if current fish stocks are to be maintained or improved.

Much of the material in this report consists of catch records, with details on size, timing, composition and economic value, for both angled and commercially caught species. Also included are summary data from various field studies, previously conducted on the system by the Department of Fisheries (Resource Development Branch). Such studies include fishway and fence-trap operation, fish tagging and recovery programmes, water analyses, observations on smolt movements, potential fish production estimates, etc.

Data contained in this report on present and past conditions will be of value in planning and assessing future development and management activities.

General Description of the System

The St. John River system was discovered in 1604 by Champlain and DeMonts. It is located in northern Maine, Quebec and New Brunswick, with a total drainage area of about 21,600 square miles. Approximately 130 miles of the river and two of its tributaries are international waters, as they form the border between U.S.A. and Canada.

About 14,000 square miles or 65 percent of the drainage area is in Canada (pop. 400,000), and the remaining 7,600 square miles (35%) are in the state of Maine (pop. 100,000). Of the Canadian portion, about 2,750 square miles are in Quebec and 11,250 square miles in New Brunswick. The watershed is composed of about 85 percent forested and 15 percent cleared land.

The St. John River rises in Little St. John Lake on the international boundary between Quebec and Maine. From here, it flows in a great arc, north, east and south, and, 415 miles later, empties into the Atlantic Ocean (Bay of Fundy) at St. John, N.B. The lower 81 miles of the river are tidal. The total fall of the river from headwater to tidewater is about 1,595 feet.

Fish Species Found in the St. John System

At least 39 species of fish are found in the St. John River system. A number of these are taken by either commercial fishermen or anglers or both. The various species are listed below, with letters "C" and "A" indicating utilization by commercial or angling fisheries respectively.

Table 1

Fish Species in St. John River System

<u>Common Name</u>	<u>Scientific Name</u>	<u>Utilization</u>
Alewife (gaspereau, kyak)	<i>Alosa pseudoharengus</i>	C
Atlantic sturgeon (sea sturgeon)	<i>Acipenser oxyrinchus</i>	C
Shortnose sturgeon	<i>Acipenser brevirostrum</i>	C
American eel (Atlantic or common eel)	<i>Anguilla rostrata</i>	C
American shad (shad)	<i>Alosa sapidissima</i>	C A (1)
Chain pickerel	<i>Esox niger</i>	C A
American smelt	<i>Osmerus mordax</i>	C A
Striped bass	<i>Roccus saxatilis</i>	C A
Atlantic salmon	<i>Salmo salar</i>	C A
Sebago salmon (landlocked salmon)	<i>Salmo salar, Sebago</i>	A
Rainbow trout	<i>Salmo gairdneri</i>	A
Brown trout (Loch Leven trout)	<i>Salmo trutta</i>	A
Speckled trout (brook trout)	<i>Salvelinus fontinalis</i>	A
Blueback trout	<i>Salvelinus oquassa</i>	A
Lake trout (gray trout or togue)	<i>Salvelinus namaycush</i>	A
Smallmouth black bass	<i>Micropterus dolomieu</i>	A
Yellow perch	<i>Perca flavescens</i>	
White perch	<i>Roccus americanus</i>	
Atlantic tomcod (Tommy cod)	<i>Microgadus tomcod</i>	
Horned pout (brown bullhead)	<i>Ictalurus nebulosus</i>	
White sucker (common sucker)	<i>Catostomus commersoni</i>	
Longnose sucker (fine-scaled sucker)	<i>Catostomus catostomus</i>	
Burbot (ling, cusk)	<i>Lota lota</i>	

Table 1, cont'd

<u>Common Name</u>	<u>Scientific Name</u>	<u>Utilization</u>
Lake whitefish (gizzard fish)	Coregonus clupeaformis	(2)
Sea lamprey (marine lamprey, lamper eel)	Petromyzon marinus	
Banded killifish	Fundulus diaphanus	
Threespine stickleback	Gasterosteus aculeatus	
Ninespine stickleback	Pungitius pungitius	
Pumpkinseed (common sunfish)	Lepomis gibbesus	
Yellowbelly sunfish	Lepomis auritus	
Freshwater sculpin (miller's thumb)	Cottus cognatus	
Blacknose dace	Rhinichthys atratulus	
Redbelly dace	Chrosomus eos	
Lake chub (northern chub)	Couesius plumbeus	
Fallfish (chub, silver chub)	Semotilus corporalis	
Creek chub (common chub, horned dace)	Semotilus atromaculatus	
Golden shiner (butterfish, bream)	Notemigonus crysoleucas	
Common shiner (redfin shiner)	Notropis cornutus	
Blacknose shiner	Notropis heterolepis	

(1) No regular angling fishery, but often taken incidentally by salmon anglers.

(2) Occasionally taken by spear fishing.

### Fishery Problems Generally

Throughout the years, population growth along the St. John River system has brought with it an increase in the difficulties facing fish survival and abundance. These difficulties consist largely of barriers to fish migrations, and the pollution and destruction of their natural habitats.

Development of many areas for hydropower production has been one of the greatest problems. Welfare of the fish has also been adversely affected by certain aspects of the lumbering and pulp and paper industries. Other problems have arisen as a result of careless methods used in the agricultural and food processing industries.

Old reports, before the turn of the century, referred to "the good old days," before the river was highly polluted and obstructed by many dams. It is therefore quite evident that many of the basic problems facing fish today are not really new. In the 1800's, it appears that most of the obstructions were in the form of driving or mill dams, and most of the pollution arose from mill wastes, such as sawdust and bark.

In more recent times, however, major obstructions have been in the form of hydro-power and storage dams. Also in later years, pollution sources have increased tremendously in number, variety and intensity. New chemicals are continually being developed and used in industry and agriculture. Population increases have also naturally caused much heavier loads of domestic sewage. In most cases, the common disposal method has been simply to dump the untreated waste products into the nearest river or stream.

As in many other parts of the world, fisheries interests in the St. John River have often been ignored or pushed aside in favour of other water uses. In some areas, waters have been so misused that fish populations have vanished, and recovery to any reasonable level of production may be next to impossible. However, fish populations in the St. John River system have survived relatively well, so far. This survival has been aided by protective regulations, hatchery stocking programmes and the construction and operation of fish pass facilities. Nevertheless, with the continued increase of fisheries hazards, modern management and conservation techniques are becoming more and more necessary, if current population levels are to be maintained or improved.

Details of the more important obstructions and pollution problems on the St. John River system are included in following sections of this report.

Power Development

Hydro-power development on the St. John River system began with the construction of the Caribou Dam in 1890. This dam was built on the main Aroostook River, about 15 miles above Aroostook Falls. During the intervening years, 10 more power dams have been built, 9 of them in New Brunswick. In association with these power installations, eight water storage dams have also been constructed.

The most recent power development on the system, the Mactaquac Dam, is also the largest. It is located on the main St. John River, a short distance above head of tide, about 10 miles above the city of Fredericton. The entire system above is now closed off to natural upstream migration of fish.

Some of the details on these power and storage installations are given below in tables 2 and 3, and in following narrative sections.

Table 2

## Power Dams - St. John River System

NAME	RIVER	OPERATING AGENCY	DRAINAGE AREA (SQ. MILES)	GROSS HEAD (FEET)	NO. of Units	INSTALLED CAPACITY		FISH PASS FACILITIES
						(Kw.)	(H.P.)	
Grand Falls	St. John	N.B.E.P.C.	8,450	(1) 125 (2) 132	4	1. 63,000 2. 57,000	1. 80,000 -	None
Beechwood	St. John	N.B.E.P.C.	13,000	(1) 57	3	1. 112,500	1. 145,000	Elevator (1957)
Mactaquac	St. John	N.B.E.P.C.	-	105	6	504,000	-	Collection Gallery plus tank trucks
Edmundston	Madawaska	Fraser Companies Ltd.	1,080	1. 21 2. 20	2	1. 2,000 2. 1,600	1. 2,060 -	None
Second Falls	Green	City of Edmundston N.B.	470	1. 35 2. 25	2	- 2. 1,100	1. 1,500 -	None
Squapan	Aroostook	M.P.S.C.	-	3. 28.5 2. 27	1	2. 1,400	-	None
Caribou	Aroostook	M.P.S.C.	-	3. 12(15) 2. 14	2	2. 800	-	Pool Type - Concrete (1955)
Tinker	Aroostook	M.P.S.C.	2,400	3. 85(88) 2. 85	4	2. 10,400	-	Pool Type - Concrete (1936)
Sisson	Tobique	N.B.E.P.C.	120	1. 135	1	1. 10,000	1. 12,500	None
Tobique Narrows	Tobique	N.B.E.P.C.	1,670	1. 75 2. 78	2	1. 20,000 2. 20,000	1. 27,000 -	Pool Type - Concrete (1953)
Hargrove	Monquart	Bernard Hargrove Bath, N.B.	approx. 75	approx. 70	1	-	-	Trapping, plus Tank truck

## Notes:

- (1) Data from "A Bibliography - Water Resources of the Atlantic Region," Nov. 1966, by Atlantic Development Board, Federal Provincial Supervisory Committee.
- (2) Data from "Water Resources of the St. John River Basin," April 1953, by, International St. John River Engineering Board.
- (3) Data from "Aroostook River - Salmon Restoration and Fisheries Management," 1956, by Kendall Warner.

Table 3

Existing Storage Reservoirs Operated for Power Generation

NAME	RIVER	OPERATING AGENCY	DRAINAGE AREA (sq. mi)	CAPACITY (Acre-Feet)
Temiscouata	Madawaska	N.B.E.P.C.	1,000	105,000
First Lake	Green	City of Edmundston, N.B.	95	17,000
Millinocket	Aroostook	M.P.S.C.	64	23,100
Squapan	Aroostook	M.P.S.C.	67	58,600
Sisson	Tobique	N.B.E.P.C.	125	(105,680) 97,000
Trousers	Tobique	N.B.E.P.C.	48	(41,870) 36,600
Long	Tobique	N.B.E.P.C.	30	(28,450) 28,300
Serpentine	Tobique	N.B.E.P.C.	29	(26,500) 25,600

Notes:

Figures in ( ) from, "A Bibliography - Water Resources of the Atlantic Region," November 1966, by Atlantic Salmon Development Board, Federal Provincial Supervisory Committee.

Remainder of figures from, "Water Resources of the St. John River Basin," April 1953, by International St. John River Engineering Board.

### Grand Falls Dam

This dam is located on the main St. John River in the town of Grand Falls, N.B., about 128 miles above tidewater, It was constructed in 1925 and is presently owned and operated by the New Brunswick Electric Power Commission (N.B.E.P.C.).

The power installation operates under a head of 132 feet. Prior to dam construction, upstream migration was completely obstructed at this site by a natural fall. For this reason, no fish pass facilities were included. Also, there have been no attempts since construction to establish migratory species in the system above.

### Beechwood Dam

Construction of Beechwood Dam was completed in 1957. It is located on the main St. John River at the village of Beechwood, about 100 miles north of Fredericton, N.B. It is owned and operated by the N.B.E.P.C.

This dam forms a total obstruction to any upriver movement of migrant species of fish. No previous barrier existed at this site. In fact, some of the better and most extensive salmon spawning and nursery areas of the system were located above this point. In addition, there was a very active and valuable salmon angling fishery located above Beechwood, particularly in the Tobique River system. For these reasons, adequate fish pass facilities were considered a necessity, and were installed at the time of dam construction. They consisted of a collection gallery and a mechanical skip hoist. Several years of operation has shown this arrangement to pass salmon and a number of other species quite effectively.

Mactaquac Dam

Location of this development is on the main St. John River, just above head of tide, about 10 miles <sup>west</sup> north of the city of Fredericton. Work on the dam was begun early in 1965 and is now nearing completion. It is being constructed for the N.B.E.P.C., and will be by far the largest hydro development in the Maritimes.

Without fish pass facilities, this dam would completely obstruct all upstream fish migrations from reaching the greater part of the system. Since the Atlantic salmon is considered to be by far the most valuable species involved, maintenance of their runs is of foremost importance. It was felt that a conventional fishway or a collection and trucking operation alone would not be sufficient to insure the continuance of the runs. Some of the reasons for this view are,

- (1) loss of extensive spawning and rearing areas by headpond inundation,
- (2) uncertainty of the salmon's and smolt's ability to navigate the length of the headpond without undue holdup or delay, and (3) the danger of high mortality to seaward bound smolts in their descent of the dam.

Therefore, to insure adequate salmon survival, a combined hatchery rearing and trucking operation was developed. Natural smolt production in the system above Mactaquac has been estimated to be in the order of a half million annually. To compensate for a total loss of this natural production, a new hatchery is being built, which will be capable of equaling this production artificially. All smolts will be released below the dam to avoid mortalities from turbine or spill-gate passage.

Hatchery brood stock will be taken from Salmon collected immediately below the dam. The annual requirement is not expected to exceed 1,000 adults. The remaining adults from this collection will be taken over by the second phase of the operation, the tank trucks. They will then be transported upriver and released in various suitable areas.

The transported adults will perform two functions, (1) that of maintaining the present angling fishery at a reasonable level, and (2) provision for the opportunity of some level of natural reproduction. With suitable water conditions to permit relatively safe smolt passage of Mactaquac Dam, this natural production may still contribute a significant amount to future runs of the system.

#### Edmundston Dam

This dam is located on the Madawaska River, in the city of Edmundston, N.B. It is built of concrete and steel, and is approximately 100 feet long and 40 feet in height. It is owned and operated by Fraser Companies, Ltd. The dam was originally constructed about 50 years ago. It is presently in good condition, having been repaired as recently as 1960.

No fish pass facilities are provided and the dam forms a total obstruction to upstream migrants. At the present time no fish use these waters because of excessive pollution. With removal of the pollution source, species which are likely to utilize the area would include speckled trout, landlocked salmon and whitefish.

### Second Falls Dam

This dam is located on the Green River, about 12 miles above the mouth, in the parish of St. Joseph. It was built of concrete, about 45 years ago. It was repaired in 1965 and is presently in very sound condition. Approximate size of the dam is 65 feet by 100 feet. It is owned and operated by the city of Edmundston.

No fish pass facilities are provided, and the dam is a complete barrier to upstream migration. Species in the area which may be obstructed include speckled trout and whitefish.

### Squapan Dam

Location of this dam is at the outlet of Squapan Lake, on the Aroostook River system, in Maine. It is owned and operated by the Maine Public Service Company (M.P.S.C.). The dam is 28½ feet high, and is a complete barrier to fish movements at all water levels. No fishway is provided, and none is recommended because of relatively high costs and limited value to the fishery.

### Caribou Dam

The Caribou Dam is located on the main Aroostook River about 15 miles above Aroostook Falls. Normal operating head is 12 feet, but a total head of 15 feet is attained by the addition of flashboards. The dam is constructed of reinforced concrete and was originally built in about 1890.

Fishway facilities originally consisted of a 13-pool structure, but salmon were reluctant to use it and many attempted to scale the dam directly. Improvements on this fishway were carried out in 1952, and in 1955, it was replaced with an entirely new, concrete pool type structure adjacent to the power house. The new fishway has two entrances,

one for high water and one for low water, and appears to work adequately.

### Tinker Dam

Although owned by the M.P.S.C., this dam is located in the province of New Brunswick. It spans the main Aroostook River about  $4\frac{1}{2}$  miles below the town of Fort Fairfield, Me. Originally constructed in 1906, it was rebuilt in 1923.

The Tinker power installation normally operated at an 85 foot head. The original diversion dam was 30 feet high, with flashboards raising it an additional 3 feet. New concrete construction in 1964 raised the diversion dam permanently, now providing a normal operating head of about 88 feet. Installation of an additional power turbine was also carried out at this time.

Prior to 1906, there was a 15 foot natural fall at the same location (Aroostook Falls). The fall was an obstacle to salmon migration, but not completely impassable.

The dam had no fishway until 1936, when a 13-pool structure was built at the diversion dam. The drop between pools is about 18 inches, except for two, which are about 3 and 5 feet. Water flow in the fishway varies from about 5 to 12 c.f.s., depending on forebay level. A few salmon have ascended the fishway during high water levels, but it is doubtful if any could pass during low flow periods.

A number of proposals have been suggested in recent years for improved fish pass facilities at this dam. However, in view of the uncertainty of future salmon runs as a result of Beechwood and Mactaquac power developments, plans for a new fishway have not yet been finalized.

### Sisson Dam

This dam is located at the foot of Sisson Lake, on the Sisson River, a headwater tributary of the Tobique River. The power plant was constructed in 1965 by the N.B.E.P.C., and is operated remotely from the Grand Falls station. The Sisson Dam was originally constructed in 1953 as a water storage reservoir, in conjunction with the Tobique Narrows power development. The dam is composed mainly of earth fill, with a concrete gate and sluice section.

The Sisson power installation operates under a head of about 135 feet. Before dam construction, a natural barrier fall existed at this site, and there was little or no useful salmon rearing area above. Consequently, no provision has been made for any fish pass facilities.

### Tobique Narrows Dam

Location of this development is on the main Tobique River, about a half mile above its confluence with the St. John River. The dam is a reinforced concrete structure, built in 1952 by the N.B.E.P.C. The plant was designed to operate under a head of 78 feet.

Before dam construction, a deep gorge and swift rapids existed at the site, but was not a barrier to fish migrations. Since this river contained some of the best salmon rearing and angling waters in the system, a suitable fish pass was a necessity. Therefore, a concrete fishway was constructed in conjunction with the dam, consisting of 75 pools and totaling 900 feet in length. It has been found to pass salmon quite efficiently.

### Hargrove Dam

Construction and operation of this power development was a private venture by Mr. Bernard Hargrove of Bath, N.B. The dam is located on the Monquart River, about one quarter mile above its confluence with the St. John River. The dam is built of earth fill.

Work on the dam was begun in 1963 and, while operating at only about 20 feet of head, some power was being produced in 1964. During 1966, height of the dam was increased and operational head is now about 70 feet. Only one generator has been installed to date, but a second is contemplated.

Since no barrier existed at this site prior to dam construction, some means of fish passage was required. A conventional type of fishway was ruled out because of excessive costs and limited availability of water. As an alternative, a netting and tank-truck transfer arrangement was established in 1965. By means of this system, the runs of adult salmon are safely transported to suitable spawning and nursery areas above.

Other Obstructions

10  
Although power development and associated storage dams constitute the major obstructions to fish migrations, a number of lesser barriers and partial barriers do exist on the St. John River system. Most of these minor barriers are mill dams, log-driving dams and a few natural water falls.

Most of these small dams are of little importance as obstructions to salmon movements. However, many form complete or partial barriers to the movements of resident species, particularly trout. Recent reports from District Protection Offices have provided some fairly up to date information on most of these sites. This information is detailed below, with obstructions being grouped as to the counties in which they are located.

Madawaska County

(1) <sup>5</sup>Pelletier's Dam - Old wooden dam, rotting away. Size - 10' x 100'.

2  
Located on Little River, parish of St. Francois, about 2 miles above confluence with St. John River. Owner - Camille Bonenfant. The dam is now unserviceable. It was constructed about 40 years ago, but has not been used during the past 20 years. The dam has no fishway and is an obstruction only at low water. Fish obstructed - speckled trout.

(2) K.C. Irving Co. Dam - Wooden driving dam, constructed about 16 years ago by K.C. Irving Co. Size - 10' x 100'. The dam is located on the Grand River, parish of St. Leonard, about 3 miles above confluence with the St. John River. The dam has not been used for the past 5 or 6 years. It was partially burned in 1966 and is now in unserviceable condition. It is an obstruction only during summer low water conditions. The only species affected is speckled trout.

- (3) Burgess Mill Dam - Old wooden dam, rotting away (10' x 80').  
Located on the Grand River, parish of St. Leonard, about 2½ miles from confluence with the St. John River. The dam has not been used for the past 11 years. It has no fishway, and is an obstruction to trout only at low water levels.
- (4) Morneault Mill Dam - Old wooden dam, rotting away, unserviceable (10' x 100'). Not used for the past 16 years. Constructed over 50 years ago. The dam is located at Morneault Mill, at Plourde Office, parish of St. Jaques, on the Iroquois River. The dam has no fishway and is an obstruction to trout.
- (5) Driving Dam - Fraser Co. - Old wooden dam, completely unserviceable, (10' x 100'). Not used for many years. It is located on the West Branch, Iroquois River, parish of St. Joseph, about 7 miles from Madawaska River. The dam has no fishway and is an obstruction only at low water. Speckled trout is the only species affected.
- (6) Old Davis Dam - Old wooden dam (12' x 100'), completely unserviceable. Owned by Fraser Co. It is located on Green River, in the parish of St. Basile, about 5 miles above the confluence with the St. John River. The dam was constructed about 35 years ago and has not been used for over 10 years. It is an obstruction, only during low water, to trout and whitefish. No fish pass facilities are provided.

Victoria County

- (1) Mill Dam - Wood construction, erected in 1895. Located at mouth of Pokiok Brook, Tobique River. Owned by Harry D. Sadler, Perth, N.B. Used for landing logs only, no log drives. The dam is in poor repair but still used. There is no fishway and it is a complete obstruction to trout.

- (2) Mill Dam - Wood construction, erected in 1886, (5' x 100').  
Located on Odellach Brook (about  $\frac{1}{4}$  mile above mouth), a tributary of the Tobique River. Used for landing logs only, not driven. In poor state of repair but still used. It is owned by Tomilson Bros., Arthurette, N.B. There is no fishway and the dam is a total obstruction to trout.
- (3) Natural Falls - Located on Odell River, tributary to Tobique River. One of these obstructions is located about  $\frac{1}{2}$  mile above the mouth of the Left Hand Branch of the Odell River. It consists of a series of 3 falls, each about 6 feet high and a fourth broken fall of about 10 feet.  
The other two obstructions are located on the Right Hand Branch of the Odell River. One is a broken fall about 12 feet high located about  $\frac{1}{4}$  mile above the mouth of this branch. The second is a near vertical fall of about 35 feet, approximately 3 miles above the mouth.  
All of these falls are considered to form total barriers to upstream fish migrations. Suitable salmon waters above are very limited so the only species of importance which may be affected is the speckled trout.
- (4) Mill Dam - Located on the main Tobique River at Plaster Rock. It is built of wood and in good condition. A pool type fishway passes salmon satisfactorily. The dam is owned by Fraser Company, and is used regularly.
- (5) Dept. of Fisheries Dam - Located on Haley Brook, about 2 miles above its mouth. It is used for water supply in operating the Haley Brook salmon rearing ponds. There is no fishway, and the dam is a complete barrier to trout.

- (6) Natural Fall - Located on Britt Brook, a headwater tributary of the Right Hand Branch of Tobique River. The fall is 5 to 6 feet high and may be a complete obstruction to trout.
- (7) Dam - Located at mouth of Barney Brook, tributary to Salmon River (6' x 30'). Owned by Alfred L. Poitras, Grand Falls, N.B., and used for swimming. Gates are closed only between June 15 and Sept. 15. Also, a by-pass channel is left open. Not normally considered to be a barrier. The only important species which may be obstructed would be trout.
- (8) Dam - Located on Barney Brook, 2 to 3 miles above the mouth (5' x 30'). Owned by Albert Cote, Drummond, N.B. The dam is used for fishing purposes, and is a complete obstruction to trout.
- (9) Storage Dam - Located on Little River at Grand Falls, N.B., about 600 feet above a natural barrier fall at the river mouth. Dam dimensions - 4' x 50'. Since the natural fall is a complete obstruction, the dam does not create any additional problem.
- (10) Driving Dam - (12' x 150') located on Little River below Perkins Brook. It is owned by K.C. Irving Co., and is in good condition. When in use, it forms a total obstruction. However, it has not been used in recent years and the gates are left open. The only species of importance which would be involved is speckled trout.
- (11) Natural Fall - (50 to 60 feet high), located on Rapide-des Femme Creek, near the mouth, and below Dept. of Fisheries dam supplying the Grand Falls hatchery. Complete obstruction.
- (12) Storage Dam - Located on Tibbits Brook, used as water supply by town of Andover, N.B. The dam forms a complete obstruction to trout, but the brook is very small.

- (13) Four Falls - A series of natural falls at the mouth of the Limestone River, a tributary to the Arcostook River. Complete obstruction - trout only, involved.
- (14) Dam - (5' x 40'), located at the outlet of a fishing pond, commonly known as Pirie Lake, on the East Limestone River (between Gillespie and California Settlement). The dam is a complete barrier to trout. It is supposedly owned by Fred F. Pirie, Grand Falls, N.B.

Carleton County

- (1) Fisher Dam - Located on Holmes Brook, about  $\frac{1}{2}$  mile above its confluence with the Monquart River. It is owned by Mr. Fred Fisher, Caribou, Me., U.S.A., and is used for recreational purposes. It was originally built many years ago, but was rebuilt in 1960 or 1961 (about 10' high). The dam is a complete barrier to trout.
- (2) Dam - Located on Shiktahawk River, about 2 miles above the mouth. It is a low dam, 2-3 feet high, of wooden construction and in good repair. It is considered to be a partial obstruction under low water conditions. Gate is opened periodically to permit fish passage, particularly salmon. The dam is used for recreational purposes by a children's summer camp, operated by the Baptist Church.
- (3) Natural Fall - Located on the Shiktahawk River in a gorge, about  $\frac{1}{2}$  mile below the entrance of the North Branch. At least a partial obstruction to salmon.
- (4) Tracey Mills Dam - Wooden dam, about 8 feet high, located on the Presquile River at Tracey Mills, N.B. Used to store logs and originally as water power source to operate mill (now diesel). It is a complete obstruction to salmon and trout. Owner - Mr. G. Trafford.

- (5) Dam - Located on Little Presquile River at Waterville, 3 miles above the mouth. Built many years ago, and used to store water to operate a mill. It is in fairly good repair and is a total obstruction. Owned by Mr. McIntyre.
- (6) Dam - Located on Little Presquile River,  $2\frac{1}{2}$  miles upstream from Waterville dam. Constructed for recreational purposes by 4H Club. It has an opening to permit fish passage.
- (7) Dam - Located on Cold Brook, small tributary of the Little Presquile River. Owned by Mr. J. Barrett and used for irrigation and recreational purposes. It is built on the site of an old beaverdam. The dam is a complete obstruction under low water conditions. However, the brook is very small and few fish (trout) would be affected.
- (8) Lakeville Dams - Situated at outlet of Williamstown Lake; 2 wood dams, each about 6 feet high and 50 feet long; one on each side of highway, about 75 yds. apart. The lower dam is used to float logs to a sawmill, and the upper one is used to maintain lake levels. Owner of both dams - Mr. Arthur Carvel, Lakeville, N.B. The dams were built about 25 years ago and are in fairly good repair. Both are complete obstructions.
- (9) Woodstock Dam - Storage dam, located on the Meduxnekeag River in the town of Woodstock, N.B. - owned by the town. Total obstruction at low water - partial obstruction at high water. This dam will be under water when the new Mactaquac headpond is filled.
- (10) Natural Fall - Located on Eel River, between mouth of river and Benton - 14 foot vertical fall. Passable to fish only during very high water levels. No salmon have been known to ascend this river in recent years.

- (11) Nashwaak Lake Dam - Located at the outlet of Nashwaak Lake. It has one gate, 10 feet high, approximately 12 feet in length. Owned by Irving Co.; it is used for stream driving operations. The dam is closed only 2 to 3 months in the spring, and no fishway is provided.

York County

- (1) Dam - Located at the outlet of Lower Lake, Nashwaak River. (Approx. 10' x 130'). Concrete construction, 4 gates. Built in 1962 by Irving Co., and used for stream driving. No fishway - dam closed only 2-3 months in the spring.
- (2) Natural Fall - Located on Dunbar Brook, about  $\frac{1}{2}$  mile above its confluence with the Nashwaak River. The fall is approximately 18 feet high, by 20 feet wide, and is a complete barrier to upstream fish movements.
- (3) Natural Fall - Located on East Nashwaaksis Stream, about 4 miles from the mouth. About 8 feet high - total obstruction to trout.
- (4) Wiggins Dam - Located on the Mactaquac River at Wiggins Mill, about 15 miles above the mouth. Owned by Cecil Wiggins, Lower Hainsville, N.B., and used for mill operations in the spring months. The dam has one gate, 8 feet high. It is not believed to obstruct fish to any great extent, at present.
- (5) Pinder Dam - Concrete structure, <sup>mouth of N.E. arm.</sup> 15 feet high, on the Nackawic River, about ~~2~~ 5 miles above the mouth. Used in operation of Corey's Mill. Complete barrier - no fishway. ~~not used at all~~ (no longer used)
- (6) Pokiok Falls - Located on Pokiok River, just above the mouth. Broken series of falls (approx. 175' high x 25' wide). Complete obstruction originally. Now partially flooded out by new Mactaquac headpond. Degree of obstruction unknown.

- (7) Natural Falls - Located on the Shogomoc River, 2 to 3 miles above the mouth. Consists of a series of 8' to 10' falls, over a distance of about one mile - complete barrier originally. May be partially flooded out by new Mactaquac Dam headpond.
- (8) Dam - (5' x 25'), wooden construction, located at the outlet of Oromocto Lake. This lake forms the headwaters of the North West Branch of the Oromocto River. Dam is owned by a fishing club and used to raise water level to improve trout angling. It was constructed many years ago and is in a poor state of repair. The dam has one spillway, but no fish pass facilities. It may be a barrier to trout movements.

#### Sunbury County

- (1) Dam - (5' x 20') - wooden construction, located on the Burpee Mill Stream at the Acadia Forestry Station. Owned by the Federal Dept. of Forestry and used as a fire protection reservoir during dry months. It was built about 4 years ago and is in good condition. The dam has two spill gates but no fishway. It is an obstruction to trout when gates are closed, usually July and August. At other times, gates remain open.

#### Queens County

- (1) Dam - Screen (4'x7') at outlet of Morgan Lake, Jones Creek, N.B., within boundary of C.F.B. Gagetown. Possibly installed by army personnel, to keep stocked fish in the lake. Installed within the past 5 or 6 years. Barrier to trout movements.

#### Charlotte County

- (1) Dam - Wood construction (approx. 5' high x 30' wide), located at outlet of South Oromocto Lake, on the headwaters of South Oromocto River. Constructed about 20 years ago, and in fair condition.

Believed to be owned by a fishing club, and used to raise lake level for better fishing and boating. No fishway in dam, but one spillway, which may pass fish during favourable water conditions. Species affected - mostly trout, possibly salmon.

Obstructions Located in the State of Maine, U.S.A.

Details are not available on the nature and numbers of obstructions on some branches of the river within the state of Maine, such as the Fish and Allagash Rivers, etc. Most dams on these waters would be either mill dams or log driving dams. The only fish affected by them would be residents, such as speckled trout and possibly some landlocked salmon and whitefish.

More detail is available on obstructions located on the Aroostook River. According to Warner, a survey of obstructions on this system was conducted between 1950 and 1955. At that time, a total of 70 man-made obstructions were listed, as well as two natural falls. For the 70 man-made obstructions, only 8 fishways were provided, and only 3 of these operated properly at most water levels.

At the present time, these obstructions would affect only the movements of resident species, particularly speckled trout. However, possible restoration of Atlantic salmon in the system at some future date could be somewhat restricted by some of these barriers. Further details on these obstructions may be found in "Aroostook River - Salmon Restoration and Fisheries Management," 1956, by Kendall, Warner.

### Pollution

One of the greatest hazards to fish life on the St. John River is water pollution, caused by both industrial and domestic sources. Examination of available data seems to indicate a yearly increase in the level of pollution in many areas, and in some cases the situation is already serious. Although the river acts as a natural purifying agent up to a certain point, rendering substantial volumes of pollutants to a stable and innocuous state, excesses are sometimes too great and some means of control is essential.

The presence of even one area of lethal pollution could be disastrous to anadromous fish migrations, as they would be unable to pass this area to reach their spawning grounds, and many would die in the attempt. On the St. John River system many areas of minor pollution are found, as well as a few areas or pockets of very high-level pollution. The pollution level of any one area often varies because of wide fluctuations in water flows and temperatures, and in relation to the amounts of wastes introduced.

In the St. John River basin, the total population (1956 census: Canada and U.S.A.) was 154,200 people, a large percentage of which would contribute raw wastes and sewage. Over one-third (52,000) are in the St. John area, where high tidal fluctuations help dilute the pollutants and wash them out to sea. Fredericton, with a population of over 18,000, is the second largest city in the St. John basin. Other larger centres of population include Edmundston, Grand Falls and Woodstock in New Brunswick and Madawaska, Presquille and Houlton in Maine.

Types of Pollution - Generally.

Pollution-causing wastes are of various general types - chemical, toxic and deoxygenating. Sources of all these types are found on the St. John River system. Some sources may release only one type of waste material, while others are responsible for more than one.

A. Chemical Wastes:

- (1) Phenolic type - causes objectionable taste and odour in the water and taints the flesh of fish. Sources of these pollutants include oil refineries and wood distillation plants.
- (2) Other types - e.g., oil and floating solids. These cause objectionable taste and odour in the water, coat ship hulls, kill fish and cause fire hazards. Sources include petroleum refineries and service stations.

B. Toxic Wastes:

These include free halogens, resins and fatty acid soaps. Sources include mine and mill refining effluents. Such wastes are toxic to humans, fish and wildlife.

C. Deoxygenating Wastes:

Such wastes overly reduce the dissolved oxygen (D.O.) content of the water. Some of the more common sources of this type are breweries, distilleries, textile mills, pulp and paper mills, dairy and pig

farms, domestic sewage and food processing plants,  
e.g., (starch factories, sugar beet, meat packing  
and fish processing plants).

Dissolved Oxygen - St. John River (Generally).

To sustain normal fish life, water must contain a minimum of about five parts per million (p.p.m.) of dissolved oxygen, or about 54 percent saturation at 20° C. In the St. John River system, D.O. level is normally between 6 and 9 p.p.m., and is sufficient for fish survival. However, in some cases, where plant wastes and raw sewage are dumped untreated into the river, the D.O. level has dropped below this critical point and produced uninhabitable waters.

Amounts of D.O. in water vary for a number of reasons. Dumping of large quantities of untreated mill wastes and raw sewage into the river creates a high bio-chemical oxygen demand for decomposition, and thus reduces the D.O. content of the water. Higher water temperatures also cause a reduction in D.O. content. Other conditions being equal, warm water is capable of holding less D.O. than cold water. In addition, higher temperatures cause an increase in the rate of decomposition, and thus further reduce the D.O. level.

One way in which D.O. is replenished in the water is by the action of oxygen-producing algae, during the process of photosynthesis. The destruction of such algae by concentrated pollution, therefore, intensifies the problem. Physical aeration occurs when water is stirred up passing over a falls or rapids. Water passing over dam spillways receives considerable aeration, but passing through turbines it receives relatively little, as is the case

during low flows when it is most needed.

Dam flowages are major drawbacks as they inhibit the processes of algae and physical aeration, by causing large slow-moving or stagnant bodies of water. Such areas are usually too deep for effective photosynthesis, and also act as storage areas in which waste materials settle and decompose. Normally the D.O. level is greater at the surface and decreases as depth increases.

Flooding has a decidedly beneficial effect, as it brings new water to the system, accelerates re-aeration and tends to cause a scouring effect on the deposits of wastes in the river. Normally an increase in flow will produce an increase in D.O. level. Correspondingly, during low flows D.O. level decreases.

Two recent instances on the St. John River system illustrate the danger of low D.O. levels. In a Department of National Health and Welfare report (1960), there is a reference to the mortality of hundreds of suckers and yellow perch on August 20, 21 and 23, 1960. This was observed in the St. Leonard - Van Buren area, and was attributed to lack of oxygen. In 1966, a kill of young gaspereau was noted in the Beechwood headpond in August, during extremely low river flows. During the same week, a number of dead adult salmon were observed in the Beechwood - Bath area. In both cases D.O. levels were well below the critical five p.p.m.

Recent construction of the Mactaquac Dam, near head of tide, will provide a new source of oxygen depletion. The D.O. levels and fish survival may be adversely affected from the dam

upriver to the Woodstock - Hartland area. Similarly, D.O. levels may also be reduced for some distance below Mactaquac Dam.

During recent years a number of pollution surveys have been carried out on the St. John River system by various agencies. Several of these are listed in the "References" section at the end of this report. Graph #1, Page 32, shows typical D.O. profiles, as found in 1960, in a Department of National Health and Welfare survey.

A. Dissolved Oxygen - Beechwood Headpond:

In order to determine the D.O. content of waters in the Beechwood Dam headpond, a number of samples were taken by Resource Development Branch personnel during the summer months of 1958, 1959 and 1960.

The locations of the sampling stations were as follows:

Station 1 - Approximately 800 yards above Beechwood Dam - at mid-river.

Station 2 - Approximately seven miles above Beechwood Dam - opposite mouth of Muniac Stream - near mid-river.

Station 3 - Approximately 400 yards below the mouth of the Tobique River - mid-river.

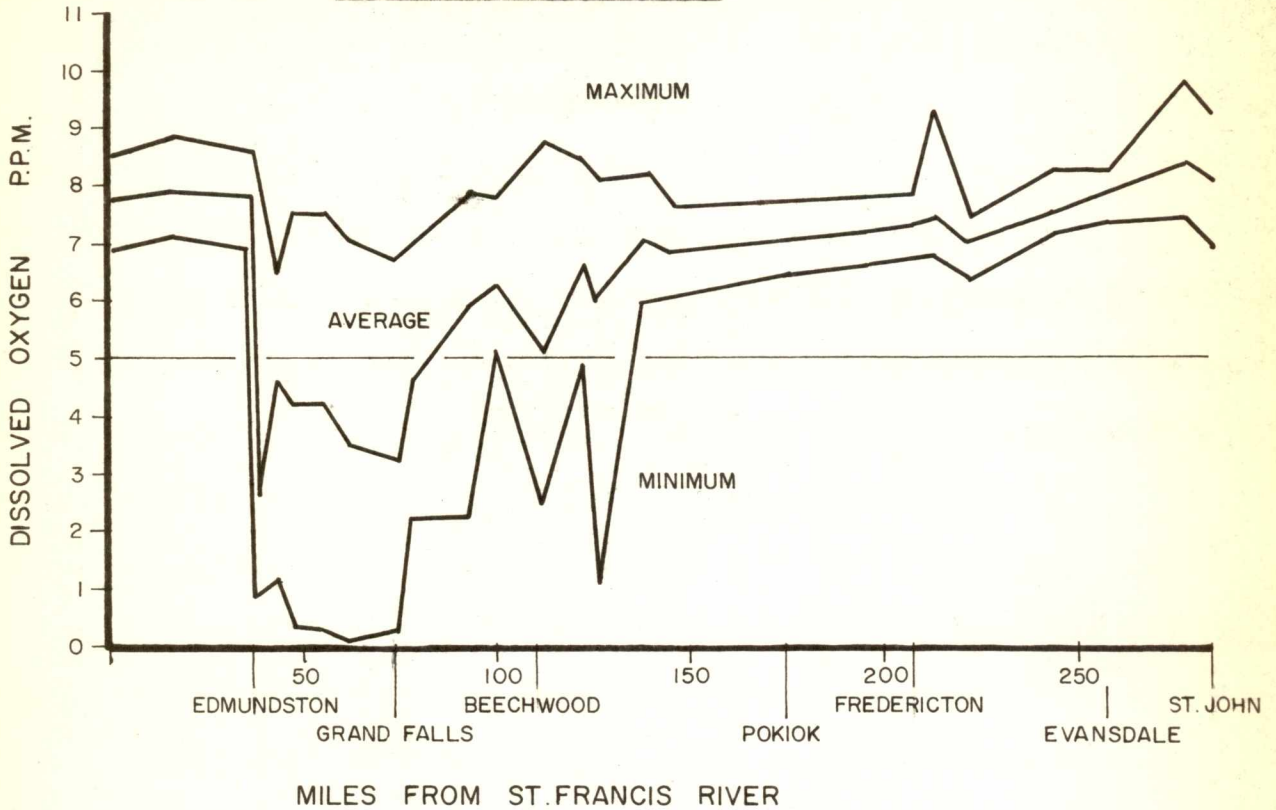
Station 4 - At town of Arcostook - one-third distance across from right shore.

Station 5 - About one-half mile above the confluence of the Arcostook River - one-third distance across from left shore.

Difficulties were encountered at Stations 4 and 5, because of high water velocities. The problems were

Graph #1.

Dissolved Oxygen Profiles.  
St. John River Basin.\*



\* From stream pollution survey July 20 - August 21, 1960.  
(Department of National Health and Welfare Report, 1960).

in obtaining accurate depth measurements, and in holding the water sampler and thermometer at any given depth, even when using a fairly heavy anchor. Stations 4 and 5 were selected for the purpose of obtaining samples both above and below any influence from Aroostook River water.

- (1) 1958 Sampling - All temperature and D.O. readings in the Beechwood headpond in 1958 were found to be within suitable range for cold water species. It should be noted that river flows in 1958 were relatively high, rarely below 10,000 c.f.s. Details of this data are given in Table #4, page 35.
- (2) 1959 Sampling - In 1959 water temperatures and D.O. content were checked at only four stations in the Beechwood headpond. The samples were taken during each month of July, August and September. Stations used were the same, #1 to #4, as used in 1958. River flows during the sampling period were much lower than in 1958. Data from these samples is detailed in Table #4, page 35.

At Station #1, a thermocline was indicated by the July 24 temperature readings. Water depth here was 64 feet and the thermocline layer located between 52 and 60 feet. August and September sampling at this Station showed no evidence of a thermocline. No thermocline was indicated at any time at the other three Stations.

In most cases D.O. content was within suitable limits for cold water species. In only one case did the oxygen level appear doubtfully low. This was in the July 24 samples at Station #1, at 64 feet depth (bottom) and 56 feet depth (thermocline). Readings here were quite low and irregular (1.3 to 5.9 p.p.m. at 64 feet and 2.5 to 4.1 p.p.m. at 56 feet). Irregularities in these readings may have been due to error in collecting, or analysing, the samples. In any event, all readings in this group were dangerously low. This problem was not encountered in later samplings.

- (3) 1960 Sampling - Again in 1960, water temperatures and D.O. levels were checked in the Beechwood headpond. Samples were taken during each month of June, July and August at Stations #1 to #4.

The only indication of unfavourable conditions to fish survival was at Station #1 on August 23. Oxygen content at the 65 feet depth (bottom) varied from 2.8 to 3.8 p.p.m. Earlier this year on July 13, Fisheries Research Board studies showed a D.O. reading of 3.3 p.p.m. in this area, at a depth of 60 feet. River flows during the 1960 sampling period were even lower than in 1959. Details of the 1960 data are shown in Table #4, page 35.

1958

TABLE 4

1959

1960

STATION	DEPTH FT.	DATE		DATE		DATE		DATE		DATE		DATE		DATE		DATE		DATE						
		TEMP. °C	D.O. p.p.m.	TEMP. °C	D.O. p.p.m.	TEMP. °C	D.O. p.p.m.	TEMP. °C	D.O. p.p.m.	TEMP. °C	D.O. p.p.m.	TEMP. °C	D.O. p.p.m.	TEMP. °C	D.O. p.p.m.	TEMP. °C	D.O. p.p.m.	TEMP. °C	D.O. p.p.m.					
1	0	May 28.	July 3.	August 2	August 24	October 2.	July 24	August 26	Sept. 23	June 23	July 28	August 23												
	32	9.9	9.4	17.4	8.9	19.8	8.2	14.9	9.9	13.0	8.6	24.2	10.4	18.8	7.8	12.9	9.3	19.5	10.7	21.0	7.9	23.0	7.7	
	35											-	-	18.3	8.7	12.2	8.9	18.8	10.2	20.5	9.4	21.5	7.7	
	56	9.9	9.5	17.2	8.8	18.5	8.1	14.5	11.2	13.0	8.5	20.2	3.0	-	-	-	-							
	64											17.3	3.3	18.1	8.3	11.6	8.1							
	65																							
	70	9.9	9.3	17.2	8.9	18.5	7.9	14.5	11.1	13.0	8.5								18.5	8.7	19.5	6.9	21.0	3.1
																							(2.8-3.8)	
2	0	May 28	July 2	July 31	August 23	October 2.	August 1	August 29	Sept. 24	June 24	July 31	August 23												
	21	12.9	9.3	17.6	10.4	18.0	8.8	15.8	10.9	12.7	8.7	24.5	9.7	18.3	8.8	13.6	9.3	19.0	8.8	22.0	8.9	22.5	10.0	
	22	12.8	9.3	17.2	9.5	17.9	9.1	15.5	11.0	12.4	8.5	24.0	7.3	18.2	8.5	12.9	9.2	18.5	9.1	21.5	9.2	22.0	6.2	
	42	12.8	9.3	17.2	7.5	17.8	9.3	15.5	11.2	12.4	8.7							18.3	9.5	21.0	8.9	20.5	5.1	
	44											24.0	7.0	18.1	8.7	12.9	8.9							
3	0	May 29	July 1	July 30	August 23	Sept. 25.	July 29	August 25	Sept. 30	June 22	July 27	August 23												
	12	11.6	9.4	16.3	7.5	18.0	11.3	16.3	11.2	13.8	10.3	24.5	6.6	17.6	8.9	15.4	8.2	19.5	10.8	20.5	8.1	22.0	7.2	
	13	11.5	9.3	16.2	8.4	18.0	11.1	16.1	11.2	13.8	10.3	23.8	6.7	17.4	8.6	15.9	9.4	19.0	10.1	20.0	8.6	21.0	8.0	
	24											23.5	7.7	17.4	8.6	14.9	10.0	18.5	11.8	19.5	8.7	21.0	7.5	
	26	11.5	9.5	16.1	8.1	17.8	11.1	16.0	10.9	13.8	10.9													
4	0	May 29	June 30	July 26	August 21	Sept. 25	July 30	August 22	Sept. 29	June 23	July 28	August 22												
	4*	12.8	9.6	15.4	10.5	20.5	8.8	14.6	12.2	13.8	10.5	26.0	8.9	19.7	8.7	15.0	11.0	19.3	10.0	21.5	8.7	24.5	12.4	
	5	-	-	15.4	10.5	20.5	-	14.5	12.2	-	-													
	7.5											25.4	8.1	19.6	8.9	14.8	10.8	19.0	10.1	21.5	8.6	23.0	11.4	
	8*	12.8	9.6	15.4	10.4	20.5	8.8	14.5	11.9	13.8	10.1													
	10																		19.0	10.3	21.5	8.6	22.0	8.5
	15											25.3	7.8	19.6	9.2	14.6	8.9							
5	0	May 29	June 30	July 26	August 21	Sept. 25																		
	4	12.7	8.8	13.8	11.8	20.5	8.7	14.8	12.4	13.8	10.4													
	8	-	-	13.8	12.5	-	-	14.8	12.3	-	-													

NOTE: \* Approximate Depths

B. Dissolved Oxygen - Beechwood and Tobique Narrows Headponds - 1964:

During the summer months of 1964, a series of D.O. and water temperature readings were taken in the Beechwood and Tobique Narrows headponds, by the New Brunswick Department of Lands and Mines. In most cases D.O. levels were above the minimum required 5 p.p.m. Details of these data are shown in Tables #5 and #6, page 37.

C. Dissolved Oxygen - Beechwood Tailrace (Dec.1965 - Dec.1966):

Beginning on December 12th, 1965, a more detailed study of water temperatures and D.O. levels in the Beechwood Dam tailrace was undertaken. Weekly samples were taken from the tailrace, immediately below the dam, and were continued until December 1st, 1966. In addition, during parts of the more critical periods in early July and September samples were taken daily.

Since the summer of 1966 produced unusually low river flows, D.O. levels dropped severely. During most of July, August and September, D.O. levels remained either near, or below, the critical level for fish survival. As a result, the salmon run through the Beechwood fishway fell off sharply in July, and almost ceased entirely during most of August and September.

Details of the D.O. readings, together with water temperatures and daily average river flows are shown in Table #7 and Graph #2, pages 38 and 39 respectively.



Date	c.f.s	DO p.p.m.	Temp. ° C.	% Sat.
<u>1965</u> Dec.12	16,850	11.9	1.5	84
Dec.18	19,200	11.6	1.5	83
Dec.25	7,100	10.7	1.5	77
Dec.31	-	-	-	-
<u>1966</u> Jan.7	11,675	8.2	1.5	58
Jan.14	-	8.3	-0.5	57
Jan.21	13,250	9.9	-0.5	68
Jan.28	8,700	9.1	-0.5	63
Feb.4	12,300	9.1	-0.5	63
Feb.11	6,850	6.7	1.0	47
Feb.18	3,900	7.6	1.0	54
Feb.26	8,770	7.6	1.0	54
Mar.4	1,100	7.8	1.0	54
Mar.12	10,500	9.9	1.0	69
Mar.18	11,700	10.1	1.0	71
Mar.26	27,760	10.4	1.0	72
Mar.27	29,540	11.8	1.0	83
Apr.1	31,450	13.2	1.0	93
Apr.9	27,000	13.2	1.5	94
Apr.15	27,000	13.4	5.5	105
Apr.22	71,700	13.9	5.5	110
Apr.29	68,845	15.9	4.0	120
May 7	57,180	14.1	5.5	110
May 13	40,850	13.4	6.5	108
May 21	56,340	11.2	9.0	97
May 27	41,700	9.8	11.5	90

Date	c.f.s	DO p.p.m.	Temp. ° C.	% Sat.
<u>1966</u> June 3	15,200	8.0	14.0	77
June 10	26,100	7.9	14.0	77
June 17	7,900	7.5	15.0	75
June 24	9,340	7.4	17.0	76
July 1	4,110	5.1	21.0	57
July 4	3,600	4.1	21.0	45
July 5	1,100	3.3	21.0	37
July 6	7,525	3.9	21.0	42
July 7	3,500	2.0	19.0	21
July 8	2,600	2.5	20.0	26
July 9	7,500	3.0	20.0	32
July 10	3,900	1.9	19.0	20
July 15	10,900	3.6	19.0	38
July 22	4,400	1.7	18.0	17
July 29	11,000	3.2	20.0	34
Aug. 5	11,000	3.2	21.0	35
Aug.12	1,510	1.6	20.0	16
Aug.19	1,440	2.7	19.0	28
Aug.26	7,850	2.1	20.0	22
Sept. 1	-	1.1	19.5	11
Sept. 2	4,250	1.7	20.0	18
Sept. 3	-	2.0	20.0	21
Sept. 4	-	1.9	19.5	19
Sept. 5	-	2.1	19.0	22
Sept. 6	-	1.8	19.0	18
Sept. 7	-	1.8	18.5	18

Date	c.f.s.	DO p.p.m.	Temp. ° C.	% Sat.
<u>1966</u> Sept. 8	-	1.7	18.0	17
Sept. 9	2,920	1.9	17.0	19
Sept.10	-	1.8	16.5	18
Sept. 11	-	3.2	17.0	32
Sept. 12	-	3.1	17.5	45
Sept. 13	-	2.7	18.0	27
Sept. 14	-	1.6	18.0	16
Sept. 15	-	2.2	18.0	23
Sept.16	1,420	1.9	15.0	18
Sept. 17	-	1.9	17.0	19
Sept. 18	-	1.9	18.0	19
Sept. 19	-	2.0	14.0	19
Sept. 20	-	2.4	14.0	23
Sept. 21	-	2.5	14.0	24
Sept. 22	-	2.7	15.0	26
Sept. 23	6,500	2.8	16.0	27
Sept. 24	-	3.3	15.0	32
Sept. 25	-	2.9	14.0	28
Sept. 26	-	3.8	14.0	36
Sept. 27	-	3.5	12.0	32
Sept. 28	-	1.7	12.0	15
Sept. 29	-	-	-	-
Sept. 30	9,400	4.5	11.0	40
Oct. 2	3,650	4.5	10.0	39
Oct. 7	5,900	7.2	9.0	62
Oct. 14	7,200	7.2	9.0	62

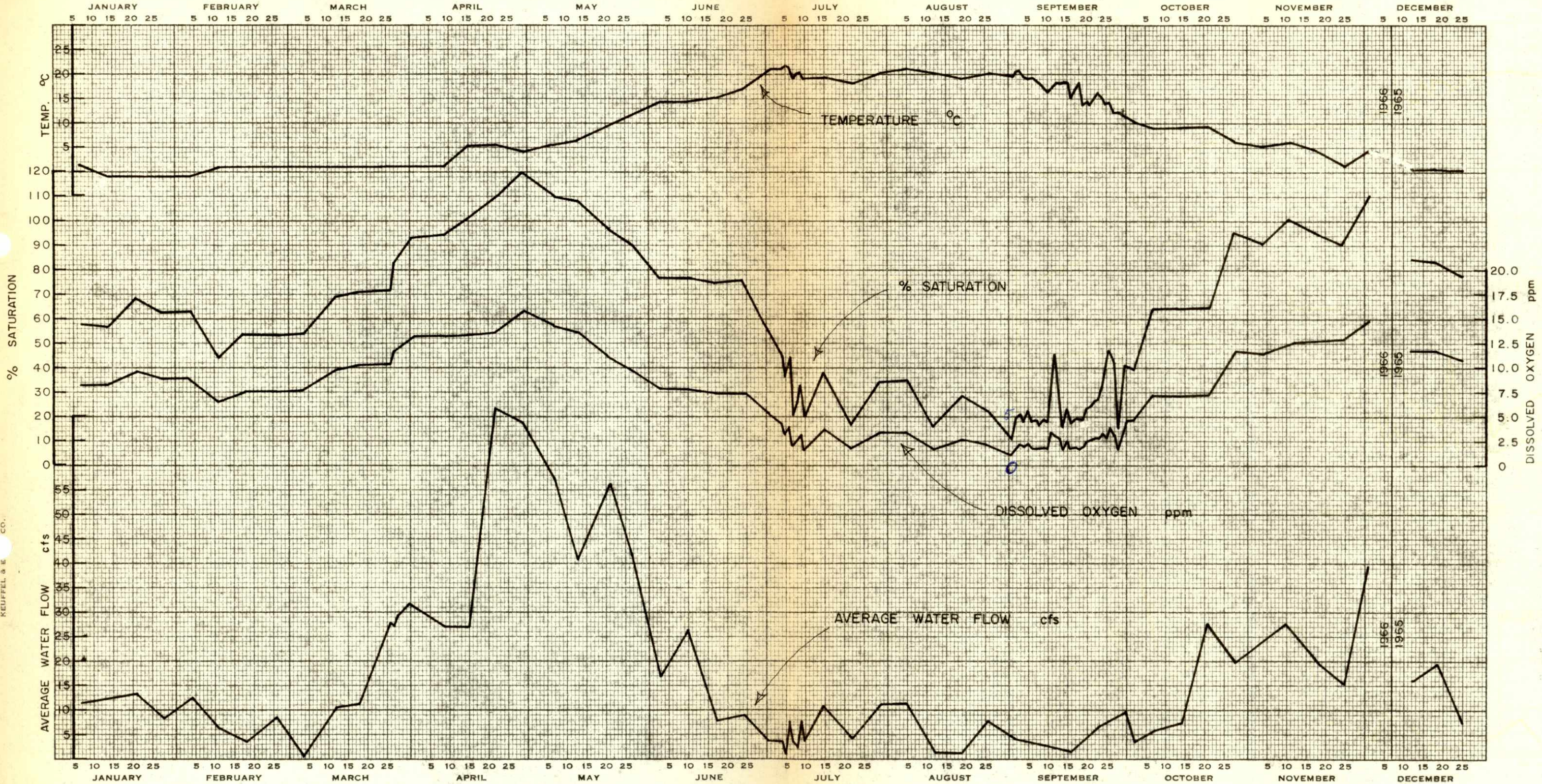
Date	c.f.s	DO p.p.m.	Temp. ° C.	% Sat.
Oct. 21	27,225	7.5	9.0	63
Oct. 28	19,570	11.9	6.0	95
Nov. 4	?	11.4	5.0	90
Nov. 11	27,450	12.5	6.0	100 -
Nov. 18	19,730	12.7	4.0	95+
Nov 25	15,000	12.9	1.0	90
Dec. 1	39,800	14.8	4.0	110 +

TABLE #7  
 WATER CONDITIONS BEECHWOOD  
 TAILRACE - 1965 - 1966

WATER CONDITIONS  
BEECHWOOD TAILRACE  
SAINT JOHN RIVER

GRAPH #2

1965 - '66



KE 1 YEAR BY DAYS  
X 150 DIVISION  
KEUFFEL & E CO.

47 2813  
MADE IN U.S.A.

D. D.O. Comparison - Beechwood Tailrace vs. Bath:

Also beginning in December 1965, were a series of D.O. checks, both in the Beechwood tailrace and at Bath, about four miles downriver. These series of checks were conducted monthly at each site. Within each series, 4 to 8 readings were made, usually within a 24-hour period of two consecutive days. Occasionally, the last readings extended over into the early part of the third day. The various readings of each series were spaced to cover as wide as possible a variation in generator loads. These series were conducted for two reasons:

- (1) To determine if there were any appreciable variations in D.O. levels at different generator loads at the Beechwood plant. No significant differences were found.
- (2) To determine if D.O. levels increased significantly during the approximately four miles of free flow from Beechwood to Bath. Each Beechwood reading was followed by one at Bath, approximately one hour later, the estimated time required for the water to flow this distance.

In most cases, the average D.O. levels had increased slightly by the time the water had reached Bath. These increases are attributed to natural re-aeration. After leaving the Beechwood impoundment, the river flows openly to Bath, predominately over moderate riffle area. Average

D.O. levels found in each series, together with other water data, are shown in Table #8 and Graph #3, pages 42 and 43, respectively.

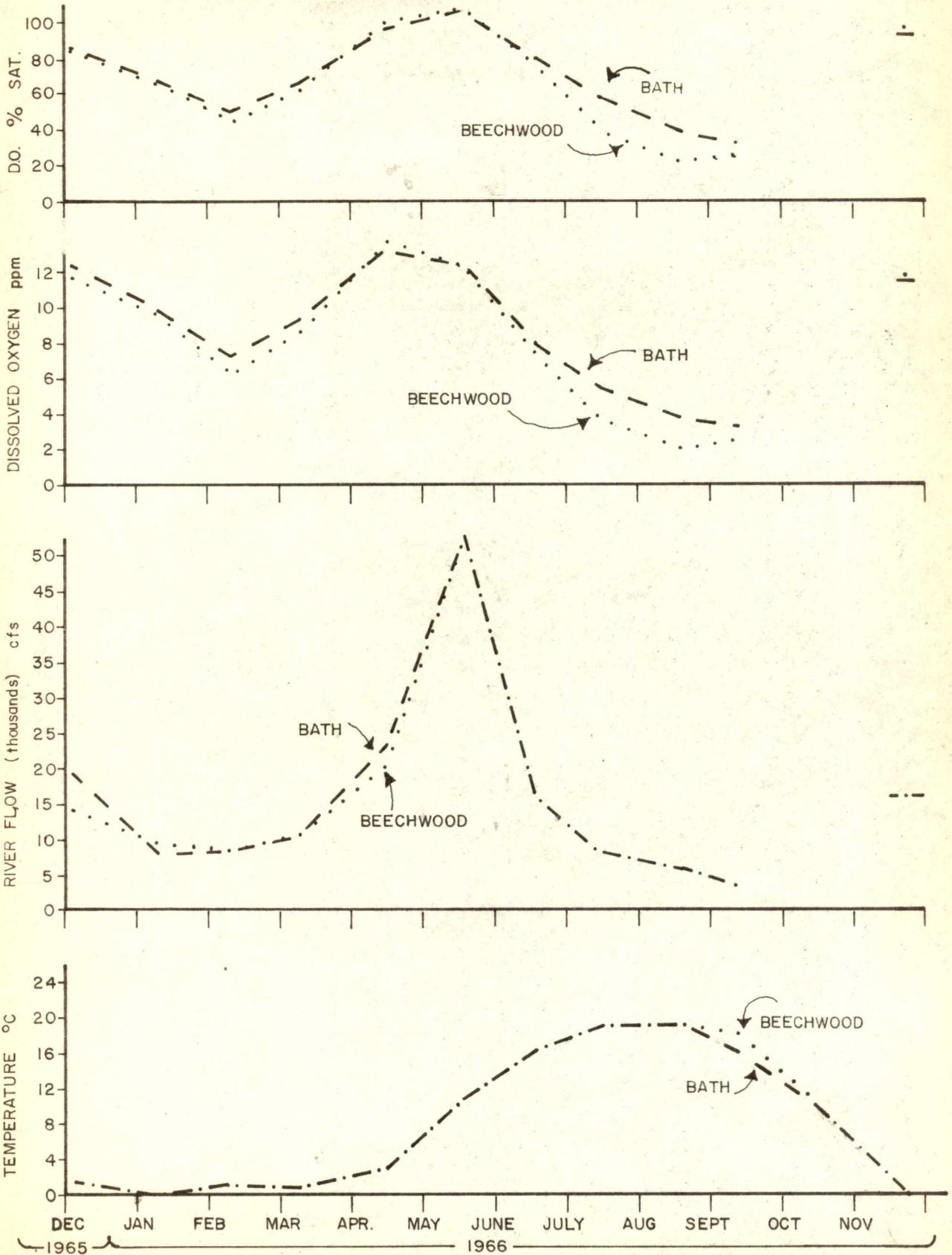
## Dissolved oxygen comparison - Beechwood tailrace &amp; Bath, 1965-66

DATE	BEECHWOOD				BATH			
	TEMP. C°	FLOW cts	DO. ppm	D.O. % sat.	TEMP. C°	FLOW cts	D.O. ppm	D.O. % sat.
DEC. 4 - 5 1965	1.5	13,925	11.85	84	1.5	19,475	12.10	86
JAN. 11 - 13 1966	0.0	9,699	9.55	66	0.0	8,853	9.94	68
FEB. 8 - 10 1966	1.0	8,022	6.26	44	1.0	8,025	7.24	50
MAR. 9 - 10 1966	1.0	11,656	8.86	62	1.0	11,650	9.36	66
APR. 13 - 14 1966	3.0	20,630	13.63	100	3.0	23,400	13.36	99
MAY 17 - 18 1966	10.5	52,437	12.27	109	10.5	52,437	12.28	109
JUNE 16 - 17 1966	16.0	16,086	7.73	77	16.0	16,086	7.90	79
JULY 14 - 15 1966	19.0	7,999	3.74	40	19.0	7,999	5.38	57
AUG. 17 - 19 1966	19.0	5,946	2.05	22	19.0	5,946	3.78	40
SEPT 12 - 13 1966	18.0	3,346	2.59	27	16.0	3,346	3.22	32
OCT. 15 * 1966	10.0				10.0			
NOV. 21 - 22 1966	0.0	16,525	13.95	97	0.0	16,525	13.75	94

\* D.O. Readings not carried out in October.

GRAPH #3

DISSOLVED OXYGEN COMPARISON  
BEECHWOOD TAILRACE AND BATH (1965 - 66).



E. Dissolved Oxygen - Upper St. John River - 1966:

Because of abnormally low river flows during the summer months of 1966, additional checks were made on D.O. and water temperatures at various upriver points. Dead fish had been reported in both the Beechwood flowage and below the dam. These checks helped determine the sources and areas of heavier pollution and the extent of the D.O. depletion.

Results indicated that deoxygenation was particularly serious on the main river below Edmundston, in the Grand Falls and Beechwood flowages, and below Florenceville. Critical D.O. levels were encountered on only one tributary, the Madawaska River, below the Fraser Company pulp mill.

These 1966 checks were made during two periods, August 12th to 19th and August 27th to 31st. Results are shown in Tables #9 and #10, pages 46 and 47 respectively. A D.O. profile of the river from just above Edmundston to about four miles below Florenceville is shown in Graph #4, page 48. The data were taken from Table #10. The major areas of D.O. depletion and recovery are quite clearly illustrated.

F. Dissolved Oxygen - Upper St. John River - 1967:

Because of the frequently lethal D.O. levels found the previous season, further checks were made along the upper St. John River in 1967. In the area between

Edmundston and Hartland, below lethal levels were found in many instances during the months of July and August. Although the situation was serious, D.O. levels did not generally drop as low as in 1966 and the duration of the critical period was shorter. This may be explained by the relatively high river flows in 1967 and the resulting greater dilution of various pollutants. In spite of the fact river discharge during the summer months of 1967 was greater than during 1966, it was still considerably below the long-term average for these months.

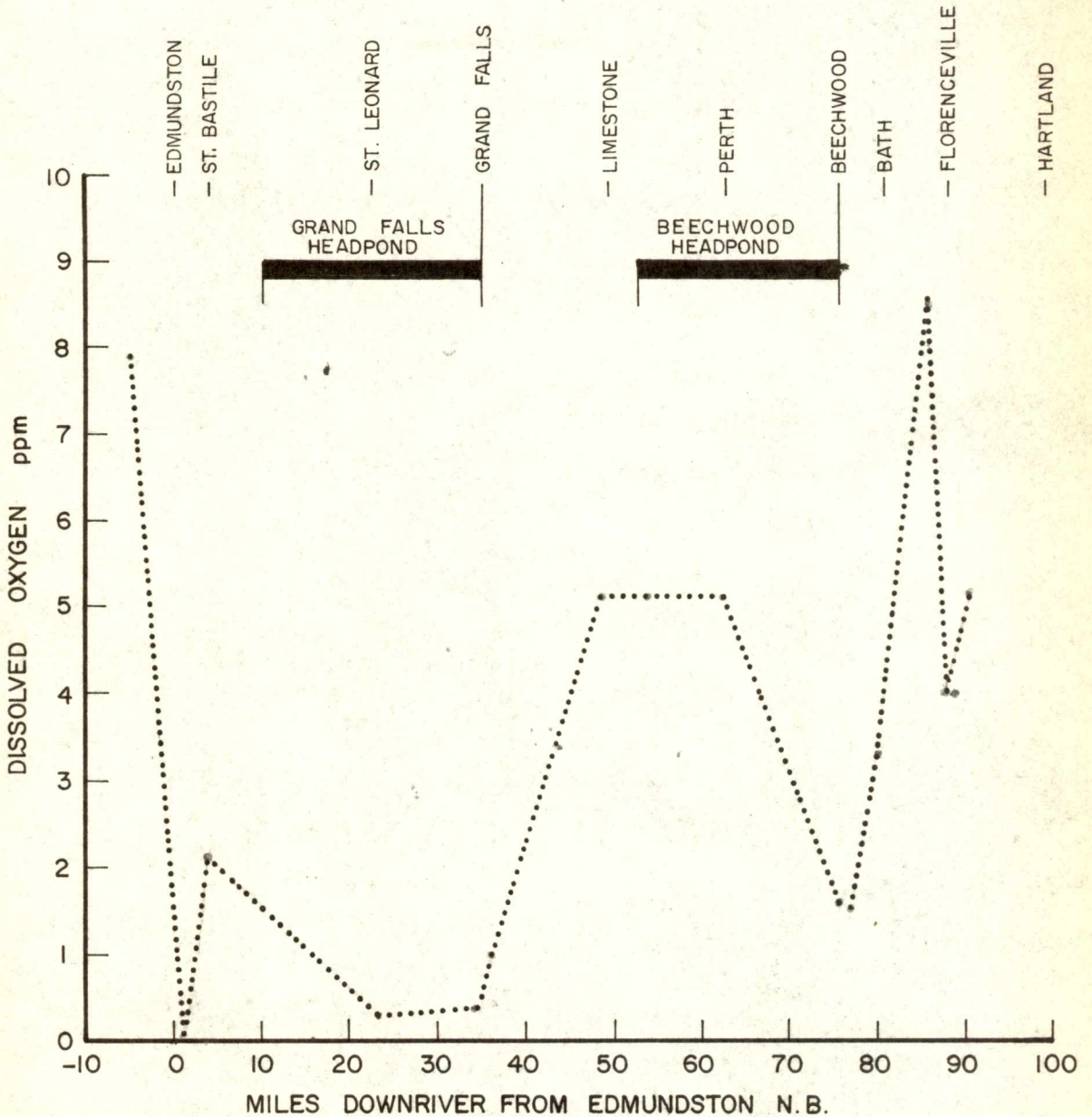
D.O. CHECKS - UPPER ST. JOHN RIVER SYSTEM  
(AUGUST 12 - 19, 1966).

STATION	DEPTH FEET.	D.O. p.p.m.	WATER TEMP (°C)	% SAT.
Green River-Grand Falls Flowage.	2	4.0	18	42
Grand Falls - Above Dam.	2	0.4	20	4
Limestone - Below Grand Falls.	2	3.3	21	36
Morrill - " " "	2	4.2	21	46
Upper Beechwood Flowage )	1	5.2	20	56
" " " " )	1	3.7	20	40
Tobique Narrows - Above Dam.	3	8.4	22	95
Aroostook River - Above confluence with Beechwood Flowage.	2	6.6	23	76
Beechwood Flowage at Perth.)	1	3.1	-	-
" " " " )	11	2.4	-	-
" " " " )	21	2.2	-	-
Beechwood Flowage at Kilburn )	1	2.7	21	29
" " " " )	14	2.5	-	-
" " " " )	27	1.7	-	-
Beechwood - Above Dam. )	1	3.1	21	34
" - " " )	15	2.6	-	-
" - " " )	35	0.9	-	-
" - " " )	55	0.1	-	-
Beechwood - Tailrace	1	1.6	21	17
Bath-midstream - St. John River.	1	1.9	21	21
Bath at confluence with Monquart River	1	6.4	17	66
Bristol - St. John River.	1	6.3	23	72
Florenceville - St. John River.	1	8.0	21	90

D.O. CHECKS - UPPER ST. JOHN RIVER SYSTEM  
(AUGUST 27 - 31, 1966).

<u>STATION</u>	<u>DEPTH FEET.</u>	<u>D.O. P.P.M.</u>	<u>WATER TEMP(°C)</u>	<u>% SAT.</u>
<u>ST. JOHN RIVER:</u>				
Edmundston - Above mill wastes	1	7.9	18.5	83
" - Below " "	1	0.0	19.0	0
Saint Basile.	1	2.1	19.0	22
Saint Leonard	2	0.3	17.2	3
Grand Falls - Above Dam.	1	0.4	18.8	4
Grand Falls - Below Powerhouse	1	1.0	19.0	10
Limestone Sta. - Bridge.	2	5.2	19.0	56
Beechwood Flowage - Upper End.	2	5.2	19.0	55
" " - At Perth	2	5.2	19.0	55
" " - At the Dam.	2	1.6	21.0	17
Beechwood Tailrace	2	1.5	19.5	16
Bath	2	3.3	20.5	36
Florenceville - East Bank - Above McCain's	2	8.5	22.0	96
Florenceville - West Bank - Opposite McCain's.	2	7.7	21.0	86
Florenceville - East Bank - 1½ Miles below McCain's.	2	4.0	24.0	47
Florenceville - East Bank - 4 Miles below McCain's	2	3.7	23.0	43
Florenceville - West Bank - 4 Miles below McCain's.	2	5.2	21.0	57
<u>MADAWASKA RIVER:</u>				
Saint Jacques - 5 Miles above Mill.	1	5.7	16.5	57
Edmundston - (Above Dam) ¼ Mile below Mill.	1	0.0	18.0	0
Edmundston - (Tailrace) ¼ Mile below Mill.	1	0.0	18.0	0
<u>TOBIQUE RIVER:</u>				
Tobique Narrows Flowage - 5 Miles above Dam.	2	8.3	18.5	88
Tobique Narrows just above Dam.	2	7.6	18.8	80
Tobique Narrows Tailrace.	2	6.4	18.5	67
<u>ARROSTOOK RIVER:</u>				
One Mile above Beechwood Flowage - 2 Miles below Timber Dam.	2	11.3	15.0	111

D.O. LEVELS - UPPER ST. JOHN RIVER  
( AUGUST 27 - 31, 1966 )



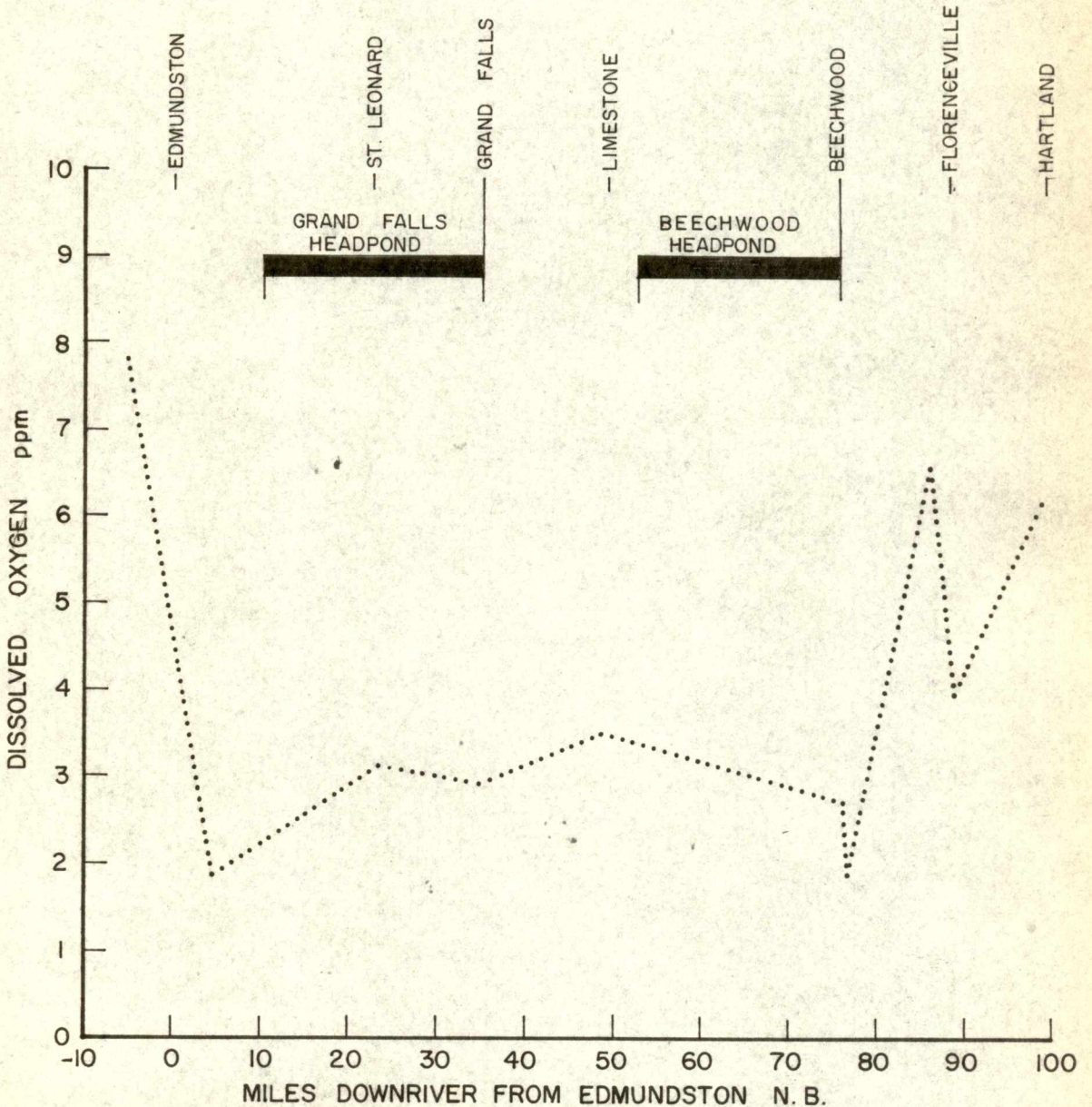
Areas of unusually low D.O. content were similar to those found in 1966. A sample D.O. profile is shown on Graph #5, page 50, for the section of the river extending from five miles above Edmundston down to Hartland. The D.O. levels in this Graph were all from surface readings, which were taken on August 1st and 2nd. These data are shown below. In some cases, readings at certain stations showed more serious D.O. depletion, both before and after these dates.

TABLE #11

D.O. LEVELS - UPPER ST. JOHN RIVER  
(AUGUST 1 AND 2, 1967)

DATE	LOCATION	H <sub>2</sub> O TEMP. ° F.	D. O.	
			p.p.m.	% Sat
Aug. 2.	5 Miles above Edmundston.	75	7.8	91
" 2.	4 Miles below Edmundston.	76	1.9	22
" 2.	23 " " " (St. Leonard)	74	3.1	36
" 2.	36 " " " (Grand Falls)	80	2.9	35
" 2.	48 " " " (Limestone)	75	3.5	41
" 2.	77 " " " (Beechwood Headpond)	74	2.7	31
" 2.	77 " " " (Beechwood Tailrace)	74	1.9	20
" 1.	86 " " " (Florenceville (Above McCain's Food Plant)	75	6.5	77
" 1.	88 Miles below Edmundston (Florenceville (2 Miles below McCain's Food Plant)	74	4.0	47
" 1.	98 Miles below Edmundston (Hartland)	72	6.2	70

D.O. LEVELS - UPPER ST. JOHN RIVER  
(AUGUST 1 AND 2, 1967)



### Specific Pollution Sources

#### A. Upper St. John River System:

This area includes all of the main river and tributaries above Grand Bay. The estuarial area from Grand Bay to the river mouth is discussed separately in a later section.

Pollution sources on the upper river are numerous, and vary in type and intensity. The following section gives brief descriptions of the more important ones, together with comments on some of the more evident minor sources:

- (1) Fraser Company Pulp Mill - This mill is located at Edmundston, New Brunswick, on the Madawaska River, about one-half mile above its confluence with the St. John River. The mill empties a large amount of sulphite wastes into the river, and is considered to be the most serious source of pollution on the system. These wastes are mainly deoxygenating solids such as bark, screenings and pulp fibres. This effluent forms a false river bottom with a sludge deposit, has a low rate of decomposition and reduces the D.O. content of the river at all times. At certain times of the year, during low water flows, the D.O. level below the mill falls to zero.  
  
In addition to these deoxygenating wastes, a certain amount of toxic effluent is also released at times. This results from waste materials from the bleaching process.

- (2) Madawaska Paper Mill: This mill is located on the St John River at Madawaska, Maine, and operates in conjunction with the Edmundston pulp mill. Wastes from this source are also mainly of the deoxygenating type.

In addition to the mill effluents, the pollution load in this area is increased by the dumping of raw sewage from the City of Edmundston, and by the effluents from a number of starch plants. In combination, these sources produce a low D.O. level in the river from Edmundston to Grand Falls. Once below the Grand Falls flowage, D.O. levels gradually increase through natural aeration until Beechwood flowage is encountered, where another drop occurs. The nature of the flowage itself is no doubt partly responsible for this drop. In addition, other pollution sources along both the main river and some tributaries are dumping more wastes. These are primarily deoxygenating types, such as those from starch and potato chip plants and domestic sewage.

Riffle area below the Beechwood Dam again facilitates natural re-aeration of the water. Even during extremely low flows, such as during the summer of 1966, the D.O. content has risen above the critical level by the time the river has reached Bath, a distance of about four miles. The next source of heavy pollution is encountered only about five miles further down-river, at East Florenceville.

- (3) McCain's Limited - This is a frozen vegetable processing plant and potato-chip manufacturing operation, located on the main St. John River at East Florenceville. The effluent from this plant includes peas, pods, stocks, corn and a variety of other coarse vegetable debris. This causes offensive odours and a heavy slime growth on the river bottom. For some distance around the outlet from this plant, the mass of decaying vegetable wastes is several feet in depth. These wastes are mostly organic matter and are of the deoxygenating type.

The intensity of the pollution in the East Florenceville area is increased by other waste disposal, both in the main river and the tributary, Presquile River. The main river receives wastes both from the Carleton County Co-operative Dairy and domestic sewage from the town. The Presquile River is used for disposal of wastes from potato-chip, starch and sugar beet plants, as well as domestic sewage. Most of these sources are located in the State of Maine.

Although D.O. levels may become dangerously low in this area, particularly during summer low water periods, they are still able to recover fairly quickly a few miles down-river. Below this area the river has remained mostly suitable for fish survival, with relatively small decreases in D.O., caused by wastes from small factories and towns. These would