INVESTIGATION OF THE MORTALITY OF SALMON IN THE RIVER ST. CROIX, OCTOBER, 1930.

by

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A telegram was received from Dr. Huntsman, Director of the Atlantic Biological Station, requesting an investigation of the cause of the mortality of the salmon, which had been reported as occurring in the River St. Croix, to the Department of Fisheries, by the local inspectors. The telegram further indicated that available information was to be secured from Mr. O. A. Rigby, Inspector of Fisheries.

Accordingly, Inspector Rigby was consulted, and the following information was secured.

> The salmon are going up the St. Croix river for the first time to any extent for years. The dead fish were seen at the Union Bridge at Milltown, and were reported in the weekly report by the guardian, Herbert Parks.
>
> The dead fish have been observed for about six weeks, about ten to twelve a week, but last week there was none.
>
> It is about a quarter of a mile from the bridge to the cotton mill. There is a dam with a fish-way at the mill, and there is also a dam and fishway at the bridge.
>
> The salmon which have been found have all been very badly decomposed; so that Inspector Rigby believes that death occurred above the upper dam.
>
> Above the upper dam, about five miles, is Chase's mill, at Baring. There is also a bridge at Baring dam, but no fish-way.

The water at Baring mill has been reported to have been tested by the United States people, and was reported to be pretty bad (by the man at the mill). This is about 7 or 8 miles below Woodland, where there is a sulphite mill (pulp) - about 13 miles above the Union bridge.

Inspector Rigby stated that he is suspicious of pollution from the pulp mill, for the dead fish have apparently been dead for from five to six days; and if death was occurring locally, where the fish have been picked up, there ought to have been found at least one freshly dead. It had been suggested that the wheel of the cotton mill was responsible, but Inspector Rigby made an examination, and does not believe that the fish could get into the wheel.

As to tributaries, there is Mohanas creek between the cotton mill and Baring, but there is nothing on it in the way of pollution; in fact, it is almost dried up. The creek is on the Canadian side.

Following Inspector Rigby's suggestion to search above the cotton mill dam, one dead, badly decomposed fish has been found above that dam.

This indicated to Inspector Rigby that the deaths must be occurring in the stretch between this dam and the dam at Baring, where there is a low dam, but with no fishway, and where American Investigators had found (according to report) foul water.

The Woodland mill is on the main river, on the American side, and the dam is across the International part, and it has no fishway. It is forty feet high. The same people have another dam at Grand Falls, for power production. This is also on the main river, at the junction of the east and west branches.

The mill at Baring is also on the American side, and is a sawmill.

Fry have been planted in Mohanas creek, from the St. John hatchery. A reference had been observed in some paper, to the year 1880, in which it was stated that 60,000 young fish had been liberated by Maine authorities, and in the same year, 125,000 by Dominion officials.

In regard to investigation by American officials, he stated that he had been in communication with Mr. Wass, Inspector of fishways, whose chief interest was in the ways, and who wanted all of the existing ones altered, as they were entirely inefficient. The headquarters of Mr. Wass were in Cherryfield, Me., but were too far away to visit conveniently.

(In regard to the matter of fishways, Mr. Rigby stated further that at least those in the lower dams were good, for one dead fish was secured above the last fishway, and observers had noticed fish going up the one in the lower dam. However, the American Inspector of Customs, and Immigration stated that the ways may be alright,

but they are kept closed for the most of the time.)

In order to assist in any investigation, Inspector Rigby loaned a copy of a Profile of the River St. Croix, which he had, and which has been copied and forms figure 1 of the present report. It extends from the bridge at St. Stephen (tide water) to Princeton, Me. On it may be readily observed the features referred to by Inspector Rigby, and also those referred to by Supervisor J. F. Calder, in a letter to the Deputy Minister of Fisheries, which has also been copied here for convenience in reference. A copy of this letter was forwarded by Dr. Huntsman for information.

> Sir: In my telegram to you dated August 27th, recommending employment of Guardian for a period of two months on the St. Croix river, I stated, among other things, that salmon were being killed in the wheels of the cotton mill. I may say that dead salmon were being found in the river from time to time at the time I sent the telegram and the general opinion was that they must have been killed in cotton mill wheels. Investigations made afterward go to show that it would be quite impossible for salmon to be killed in the cotton mill wheels while attempting to ascend the river. However, dead salmon are still being found in the river. I was informed by Guardian Parks the other day that he had found 12 in the course of the last week. He had tied the last one to the shore and showed it to Inspector Rigby and me. It was a very large fish and did not show any bruises or scars. It had been dead for quite a while, as decomposition was setting in. He said that he had never seen a freshly killed fish among all that he had found. Evidently, the fish die some considerable distance above the Union, as they had all been dead quite a length of time before being found there. The fish are either killed by the use of dynamite or by some poisonous substance in the river. Guardian Parks says he has never heard a hint, even, that anyone was using dynamite among the fish. Rigby and I went up the river as far as Baring, with similar result. We did talk to a man at Baring, however, who said that employees of the Woodland paper mill had been making tests of the water in the river in the vicinity of Baring and that he had been informed the analysis showed the water to be poisonous. Of course, I do not know whether such statement is correct or not. I would suggest, however, that you arrange with Dr. Huntsman and have tests made of the water to find out whether or

not it is being polluted by acids from the paper mill to the extent that mature salmon in it are dying.

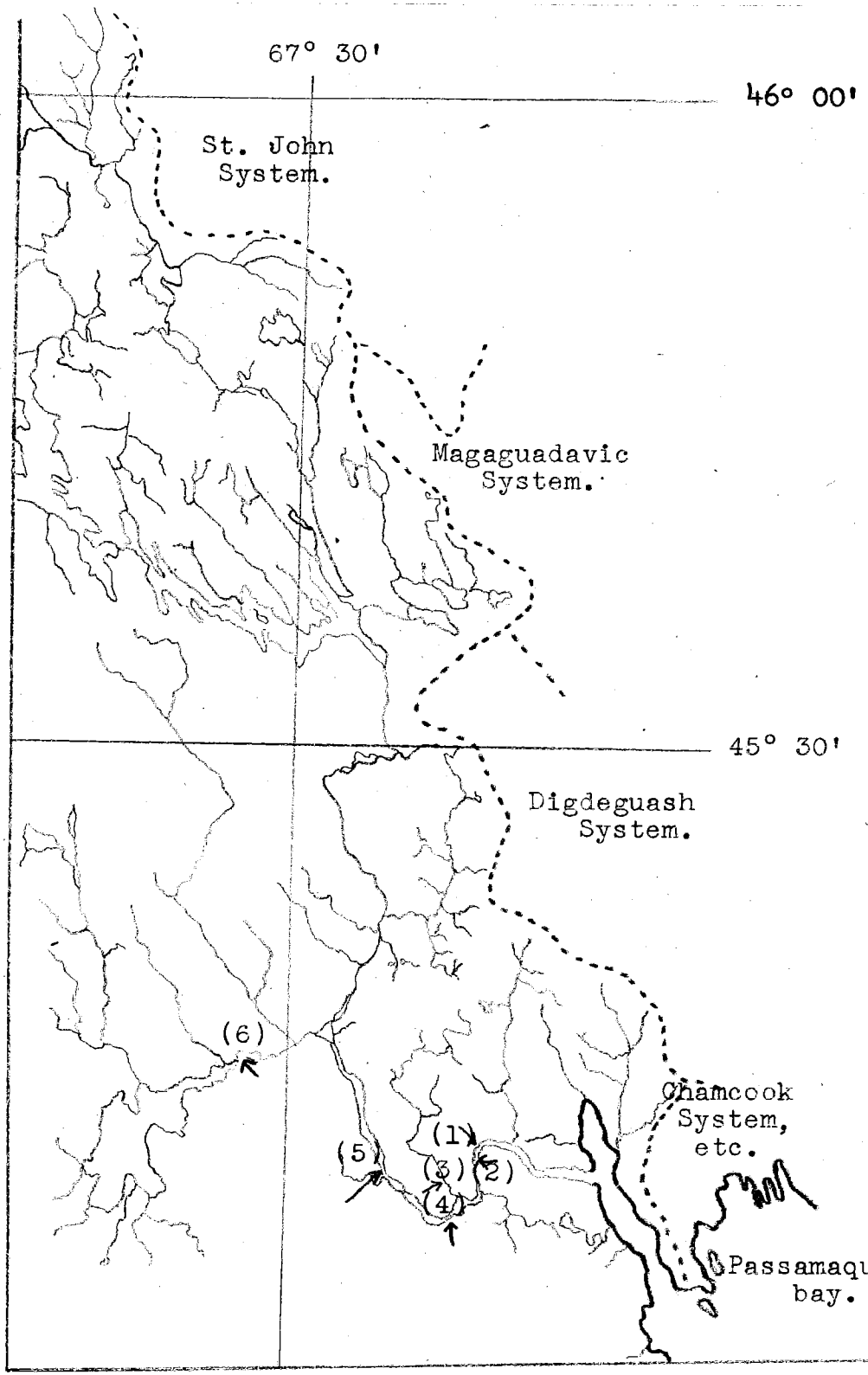
sgnd J. F. Calder.

With this information in mind, in order to secure proper orientation of the situation, a tracing of the St. Croix water-shed was made from a road map, which seemed to have the majority of the streams shown on it. This tracing forms figure 2 of the present report.

From a study of the tracing and the profile (figure 1) with the information already secured, certain sites were selected for investigation, as being most likely to yield the necessary information. Six stations were chosen as follows:

Station 1. Above the cotton mill dam.
Station 2. Above the Milltown Upper Dam.
Station 3. In Mohanas Creek.
Station 4. Above Baring Dam.
Station 5. Above Woodland dam.
Station 6. At Grand Falls (Jct. of E. and W. Branches).

It was believed that, through the selection of these stations, the following points might be established, since no fish could get past the Baring dam, and since the suspected source of pollution was the sulphite mill at Woodland. Stations 5 and 6 ought to establish the conditions existing above the suspected source of pollutions, and if markedly different from the conditions found below, at stations 1, 2 and 4, then a definite conclusion as to existence of pollution might be drawn. Station 3 was selected on a tributary, below the suspected source of pollution, to serve as a further check upon the condition of the natural water.



THE WATERSHED
OF THE
RIVER ST. CROIX.
(major part)

* * *

with Boundaries of the
Contiguous Systems Indicated.

* * * *

Traced from Road Map
supplied by
The Tourist Information Bureau
of
New Brunswick.

+

Stations
Indicated by Red Numerals
Enclosed by Brackets.

* * * * *

FIGURE II.

HYDROGRAPHICAL AND METEOROLOGICAL CONDITIONS.

This has been a remarkably dry season, in the whole of this region, particularly in the past few months. All of the rivers have been very low. Hence, the circulation of the River St. Croix must have been minimal during the latter portion of this period. The numerous dams form large ponds, or lakes, and hence the possibility of stagnation is much increased. Any pollution during this period must aggravate a condition already bad.

Rains fell during the night of October 16, but were not very heavy, but on October 19, very heavy rains fell all morning.

Recently the temperatures have also been quite high - in fact, all fall the temperatures have been above average.

INVESTIGATION.

Directions to make the investigation were first received on October 12, but as Inspector Rigby was away contact with him was not established until October 17, and on account of pressure of other work, the investigation was put off. However, when the heavy rains of the nineteenth appeared, it was decided that it would have to be made at once, or the whole picture would be altered. Accordingly, the various stations selected (above) were visited, with the exception of the last one. Samples for oxygen determinations, and for pH determinations were taken at each.

The original station 6, was planned to be at the power dam at Grand Falls, at the junction of the east and west

branches of the St. Croix, but the road was missed, and the west branch, at Princeton, Me., was reached instead. As it was getting late, and the colours of the pH set would soon be difficult to distinguish, it was decided to determine conditions at the bridge at Princeton.

RESULTS.

The following results were secured:

Station	Location	pH	Oxygen Content cc. per L.
1.	Milltown - above cotton mill dam	6.2	5.32
2.	Milltown - above upper dam, above bridge.	6.2	4.90
3.	Mohanas creek - below the bridge	7.0	7.06
4.	Below Baring bridge - above dam	6.2	5.40
5.	Woodland Jct. - above dam; above sorting slip.	6.8	6.37
6.	Princeton, Me., below highway bridge.	6.8	6.66

DISCUSSION.

A study of these results indicates a significant change in the water condition between station 5 (mile 11.5) and station 4, at Baring dam (mile 6), in which station 3 does not participate.

Stated roughly, the oxygen content below station 5 was about five and a quarter cubic centimetres of oxygen per litre, while above, it was about six and a half. In Mohanas creek, the oxygen was seven - the highest value obtained. It is significant that this creek was shallow, with small pools, and numerous rapids, and riffles. These aid gaseous exchange.

Although temperatures were not taken, due to forgetting the thermometer, they were likely about 12°C. (53°F.), lower if anything; this may be concluded from temperatures taken elsewhere. At this temperature, distilled water would hold about seven and a half cubic centimetres of oxygen per litre. Thus, a certain degree of organic pollution exists in all of the water tested, but it is greatest below station 5, in the main river, and least in the tributary, Mohanas creek.

In this connection, the American Customs and Immigration Inspector at the Milltown Upper Bridge, who was very much interested in the re-establishment of the St. Croix as a salmon river, stated that the dam at Baring was full of pulp from the Woodland pulp mill, and this observation was confirmed in this investigation.

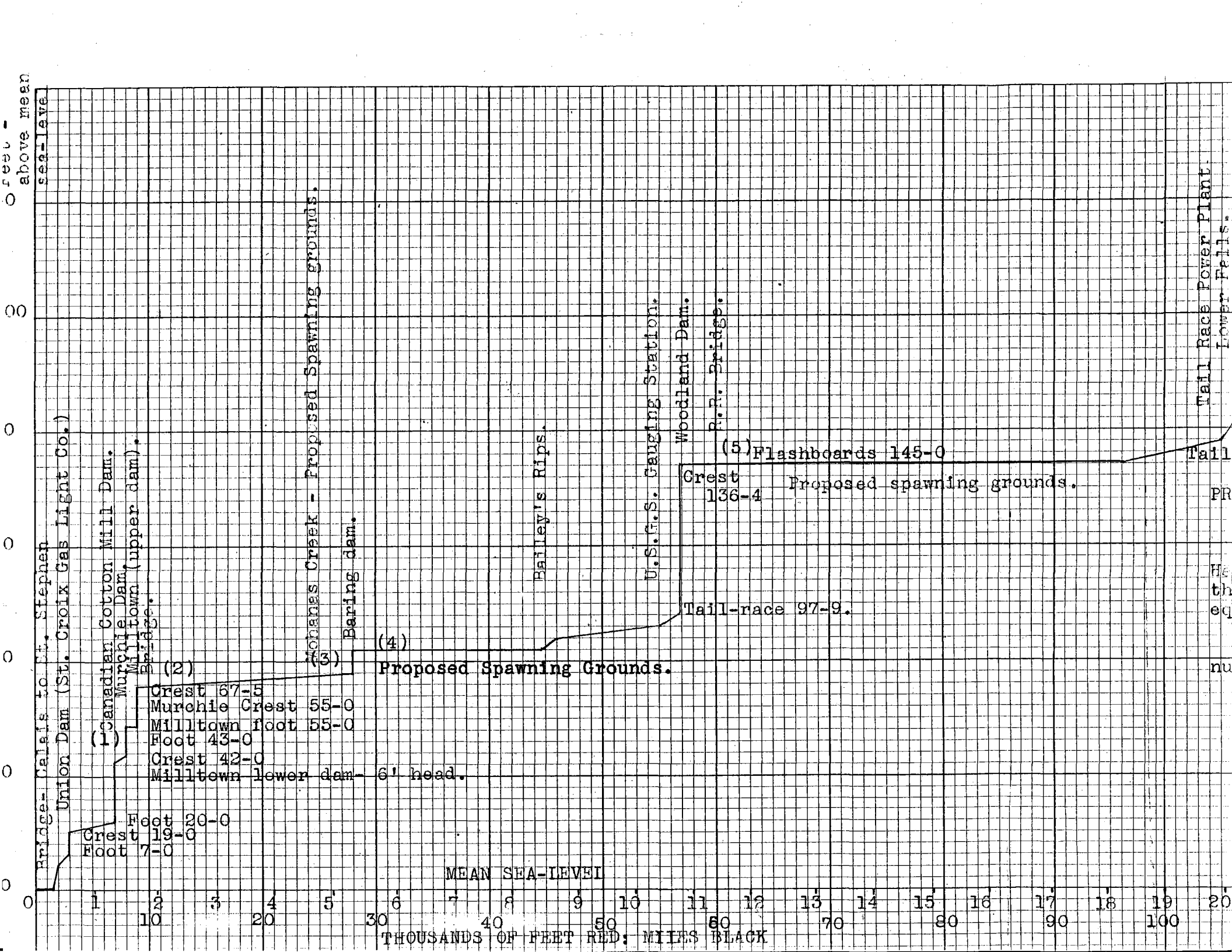
Associated with the oxygen values are the pH values (acidity). The value above station 5, 6.8, is acid already. These fish (salmon) are believed not to be very tolerant of values of much lower pH than 6.8 (greater acidity), so any change in the more acid direction, as does occur below this station (5) is probably definitely detrimental.

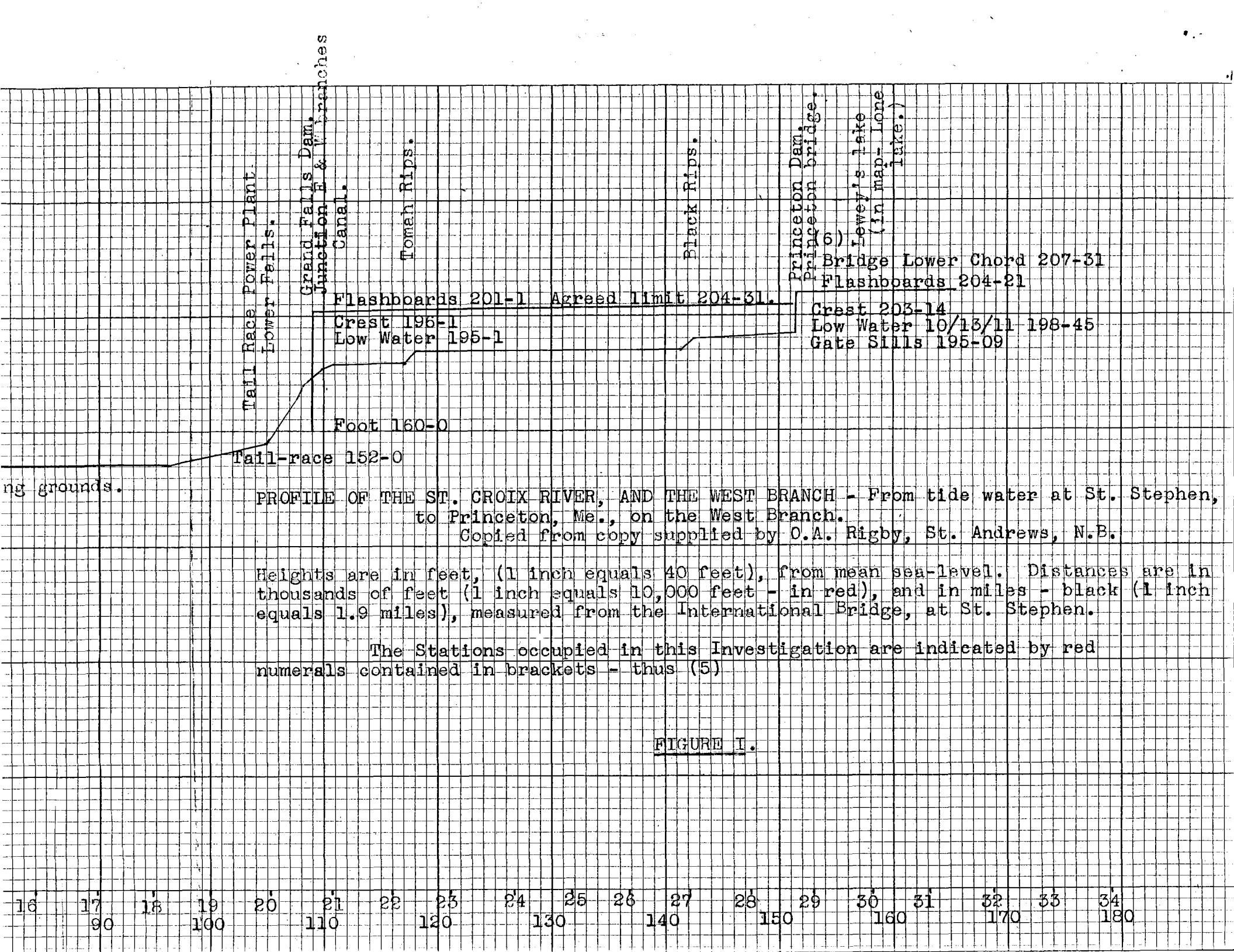
The possibility also exists that the rains referred to above may have affected the run-off even before the investigation could be made, but it was definitely stated that no increase in the level of the river had been observed. Guardian Parks was consulted in this as in the other matters, and this was his opinion. But the possibility does exist that the acidity has been even greater, and the oxygen even lower than the values found. Further, the pulp mill people may have benefited from their exploration, and decreased the degree of pollution, so that the amount now occurring, while apparently great, is less than actually occurred when the salmon deaths were reported.

CONCLUSIONS:

1. The river St. Croix is at the present very low, and is acid for a large part, if not all of its course. It also probably carries, as do the majority of the streams of this district, a heavy load of organic matter (swamp), as most of them are a rich brown like tea. This is often associated with low oxygen values.
2. Between station 4 and 5, evidence indicates the addition to the river of substances which further increase the acidity and decrease the oxygen content.
3. The combination of circumstances, low water, high acidity, low oxygen, all combined with the remarkably high temperatures which have obtained in the early part of the period under consideration, may be fairly ascribed as the causes of the mortality of the salmon.

4. Evidence seems to point to the Woodland Pulp Mill as contributing a part, which in the drought condition of the river, was ample to turn the scale in the unfavourable direction too far, but which in ordinary conditions might not be a serious factor at all.


Feet - above mean sea-level
Bridge- Calais to Ft. Stephen
Union Dam (St. Croix Gas Light Co.)
(1)
Canadian Cotton Mill Dam.
Murchie Dam (upper dam).
Millstown Bridge.
(2)
Crest 67-5
Murchie Crest 55-0
Milltown foot 55-0
Foot 43-0
Crest 42-0
Milltown lower dam- 6' head.
Foot 20-0
Crest 19-0
Foot 7-0
Mohanes Creek - Proposed Spawning grounds.
Baring dam.
(3)
(4)
Proposed Spawning Grounds.
Bailey's Rips.
U.S.G.S. Gauging Station.
Tail-race 97-9.
Woodland Dam.
R.R. Bridge.
(5) Flashboards 145-0
Crest 136-4
Proposed spawning grounds.
Tail Race Power Plant.
Lower Falls.
Tail
PR
MEAN SEA-LEVEL
THOUSANDS OF FEET RED: MILES BLACK



ng grounds.

PROFILE OF THE ST. CROIX RIVER, AND THE WEST BRANCH - From tide water at St. Stephen, to Princeton, Me., on the West Branch.
Copied from copy supplied by O.A. Rigby, St. Andrews, N.B.

Heights are in feet, (1 inch equals 40 feet), from mean sea-level. Distances are in thousands of feet (1 inch equals 10,000 feet - in red), and in miles - black (1 inch equals 1.9 miles), measured from the International Bridge, at St. Stephen.

The Stations occupied in this Investigation are indicated by red numerals contained in brackets - thus (5)

FIGURE I.