



# FISHERIES RESEARCH BOARD OF CANADA

MANUSCRIPT REPORTS OF THE BIOLOGICAL STATIONS

No. 207

Title

ATLANTIC SALMON AND TROUT INVESTIGATIONS 1939

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White, H. C.

ATLANTIC SALMON AND TROUT INVESTIGATION

VOLUME XVII

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1939

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ATLANTIC SALMON AND TROUT INVESTIGATIONS 1939.

Report No. VI.      Meteorology, salinity of estuary, water  
                         control and water levels, Moser River, 1939.  
                         By H. M. Rogers

Meteorological Data, Moser River, 1939

Data on the air temperature, wind direction and intensity and sky were collected from June 7 to August 23, the site being George Kitty Moser's field. The wind intensity and degree of cloudiness were reckoned on the Beaufort scale.

Caution should be exercised in interpreting the data on wind direction. Due to the fact that the estuary extends in a south easterly direction, winds, which on the coast would be south-west, appeared in the estuary as south east winds, blowing up the estuary from the mouth to the head.

The prevailing winds, as recorded at George Kitty Moser's field were south-east. Only two north winds of any appreciable strength were experienced - June 7th and June 18-19th.

## Moser River, 1939

Air Temperature			Wind			Sky		
s.m.	noon	p.m.	s.m.	noon	p.m.	s.m.	noon	p.m.

June

1									
2									
3									
4									
5									
6									
7									
8				NE4	NE4	NE4	10	10	10
9				SE2	SE1		6	10	8
10				SE2	SE1	SE1	3	9	10
11		19.9	12.0	SE1	SE2	SE1	2	3	0
12	20.1	21	12.5	S1	SW1	SW1	8	3	10
13	16	20		S1	S1	S1	10 fog	10 fog	10 fog
14	18	23	23	S1	S3	0	0	0	1
15	17		15	SE1	SE1	SE1	9	10 fog	10 fog
16		warm		very	little	wind	0	0	0
17	16.8			S1	S1	S1	9	10	drizzle
18	13.5		7	NW2	NW3	NW3	1	2	3
19				N3	N4	N3	3	9	8
20	15	18	17	N4	N4	0	0	1	1
21	18	22	+	S2	S2	S2	1	1	7
22	15			N1	N1	N1	10	1	1
23	17	18	18	NW3	NW3	N2	4	2	1
24	17	16	18	N3	N2	0	1	5	5
25	21			0	NW2	N1	8	5	7
26	14			SE1	SE2	SE1	10	10	10
27	17	15		NE2	SE4	SE3	9	10	10
28	9	12	13	E1	E3	E2	10	10	9
29	9	11	6	SE1	SE3	SE2	10	1	0
30	11	14		SE2	SE2	SE1	0	0	10 fog
	10	14	14	SE1	SE2	SE1	10	10	10 fog

July

1	13	15	15	SE1	SE2	SE1	10	10	10
2	12	16	14	S1	S1	S1	10	10	10
3	11	14	13	SE1	SE1	SE1	10	9	10
4	17	20	22	N2	N4		10	7	
5	22			SE1	SE1	SE1	1	1	1
6	18	19	18	SE1	SE2	SE1	1	1	1
7	21	22	20	SE1	SE1	SE1	1	0	0
8	20	24	16	SE1	SE2	SE1	1	1	10
9	20	23	17	SE1	SE3	SE2	5	3	2
10	18	17		S2	SE3		6	10	
11	15	18	17	SE1	SE2	SE1	10	10	10
12	14	20	15	SE1	SE2	SE1	10	5	10
13	16	19	17	SE1	SE1	SE1	10	5	10

## Moser River, 1939

	Air Temperature			Wind			Sky		
	s.m.	noon	p.m.	s.m.	noon	p.m.	s.m.	noon	p.m.

## July

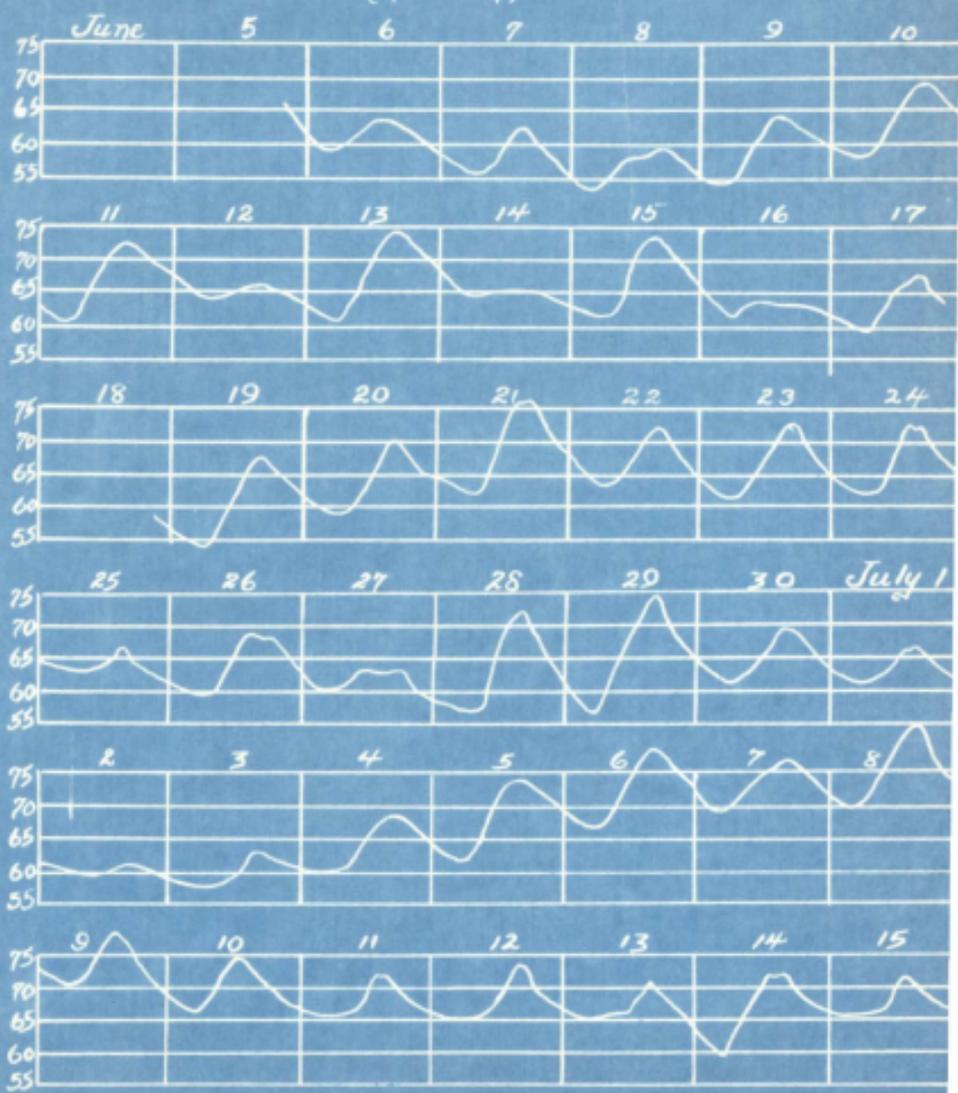
14	18	20	15	SW1	SW3	SW2	10	10	10
15	17	18	16	SE2	S3	S2	10 fog	10	10
16	14	16	15	SE1	SE1	SE1	10 fog	10	10
17	16	19	15	0	SW2	S2	0	1	10
18	16	19		S2	S2		9	7	
19									
20	17	20	16	SE1	SE2	SE1	9	10	10
21	15	19	17	N1	N3	N2	8	3	4
22	16	20	18	NW1	NW2	NW1	7	6	4
23	22	24	20	0	0	0	4	3	4
24	19	23	17	0	N2	N1	9	10	10
25	22	30	27	N1	N1	0	0	0	0
26	20	29	26	SE1	SE1	0	2	1	0
27	18	19	17	SE1	SE1	SE1	10	10	10
28	19								
29	21	23	19	S1	S2	S1	10	8	6
30	20	22	18	SE1	SE1	0	10	10	10
31	21	22	17	0	SE1	0	10	8	6

## August

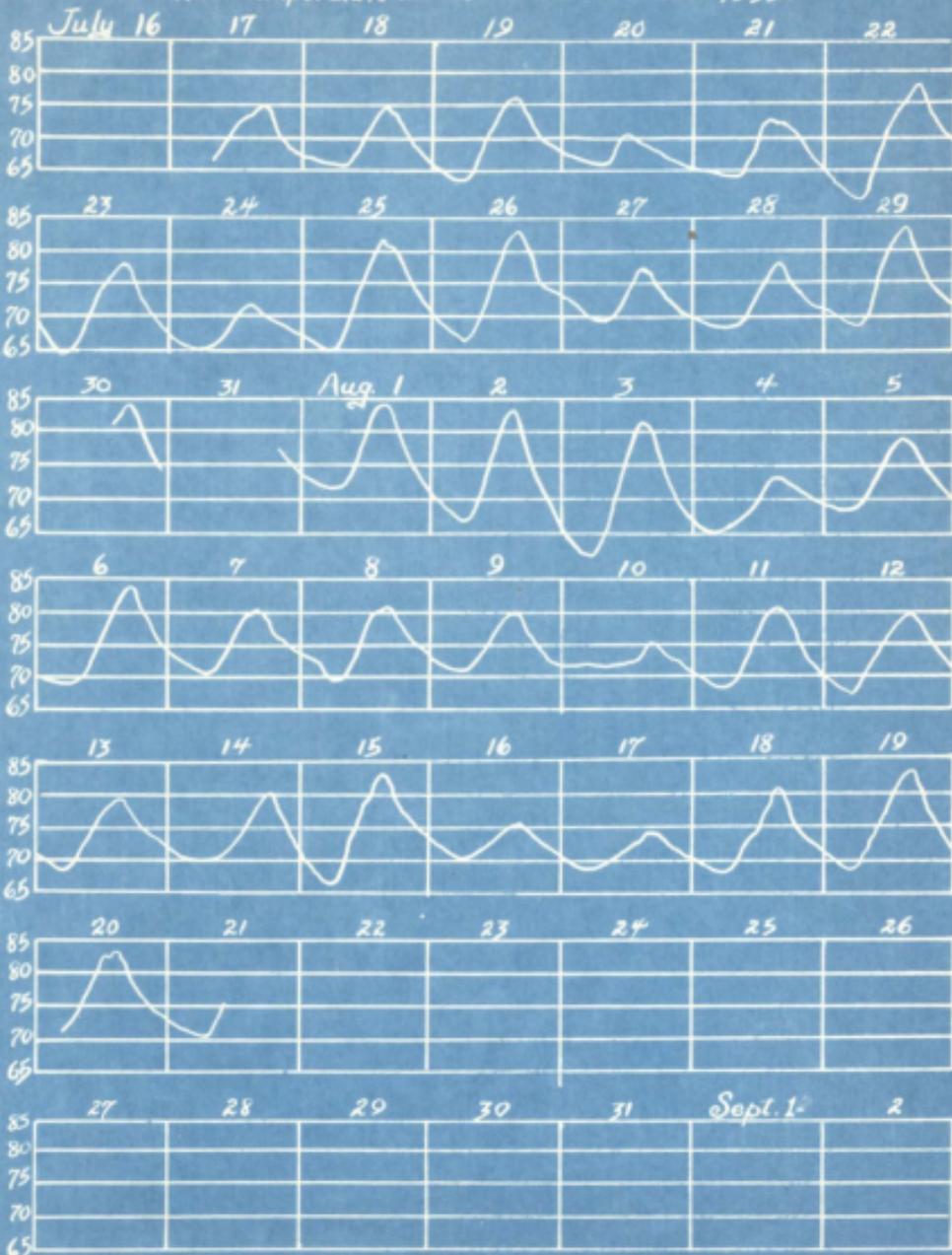
1	17	21	20	SE1	SE2	0	3	4	3
2	20	23	22	NW2	NW3	0	0	2	1
3	14	21	18	NW2	NW3	SW3	4	4	3
4	19	23	21	SW3	SW3	SW1	10	10	10
5	18	22	20	SE2	SE3	SE1	10	10	10
6	22	25		0	SE2		1	3	
7	18	22	20	SE1	S2	SE1	10	10	10
8	19	30	28	0	N1	SW1	1	1	3
9	22	23	22	0	S1	0	3	2	10
10	20	23	21	SW1	SW1	SW1	10	8	9
11	21	hot	23	N1		0	0		2
12	21	24	22	0	SE1	SE1	3	6	5
13	19	23	21	SW1	SW3	SW2	1	2	3
14	20	23	20	SE1	SE1	0	2	3	0
15	17	20	18	S1	S2	SE1	0	2	10
16	19	20		S1	S1		10	10	10
17	20	22	19	SW1	SW1	0	10	10	10
18	20	23	20	S1	SW2	N1	10	2	4
19	22	26	23	SW1	SW1	0	3	1	2
20	21	24	21	S1	S1	S1	4	4	2
21	20	22		0	SE1		10	10	10
22	20	23			S1		10	10	
23	24			SW1			10		

Water Temperature  
 Moser River - 1939  
 (At the trap)

Fahrenheit



Water Temperature (cont'd) — Moser River — 1939.



### Salinity in the estuary of the Moser river.

On August 18/39, a survey was made for salinity beginning at George Kitty Moser's slip and working out toward the mouth of the estuary. Tide had been flooding for about one-half hour when the survey began (about 4.30 p.m.). It was completed at 6 p.m. The drop method was used for determining salinity. The figures are given in the accompanying diagram.

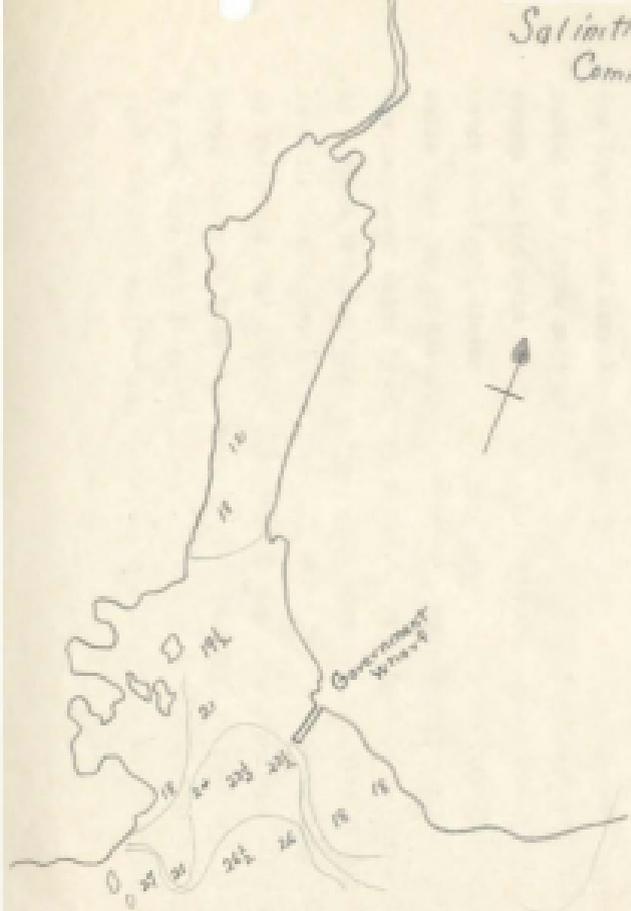
### Water control.

As part of the program of water control, the two outlets to Mill lake were dammed by wooden structures in the form of movable gates placed in position on June 14 and 15. The terrain between the two outlets consisted of peat which came there as floating islands. A considerable seepage of water was apparent under this material. As much of the leak was stopped as was possible.

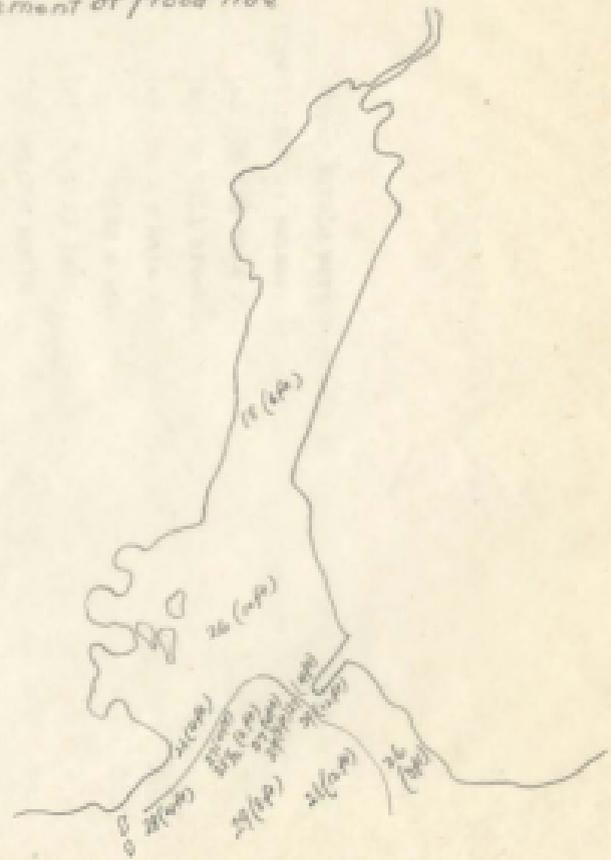
The mouth of the dam on the north branch was made 12 feet wide, that on the south outlet, ten feet. Each dam consisted of a sill of one inch boards, 4 feet wide upon which were mounted the gates which sloped back at a 60° angle. The gates were placed on the upstream side of the sill in order that the overflow would fall on the sill and not the gravel behind, where it would tend to undermine the dam.

The gates in each dam were made in three equal sections and consisted of two inch planks laid horizontally, and kept in position by water pressure.

Salinities Moser River 1929  
Commencement of flood tide



Surface Salinity  
Aug 18/29 Commencement  
of flood tide



Depth salinity  
Aug 18/29 Commencement  
of flood tide

11 The accompanying diagram illustrates the construction of the dam.

#### Water Level.

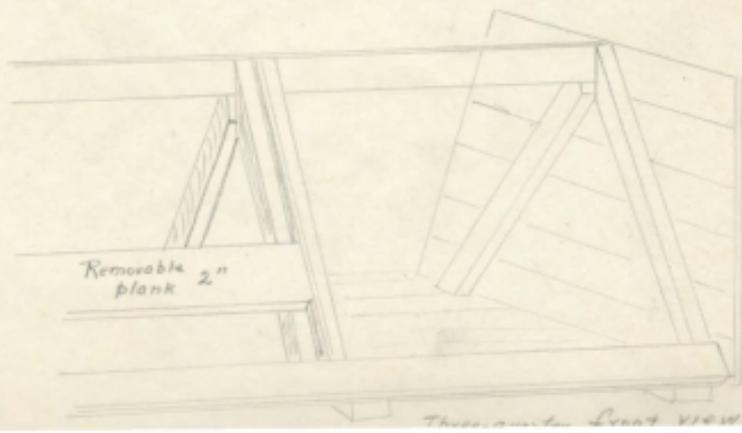
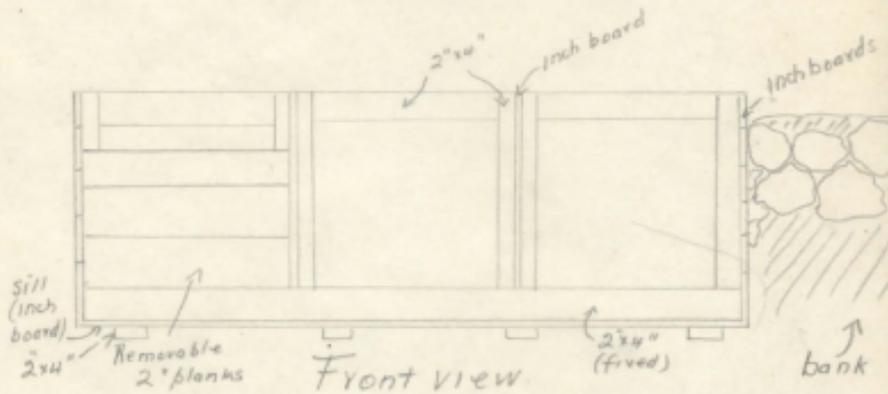
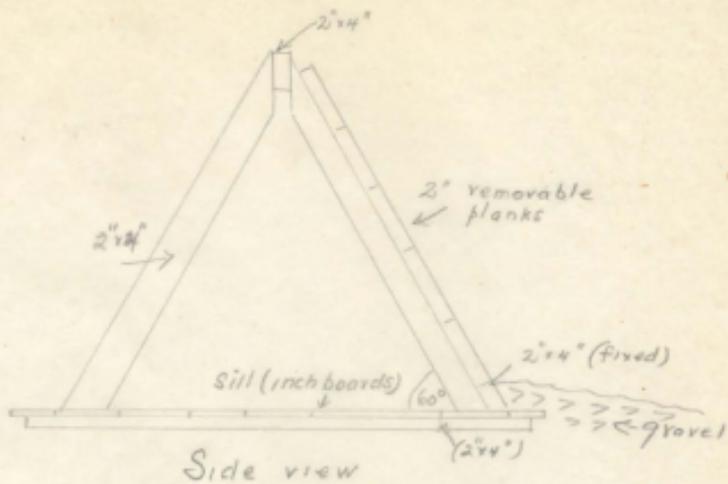
Water levels were recorded in the Moser river investigation at five different points, by hydrographs.

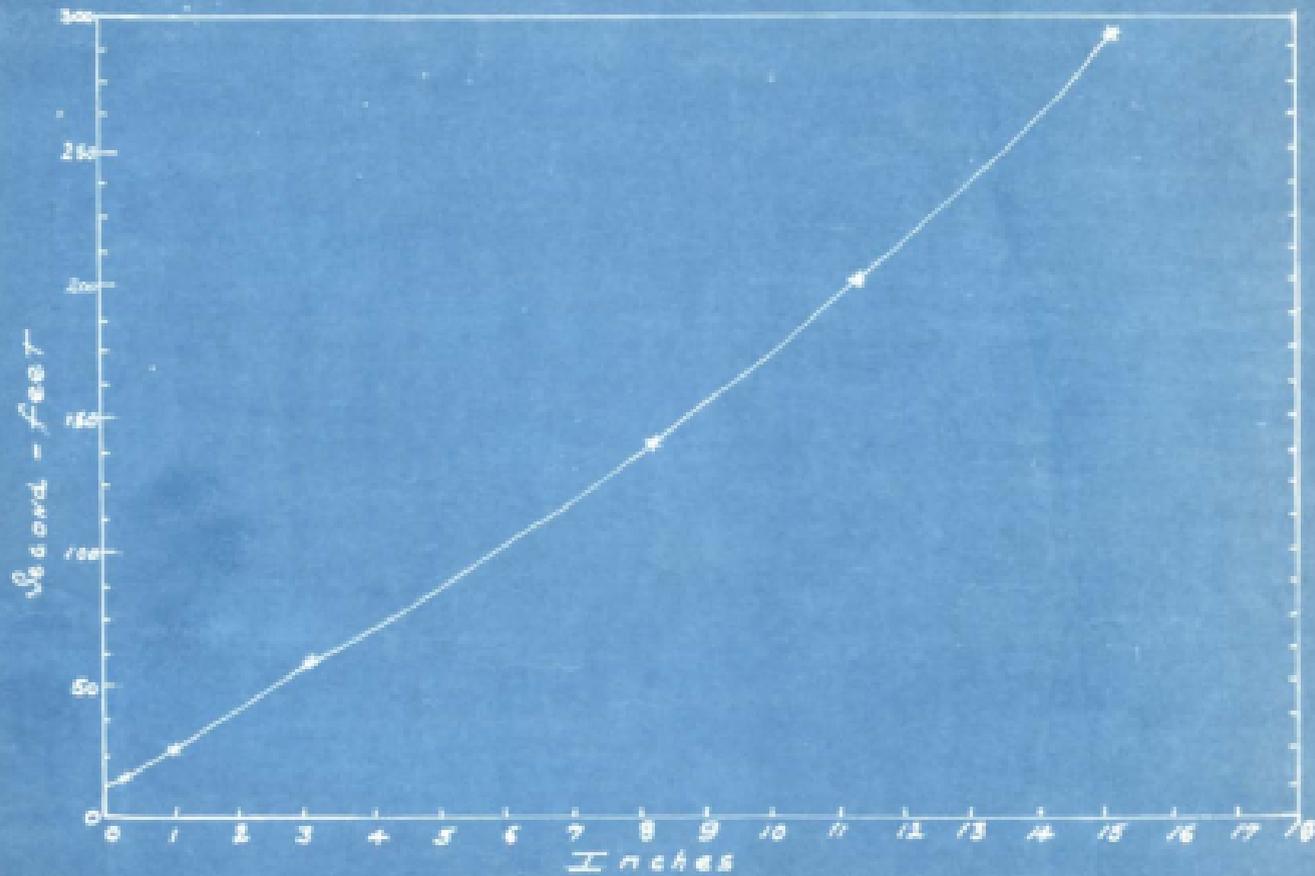
- (a) On the main river at the salmon trap.
- (b) On Mill brook at the bridge.
- (c) On the main river just above the highway bridge (this being a combination of the above two).
- (d) On Mill lake.
- (e) At the mouth of west Branch (flowing into Mill lake).

The continuous records are included in this report.

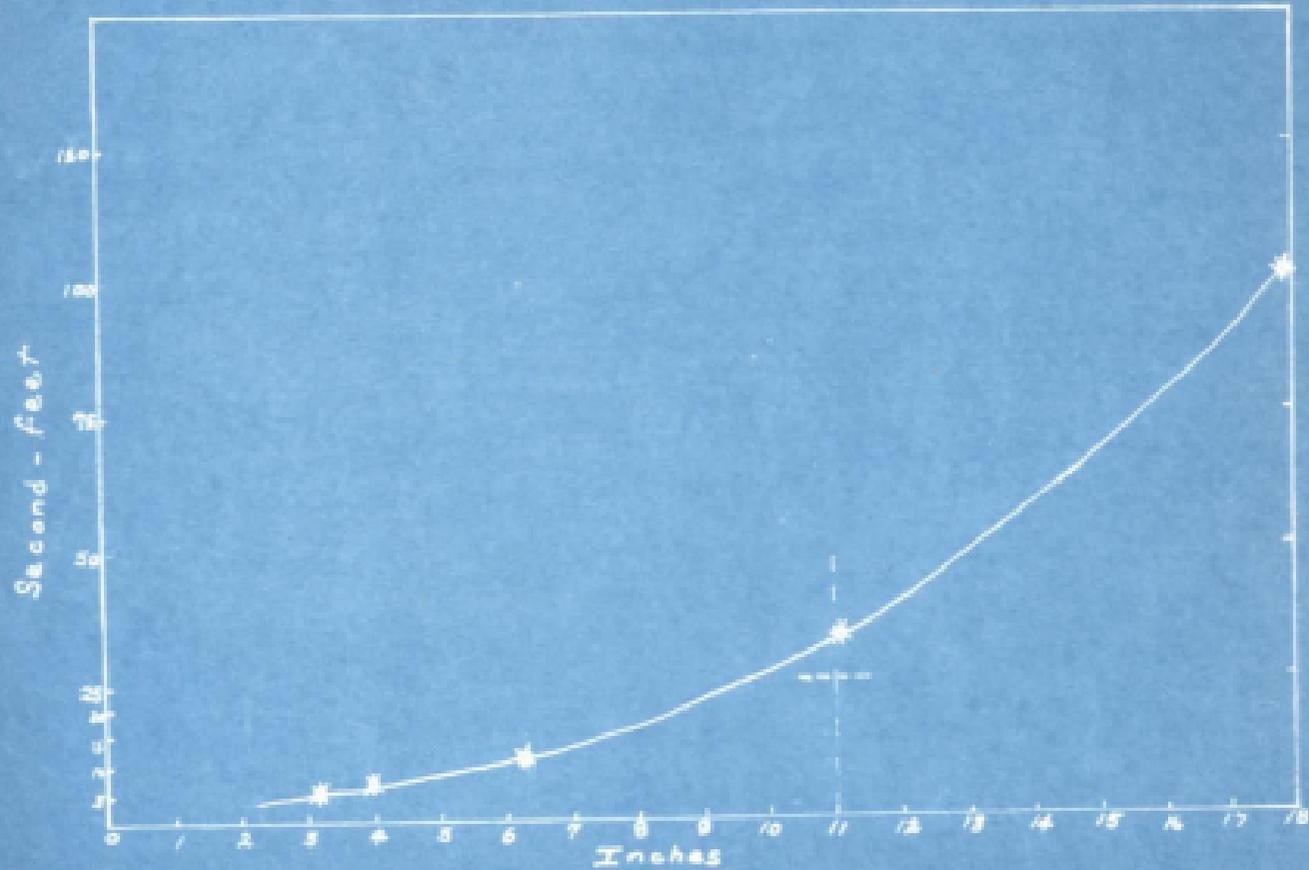
The water level in the river, Mill lake and the streams emptying into it was very low for the greater part of the summer, especially during the latter part of the season, and as a consequence, the discharge in the main river was small. From the accompanying graphs of water level and discharge in second-feet, the discharge for any particular time may be calculated. The figures marking the "inches" on the graphs of water level and discharge are those on the gauge used as a check for the thermograph. The vertical position of the figures is but an arbitrary one - that is, zero does not indicate the bottom of the river, but a level below which the water would probably not drop. In order that the water levels from year to year may be compared, a reference mark in green paint was placed on the highway bridge, with the figure "36" indicating the mark to be 36 inches above the level of zero on the hydrograph at the old mill dam just above the

# Mill Lake Dam.





Discharge - Main River (above bridge)

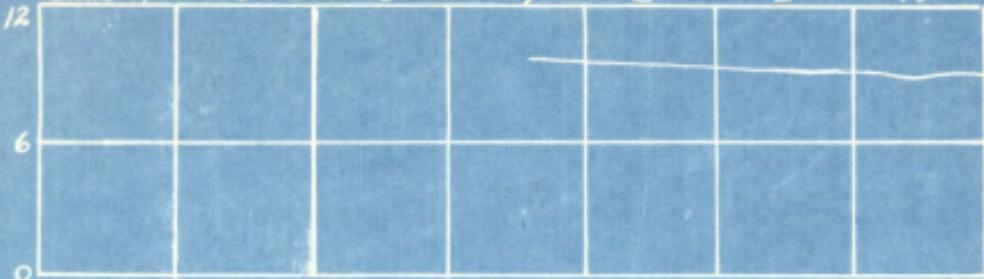


*Discharge - Mill Brook*

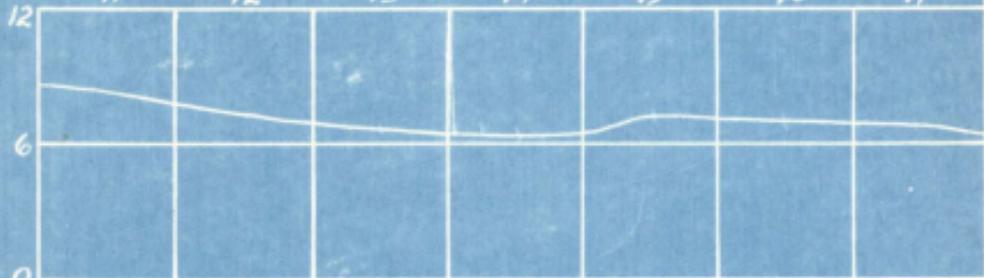
Water Level - Moser River - 1939.

At the trap.

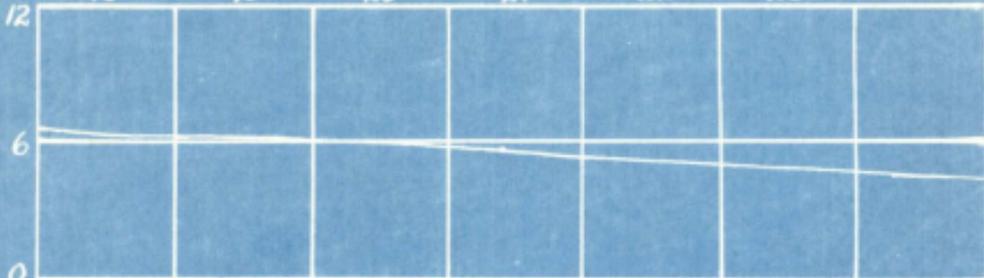
June 4 5 6 7 8 9 10



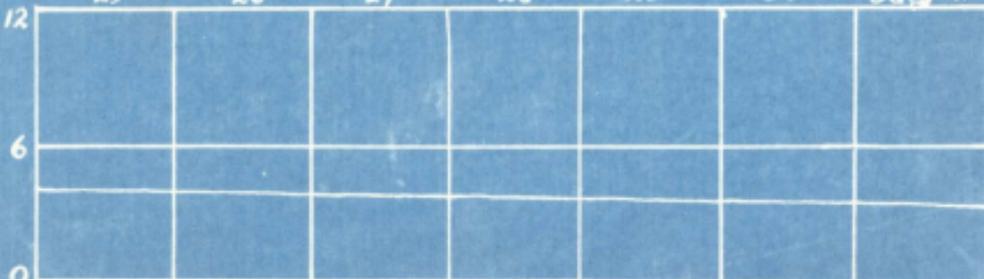
11 12 13 14 15 16 17



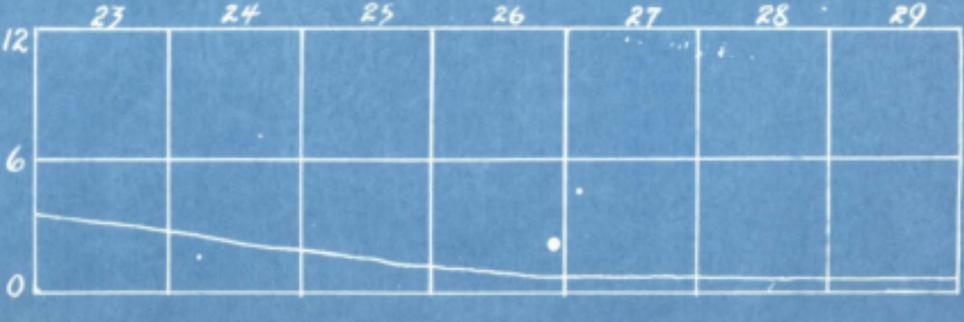
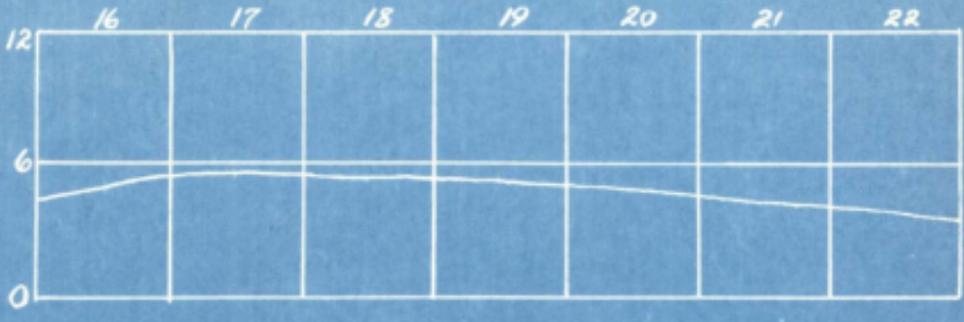
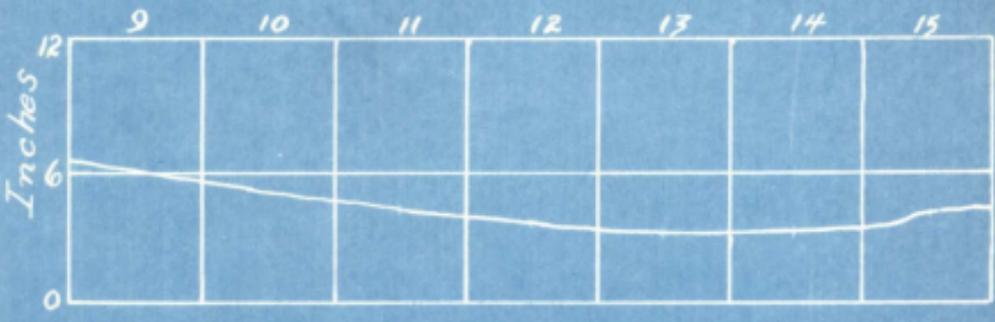
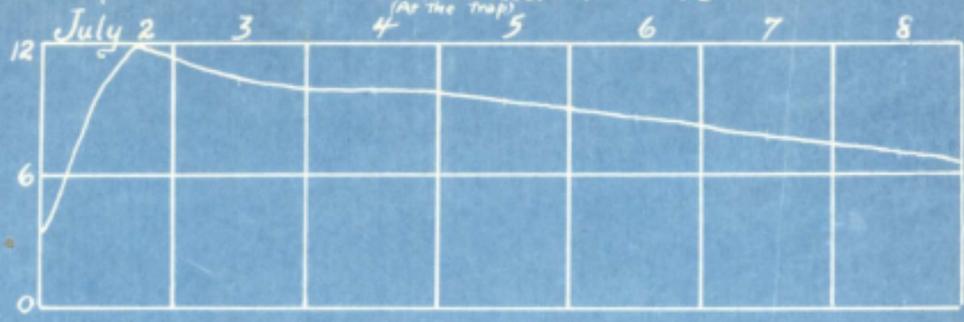
18 19 20 21 22 23 24



25 26 27 28 29 30 July 1

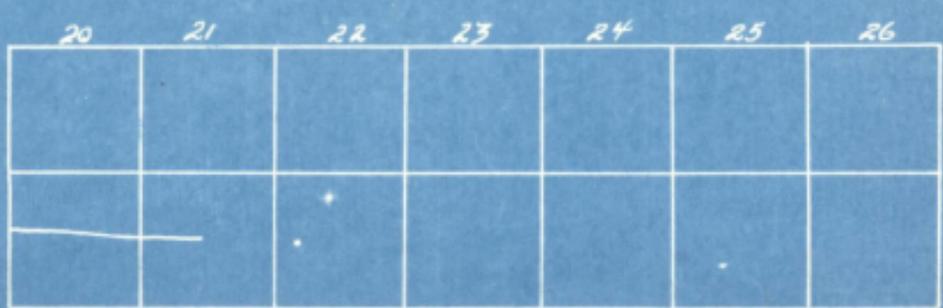
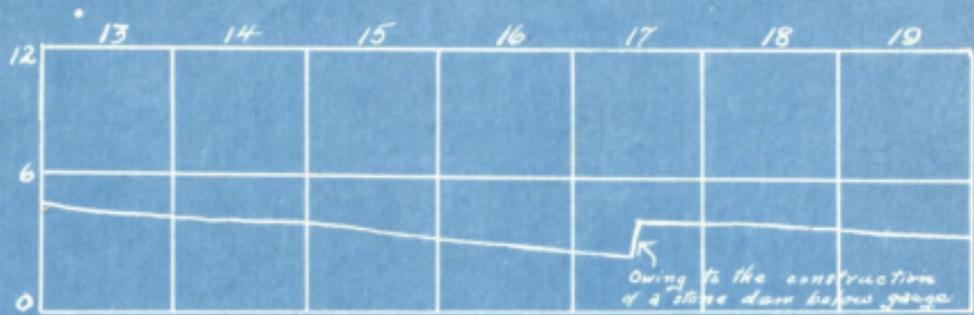
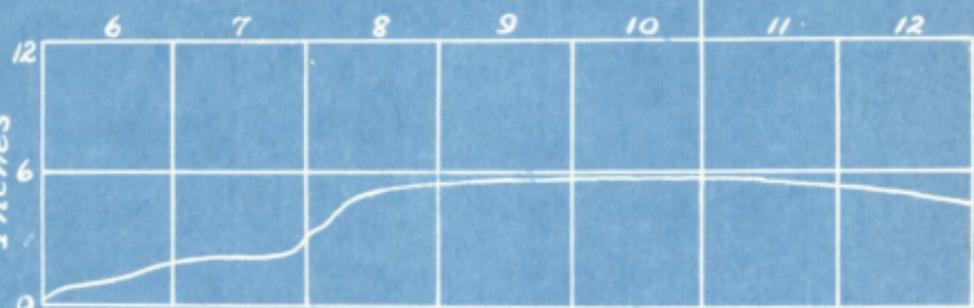
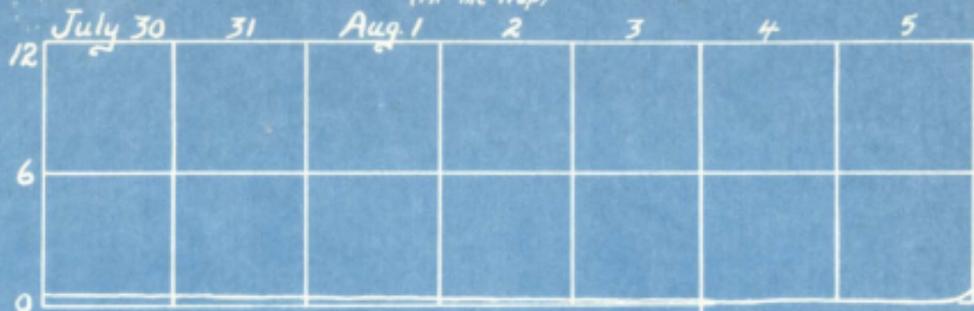


Water Level - Moser River - 1939  
(At the Trap)



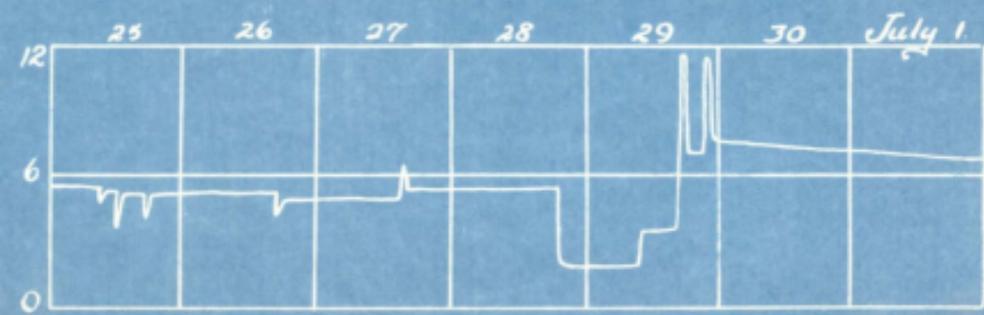
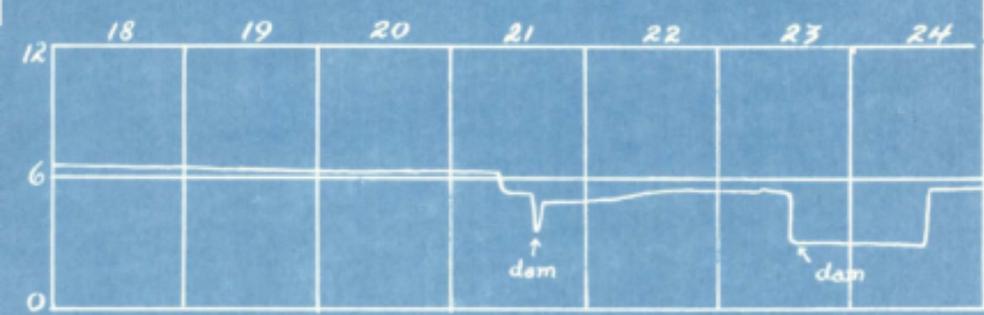
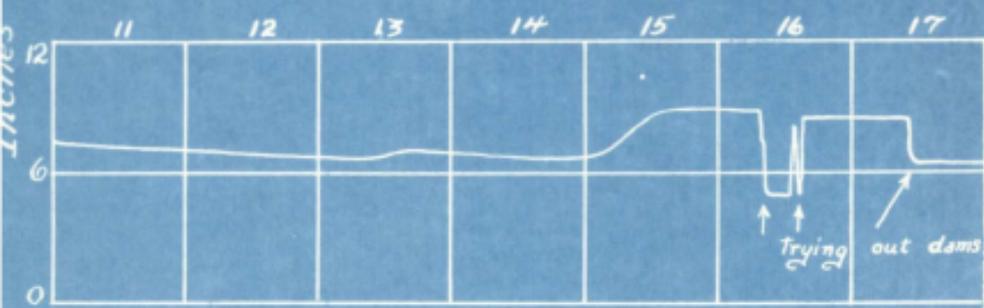
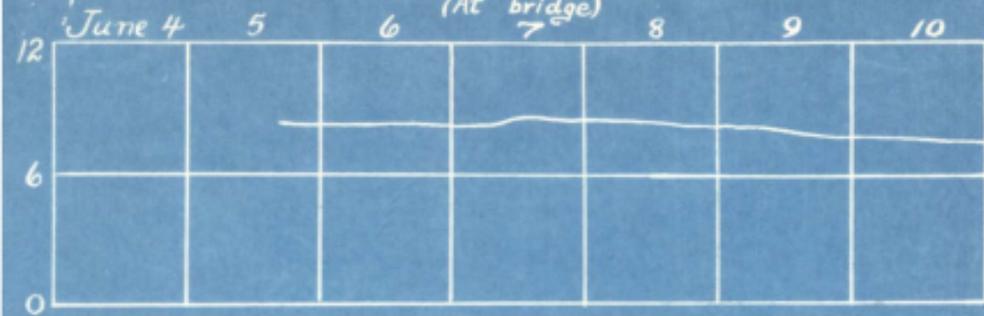
# Water Level - Moser River - 1939

(At the trap)

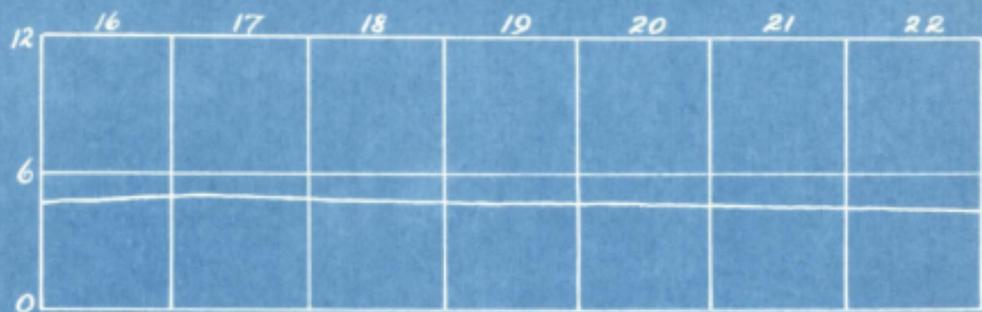
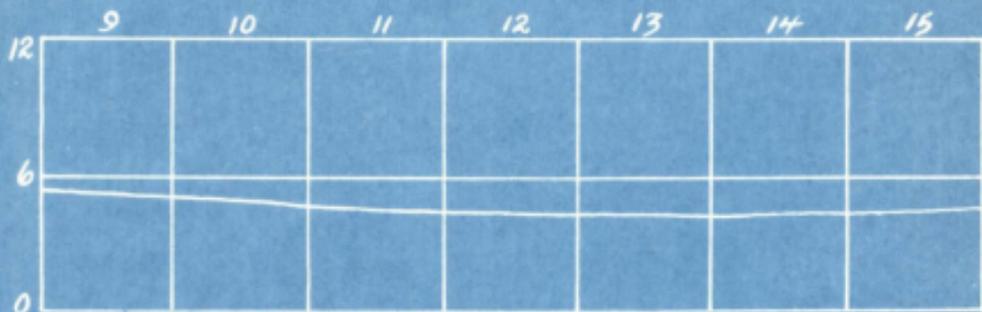
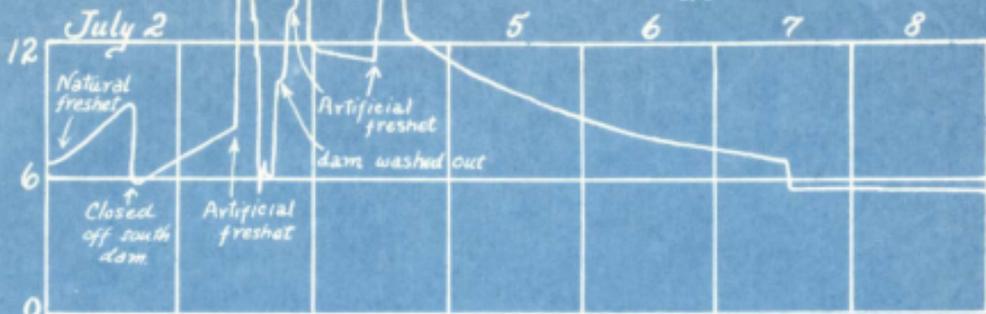


# Water Level - Mill Brook - 1939

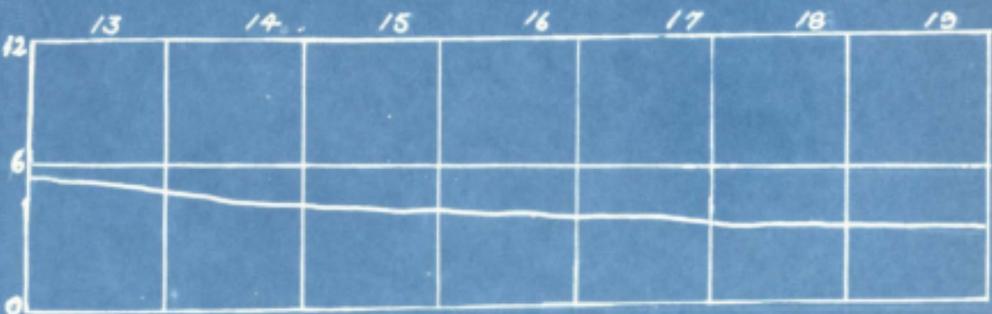
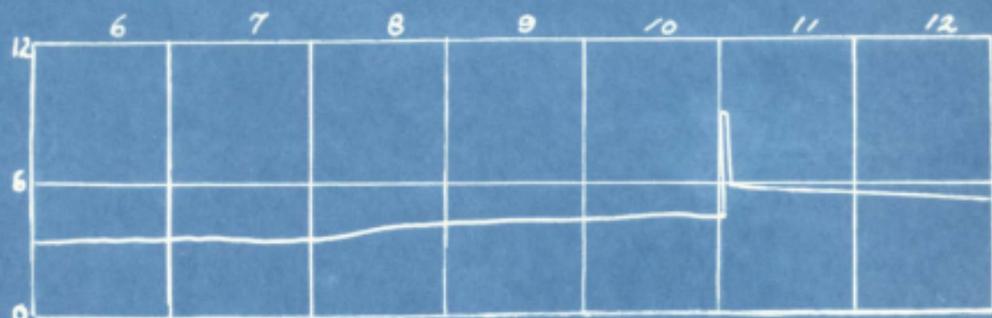
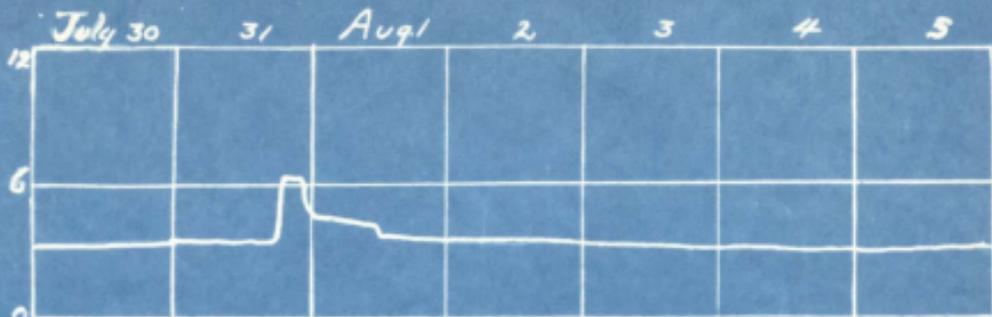
(At bridge)



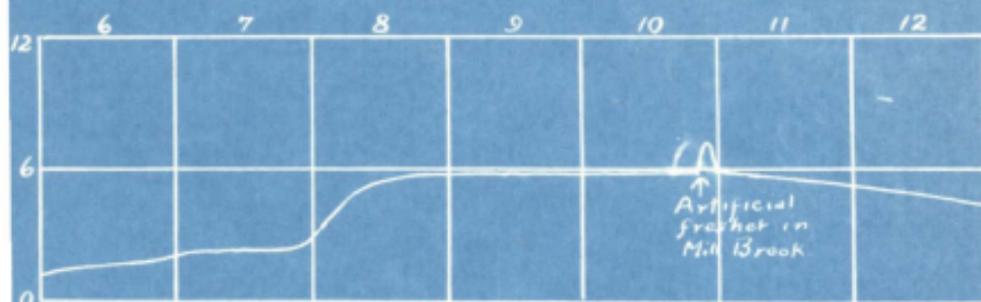
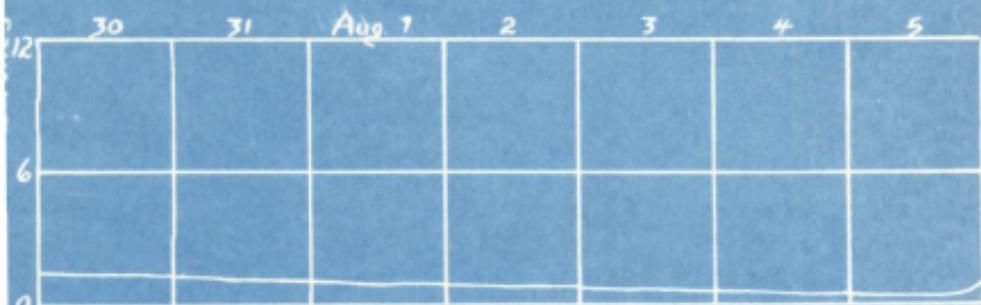
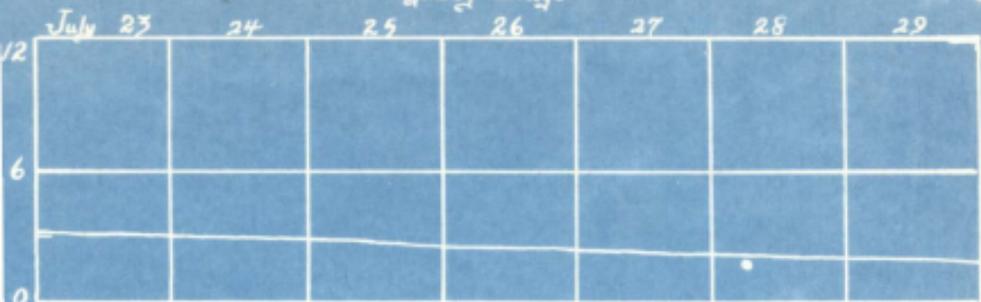
Water level - Mill Brook - 1939  
(At bridge)



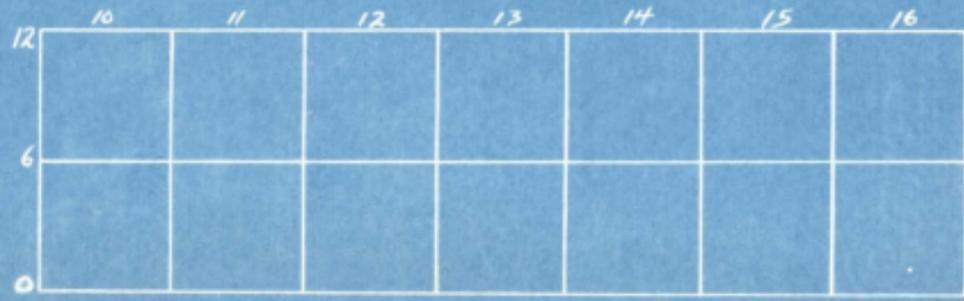
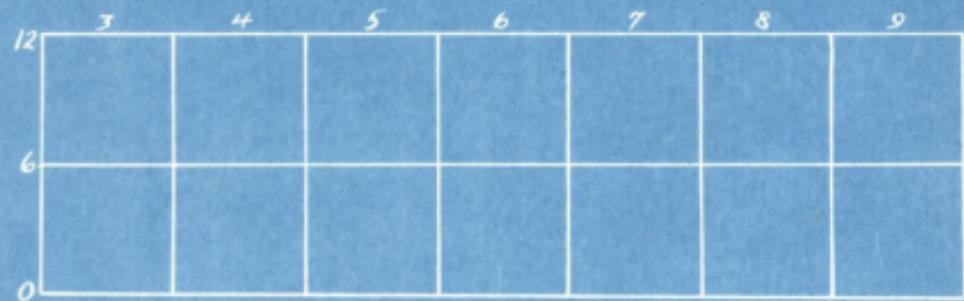
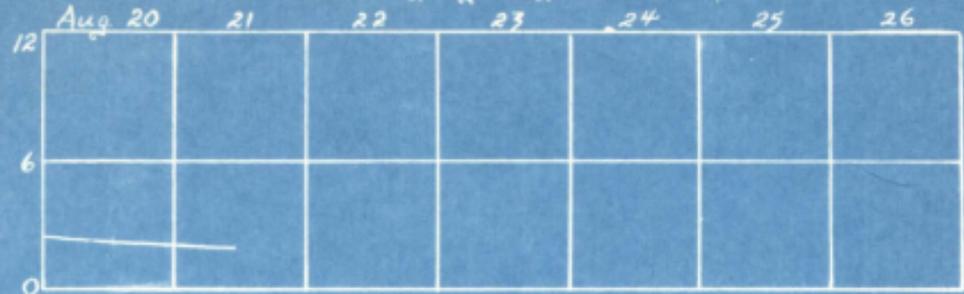
# Mill Brook (at Bridge)



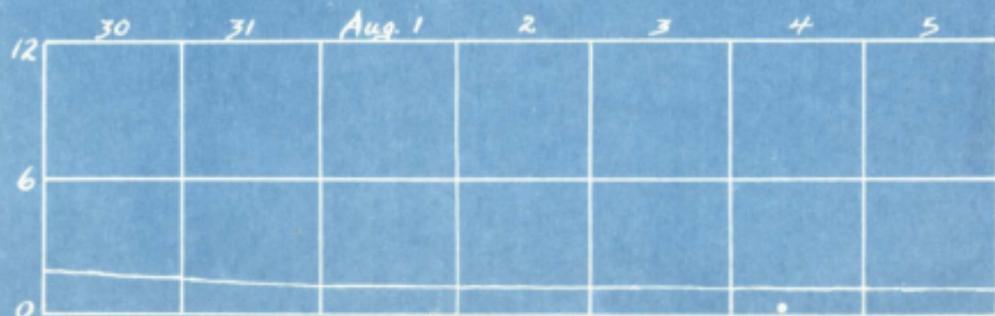
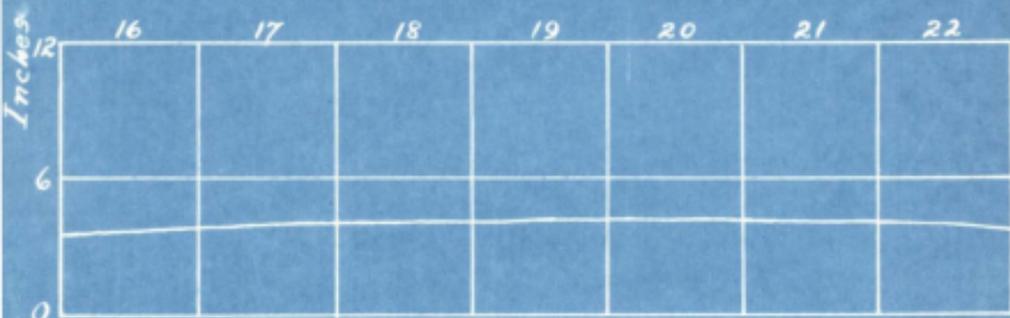
Water level - Moser River - 1939  
At highway bridge



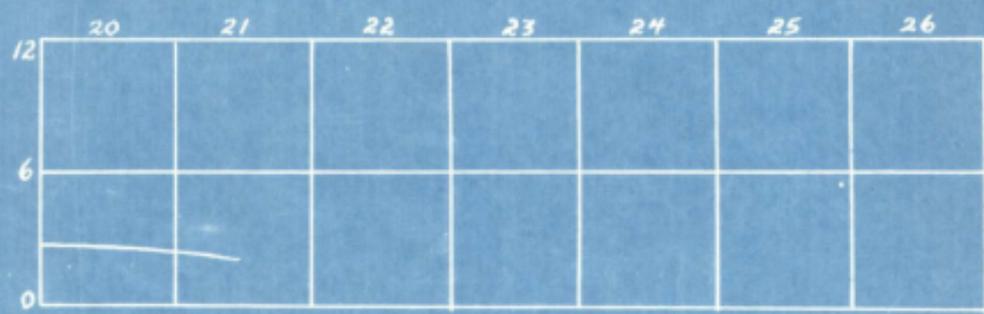
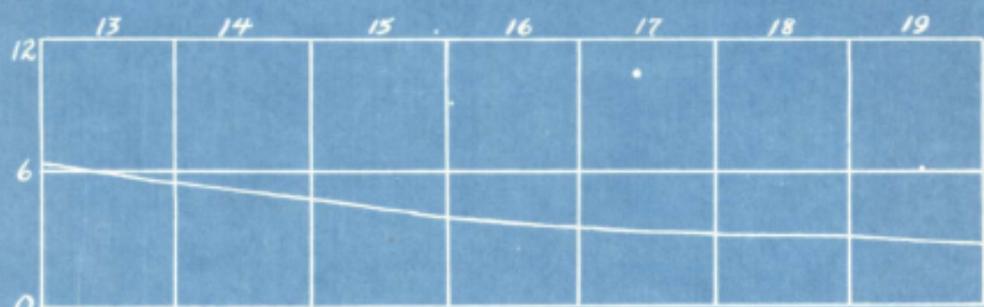
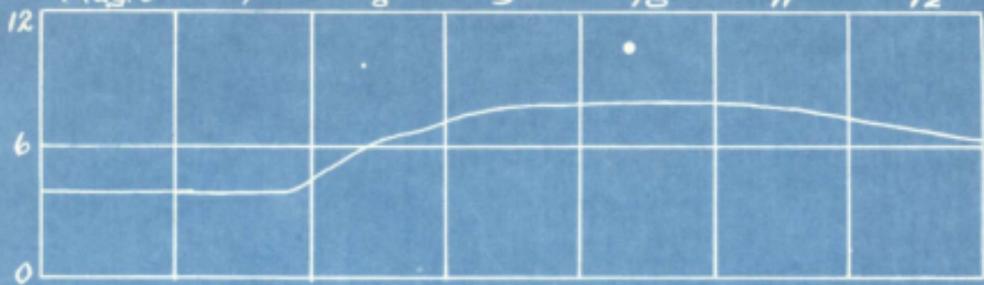
Water Level - Moser River - 1939  
At highway bridge



# Water level - Mill Lake - 1939

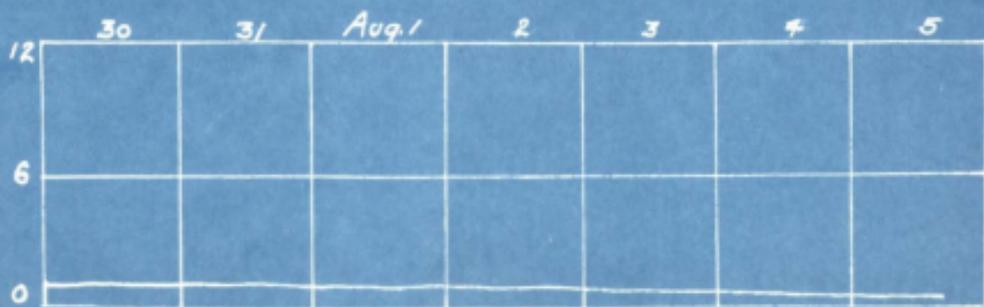
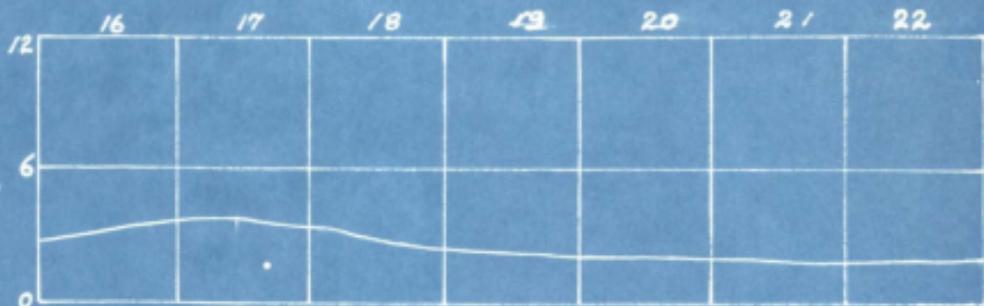
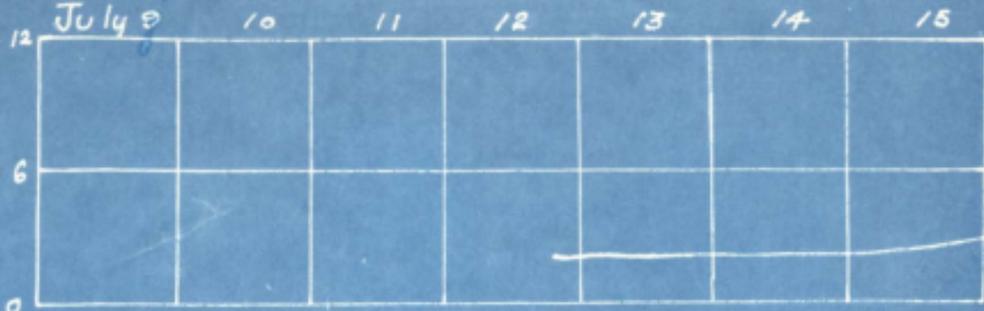


Aug. 6 7 Water Level - Mill Lake - 1939 8 9 10 11 12

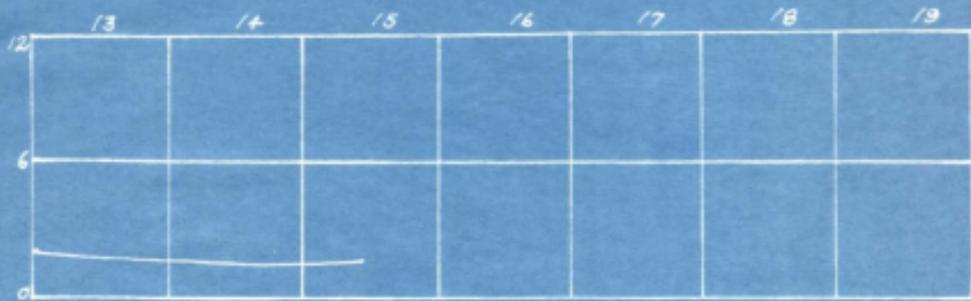
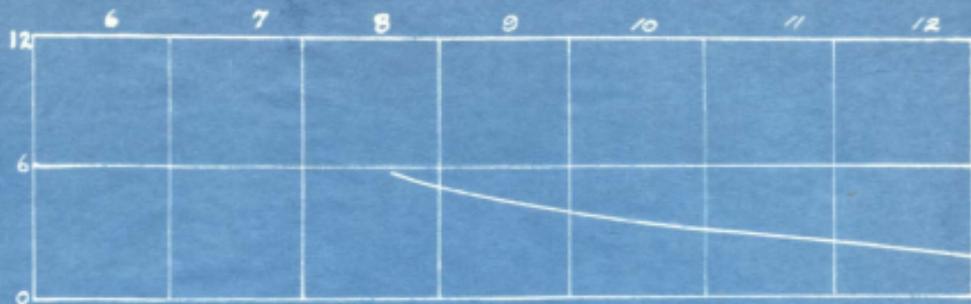


# West Branch

Sunday  
July 9



West Branch



Inches



## Report No. VII, AUGUST SURVEY OF BIRDS ON THE MARGAREE RIVER

By H. C. White

On August the 23rd and 24th, we attempted to assess the abundance of fish-eating birds on the North East Margaree. Incidental to this survey we noted also the abundance of young salmon and trout.

Since in the limited time at our disposal it was impossible to examine the entire river we made personal examinations of sections of the river from the estuary to the lower part of the gorge above the head of settlement and also some of the tributary streams. Our personal observations were supplemented with inquiries (concerning the abundance of birds) of reputable disinterested parties who had angled recently along other parts of the river.

Along the estuarial part of the stream haymaking was in progress and any mergansers there would have been frightened away. None were seen in this area. The estuarial part had not in previous years supported a large population of kingfishers but several were seen along this part. On the North East branch, in the region of Doyle's bridge, which place was in former years frequented by mergansers, neither kingfishers nor mergansers were seen.

In the region of Garden and Wash pools one kingfisher was seen but no mergansers. However, an angler who had just returned from fishing above Garden pool said that he had seen a large flock of young mergansers. Two anglers interviewed at North East Margaree who had fished from Granton's bridge to Hart pool said that they had seen two flocks of young mergansers.

At Long Intervale above Black Rock pool, I saw a female merganser and about ten half-grown young. There were merganser

manure splashes on their favourite roosting rocks in this area. In this section I saw also four kingfishers.

Special attention was given to Forest Glen brook, where last year I concluded the bird-control experiment. In the favourite resort of kingfishers on this stream two kingfishers were seen, but no mergansers were found nor were any manure splashes evident on their roosting rocks. Angus Stewart, who goes up this stream daily for his cattle, said that he had seen no mergansers there this past summer, but that recently he had seen several "cranes" (Great Blue heron) in the intervale part of this brook. We shot herons there in 1937.

Above Forest Glen brook and up the gorge of the North East branch I examined the river to a point a short distance above First Forks brook. I observed two kingfishers in that area (A local resident has been killing a large number of kingfishers in this vicinity. He killed two the day before my arrival). Marcel Murray and John MacKinnon had severally made recent trips up the gorge as far as Three Brooks. MacKinnon reported seeing one merganser and also some "cranes" and kingfishers. Murray said that he had seen two broods of mergansers and "a lot of kingfishers and cranes."

We made observations on Hatchery brook at several points above the hatchery but saw no fish-eating birds. Superintendent Turnbull stated that lately they had killed some kingfishers around the hatchery ponds, but there were not as many as in former years. He said that there were no mergansers around the stream this summer.

We found young salmon and trout abundant in Forest Glen brook, but apparently somewhat below the numbers which were there last year. In the gorge on the river young fish were plentiful and

Murray and MacKinnon said that there were many all the way up the gorge.

At Long Intervale, young fish appeared to be fairly scarce. Anglers interviewed said that young fish were plentiful in other parts of the river.

When we left the Margaree last year at the conclusion of the bird-control experiment, fish-eating birds over a large part of the stream were very scarce and coincident with that condition there was an abundance of young salmon and trout. The birds present on the river at this writing are capable of greatly reducing the stock of young salmon and trout, and if allowed to reproduce another year could easily reduce the stock of young fishes to the low level which we found there in 1935. Moreover, there are at present large flocks of mergansers feeding along the coast some miles west of the Margaree river, and should these ascend the river even for a short period they would consume large numbers of young fish.

In view of our work there in the past years and our recent observations we consider it of utmost importance that a special effort should be made to eliminate the fish-eating birds and preserve the valuable young salmon and trout which are now in the river.

H. C. White,

Moser River, N. S.

Sept. 1, 1939.

ATLANTIC SALMON AND TROUT INVESTIGATIONS

1939

Report No. VIII. Mortality of salmon at high temperatures.

By A. G. Huntsman.

The local Inspector of Fisheries, E. G. Beaver, stated in 1938 that salmon had died in Moser river during the dry summer of 1937. In 1939 quite a number of salmon died on August 6 and during the following fortnight. In 1937 they were found dead from the head of tide as far up as the Beaver hole. In 1939 they were found dead from the head of the estuary (at low tide), where the Drillic salmon net is operated early in the season, as far up as Rocky island. (figure 1).

On August 24, 1939, I was able to follow a more limited mortality and obtain data that might assist toward explanation. For five previous days the fish trap, situated five-eighths<sup>h</sup> of a mile above the head of tide, had failed to reveal any movement of salmon, although some were known to be in pools just below the trap and also near the highway bridge just above the head of tide.

Some of the resident boys and men had come to expect from their experience in other times when salmon died that salmon in evidence in the pools near the highway bridge were likely to die and so were fair game. On August 23 and possibly also on the previous day, salmon were in evidence there at mid-day and were being stoned, although there is nothing to show that any were



Fig. 1. Lower part of Moser river, where Salmon died in 1857 and 1858, showing temperature (°C) observed between 11:00 and 5:00 p.m. on Aug. 25, 1886, going upstream and (in brackets) returning.

secured. Shortly after noon on August 24, these stoning operations again began and became more intense than previously, some individuals even entering the water to secure the fish or drive them ashore. At 3.30 p.m. the first fish was secured, it having turned on its back, and being in the stream below the bridge. It was a two-sea-year fish, 71 cm. long and without any signs of injury. At various times subsequently until about 5.30 p.m. there were taken from the water from the head of tide upstream about three-eighths<sup>h</sup> of a mile six one-sea-year salmon or grilse, from 52 to 56 cm. long and from 2½ to 3 lb. in weight. All seven fish were females. Three of them were badly marked around the occipital region, with epithelium removed and in one case some of the muscle of the back showing. One had some of the epithelium near the anal fin gone. These marks were clearly evidence of the action of Lepeophtheirus salmonis, but no copepods were to be seen either on the skin or on the gills of any of the fish that died or of any of the others that were closely observed when in shallow water near the shore. The absence of copepods was evidence that the salmon had not recently entered the river. One of the grilse that died at the bridge bore a tag, which showed that it had been up to the trap on July 4, and had, therefore, presumably been at least 51 days in the river.

The local Guardian, Raymond Drillo, had soon stopped the boys and men from molesting the salmon, but they watched carefully for them to show sufficient evidence of dying to warrant taking them from the water. One was found upstream, beginning to be eaten by gulls, and one down stream that was in rigor mortis and, therefore, dead for some time.

Examination of the river near the highway bridge showed that from five to seven grilse were in a shallow side arm of the river below the bridge on the west side, and three in another small side arm above the bridge on the west side. In <sup>no</sup> other place were any seen congregated. Some were so far into shallow water that not only the upper part of the caudal fin and all the dorsal fin, but also part of the back from the head to behind the dorsal fin was exposed. The individuals farthest in and that later died, remained quiet, breathing very rapidly (120 to 140 respirations per minute). They seemed quite insensitive to light, not only as shown by their coming and resting in such shallow water, but also by not reacting to moving shadows as one moved one's body or arms near them. The more vigorous reacted to moving shadows, leaving the side arm for deeper water, but invariably returned while the water continued very warm. There was some evidence that individuals recovered somewhat in the side arms and swam out to return almost immediately. At 4.20 p.m. temperatures were taken, and it was found that while the running water of the river was from 30.4 to 30.6°C. the side arm above the bridge was only 29.7° at its head and the side arm below the bridge only 28°, in each case where the fish were congregated. Later observations showed that the latter side arm ranged in temperature from 26.1 at its head to 28.8° at its mouth. The coolness of the side arms was quite evidently due to the entrance of spring water, probably from the gravel bed of the river present on that side.

Salmon parr were also congregated in each of the side arms as well as one fry of the year. They were more active than the

adult salmon and remained farther out in the arm. Mr. A. C. Nicol in examining the river up as far as the trap saw both parr and fry in shallow water near shore on the west side for some distance down from the mouth of Mill brook. This was doubtless because the water from Mill brook is not so warm during the heat of the day as the river water.

One grilse was observed to ascend the rapids above the bridge about 4 p.m. By 5 p.m. one had entered the trap together with 29 parr as counted by Mr. Nicol at 9 p.m. Another grilse entered the trap during the following night.

The course of the water temperature near the trap from August 20 to 27 is shown in figure 2. It was exceptionally high on August 24, rising quite rapidly to a maximum of 30.5° at 1 p.m. The mortality occurred on the day of highest temperature and followed the attainment of the high temperature. As the temperature fell in the late afternoon, first the parr and then the grilse left the side arms and the mortality ceased with only two of the ten grilse that were in the side arms being known to have died.

The only two-sea-year salmon known to have been in the area died; two-sea-year salmon were very few in number in this river compared with grilse (4.5% of 486 salmon ascending in 1939 up to August 26). Of at least twelve grilse known to have been in the vicinity of the highway bridge only four died. No dead parr were found. This shows a gradation with size in susceptibility to high temperature.

WATER TEMPERATURE

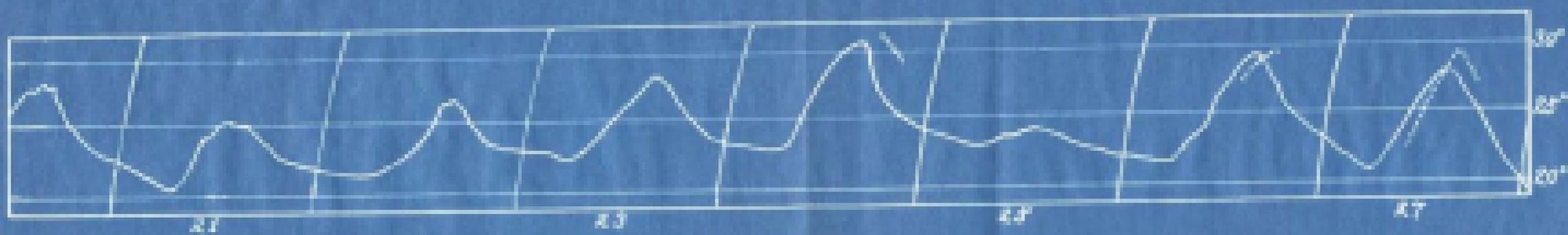


Fig. 26. Water temperature at the Montrose from August 2<sup>nd</sup> to 8<sup>th</sup> 1907, with some records (solid lines) taken at the Highway bridge.

The effect of the high temperature on the movement of the salmon was to bring them near the surface and to cause them to move about so that they went into shallow water, ascended rapids and entered the trap, which had not occurred for some days even at night, the usual time. The parr also showed this movement, such an entrance into the trap as had not occurred before even at night.

Their presence in the side arms can be explained by their coming near the surface as their sensitivity to light decreased and then in moving about reaching the shallow water including that in the side arms. On entering the latter where the water was cooler, they had such a behaviour as kept them there,- they were little inclined to move, and, if on recovering they started to leave, they turned back on reaching the warmer water at the mouth.

On August 25 it was cloudy and misty during the day and the water failed to become very warm. On August 25, however, it cleared during the forenoon and the temperature of the running water near the bridge rose to 29.3 by 2.30 p.m. Grilse had remained in the pools there, being seen on both days. About 4 p.m. on August 26 three were seen entering the side arm above the bridge, but they did not reach very shallow water. No parr were seen and neither dead nor dying salmon were found in the vicinity. Yet about 4 p.m. a dying male grilse with rather many Lepeophtheirus on its skin, but the skin not perceptibly injured by them, was taken at the river mouth in shallow water near shore, the mouth being just above the head of tide at low water. This shows that a temperature insufficiently high to have much effect upon grilse that have been in the warm water of the river for some time will kill those entering from the relatively

cool water of the estuary. A possible differential mortality between the sexes is to be considered.

The mortality of the salmon fresh in from the sea seems to have been principally of the males. Of 7 that died on August 6, 4 were males, and the single one on August 26 was a male. The disproportion is much greater than it appears, since Dr. Hoar has found (for the Margaree) that males form only from 20 to 30% of the smolts as well as of the adult salmon. That this holds also for the Moser river is indicated by the facts that males formed 29% of the kelts trapped during their descent in the spring of 1939, and of 16 parr examined by Dr. Hoar, only 31% were males.

Why all the fish dying on August 24 were females is not clear. If males are more susceptible to high temperature than the females, there cannot have been any males in the lower part of the river at that time.

In all cases the mortality was most severe near the river mouth, and no dead salmon were reported as being found very far up the river. Since the mortality on August 24 was of salmon that had been in the river for some considerable time, its severity near the river mouth cannot be attributed to the fish being freshly in from the sea. There were no deaths near the trap, and the records indicate that the temperature did not go so high and dropped much sooner and more rapidly there than near the bridge. The records for August 26 <sup>(fig. 2)</sup> show that the temperature at the bridge rose somewhat later and to a slightly higher level and probably remained high considerably later than at the trap.

An accurate comparison of the water temperatures at the two places was made during the following week with a thermograph at each place. With clear dry weather following a northerly wind the water at the trap was warmer than that at the bridge even as much as two degrees, except from 4 to 11 p.m. when it was slightly colder. Also at its highest as well as at its lowest the temperature at the trap was around two degrees lower than at the bridge. This latter condition did not obtain on the days when the salmon died. They were in a period characterized by very slight southerly wind with fog during the night, but dissipated during the day by the sun. The humidity was very high and the temperature of the water on the whole mounted from day to day as shown for the first four days in figure 2. This condition was definitely of sea origin and it would be expected that it would be most extreme nearest the sea, that is near the river mouth.

The rarity of deaths above the Oak islands both in 1937 and in 1939 raised the point as to whether the temperature of the water farther up was lower than that of the water below the islands. On August 28 temperature observations were made from 1.15 to 3.40 p.m. going up from the highway bridge to Rocky island and back <sup>(fig. 1).</sup> Below the Oak islands the range in temperature was from 26.3 to 27.6 and above the islands from 24.2 to 25.8. The average difference was 1.8°C. The lower temperature in the upper part finds explanation in the narrower river bed and in the steeper slope. There are rather frequent cascades, known as falls or reefs, some of them being named, as Little Gaspereaux, Big Gaspereaux, Beaver Hole and Rocky Island. The temperature below each series of cascades was from 0.3 to 0.7° lower than it was above, the air being comparatively dry and evaporation

correspondingly rapid. When humidity is high with a movement of air from the sea, there will be a mounting temperature, but less pronounced than nearer the sea.

Farther up than Rocky island there are stretches of comparatively deep water, e.g. the Salmon hole and John Lowe's still. These exercise a stabilizing effect, keeping the water warmer at night and cooler during the day. This is well shown in the effect of Mill lake on the water from the West branch where it joins the main river just below the trap. Its temperature is lower than that of the river in the heat of the day (July 25, 1.15 p.m., 26.1 compared with 27.6°), and higher in the early morning (July 26, 5.15 a.m., 21.3 compared with 19.4°C.). In the lake itself on the afternoon of July 25 the temperature of the surface water was found to vary with the depth, being from 24.2 to 24.8° where the depth was from 4 to 6 feet and over 25° where less than 4 feet.

#### Mortality of August 6 to 19, 1939 in Moser River.

The heaviest mortality of the season of 1939 occurred on August 6. The lower part of the river had been comparatively barren of salmon for some time, not a single fish passing through the trap during the first five days of August. Large numbers had been seen in the estuary for a considerable time, and after a shower of rain in the afternoon of August 4 there seemed to be hundreds (salmon jumping everywhere) at the very head of the estuary at 7 p.m. as observed by Dr. W. S. Hoar. The next morning at 7 a.m. Dr. H. M. Rogers saw three or four of them in a pool well above the head of tide at the

time. Toward noon when the tide was high, Mr. H. C. White saw about 60 salmon at the head of tide, many with their dorsal fins and the upper parts of their caudal fins out of the water, milling about and jumping frequently, some of them being out of the channel among the rocks. One of them, a grilse was caught and found to be heavily infested with copepods on the skin.

That evening and night a heavier rain fell, and the next day many salmon were observed at 8.00 a.m. by Mr. Drillio to be splashing in the water above the head of tide at the time.

About 10.30 a.m. with rising tide, Mr. White noticed salmon jumping in the estuary near the point on the west side below the uppermost basin, then saw them clearly with the telescope moving up and across the basin over the wide shallows, just covered by the tide to the point on the east side of the river mouth. About half an hour later he saw salmon at the Little Dam pool a short distance above the point, both in the channel, and among the stones in the shallow water, and their fins were showing part of the time, and some of them were jumping. About 1 p.m. he saw salmon ascending the small channel on the east side of the river below the bridge, and the fish were beginning to die.

At noon the trap was found to contain a 7 lb. salmon and 23 grilse, three of which were dying. Many had "white heads, but there were few copepods on them. Two grilse were found dead in the pool below the trap and one larger salmon in the pool at the mouth of Mill brook a little farther down stream. According to the Guardian, the fish near the highway bridge became evident about noon, and at 1 p.m. the first one turned over and went ashore on the west side of the river above the bridge. From that time until 4 p.m. quite a number of salmon, all

grilse but one, variously estimated from 20 to 50 in number, were picked up in a dead or dying condition from the head of tide up to the trap. During the next fortnight at least fourteen dead salmon were seen from the head of the estuary up as far as Rocky island. Quite a number of them had the occipital region appearing white from the removal of the epithelium ("white heads") or even red through the removal of the tissues down to the muscle ("red heads").

The course of the temperature from August 4 to 19, the numbers of salmon passing through the trap, the rainfall and the water level at the trap are all shown in figure 3. At no time did the temperature go as high as it did on August 24, but it did go as high on August 6 as on August 26. Judging by the evidence for those two days (August 24 and 26), no deaths from high temperature were to be expected except of fish freshly in from the sea. The trap records show that salmon were ascending following the rains of August 4, 5, and 7, which caused the river to rise. That they were freshly in from the sea was evidenced by the copepods found on them, both in the trap and when picked up in a dying condition. The most pronounced mortality occurred on August 6 when the temperature was the highest and following the attainment of the day's peak. The Guardian stated that on that occasion these salmon freshly in from the sea crowded into the same side arms near the highway bridge as have been mentioned as being occupied on August 24 (but scarcely so on August 26) by fish long in the river. Mr. White recorded a temperature of 29.4° for the water at the bridge at 1.30 p.m. on August 6, which is similar to that for August 26 but over a degree lower than that for August 24. It is clear that salmon fresh in from the sea crowded into the side arms at a lower temperature than was required by those that had been in the river for some time.

The injury done to the salmon by the copepods seems to have definitely contributed to the deaths occurring during the fortnight after August 6, since many of the dead fish were badly injured. Such injury was evidently not an important factor in the principal mortalities, since both on August 6 and August 26 uninjured as well as injured fish died, and badly injured as well as uninjured fish survived.

MUSEE RIVER

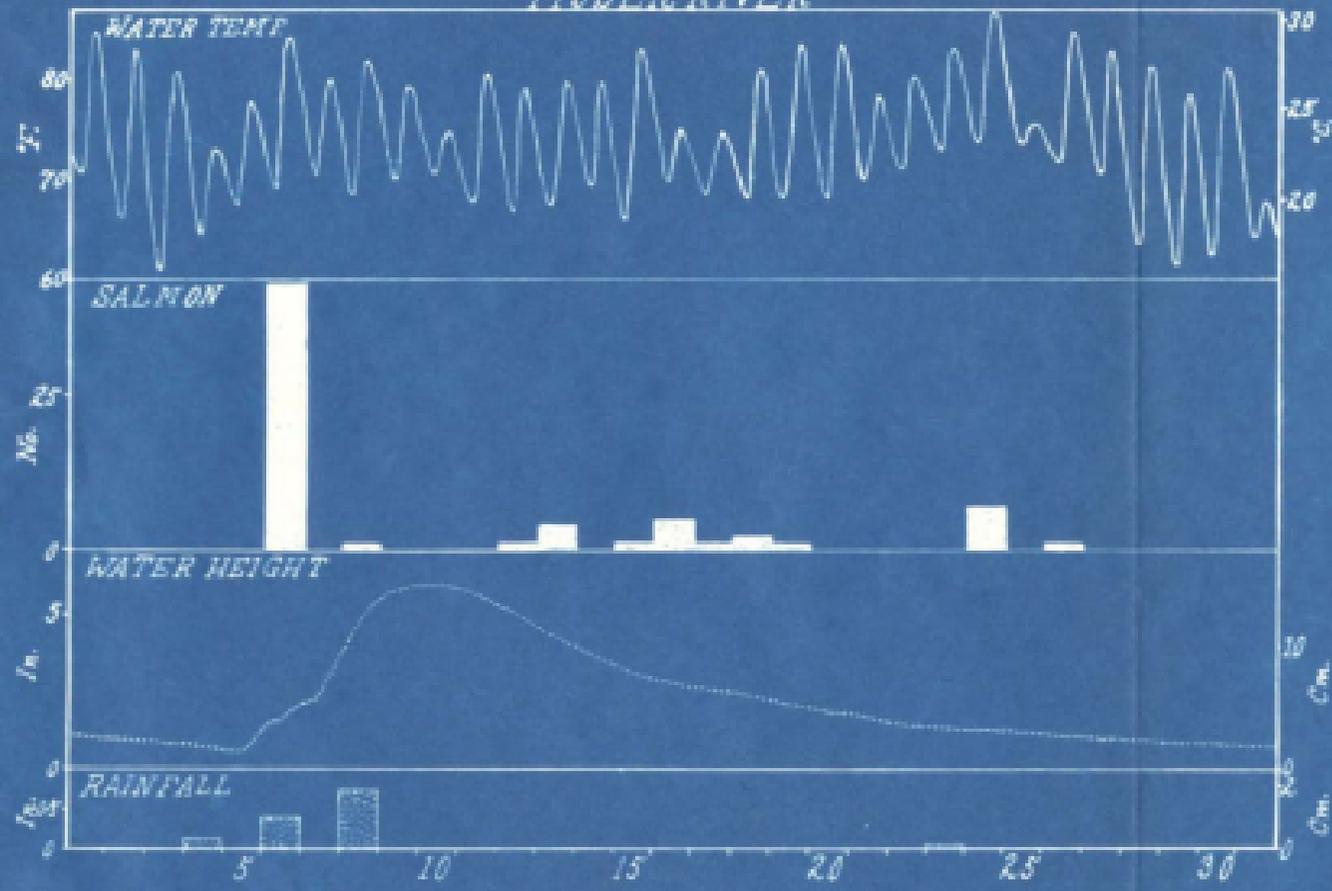


Fig. 3. Rainfall, water height and water temperature in relation to death of salmon at the Musee river N.S. in August of 1887.

Mr. White stated that some of the fish dying on August 6 made rapid dashes along the surface of the water when dying, and these sometimes took them ashore. This evidence of asphyxia, which was not seen for those dying on August 24, is perhaps to be explained by excessive activity stimulated by the high temperature or otherwise.

#### Mortality of 1937 in Moser River

As remembered by the Guardian, the mortality in Moser River in 1937 was of similar character to that of August 6 to 19 in 1939. With continued dry weather the river was low and there were very many fish in the estuary. Probably over 50 fish were taken out, chiefly in the vicinity of the highway bridge, where they were seen to go ashore in a weakened condition or to die in the pools, turning belly up. There were only a few of the "lice" to be seen on them and few with whitish heads as compared with 1939. Most of the fish were taken out on the first day, which was very warm, and the deaths lasted only a week or so, ending when a rain came.

#### Mortality of 1937 in St. Mary River

Mr. M. M. Manson, the local Inspector of Fisheries and Mr. L. M. Silver of Halifax have given the following information concerning a mortality of salmon in St. Mary River, N. S. in 1937. This river is about 18 miles east from the Moser river.

After about eight weeks of dry weather, and with the river exceptionally low, dead salmon were found in and near the Silver pool (as far away as the Crow's Nest), which is at the junction of the East and West rivers as follows: for the successive days from August 6 to 12, 1, 1, 0, 4, 9, 7, and 3 salmon. In the week previous to August 26 one was found dead at Caledonia far up the

West river and one at Sherbrooke near the mouth of the main river. Also two that had been dead some time were found in Glenslg lake, which is on the East river a short distance above Silver pool.

From August 6 to 10, the temperature ranged from 76 to 84°F., on August 11 and 12 from 82 to 84°, and by August 16 it was down to 76°. At the height the temperature rose from 77 in the morning to 85° in the evening.

No grilse died, only large salmon, mostly about 20 lb. in weight, but one as small as 7 lb.

There were hundreds of salmon in the pool, and there had been so many there in July that the pool was closed to angling on or about July 25. There was a mere trickle of water entering the pool from the East river, this coming from Glenslg lake through a sluggish channel full of various aquatic plants. The salmon came near the surface with the back and tail fins protruding. While there were "lice" on the gills, only two of the dead fish had a large number of them.

Mr. K. G. Chisholm of the Dominion Water and Power Bureau has furnished data for the figure, which shows the course of the flow of water in the St. Mary river from July to September of 1937 as measured at Stillwater on the main river. These have been plotted in figure 4 together with the data on dead salmon. It will be seen that the deaths occurred in the middle of a very dry season lasting from early July to the middle of September. They did not occur when the water was lowest the first week or so of September, but following a slight freshet developing on the 4th and 5th of August.

The temperatures reported are such as would be expected to kill the large salmon, perhaps even those that had been in the river some time. It is possible that asphyxiation may have played a part with

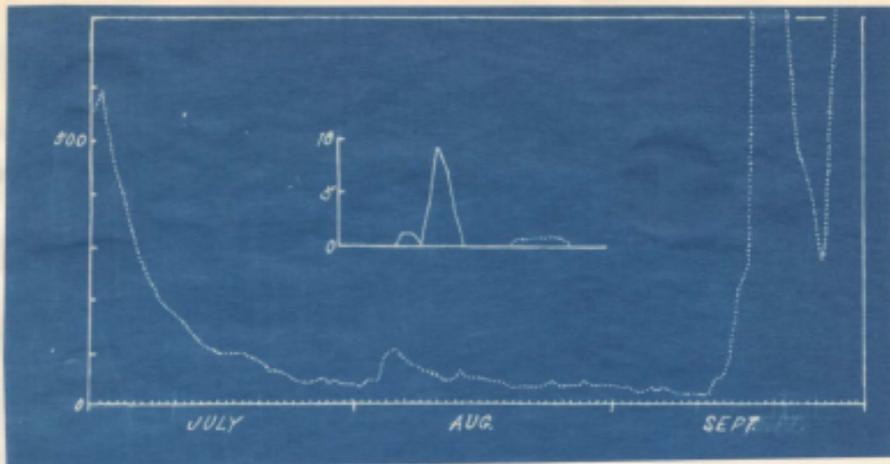


Fig. 4. St. Mary River, N. S. Discharge in cu. ft. per sec. in summer of 1937 (from records of Dominion Water and Power Bureau). Inset shows numbers of salmon found dead each day as reported by Inspector Manson.

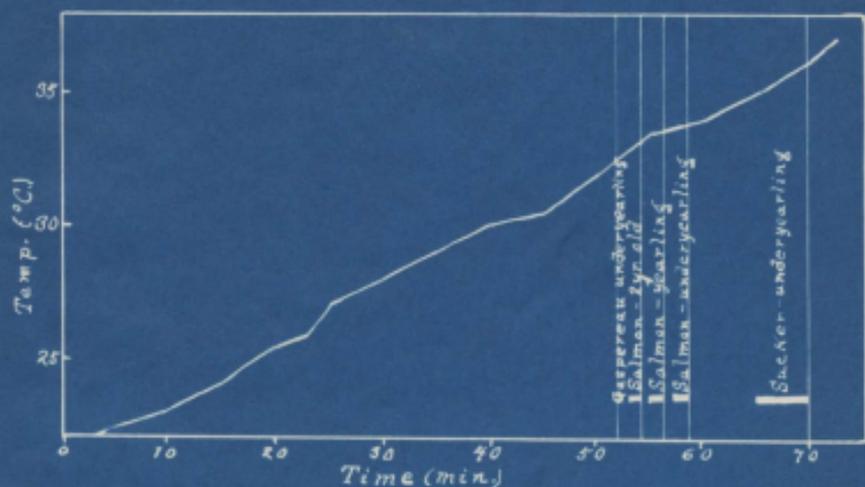


Fig. 5. Bath of young fish with rising water temperature, Mow river August, 1937.

so large a number of salmon in the Silver pool and so little water flowing through it from the East river.

Lethal Temperatures of Young Salmon, etc.

At a temperature of between 30 and 31°C., the parr and fry came into shallow water, particularly the cooler places where they congregated, but there was no indication that any died. On August 28 some were secured from the river above the highway bridge, placed in a large basin of river water, and the temperature raised at the rate of approximately 1°C. every 5 minutes (figure 5). To prevent exhaustion of the oxygen supply, the water was from time to time replaced by fresh and also taken out and poured from a height.

Small suckers (Catostomus commersonii) and a small gaspereau (Bomolobus pseudoharengus) were included in the experiment.

The effect of the high temperature as recorded for the dying period of each kind of fish was successively (1) a slowing up of the swimming movements, (2) loss of equilibrium as shown by turning on the side or on the back, and (3) cessation of movements. Owing to the confined space the fish were in movement from the beginning both vertically and horizontally so that it was not feasible to observe a stimulating effect of high temperature on movement or a change in sensitivity to light.

The lethal temperatures were as shown in figure 5 and as follows:

gaspereau, 4.0 cm. long, -	32.5
salmon parr, 16.0 cm. long, 2-yr. old, -	32.9-33.2
salmon parr, 12.7 cm. long, yearling, -	33.5-33.7
salmon fry, 6.3, 6.2, 5.9, 5.8, 5.7 cm. long, -	33.6-33.8
sucker, 4.8 and 4.2 cm. long, -	35.1-36.1°C.

The lethal temperature will vary with the rate of rise, being higher the more rapid the rise. In this experiment the rise was

seven times or more as rapid as it appears to have been in the river on August 24; therefore, the lethal temperatures are higher than they would be apt to be in a river. It can be confidently stated, however, from the results of this experiment and from the mortalities in the Moser and St. Mary rivers that under comparable conditions, for salmon from the fry to those over 20 lb. in weight, the larger the fish the lower the lethal temperature.

The difference in the symptoms of death from high temperature from those with death from lack of oxygen was demonstrated by putting salmon fry into water practically devoid of oxygen (boiled and cooled). In a very short time they exhibited convulsive movements, which continued periodically for some time, with intervals in which no movement of any kind was apparent. The convulsive movements sent them rapidly in any direction in which they happened to be headed. This was in strong contrast to the gradual weakening resulting from steadily rising temperature.

#### Acknowledgments

Dr. H. M. Rogers has been responsible for the records of water levels and of the thermograph. Mr. H. C. White has been responsible for the rain records and (with Mr. A. C. Nicol) for the trap records of salmon.

#### Prevention of Mortality in Moser River

Measure<sup>s</sup> to prevent the temperature of the lower part of the river from rising too high are required. If the general level of the water were kept sufficiently higher during a dry season by having a greater reserve of water in the lakes available for use as required, the temperature would not rise so high. If there were larger pools in the

lower part of the river and if the water there were confined to narrow deep channels, it would not warm up so rapidly. Probably the most effective, direct measure would be to make low dams or "reefs" at intervals along the lower part of the river to produce successive pools and cascades. This would have the added advantage of giving more suitable pools for holding the salmon along this first and most accessible part of the river.

ATLANTIC SALMON AND TROUT INVESTIGATIONS

1939

Report No. IX. Salmon Fry Planting in Goldmine Brook.

By H. C. White

During our various investigations on salmon fry, particularly on the Margaree river, we had been impressed with the importance of predator control for the conservation of salmon fry. Although this phase had received special attention in relation to the control of fish-eating birds, we had recognized the importance of various other factors. However, it was considered that, although the other factors had not been as thoroughly investigated, some attempt should be made to plant fry in such a manner that they would survive to produce a relatively high percentage of smolts. For this planting it was proposed to use some stream which could be conveniently handled.

Choice of Stream

It was desired that the salmon investigations should be concentrated in one locality to facilitate the handling of the various phases of the work. Moser River, N. S. had been selected for other investigations and consequently a stream in that locality was sought for the planting experiment. Goldmine brook, a small tributary of West brook was found to be the most available small stream and appeared satisfactory for such a planting.

Goldmine Brook

This stream discharges into Mill lake, the lowermost lake of the West brook watershed. The main part of the stream is about a mile and a quarter in length. The lower part of the stream flows through alders and has a bed of fine gravel. Ascending the stream it becomes more precipitous and consequently there are consecutive areas of coarse gravel, coarse gravel and small boulders, shale and fragmented rocks, cascades over bed rock with large boulders and large rock fragments. Above the cascades the stream is less precipitous and the stream bed is composed largely of boulders and rock fragments. This area extends nearly to the stillwater, which is a broad slowly-flowing stretch passing through swamps and boggy country. Above First still there are successive gravel and stony areas between the various still-waters. Above the upper stillwater there is another gravel area which extends to the headwaters. These are a number of meandering branches draining an extensive bog and swamp area. Besides these branches there is another small branch, Spears' brook, which empties into First still. This brook is fed largely by springs arising in the higher land. There are a number of small runs and bog springs entering the stream at various places. With its still, cascades, etc., Goldmine brook provides a variety of habitats. Except for the stillwater areas the stream is mostly shallow, although there are below First still a number of small pools.

The upper waters as they come from the bogs and stillwaters are fairly dark in colour but below the cascades the water is much clearer. Much of the brook is shaded and the water, excepting the surface water in the stills, remains relatively cool throughout the summer. The pH of the water during normal-water periods is about 6 but during flood periods in the summer it becomes more acid.

### Fauna

Trout are the dominant fishes being found in all parts of the stream but especially in First still, Spears' brook, and the lower gravel area. These are mostly indigenous trout although it is possible that some sea-run trout spawn in the lower gravel area.

Salmon parr were found from First still to the mouth but they were most abundant below the cascades. There were about twenty-five parr in this area but only three were found above the cascades. In the Fall of 1938, three small salmon redds evidently those of one or more small female grilse were found in the lower-gravel area. The redds contained very small salmon eggs. From these eggs fifty or more fry resulted and these remained throughout the summer of 1939 in the lowermost part of the stream near the site of the salmon redds.

Eels occur but are scarce. During the summer eight were caught in the stream and a few others were observed. These were all small eels, only one over a foot in length was found.

Fundulus (F. *disphemus*) and doubtless other fishes enter the pool at the mouth of the brook but are not known to ascend the stream.

### Insecta.

Most of the common aquatic families of insects are represented in the brook but black flies (Simuliidae) and stone flies (Plecoptera) appear to predominate. Throughout the summer, Mr. Colin Nicol maintained insect traps to capture samples of the emerging insects and he is reporting on his investigation. However, it may be said that the insect fish food of aquatic origin is relatively poor.

### Removal of Predators

Since trout and eels are known to be enemies of young salmon as well as competitors for the available food an attempt was made to rid the stream of these. Seining was impracticable excepting in the lower fine-gravel area consequently the trout were mostly removed by angling with a baited hook. Removal by angling was greatly facilitated by making small rock shelters for trout on the stream bed beneath the water. On subsequent trips along the stream it was necessary to fish only these rock shelters as the trout readily occupied them. Trout fry were confined largely to the lower gravel area from which they were seined. It was proposed to use for the salmon fry planting this year only that portion of the stream below First still and consequently the predator fishes were removed from this area. Seventy-one trout, yearlings or older, and sixty-one fry were removed from the area below the still. Also twenty-one trout were taken from First still. Only eight eels were killed in the area some of which were trapped in small eel pots and others were killed by various means.

The indigenous salmon parr and fry were not removed as they were retained as part of the experiment.

#### Fish-eating Birds

During our various trips up Goldmine brook throughout the summer neither Mr. Nicol nor I saw any fish-eating birds on the brook or any manure splashes which we could attribute to fish-eating birds. Kingfishers are rare on the Moser river. No mergensers have been seen in the vicinity of the mouth of the brook and also the stream is too small and too heavily wooded for them to frequent. Great blue herons were scarce in the vicinity and the feeding in Goldmine brook was too poor to attract them. Thus there was at no time any need to adopt measures to protect the stream from bird attack.

#### The Planting

On July 27th the salmon fry, which had been fed for some time and were fairly well advanced arrived from Bedford hatchery. These fry ranged from forty to sixty millimeters and averaged about fifty. They were apparently free from disease and showed no evidence of fin erosion. However they were not in as good condition as the local native fry and their heads were relatively larger.

After their arrival the fry were placed in screen boxes in Mill brook, the outlet of Mill lake, where they were allowed to rest until the following day when the allotment for Goldmine brook was placed in a screen box in the lake and were towed behind a boat to the mouth of Goldmine brook. The screened box was anchored in the mouth of Goldmine brook and the fry were allowed to remain in the water from the brook so that they would become accustomed to it. The transfers were made with no appreciable loss.

The following day the distribution was made. Fry were dipped from the retaining box and placed in a large wooden bucket which had screen wire fastened over one half of the top. This was to facilitate the changing of the water in the bucket while the distribution was being carried on. Beginning at the edge of the alder section above the short area of the finest gravel, which was above the part already occupied by the native fry, the hatchery fry were planted in lots of from ten to twenty-two at intervals of five to eleven paces. That is, they were distributed at the rate of two fry for each pace of approximately two and one third feet. Two thousand, four hundred and eighty one fry were thus planted.

#### Observations on the Planted Fry.

Small fine-screen barriers were placed below the area of planting, at the upper end of the coarse gravel and boulder areas and at the foot of the cascades. These were for the purpose of determining whether or not there was any "drifting" of the fry. During the planting there was no evidence of any drifting excepting at the very upper end of the planting in the water which came directly from First still.

Following the date of planting there was a period of very warm dry weather. During this period observations were made on the planted fry. There were no excessive water temperatures and no sign of concentration of fry at the screen barriers. Few fry were observed by direct observation but since there was an abundance of hiding places beneath the stones, shale, etc. no significance was attached to these observations. No dead or sick fry were seen.

### High Water

On August 5th, 0.39 inches of rain fell and on the 7-8th 0.76 inches. This amount of precipitation was sufficient to cause fairly high water in the brook. We visited the stream during this high water but owing to the dark colour of the flood water only an occasional fry was seen. The water was high enough to render the small screen barriers ineffective. On August 12th when the water had returned to near its low-water level, Mr. H. Leverin of the Department of Mines and Resources took test samples of the water of the brook and found that the water just above the mouth of the brook gave a pH reading of 6.0.

Just above the mouth of Goldmine brook an eel trap of fine-mesh screen had been maintained for a considerable part of the summer to catch eels or other fish entering from the lake. During the flood the water had flowed over this trap. On August 14th when the water was low two salmon fry were found in the trap and on August 18th there was one fry. From their condition I judged them to be hatchery fry. This was the first time fry had been taken in the trap. Evidently, they had drifted down to the lake during high water and later had attempted to ascend the stream.

### The Surviving Fry.

On August 23rd, while I was at the Margaree river, Dr. Huntsman and Mr. Nicol made a night inspection of the stream. I have found a night survey to be one of the most reliable methods of taking a census of the fishes as at night the fish emerge from their hiding places and may be readily counted with the aid of a proper light. The common gasoline lantern gives a very satisfactory light for this purpose. As a result of the survey Dr. Huntsman estimated

"a disappearance (1) of 83% of the fry just above the alders, (2) of 90% of the fry farther up in the gravel sections and (3) 97% of the fry in the cascades section --". These figures were based on a count made on seven sections of the stream.

On August 28th I made a daylight survey of the stream turning many of the stones and found the fry very scarce.

On September 7th Mr. Nichol and I made a night survey counting all fish observed in that part of the stream where the fry had been planted. The night was dark and calm and the water low and clear, making ideal conditions for such a survey. For illumination we used a gasoline lantern and a flash light. On this survey we found 133 salmon fry, 25 parr, 6 trout fry, 8 trout of yearling size and one larger. We saw also five small eels. Undoubtedly the count gave a fairly accurate census of the survivors. This indicates a loss of 94.7% of the planted fry.

#### Causes of Loss

The possible causes of loss may be summed as (1) enemies (2) insufficient food (3) unfavourable environment. The enemies as we have pointed out were largely under control. Fish-eating birds were absent. An exposed pool in the open marsh near the lake which was certainly the part of the stream most vulnerable to bird attack contained throughout the season a considerable number of native fry. Although several small trout had been netted from this pool one yearling trout remained there with the salmon fry throughout the season. Of the nine trout (older than fry) eight of those found in the <sup>planted</sup> area were of yearling size about four inches in length while one older fish was about six inches. It is scarcely possible that

these trout could have caused the loss as in a stream their ranging is very limited. It is also inconceivable that the several small eels observed could have caused any considerable loss. As for the parr, none of which had been removed, we have never found them taking fish of the size of the planted fry.

Insufficient or nonavailable food may have been a factor in weakening the fry but our experience has shown that starvation in fish is a very slow process. Moreover if there had been any serious weakening in the fry they would have been found congregated above the screen barriers.

Previous experiences with both trout fry and salmon fry had shown us the desirability of acclimating the fry to the water in which they were to be planted. In the case of Goldmine brook we had taken special precautions previous to the planting to acclimate the fry to the water of Goldmine so that they would not drift. At the time of planting the fry the condition of the brook was about the same as it was on August 12th when Mr. Leverin took the pH reading. (at that time 6.0). Water of this acidity is near the unfavourable condition for most fishes. Streams usually show a lower pH reading during flood conditions especially where some bog water enters. We believed that since the upper basin of Goldmine is mostly a large bog with peat areas there would probably be a decided drop in the pH during flood conditions and that it might be especially low following a drought period such as we experienced this past summer.

After it had been determined that there was a large loss of fry from the brook we secured some universal pH indicator and took readings of the brook during low water and during high water. On

September 15 when the stream was low we found the following readings: Mouth of the brook pH 6 minus, coarse gravel section 5.5, below cascades 6 minus, middle cascades 6.5, upper cascades 6.5 minus, outlet of first still 6, inlet of first still 5.5, second still 5.5. The runs entering the stream at this time were very low and readings of those tested were as follows: Lower spring rill pH 5, N. E. run below cascades 5, spring run from bog above cascades 4, Spears' brook 6.5, drain from bog above Spears' brook 4 minus. The low readings from the bog areas appeared especially significant.

On September 18th, during a freshet on the stream the water at the mouth of the brook gave a reading of pH 4. On September 20th during fairly high water when the level was dropping another series of readings was made. These were as follows: Mouth of brook 4.5, cascades 4, above cascades 4, first still 4 plus, readings of the runs were: lower spring rill 4 plus, spring run above cascades 4 minus, Spears' brook 6, drain from bog above Spears' brook 4 minus.

#### Discussion

It appeared that some unfavourable condition of the environment was the most probable cause of the loss of fry from the brook. Since the temperature was not unfavourable and hiding places or covers were abundant it seemed that the acidity of the water during flood conditions was the most likely cause of the disappearance of the planted fry.

When unfavourable water conditions e.g. the introduction of toxic substances takes place, the fishes leave their hiding places and begin roaming, feebly stemming the current or swimming down stream. Since Goldmine brook has a swift current especially during high water

any factor which would cause the fry to begin roaming would result in their being swept out of the stream. The current at such times runs well out into Mill lake among lily pads and pond weeds and any fry in the current would be carried well away from the brook. That this did occur to some extent was indicated by the taking of the hatchery fry in the eel trap at the mouth of the stream some days after the water had fallen.

Undoubtedly fry do not all possess exactly the same degree of tolerance for acid water and thus some would be able to withstand the periods of excessive acidity. Moreover the tolerance may be partly a matter of acclimatization. During the planting of the fry there was no tendency for them to drift excepting in that part of the stream immediately below first still, where the water was of somewhat different character to that in which they had been held at the mouth of the stream.

In the count of the survivors there were more of them in the lower part than in the upper part. This would be expected if there was a grading in the tolerance of the fry.

The native fry were confined to the lowermost part of the stream where they had been hatched. They had been acclimated throughout the egg and alevin periods to changes in the acidity and thus did not drift out of the stream during the flood periods. Parr resulting from previous hatchings had spread toward the upper part although none were found near the outlet of First still or above it. The facts which we have indicate that whatever the cause of the loss it was not operative, at least to any appreciable extent on the native fry.

Preliminary experiments of artificially increasing the acidity of a brook showed that increased acidity caused the salmon fry to leave their hiding places and that there was an initial tendency to drift even during very low water and bright sunlight. During high water and darkness this tendency would doubtless be accelerated.

## Planting of Salmon fry

### Goldmine brook, July 29th

Two fry were planted for each pace of approx. 2 1/3 feet and except for the first two lots in lots as shown below.

In the forenoon from 10.50 to 11.50 the lower part was planted from a short distance within the alders to the point where the thermograph was located. The cold rivulet on the south side was just above where the 19th lot was put out. The first spring on the north side was similarly related to the 29th lot. The first and 3rd right-angled bends were similarly related to the 44th and 63rd lots. These are all underlined, in the list of lots that follows.

18, 22, 28, 12, 18, 16, 16, 26, 20, 14, 18, 16, 16, 30, 20, 20,  
18, 22, 22, 12, 12, 18, 16, 18, 26, 22, 28, 18, 16, 18, 16, 12, 24,  
18, 16, 16, 20, 18, 22, 24, 18, 22, 20, 16, 18, 18, 20, 20, 22, 18,  
20, 16, 22, 22, 20, 18, 18, 22, 22, 22, 24, 18, 16, 20, 18, 20, 20,  
22, and 7. Total - 1295 fry.

In the afternoon from 2.55 to 4.58 the upper part of the experimental area was planted from the thermograph to the dead spruce (?) obliquely placed across the brook a short distance below the dam at the lower end of the first still. The screen separating the "stony" section from the "cascades" section was just above where the 4th lot was placed. A birch log with rusted snare crossed the brook just above the place where the 25th lot was placed. The end of the "cascades" section, where there are clusters of maples on both sides of the brook was just above the 40th lot. A slight dam of moss was just above the 54th lot.

20, 18, 20, 26, 20, 16, 20, 16, 20, 20, 20, 20, 26, 20, 24, 16,  
18, 20, 20, 20, 16, 18, 24, 20, 20, 20, 20, 16, 20, 18, 20, 18,  
18, 14, 18, 18, 18, 14, 20, 20, 24, 20, 20, 22, 20, 18, 22, 20, 20,  
20, 24, 20, 18, 20, 12, 24, 20, 18, 20 and 14. Total - 1186 fry.

### Johnny Smith Brook, August 4th.

Four fry were planted for each step of approx. 2 1/3 feet from a short distance (40 rods ?) above the upper of the two bridges across the brook near its mouth, nearly to the stillwater, a distance of 1643 steps as measured variously by H. C. White, A. G. Huntsman and A. G. Nicol in stretches each for planting by another. The stretches were in steps or paces as follows: 300, 300, 300, 300, 258, 50, 70, 50, 15. Measured along the path or road a distance of 1180 paces intervened between the above planting and another planting of two fry per pace from the bridge above the stillwater for 110 paces in three stretches, - 30, 62 and 18 paces.

The time involved from the bridge near the mouth was in two periods, the first from 5.30 to 7.00 and the second from 7.30 to 10.00 a.m. The return was, however, made slowly.

On July 29, the brook was planted with salmon fry from near the mouth nearly to the first still, quite uniformly in lots of from 8 to 28 on the basis of two for every pace.

Inspection with a gasoline lantern shortly after sunset (8 to 9.30 p.m.) on August 23 gave the following results.

(1) Narrow stretch of rather rapid water from upper end of alders upstream for 17 paces, - 6 fry, fairly evenly distributed.

(2) Broad shallow pool just above and on east side of brook bed, 15 paces long, - lower shallow part with 5 fry, upper deep part with 3 parr. This was done four times with the same result except that at first only two parr were seen. This was the beginning of the inspection, when it was not fully dark.

(3) Just above spring rill from east in gravel section, a narrow stretch along west side, 18 paces long, - 4 fry.

(4) First snag pool on west side above the spring rill, 7 paces long, - no fry, 1 parr and 1 trout, the latter preserved.

(5) A narrow stretch above this snag pool, partly on one side and partly on the other, - 6 fry.

(6) A short distance below the insect net in the "cascades" section, a pool, 5 paces long, - no fry, no parr.

(7) Shallow stretch above the last for 12 paces, - 1 fry, 1 small eel.

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Manure splashes of birds were seen on large stones along and above the "cascades" section before sunset.

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Fry may have been missed, and also after planting, fry of the parts examined may have moved to other parts of the brook. As the facts stand, however, they indicate a disappearance (1) of 83% of the fry just above the alders, (2) of 90% of the fry farther up in the "gravel" section, and (3) of 97% of the fry in the "cascades" section just below the insect net.

The failure to find fry in the deep portions inhabited by parr or trout may be due to the larger fish eating the fry. The availability of food suitable for these larger fish might well be determined. The greater paucity of fry farther up the brook seems to show that enemies are more numerous there or are invading the planted stretch of the brook from the upper end. The manure splashes of birds are perhaps significant in this connection.

