LIMNOLOGY SECTION

CANADIAN WILDLIFE SERVICE

MANUSCRIPT REPORTS

Limnology and Experimental Fishery Management Studies in Gatineau Park, during 1968

J.P. Cuerrier
and
M.J. Dadswell

March 1969

CANADIAN WILDLIFE SERVICE

Limnology Section

MANUSCRIPT REPORTS

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Limnology and experimental fishery management studies in Gatineau Park during 1968

Report

by

Canadian Wildlife Service

to

National Capital Commission

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QUOTATION

"Ultimate recreational development of Gatineau Park's variety of lakes 'for the expert fly fisherman as well as for the little boy with a fishing pole' is now being studied by Lt.-Gen. S. Findlay Clark, National Capital Commission chairman."

Ottawa Citizen, February 21, 1962.

Introduction

Investigations and experimental management projects carried out in past years, particularly during 1967, stimulated the National Capital Commission and the officers of Gatineau Park to request further studies. Projects aimed at fostering knowledge of the conditions prevailing in park waters and at experimenting with fishery management practices were carried out under the auspices and the direction of the Canadian Wildlife Service.

Results of the studies and other activities carried out during 1968 are presented in this report. It is hoped that the accumulated information available will be useful in implementing a program aimed at providing recreational fishing opportunities in Gatineau Park in a near future.

Chapter I

Observations on yellow perch and their experimental control in Mousseau Lake during the spawning season

Introduction

Observations carried out during 1967 indicated that yellow perch spawn in waters 3 to 12 feet deep, among sunken tree branches, in areas of wave agitation. The gelatinous tubular egg masses were easily observed from the surface. Attempts were made in 1967 to destroy the perch eggs by application of copper sulphate as crystals and in solution; but because of rapid but local dispersal of the chemical, only the eggs in very close contact with the copper sulphate were affected. This method was considered only 50 per cent effective in killing eggs. A more effective method involved the removal of egg masses with a long handled dip net. However, because of cold temperature of the water and the interference from the submerged branches the method was slow. Only a short segment of shore line could be covered each day. A new method of egg removal employing a pump as suggested in our 1967 report, was tested during the spring of 1968.

Spawning of Perch

Water temperature is the main factor controlling the spawning activities of most species of fish. Therefore the spawning time in a lake is determined each year by the spring weather conditions. Since the egg removal operation must begin only after the spawning activities of all perch are completed and also before hatching begins, a close watch must be made on perch population along with the progress of the warming temperature to determine the optimum period for egg removal. This period will vary from year to year.

The spring of 1968 was very warm; this brought an early break-up of ice so that field observations on Lac Mousseau began early. On April 19, a gill net set on a main spawning area caught 22 perch; all except one were males in spawning condition, with milt running out by light abdominal pressure. On April 22 and 23, a gill net caught 62 females and 94 males on the spawning grounds, an indication that the major proportion of the perch population was invading the shallow water at this time for spawning. When the gonads were examined it was found that 4 females of this group had released their eggs, the rest had not. The first egg mass was observed on the bottom on April 22. The water temperature at this time was 49° F. Spawning areas were observed daily; by May 7 spawning appeared to be completed and the early released eggs had reached the eyed stage of development. The water at this time was 50°F. Hatching began about May 15th when the water temperature was 59°F.

Control Method

In our 1967 report we mentioned that a pump to lift eggs from the bottom might be a feasible method of perch egg control. That method was employed during 1968.

Several models of pumps were examined. Out choice rested with a 1/3 H.P. gasoline engine driven pump with a 3/4 inch intake hose. The intake pipe was fitted with a ½" mesh screen to prevent the sucking up of large pieces of rock and branches that could clog the pump; small pieces of rock and twigs could pass through without damage. The outlet nozzle was fitted with a ½" pipe. The stream of water from the pipe was directed into a large box on the side of the boat. The bottom of the box was made of a fine mesh screen of 40 meshes per inch. The stream of water was passed through the screen so that all eggs were completely shredded and the embroys killed.

A viewing box, 16" high with an 8" x 8" plexiglass plate was constructed for use during the pump-hose operation. This extended vision down to depths of 15 feet from the boat.

Two men to a boat work as collecting unit. One man uses the bottom viewer to locate the egg masses, to anchor the boat over them and then to manipulate the suction hose to pick up the eggs. The eggs are then broken up inside the pump and shredded through the screen by the exit jet of water coming from the outlet hose held by the other man who also operates the outboard motor.

This method was 100 per cent efficient in killing perch embryos.

Operation

An intensive search for perch egg strings began on May 7th. The search consisted of moving the boat slowly along the shore over water depths of 5-10 feet, while observing the bottom through the viewer. Particular care was taken to observe the entire visible lake bottom in areas of sunken tree and branch concentrations. Once located the eggs were destroyed.

The pumping method was highly effective and quite fast. During the period May 7-15, an average of 200 egg strings per day were destroyed. The entire shore line of Lac Mousseau was searched for perch eggs and a total of 1630 egg strings were observed. The numbers observed and the areas of concentration are shown on Map I. Time did not permit the removal and destruction of all egg masses. Of the total number seen, 1237 were destroyed or 75 per cent of the total 1968 egg production. Since perch females produce each between 10,000 and 48,000 eggs with an average of 25,000 eggs per string, it is estimated that 31 million eggs were destroyed.

Life history of Perch

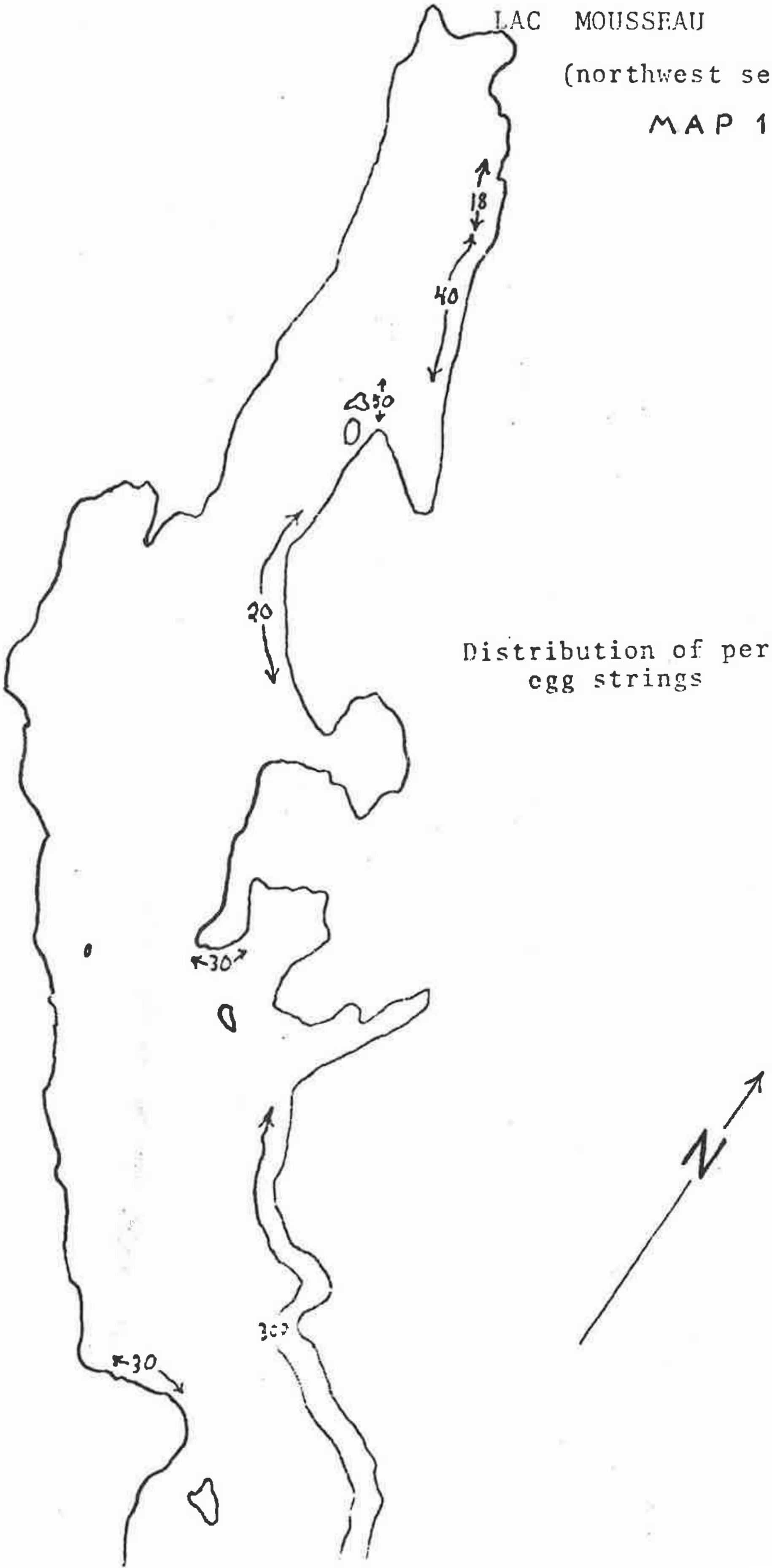
The female perch lays a long gelatinous and accordion-like string of eggs in the vicinity of sunken wood in shallow water in areas of clean bottom, i.e. areas exposed to wave action.

The males move onto the spawning beds at night before

LAC MOUSSEAU

(northwest section)

MAP 1

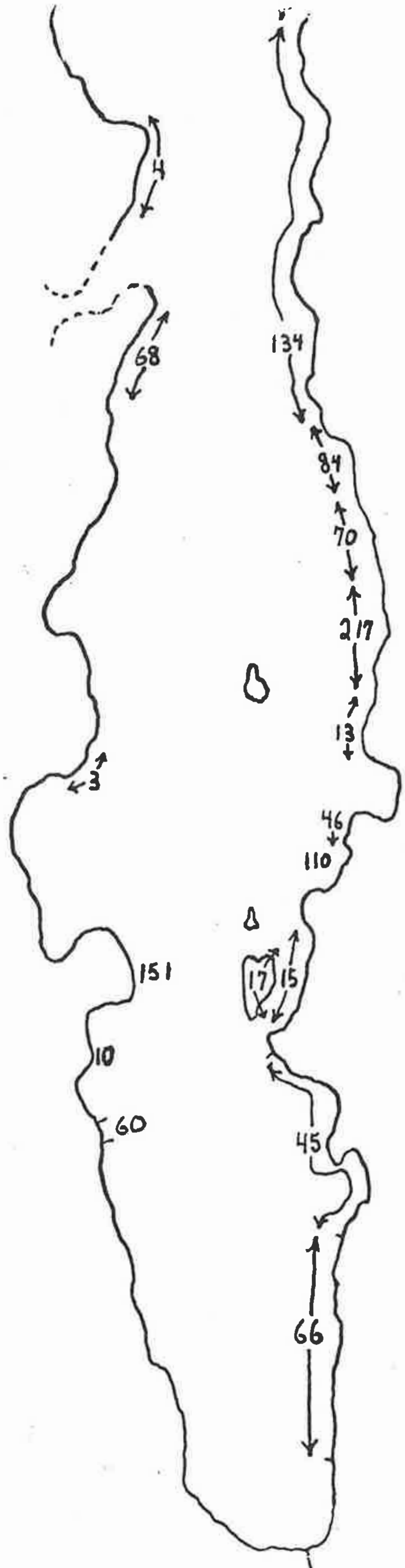


Distribution of perch egg strings

LAC MOUSSEAU

(southeast section)

Distribution of perch egg strings



the females. Spawning takes place at night in large groups of males and females. The incubation period from the eggs lasts 18 to 22 days, depending on water temperature. When hatched the perch are small transparent larvae, less than ½ inch long. These larvae are planktonic during their first months of life and feed extensively on plankton. At the end of their first year the small perch are 3" in length. At the end of their first year the perch school up and move into the shallows where they remain during the second year. Travelling in schools, they alternate between bottom feeding in spring and fall and planktonic feeding in the summer. Adult size is reached at a length of 7 inches, at the end of the second or third year. In the Gatineau Park area, the males reach 11 inches and the females about 13 inches in length after eight years of growth.

When the perch attain adult size, they school over moderately deep water and feed on plankton (large zooplankton) and emerging insects, it is at this time they offer their greatest competition for the trout (Table I). Both speckled trout and perch occupy the same water areas during the spring and early summer, the time of maximum growth in trout.

A net, set in water depths between 20 and 30 ffet on June 24, (within the thermocline area), resulted in a catch of 37, 11" - 12" perch and 9 large speckled trout (av, 15"). Both species were feeding on the same food items although the trout were concentrating on the planktonic perch to a greater extent. Due to the large perch population still present in Lac Mousseau, this competitive feeding decreases the possible trout production of the lake.

In Table I a comparison of the food competition between the two species is shown. During April the perch were feeding very little (72 per cent stomachs empty) whereas the trout were feeding heavily on all types of food organisms. In May the perch increase their feeding activities and concentrate on plankton and mayflies, trout were also feeding on those items (both 100 per cent in trout stomachs). During June feeding becomes more general in both species with a concentration by perch on plankton and mayflies, while the trout were feeding mostly on plankton and perch fry. By July the mayfly emergence is over, and both species concentrate on plankton and perch fry. From this table, it is evident that perch and trout are competitors in terms of food requirements.

Table I: Frequency of occurrence of food items in Perch and Trout in Lac Mousseau. Occurrence is expressed in per cent.

P = Perch
T = Speckled trout

Food items	April		May		June		July	
PLANKTON	P	T	P	T	P	T	P	T
Daphnia sp	14	50	20	100	60	20	70	50
Holopedium sp.					5			
INSECTS LARVAE								
Mayfly	21	61	40	100	36	13	15	25
Dragonfly	3	17			10			
Chironomid		5	66			6		25
Choaborus sp.			13					
Beetle		17				6		
Caddis		5						
OTHER								
Amphipods	-	-	-	-	-	13	-	-
Crayfish	-	5	-	-	10	-	15	-
Perch fry	-	5	-	-	20	38	20	100
Mammals	-	5	-	-	-	-	-	-
Number of stomachs	106	18	32	3	48	20	5	6
Empty stomachs in per cent	72	10	27	0	1	25	0	0

Discussion

The experimental pumping of egg masses off the bottom proved highly successful. During 1968, 75 per cent of the total perch egg production was destroyed in Lac Mousseau. This method is the best that we have experimented with so far and is recommended over copper sulphate application. We recommend its use in the future.

Using the pumping method, four men, in two boats could destroy most of the eggs in Lac Mousseau in 10 days. The spring of 1968 approached normal conditions; therefore it is recommended that the egg destruction program should be scheduled for the period between May 1 and May 15. The gasoline engine driven pumps used are inexpensive, each underwater viewer can be made in an hour, and boats are readily available. A scoop net should be carried as an aid in removing eggs quickly from shallow water areas.

Chapter 2

Reduction of the adult Bass Population

Introduction

Bass have overpopulated Lac Mousseau due to lack of fishing pressure and because there are no larger species of fish competing with them for food and living space during the warmer months of the summer. Since Lac Mousseau is a large body of water, the complete eradication of the bass population by the use of a fish toxicant would be too costly to be justified. During the spring of 1967 two methods were tested to control bass:

(1) intensive angling to remove adult males from their nests, and

(2) the placing of copper sulphate crystals on the nests still guarded by the adults, to kill the developing eggs.

Both methods were highly successful. The eggs in nests died soon after removal of the guardian adults, thus destroying both segments of the population. That fact, combined with possible high rate of removal of adult bass, suggested that the intensive angling method was the best means of controlling the population of bass. That method was selected for the 1968 season.

Methods

Prior to and during the spawning season bass are very vulnerable to artificial lures. Angling was carried out with spinning tackle, using orange coloured "flatfish", "rapalas" and "red devil" lures. Fishing was carried out from a boat moving 40-70 feet off shore with the anglers casting into the very shallow water near shore over the spawning areas. While guarding the nest, the male bass attacks anything that intrudes into its territory. When attacking the lure the bass generally hits it with its head rather than grabbing it in its mouth. For that reason a lure with 3 or 4 gang hooks should be used in order to snag as many bass as possible.

During the 1968 season we attempted to estimate the bass population in Lac Mousseau by the capture-recapture method. During April 1968, 100 bass were caught, tagged and released. During May and June 1968, when intensive angling was being carried out, a count of the number of tagged fish recaptured was kept, and from those data, we had hoped to make the population estimate.

Catch of Adults

During the last two weeks of May and the first two weeks of June, bass move onto the shallow rocky areas on the lake's shoreline to spawn. The male bass clears a circular area about 2 feet across by fanning with its fins and then protects its territory by charging at any intruder and chasing it off or eating it. The angler's lure acts as this intruder.

On May 1, 1968, 18 bass were taken in 3 man-hours of fishing, or six bass per hour. This is low level of efficiency and is an indication of fishing conditions before the beginning of spawning. On May 22nd when the spawning season was well under way, 100 bass were taken in 9 man-hours of fishing (11 bass/man-hour); on June 11, 45 bass were taken in 4 man-hours (11.25 bass/man-hour) but by July 6 after the spawning had ended, the catch dropped to 6 bass per man-hour. The first bass nest was seen May 15, the last active nest was seen on June 17; it is during this one month period that the bass are most vulnerable to angling.

Netting was also used in an attempt to catch large numbers of bass. However, only four bass were taken in nets so this method was discontinued. The fish taken for sampling were killed, dissected and the sex and stomach contents noted.

Distribution of Nests

The greatest concentration of nests are found around shallow water gravel bars and close to shore, in depths less than 5 feet. Nests are particularly abundant around logs or other natural cover. In 1967, nesting bass were abundant; a count of 10 selected areas gave an average of 4.1 nests per 100 feet of shore line. This nest count was used as population estimate in 1967, but due to the tagging effort in 1968 no nest counts were made. Even though no actual counts were made, the investigators noticed a sharp drop in the number of nests. In areas where 10-15 nests were seen in 1967 only 5 were seen in 1968. The drop in the bass population has probably been brought about by the removal of a large number of males in 1967. To establish whether the decline in bass numbers is due to control methods, it would be necessary to observe the spawning in 1969.

Tagging

As a means of estimating the bass population a program of tagging was carried out to give capture-recapture data. The tag consisted of a soft yellow plastic dart, which was inserted into the back of the fish just below the dorsal fin.

During April and the early part of May, 100 bass were tagged and released in various parts of the lake. Of these 100 tagged fish only 4 were recaptured. That number of recaptures was too small to give a statistically accurate population estimate. Often while fishing the tagged bass were observed following the lure but they seemed reluctant to strike. It is proposed that a larger sample of fish be tagged in 1969, perhaps 300. Tagging operations well in advance of the spawning season should allow the bass to return to normal habits in time for intensive fishing.

1968 Population Control Results

From May 22 to June 12, 1968, 655 bass were removed from the lake during 75 man-hours of fishing. This catch represented an average of 9 bass per man-hour, which was a little below the rate of capture in 1967. Fishing was continued throughout the summer; by the end of October 1968, 1177 bass had been captured.

Feeding Habits

From April 14 to October 15, some of the bass caught by netting and angling techniques were sampled for the purpose of studying feeding habits. Table I shows the results of this study.

During the months of April and May, mayfly and dragonfly nymphs dominated the diet of 8 to 13 inch bass. During June, when the dragonfly nymphs are less abundant, bass begin to feed on crayfish, but insect larvae still make up a substantial portion of the diet, as do the planktonic perch fry. In July the diet consists of crayfish, small fish and surface insects.

The main food item in the bass diet changes throughout its life. When the bass reaches a length of three inches its diet consists of insects and some fish. At a length of 10 inches, the diet is dominated by crayfish supplemented with fish; bass over fourteen inches in length fed predominantly on fish.

Table I: Occurrence of food organisms found in the stomachs of bass (occurrence expressed in per cent)

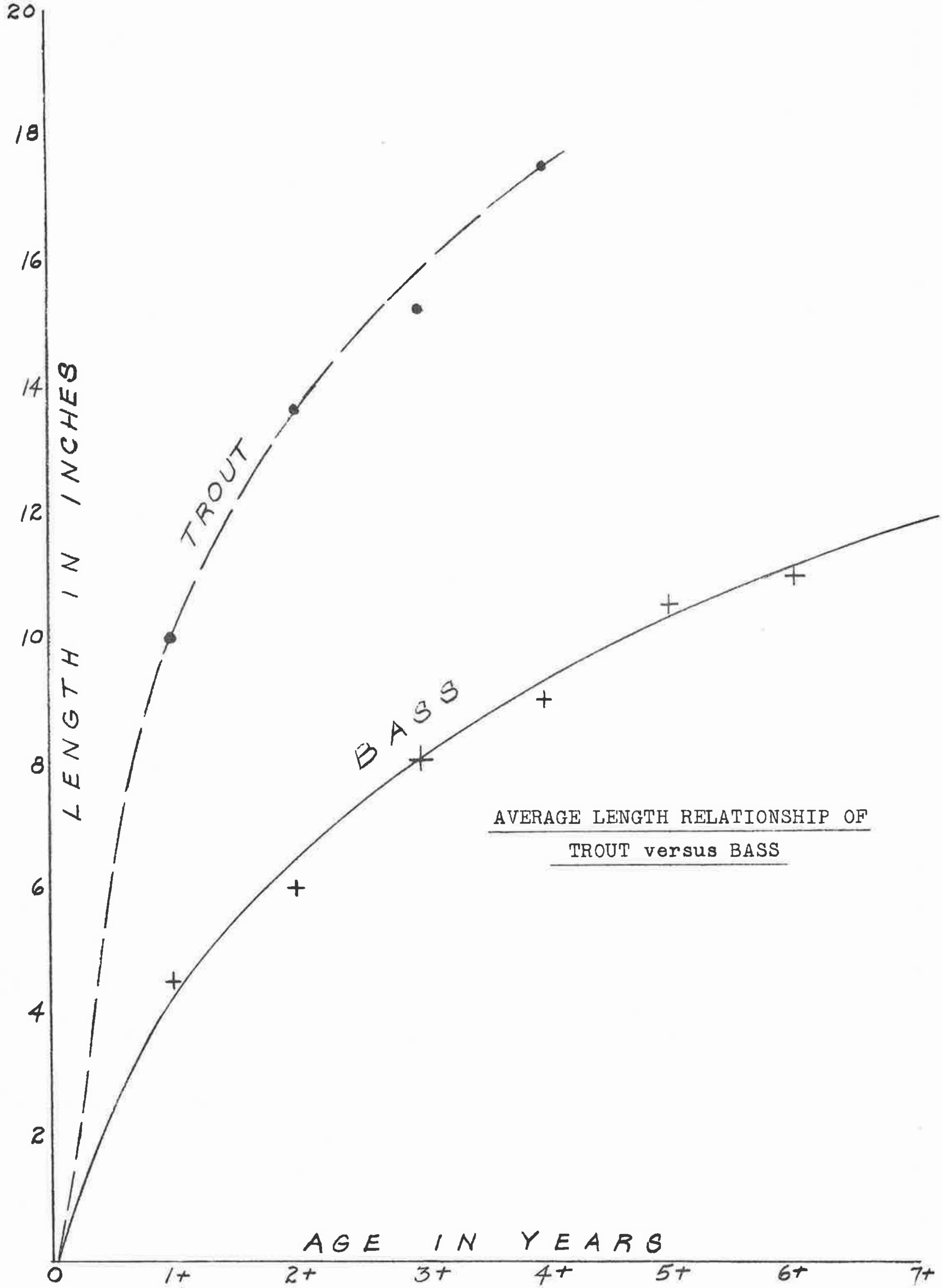
Food Items	April	May	June	July	August
			Month		
Insect larvae					
Mayflies	60	55	16	-	7
Dragonflies	40	11	-	-	7
Beetles	-	-	11	-	-
Neuroptera	-	11	14	-	-
OTHERS					
Crayfish	-	11	25	50	53
Small Fish	-	-	16	17	7
Insects (surface)	-	-	-	17	27
EMPTY STOMACHS	20	22	33	17	-

Besides acting as direct predator on trout during the colder months of the year, bass are heavy competitors of the trout for certain available food items during the warmer months, notably the mayfly and dragonfly larvae and the large numbers of small perch which inhabit the open waters of the lake in June. The two species of fish are effectively separated in the summer and feed on separate diets: the bass feeding on crayfish, and the trout on plankton. There are large numbers of bass in Lac Mousseau. They are voracious feeders, competing for the available food with the trout in the spring, which is the period of trout growth. The competition is detrimental to the chances of maintaining a large trout population. The food competition with both bass and perch is the biggest single factor affecting growth of the trout population in Lac Mousseau.

Growth of Bass and Trout

The age of the fish is determined by examining the growth zones of their scales which are laid down in direct relation to the growth rate, wide rings in summer, narrow rings in winter. This causes the scale to take on the

FIGURE 1



AVERAGE LENGTH RELATIONSHIP OF TROUT versus BASS

Recommendations

Investigations and experiments in Lac Mousseau indicate that the control of bass is feasible and that biological conditions are suitable for speckled and rainbow trout.

It is recommended that:

(1) the program of bass control by intensive angling be continues in 1969;

(2) further stockings of speckled and rainbow trout be carried out;

(3) several million smelt eggs be transferred from Meach Lake to Lac Mousseau to provide suitable fish for trout in deep water.

Chapter 3

Introduction of Smelt in Lac Mousseau

When the surface waters of a lake warm during the early summer, the trout move to deeper levels within and below the thermocline. At those depths, Lac Mousseau lacks a link in its food chain, that is a deep water plankton-feeding fish, which are generally forage fish for the larger game species. For this reason, larger game fish species have to feed directly on plankton. That reduces their growth rates through inefficient energy tranfer. Therefore an effort should be made to introduce the missing forage fish. The fish selected was the smelt because of its availibility in large numbers in near-by Meach Lake.

Several days were devoted to observations on the spawning activities of the smelts in Meach Lake. McCloskey Creek had been selected as a possible source of eggs because of its accessibility and its previous years large run of smelts; however, very few smelt entered McCloskey Creek during 1968 causing the search for spawning runs to be directed to other inlet creeks.

Plans had been made to collect eggs on burlap frames and to transfer the fish eggs to inlet creeks in Lac Mousseau. This method of collection was developed by New Hampshire biologists; it insures a large quantity and high survival of eggs.

On May 2nd large numbers of smelts were observed at the outlet of Meach Lake below the dam; the water temperature was 42^{o}F. These smelt did not seem to be in spawning condition. The location was not considered favorable for laying the burlap frames on the stream bottom due to possibility of vandalism and the strong water currents. Other areas were examined and on May 3rd, two creeks on the north-east side of the lake were visited. Here it was found that the smelt had completed spawning during the previous night. The stream bottom was covered with several inches of eggs. Most of the adult smelt had moved back into the lake. Observations were then concentrated on the development of the eggs on order to establish the time when a large percentage had reached the eyed stage. This is the period when they can be moved.

On May 16, 1968 five hundred thousand smelt eggs were collected from a stream entering Meach Lake. These eggs were collected in buckets and transfered to the small stream located on the south-west end of Lac Mousseau. The eggs were laid out in the stream bed on canvas and wooden trays in a area of moderate flow of water. The temperature on both streams (parent and stocked) was 59°F so that no thermal shock would have taken place during the shipment. The eggs when shipped were in the advanced stage and some were observed to hatch during the shipment. Five days later all eggs had hatched and the fry had entered the lake. It will take two or three years before the smelt begin returning to the stream to spawn if the plantings are successful. Further plantings of several million eggs are indicated, until a local spawning run is established.

Chapter 4

Physical and Biological studies in Lac Mousseau

Introduction

The production of trout and other game fish in a lake depends on a long chain of necessary environmental conditions. Many lakes will not produce certain fish due to a lack of the necessary physical or biological conditions.

The first and foremost factors are the concentration of dissolved oxygen, the temperature and the water chemistry. All three factors are related to the basic food production of the lake in terms of plankton and bottom fauna. This section of the report will discuss findings in these areas in Lac Mousseau during 1967 and 1968.

Methods

Temperature readings were taken at various depths with an electronic temperature probe. Oxygen was determined with a Hach Chemical Kit; water samples were taken with a 500 c.c. closing jar at the depths sampled. Plankton samples were taken bi-monthly with a 12" plankton net. Data on temperature and oxygen are presented in Table I and II.

Temperature and oxygen

It is not the purpose of this report to present a detailed discussion on the data obtained during the past years. However, some of the most interesting features may be pointed out. For example, one may recall that the Spring of 1968 was warmer that of 1967, and that the summer of 1967 was warmer than that 1968. Surface water temperatures on May 31, June 13, June 27, August 31, 1967 were 54°, 64°, 71° and 70°F respectively. During 1968 the surface temperatures were 60° on May 28, and 69° on June 17, but dropped to 65° on June 25.

Thermal stratification however is comparable between the two years. In June the upper portion of the thermocline began at about the 20 foot level; in each summer, the thermocline descended to a depth of between 25 and 30 feet. The concentration of dissolved oxygen in deeper waters in late summer was better in 1968 than during 1967, as a direct result of the higher water temperatures which prevailed during the summer of 1967. In August, at a depth of 30 feet the concentration of oxygen was 4 p.p.m., in 1967 as compared to 6 p.p.m. in 1968.

At the same depth in September the readings were 2 p.p.m. for 1967 and 5 p.p.m. for 1968.

Data collected at several intervals during the vertical distribution of oxygen revealed important facts with respect to the speckled trout management. In fact, the minimum requirement of 5 p.p.m. was present at the depth of 50 feet on July 8, at 40 feet on July 22, of 35 feet on August 3rd and 30 feet in September 3rd.

In practice this mean that eventhough the oxygen conditions are excellent during the winter, during the spring and early summer in Lac Mousseau, the production and distribution of trout is limited to a narrow layer of water, between a depth of 25 feet, (because the water is too warm for trout above that depth) and a depth of 30 feet (because the water is deficient in oxygen at deeper levels). We feel that these conditions could be corrected by artificial aeration in the two areas where the lake is very deep. Lac Mousseau offers an excellent opportunity to experiment with the control of thermal stratification and the prevention of oxygen deficiency in a large body of water.

Plankton

Plankton samples were taken with a net hauled from a depth of 60 feet to the surface. The samples were preserved and analysed. Detailed studies are in progress. Qualitative amounts were determined by visual estimates. Table 3 presents the list of more important members of the planktonic community of Lac Mousseau.

The general characteristics of the planktonic community are:

(1) a spring pulse of phytoplankton followed by a spring burst of herbivorous zooplankton (Daphnia, Kellicottia, Diaptomus);

(2) a summer pulse of phytoplankton, (Anabeana) followed by a burst of herbivorous zooplankton (Trichocera and Diaptomus) and then

(3) the late summer burst of carnivorous zooplankton (Leptodora).

The larger zooplankton organisms are utilized as food by all species of fish and are a main link in the conversion of plant primary production into a game fish production.

Depth in feet	May 31		June 7		June 13		June 20		June 27		August 31		Sept 14	
	°F	O_2	°F	O_2	°F	O_2	°F	O_2	°F	O_2	°F	O_2	°F	O_2
0	54.0		65.0		64.0		68.5		71		70		71	
5	54		65		64		68.5		69		69.5		68	
10	54		57		64	8	68.5	8	68		69.5		68	9
15	54		56		56	10	58.5		67	7	69.5		68	
20	54	10	53		54		54		56.5		69.5	8	67.5	9
22	52								54		63			
25	51		53		51		52	10	52.5	10	59	6	65.5	6
27											56		63	
30	50	10	51		49.5		51		51		54.5	4	56	2
35	49		50		49.5		50	8	51		53		54	
40	48		49		48.5	9	50	7.5	50	8	52		52	
45	48		49		48		49		49				51	
50	47.5		48.5		48		48		49		50		50	
60	47.5	10	48		47	7	48	6	48	6	50		49	
70	47.5		47.5		47		47.5		48				49	

Table I: Data on temperature and dissolved oxygen in Lac Mousseau during 1967.

Depth in feet	March 22		April 17		May 1st		May 28		June 11		June 17	
	°F	O_2	°F	O_2	°F	O_2	°F	O_2	°F	O_2	°F	O_2
0	32.5		42.7	9	49.3	10	60.0		64.5		69.0	
5	35.8	12			49.3		60.0		64.5		67.5	
10	37.5		42.0		48.3		59.5	9	63.0	9	66.4	10
15	38.0	11			47.8		58.5		60.8		64.5	
20	38.0		41.5		47.6	9	56.8	10	57.2		59.3	
22							55.0		55.8		58.0	
25	38.5		41.5		47.0		52.0		53.6	9	54.3	
27									53.1		54.3	9
30	39.5	8	41.0	8	46.6		50.9	9	52.0	8	52.3	
35									51.4		51.1	8
40	39.5		41.0		45.4	9	49.8		50.5		49.8	
45											47.9	
50	39.5	6	41.0		42.7		47.7	8	46.4	6	46.1	
60	40.2		41.0	8	42.3	8	44.7	5	44.6	4	44.9	4
70	40.2		41.0		41.9		44.0		43.8		44.5	

Table II: Data on temperature and dissolved oxygen in Lac Mousseau during 1968.

(continued)

Depth in feet	June 25		July 8		July 15		July 22		August 3		September 3	
	°F	O_2	°F	O_2	°F	O_2	°F	O_2	°F	O_2	°F	O_2
0	65.0		69.9		75.5		75.8		70.9		68.0	
5	65.0		69.5		74.0		75.8		70.9		68.0	
10	64.0	10	69.5	8	72.5	8	75.8	8	70.9	8	68.0	8
15	64.0		66.5		70.9		69.2		70.9		68.0	
20	62.0		62.6		65.0		65.8		70.0	8	68.0	
22	62.0		61.0		61.5		62.6					
25	57.5	10	58.7	8	58.8	8	59.5	8	66.0		67.0	7
27	54.5		56.8		55.5		58.2		59.0		66.0	
30	52.0	8	54.3	7	54.8	6	55.5	7	56.8	6	60.0	5
35	51.0		53.1		53.5		53.5		54.0		55.0	2
40	50.5		50.9		51.5		51.3	5	51.5	4	52.0	1
45	48.5		50.0		49.0	4	49.5		49.5		48.5	
50	46.0	6	47.7	5	47.0	2	47.5	3	47.5	2	47.0	
60	44.0	4	45.7	3	45.6		45.6	1	45.8	1	45.0	
70	43.0		45.7		45.0		45.0		45.6		45.0	

Table II: Data on temperature and dissolved oxygen in Lac Mousseau during 1968.

Table III:

List of Planktonic organisms collected at Lac Mousseau during 1968

Cladocerans	Copepods
Daphia galeata	Cyclops sp.
Daphia pulex	Eucyclops agilis
Holopedium gibberrum	Macrocyclops
Bosmina coregoni	Diaptomos sp.
Leptodora Kindii	

Rotifers	Phytoplankton
Kellicottia longispina	Desmidium sp.
Kerratella cochlaris	Asterionella sp.
Kerratella hiemalis	Dinobryon sp.
Asplanchna sp.	Ceratium sp.
Polyarthra sp.	Arabeana sp.
Trichocera sp.	Staurastrum sp.
Filina longiseta	

Chapter 5

Observations on speckled trout in Lac Mousseau

Originally, prior to the introduction of bass in the Gatineau region during the 1930's, Lac Mousseau was a trout lake. The fish population of the lake consisted of lake trout, speckled trout, ciscoes and whithefish. The last lake trout was reported to have been seen in 1939; whitefish were thought extinct until two specimens were obtained in the nets this year; no ciscoes have been collected in the course of the present studies. The speckled trout managed to maintain a continuous population and were present in small numbers when these investigations began in 1967.

During 1967, eight speckled trout were taken accidentally in the nets. In 1968 we began actively sampling the trout population. Sixty speckled trout were taken in Lac Mousseau between April and September; only one rainbow trout was caught by angling. That species will not be discussed here.

Feeding Habits

Speckled trout generally select an area with water temperature between 50 and 60°F. For this reason they are found most often during the summer in or just above and below the thermocline. It is in this area that they do the majority of their feeding.

During the spring when water temperature are nearly homogenous throughout a lake the speckled trout feed on surface insects in the open water or on bottom organisms. In short the trout is an indiscriminate feeder and, as shown in Table I, trout taken during April, 1968 had fed on nearly every available food items in the lake, from plankton to small mammals. In May, plankton and mayfly nymphs of the genus Hexagenia were the only items found in the single specimen caught.

The thermocline is usually established by mid-June and the surface waters warm to above 60°F. The increase in temperature drives the trout into deeper water and changes their feeding habits. By this time, the small perch, which are planktonic, have reached edible size; the trout exploit this food source heavily, along with plankton, mayflies and amphipods. At this time the major concentration of trout in Lac Mousseau occurs between the depths of 15 and 25 feet.

Table I: Frequency of occurrence of food items in speckled trout stomachs, during 1968, according to monthly periods (occurrence expressed in per cent)

Food Items	Month				
	April	May	June	July	September
Insect larvae					
dragonfly	19	-	-	-	-
mayfly	69	100	17	25	-
Chironomid	6	-	8	25	50
beetle	13	-	8	-	-
caddisfly	6	-	-	-	-
Plankton	50	100	24	50	50
perch	6	-	50	100	
shrimp	-	-	17	-	50
crayfish	6	-	-	-	-
frog	6	-	-	-	-
rodent	6	-	-	-	-
Number of empty stomachs	2	-	4	14	2
Number of specimens examined	18	1	16	21	4

In July, the water temperature above the thermocline climbs above 70^{o}F; and the thermocline itself sinks deeper as the summer season progresses; trout are then driven into much deeper and colder waters. In early July, all trout caught had perch fingerlings in their stomach; during late July, only four of the 17 trout caught were feeding. No trout were caught in August. Those caught in September, had selected plankton, amphipods and chironomids as the items in their diet.

Growth studies

In order to provide material for a study on the growth of trout under the conditions prevailing during the early stage of the bass and perch control program, the following plantings were carried out:

(a) 7,000 speckled trout yearlings, 4 inches; planted in April 1967

(b) 1,000 speckled trout yearlings, 8-10 inches, all with the right ventral removed; planted in October 1967

(3) 3,000 rainbow trout fingerlings, 4-6 inches; planted in February 1968.

Fish from the first two stockings are now showing up in the gill net catches as 2-year-old trout, some with the right ventral fin clipped. Another large group of fish are those of three years of age; these are believed to be original inhabitants resulting from natural propagation or they may have moved down into Lac Mousseau from stockings in Lusk and Charette Lakes. Seven of the 1,000 speckled trout planted in October 1967 with the right ventral fin removed were taken in 1968.

Scale samples were collected from 53 of the trout caught. The relationship between age, length and weight is as follows:

Age	Length in inches		Weigth in ounces		Number of
years	Average	Range	Average	Range	specimens
1	10.0	8.5-12.25	6.4	4-11	5
2	13.6	12.0-15.5	15.5	11-20	24
3	15.2	13.5-17.25	21.0	15-27	19
4	17.5	16.5-19.0	34.0	30-36	5

Data available indicate that trout growth in Lac Mousseau is very rapid with an average length gain per year of 2.8 inches. This is comparable to Lusk Lake where the average length gain per year was 3.0 inches. Three-year-old trout from Lusk Lake averaged 14.5 inches; those from Lac Mousseau, averaged 15.2 inches.

Growth is most rapid during the spring when the trout are feeding heavily. The period of the trout's greatest growth is also the period of its greatest competition with perch and bass, because water temperature are such that all 3 species share the same living and feeding areas. Although growth of trout is very good in Lac Mousseau, it could be better; in certain lakes where competition with other species is less intense or absent, trout reach a size of 4 to 5 pounds in 3 years of growth, twice the rate of growth in Lac Mousseau at present.

Chapter 6

Artificial Aeration Project at Edwards Lake

As outlined in our 1967 report on Gatineau Park, the "Air-Aqua" system installed at Edwards Lake was put into operation during the winter season in a attempt to prevent a winter kill among the trout population due to an oxygen deficiency.

On December 5, 1967, when the ice at Edwards Lake was about 4 inches thick, the release of compressed air began. The generator broke down on December 9th but was re-activated on December 15th. A few days later, the area of open water was about 100 feet long and 30 feet wide.

The aeration system worked steadily, 24 hours a day, until February 15th when the generator broke down again. A gas generator was immediately installed but it broke down on February 23rd.

Oxygen determinations were carried out on February 26th to make an assessment of the situation. No depletion was detected. Experimental angling resulted in the catch of 12 trout on February 27th and 28th.

On March 7th, the repaired propane-powered generator was reinstalled, and the compressed air started to flow again. Thanks to several holes cut through the ice, the area of open water was visible the next morning.

On March 27th the generator ran out of propane; because the spring break-up was to occur soon, no effort was made to activate the generator again. On April 2nd, oxygen determinations were taken at the edge of the still open water and at 150 yards from open water. Data presented in Table I. The aeration effect is clearly shown from these two readings, oxygen was only slightly better at all levels over the aeration pipe than it was 150 yards from the pipe.

On April 12th the ice broke up. The first oxygen determination on the open lake were taken on April 17th and showed 10 p.p.m. of oxygen at all depths. The temperature was 48°F at the surface and 43.8°F near the bottom of the lake.

Subsequent oxygen determinations were carried out at intervals of five to fifteen days throughout the summer to trace the course of oxygen depletion and to establish the effects of aeration. Data are presented in Table II.

The 'Air-Aqua" system was not in operation until late July. The oxygen content remained high probably as a prolonged effect of the aeration over the winter period. However, on July 22nd, oxygen depletion was observed below a depth of 16 feet; the aeration system was started on the same day. Oxygen determinations were 36 hours later at two stations directly over the pipe. In the immediate area of the outlet pipe, the oxygen concentration was increased from 1.0 p.p.m. to 5 p.p.m.. After 3 days of aeration, the lake had stabilized at 4 p.p.m. below the 15 foot level.

During the month of August, aeration was very intermittant due to a lack of propane; a complete oxygenation was never obtained, but the low oxygen condition recorded in previous years was not observed this year.

Data on vertical distribution of temperature, Table II, show that the thermal stratification was established by June 17th. It dissappeared during late June and early July but was recorded again on July 15th with a difference of $8^{O}F$ between the surface and the 10 foot depth. Strong mixing occured during the seven days following and from there on, the upper ten feet of water remained almost isothermic. As a result of the air-bubbling operation during late July, a difference of only 6^{o}F was recorded on August 3 between the surface and a depth of 18 feet as compared to a difference of 16^{o}F on July 15th.

By September 3rd the lake was well mixed due to wind action and was still completely oxygenated. This year, due to better oxygen conditions created by the "Air-Aqua" system, there was no summer fish kill like that which occured among the rainbow trout during 1967. The fish taken by rod and line this summer were in better condition than during the previous summer.

As a result of artificial aeration in Edwards Lake during the winter of 1967-68 and during mid-summer of 1968, the oxygen concentration was maintained at a desirable level. Convincing evidence of the effect of artificial aeration is shown in Table III. The dissolved oxygen concentration on March 7, 1967 before the installation of the "Air-Aqua" system was 3 p.p.m., well below the minimum requirement for trout life. One year later, on March 7, 1968, the concentration of oxygen was 8.5 p.p.m. as a result of artificial aeration.

At a depth of 15 feet, the oxygen went from complete depletion in March 1967 to 6 p.p.m. in March 1968.

Observations on Trout

To our knowledge no angling activities were carried out at Edwards Lake during 1968. Therefore, the creel census study was not possible.

Samples of speckled and rainbow trout were collected. Survival of trout during the winter with aeration was excellent. The speckled trout were fat and healthy. Rainbow trout were still thin but were brightly colored and healthy.

Depth in feet	Station A 10 yards from open-water		Starion B 150 yards from open-water	
	Temperature ^{o}F	Oxygen p.p.m.	Temperature ^{o}F	Oxygen p.p.m.
0	32.8		32.5	
3	36.3	9.0	35.5	9.0
5	36.5	9.0	36.5	8.0
10	37.0	8.0	37.5	6.5
15	39.5	6.0	38.6	5.0
20	39.8		40.2	

Table I: Data on temperature and dissolved oxygen in Edwards Lake following artificial aeration operation. Sampling on April 2nd 1968.

Depth in feet	May 1st		May 28		June 12		June 17		June 25		July 8	
	°F	O_2	°F	O_2	°F	O_2	°F	O_2	°F	O_2	°F	O_2
0	52.3	-	64.2	-	68.9	-	72.9	-	69.5	-	71.5	-
5	51.5	-	62.6	-	67.5	-	69.0	-	68.5	-	70.9	-
10	51.5	10.0	62.6	9.0	67.0	8.0	67.5	8.0	67.0	9.0	67.5	8.0
15	50.5	10.0	61.5	9.0	62.8	9.5	64.2	8.5	66.0	8.0	64.2	7.5
18	49.0	10.0	-	-	61.8	8.0	62.0	8.0	64.0	7.5	63.0	6.0
20	48.0	-	58.2	9.0	59.3	-	61.2	-	-	-	62.6	-

Table II: Data on temperature and oxygen in Edwards Lake during the summer of 1968.
Note: artificial aeration system in operation starting July 22.
Temperature in °F. dissolved oxygen O_2, in p.p.m.

(continued)

Depth in feet	July 15		July 22		July 24		July 26		August 3		September 3	
	°F	O_2	°F	O_2	°F	O_2	°F	O_2	°F	O_2	°F	O_2
0	78.5	-	77.5	-	75.0	-	74.0	-	72.8	-	69.0	-
5	75.0	-	76.9	-	75.0	-	74.0	-	72.0	-	69.0	-
10	70.9	8.0	73.0	7.0	75.0	7.0	74.0	7.0	70.9	7.5	69.0	7.0
15	65.8	8.0	66.5	6.0	67.5	6.0	67.6	8.0	70.9	7.0	68.0	6.5
18	62.5	7.0	62.0	1.0	66.0	5.0	-	4.0	66.0	4.0	67.0	-
20	61.0	-	61.0	-	65.0	-	62.6	4.0	64.2	-	-	-

Table II: Data on temperature and oxygen in Edwards Lake during the summer of 1968. Note: artificial aeration system in operation starting July 22, Temperature in °F. dissolved oxygen O_2, in p.p.m.

Table III: Comparative data on dissolved oxygen conditions at Edwards Lake during two late winter seasons prior to and following artificial aeration.

Depth in feet	Oxygen concentration, in p.p.m. March 7, 1967 Without aeration	March 7, 1968 With aeration
0	5.0	9.0
3	4.0	9.0
5	3.0	8.5
7	1.0	8.0
10	0.0	6.0
15		

Chapter 7

Observations on dissolved oxygen conditions during the late winter of 1968 in Gatineau Park

Once a lake has been sealed by a sheet of ice during the winter it must maintain all of its organisms throughout the rest of the winter on the oxygen that it contained when it was cut off from contact with the atmosphere. If this oxygen, for various reasons, is used up before the ice cover breaks and melts in the spring, fish and other organisms in the lake will die, resulting in what is called a "winter-kill".

It is necessary then for proper management of fish to know the late winter oxygen conditions in the lakes in order to apply proper methods to prevent oxygen depletion. For this reason, we undertook during the last two weeks of March, 1968 an investigation of sixteen lakes in the Gatineau Park.

In general, every lake in the Gatineau Park has oxygen depletion in the deeper waters. This depletion varies from lake to lake depending on fertility and whether or not the lake has a complete turnover before ice forms. Some lakes were found to have oxygen depletion severe enough to kill fish present or to severely limit the carrying capacity of the lake. The one lake that was very poor in dissolved oxygen in previous winters but that now has a large supply due to artificial aeration is Edwards Lake.

Method

A hole was drilled with a gasoline powered ice auger through the ice over the deepest section of the lake to be examined. A thermometer was lowered through the hole in the ice and water temperatures were measured at 5 or 10 foot intervals. Samples of water were then taken at various depths and analysed for dissolved oxygen with a Hach Chemical Kit. In lakes with critical oxygen values (between 3 and 4 parts per million), samples were taken at more frequent depth intervals.

Observations

Water is densest and heaviest at 39.4^{o}F. or 4^{o}C. In late fall, when the surface water cools it sinks to the bottom, the lake becomes isothermic. As the surface water becomes colder ice is formed on top of this cooler water. Therefore in the winter, the thermal stratification is the reverse of the summer, the coldest water is on the surface and the warmest water at the bottom. This condition exists in all the park lakes. Oxygen depletion occurs from the lake bottom up. If the ice cover is maintained for a long period, oxygen depletion can occur underneath the ice. This has happened in only one lake in the park. In general, oxygen conditions under the ice in Gatineau Park are marginal in small lakes and good in larger lakes although some of the lakes have a restricted survival area. Between March 18 and April 3, several lakes were visited and water samples were collected for oxygen determinations. Data are presented in Table I to XVI.

Black Lake

This is a small lake with water 30 feet deep. Winter conditions are marginal but a fair population of trout have survived there following a stocking two years ago. The lake is of the right size for temporary aeration and could be oxygenated rapidly. A low concentration of dissolved oxygen here is a result of the high productivity of the lake.

Charette Lake

This lake has a good amount of dissolved oxygen during the winter. About half of the water, to a depth of about 30 feet, is good trout habitat in late March. Aeration and fertilization would increas the productivity of this lake.

Clear Lake

This is an excellent body of water for the introduction of trout. Oxygen conditions are good down to a depth of 40 feet, which is one half the lake's depth. The water is extremely clear and should be better oxygenated than this but large hills around the lake reduce agitation by wind and prevent a complete mixing of water in the fall. If the lake was artificially turned over by oxygenation, during the fall, it would probably maintain high oxygen conditions throughout the winter and subsequently maintain a high production of trout.

Edwards Lake

Data show the dramatic change brought about by artificial aeration in this lake. In 1967 the lake was marginal for trout survival; in 1968 conditions for trout survival were optimum. Aeration like this could more than double the production of trout in other Gatineau Park lakes.

Fortune Lake

This deep lake (70 feet) has poor oxygen conditions starting at a depth of 10 feet. Aeration would be essential to ensure the survival of trout.

Hay Lake

This lake is really a large beaver pond. It is out of the way and should be left as it is. It has minimal oxygen conditions and this factor combined with its small size and inaccessibility makes it unsuitable for fisheries development at this time.

Kidder Lake

This lake is suitable for trout to a depth of about 20 feet. Aeration would increase the production of trout.

Lusk Lake

The experimental stocking of trout in this lake has been highly successful, with good survival, excellent growth and some limited natural spawning.

Conditions were excellent from the surface to a depth of 40 feet. In late winter, there was a rapid drop in oxygen below the 40 foot level. Aeration would be necessary to increase trout productivity.

Philippe Lake

This is one of the four largest lakes in the park; it is also the shallowest. Oxygen conditions here are good right to the bottom in the winter.

Lac Mousseau

This lake has excellent oxygen conditions throughout the winter.

Meach Lake

Meach Lake has excellent oxygen conditions.

Pinks Lake

Pinks Lake is a deep, steep-sided lake in a very sheltered position, resulting in little wind action and a lack of mixing. For this reason, oxygen is marginal at all times of the year. Aeration would have to be introduced to insure survival of trout.

Ramsay Lake

Ramsay Lake is open and well agitated during the summer. This results in fair oxygen conditions throughout the winter to a depth of about 25 feet. Limited artificial aeration would increase the production of trout.

Sandy Lake

This is a small lake with marginal conditions for trout survival. Oxygen conditions are poor starting at a depth of 10 feet. Aeration would be essential for maximum survival and production of trout.

Taylor Lake

Oxygen conditions in this lake are far from optimum either in summer or winter. In late winter, oxygen depletion occurs below the 15 foot level. Aeration would be essential for the survival of trout.

Wadsworth Lake

This lake has complete oxygen depletion during the winter and is totally unsuitable for trout. The lake is inaccessible and should be left in its natural state.

Conclusion

Low oxygen concentrations were noted in several of the lakes in Gatineau Park during the winter. In order to insure the survival of trout, artificial aeration would have to be provided in the following nine bodies of waters:

Lusk Lake	Hay Lake
Clear Lake	Black Lake
Taylor Lake	Sandy Lake
Edwards Lake	Ramsay Lake
Fortune Lake	

Artificial aeration would greatly increase the production of trout in the following six lakes: Kidder, Charette, Pinks, Lusk, Philippe and Mousseau.

TABLE I

BLACK LAKE

March 26th, 1968 (ice 26")

Depth in feet	Temperature in °F.	Dissolved oxygen in p.p.m.	Dissolved oxygen in % saturation
0	32.5		
3	34.2		
5	36.3	5.5	43
10	38.6	4.0	32
15	39.4		
20	39.4	1.0	8
30	40.2		

TABLE II

CHARETTE LAKE

March 19th, 1968 (ice 24")

Depth in feet	Temperature in °F.	Dissolved oxygen in p.p.m.	Dissolved oxygen in % saturation
0	33.0		
3	37.5		
5	38.2	7.0	52
10	38.2	6.5	51
15	38.6		
20	39.0	6.5	51
30	39.0		
40	39.0	4.0	32
50	39.6		

TABLE III

CLEAR LAKE

March 25th, 1968 (ice 20")

Depth in feet	Temperature in °F	Dissolved oxygen in p.p.m.	Dissolved oxygen in % saturation
0	32.8		
3	36.5		
5	37.5	11.0	82
10	39.0		
15	39.0	8.0	62
20	39.0		
30	39.0	6.0	47
40	39.0		
50	39.0	3.0	24
60	39.4		

TABLE IV

EDWARDS LAKE

April 2nd, 1968 (ice 16")

STATION A: 10 yards from open water

Depth in feet	Temperature in °F	Dissolved oxygen in p.p.m.	Dissolved oxygen in % saturation
0	32.8		
3	36.3	9.0	67
5	36.5	9.0	67
10	37.0	8.0	61
15	39.0	6.0	46
20	39.8		

STATION B: 150 yards east of open water

Depth in feet	Temperature in °F	Dissolved oxygen in p.p.m.	Dissolved oxygen in % saturation
0	32.5		
3	35.5	9.0	67
5	36.5	8.0	61
10	37.5	6.5	50
15	38.6	5.0	39
20 bottom	40.2		

TABLE V

FORTUNE LAKE

March 26th, 1968 (ice 26")

Depth in feet	Temperature in °F	Dissolved oxygen in p.p.m.	Dissolved oxygen in % saturation
0	32.5		
3	34.0		
5	37.2	6.5	50
10	38.6	4.0	32
15	38.8		
20	38.8	3.0	23
30	38.8		
40	38.8		
50	38.8	2.5	19
58	39.0		

TABLE VI

HAY LAKE

April 3rd, 1968 (ice 16")

Depth in feet	Temperature in °F	Dissolved oxygen in p.p.m.	Dissolved oxygen in % saturation
0	35.5		
3	41.0		
5	41.0	9.0	74
10	41.0	4.0	32
15	41.9	2.0	16
20	42.7		

TABLE VII

KIDDER LAKE

April 3rd, 1968 (ice 17")

Depth in feet	Temperature in °F	Dissolved oxygen in p.p.m.	Dissolved oxygen in % saturation
0	33.5		
3	38.4		
5	39.4	10.0	80
10	39.4		
15	39.4	7.0	55
20	39.4	6.0	48
30	39.4	4.5	35
40	39.4		
45	39.4		

TABLE VIII

LUSK LAKE

March 21st, 1968 (ice 24")

Depth in feet	Temperatrure in °F	Dissolved oxygen in p.p.m.	Dissolved oxygen in % saturation
0	32.8		
3	36.0	11.0	82
5	39.0		
10	39.0	7.0	55
20	39.0	7.0	55
30	39.0		
40	39.0	6.0	48
50	39.0		
60	39.4		
65	39.4	2.0	17
70	39.6		

TABLE IX

MEACH LAKE

March 18th, 1968 (ice 28")

WEST end

Depth in feet	Temperature in °F	Dissolved oxygen in p.p.m.	Dissolved oxygen in % saturation
0	32.5		
5	34.2	11.0	80
10	36.8	10.0	75
15	37.0		
20	37.5	9.0	68
25	37.8		
30	38.2		
40	39.0	6.5	50
50	39.0		
60	39.4	6.0	47
70	40.5		

EAST end

Depth in feet	Temperature in °F	Dissolved oxygen in p.p.m.	Dissolved oxygen in % saturation
0	32.5		
5	36.0	11.0	81
10	37.3		
15	37.5	10.0	75
20	38.0		
30	38.6		
40	38.6	6.5	50
50	39.0		
60	39.6	4.0	32
	39.6		

NEAR OUTLET

Depth in feet	Temperature in °F	Dissolved oxygen in p.p.m.	Dissolved oxygen in % saturation
0	32.5		
3	34.5		
5	36.5	11.0	84
10	37.2	10.0	76
15	37.6		
18	38.0	9.5	73

TABLE X

MOUSSEAU LAKE

March 22nd, 1968 (ice 28")

Depth in feet	Temperature in °F	Dissolved oxygen in p.p.m.	Dissolved oxygen in % saturation
0	32.5		
3	33.5	12.0	86
5	35.8	12.0	90
10	37.5		
15	38.0	11.0	85
20	38.0		
30	39.0	8.0	63
40	39.0		
50	39.2	6.0	47
60	40.2		
65	40.2		

TABLE XI

PHILIPPE LAKE

March 25th, 1968 (ice 30")

Depth in feet	Temperature in °F	Dissolved oxygen in p.p.m.	Dissolved oxygen in % saturation
0	32.8		
3	35.5	11	80
5	36.3		
10	37.5		
15	37.8	11	80
20	37.5		
30	38.5	8	60
40	39.5		
48	39.5		

TABLE XII

PINKS LAKE

April 2nd, 1968 (ice 15")

Depth in feet	Temperature in °F	Dissolved oxygen in p.p.m.	Dissolved oxygen in % saturation
0	32.8		
3	37.0		
5	38.6	6.0	47
10	38.6	5.0	38
15	38.6		
20	38.6	5.0	38
30	38.6		
40	38.6	3.0	23
50	39.0		
60	39.0	0(H_2S)	
65 bottom	39.4		

TABLE XIII

RAMSAY LAKE

April 3rd, 1968 (ice 15")

Depth in feet	Temperature in °F	Dissolved oxygen in p.p.m.	Dissolved oxygen in % saturation
0	35.5		
3	37.5		
5	37.5	9.0	68
10	37.5		
15	38.5	6.5	50
20	39.4		
25	39.5	2.0	15
30	39.6		
35	40.2		

TABLE XIV

SANDY LAKE

March 22nd, 1968 (ice 16")

Depth in feet	Temperature in ^{o}F	Dissolved oxygen in p.p.m.	Dissolved oxygen in % saturation
0	33.5		
3	37.5	6.0	46
5	39.0	7.0	55
10	39.2	4.0	31
20	39.2	2.0	16
30	39.8		
40	39.8		
45	40.2		

TABLE XV

TAYLOR LAKE

March 21st, 1968 (ice 18")

Depth in feet	Temperature in °F	Dissolved oxygen in p.p.m.	Dissolved oxygen in % saturation
0	33.2		
3	39.0		
5	39.4		
10	39.8	6.0	48
15	40.2	4.0	31
20	40.2		
30	40.2		
35	40.2	1.0	8
40	41.0		

TABLE XVI

WADSWORTH LAKE

March 19th, 1968 (ice 36")

Depth in feet	Temperature in °F	Dissolved oxygen in p.p.m.	Dissolved oxygen in % saturation
0	33.5		
3	36.3		
5	39.4	2.0	15
10	39.4	2.0	15
15	40.5		
18	40.5	0(H_2S)	0

Chapter 8

Lusk Lake

Open Season Trout Fishing

Lusk Lake was closed to fishing and was stocked with fingerling speckled trout in 1964 and 1965 after preliminary investigations showed the lake was well suited for those fish. A follow-up survey to study the trout growth was undertaken during the summer of 1967, the results of which were given in our 1967 report to the Commission. From this survey we found that trout growth was very good; up to 14" in 2 years, 16" in 3 years, but that natural spawning was limited. The report recommended that the lake be reopened for public angling in the spring of 1968. However, administrative technicalities prevended the lake from being opened until August 15.

We arrived at the lake at 7 A.M. on August 15, there were already 30 fishermen. During the balance of the day, the crowd fluctuated, with a total of 200 persons fishing in the lake. A total of 140 cars were seen in the parking lot during the first day. After the first day, the number of fishermen dropped to about a steady 30 a day.

On opening day, a catch of 10 speckled trout was recorded. Eight of these were large 2 to 3 pound trout from the 1964 and 1965 stockings. According to Park Wardens on duty at Lusk Lake, not more than 20 trout, speckled and rainbow, are know to have been taken. Data on trout examined are presented in Table I. Again nearly all of these were large fish from the early stockings. The one and the two year old trout resulted from natural reproduction. The rainbow trout caught had been planted in 1964.

In December a stocking of 1,000, 9"-12" speckled trout was carried out in Lusk Lake to provide angling opportunities during the 1969 angling season. Further stockings should be made when fish become available.

From discussions with anglers who visited Lusk Lake and from local newspaper reports, it appears that catches by angling were very disappointing. Several factors contributed to those results: (a) the late opening for angling when the lake was well stratified and trout difficult to catch in the cool and deep waters; (b) the very low population level from the survivals of the 1964 and 1965 plantings that by 1968 were

4 and 3 years old respectively (c) the life span of speckled trout wich seldon exceeds 3.5-4 years; (d) the numerous samplings in the course of authorized investigations and (e) the intensive illegal fishing carried out in past years.

There is no doubt that the demand for trout angling opportunities in this area is very high. Any efforts which could be made to provide this type of recreation would be well received by residents and visitors to this area.

Table I: Data on Trout caught by angling in Lusk Lake

Species	Date 1968	Serial Number	Length in inches	Weight in pounds	Sex	Age in years
Speckled trout	Aug. 15	1	11.5	0.75	male	2+
	"	2	18.0	2.75	female	3+
	"	3	16.0	2.0	female	3+
	"	4	18.5	3.0	male	4+
	"	5	15.75	2.0	female	3+
	"	6	9.50	0.3	male	1+
	"	7	18.0	3.0	male	4+
	"	8	16.75	2.5	female	3+
	"	9	14.0	2.0	female	3+
	"	10	15.5	2.0	female	3+
	Aug. 17	11	13.75	-	-	2+
		12	16.0	2.0	-	3+
		13	10.5	-	-	1+
		14	17.0	3.0	-	
	Aug. 18	15	13.0	1.5	-	2+
		16	15.0	2.0	-	3+
	Aug. 20	17	14.0	2.0	-	2+
	Aug. 24	18	14.0	1.5	-	2+
		19	18.0	3.0	-	3+
Rainbow trout	Aug. 18	20	20.0	2.5	-	4+
	Aug. 21	21	20.0	3.0	-	4+

Chapter 9

Introduction of Walleye in Lac LaPêche

Introduction

Lac LaPêche, which covers an area of 1682 acres, is the largest lake in the Gatineau Park. It consists of three distinct sections: the northern part of 584 acres is shallow, averaging 3 feet in depth and its bottom is completely covered with vegetation; the central area is 456 acres in size and thirty feet deep, and the narrow southern section covers an area of 642 acres with depths up to 100 feet. This range of ecological conditions in a large lake allows possible utilization of the lake by a variety of species of game fish. Only bass and a small population of speckled trout were present, as game fish, before the first planting of walleye in 1967.

The northern shallow section with its profuse development of aquatic plants is ideal as a breeding ground and for the growth of young forage fish such as minnows, suckers and perch and for shallow water game fish such as bass, pike or maskinonge.

The central section is populated by a large number of perch, which are the chief forage fish for walleye. This area does not develop a permanent thermocline during the summer and could therefore be utilized throughout by perch, walleye, bass or maskinonge. Since perch are in great abundance in Lac LaPêche and since they are the chief food item for young walleyes, there should be an extremely rapid growth for the first few years among introduced walleyes. However, heavy predation by perch of all sizes on young walleye is to be expected.

The western section of the lake is characterized by depths of 100 feet, but also by wide shallow bays. The deeper waters at present are being utilized by a small population of speckled trout. As this area quickly becomes depleted of oxygen during the summer below the thermocline, little can be done at present with respect to deep water game fish. The wide shallow bays on the other hand are well suited for warm-water game fish.

Fish Culture Operation

Acting on experience obtained in last year's walleye operation, the hatching of three million eggs in 1968 was very successful. The hatching station was set up one week prior to the arrival of the eggs. The system was functioning perfectly on the arrival of the eggs on May 24. This year, a first batch of 1½ million eggs was shipped to Ottawa in the early eyed stage. A well insulated box was used to ship the eggs, and they arrived in excellent condition. These eggs took a week to hatch at Lac LaPêche. A second shipment of 1½ million eggs which arrived on June 4th was received in an advanced stage of development. Although the eggs were well packed there was approximately a 10 per cent mortality due to hatching in transit. It took only 3 days for these eggs to hatch.

The system used to hatch the eggs involved a continuous flow of water. Water was pumped from the lake to a head tank of 54 cu. ft in order to reduce turbulence and air bubbles which can damage the eggs and to provide a reservoir of water in case of a pump stoppage. The pumps used this year gave exceptional service. The main pump in operation was a 1/3 H.P. electric pump that worked continuously for 17 days. A ½ H.P. gasoline pump was kept in standby in case of a electrical pump failure. The intake consisted of a 200 foot, 2 inch diameter, plastic pipe projecting onto the lake surface. The outer end of this pipe was fitted with an elbow and a 15 foot extension pipe with a foot valve projecting down into the water. The cool water removed from the 15 foot depth in the lake kept the water in the hatching jars between 50^{o} and 59^{o}F during the two week hatching period. This colder water reduced thermal shock to the eggs when first removed from the shipping containers into the jars, retarded fungus growth, and kept the egg development at a slow steady pace.

The water in the reservoir tank was allowed to flow through twelve jars which overflowed into two troughs connected to the lake by two plastic pipes, two inches in diameter. When properly regulated the flow into the incubating jars was enough to keep the eggs in motion within the lower half of the jars.

When the fry hatched they swam with the current to the top of the jar, went down the drain tubing into the troughs and from there they drifted with the current down the outlet pipes into the lake, about 300 feet away from the shore.

Recommendations for 1969 operation

Since about one thousand acres of the total acreage of Lac LaPêche is considered as excellent walleye water and since recent publications have suggested a stocking rate of 2,500 fry per acre, a total of 2,500,000 fry should be released each year in Lac LaPêche until there is evidence that natural propagation is taking place.

Predation by perch was evident last spring. A large school of perch was observed in the vicinity of the outlet pipe during the entire hatching period. In order to reduce such predation, fry were collected with dip nets from the troughs into buckets and released in shallow waters in various parts of the lake.

In view of the high rate of mortality among walleye fry during incubation and during the first days of planktonic life, a supply of 7,000,000 eggs should be made available for hatching at Lac LaPêche.

The following suggestions are offered:

(a) Continue to have a gasoline pump stand-by in case of failure of the electrical pump.

(b) Install an alarm system to warn the workers in case of flow stoppage.

(c) Avoid free movement of the fry into the lake; 2 or 3 circular tanks should be utilized to collect and concentrate the fry. From these tanks the fry could be removed for distribution to all parts of the lake.

(d) Most of the eggs should be shipped to Lac LaPêche in the very early stage in order that the walleye fry may hatch before the young perch of the year become too large to serve as prey.

Chapter 10

Growth of lake trout in Meach Lake

Meach Lake is a moderately deep lake, three miles long and averaging 1/3 of a mile in width. It occupies a glacially dammed trech on the north side of the Gatineau hills. The axis of the lake is oriented north-west south-east and therefore lies along the path of prevailing winds. It is the only lake in the Gatineau Park which still contains lake trout.

The lake trout population has remained at a low level for the last twenty years. Very few fish are caught each year, and those taken are usually quite large. In the spring of 1967, 9,000 lake trout yearlings, from 3 to 5 inches in length, were stocked in the lake.

The conditions that make Meach Lake suited for lake trout are: morphometry, presence of a large supply of forage fish, and a large number of excellent rocky reefs for spawning. The lake, although only 70 feet deep and 2/3 of a wide at its widest point, has depths of 40 feet close to shore. Sixty per cent of the lake is over 40 feet in depth. This allows for a large volume of well-oxygenated cold water below the thermocline throughout the summer which can support a large population of lake trout.

Lac Mousseau and Lac LaPêche both had lake trout populations prior to 1940. Those populations have desappeared due to the oxygen depletions that now exist in these lakes below the thermocline and to heavy bass and perch populations. It is most likely that illegal netting also had much to do reducing the lake trout in all the lakes of the park. Meach Lake also possesses a large smelt population that is lacking in other park lakes. This small fish is an excellent forage fish and as a result there is very fast growth in young lake trout. Thirdly, the presence of shallow and rocky shores, perfect for spawning, has allowed the lake trout to maintain themselves by natural propagation in spite of large populations of predators, such as perch and bass.

Sampling was very spotty during 1968, only three fish were examined. All were taken by angling. Nets were set during one evening in August; 7 nets were set between 20 and 50 feet, but no trout were taken. Sampling planned for the month of December was not possible due to early ice formation. Data on the three lake trout examined were as follows:

Date	Lenght in inches	Wt. ounces	Sex	Age	Stomach content
May 14	16	16	M	3+	-
July 9	9	4	M	2+	2 smelt
July 9	12.5	12	M	2+	3 smelt

The two specimens caught on July 9 may be related to the planting of yearlings in the spring of 1967.

CHAPTER 11

Detailed Chemistry of Gatineau Park Waters

Introduction

As requested, water samples were collected from several lakes in Gatineau Park for detailed analysis. The following lakes were studied: Meach, Philippe, LaPêche, Ramsay, Kidder, Leblanc and Pinks. Two samples were obtained from each lake: one at the water surface and one within the thermocline. The analysis was carried out by the Water Quality Division, Department of Energy, Mines and Resources. Results are presented in Table I.

In lakes as on land, nutrients for biological productivity are provided by soils and rocks. Data on the quality and the quantity of nutrients are essential in estimating the production of fish in a body of water. Information available to date on the chemistry of Gatineau Park waters is too sketchy to allow at this time a detailed discussion on the problems involved in planning a long-term sport fishery management program. However a brief summary of the highlights will be presented. In order to facilitate comparaisons with other regions of Canada, we have followed the pattern adopted by Kerekes (1968) in his report dealing with Newfoundland waters.

Sum of constituants

The sum of constituants ranges from 47.0 to 60.8 p.p.m. for the three larger lakes, Philippe, Meach and LaPêche, and from 35.7 and 39.7 p.p.m. for Leblanc, Ramsay and Kidder lakes. These values reflect the unproductive contribution of the pre-cambrian granite rock formation to the local soil and watershed. Pinks Lake shows a value of 148 p.p.m.; this high value, particularly made of calcium and bicarbonate, is due to the crystalline limestone formation found in this area.

In most cases, the sum of constituants is higher in deep waters at the surface.

Specific conductivity

The salinity of waters, the concentration of total solids and the specific conductivity are usually closely related. These latter values range from 88.1 to 120.0 for the larger lakes and from 61.3 and 69.0 for the smaller ones. Pinks Lake again shows a higher value than the other lakes in Gatineau Park because of the geological formation on which it rests.

Hydrogen ion concentration

Except for the surface water samples from Lac LaPêche with a pH of 7.2 and Pinks Lake with a pH of 7.7, all other waters in Gatineau Park range between a pH of 6.2 (Ramsay Lake, deep) and the 7.0 neutrality (Meach Lake, surface). In most cases, the waters from deep levels, within the thermocline, are more acid than from the surface. The widest range in a body of water was found in Lac LaPêche were the pH changes from 7.5 at the surface and 6.0 at the 30 foot level. This information indicates that the carbon dioxide accumulates in deep waters and reflects the eutrophication condition of this portion of Lac LaPêche.

Total alkalinity

This value ranges between 14.7 and 24.3 for the smaller lakes, namely Ramsay, Kidder and Leblanc, and between 26.6 and 44.6 for the larges lakes, namely Philippe, Meach and LaPêche. The total alkalinity in Pinks Lake is exceptionally high with a value of 112.0 p.p.m.

Total hardness

Waters from Gatineau Park are classified as soft with total hardness values ranging from 25.3 (Leblanc Lake, surface) to 54.8 p.p.m. (Lac LaPêche, deep). Here again Pinks Lake with a hardness value of 134.0 p.p.m. represents an exception for this area.

Cations and anions

The typical order of dominance of cations is, from high to low, sodium, calcium, magnesium and potassium, expressed as follows:

Na > Ca > Mg > K. In Gatineau Park, the order is as follows: Ca > Mg > Na > K. Values in p.p.m. for surface water samples are as follows:

	Ca	Mg	Na	K
Lac LaPêche	17.5	2.2	1.7	0.8
Meach Lake	14.5	2.3	1.3	0.8
Philippe Lake	11.5	2.6	1.8	0.7
Ramsay Lake	9.5	1.5	1.2	0.6
Kidder Lake	9.8	1.3	1.5	0.6
Leblanc Lake	7.8	1.4	1.4	0.7
Pinks Lake	49.4	2.6	2.3	1.1

The anion results show that bicarbonate is higher than sulphate, and higher than chloride. Details for surface water samples are as follows:

	HCO_3	SO_4	Cl
Lac LaPêche	52.8	10.6	0.8
Meach Lake	41.3	11.7	1.5
Philippe Lake	32.4	10.6	3.1
Ramsay Lake	27.0	9.2	1.1
Kidder Lake	24.7	9.6	0.7
Leblanc Lake	17.9	10.0	1.6
Pinks Lake	137.0	21.5	2.2

Pinks Lake shows high concentration of bicarbonate and sulphate. Analysis shows that the average values are higher for the larger lakes than for the smaller ones. The values in sulphate are about the same in all lakes; the chloride shows slightly higher values in large lakes than in small ones.

Silica

In all lakes, the value of silica are higher from deep water samples than surface samples. The widest difference is found in Ramsay Lake with 1.8 p.p.m. at the surface and 6.0 at the 18 foot level. The average concentration of silica in deep water samples from the smaller lakes is 5.2 p.p.m. while in larger lakes the average is 3.2 p.p.m.

Minor metallic values

Several minerals listed in the analytical tables include iron, aluminum, manganese, copper and zing. Little is known on the significance of these trace elements in the productivity of waters for various species of fish. However data show that the value in iron are almost uniform, except in Leblanc Lake with 0.15 p.p.m., about 4 times the average. The concentration of aluminum is low, but Leblanc Lake has twice the overall average. Manganese was found only in Kidder Lake. Copper is found in all the lakes except in Philippe Lake. The concentration of zing is low in all waters but much higher in Ramsay, Leblanc and Pinks Lakes.

Summary

In summary, studies carried out indicate that most lakes in Gatineau Park are soft, slighly acid with low conductivity. The productivity will be much lower than in waters favoured with high dissolved mineral concentrations and high conductivity. However Gatineau Park offers excellent opportunities to carry out fundamental research on the relationship between chemistry and trout production, once the lakes have been rehabilitated and restocked.

Table I: ANALYSIS OF WATER SAMPLE(S)

(In parts per million)

Location	Gatineau Park, Quebec	
Source of water	Lac Philippe	Lac Philippe
Sampling point Level at sampling (ft.)	surface	40
Reference	J. P. Cuerrier, Canadian Wildlife Services	
Laboratory number	1243	1244
Date of sampling	14-9-68	14-9-68
Storage period (days)	10	10
Temp. at sampling (°C)	18.3	10.6
Temp. at testing (°C)	20.6	20.7
Appearance, odour, etc.		
Organic matter:		
Oxygen consumed ($KMnO_4$)	3.2	3.0
Chem. oxygen demand (C.O.D.)		
Ultra violet absorption (mμ)		
Carbon dioxide (CO_2), calculated	3.	19.
pH	7.2	6.5
Colour (Hazen units)	5.	10.
Turbidity (Units)	0.28	1.2
Alkalinity as $CaCO_3$ (-Phenolphthalein	0.0	0.0
Alkalinity as $CaCO_3$ (-Total	26.6	30.4
Susp. matter, dried at 105°C		
" " ignited at 550°C		
Res. on evap., dried at 105°C		
Loss on ignition at 550°C		
Sp. conductance, micromhos at 25°C	88.1	93.4
Hardness as $CaCO_3$ (Total	39.4	41.9
Hardness as $CaCO_3$ (Non-carbonate	12.8	11.5
Calcium (Ca)	11.5	12.5
Magnesium (Mg)	2.6	2.6
Iron (Fe) Total	0.05	0.960
Iron (Fe) Dissolved	0.00	0.005
Aluminum (Al)	0.03	0.02
Manganese (Mn) Total	0.00	0.75
Manganese (Mn) Dissolved	0.00	0.00
Copper (Cu) Total	0.000	0.008
Zinc (Zn) "	0.005	0.003
Sodium (Na)	1.8	1.9
Potassium (K)	0.7	0.6
Ammonia (NH_3)	0.1	0.2
Carbonate (CO_3)	0.0	0.0
Bicarbonate (HCO_3)	32.4	37.1
Sulphate (SO_4)	10.2	8.6
Chloride (Cl)	3.1	3.1
Fluoride (F)	0.04	0.04
Phosphate (PO_4) Total		
Ortho (Dissolved)	0.00	0.00
Nitrate (NO_3)	0.00	0.10
Silica (SiO_2)	1.1	4.2
Sum of constituents	47.0	51.9
% Sodium	8.9	8.9
Saturation index at test temperature	-1.8	-2.4
Stability index at test temperature	11.0	11.0
Sodium Absorption Ratio (SAR)	0.1	0.1

Table I: ANALYSIS OF WATER SAMPLE(S)

(In parts per million)

Location	Gatineau Park, Quebec		
Source of water	Pinks Lake	Lac Lapeche	Lac Lapeche
Sampling point			
Level at sampling (ft.)	0	30	surface
Reference	J. P. Cuerrier, Canadian Wildlife Services		
Laboratory number	1240	1241	1242
Date of sampling	12-9-68	13-9-68	14-9-68
Storage period (days)	11	10	10
Temp. at sampling (°C)		14.4	18.3
Temp. at testing (°C)	20.3	20.9	20.8
Appearance, odour, etc.			
Organic matter:			
Oxygen consumed ($KMnO_4$)	4.3	6.3	6.0
Chem. oxygen demand (C.O.D.)			
Ultra violet absorption (mμ)			
Carbon dioxide (CO_2), calculated	4.	14.	3.
pH	7.7	6.8	7.5
Colour (Hazen units)	5.	10.	5.
Turbidity (Units)	0.46	0.78	0.33
Alkalinity as $CaCO_3$ (-Phenolphthalein	0.0	0.0	0.0
(-Total	112.	44.6	43.3
Susp. matter, dried at 105°C			
" " ignited at 550°C			
Res. on evap., dried at 105°C			
Loss on ignition at 550°C			
Sp. conductance, micromhos at 25°C	271.	114.	120.
Hardness as $CaCO_3$ (Total	134.	54.8	52.8
(Non-carbonate	22.	10.2	9.5
Calcium (Ca)	49.4	18.3	17.5
Magnesium (Mg)	2.6	2.2	2.2
Iron (Fe) Total	0.05	0.08	0.03
Dissolved	0.00	0.00	0.00
Aluminum (Al)	0.044	0.017	0.02
Manganese (Mn) Total	0.00	0.07	0.00
Dissolved	0.00	0.00	0.00
Copper (Cu) Total	0.002	0.007	0.014
Zinc (Zn) "	0.010	0.003	0.005
Sodium (Na)	2.3	1.7	1.7
Potassium (K)	1.1	0.8	0.8
Ammonia (NH_3)	0.40	0.10	0.00
Carbonate (CO_3)	0.0	0.0	0.0
Bicarbonate (HCO_3)	137.	54.4	52.8
Sulphate (SO_4)	21.5	10.1	10.6
Chloride (Cl)	2.2	1.1	0.8
Fluoride (F)	0.05	0.05	0.05
Phosphate (PO_4) Total			
Ortho (Dissolved)	0.00	0.00	0.00
Nitrate (NO_3)	0.01	0.03	0.00
Silica (SiO_2)	2.0	2.3	1.2
Sum of constituents	148.	63.3	60.8
% Sodium	3.6	6.2	6.4
Saturation index at test temperature	-0.07	-1.8	-1.1
Stability index at test temperature	7.8	10.0	9.7
Sodium Absorption Ratio (SAR)	0.09	0.1	0.1

Table I: [illegible]

(In parts per million)

Location	Gatineau Park, Quebec			
Source of water	Kidder Lake	Kidder Lake	Lac Leblanc	Lac Leblanc
Sampling point				
Level at sampling (ft.)	23	0	0	22
Reference	J. P. Cuerrier, Canadian Wildlife Services			
Laboratory number	1236	1237	1238	1239
Date of sampling	11-9-68	11-9-68	11-9-68	11-9-68
Storage period (days)	9	9	12	12
Temp. at sampling (°C)	10.0	18.9	18.9	10.0
Temp. at testing (°C)	20.0	20.3	20.3	20.2
Appearance, odour, etc.				
Organic matter:				
Oxygen consumed ($KMnO_4$)	3.5	4.3	4.3	4.7
Chem. oxygen demand (C.O.D.)				
Ultra violet absorption (mμ)				
Carbon dioxide (CO_2), calculated	15.	8.	5.	13.
pH	6.5	6.7	6.8	6.4
Colour (Hazen units)	5	5.	5.	10.
Turbidity (Units)	0.22	0.16	0.76	2.4
Alkalinity as $CaCO_3$ (-Phenolphthalein	0.0	0.0	0.0	0.0
(-Total	24.3	20.3	14.7	16.7
Susp. matter, dried at 105°C				
" " ignited at 550°C				
Res. on evap., dried at 105°C				
Loss on ignition at 550°C				
Sp. conductance, micromhos at 25°C	72.6	65.6	61.3	63.6
Hardness as $CaCO_3$ (Total	33.7	29.9	25.3	26.2
(Non-carbonate	9.4	9.6	10.6	9.5
Calcium (Ca)	11.0	9.8	7.8	8.0
Magnesium (Mg)	1.5	1.3	1.4	1.5
Iron (Fe) Total	0.04	0.04	0.15	0.46
Dissolved	0.00	0.00	0.00	0.01
Aluminum (Al)	0.03	0.03	0.06	0.02
Manganese (Mn) Total	0.03	0.01	0.00	0.13
Dissolved	0.00	0.00	0.00	0.00
Copper (Cu) Total	0.005	0.010	0.005	0.012
Zinc (Zn) "	0.005	0.010	0.010	0.005
Sodium (Na)	1.1	1.5	1.4	1.5
Potassium (K)	0.6	0.6	0.7	0.8
Ammonia (NH_3)	0.0	0.30	0.40	0.10
Carbonate (CO_3)	0.0	0.0	0.0	0.0
Bicarbonate (HCO_3)	29.6	24.7	17.9	20.4
Sulphate (SO_4)	9.5	9.6	10.0	9.6
Chloride (Cl)	0.8	0.7	1.6	1.7
Fluoride (F)	0.03	0.02	0.08	0.07
Phosphate (PO_4) Total				
Ortho (Dissolved)	0.00	0.00	0.00	0.00
Nitrate (NO_3)	0.00	0.00	0.00	0.00
Silica (SiO_2)	5.3	3.7	3.9	4.3
Sum of constituents	44.4	39.4	35.7	37.5
% Sodium	6.5	9.6	10.0	11.0
Saturation index at test temperature	-2.6	-2.5	-2.6	-2.9
Stability index at test temperature	12.0	12.0	12.0	12.0
Sodium Absorption Ratio (SAR)	0.08	0.8	0.1	0.1

Table I: ANALYSIS OF WATER SAMPLE(S)

(In parts per million)

Location	Gatineau Park, Quebec			
Source of water	Meach Lake	Meach Lake	Ramsay Lake	Ramsay Lake
Sampling point				
Level at sampling (ft.)	35	0	18	0
Reference	J. P. Cuerrier, Canadian Wildlife Service			
Laboratory number	1232	1233	1234	1235
Date of sampling	10-9-68	10-9-68	11-9-68	11-9-68
Storage period (days)	10	10	9	9
Temp. at sampling (°C)	10.6	18.9	10.0	18.9
Temp. at testing (°C)	20.5	20.8	20.9	20.2
Appearance, odour, etc.				
Organic matter:				
Oxygen consumed ($KMnO_4$)	4.0	3.5	6.7	6.7
Chem. oxygen demand (C.O.D.)				
Ultra violet absorption (mμ)				
Carbon dioxide (CO_2), calculated	17	6.	25.	9.
pH	6.6	7.0	6.2	6.7
Colour (Hazen units)	5	5.	20.	10.
Turbidity (Units)	0.26	0.18	0.98	0.27
Alkalinity as $CaCO_3$ (-Phenolphthalein	0.0	0.0	0.0	0.0
Alkalinity as $CaCO_3$ (-Total	34.9	33.9	20.5	22.3
Susp. matter, dried at 105°C				
" " ignited at 550°C				
Res. on evap., dried at 105°C				
Loss on ignition at 550°C				
Sp. conductance, micromhos at 25°C	105	104	66.0	69.0
Hardness as $CaCO_3$ (Total	46.1	45.7	29.9	33.7
Hardness as $CaCO_3$ (Non-carbonate	11.2	11.8	9.4	11.4
Calcium (Ca)	14.5	14.5	9.5	10.7
Magnesium (Mg)	2.4	2.3	1.5	1.7
Iron (Fe) Total	0.08	0.02	0.31	0.05
Iron (Fe) Dissolved	0.00	0.00	0.01	0.01
Aluminum (Al)	0.01	0.01	0.02	0.01
Manganese (Mn) Total	0.07	0.00	0.25	0.00
Manganese (Mn) Dissolved	0.00	0.00	0.00	0.00
Copper (Cu) Total	0.004	0.004	0.005	0.008
Zinc (Zn) "	0.002	0.002	0.006	0.020
Sodium (Na)	1.3	1.3	1.2	1.2
Potassium (K)	0.8	0.6	0.6	0.6
Ammonia (NH_3)	0.2	0.0	0.0	0.20
Carbonate (CO_3)	0.0	0.0	0.0	0.0
Bicarbonate (HCO_3)	42.5	41.3	25.0	27.2
Sulphate (SO_4)	11.2	11.7	8.8	9.2
Chloride (Cl)	1.5	1.5	0.9	1.1
Fluoride (F)	0.06	0.05	0.05	0.05
Phosphate (PO_4) Total				
Ortho (Dissolved)	0.02	0.01	0.03	0.00
Nitrate (NO_3)	0.09	0.04	0.02	0.02
Silica (SiO_2)	3.1	1.4	6.0	1.8
Sum of constituents	55.9	53.7	41.0	39.7
% Sodium	5.7	5.7	7.8	7.0
Saturation index at test temperature	-2.2	-1.7	-3.0	+2.4
Stability index at test temperature	11.0	11.0	12.0	11.0
Sodium Absorption Ratio (SAR)	0.08	0.08	0.08	0.09

Chapter 12

Vertical distribution of Temperature and Dissolved Oxygen in Gatineau Park waters during 1968

Introduction

Two of the basic requirements for aquatic life are the maintenance of the necessary levels of oxygen and temperature. These two factors determine the fish life that can exist in a body of water. In a study to determine the feasibility of a trout fishery in certain lakes those are the first two factors that should be examined. If they are not acceptable for fish steps must be taken to correct the deficiency. There are two critical times of the year with respect to temperature and oxygen: late winter, which has already been discussed under a separate heading, and late summer which will be discussed in this section. This report presents data on temperature and oxygen at various depth in most of the lakes in the park.

Method

Temperature were taken with an electronic thermometer with a depth range of 100 feet. Readings were taken at 5 foot intervals and at 2-3 foot intervals in the area of the thermocline.

Oxygen determinations were made by collecting a volume of water at the desired depth in a closing bottle and then determining the dissolved oxygen content with a Hach Chemical Kit.

A station was established in each lake over the deepest area where temperature and oxygen determinations were made on the site.

Observations

The lakes of the Gatineau Park belong to two drainage systems. The first and largest of these inside the park is the Philippe-Meach Lake watershed system draining Lusk, Taylor, Clear, Mud, Philippe, Mousseau, Charette, Wadsworth, Carmen, Brown, Spring and Meach Lakes. The second is the LaPêche River which drains Kidder, Ramsay, Holly, Ben, Richard, Leblanc, LaPêche, Kelly and Sandy lakes. Fortune lake drains into the Gatineau River via the Chelsea Brook.

The Philippe-Meach Lake system is entirely inside the park, has the largest area and diversity of lakes and is the most remote of the drainage systems. It is better suited for the development of a trout fishery and as such has received the greatest emphasis of study.

In general all the lakes in the park undergo oxygen depletion to some extent during the summer. Most lakes undergo depletion because they are rich eutrophic lakes such as Mousseau. Low levels of dissolved oxygen occur year round in the deeper waters of the more oligotrophic lakes. They do not undergo complete mixing by wind action in the spring because they are sheltered by surrounding mountains. Pinks, Richard and the deepest section of LaPêche Lake are examples.

The main purpose of this study was to determine the suitability of Gatineau Park waters for trout with respect to thermal stratification and particularly with respect to the most vital factor, i.e. the concentration of oxygen. The lower limit for trout survival in various lakes is presented in Table I. Details of vertical distribution of temperature and oxygen are presented in Table II.

Data show that the following lakes should be disregarded for game fish management because the oxygen is extremely low even during the early part of the summer:

Holly Lake
Wadswoth Lake
Mud Lake

Aeration would be required to insure survival during the latter part of the summer and during the winter in the following lakes:

Fortune Lake

Ramsay Lake

Black Lake

Taylor Lake

Pink Lake

Maximum production of the trout population could be obtained by artificial aeration in the following lakes:

Charette Lake	Lac LaPêche
Clear Lake	Lusk Lake
Kidder Lake	Meach Lake
Leblanc Lake	Mousseau Lake
Richard Lake	Philippe Lake

Table I: Data on dissolved oxygen concentration at a critical depth for trout survival as compared to the maximum depth, in feet.

Lake	Oxygen	Critical depth in feet	Maximum depth in feet
Black	0.5	15-20	30
Charette	3	16	50
Clear	4	35	70
Fortune	2.5	13-15	70
Holly	1	8	19
Kidder	3.5	30	45
Leblanc	3	22	30
LaPêche (west)	4	25	100
Lusk	4	20	70
Meach	4.5	30	70
Mousseau	4.5	30-35	70
Mud	3	10	17
Philippe	4	35	48
Pinks	0	22-25	65
Ramsay	4.5	15	35
Richard	4	25	60
Taylor	4	23	40
Wadsworth	4.5	10	18

Depth in feet	Black Lake Sept. 25		Charette Lake Sept. 9		Clear Lake Sept. 4		Fortune Lake Sept. 25		Holly Lake June 26		Kidder Lake Sept. 11	
	°F	O_2	°F	O_2	°F	O_2	°F	O_2	°F	O_2	°F	O_2
0	63	-	64	-	67		62		65		66.0	
5	61	-	63	-	67		62		63.5	7	66	
10	61	8	62.5	7.5	67		57	8	54.3	1	66	
15	58	6	59	5.5	67		50	2.5	41.0	0	66	
18	53		51.5	0			46		46.0		63	
20	48	0.5	46.5	0	66.5	8	43	1.0	45.6		60	8.5
22	45		44.0		59				-		52	
25	43		40.5		55		39.5				48	8.0
27	42										46	6.5
30	-		40.0		48		39.5				44	3.5
35					43.5	4					40	
40			39.5		41		39.5				40	
45					39.5		-				—	
50			39.5		39.5	0						
60					39.5							
70					—							

Table II - Detailed data on vertical distribution of temperature and dissolved oxygen in Gatineau Park waters during criticals periods in 1968. (continued)

Depth in Feet	Lapêche Lake Oct. 12 °F	O_2	Leblanc Lake Sept. 12 °F	O_2	Lusk Lake Sept. 4 °F	O_2	Meach Lake Sept. 4 °F	O_2	Philippe Lake Oct. 12 °F	O_2	Pinks Lake Sept. 25 °F	O_2
0	65.0		66		68		66		57.5		65	
5	65		66		68	8.0	66		57		63	
10	65	7.5	66		68		66		57		62	
15	65		64.5	7.0	66		65.5		57		62	9
18			57		60						59	
20	65		53	5.5	55	4.0	65.0	8.5	57	8	56	16
22			50	3.0	51						48	
25	61	4.0	45.5		46.5		63	6.5	57		43	0
27	58		44.5		44		61					
30	54.5	1.0	—		43	2.0	55.5	4.5	56.5	8	39.5	0
35	50.5				41.5		50.5	4.5				
40	48.5	0			40	1.5	47.5	4.5	54	1	39.5	
45	47.0						45	2	—			
50	46				39.5		43				39.5	
60	45				39.5	0	—				39.5	
70	44				—						—	
80	43											
90	43											

Table II (Continued)

Depth in Feet	Mousseau Lake Sept. 3 ^{o}F	O_2	Mud Lake July 24 ^{o}F	O_2	Ramsay Lake Sept. 11 ^{o}F	O_2	Richard Lake June 20 ^{o}F	O_2	Taylor Lake Sept. 5 ^{o}F	O_2	Wadsworht Lake Sept. 9 ^{o}F	O_2
0	68		77		66		65		67		65	
5	68		70	5	66		65	8	67		62.5	4.5
10	68	8	58.5	3	66	8	63.5		67		59.5	
15	68		47.5	0	58	4.5	54	11	67	7	50	0
18			46.5		50	1	46				—	
20	68		—		47		43	11	63	6		
22					44		41		58	4		
25	67	7			42.5		40	4	54	1.5		
27	66				42				50.5			
30	60	5			41.5		39		46	0		
35	55	2			41.5				44			
40	52	1			—		39	0	—			
45	—											
50							39					
60							39					
70												
80												