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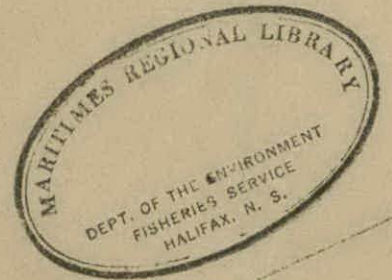
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RESOURCE DEVELOPMENT BRANCH

MANUSCRIPT REPORT

No. 53 - 1



Report on Fish (Salmon) Management - 1953

by

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and

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DEPARTMENT OF FISHERIES AND FORESTRY OF CANADA
HALIFAX, N.S.

REPORT ON FISH (SALMON) MANAGEMENT - 1953

In 1952, conclusions were reached on salmon management for Shubenacadie Lake, at the end of a five-year attempt to use for lake salmon the results of previous investigations on sea salmon. These conclusions were embodied in the Annual Report for 1952. Since the local salmon are four and five years old as taken by anglers and since management presents a changing problem, five years seemed to be the minimum period for this investigation of management. The situation has been followed for a sixth and last year, which has permitted some test of the sufficiency of the five-year period. Our knowledge has been amplified, but nothing has arisen to alter the conclusions of a year ago and it is to be inferred that the time taken was adequate for what was attempted.

Saving Small Salmon. Of 918 three-year-old salmon averaging 10.6 inches long, which were tagged and liberated in the lake in the autumn of 1951, 154 were taken by angling in the spring of 1952. It was calculated from a sample held in a pond that, since 5% lost their tags by the spring of 1953, there remained 726 to serve as a test of the value of saving such small fish and of maintaining a lower size limit for capture of 15 inches. Not a single one was captured by anglers in the season of 1953. This makes the case for saving small fish even poorer than it was as reported a

year ago.

Planting of Smolts. In 1953 there was a further opportunity to determine the effectiveness for angling of planting smolts that had been reared in the ponds. A planting of 26,100 marked smolts out in the Grand portion of the lake in June of 1950 would provide five-year-old fish and a similar planting of 16,476 in June of 1951 would provide four-year-olds for the angling. During the season of 1953, a total of 229 untagged salmon were reported caught by anglers. With more experience, 112 of these were critically examined for missing fins, a larger proportion than in any previous year. Not a single marked salmon was found. Whatever may have been the reason, there was thus total failure of evidence that smolt planting is of value for the fishing. It confirms what was reported a year ago that, poor as were the results from planting at the head of the lake, planting in the deep and wide Grand part of the lake is poorer still.

Planting Salmon Parr. A good test of planting is to alternate it with no planting in successive years. It happens that the streams tributary to Cobequid Bay, N. S., were rather heavily planted (127,000 to 382,000 fish per year) with underyearling (and a few yearling) salmon from 1941 to 1950, with the exception of two pairs of years, 1943-1944 and 1947-1948, when only from 20,000 to 30,000 were planted. Nearly all the Cobequid salmon caught by fishermen are in

their fourth year, so that it is easy to relate the landings for any year to the proper plantings. While the landings have risen markedly in the last three years in correspondence with increased plantings from 1948 to 1950, the extremely low catch in 1951 with apparent utter absence of the 1948 year-class, which would then be in their fourth year, presented a problem quite outside planting practice. In itself, that low catch actually indicates that the 20,000 underyearlings planted in 1948 had no effect whatever. That low catch and the rise in 1952 and 1953, for which it paved the way, have been related to water conditions for spawning in 1947, 1948 and 1949, from which would come the catches for the three years. On comparing the plantings from 1942 to 1950 with the landings from 1945 to 1953, it is quite evident that the latter do not vary with the former, but change as frequently in the reverse direction as in the same direction. There is failure of evidence that the plantings are effective.

Stream Dams. The importance for maintaining and increasing the production of salmon smolts for Shubenacadie Lake, of constructing stream dams at the outlets of the source lakes of the Beaver-Rawdon River to maintain stream flow has been repeatedly stressed. Lakes rather than springs maintain this stream flow, and their outlets are so broad that water from rainfall runs out quickly, giving very

heavy floods, and with prolonged drought reducing flow to a mere trickle. Heavy floods carry the young salmon down and lack of flow deprives them of their habitat, the rapids, making them easy prey for eels and other predators.

Construction of a sample stream dam on Lewis Lake at the very head of the Beaver River continues to be held up through lack of permission from the landowner. The device is so novel that there is difficulty in getting appreciation of how it can fit into other uses of the water. The only essential is that the stored water should continue to run out slowly. The level of the lake water that will prevail is immaterial. The dam may be of whatever height will give the desired level. If the present level is preferred, provision must be made for the water to run out below that level through a trench cut through the sill at the outlet or through a pipe embedded in the sill. The engineering problem is how to construct at low cost what will suit local wishes and conditions and give adequate flow during drought. Some experimenting will be necessary.

Elimination of Eels. High summer temperatures, an abundance of large stones for cover during the day and small flow of water make it easy for eels to prey upon young salmon in the Beaver-Rawdon River, and they seem to be the chief predator there on small fish. The elimination from the river would increase the production in it of salmon smolts for

Shubenacadie Lake.

Experiments have shown that eels fail to ascend a sharp fall of water, which need not be very high. Since they reach the river from the ocean where they breed, they could be excluded from it by construction near the outlet of the river of a dam that would give the necessary fall of water and around which they could not make their way. This means a perfectly tight dam, which could be of concrete, with an apron or spout which would at all times give a clean fall of water. There will be success only by having the proper fall and no other water course by which the eels might get above the dam.

Removal of eels by trapping in order to increase the number of salmon smolts descending the Lower Rawdon River from summer plantings of yearling salmon was attempted in the summer of 1951. This was somewhat successful as shown by smolt trapping in 1952, but a winter flood was thought to have removed some of the fish, reducing the apparent survival. A second experiment was tried, 400 yearlings being planted on July 26 in 1952. A very heavy winter flood again occurred to reduce the count of smolts in the spring of 1953. Only 0.25% was taken, a much poorer result even than that obtained before eels were removed. But the eels had not been as thoroughly removed. No good basis is yet seen for trapping eels to increase smolt production.

Eels are particularly abundant in the streams of outer Nova Scotia because the young eels come from the ocean. Considering the wealth and variety of fish in that region, it should not be surprising that they are not highly regarded when not readily available in large lots. Since the small eels or elvers are comparatively hardy, it seemed to be possibly worth while to ship them to the Prairie Provinces for planting in waters where fish are comparatively scarce. The scientific basis for this shipment was worked out in 1952. In May of 1953, 14,000 elvers were shipped by air in waxed paper containers with the proper proportions of water and air for the conditions involved, to Mr. F. M. Atton, who is in the service of the Saskatchewan Government. These were planted in Lac Pelletier, which had been carefully selected for the purpose. From what is known of the life history of the eel, it will take five years or more for these fish to become large enough for use as food. If experiments should show that this is worth while, there would need to be regular shipments of the elvers from the Atlantic coast to the interior of the continent, since eels cannot breed in fresh water. It is desirable that eels, which are abundant and not wanted or even objectionable in Nova Scotia, should be shipped to regions where they may be wanted.

Fluctuations in Fish Abundance. Unpredictable drops in fish abundance form the chief matter of complaint by fisher-

men. Natural fluctuations in fish abundance have long been recognized, but there has been little scientific elucidation of their nature.

The landings of salmon from Cobequid Bay, into which the Shubenacadie River discharges, fell from 131 to 3 cwt. from 1946 to 1951 and rose to 57 cwt. in 1953. It has been found that the very low amount in 1951 was due to complete absence of the salmon spawned in 1947, which should have formed the bulk of the catch. Since sea salmon stocks are maintained from young salmon spawned and reared in rivers discharging into the sea, low water in the rivers reduces the number of young in varied ways. Discharge records for streams in the region show that the rivers were high early in October of 1947 when salmon would be ascending from the sea and were then very low for a full month covering the spawning period. This serves to explain the failure of spawning that year through the fish either not succeeding in spawning or being removed by poachers before they could spawn, which can be done easily and thoroughly with low water in streams cleared of obstructions. The matter of the effects of low water in streams on the spawning of salmon should be investigated.

In a brief study of the salmon of the Tobique River, the branch of the Saint John River, N. B., in which angling is very successful, complete local absence of young salmon

and other fish was observed in most of the streams above the forks at Nictau Miller in late August of 1953. This was associated with a heavy growth and rotting of algae. A quick survey showed that fish (trout and sculpin) had not been killed in cool source streams with little algal growth. Young salmon were found only near a lake outlet. Much of the drainage basins involved was sprayed during the summer with D D T to control the spruce bud worm, and thus may have had lethal effects on the fish. Unusually low water in the streams during the summer is seen as responsible for the heavy growth of algae. An effort is being made to elucidate the whole matter as far as available records permit. This mortality will reduce the numbers of adult salmon in 1955, 1956, 1957 and 1958. The effects of heavy growths of algae in streams on the fish populations should be investigated.

It was found in 1932 that, when demand for sardine herring in the Passamaquoddy region of southern New Brunswick was firm and steady, the quantities of herring taken varied with the spring and summer outflow of the Saint John River, which reaches the region. In 1951 and again in 1953, sardine herring were very scarce early in the season when they consist of fish about two years old. These fish have largely been produced in Passamaquoddy Bay during the previous year and move out in late fall to be found during win-

ter in the Lepreau region towards Saint John. With the spring freshet and when they rise toward the surface with warming water, they are carried thence to the passages leading into Passamaquoddy Bay where they are chiefly caught by the many weirs in the Channel district. Examination of the records of the height of the water in the estuary of the Saint John River, which determines the rate at which fresh water passes out through the Reversing Falls, shows that the run-off of the spring freshet was early in both 1951 and 1953. There is thus a correlation between early run-off of the spring freshet and scarcity of sardine herring early in the season. The new crop of sardines produced in Passamaquoddy Bay becomes available only late in the season. The relation of river discharge to the abundance and distribution of these herring should be thoroughly investigated.

The Grand Lake Rearing Ponds. The Grand Lake Rearing Ponds are located at the head of Shubenacadie Lake and have a very dependable supply of water from the Waverley series of lakes. They have been of very great value for our investigations of fish management, since salmon are reared to sexual maturity there. The facilities they afforded were a prime reason for the selection of that lake for the work. One object was to demonstrate effective planting of small salmon for use as large salmon by anglers. Reports by the Department that large salmon trapped when ascending streams

at the head of the lake in the autumn included marked fish planted from the ponds to the extent of from 18% (1946) to 89.5% (1942) aroused expectations that operation of the ponds rather than natural breeding in the distinctly poor streams above the lake was maintaining angling in the lake.

The Ponds were constructed in 1933 on land purchased by interested anglers and they were operated by the Province of Nova Scotia until transferred to the Department of Fisheries in 1936. They were intended for rearing trout, but the temperature of the water is for the most part too high in summer and accordingly they have been used "for winter rearing" of trout, which are placed there in the fall and distributed in the spring.

When transferred, the Ponds contained "Atlantic salmon", "Sebago salmon", and "ouananiche". Traps in the two nearby streams took in the fall the local "grayling". These are all salmon, to the rearing of which the Ponds have been largely devoted. Great difficulty has been experienced in getting enough eggs either from the "grayling", of which not very many and even none may be caught, or from the fish reared to sexual maturity in the ponds. This is to be contrasted with the comparative ease in getting eggs from sea salmon, whose young are given space in the ponds that is not filled by the young of the fresh-water salmon no matter how named. Prolonged attempts to find hereditary differences between

the offspring of sea salmon and of these lake salmon when exposed to the same conditions have failed, as regards structure, colour and migratory behaviour. Also, there is definite evidence of interchange between the Shubenacadie populations of lake and sea salmon. Unless some difference can be found, it is pointless to incur the extra expenditure for breeding from lake or pond salmon that produce few eggs.

There are indications that high summer temperatures are mainly responsible for failure of these lake and pond salmon to become large and yield many eggs. The temperature has even been so high as to stop growth in the underyearlings that can stand warmer conditions than can the older fish. No matter how well fed, the pond salmon rarely exceed 15 inches in length. Experiments in feeding kelts in such warm water show that they may become very fat but make no increase in length. The salmon in Shubenacadie Lake, where they are not exposed so steadily to such high temperatures reach a length of somewhat more than 20 inches, but this is far short of the length attained by sea salmon, which are at lower temperatures. The effect of temperature on growth is in definite need of investigation.

There has been no success in the attempt made to demonstrate effective planting of small salmon for use as large salmon by anglers. Whether or not it is worth while to rear salmon for use forthwith by anglers, perhaps merely at sizes

below the present legal limit of 15 inches, is an open question. The situation should be carefully reviewed in order to determine what is worth while policy in any use of the Ponds for salmon angling in Shubenacadie Lake.

It should be pointed out, first that the Shubenacadie system of lakes presents waters of considerable variety that represent the immense number of lakes in the outer half of Nova Scotia, and second that the Grand Lake Rearing Ponds, which are being put into excellent shape, are very well located to serve for investigation of the problems of these lakes and for working out their most effective use for fishing.

Fish Capture and Reorientation in Research

An outstanding fishery scientist told me that we should not try to discover where the fish are in the ocean because fishermen are already taking too many of them. For a very long time the prevailing ideas have been that stocks have been seriously depleted, that fish culture would remedy the deficiency and that fishing should be restricted to give the greatest long-term yield, that is, the optimum catch. In recent years a gradual change has been taking place so that one can now publicly state with impunity that these ideas are chimerical, that with high breeding rate a large proportion of the stock can be taken without affecting the next generation of fish, that for the most part stocks are

underfished rather than overfished and that there should be research to enable the fishermen to catch more fish more easily. In Canada particularly, with a surplus of food and of fish, costs need to be reduced all along the line to make our fish available for food to the populations of the world that need them.

Even salmon, the first fish to become scarce with increased demand, are underfished. But the old idea of the destruction of stocks is, nevertheless, right for certain places at certain times. When salmon can be taken very easily practically every one of such prized fish may be taken. The facts indicate that the Cobequid salmon were so readily available in their rivers near spawning time in 1947 that there was an utter absence of the 1948 year-class that should have come from their spawning and this was in spite of governmental protection and fish culture. Consequently the fishery in Cobequid Bay in 1951 was by far the poorest ever recorded. Capture of fish in streams by poachers should clearly be made more difficult by reversing policy regarding obstructions in streams. Obstructions are not likely to prevent ascent of the fish, but they will make poaching difficult. Notwithstanding this, there is underfishing of salmon in Cobequid Bay and this legal fishery should be assisted by research.

Fish capture is the main objective in the management

of fish and fishery. To assist capture there are three directions in which knowledge is required. The first thing is to know, if possible, what fish there are to catch which would warrant preparations. The second thing is to know the location of the fish, where and when to go to catch them. The third thing is to know by what methods they can be most easily caught.

Prediction of fish abundance has been both investigated and practiced. But research has scarcely as yet got beyond mere learning from the fishermen's catches that there is an abundance or scarcity of small fish to become large in due course. Research should be more basic, go back farther in time. For the Cobequid salmon, one could assess the numbers of salmon parr in the streams, but this is merely remedying the failure of the fishery to provide knowledge of the numbers of the small fish. One might predict that absence of the 1948 year-class of Cobequid salmon would mean failure of spawning in 1951 and a very low catch in 1955. But, we do not know how much spawning there was in 1951, of older fish if not of the 1948 year-class. Nor do we know how little spawning may be required to stock the streams. Our chief lack of knowledge, however, is of the many varied factors, perhaps chiefly rainfall, that determine how many young salmon the Cobequid streams produce.

There has been some scientific investigation of the

location of the fish. But there has been little more done than to employ fishermen to fish more generally and then to analyse the results. That fishing is uneconomic unless the fish are concentrated is only beginning to be appreciated. Study of the factors that determine fish concentrations is still to come. As an example let us take the most intensive fishery for salmon in the sea of which we know. The driftnet fishery for salmon in the Saint John outflow from the Reversing Falls inside Saint John harbour out to Lorneville takes 70% of the fish there concentrated. We vaguely see that the concentration is brought about by the mixing of a great discharge of river water with sea water at the Reversing Falls. The greatest capture in one day by this fishery was with continued prevalence of rather strong southwest winds which would concentrate the mixed water toward the harbour.

Investigators have been definitely concerned with fishing methods, to get their own facts, if not to help the fishermen. But, they have scarcely done more than test the methods developed and in use by fishermen. Knowledge of the behaviour of the fish that determines their capture is almost non-existent. That a lobster pot may not be a trap, but a retreat that the lobsters select seems to be a new idea. That, although herring are traditionally caught with gill nets, the basis of their being trapped so well in weirs

is that they avoid nets, seems to be little appreciated, and this behaviour has not been scientifically investigated. That salmon sometimes behave like lobsters and sometimes behave like herring in being caught is perhaps beyond comprehension.

A reorientation in research is a great need if our fishery resources in ocean and in lake are to be made readily available as food for mankind. Easy removal of enough fish from any waters other than the smallest presents a very difficult problem.

Organization

Dr. Davidson was at Wellington Station from April 10 to October 10. She followed the angling results during the early part of the season and then concentrated on experiments with the behaviour of fish as far as could be observed in the Biapoc Ponds. She is working on reports at Toronto for the remainder of the year. My periods at Wellington Station were as follows: June 25 to June 30 and August 30 to September 9. In addition, I made a brief hydrographic survey of Chignecto Bay and associated waters on June 24 and visited the Moser, the Margaree and the Tobique Rivers for information in dealing with these in the bulletin that is being written. Miss Lillian R. King was again employed on part time for operating of traps and for marking of fish.

Publications and Reports

Publications

- Huntsman, A. G. How Passamaquoddy produces sardines. Fundy Fisherman, 24 (24): 5, 1952.
- The production of life in the Bay of Fundy. Trans. Roy. Soc. Can., Ser. 3, 46: Sect. 5, 15-38, 1952.
- Movements and decline of large Quoddy herring. Journ. Fish. Res. Bd. Canada, 10 (1): 1-50, 1953.
- Canada's fisheries and their Atlantic situation. The Canadian Banker, 60 (2), 1-11, 1953.
- Ausrichtung der Fische durch die Strömung und ihre Bedeutung; für den Fang von Meeresfischen. Die Fischwirtschaft. Heft 6. (By A. G. Huntsman and F. Schiemenz). 144-146, 1953.
- Fishery management and research. Conseil Intern. Perm. Expl. Mer, J., 19 (1): 44-55, 1953.

Reports submitted

For "Fish (Salmon) Management - 1952"

- I. Report of V. M. Davidson for 1952. (Correction)
1. Salmon angling in Shubenacadie Lake in 1952.
 2. Death of elvers in shipping containers.
 3. Feeding of salmon kelts.
 4. Salmon movement in still water.
 5. Eel movement in rapids.
 6. Gaspereau and brown trout movement in still water.
 7. Current growth of young salmon trapped in 1952.

8. Striped bass angling in Shubenacadie Lake in 1952.
 9. Gaspereau migration and fishing in 1952.
 10. Smelt fishing in Shubenacadie Lake and its tributaries in 1952.
 11. The plankton of the Fletcher River and the Rawdon River in 1952.
- II. Tagging of Salmon - 1952. By A. G. Huntsman.

A. G. Huntsman

October, 1953

REPORT ON FISH (SALMON) MANAGEMENT - 1953

Appendix No. 1

Salmon angling in Shubenacadie Lake in 1953

Total catch

The total number of salmon taken by angling in Shubenacadie lake in 1953 was less than the large catch of 1951 and greater than that of 1950 or of 1952.

Since between 900 and 1,000 salmon had been tagged and released in the lake each previous autumn and since the marked fish also put in the lake would be of angling size, the numbers of fish available for the anglers could be expected to show little variation unless the physical conditions in the lake and its tributary streams changed.

A mild winter favourable for feeding and the fact that the pond fish which were fat at tagging and remained in the head waters where they were easily caught in the spring, seemed to be the explanation for the large catch in 1951. The decrease in 1952 was attributed chiefly to loss of fish from the lake during a sudden, strong freshet in January. In 1953, both the favourable factor of a mild winter and an early spring for feeding and the adverse effect of an even sharper flood during the winter were operating. These combined conditions seemed to be the cause of fewer salmon being caught than in 1951 and more than in 1950 or in 1952.

In the following summary the total numbers caught and the percentages taken in each month of the fishing seasons are shown:

<u>Year</u>	<u>Total numbers salmon caught</u>	<u>April 15-30</u>	<u>May</u>	<u>June</u>	<u>July-Aug.</u>
1950	392	23%	46%	25%	5%
1951	548	63.5%	34%	2.5%	0
1952	360	48%	44%	8%	0.2%
1953	419	44%	51%	4%	0.5%

In the past three seasons over 90% of the successful angling was done in the first six weeks of the season. In 1950, the exception, the water warmed up more slowly and the unmarked and untagged salmon ordinarily found in the deeper and cooler water were feeding later in the season.

Tagged pond fish

In November and December of 1952, a total of 901 pond fish from 6½ in. to 15 in. long and three years old were tagged and released in Shubenacadie lake. Anglers caught 188 of them in 1953. The percentage of recaptures in the first year after tagging (21%) was intermediate between that of 1951 (26%) and that of 1952 (17%). The low percentage recovered in 1950 (8.8%) was attributed partly to loss of tags.

Proportionally more fish over 11 inches were recaptured than of those under 11 inches. The numbers tagged and the percentages recaptured in the first year after tagging were as follows:

	<u>Under 11 inches</u>		<u>Over 11 inches</u>	
	<u>Number tagged</u>	<u>Percentage recaptured</u>	<u>Number tagged</u>	<u>Percentage recaptured</u>
1950-51	314	21	571	29
1951-52	531	13	402	22
1952-53	527	15	374	29

Since the number tagged of each group varied from year to year, the comparison might be shown more clearly by taking 100 of each size each year:

	<u>Tagged</u>		<u>Recaptured</u>	
	<u>Small</u>	<u>Large</u>	<u>Number</u>	<u>Percentage large</u>
1950-51	100	100	50	58
1951-52	100	100	35	63
1952-53	100	100	44	66

The reason for the larger fish being more easily caught and increasing in proportion in the past three years is not clear. It may have been the result of improved tagging. We know that the anglers bait for the large fish and a few among them return small fish to the lake in spite of rewards having been paid for all tags. That the uncaught pond fish disappear from the lake whether large or small is shown by the few caught in subsequent years. In 1953, not a single pond fish tagged prior to 1952 was recaptured. In 1952, one small fish and two large, tagged in 1950, were recaptured and in 1951, there were three, all large, recaptured from those tagged in 1949.

Migrations of pond salmon

Movement of the tagged fish into the head waters in the fall and winter of 1952-53 was indicated by the recapture of them in the following spring in the lower half-mile stretch of the Rawdon river; movement seaward also took place since six of the pond fish were caught in the upper 1 1/2 miles of the Shubenacadie river and one was netted by a commercial fisherman in the tidal portion of the river below Milford.

The table below shows the various districts in which the pond fish of different lengths tagged in the fall of 1952 were recaptured in 1953 and the number taken in each district. The lengths given are the averages for each district.

Shuben- acadie River		Shubenacadie Lake				Head waters Lower Rawdon River	
No.	Lgth.	No.	Lgth.	No.	Lgth.	No.	Lgth.
7	12.1	1	11.5	67	11.5	23	11.4
						70	10.7
						21	10.5

The larger fish tended to be distributed down stream and to a small extent to leave the lake while the small fish were taken at the head of the lake near where they were released in the fall or a short distance above the lake.

A summary of the distribution of the three-year-old pond fish which formed the majority of those tagged each year, showing the percentages recaptured in each district in the past four years follows:

Year	Number of fish		Shubenacadie Lake				
	Tagged	Recap.	Shuben- acadie River	Little Lake	Mouth	Middle	Head
1949-50	609	66	0	0	23%	29%	24%
1950-51	857	220	0	0	14%	19%	40%
1951-52	918	150	4%	0	27%	17%	49%
1952-53	901	189	4%	0.5%	35%	12%	37%

	<u>Fletcher River</u>	<u>Head Waters</u>		<u>Upper Rawdon River</u>
		<u>Lower Rawdon River</u>	<u>Kinsac Lake</u>	
1949-50	0	24%	0	0
1950-51	0	11%	16%	0
1951-52	0.7%	1.3%	0.7%	0.7%
1952-53	0	11%	0	0

The high percentages retaken at the head of the lake and in its head waters in 1951 (67%) has been explained already as due to the fish being fat at tagging and having a tendency to ascend in the fall. The freshet in January of 1952 seemed to be a stimulus to upstream migration as well as movement toward the mouth. The sharper freshet in February of 1953 had less effect upon upstream movement but a greater effect on movement seaward.

Trapped fish

No lake salmon were taken in traps at spawning time in 1952. The decrease in numbers has been rapid (1950: 38; 1951: 4; 1952: 0). Two trapped fish were recaptured in May of 1953. One was a lake salmon 17 inches in length at tagging in 1951 and according to the angler had increased in length to 18 inches. It was reported to be a female containing a few unextruded eggs from the spawning of 1952. Study of the scales showed that it was 6 years old and had probably spawned twice. Growth in the fifth and sixth years had been slow and there was no evidence of growth in the current year. The other was a marked pond fish of lake salmon origin, 19 inches in length when trapped and tagged in the fall of 1950. Study of the scales indicated the age to be at least 7 years with very slow growth in the last three years. A length of 20 inches at recapture as reported by the angler and the fact that a marking by removal of the right ventral and anal fins was used for the last time for planting the year class of 1946 in Shubenacadie lake would be in accordance with the appearance of the scales.

Neither of the fish showed indication from its scales of having lived in the sea.

Marked fish

Paying a small reward to selected examiners at Sandy Cove and at Grand Lake Station was continued in 1953. In spite of a higher proportion of the untagged fish reported

having been critically examined (50%) no marked fish were found. Two large plantings were made in Shubenacadie lake of marked smolts that should have been large enough to contribute to the catch of 1953 (1950: 26,100; 1951: 16,426). It is true that percentages of marked fish recaptured have been small but this is the poorest result yet obtained from the planting in the lake of marked fish reared in the ponds at Wellington.

Untagged and unmarked fish

Anglers reported 229 salmon bearing neither tag nor marked fins as taken from Shubenacadie lake in 1953. This was an increase over 1952 (177) but fewer than in 1951 (284) or in 1950 (297).

Improved facilities for reaching the boat landing near the mouth of the lake led to more of the fish being handled there by Mr. Andrew King and fewer being brought in at the head of the lake than formerly. Nearly half of the number (112) were critically examined for fin marking by Mr. King, Mr. Beanlands or myself.

A larger proportion of the catch was measured and weighed with reasonable accuracy than in previous years, reaching 57% of the lengths and 46% of the weights as compared with 30% in 1952 and 20% in 1951. The lake fish caught were similar in size in the past three years as shown by the following comparison:

	<u>15 in. to 20 in.</u>	<u>1 lb. to 2½ lb.</u>
1951	85%	85%
1952	87%	80%
1953	90%	78%

The differences in the percentages are probably due to more accurate reporting from year to year.

Samples of scales from 123 fish were obtained for study. Of these 7 came from young fish, 2 years and 3 years old, probably injured in the angling; 112 were representative lake fish 4 years, 5 years and 6 years old and the remaining 4 bore evidence of life in the sea. It was calculated on the basis of the scales received that of the lake salmon, the 4-year-olds formed 58 percent, the 5-year-olds 35 percent and the 6-year-olds only 2 percent. The young fish together accounted for 5 percent and cannot be considered representative of the catch since many are returned to the lake or unreport-

ed, being under the legal limit of 15 inches.

The total numbers of salmon reported caught by angling, the numbers of samples of scales examined, and from the latter the calculated numbers (number of scale samples examined in brackets) and the percentages of each age taken in the past four years are shown as follows:

Year	Number caught	Number examined	Number Calculated number (actual number) percent caught						
			2 years	3 years	4 years	5 years	6 years	7 years	
1950	297	63	5(1)2%	5(1)2%	254(54) 85%	33(7)11%	0	0	
1951	284	61	4(1)1%	23(5)8%	210(45) 74%	47(10) 17%	0	0	
1952	176	63	0	33(12) 19%	67(24) 38%	67(24) 38%	6(2)3%	3(1)2%	
1953	225	119	7(4)3%	6(3)2%	130(69) 58%	78(41) 35%	4(2)2%	•	

The four-year olds have made the greatest contribution to the catch and the numbers of five-year-olds have been increasing. In 1952, when the number taken was the smallest there were more three-year-olds than in any other year.

The contribution to the total number of salmon caught made by each year-class as summarized from the table above makes an interesting comparison with the numbers of two-year-old smolts that descended through a trap in the Lower Rawdon river, the chief source of "native" lake salmon. The numbers were as follows:

Year class	Number smolts	Calculated numbers of each age caught					Total number
		2 yr.	3 yr.	4 yr.	5 yr.	6 yr.	
1946	69			254	47	6	307
1947	317		5	210	67	4	286
1948	28	5	23	67	78	?	(173)
1949	84	4	33	130	?	?	(167)

The year class of 1948 made a smaller contribution than that of 1946 or of 1947 and in all probability it will be less than that of 1949 when completed. This is in accordance with the report of the total absence of this year-class in the salmon catches from Cobequid Bay and was explained by Dr. Huntsman as due to a freshet that brought in the spawners in the autumn followed by very low water that encouraged poaching there. The same general weather conditions would

affect the lake salmon. In all probability very low water would retard the progress of the salmon into the head waters.

The four salmon that had scales resembling sea salmon varied in length from 23 inches to $26\frac{3}{4}$ inches and in weight from 3 lb. to $4\frac{1}{2}$ lb. Three of them were caught in the broad, deep, central part of the lake and the fourth nearer to the mouth. They were relatively thinner fish as shown by the average condition factor being less than that for lake salmon caught about the same time (0.35; 0.53). This would lead to the conclusion that they had left the sea some time before being caught and were not feeding as well in the lake as the lake salmon. They had assumed or retained from the spawning stage the darker colour characteristic of lake salmon or they would have been recognized by the anglers.

The untagged and unmarked fish were found along the margins of the deep part of the lake and in the region of the mouth as in previous years. Using the same divisions of the lake as given for the tagged fish, the distribution was as follows: Mouth: 67%; Middle: 32.5% and Head 0.5%.

Condition of the salmon

Condition factors based on the formula $\frac{100 \times W}{L^3}$

were calculated for 131 tagged fish and 102 untagged salmon for which the information received was considered reliable. Since most of both kinds are caught annually in April and May the averages of the condition factors for these months are believed to be significant in making a comparison of the condition from year to year. For the past three years they are as follows:

	<u>Pond fish tagged the previous fall</u>	<u>Untagged and unmarked lake salmon</u>
1951	0.50	0.54
1952	0.43.5	0.50.5
1953	0.44.5	0.53.5

The lake salmon were proportionally fatter than the pond fish, and early spring (1951 and 1953) was more favourable for feeding than a late spring (1952) and the pond fish were much fatter in 1951 than in 1952 or in 1953.

The stomachs of the pond fish examined on April 15 and April 16, when the season opened, contained insect larvae

and bivalves and none of the few stomachs of fish caught later and examined were empty.

A single trapped fish tagged and released in 1951 and caught in May had a condition factor of 0.48, the same as the average for the pond fish for that month but less than the average for the untagged lake fish (0.53).

V. M. Davidson

Appendix No. 2

Current growth of young salmon
trapped in 1953

While a smolt trap was being operated in the Rawdon river between April 17 and July 15, samples of scales were collected from 130 salmon. Of these, 102 samples were from marked fish. Eleven were from the year class of 1950 planted in 1951 and 1952 and the rest from the year class of 1951 planted in the summer and fall of 1952 and during May of 1953 after the trap was in operation. The remaining 28 samples were from "wild" or "native" fish descending into Shubenacadie lake. The age and the number of circuli of current growth were recorded for all the fish except about half of those that were planted in May and had passed through the trap within the next four or five days. The results are shown as follows:

<u>Kind, Year-class</u>	<u>When planted</u>	<u>Number of samples</u>	<u>Age (yrs.)</u>	<u>Month</u>	<u>Circuli in 1953</u>	<u>Average number circuli</u>
Pond-1950	1951-52	11	3	May	0 to 4	2.3
1951	1952	23	2	May	0 to 7	4.6
"	1953	41	2	May	6 to 9	8.2
		10		June	9 to 13	10.9
"Wild"		26	2	May	4 to 8	5.9
		1	3	"	5	
		1	2	June	12	

With the exception of 3 samples of the year-class 1950 and a single sample of the year class 1951 planted in October and trapped on May 11, all of the samples showed growth in the current year. The two-year-olds were grow-

ing more rapidly than the three-year-olds and the numbers of circuli increased with the advancing spring. The pond fish planted in the fall did not grow as rapidly as fish of the same age held in the ponds and planted in May or as well as the "wild" fish of the same age. The pond fish grew better than the "wild" fish when in the ponds, but less well when in the river.

A comparison between the average numbers of circuli on the scales of two-year-old fish trapped in May in the past three years is tabulated below:

<u>Year</u>	<u>Pond fish planted the previous fall</u>	<u>Pond fish planted in the spring</u>	<u>"Wild" fish</u>
1951	2.7		5.5
1952	4.4	4.2	4.4
1953	4.6	8.2	5.9

The difference in the rate of growth in a warm spring (1951 and 1953) as compared with a cool spring (1952) was more apparent for the native or "wild" smolts and for those held in the ponds during the winter and planted in May than for pond fish of the same age planted the previous summer and fall and which had to feed under new conditions.

V. M. Davidson

Appendix No. 3

Gaspereaux migration and fishing in 1953

Arrival of gaspereaux at the head of Shubenacadie lake in their spawning migration coincided in time with the warming of the surface water to 50°F. as has been reported in previous years. Fish were dipped from the Fletcher river on April 11, about ten days earlier than in the warm spring of 1951. A large female (15 inches long) with a well developed gonad was taken in a smolt trap in the Rawdon river on April 17th, the first day that it was operating. Since the males have been trapped first in former years the earliest migrants were probably missed.

The first period of marked abundance occurred from May 6th to May 10th when there was a further rise of 10°F. in the temperature of the water. Subsequent "runs" which did not seem to be related to change in temperature occurred from May 20th to May 27th and from June 6th to June 9th.

There was no late run of the smaller variety known as "mulhaden".

The commercial catch of gaspereaux for fresh lobster bait and for salting was so small in 1953 that the closing date for dipping gaspereaux was extended from June 15th to July 1st. In spite of this regulation the total catch from the Shubenacadie tributaries was smaller than usual. From 278 barrels salted in 1952 the number dropped to 68 (approx. 10 tons). The weight of fish used fresh for human food, for bait and for feeding the salmon in the ponds is estimated at about 2 tons.

The early spawners began to descend about the middle of June. Many were still only partly spent at that time.

Young gaspereaux from 2.5 to 3.5 cm. in length entered the Biapoc ponds from the Fletcher river on July 15. After heavy rain on August 6 large numbers from 4 to 7 cm. long were descending. A month later fish of the same size from the late spawners were migrating.

Little Lake, the more shallow and warm region of Shubenacadie Lake north of the outlet, has many spawners every spring. No use is made of them since it became illegal to take them in nets. They are known to spawn along the shores or in the brooks and the young become very abundant in late summer. Similarly Fish Lake which drains into Shubenacadie Lake near its mouth is entered in great numbers by the spawners.

V. M. Davidson

Appendix No. 4

Survey of Fish Lake

A survey of the depth and plankton of Fish lake which lies east and above the outlet of Shubenacadie lake and is drained into it by a small brook, was made on the morning of September 2nd when the temperature of the surface water was 22°C.

The deepest water located (15 ft.) was approximately 2/3 of the distance across the lake and opposite Colonel Laurie's boat landing below the Railway station.

The following plankton tows were made while a boat

was rowed at a uniformly slow rate for 10 minutes: (a) No. 20 net at the surface, (b) No. 5 net at 5 ft. to 10 ft. and (c) No. 5 net at 5 ft. to 12 ft. (approx. 10 min.). The content of the plankton was chiefly copepods and cladocerans in about equal numbers. Of the copepods the chief genera were Diaptomus, Cyclops and Epischura and of the cladocerans, Daphnia, Ceriodaphnia and Bosmina, with an occasional Leptodora.

Plankton containing similar genera was obtained from Shubenacadie lake near its mouth on September 6, 1950. In Fish lake the animals were approximately 10 times more abundant and there were relatively more copepods than in Shubenacadie lake.

An examination of Trout Brook, which enters the lake at its southeast corner, was made on September 6th. Above the highway it is rather dense forest. Its flow is small but seemingly well maintained. The only fish found were trout, underyearlings and an apparent yearling (19½ cm. long).

V. M. Davidson

Appendix No. 5

Air transport of live elvers

Preliminary experiments undertaken and described in 1952 led to the conclusion "that the most satisfactory method for shipping elvers would be in small waxed paper containers with water to one-sixth their capacity and with the quantity of eels in accordance with the duration and temperature of shipment". The plan was to make an experimental shipment from Halifax to Regina, Sask., where it would be met and transported to nearby lakes for immediate planting.

Daily air-cargo service by T.C.A. required 20 hours for transport and an additional hour for handling before departure time was requested. Transport by rail-express required 4 days with the additional risk of deterioration of the shipment at summer temperatures when changing trains at Montreal and Winnipeg. A test shipment by air was decided upon with the hope that packing might be postponed in case of unfavourable weather for the flight.

Short preliminary tests of the size of waxed container and of the number of elvers per container, based on the experience of 1952, were made as soon as the fish began

to enter the salmon rearing ponds at the mouth of the Sackville river at Bedford. The results indicated that the half-pint size and about 30 elvers, which at that time were averaging 6 cm. in length, would be best. In accordance with the results of 1952, a small wine-glass (40 c.c.) of water was placed in each and for safety this was taken from the same source and at the same temperature as that from which the elvers were collected. Counting the elvers was found to be impracticable and they were measured in a small sieve. Each container was closed with an electrically heated and manually operated sealer.

On May 19th, the elvers were in sufficient quantity in the ponds and the weather favourable for a first shipment. With the efficient help of Mr. R. O. Barrett, Superintendent of the Hatchery and his staff, approximately 6,000 were packed before noon. The sealed containers were placed in cartons in 2 layers of 15 each. A loss by death of 231 elvers when ready to be planted was deemed so small that a second and larger shipment was made on May 25th. Of the 8,000 then shipped, about 1,000 were dead when ready to be planted. The loss was attributed to some extent to a slight increase in the number of elvers per container, but mainly to the condition of the stock of elvers available at the time. The water in the ponds had been considered unfit for the young salmon, which had been removed before the first shipment was made, and a noticeable increase in the mortality of the elvers in the ponds took place after the first shipment. It was not feasible to cull out the poorer ones and a dead eel in any experimental container would soon hasten the death of the rest.

V. M. Davidson

Appendix No. 6

Descent of marked smolts

Six lots of young salmon of the 1951 year class were distinctively marked by fin removal and planted in the Lower and Upper Rawdon Rivers in 1952 and 1953 to determine the proportion that would descend the Lower Rawdon River as smolts in 1953.

To test their survival during the summer period when preyed upon by eels, 300 of the fish with right ventral and adipose fins removed were planted on July 26, 1952, above the big pool about half-way up the Lower Rawdon River. Only one, that is, 0.25% was taken as a smolt in 1953, a very poor

result. Again, a short and heavy flood early in February seemed to have interfered by taking some of the fish downstream, thus preventing determination of the extent of survival.

Two lots were planted in November of 1952, 300 in the same place in the Lower Rawdon River as the above, and 300 in the Upper Rawdon River, midway in its length. As found last year and in contrast with the result of the year before last, a larger proportion were taken of those planted farther up, namely 5.6% of those in the Upper Rawdon and only 1.3% of those in the Lower Rawdon. The conclusion to be drawn is again that winter floods largely swept those fish down from the streams and that Kinsac Lake into which those from the Upper Rawdon would be swept held many of the fish. The percentages taken were higher than for the previous year, indicating that the winter flood had not swept as many out.

Three lots were planted as smolts in May of 1953, 196 in the Upper Rawdon River, well above its mouth on May 16, 97 in the Lower Rawdon River just above the big pool on May 16, and 193 in the Lower Rawdon River near its head on May 20. Of those in the Upper Rawdon, only 11.2% were taken, of those near the head of the Lower Rawdon only 14.8% and of those farther down 40.2%. In 1952, 67.9% were taken of a lot planted several hundred yards only above the traps. These facts show clearly that there is a heavy loss of smolts during their descent. In a distance of a little more than half-a-mile, the losses increase with distance planted above the trap, the proportions being 32, 60 and 85%. This important and doubtless variable factor affects all smolt counts.

Miss Lillian King, who operated the smolt trap, reported that from her observations at least 25% of the smolts planted in all places were taken by anglers and that the proportion may have been more. This is a similar result to that obtained by Dr. C. W. Andrews on the Pollett River, N. B. In 1944 with low water, anglers took from the pool above about one-third as many smolts as descended through the trap, but with high water during smolt descent in 1945 they took none.

A. G. Huntsman

Appendix No. 7

Fluctuations in Cobequid salmon

The catch of Shubenacadie sea salmon, which are

taken with those from other rivers in Cobequid Bay and the Shubenacadie estuary, dropped to a negligible amount in 1951. This raised the question of cause, which might be discovered in such extreme condition. Examination of the few samples of salmon scales which could be obtained from those caught that season revealed a total absence of the virgin fish in their fourth year that should form the bulk of the catch. The life history of these salmon was worked out in 1930 (Bull. 21. The Maritime Salmon of Canada) as being usually two years of life in rivers as parr and a year or so in the sea with spawning as grilse, which agreed with an evident four-year periodicity in the landings. All the scales examined were of fish that had previously spawned as grilse. This indicated complete absence of the 1948 year-class, which were spawned in the autumn of 1947 and would be in their fourth year in the summer of 1951.

In 1952, scale samples were secured from 181 salmon taken in Cobequid Bay and in the Shubenacadie estuary. All but four of these were grilse in their fourth year and only one of the four previously spawned fish seemed possibly referable to the 1948 year-class. As a further check, 38 samples were secured in 1953 from Cobequid Bay. Of these 30 were grilse and 8 older fish. The former were in their fourth year and the latter in their fifth year and had spawned in their fourth year.

The salmon landings from Cobequid Bay and Shubenacadie estuary are shared between Colchester County on the north side and Hants County on the south. They were as follows in hundredweights for the past eight years:

	<u>1946</u>	<u>1947</u>	<u>1948</u>	<u>1949</u>	<u>1950</u>	<u>1951</u>	<u>1952</u>	<u>1953</u>
Colchester	107	42	11	10	10	1	27	36
Hants	24	18	5	19	9	2	10	21

The evidence is definite that the stock dropped to an extremely low level in 1951, which represented a practically complete absence of salmon spawned in 1947. Water conditions have been seen as acting on the stocks, the water height in a stream being very important for a fish which is spawned and reared in streams. Examination of the records of the discharge of the Rawdon and Musquodoboit Rivers, which are adjacent to, although not among, the streams involved, shows that for salmon spawning in the autumn of 1947 there was good water to bring the fish into the streams early in October, but that there was exceptionally low water for a

full month from the tenth of October until the tenth of November, during which time the salmon should have spawned. During 35 and 30 years of records for these two rivers, this occurred only in 1947. How this acted can merely be surmised. The spawning fish may have been unable to reach or to find suitable rapids for making redds and depositing eggs. Poachers may have taken advantage of the ease with which salmon can be located when water is low in streams cleared from obstructions to remove all the spawning fish. We have had definite evidence, in rivers that have been studied, of these factors operating.

For the spawning in 1948, to explain the higher catch in 1952, there was no good water to bring the salmon in in the fall until the middle of October. There was fair water then which continued through the spawning season. For the spawning in 1949, to explain the still higher catch in 1953, exceptionally high water came at the end of September to take the fish into the rivers, after which there was good water through the spawning period.

While the water conditions for spawning in 1947, 1948 and 1949 are considered responsible for the course of the catch of salmon from 1951 to 1953, other factors are involved in the fluctuations of the fishery from 1946 to 1953. Low water in summer is apt to reduce greatly the numbers of underyearlings and yearlings in the streams. Also, low water in May is apt to result in a high mortality of smolts that are then descending.

A. G. Huntsman

Appendix No. 8

Effectiveness of planting salmon parr in Cobequid Rivers

It has been considered that an alternation of planting with no planting of young fish would be a good test of the effectiveness of the practice for increasing the stock, since the effect would be revealed in the relative abundance of the year classes in samples of the stock. When the catch is confined to one year-class, the effect of the alternation will be well seen directly in the catches.

The salmon of Cobequid Bay are practically all taken in their fourth year, when as three-year-olds they are grilse of from four to six or more pounds in weight. The catch increased from 3 cwt. in 1951 to 37 in 1952 and 57 in 1953.

This has been attributed to plantings of young salmon in tributary streams and indeed underyearling parr to give three-year-olds in those years were planted in tributary streams, namely the Economy, Portaupique, Great Village, Folly, Debert, North, Salmon and Stewiacke Rivers, to the numbers of 20,000 in 1948, 165,000 in 1949 and 382,000 in 1950. This seems to be proof, but the plantings do not explain the extremely low catch in 1951, which showed on scale examination to lack three-year-old fish, that is, the 1948 year-class. This lack and the subsequent rise in catch with plenty of three-year-olds in 1952 and 1953 has been traced (appendix No. 7) to water conditions when these fish were spawned. The facts actually indicate that the 20,000 parr planted in 1948 had no effect whatever.

A study was then made of the landings in all the years since the last war (fishing in this area was then restricted) in relation to the corresponding plantings. The latter happened to be quite low (only 20,000 to 30,000) in 1943 and 1944 and again in 1947 and 1948. This gave a double alternation of rather heavy planting (127,000 to 382,000) with light planting.

The landings for 1946 were by far the largest for the whole period (131 cwt.) and yet only 30,000 of the 1943 year-class had been planted. The landings dropped markedly to 60 cwt. in 1947 with another light planting (25,000) of parr, and they dropped much farther to 16 cwt. in 1948 with a heavy planting (179,000 of the 1945 year-class). Also, the landings rose from 1948 to 1949 while the corresponding plantings fell from 1944 to 1945.

In short, this rather good experiment fails to provide evidence that the plantings are effective in benefiting the fishery. Nevertheless, it has been shown that under suitable conditions plantings can be somewhat effective in waters unoccupied by native salmon.

A. G. Huntsman

Appendix No. 9

Salinity and circulation of Chignecto Bay

Very little is known concerning the hydrography of the inner waters of the Bay of Fundy, that is, beyond where it branches into Minas Channel and Chignecto Bay. It seemed desirable for an understanding of sea conditions at Apple River to work out roughly the character of Chignecto Bay in-

to which it discharges.

On June 24, 1953, samples were taken on the shore along both sides of this bay, and, as far as was possible, with rising tide while proceeding from the mouth inwards. On the New Brunswick side, this was done in the forenoon from Point Wolf at 7.20 a. m. to Wood Point, near Sackville at 11.30 a. m. On the Nova Scotian side, a sample was secured at Joggins Beach at 2.35 p. m. and then a series from Port Greville in Minas Channel to Sand River from 5.45 to 9.10 p. m. The salinities of the samples were kindly determined by the Atlantic Oceanographic Group.

The salinities ranged from 31.04‰ at West Advocate to 28.49‰ at Wood Point, all being quite high in accordance with the heavy tidal action. The latter was expected to eliminate stratification, as it has been shown to do in the inner part of the Bay of Fundy proper and in Minas Channel, but very local effects from river discharge may give unrepresentative salinities. Since the salinities for all points on Chignecto Bay itself were for the latter half of the flood tide, it seems warrantable to infer from the facts (1) that water of somewhat lower salinity than that in Chignecto Bay occupies Shepody Bay and Cumberland Basin in correspondence with the large discharges they receive from rivers, (2) that this water moves out with ebbing tide along the New Brunswick shore and (3) that some of it remains with flooding tide along that shore as far in as Salisbury Bay, the projection of Cape Enrage preventing its being backed farther in or being dissipated by tidal mixing. In accordance with the effect of the earth's rotation, there is saltier water entering Chignecto Bay along the Nova Scotian shore. The highly salt water entering the Apple estuary with flooding tide is worthy of note.

The critical advice of Dr. Hachey has been valuable.

A. G. Huntsman

Appendix No. 10

Tobique Salmon

In late August, 1953, I went to the forks of the Tobique River at Nictau Miller, N. B. to obtain information on the character of the salmon taken by angling in that river. The question was: To what extent do the fish there consist of those that enter the tidal portion of the Saint John River in the late fall, which have been studied as obtained through

at Saint John

experimental fishing/in 1932 and as taken early in the season just above the head of tide at Fredericton?

To judge from the recorded weights of about 1,400 salmon taken by angling at the Forks on the Tobique River in three successive years, fish from 11 to 15 pounds in weight form the bulk of those caught (55 to 67%). These would be salmon that had been two years in the sea and that are shown by net catches to be concentrated in the Saint John outflow from Lorneville to the Reversing Falls beginning in late May. They appear at the Forks in the latter half of June and become abundant in July. It has been reported that, as concentrated in the outflow, they become heavier as the season advances, but there is no evidence of their average weight increasing from half-month to half-month as taken at the Forks (table I).

Table I. Average monthly weights per half-month in pounds of salmon from 11 to 15 pounds in weight as taken near the Forks on the Tobique River in three successive years.

Year	June	July		August		September
	16-30	1-15	16-31	1-15	16-31	1-15
First	12.7	13.1	13.0	13.2	12.5	12.8
Second	12.5	12.5	12.8	12.2	12.2	12.5
Third	12.8	12.8	12.6	12.6	12.9	

It could be that a drop in weight of those that come first offsets any rise in the weight of newcomers, since the average weights remain at a rather steady level from June to September, this being from about 12½ to 13 pounds.

The grilse, that is, fish that have been a year or somewhat more in the sea, appear later, both in the outflow and at the Forks. At the latter place, they begin to be taken as fish weighing from 2 to 5 or even 6 pounds, about the end of the first week in July. From the latter part of July or early in August they form rather steadily from 20 to 35% of the take (table II). As with the two-sea-year fish, the records leave the matter of any change in weight in doubt.

The first salmon to appear at the Forks are fish of from 6 or 7 to 10 pounds in weight, which begin to be taken early in June, forming the entire catch at that time. These are quite evidently salmon that have been a year and a half in the sea and that are known to be concentrated in the out-

flow in November and December. They are then about 9 pounds in weight. They largely winter in the estuary between Saint John and Fredericton, whence they begin to ascend the river at the head of tide in late May. After the other fish have come by late July, they form steadily from about 10 to 15% of the take (table II).

Table II. Percentages of 3 to 6 pound salmon (grilse) and 7 to 10 pound salmon (winter fish) per half-month in salmon taken near the Forks on the Tobique River in three successive years.

Year	June		July		August		September
	1-15	16-30	1-15	16-31	1-15	16-31	1-15
<u>Three to six pound fish</u>							
First	0	0	1	4.4	14	24	19
Second	0	0	14	28	33 $\frac{1}{2}$	30 $\frac{1}{2}$	26
Third		0	7	23	23	23	
<u>Seven to ten pound fish</u>							
First	92	16	12 $\frac{1}{2}$	6 $\frac{1}{2}$	9 $\frac{1}{2}$	9	6
Second	100	56	18	14	16 $\frac{1}{2}$	17 $\frac{1}{2}$	16 $\frac{1}{2}$
Third		15	18 $\frac{1}{2}$	13	15 $\frac{1}{2}$	12 $\frac{1}{2}$	

The view prevails that these early fish pass on up into the Serpentine River and that a substantial portion does this seems to have been established. However, since the percentage they make of all the fish taken does not increase after July even by September, that is, after they have been present for three months, it would seem that a large part of them remain near the Forks. Definite information on those taken in the Serpentine River would show whether these fish are considered as the "Serpentine run" merely because they contribute proportionately more to the take in the Serpentine than they do to that at the Forks.

For more precise knowledge of the movements of the salmon to the angling streams, it will be necessary to make a detailed study of the scales of representative samples of the fish, or, what would be better, to carry out a well-planned program of tagging. The tagging that was done of salmon taken in the Saint John outflow early in the season of 1938 did not suffice to give this knowledge, perhaps because too few fish were tagged.

Appendix No. 11

Mortality of Fish in the Tobique River, N. B.

When at the forks of the Tobique River on August 18 and 19, 1953, I was informed of a heavy mortality of fish which had occurred the previous week. The decomposing bodies of whitefish and burbot were still in evidence.

A guide, Mr. Lewis McAskill, stated that, when a flood of water was released from Sisson Lake to replenish the water supply for the new power plant on the Tobique River near its mouth, whitefish of a kind found in the lake, but not in the river were to be seen in it, gasping and dying. There were also dying burbot and salmon parr. The water had a very foul odour, even nauseating one person, and it contained masses of slime. The large salmon at the forks were not killed. There had been an earlier less striking death of fish early in June, large suckers dying first and then salmon parr.

Examination showed the following: There was an abundance of greyish masses of dead algae over the bottom in all the streams at the Forks, the Tobique, the Sisson, the Mamozekel and the Campbell Rivers. The large salmon were in evidence, but seining failed to yield any small fish whatever, except a couple of small minnows which might have come from a side water, nor could any small fish be seen. A flood, which had not yet subsided, had been made from Trousers Lake, one of the head waters of the Campbell River, but no dead fish were seen in it. A lumber road permitted a brief survey of the Mamozekel River throughout its length. At four, eight and eleven miles upstream this river showed the same condition - masses of dead algae and no fish. Of the three brooks entering the river at these points, only the first had fish (sculpins and trout, which indicate cold water) and the algae were in fair part living. At the head of the river, fourteen miles up, only one of the two brooks, which come together there to form the river, contained fish (sculpins) and again there were less dead algae in it. At the nearby Nictor Lake, from which the Tobique River arises, minnows were abundant in the outflow, and four yearling salmon parr were taken in the first rapid below. Mountain Brook, which discharges into the lake was without dead algae and contained an abundance of small trout.

During the summer there had been an extensive spraying of the forests of the region with D D T for control of the spruce budworm. From a local air base, 300,000 acres

had been sprayed in primary operations and 100,000 acres in secondary. The period was from May 27th to June 30th. To what extent this may have been responsible for death of fishes is uncertain. An effort is being made to obtain details of the spraying for possible correlation with the mortality.

Sisson Lake and River are just outside the area which it was planned to spray, but whether or not there was any spraying on that watershed will appear later. That the whitefish were dying rather than dead indicates that they were being brought into lethal conditions in the flood from Sisson Lake. That the large salmon living locally were not killed indicates that the flood was lethal in the Sisson River, but not when mixed with the waters of other rivers at the forks. That the flood water was foul and full of slime indicates a heavy growth and rotting of algae in the Sisson River. If such growth and rotting was general in most of the local streams and occurred early in the summer, it may have been responsible for the early mortality, which would have been gradual and not markedly in evidence.

Sunshine records at Fredericton show only normal conditions in May, June and July of this year. Rainfall records at Plaster Rock on the Tobique River and at Grand Falls on the Saint John River show low amounts in June, particularly low at Plaster Rock. Discharge records for the Tobique were discontinued in 1934. Discharge records for the Saint John at Pokiok have been taken for the past 35 years. The mean discharge in February, March and April of 1953 were for each month twice as great as the average for that month. In May, the discharge was three-quarters of the average amount, in June and July it was little more than half the average and in August less than half. In no other previous year of record have there been such uniformly low discharges through the summer.

The inference to be drawn is that, with slight flow of water, there was very heavy growth of algae, as is frequently observed, and that, lacking freshets to sweep the growth away (only a slight one toward the middle of July) the algae rotted and killed the fish, a phenomenon that is occasionally observed in ponds.

A. G. Huntsman

Appendix No. 12

Concentration of Passamaquoddy sardine
herring for capture

In 1932, the relation of the outflow of fresh water from the Saint John River to the landings of herring (largely sardines) in the Passamaquoddy region was studied. It was found that from 1917 to 1923, with a firm continuing demand for sardines, the landings of herring fell progressively, taking a zigzag course. Also, the discharge of the Saint John water through the Reversing Falls into the Bay of Fundy during the main season of herring capture, as measured by the height of the water inside the Falls above sea level, took the same zigzag and declining course from year to year from 1917 to 1923. Whether their correspondence was due to greater abundance of the fish with better feeding through increased circulation or to greater availability of the fish for capture was uncertain.

Since that time, it has been possible to elucidate the mechanism by which sardines are produced in Passamaquoddy Bay, which is by concentrating the britt (herring, smaller than sardines) there with suitable food. An exceptionally great quantity was so produced in 1951 and gave unexampled fishing for small sardines that fall. These fish were found to go from the Bay late in the fall and to be found during the winter along the coast toward Saint John between the Wolves and Point Lepreau. In their next year when they become two-year-olds, they are ordinarily taken in greatest quantity in the Channel district at the mouth of Passamaquoddy Bay, where accordingly most of the weirs are located. These sardines were very scarce in the season of 1951 and again in 1953, but there were said to be plenty of them in evidence offshore.

Study had shown that the distribution of the small herring for capture is determined by circulation of the water, that is, that they are carried along in currents. The pattern of the catches as the season develops is that in the spring they are taken first near the Wolves, and then progressively later at Beaver Harbour, L'Etang, Bliss Island, Letite, Deer Island and Campobello. These places are in order from the winter quarters of the sardines along the coast to and across the mouth of Passamaquoddy Bay. Mavor showed with drift bottle experiments in 1919 that the outflow from the Saint John River, which is mixed strongly with the sea water, flows westward along the coast to the passages of the entrances to Passamaquoddy Bay. It is evi-

dent that, as the sardines rise in the water at their winter quarters near Point Lepreau, they will be shifted by this movement along the course indicated in the development of the fishery. They will be taken to the Channel district, which is the terminus of the surface movement. A deeper movement passes thence outward to Grand Manan and it will depend upon the size of the herring whether or not they are carried to Grand Manan, since the larger they get the deeper they swim.

The characters of the spring freshets from the Saint John River have been studied from the records of the height of the water in the estuary at Oak Point for the past seven years that are taken by the Department of Public Works, as well as from the records of the discharge of the river at Pokiok for the past 35 years. As described in another Appendix (No. 11) the spring discharge of the river in 1953 was unusually early and the summer discharge was unusually low. Correspondingly, the height of water in the estuary, which is the head to drive fresh water out through the Reversing Falls, was at its peak on April 5, an extremely early date, and by the end of June was at a very low point. There was a similar early run-off of the spring freshet in 1951.

From these facts it may be concluded that the great lack of sardines early in the seasons of 1951 and 1953 was the result of early passing of the heavy spring outflow of the Saint John River, so that the fish were not carried to any great extent from their winter quarters near Point Lepreau to the Channel district, where they can be very effectively caught.

A. G. Huntsman

Appendix No. 13

Salmon Movement in Experimental Ponds

Study of the movement of young salmon of different ages and lengths in the Biapoc ponds constructed in 1950 was begun on April 25th and continued until the station closed on October 10th, except for a brief period of unsuitable weather in May when the ponds were being cleaned and occasional days in September when the dam above the ponds was being repaired. More use was made of the largest pond, 20 ft. in diameter and 4 ft. deep than formerly. When filled with water the diameter and depth were such that the fish were just within range of vision in cloudy weather and when

the sun was low in the sky. During the spring, especially when the water entering the ponds contained silt, shade cast by a maple tree nearby reduced the time of observation considerably and its removal by Mr. Cameron's staff was much appreciated. The pond seems to be at about the upper limit in size for effective observation of the fish.

The salmon studied may be divided into three groups - (a) two-year-olds that were smolts in the spring and darkened as the season advanced, (b) yearlings, some of which became smolts and (c) underyearlings which were studied in the same ponds along with the older fish and in ponds by themselves.

Movement in relation to the following factors was studied chiefly:

- (1) change from parr to smolt and a later darker phase,
- (2) new environment and conditioning to environment,
- (3) changes in depth and temperature of the water,
- (4) changes in light intensity with the same and different previous light history,
- (5) food and starvation, and
- (6) change from still water to rapids and falls at the inlet.

As in nature, various factors were acting at the same time and their interplay was very difficult to assess. Careful records were kept of the physical conditions and the particular factor being studied was varied as much as possible in an outdoor situation.

Change from parr to smolt and ^adarker phase

Since it was not feasible to keep the same fish under observation in the experimental ponds during the change from parr to silver or smolt and the darker phase, fish, two at a time, as nearly of the same length as could be found in the rearing ponds were selected and removed to the deepest pond (4 ft.). Of six pairs of parr and smolt under observation between June 25th and July 15th, the smolt tended to swim when wandering or holding position in the water from 1 to 2 in. or more above the parr although the latter might be from 1 to 2 in. less in length. The smolt, too, was re-

latively more active as shown by less time spent resting on the bottom of the pond and by the escape of one of them from a full pond during the night. Observation of the salmon in the ponds during the late evening while they were striking at insects near the surface of the water led to the belief that a fish might reach the top of the wall or even be carried over it.

Several post-smolts were held in the largest pond during August in 4 ft. of still water and in September in 2 ft. of water with a falls or a rapids at the inlet. The fish were less active than fish of similar size in the spring. None escaped and none ascended the rapids nor were they seen to try ascending the falls. When unfed they did not strike often at particles on the surface like the younger fish in the same pond.

New environment

Out of two dozen two-year-olds from $6\frac{1}{2}$ to 11 in. in length all but two went to the bottom of the pond when first released. The exceptions occurred on May 2nd under a cloudy sky when a pair $7\frac{1}{2}$ in. long swam from 2 to 6 in. from the bottom. During the first hour the tendency was to wander about near the bottom either close to the wall for part of a circuit and then across the pond near the centre followed by movement through the mid-section between the walls and the screen about the outlet at the centre. The whole gave the impression of complete lack of pattern. Typical reports are shown:

<u>Length</u> <u>(in.)</u>	<u>Date</u>	<u>Temp.</u> <u>(°C.)</u>	<u>Sky</u>	<u>Distances in inches from</u>	
				<u>bottom</u>	<u>sides or screen</u>
$7\frac{1}{2}$	1/5	10	Cloudy	6	24
8	13/5	14.5	"	4-6	Various
9	16/6	15	"	4-10	4-12; 6-12; 24-30
11	8/7	22	Bright	1-2	rested close to wall
11	18/9	18	"	1-2	rested except for several trips close to wall or across the pond

(Depth of water was 4 ft. except 2 ft. 10 in. on September 18).

Individual differences were apparent. The fish showed less activity in the higher temperatures.

Out of eighteen yearlings from $3\frac{1}{2}$ to 7 in. in length, all except one went to the bottom when released and it remained within 2 ft. of the surface in 4 ft. of water. They wandered more steadily than the older fish during the first hour even at the higher temperatures and at a greater distance from the bottom. Their movements, too, lacked pattern. Some typical observations are as follows:

Length (in.)	Date	Temp. (°C.)	Sky	Distances in inches from	
				bottom	sides or screen
6	25/6	19	Bright	3 (sun)	30-36
				5-6 (shade)	
6	8/7	22	"	5-6	50-60
$5\frac{1}{4}$	23/7	21	Cloudy	4-5	2-4
$5\frac{1}{2}$	20/8	21.5	"	2-6	varied widely
5	28/9	18	Bright	4-5	6-8

Underyearlings from $3\frac{1}{2}$ to 7 cm. in length were studied in the large pond when it contained other fish. Even in 4 ft. of still water they swam to the bottom. Subsequent movement in water of that depth and in a pond 20 ft. across was difficult to watch. When a group of 11 was released, one at a time, the fish often schooled and could be studied more easily. They tended to stay near the bottom and wander at widely different distances from the wall and screen. More frequently than the larger fish they settled for brief rests between periods of wandering. In still water 12 inches deep in the next pond of half the size a school of 8 similar fish wandered without pattern feeding at all depths and were not seen to settle in the first hour. Details of 4 experiments were as follows:

Length (cm.)	Date	Temp. (°C.)	Sky	Depth (ft.)	Distance in inches from	
					bottom	sides or screen
$3\frac{1}{2}$ to 5 (4 fish)	18/7	22.5	Bright	4	rested	lost to view
$3\frac{1}{2}$ to $4\frac{1}{2}$ (11 fish)	22/8	19	"	$3\frac{1}{2}$	2 to 4	varied widely
(8 fish)	"	"	"	1	2 to sur- face - feeding	" "
$4\frac{1}{2}$ to 7 (18 fish)	16/9	17	Cloudy	$2\frac{3}{4}$	2 to 3	50 to 60

On July 30th, a group of 6 underyearlings from 3.2 to 3.5 cm. in length were set free in the large pond in water 2 ft. deep and having a fall with a strong flow over it at the inlet. All swam to the bottom. Three of them

wandered close to the bottom for less than a minute and then settled, the rest swam near bottom toward the intake and held position in the current.

Conditioning to environment

The large pond was cleaned and refilled about once a week. The fish were removed and it was restocked and thus the same fish were under observation long enough to become accustomed to their environment. From the mass of facts accumulated the following are significant of conditioning:

Two-year-olds. Longer time was spent during the day resting on the bottom singly or in groups near the walls or the screen about the outlet than in wandering. At the higher temperatures they rested in the shade and below the inlet. At night and in the early morning they were scattered about on the bottom within a foot or so of the walls rather than in groups. Attack upon new arrivals especially over the feeding ground was observed.

Yearlings. Selection of a home and defence of it by the yearlings was more often observed than for the older fish. If the pond were well lighted they began to feed within an hour of their arrival upon minute particles in the water and rose to the surface for them. They did not seem to avoid the larger fish and soon swam close to them and often rested close to them during the day.

Underyearlings. Underyearlings adopted homes and defended them in the large pond containing both yearlings and two-year-olds. They sought shelter in bright sunlight under large stones placed on the bottom and probably at night although escape upstream through a rapids was provided.

Changes in depth and temperature of the water

Observations in relation to changes in depth were made chiefly when other factors were being studied. It seemed that in still water the salmon tended to stay in deep water or move to it. A current produced upstream orientation accompanied by movement into the more shallow ponds during the day. At night they dropped back or into more quiet water to rest on the bottom.

If the temperature increased slowly or steadily as from morning to afternoon or with the season, activity was less at the higher temperatures. Cooling associated with sunset was accompanied by increased movement in summer

but may have been due more to change in light intensity and presence of insects on the surface of the water than to the slow cooling. Rapid warming of the water in September after a cool spell was accompanied by increased activity.

Changes in light intensity with the same and different previous light history

Judging the effect of changes in the intensity of light upon movement presented more difficulty than for any other factor studied, chiefly because actual measurements were impracticable and because changes in temperature were effective at the same time. Changes in activity and changes in depth when swimming (distance from the surface and distance from the bottom in deep water) were the criteria used. In assessing activity, it was realized that a two-year-old fish might use as much of its energy in rapid swimming for a short period of time as a yearling or underyearling at a slower rate for a longer period or in swimming to hold its position in a current.

(a) During the day (same previous light history)

On bright days in summer when the intensity was increasing (9 a. m. to 2 p. m.) the fish seemed to be less active than later in the day when the intensity was decreasing (2 to 6 p. m.). At this time the change in temperature was about 3°C. and reached its maximum in the late afternoon. On cloudy or rainy days in summer activity seemed greater than on bright days. In autumn at lower water temperatures the converse seemed to be true.

At higher intensities (sun versus shade; clear sky versus cloudy sky) the fish moved farther from the surface particularly in deep water. Even when passing from a sunlit part of the pond to the shade cast by the wall a change in level might amount to an inch or more.

(b) Morning and evening (different previous light history)

When the light was rapidly changing from the darkness of night to daylight for a brief period just before and just after sunrise the fish were more active. Corresponding activity was observed when daylight was rapidly changing to darkness just after sunset. During these periods of rapid change insects were active near the surface of the water on a calm night and the fish may have been excited by them. Although the insects remained after the fish had settled on the bottom, the surface was then dark

and their movements inconspicuous. Activity was later on a cloudy morning by approximately 15 minutes. Small parr and underyearlings were difficult to locate in low light intensities and by artificial light, but it seemed that they settled sooner after sunset and were a little later becoming active than the older fish.

Typical measurements made for salmon 6 in. long when swimming in water 4 ft. deep at different times of day and under different light from the sky are shown:

Date	Time	<u>Clear sky</u> <u>in the sun</u>	<u>Clear sky</u> <u>Light shade</u>	<u>Overcast sky</u> <u>x rain</u>	<u>Near sun-</u> <u>set or sun-</u> <u>rise</u> <u>x artific-</u> <u>ial light</u>
15/7	10 a.m.			12 in.	
	11.30 a.m.			x 24 "	
16/7	2 p.m.	4	12		
	5.30 p.m.		24		
	9.30 p.m.				x 36-45

Food and starvation

Two-year-old and yearling salmon were fed regularly three times a week in the rearing ponds and underyearlings several times a day according to their age and the temperature of the water. The fish selected for study were transferred to the experimental ponds usually in the morning before being fed unless provision had been made for keeping them longer without food. When fed in the experimental ponds they were given ground-up liver, the amount and size of the particles depending upon the number and size of the fish.

From the few experiments carried out it seemed that starving the two-year-olds in July and August for 10 days when the range of temperature was from 19 to 26°C. and in September with cooler water (14 to 20°C.) for 24 days made no appreciable change in their activity or type of movement. In the case of yearlings starved for 10 days (20 to 26°C.) and then well fed, a change from activity during the greater part of the day before being fed to resting for hours after being fed took place. The smaller yearlings wandered with ever changing direction and depth and seemed to take plankton from the water but were unsatisfied until properly fed. The underyearlings fed upon the particles in the water almost as soon as liberated in the pond and were relatively less interested in the food introduced. It is possible that

many of the particles were too large for them.

Feeding habits were interesting to watch. In cloudy weather the fish hovered over the feeding ground and ate there or nearby. When the food was thrown into a brightly lit part of the pond, each took a mouthful and retreated to the shade to feed and much was scattered about there. If the particles of food were small the large fish stirred up the water with their tails and took it as it sank in the water. Feeding went on for several hours. Contests for the food were not very evident, probably because there was a good supply. Sometimes a small fish was driven off by a larger one and new arrivals were chased from the feeding grounds.

Change from still water to rapid water

Very limited study of movement in relation to current over rapids in the runways between the ponds and with a fall over a dam at the inlet to the deepest pond were made in August and September. Swimming to hold position in the current below the falls and ascent part way up the rapids were observed for the underyearlings during the day. They seemed to retreat to the deepest pond at night but this was not verified. The larger fish were not seen to attempt the rapids or the falls. They tended to rest on the bottom under the fall.

Cover suitable for the underyearlings were placed at intervals along the rapids and was used by them in their ascent.

In the spring, the fish were more active in swimming nearer the surface and entered the runways between the larger ponds where they were trapped and removed. Had the rapids been constructed then it is probable that the smolts would have ascended readily.

V. M. Davidson

Appendix No. 14

Movement of fish other than salmon in experimental ponds

Yellow perch

Small perch (3 to 3.5 cm.) entered the experimental ponds from the Fletcher river through the inlet pipe and were observed in schools of from 7 to 12 fish for several

days. On a bright afternoon they would be wandering from 2 to 6 in. from the wall and within 6 in. of the surface at a fairly steady rate of from 45 to 50 ft. per minute. In the morning and evening they would be wandering near bottom or feeding upon the algae on the bottom and walls of the ponds and on the food provided for the young salmon.

During September, six perch from 4 to 9 in. long were trapped individually at the head of Shubenacadie Lake and placed in the deepest pond. The two largest fish died within 24 hours probably weakened in the trapping. One lived for 10 days but after 5 days all tended to be heavily infected with fungus. When released they swam to the bottom and then schooled if other perch were in the pond. They wandered close to the wall (4 to 6 in.) or the screen about the outlet more consistently than the salmon and seemed to vary their depth in relation to the light, being deeper in bright sunlight. They readily fed with the salmon and did not withdraw to the shade with a mouthful as the latter were observed to do. The rate of swimming was usually less than 40 ft. per minute.

Cyprinids (Notropis cornutus)

Cyprinids were easily obtained with a net or trap at the head of Shubenacadie Lake on a sunny afternoon. Study of their movements in the ponds during September may be summarized as follows:

- (a) They were strong swimmers and held position in a current similarly to young salmon.
- (b) They moved from deep to shallow water upstream during cloudy days and overnight and dropped back to deeper water in bright sunshine.
- (c) In still water (3-4 ft.) they tended to wander during the day without pattern as though feeding at various depths and frequently struck at objects on the surface. They readily ate the food supplied to the salmon.
- (d) In shallow water (1 to 1½ ft.) small fish (4-5 cm.) swam at mid-depth or below it according to the light and large (10 cm.) sought cover.

Suckers

A sucker, 10 inches in length, was trapped at the head of Shubenacadie Lake on September 19th and transferred

to the deepest pond where it lived in spite of an accumulation of fungus about the mouth until removed on October 10th. The depth of the water varied from 3 ft. to as little as 6 in. on one occasion and the temperature from 13 to 19°C.

When released, it swam to the bottom and moved about very little during the next five days and was not observed to feed on the algae at the bottom. With a rise in temperature it began to feed and to swim about, rising as much as 6 in. from the bottom of the pond. In feeding, it progressed slowly with its mouth close to the bottom. It worked over the salmon-feeding ground but did not seem to take the particles of liver. Activity became less with decreasing temperature.

On October 1st, a sucker, 10 $\frac{1}{2}$ inches in length, was put in the next pond above in about 1 ft. of water. It wandered about the circumference, completing the circuit (10 ft. across) six times and then settled. Two hours later it was found in the next lower pond in water 3 ft. deep, swimming around with the first fish about 4 to 6 in. from the bottom.

A small sucker (3 in.) which entered the ponds through the inlet pipe descended to the deepest pond and could be distinguished from the other small fish there by its habit of feeding on algae at the bottom.

Fresh-water eels

The nocturnal habits of the eel were demonstrated in an experiment begun on September 1st and terminated by their escape during the night of the 5th. Two eels, 25 inches and 27 inches in length, were trapped at the head of Shubenacadie Lake and transported to the second largest of the Biapoc ponds, 10 ft. in diameter. Water was flowing slowly through the screened ends of the runways joining it to the others in the series and a depth of 6 in. of water was maintained. Cover was provided in the form of some large stones and several bundles of weighted excelsior. When released, both swam along the bottom and sought cover. Little movement was observed during the next three days. On September 5th, 3 more eels of similar size were trapped and these were placed in a smaller, adjoining pond at a higher level in which the current was stronger and the depth about 3 inches. They descended at once to the deeper pond. Two swam along the bottom and close to the wall until they joined those already there under cover. The third wandered for about 10 minutes, seeming to explore the inlet and outlet and then went under cover. An hour later one of them had descended into the

deepest pond through a tunnel containing a rapid current which had been opened in the interval.

Half an hour after sunset when it was too dark to see to the bottom of the ponds, a flash-light was used to locate the eels. Four were under cover in the pond with 6 in. of water and one was on the bottom in the deepest pond in $3\frac{1}{2}$ ft. of water. Ten minutes later the eels became active. The one in the deep water began to swim about 2 ft. below the surface on a level with the mouth of the tunnel and through it entered the upper pond. An hour after sunset there was only one eel left in the upper of the two ponds and the rest were swimming at the surface of the deep pond near the wall and stretching their heads above the surface. By morning all had escaped, presumably over the top of the wall which was about 6 inches higher than the surface of the water.

Catfish

Catfish from 8 to 10 inches long were trapped with the eels and suckers. One or more were under observation in the ponds from September 1st to October 5th. They were extremely easy to keep in the ponds. Other fish were unaffected by them since they moved little during the day and like the eels they became active about 40 minutes after sunset. Then they passed back and forth from the deep pond to the one above through a tunnel carrying a moderate current.

A fading to a lighter colour, which tends to be common to all the fish held in the concrete ponds was quite pronounced in the catfish. It was quite apparent and probably almost complete on the second day after the fish were put in the pond. The fish sought cover during the day, especially for their heads, and were more sensitive to artificial light than salmon, perch, gaspereaux and suckers.

V. M. Davidson

Appendix No. 15

Striped bass angling in Shubenacadie Lake in 1953

Scarcity of striped bass was the outstanding feature of the angling in Shubenacadie Lake in 1953. Although bass are considered secondary in importance to grayling (lake salmon) by most anglers, one could not fail to be impressed by the disappointment over the few bass available. The

sharp decrease is indicated by comparing the total numbers caught in the past four years:

<u>1950</u>	<u>1951</u>	<u>1952</u>	<u>1953</u>
418	212	327	75

About 100 bass were caught in Little Lake, the warm, shallow, northern part, in April, May and June of 1950, 1951 and 1952 by comparatively few anglers who reside nearby or have summer camps on its shores. Only 3 bass were reported from that part of the lake in 1953. Angling in the deep, broad part and near its mouth from 1950 to 1953 accounted for less than Little Lake and the numbers were decreasing (51: 39: 27: 25). Ten of the 25 taken in 1953 were reported for September, a month in which none was reported in other years. It would seem, therefore, that a report of the angling at the head of the lake would be the best criterion of the fluctuations in supply.

One of the most enthusiastic and regular anglers at the head of the lake reported a decrease from about 60 bass, 14 of which weighed from 5 to 9 lb. in 1952 to 3 fish weighing 2½ lb., 6 lb., and 7 lb. in 1953.

In a warm spring bass were caught earlier than in a cool spring. Bass were reported in April of 1951 and of 1953 but none until May of 1950 and of 1952. The greatest numbers were taken in May and June, the same months in which gaspereaux were most abundant in spawning migration.

The numbers of bass taken and the estimated weight of gaspereaux in the commercial catches at the head of the lake in the past four years were:

	1950	1951	1952	1953
Bass (no.)	248	71	193	47
Gaspereaux (tons)	30x	30	45	12

x probably would have been greater under the better methods of capture in 1951, 1952 and 1953.

Similar fluctuations in abundance for the two kinds of fish seemed to take place and the same factors may have been responsible.

Size and condition

Lengths and weights of only 7 bass were obtained in 1953. The lengths varied from 10 to 23 in. and the weights from 7 oz. to 4 lb. 2 oz. That the fish were similar in condition to those caught in 1952 was shown by the average condition factors for fish over 15 inches in length caught before July 8th, based on the formula $\frac{100 \times W}{L^3}$, being 0.55 for 1952 and 0.545 for 1953.

V. M. Davidson