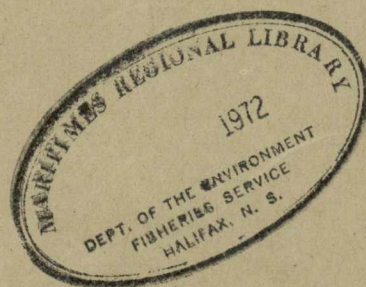


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RESOURCE DEVELOPMENT BRANCH

MANUSCRIPT REPORT

No. 61-2



A Biological Survey
of
East River, Sheet Harbour

by

H.E. Edwards

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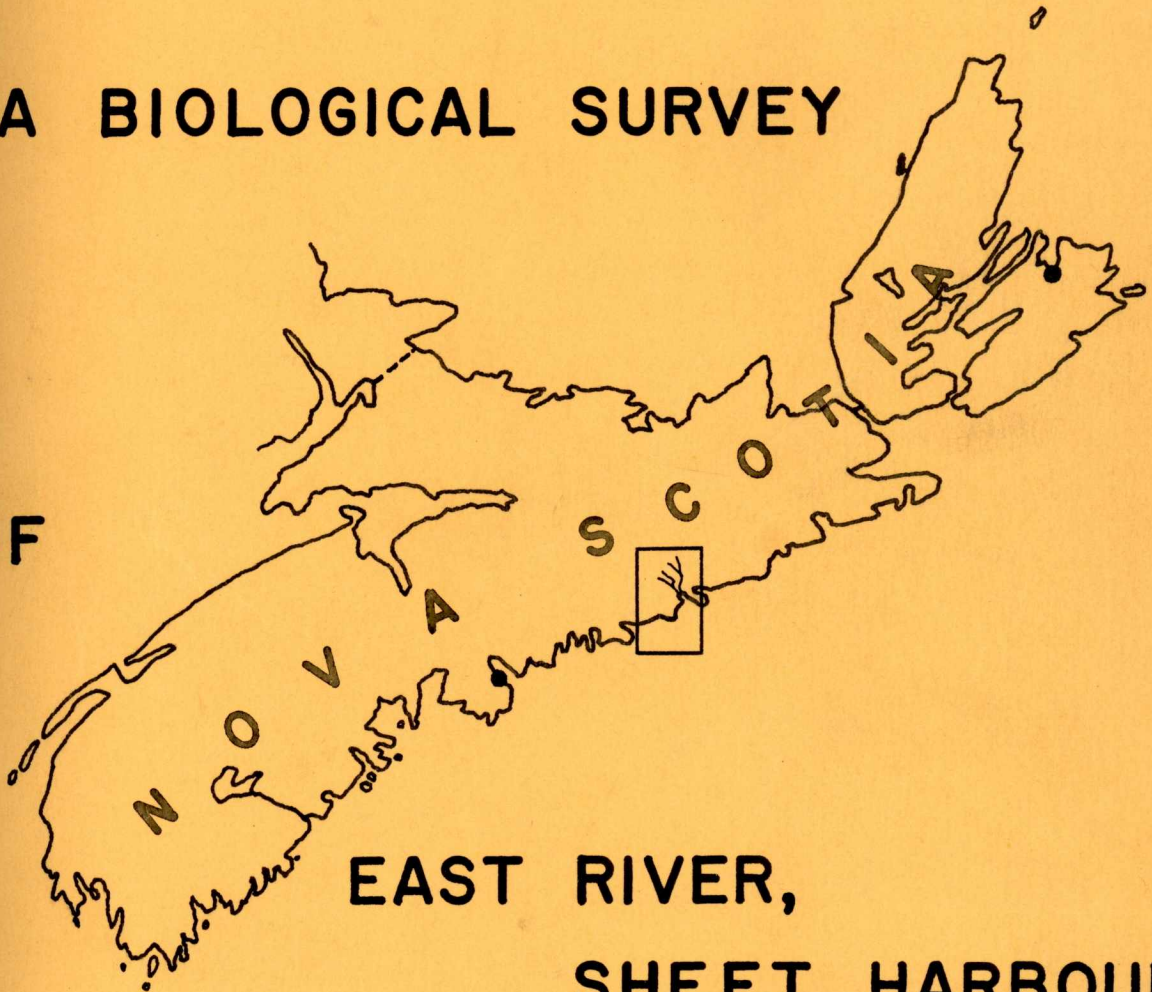
FISHERIES SERVICE
DEPARTMENT OF FISHERIES AND FORESTRY OF CANADA
HALIFAX, N.S.

CANADA DEPT OF FISHERIES

FISH CULTURE BRANCH

A BIOLOGICAL SURVEY

OF



EAST RIVER, SHEET HARBOUR

BY

H.E. EDWARDS

HALIFAX, N.S.

1961

A BIOLOGICAL SURVEY OF EAST RIVER, SHEET HARBOUR

by H. Edwards

Fish Culture Development Branch

Department of Fisheries

Halifax, N. S.

April 1962

A B S T R A C T

A biological survey was made on East River Sheet Harbour in order to assess the river's potential capacity to raise young salmon to the smolt stage.

The survey entailed the inspection of 75-100 miles of main stem and tributary waters above the dams at Malay and Marshall Falls and eleven upriver storage dams. All of these are barriers or partial barriers to the movement of anadromous species of fish upstream and downstream.

The survey consisted of a study of conditions on the main river and four main tributaries. Among the many factors considered were water levels, stream gradients, bottom rock formations, pools and riffles, pollution, barriers, et cetera.

From the survey it was concluded that the river contained better than 640,000 square yards of spawning and nursery potential. On the Fifteen Mile stream, alone, some 400,000 square yards of good nursery material was found along with over 300,000 square yards of good spawning potential. It was also evident from the survey that, in order to utilize the spawning and nursery potential of the system, adequate provision for the upstream and/or downstream movement of anadromous fish would require the construction of fish-passing facilities at at least eight dams.

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INTRODUCTION

In the biological survey of East River at Sheet Harbour, the primary concern was for the Fifteen Mile stream, sometimes referred to as the main stem. Most of the main tributaries of the system were surveyed, however, with a view to assessing their potential capacity to produce Atlantic salmon smolts.

In 1924 the Nova Scotia Power Commission erected a dam at Ruth Falls, on the Fifteen Mile stream. From this dam, water was fed through a diversion canal to a power plant some 8000 feet further downstream. From this beginning, the development of the East River for power production continued until today the river's power production is realized through the use of two power dams and eleven upriver storage dams.

A fishway installed in the dam at Ruth Falls permits the passage of salmon and other anadromous fishes upstream to the Ruth flowage and a small tributary Grant River. However, the power and storage dams preclude the passage of anadromous fish to the upriver reaches of the system.

Since 1959, representations from the Eastern Shore Fish and Game Association, to both the Federal Department of Fisheries and the Nova Scotia Power Commission, led the Department of Fisheries to attempt to determine the economic and biological feasibility of measures needed to

open the upriver reaches of East River to salmon.

This report discusses the biological survey and assessment of the river.

WARD SMITH
JOEY BOND
MADE IN CANADA

METHODS and MATERIALS

The stream was surveyed by visual inspection mainly through the use of canoes, boats, and on foot. In one area of difficult access, stream conditions were inspected by several low-flying "sweeps" in a light plane. The usual method, however, was to walk or canoe the streams from or near the headwaters to the mouth. Used to record various data during the survey were the following: a pocket thermometer, a Taylor Comparator pH meter, a 100 foot measuring tape, a cork disc, a hand seine, a 40 foot beach seine, fly-fishing tackle, hand lense, and various maps of the watershed together with a map sealer.

During the survey, the basic reference texts used were "Instructions for Conducting Stream and Lake Surveys" by H. S. Davis and "Studies in Freshwater Biology" by Karl F. Lagler.

GENERAL DESCRIPTION OF THE RIVER

East River Sheet Harbour drains an area of approximately 232 square miles on the south eastern part of the Nova Scotia mainland. Most of the river lies in Halifax County but its main stem, known as the Fifteen Mile Stream, drains headwater lakes in Guysborough County. From the headwaters the stream flows in a southerly direction for about 23 miles before entering the Atlantic Ocean at Sheet Harbour. Four main tributaries give the stream a roughly dendritic shape and drains over 10,000 acres of lakes and over 100 miles of streams.

The East River system lies in an area of Pre-cambrian formation found in the south eastern part of the Nova Scotian mainland.

Its source is mainly run-off water, though some ground water does enter. Its pH during the survey was in the 5.8 - 6.2 range.

Flowing, for the most part, through densely wooded, uncultivated land, the stream can be described as rapid (greater than 1/2 ft./sec. over a moderate slope) generally. Except for the tributary known as the Twelve Mile, a relationship of 50% pools to riffles predominates.

The width of the stream varies considerably ranging from a 35 foot width on the runs below Grassy Lake, on the Fifteen Mile stream, to 250 feet about halfway between Ruth Falls dam and the head of tide.

The average width of the Fifteen and Twelve Mile streams approximate 75 to 100 feet. The Ten Mile stream is a stream which approximates a 50 foot average width. The Seven Mile and Grant River streams are much smaller.

The water was dark in colour and slightly turbid. Considerably silting was observed on the Fifteen Mile especially, but this was probably due to the opening of gates on headwater dams.

Fair to good spawning and nursery potential was observed throughout the whole system. What appeared to be the best was found on the Fifteen Mile stream. Commencing at the head of Marshall Flowage on the Fifteen, there was almost a continuous succession of pools and riffles. Riffle areas showed a bottom of mainly rubble and coarse gravel spotted with large boulders.

It was established that salmon had spawned on the Grant River stream; this use probably involves capacity or near capacity utilization.

Accessibility was good along the stretch of the river known as the Fifteen Mile Stream; however, in other parts of the system the accessibility was poor.

Only a few mergansers and kingfishers were seen during the survey. Reports indicate that large numbers of these frequent the system.

No evidence of any serious pollution was recorded during the survey.

With the exception of the Ruth Falls dam, all dams are barriers or partial barriers. At Ruth Falls a fishway provides for the adequate passage of fish upstream.

Between Ruth Falls and the head of tidewater stream improvements are needed at the original Ruth Falls, Gaspereau Falls, and MacDonald Shoals.

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FISH FAUNA

Fish fauna observed during the survey were Atlantic salmon, *Salmo salar* Linnaeus, both river and adult stages. Speckled trout, *Salvelinus fontinalis* (Mitchell), were present on the whole system. Brown trout, *Salmo trutta* Linnaeus, introduced into the system in 1956, were observed though not positively identified. Their known distribution extends from Marshall Flowage, where they were introduced, to the upper reaches of the Fifteen Mile stream above Anti dam; to the foot of Union dam on the Twelve Mile; and to Como Lake on the Seven Mile stream. They have been reportedly taken on the Grant River stream, although they are apparently not plentiful there. In their downstream movements, the "browns" have gone to sea and some brown trout taken on the West River are believed to have come from the Marshall Flowage stockings.

Other fish observed were yellow perch, *Perca flavescens*; golden shiners, *Notemigonus crysoleucas*; suckers, *Catostomi commersonnii*; three spined sticklebacks, *Gasterosteus aculeatus*; and one of the chubs, *Cyprinidae*. Catfish, *Ictalurus nebulosus*, Le Sueur; eels, *Anguilla rostrata*, LeSueur; white perch, *Morone americana*; and gaspereau, *Alosa pseudoharengus* (Wilson), have been reported but none was seen during the survey.

SPAWNING AND NURSERY AREAS

In describing an area or section of the watershed, particular reference is made to its quality as a spawning or nursery area. Specific areas are referred to as S_1 , S_2 , et cetera, for spawning areas. These are numbered from mouth to headwaters consecutively starting with the tributary with the highest quality followed by other tributaries of descending order of importance. The same procedure is used for nursery areas; i.e. N_1 , N_2 , et cetera. Most of the time each area described will show qualities of both but with one or the other predominating. On the map appended, spawning areas are indicated by a closed circle and nursery areas by a triangle.

FIFTEEN MILE STREAM

Spawning area S_1 - This area is found on the Fifteen Mile between tidewater and the Marshall Flowage dam. The upper two-thirds of the area are dominated by flowages - Ruth and Malay. In the lower third, between Ruth and tidewater, the stream's gradient becomes sharp and rough, rocky rapids join a succession of small and large pools. It is in this area that spawning area S_1 is found. It is estimated that about one mile of this section is rough, rocky rapids with the remainder being made up of small and large pools.

The pools being referred to as larger or smaller are those having a width and length greater or lesser than the average 75-100 foot width of the stream in this area. Most of the suitable spawning rubble and coarse gravel was found near the inflows and outflows of the pools. However, while some suitable spawning material was found above and below the pools particularly, it was not present in substantial amounts. A rough estimate of the available spawning material is 11,000 square yards or 1/4 of the riffle area, found mostly above and below pools. Photographs showing areas of pools and riffles are found in Appendix I.

Spawning area S₂ - This second area, where suitable spawning material was found, was located between the head of Marshall Flowage and McBain Falls. The downstream limit of the area is bounded by a small falls known as the Fifteen Mile Falls. Below the falls, a large pool exists which according to reports was a very good salmon angling pool in earlier years. Between the Fifteen Mile Falls and McBain Falls, the stream, approximately 3/4 mile in length, was mainly riffle area though a large pool also was found below McBain Falls. Good spawning bottom, rubble and coarse gravel, dominated the entire length of the section. Its width approximated an average of 100 feet. It is estimated that the area contained about 44,000 square yards of good spawning bottom. McBain Falls, the upper limit of the section, had a natural run-around on its right bank. Photographs are shown in Appendix I.

Spawning Area S₃ - This spawning area was located between McBain Falls and Anti Dam. This section of the Fifteen Mile presented a contrast to that below the McBain Falls. The stream here is the meandering type with long stillwater and flat pools alternating with gentle riffle areas. Its width varies from 50-250 feet, with an estimated average of 110 feet. Good pools dominate the lower section of the area, riffle water the upper section. Pools and riffles were present in the relationship of 40% pools to about 60% riffles. The estimated number of square yards of spawning material was 96,799, found over 1½ miles of stream, mostly in the upper half of the section.

Spawning area S₄ - The fourth spawning area, potentially at least, was located between the Anti Dam flowage and the entrance of Bear Brook, a small tributary. This section of the Fifteen Mile stream was about 1 mile in length with an average width approaching 110 feet. Some large boulders were present, particularly in the low reaches but, for the most part, the bottom was predominantly rubble and coarse gravel. A number of large pools were found at various places along the one mile stretch of river. An estimated 64,533 square yards of excellent spawning material was found in this section.

Spawning area S₅ - On the Fifteen Mile Stream, the fifth area with good spawning potential was found between Bear Brook and the mouth of the Sloan or Seloam Lake Brook. In this area the stream changed from the smooth riffle and pool area below to a sharper grade with rapid water. The stream, maintaining an average width of 60 feet, became rough and rocky with large and small boulders predominating. Suitable spawning rubble and coarse gravel, however, was very much in evidence between the larger rocks and boulders. It is estimated that 26,400 square yards of good spawning material was observed here in about 3/4 of a mile of the section.

Spawning area S₆ - This sixth area with fair to good spawning potential was found on the Fifteen Mile between the mouth of Sloan or Seloam Lake Brook and Otter Brook. The area extends about 2 1/4 miles in length. See photographs Appendix III. The area was divided approximately into an upper and lower half by a long stillwater pool. In the upper half, the stream is the slow meandering type with a succession of small pools and riffles. In the lower half, the stream gradient became quite sharp and fast flowing water over a bottom dominated by cobble and coarse gravel among some small and large boulders. The stream bottom averaged about 75-100 feet in width. About one mile of the riffle area was considered to have good spawning cobble and gravel; an estimated 58,666 square yards.

Spawning area S₇ - The seventh area with spawning potential was located on the Fifteen Mile stream between the Rocky Lake dam and the confluence of Otter Brook. The stream is predominantly stillwater pools, some of which on the upper part of the area approximate the size of small lakes. The pools probably represent about 70% of the whole area. Between the pools, short gravel runs were found with excellent spawning material. The stream, approaching an average 50 foot width in the riffle areas, was made up mainly of rubble and coarse gravel, though some small boulders were found. It is estimated that the area contained about 14,666 square yards of good spawning material.

TWELVE MILE STREAM

Spawning area S₈ - On the Twelve Mile stream, the first area with some spawning potential was found in the area from the mouth of the stream to Sandy Island pool just at the road bridge. Water conditions were high at survey time and good observations were impaired. However, about $1\frac{1}{2}$ mile of the stream in this area had some fair potential. Several large pools below the Sandy Island pool linked several rocky riffle areas to a large stillwater pool at the mouth of the Twelve Mile. Approximating an average width of about 50 feet, the stream bottom was dominated by large boulders and large cobble with some good spawning gravel

scattered throughout the riffle areas. An estimate of the spawning potential gives an area of roughly 14,000 square yards of suitable material.

Spawning area S₉ - The ninth spawning area, found on the Twelve Mile stream, lies between Ragged Falls and the Sandy Island pool. Three large pools were noted, these being the Ragged Falls, Otter Falls, and Sandy Island pools. Riffle water dominated the area with pools making up in the vicinity of 40% of the stream. The stream in the riffle areas averaged about 75-85 feet wide. The stream bottom was mainly small boulders and cobble totalling about 50% with the remainder being 10% large boulders, 30% coarse gravel, and 10% fine gravel. An estimated 58,666 square yards of good spawning material was found in about 1½ miles of this section of the Twelve Mile.

Spawning area S₁₀ - This spawning area was located on the Twelve Mile between a long stillwater area known as Jam Can Barrens and Ragged Falls. Below the barrens, the stream changes abruptly into fast flowing riffle area. The stream, averaging 50-75 feet wide, is dominated in the riffle areas, by large rocks and coarse gravel. The percentage relationship of pools to riffles is about 50%. The lower or downstream portion held particularly good spawning gravel; i.e. a stretch of about 1/2 mile joining two fairly large pools.

In all, an estimated 35,200 square yards of excellent spawning material was found here in $3/4$ of a mile of this area.

Spawning area S₁₁ - Above the "barrens" on the Twelve Mile stream and extending to the Union dam was another area of good spawning potential. The stream averaged 75 feet wide with a pool to riffle area relationship of approximately 50%. Worthy of note were several large pools found in the area commencing below Union dam. The stream bottom in the runs was rough with small boulders making up about 45%. Large boulders accounted for 15% of the bottom material with about 20% each of cobble and coarse gravel. An estimated 22,000 square yards of good spawning material was found here.

Spawning area S₁₂ - This is an area extending about $1\frac{1}{2}$ miles above Union dam. Only limited spawning potential was found. Throughout the area, mainly riffle area, with a few pools on the lower stretches, the stream was very rough and large and small boulders dominated the bottom. Throughout the section the flow is quite sharp over a steep slope. The stream approximated a 50 foot average width. It was estimated that about 29,000 square yards of this section afford only fair spawning potential.

Spawning area S₁₃ extends from Governor Lake dam downstream about four miles on the Twelve Mile stream. In this area good observations were hindered by high water conditions created by recent opening of the Governor Lake dam. At survey time almost the first two miles of the stream below this dam was flowage area. Small runs were only barely visible between what looked like small pools now flooding their low banks. It was thought that some spawning potential existed here but its extent was virtually impossible to assess. The lower reaches of the area below the flowage were also much affected by the high water. The steeper slope produced a rapid stream, almost torrential in places, over a stream bottom that was 60% large and small boulders. In these riffle areas, the stream width approached an average of 50 feet. The lower stretch of about 1½ miles of riffle area possessed a fair potential spawning area of about 44,000 square yards.

TEN MILE STREAM

Spawning area S₁₄ is an area of the Ten Mile stream between the Ten Mile Lake and the mouth of the stream at Union Flowage. Flowing over a moderate slope the stream is almost a continuous succession of small pools and riffle areas.

The stream bed in the riffle areas approximates an average of 45 feet wide and is mostly cobble and coarse gravel. It was considered that some good spawning potential existed in about 19,800 square yards of this area, particularly above and below the first long stillwater above the Union Flowage and in the riffle areas in the upper section. It is estimated that good spawning material made up about 3/4 of a mile of the area.

Spawning area S₁₅ - This area was found between Grassy Lake and Ten Mile Lake on the Ten Mile stream. Not unlike the stream below Ten Mile Lake, the stream is a little smaller, averaging about 35 feet in the runs. The slope of the stream here is also quite moderate and long stillwater pools linked by short riffle areas characterize the stream throughout most of its length. Water conditions were quite low at the time the stream was inspected; the riffle areas were practically dry. The stream bottom, in the riffle areas, was predominantly cobble and coarse gravel. Potentially, at least, the stream appeared to have about 15,400 square yards of suitable spawning material scattered throughout an area extending between 1/2 to 3/4 of a mile in length.

SEVEN MILE STREAM

Spawning area S₁₆ - This is an area found on the Seven Mile stream extending from Mulgrave Lake to the mouth

of the Seven at Marshall Flowage. For the most part, the stream was made up of long stillwater pools, at the time of the survey. The only extensive area of rocky riffles was on the upper half near Mulgrave Lake. This was an area approximating 1/2 mile in length and about 40 feet wide. Here the stream bottom was predominantly large and small boulders with smaller percentages of coarse gravel and cobble. Little or no spawning potential of any value existed in this area at survey time.

Spawning area S₁₇ - This spawning area was found on the Seven Mile between Mulgrave and Como Lakes. Almost the entire first two miles of the stream below Como Lake was stillwater pools with short riffle sections between them. In the middle portion of the stream, for about one mile below the still pools, the stream grade increases slightly. This allows a continuous succession or a 50% relationship of pools to riffles in this section. In the lower portion of this area stream gradient becomes sharper. Pools are infrequent, although one or two large pools did exist. The stream bottom throughout most of the riffle areas consists of small boulders, cobble, and coarse gravel and a few large boulders. The average width of the riffle areas was about 50 feet; the area was considered to have about 58,000 square yards of potentially fair to good spawning area in a two mile stretch of riffles.

GRANT RIVER

Spawning area S₁₈ - This area was located on Grant River which flows into the main stream at Ruth Falls Flowage. Evidence existed, at survey time, to indicate that some salmon have spawned in the lower reaches of the river. It is one of the smaller tributaries to the East River system stretching about 5 miles in length. The stream was mainly still pools in its upper reaches as the gradient was very slight. However, some swift water riffle areas were found near the mouth of the stream. In this area, where salmon parr were discovered, the stream averaged about 25 feet in width. The bottom was dominated by cobble and coarse gravel with small amounts of sand and the occasional large boulder. The riffle area extended about 1/2 mile in length. In an area of about 7,000 square yards, it appears that some salmon did spawn. However, conditions for spawning purposes were not considered good for large numbers of spawners.

Spawning area S₁₉ - Limited spawning facilities were observed on the downstream portion of the Sloan Lake branch, in a section extending about 1/2 mile up from its confluence with the Fifteen Mile stream. The stream bed in this area was almost dry during the survey. Its width, in this section, approached an average of 35 feet. The bottom was predominantly small boulders and cobble with some coarse gravel and sand. Roughly 10,000 square yards of fair spawning material existed here.

SUMMARY OF SPAWNING AREAS

<u>Stream</u>	<u>S</u>	<u>No.Sq.Yds.</u>	<u>Quality</u>
Fifteen Mile Stream	1	11,000	Fair
	2	44,000	Good
	3	96,000	Fair to good
	4	64,533	Excellent
	5	26,400	Good
	6	58,666	Good
	7	14,666	Good
Twelve Mile Stream	8	14,000	Fair
	9	55,000	Good
	10	35,200	Excellent
	11	22,000	Good
	12	29,000	Fair
	13	14,000	Fair
Ten Mile Stream	14	19,000	Good
	15	15,000	Good
Seven Mile Stream	16	Nil	Nil
	17	58,000	Fair to good
Grant River	18	7,000	Poor
Sloan (seloam) Lake Bk.	19	10,000	Fair
		<u>593,265</u>	

This makes for a total of 593,265 square yards of fair to excellent spawning potential found dispersed throughout the East River system. Roughly 53% of this amount was found on the Fifteen Mile stream. It also includes 7,000 square yards of the Grant River tributary where salmon appear to have spawned despite seemingly inadequate or unfavourable conditions. For the most part, these spawning areas are adequately dispersed throughout existing nursery areas; the one possible exception is the Twelve Mile stream, where a

preponderance of spawning areas exist. The total of 593,465 square yards of spawning material is, however, much more than adequate to support the more than 600,000 square yards of nursery areas described below.

NURSERY AREAS

Nursery areas are referred to as N₁, N₂, et cetera as previously indicated. In discussing these, areas already referred to in a consideration of spawning areas will be considered again in respect to their potential nursery value. It follows, therefore, that their place in the discussion which follows does not necessarily indicate quality.

In the nursery area assessment, the two factors of prime importance are stream bottom types and depth of water. In estimating the potential salmon nursery value of the East River system, the work of Dr. P. F. Elson¹ is used as the standard reference.

FIFTEEN MILE STREAM

Nursery area N₁ - This is found on the Fifteen Mile stream between the head of tidewater and the Marshall Flowage dam. Except for a few small patches of insignificant size this whole area was judged unsuitable for nursery purposes. There is a predominance of large rocks and boulders in this area, the least productive of all types of riffle areas. The large pools, many of which exceed three feet in depth, while being good adult salmon pools, are a haven for the predators of young salmon, particularly the eel.

It is noteworthy that although some salmon do spawn in this area, no fry or parr were observed during the survey. Seining and fly-fishing efforts yielded different types of small fish but no salmon parr were found.

Nursery area N₂ - This area is located between Marshall Flowage and McBain Falls. In this area, about 3/4 mile in length, the nursery potential looked good. Almost continuous riffle area, except for a few small pools, was observed at survey time. The stream bottom, covered to a depth between three to five inches, was mainly cobble and coarse gravel with fine gravel and sand. The few small pools had depths averaging between eight to ten inches. The estimated 44,000 square yards of the stream appeared to have good nursery potential.

Nursery area N₃ - This area takes in the section of the Fifteen Mile stream between McBain Falls and Anti Dam. The upper part of the area had very good potential. This portion includes the area extending downstream about 1½ miles below Anti Dam. Averaging about 110 feet in width, the stream is almost entirely coarse and fine gravel; some large cobble, as well as the occasional large boulder, was also found. The depth was between 3 - 10 inches in the riffle areas and was broken occasionally by small shallow pools about 8 inches in depth. This section contained about 96,800 square yards of very good nursery potential.

In the lower portion of the area, a section extending about $1\frac{1}{4}$ miles above McBain Falls, the nursery potential was regarded as only fair. The stream bottom here was made up of small boulders, cobble and coarse gravel dotted with large boulders. Huge boulders and ledge rock were present though not extensive. Some 88,000 square yards of fair nursery potential existed here, bringing the total to 184,800 square yards of fair to very good nursery potential.

Nursery area N₄ - This area takes in the portion of the Fifteen Mile extending from the Anti Dam flowage to the inlet of Bear Brook, a distance of about 1 mile. This area was considered to have the best nursery potential on the Fifteen Mile stream. It was predominantly riffle area averaging between 6 - 10 inches in depth. The stream bottom was mostly coarse gravel with some cobble and the occasional large boulder. The area was thought to have excellent nursery potential throughout its estimated 64,533 square yards.

Nursery area N₅ - is located on the Fifteen Mile stream between Bear Brook and the mouth of the Sloan Lake Brook. In this area, the stream was almost entirely rough rapid water over a stream bottom dominated by large and small boulders. Although some coarse gravel was observed, it was not extensive.

The depth of water generally exceeded 12 inches. Though some large parr might survive and grow in this habitat, it is generally regarded as having only fair nursery potential, because of the potential predator populations, in the 26,400 square yards noted.

Nursery area N₆ - The area is found on the Fifteen Mile stream between the mouth of Sloan Lake Brook and the mouth of Otter Brook. In a section of the area extending about $1\frac{1}{2}$ miles above the inlet from Sloan Lake, the stream offers some nursery potential. Because of the substrate generally it is not considered that nursery conditions are optimum; however, conditions were thought to be potentially fair. The stream, which averages about 8 - 10 inches in the riffles, covers a bottom comprised mainly of large cobble with smaller percentages of large boulders, coarse gravel, and small boulders. Only fair nursery potential existed over some 73,300 square yards of this area.

Nursery area N₇ - This area extended between Otter Lake Brook and the Rocky Lake Dam. Generally, the area was dominated by still pools, though some riffle areas existed between the pools. The riffle areas on the whole were not long and generally covered with deep water, at survey time, over one foot in depth. The area was not considered as having any significant nursery potential.

TWELVE MILE STREAM

Nursery area N8 - This is an area on the Twelve Mile stream extending from the Sandy Island Pool to the mouth of the stream at the head of Marshall Flowage. Water conditions were high on this stream during the survey and good observations were difficult. From observations made, however, it did not appear that the nursery potential was very good. The stream was predominantly large stillwater pools and rocky riffles. The riffle areas were not extensive and consisted mainly of large boulders and cobble.

Nursery area N9 - This area is located on the Twelve Mile stream extending from Sandy Island Pool to Ragged Falls. The stream in this section is quite rapid and though numerous small pools exist only three large pools were noted; these were Ragged Falls pool, Otter Falls pool, and the Sandy Island Pool. The stream bottom was about 50% small boulders and cobble with the remainder being about 10% large boulders, 30% coarse gravel, and 10% fine gravel. Water depth in the riffle areas was about an average of five inches. Nursery potential ran from fair in some areas to good in the area of the stream below Ragged Falls. An estimated 58,666 square yards of good nursery potential were found here.

Nursery area N₁₀ - This area takes in the section of the Twelve Mile stream between a long stillwater area known as Jam Can Barrens and Ragged Falls. Below the barrens the stream changes abruptly into fast flowing riffle area. In the lower half of the section above Ragged Falls, there is an area extending about 1/2 - 3/4 of a mile in length and about 75 feet in width, which is almost entirely coarse gravel. This area is known locally as Heart's Gravel; it is a horse-shoe bend with good pools on each end. Water conditions were high during the survey and depths were greater than the 10 inch average thought to be optimum. However, about 22,000 square yards of this area were judged to have good nursery potential.

Nursery area N₁₁ - Nursery potential was considered very poor. This is in the area below Union Dam, on the Twelve Mile stream, extending down to the long stillwater area. Water levels were high and the area was predominantly large pools linked by short rocky rapids. The stream bottom, in the short rapids between pools, was dominated by large and small boulders with small amounts of cobble and coarse gravel.

Nursery area N₁₂ - The twelfth area studied for its nursery potential was on the Twelve Mile stream above Union Dam Flowage.

This area extending upstream about $1\frac{1}{2}$ miles was considered as having poor nursery facilities over the 29,000 square yards of the area. The stream throughout the area was swift and rough. Large and small boulders dominated the steep grade right to the mouth of the stream at the Union Dam Flowage.

Nursery area N₁₃ - This is an area below the Governor Lake Dam extending downstream about four miles. Good nursery facilities were practically non-existent in this area. The first two and one half miles below the Governor Lake Dam was almost continuous flowage area. Below this point the stream gradient increases sharply and fast flowing riffle water predominated. The stream bottom was made up mainly of small and large boulders with small amounts of coarse gravel and cobble. High water, coupled with the increased slope of this lower section, gave the stream its torrential nature in this section. Fair nursery conditions only were observed in the $1\frac{1}{2}$ miles of riffle area in the middle half of the stream, approximately 44,000 square yards.

TEN MILE STREAM

Nursery area N₁₄ - This is an area on the Ten Mile stream lying between Ten Mile Lake and Union Dam Flowage.

In this section of the Ten Mile, roughly $4\frac{1}{2}$ miles in length, the stream appears to have some good nursery potential. A gentle gradient allows for a 50% relationship of pools to riffles, and the riffle areas are made up almost entirely of coarse gravel and cobble. The water levels were low during the time of the survey but it appeared that good potential existed on about 26,000 square yards of the riffle areas.

Nursery area N₁₅ - This area extends between Grassy Lake dam and Ten Mile Lake. Water levels were low at the time of this inspection and riffle areas were pretty dry. The gradient of the stream was moderate and stillwater pools and riffles characterized the stream throughout its length. The riffle areas were mostly cobble and coarse gravel. Approximating an average width of about 35 feet, the stream, in the riffle areas, potentially at least, possessed some good nursery material. An estimated 10,000 square yards of potential nursery area was found here.

SEVEN MILE STREAM

Nursery area N₁₆ - This nursery area was located on the Seven Mile stream below Lake Mulgrave. It is on the only extensive riffle area existing on the Seven Mile Stream between Lake Mulgrave and the mouth of the stream. Its nursery potential was considered to be poor, because of the predominance of large and small boulders, although some gravel and cobble were also present.

Water levels were low on this stream during the survey and the riffle areas were shallow over most of the 40 foot average width.

Nursery area N₁₇ - This is an area between the Como Lake dam and Mulgrave Lake on the Seven Mile. Much of the upper section, for about 2 miles below Como Lake, was stillwater pools with very short rocky runs between them. Following this section downstream, the stream grade increases slightly. The next mile or so is made up of pools and riffles in about a 50% relationship. In the lower section above Mulgrave, the stream grade increases further and pools become infrequent. The bottom in these riffle areas consists of small boulders, cobble with small percentages of coarse gravel and large boulders. This type of bottom predominates over the 50 foot average width of the stream. The area is perhaps best described as having fair to good nursery potential throughout most of the lower half of the stream. Almost 60,000 square yards of fair to good nursery potential existed in this area of the Seven Mile Stream. Photographs - Appendix V.

GRANT RIVER

Nursery area N₁₈ - The Grant River tributary, entering the main stem at the Ruth Falls Flowage, was the only one on which salmon parr were found. They were not plentiful however; only two or three were taken on a wet fly. These were captured in a small pool above a 1/2 mile stretch of riffle area near the mouth of the stream. The parr were all about the same size, approaching four inches in length and were in good condition. The riffle area below this small pool was considered to have some value as a nursery at the time of the survey, particularly for salmon fry. The bottom in the riffle area of the stream, averaging about 25 feet wide in this area, was made up mainly of small boulders, cobble and coarse gravel. Nursery conditions on the stream generally, however, were not considered good.

SUMMARY OF NURSERY AREAS

<u>Stream</u>	<u>S</u>	<u>No.Sq.Yds.</u>	<u>Quality</u>
Fifteen Mile Stream	1	-	Poor
	2	44,000	Good✓
	3	184,800	Good✓
	4	64,533	Excellent✓
	5	26,400	Fair
	6	73,300	Fair
	7	-	Poor
Twelve Mile Stream	8	-	Poor
	9	58,666	Good
	10	22,000	Good
	11	-	Poor
	12	29,000	Poor
	13	44,000	Fair
Ten Mile Stream	14	26,000	Good
	15	10,000	Good
Seven Mile Stream	16	-	Poor
	17	60,000	Fair to good
Grant River	18	-	Poor

This amounts to 642,699 square yards of fair to excellent nursery area found throughout the whole East River system. Roughly 61% of this amount was found on the Fifteen Mile Stream. Despite the poor rating of nursery conditions on Grant River and that part of the main stream from tidewater up to and including Ruth Flowage, these areas support the present run of salmon into the river. From Table II below it can be shown that over an eight year period anglers have taken an average annual catch of 50 salmon. If one assumes these to be all East River fish, then it appears that these poorly rated areas are producing an average of 2500 smolts annually.

PRODUCTIVE POTENTIAL OF NURSERY AREAS

In attempting an assessment of the smolt producing potential of the East River system, the research work of Dr. P. F. Elson² has been used almost exclusively as a guide.

As a general rule, broad and sweeping extensions of experimental findings are not permissible. Still the true value of applied research must be reckoned in terms of its practical application. When common denominations are established then conservative generalizations or conclusions can be made. For example, in his research studies on the habitat of young salmon, Dr. Elson has found that there was ample evidence to show that survival rates of young salmon were the highest where the young fish were planted in shallow rapids where the bottom was mainly rubble and coarse gravel. Further observations through electro-seining showed that this was so also in streams outside the experimental area, where "fish-pure" water supported the progeny of wild salmon. An extension of this type of experimental work in this field over many years has permitted researchers to study the productive capacities of the various types of stream conditions available to young salmon. It is now possible to make safe generalizations concerning the relative productivity of each "habitat type" on a unit of area basis.

When all factors, such as types of bottom material, water depth, temperature, and flow pattern, are considered, along with the presence or absence of predators and pollution, useful approximations of a stream's potential productivity can be made.

SMOLT SIZE

Given a specific survival rate for an earlier life stage of young salmon then the number of these eventually running to sea as smolts will be greatly influenced by the age at which they migrate. In other words, the longer it takes a given number of yearling salmon to develop to the smolt stage, the smaller the number surviving. It has been well established by Dr. Elson et al³ that large parr having reached about four inches in length by late summer will travel to sea as smolts the following spring while those under four inches will remain in the stream another year. This tendency to run to sea at or near a certain size is one of a physiological condition associated with size. It is, therefore, under the sway of existing ecological conditions. Some streams with temperatures during the growing season in the 60-65 degrees Fahrenheit range usually have three year smolts while others with temperatures at this period running around 68 degrees Fahrenheit usually have two year smolts.

SIZE OF SMOLTS AT EAST RIVER

It appears likely that two year smolts have been found on the Moser River, White⁴. This is also a small stream, part of which lies in Halifax County on the south coast of the Nova Scotia mainland. In common with East River, it is a warm stream with a low pH (6.2) and found in an area of Precambrian formation. Such similarities suggest that somewhat similar ecological conditions might be found on East River with the consequent possibility that the river might also produce two year smolts.

POTENTIAL PRODUCTION OF EAST RIVER NURSERIES

A survey of the East River system was made and the area of potential nursery has been calculated. By the application of research findings, such as has been mentioned briefly in the foregoing, an estimate of potential smolt production from these areas can be made.

POTENTIAL SMOLT PRODUCTION ON
THE FIFTEEN MILE STREAM

Following the survey of the Fifteen Mile Stream, it was estimated that 393,033 square yards of it provided good nursery conditions at the time of the survey.

While the summation refers to the availability of good nursery conditions, it must be realized that conditions of quality found ranged from poor to excellent. Further, the potential smolt producing capacity of a stream may be influenced greatly by factors not always evident during a survey of the stream. Principal among these factors is the presence or absence of predator birds, particularly the merganser (*Mergus merganser americanus*). White⁵ demonstrated that a single merganser, in rearing to full growth, may consume a total of 1,584 young salmon. This demonstration was all the more remarkable when he pointed out that this amount could be less than 50% of the birds' diet during this period. During the survey of East River very few mergansers were observed.

After many years of research, Dr. P. F. Elson⁶ has recommended planting procedures which are designed to obtain the full smolt producing capacity of a stream. In brief, it states that if a stream is fertile, then the numbers of young salmon to be planted for maximum smolt production will vary with the numbers of mergansers present on the stream. In fertile streams, with mergansers present in numbers less than one per ten miles of stream ten yards wide, the number for two year smolts is 7,000 fingerlings per mile of stream ten yards wide. With the same stream, if mergansers were more abundant, the numbers of fingerlings to plant would be 2,500 fingerlings per mile of stream ten yards wide.

In the Fifteen Mile Stream, the 393,033 square yards of nursery potential, provides roughly 22 units of area to be stocked. At survey time, mergansers were present on the East River system at numbers less than one per ten miles of stream ten yards wide. This means that 154,000 young salmon should be planted on the Fifteen Mile Stream. The generally accepted survival rate of late summer fingerlings to two year smolts is about 15%. This allows for a maximum smolt production of about 23,100 smolts.

In the event that mergansers had been observed during the survey, in numbers more abundant than one per ten miles of stream ten yards wide, then the numbers to be planted would be reduced to 2,500 per unit of nursery area or a total of 55,000. Smolt production in this case would be reduced to about 8,250 smolts.

PRODUCTIVE CAPACITY OF THE TWELVE MILE

The potential smolt production of the Twelve Mile Stream can likewise be assessed. On the Twelve Mile Stream a total of 153,666 square yards of good nursery material was observed. Furthermore, mergansers were present in numbers fewer than one per ten miles of stream ten yards wide. This dictates stocking at the maximum rate of 7,000 per unit of nursery area or a stocking of 63,000 late summer salmon fingerlings.

Potentially this represents a production of 9,450 salmon smolts. Here again if an assessment were made at the minimum rate allowable when mergansers are more abundant, then a stocking of 22,500 fingerlings is dicated with a potential production of 3,375 smolts.

PRODUCTIVE CAPACITY OF THE TEN MILE STREAM

Similarly the productive capacity of the Ten Mile Stream is calculated as follows - the estimated 34,000 square yards of good nursery material permits the planting of 9,100 salmon fingerlings if mergansers are not present in numbers exceeding one per ten miles of stream ten yards wide. If mergansers were more plentiful then stocking the area with 3,250 salmon fingerlings would be recommended. The estimated survival to the smolt stage would be in the former case - 1,365 smolts; in the latter - 487 smolts.

PRODUCTIVE CAPACITY OF THE SEVEN MILE

The productive potential of the Seven Mile Stream, based on the presence of 60,000 square yards of good nursery potential, indicates that a maximum stocking of 23,800 fingerlings is permissible. Minimum stocking, where mergansers are fairly abundant, would indicate the planting of 8,500 salmon fingerlings. These plantings would permit survival to the smolt stage of 3,570 and 1,275 smolts respectively.

SUMMARY OF PRODUCTIVE POTENTIAL OF EAST RIVER

Table I below shows a summary of nursery areas; the estimated maximum and minimum numbers of young salmon to be planted for capacity utilization, maximum numbers are those used when mergansers are present in numbers less than one per 17,600 square yards of nursery area; minimum numbers are used when mergansers are more abundant. Also shown are the calculated survivals to the smolt stage from each group.

Stream	Nursery Area Sq.Yds.	Numbers to Plant		Estimated Survivals from plantings	
		Max.	- Min.	Max.	- Min.
Fifteen Mile	393,033	154,000	- 55,000	23,100	- 8,250
Twelve Mile	153,666	63,000	- 22,500	9,450	- 3,375
Ten Mile	34,000	9,100	- 3,250	1,365	- 487
Seven Mile	60,000	23,800	- 8,500	3,570	- 1,275



PRESENT PRODUCTION OF EAST RIVER

East River Sheet Harbour presently has a small run of salmon. Since the early '50's a small run of early running salmon enter the river and provide fair early summer angling. In a recent study of the Atlantic salmon fishery in Nova Scotia, East River was twenty-third on a list of thirty-two rivers in order of their percentage of the total average catch between 1949 and 1961.

Table II below shows angling catches and counting trap records since 1953.

TABLE II
COUNTING TRAP AND ANGLING DATA AT
EAST RIVER

YEAR	NUMBERS THROUGH TRAP	NUMBERS TAKEN BY ANGLERS
1953	None trapped	51
1954	" "	105
1955	93	24
1956	61	10
1957	78	11
19 58	None trapped	129
1959	" "	84
1960	" "	16

BARRIERS

There are a total of thirteen dams on the East River system. These include eleven upriver storage dams and two power dams. The power dams have their storages tapped directly by diversion canals which feed water to power wheels for production of hydro-power. All of these dams are barriers or partial barriers to the upstream and/or downstream movements of anadromous or residual species of game or sport fish.

Barrier B-1 - This is the Ruth Falls dam on what is now known as Ruth Flowage. The dam, a concrete structure, is 22 feet high. Its length was estimated to be 648 feet including corewalls, fishway, and canal. The whole structure must be viewed as a partial barrier.

A pool and weir type fishway circumvents the dam on the west side. The fishway which is made of concrete permits the adequate passage of salmon and trout upstream. However, as a device to allow descending fish to pass downstream, it is almost completely ineffective. However, its inadequacy in this respect is due mainly to errors in its location rather than its design. In addition to this, the large draw-down at the eastern side of the dam through the canal is large enough, relative to the fishway draw, that most descending fish are attracted to the canal.

Once in the forebay close to the canal entrance, these fish are immediately drawn into the unscreened canal where they gradually work down the 8,000 foot canal.

The canal extends 8,000 feet downstream to a hydro-electric plant located on the eastern bank of the stream. Through the canal-diversion system, a static head of 109 feet is maintained. At the plant, power production is realized through the use of three "Francis" type turbines. Two of the units use 400 R.P.M. generators producing 2500 K.V.A. each and the third used a 360 R.P.M. generator producing 3300 K.V.A.

Barrier B₂ - The second barrier dam on the East River system is located at Malay Falls on the Fifteen Mile stream. This is a power dam which is a complete barrier to upstream and downstream movements of anadromous species of fish. At this dam, also, a diversion canal is used to carry water to a power plant further downstream. The height of the dam is 41 feet.

No fishway exists at this dam although provision for a fishway was provided around 1925. The fishway was never built, however, and the present dam structure still has an opening for a fishway. Presently the slot, originally intended for this purpose, is rock filled. See photographs Appendix II.)

At the Malay Falls dam, the diversion canal carries water, along the eastern bank of the stream, a hundred yards or so to the power plant. At the plant, power is produced from a static head of 41 feet by three turbine units of the Francis type. The turbines use 225 R.P.M. generators to produce 1,500 K.V.A. each.

Barrier B₃ - Marshall Falls Dam - This barrier is located a mile or so above The Malay Falls dam. The dam is a storage dam which is 24.4 feet high with electrically operated gates which are controlled from the Ruth Falls plant at the head of tide. To the west of the main dam, a series of four spill dams are located at irregular intervals. These are designed to hold water in those low lying, flat areas around the south western end of the flowage. These dams are all complete barriers, except in very high water, to the ascent of anadromous fish. The movement of fish downstream through the dam could not be tested at survey time. It was established, however, that brown trout have successfully moved downstream either through the gates of the dam or over the small spill dams. Head pond levels vary considerably and fluctuations have been recorded as great as 17 feet.

Barrier B₄ - Anti Dam - This dam is a large wooden structure on the Fifteen Mile Stream roughly 12 miles from tidewater.

This dam is used for storage purposes. The height of the dam is 23 feet. The dam must be regarded as a complete barrier. In high water it is expected that head pond pressures would be too great to allow upstream passage through the existing sluice gates. In low water periods, the height of the sluice from the shallow stream is expected to present a barrier. See photographs Appendix III.

Barrier B₅ - Rocky Lake Dam - This is also a wooden structure, used for storage purposes. Its height is 22 feet. Similar to the Anti Dam, it is a barrier to the ascent of fish into Rocky Lake. This lake is the downstream limit of a series of small headwater lakes on the Fifteen Mile. Salmon would not be as affected by the dam as are trout, since no suitable salmon spawning water exists above the dam.

Barrier B₆ - Union Dam - This dam is located on the Twelve Mile Stream, the largest tributary to the Fifteen Mile. It is situated about 9 miles from the mouth of the stream. It is one of the largest dams on the system and is 34 feet high. It is an earth-fill dam with a rock-crib core. While there is no fishway for fish to move up above the dam, it appears likely that fish can descend through the open gates. See photographs Appendix IV.

Barrier B₇ - Governor Lake Dam - This dam is also located on the Twelve Mile Stream about 7 or 8 miles above the Union Dam. It is a wooden dam about 8 feet in height. Governor Lake, a large lake - 1389 acres, is the main headwaters of the Twelve Mile Stream. It forms a complete barrier to the ascent of fish into Governor Lake while egress is had through the open gates in the spring.

Barrier B₈ - Ten Mile Dam - The Ten Mile dam on the Ten Mile Stream is another wooden storage dam. Its height is 13.5 feet. Like most of the similar storage lakes on the system it prevents the upstream movement of fish into Ten Mile Lake. Egress is had, however, through open gates when the storage is being used.

Barrier B₉ - Grassy Lake Dam - This dam is located on the Ten Mile Stream and forming the headwater storage for it. The height is approximately 8 to 10 feet. It is a wooden structure which also forms a barrier to the upstream movement of fish. Fish move from the lake downstream through the gates when the lake is being drained. Aerial photograph, Appendix VII.

Barrier B₁₀ - This dam, located at the outlet of Lake Mulgrave, is on the Seven Mile Stream. Another wooden storage dam, it is 15 feet high. It also prevents the upstream movement of fish while allowing movement from the lake when gates are open and storage water is being used.

Barrier B₁₁ - Como Lake dam is another storage dam on the Seven Mile Stream. A barrier similar to that of the Mulgrave storage, it is 14 feet in height. It is also a wooden structure. See photographs Appendix V.

Barrier B₁₂ - This barrier dam, also a wooden storage dam, was located on Frasher Lake. This is one of the larger dams on the system, about 26 feet in height. While still a barrier similar to other storage dams, it was not considered too significant since it is the main source of a small stream draining directly into Lake Mulgrave.

Barrier B₁₃ - This is a wooden dam on Seloam (Sloan's) Lake. It is a small storage dam reaching 7 feet in height. It is not considered to be of paramount importance, salmon wise, since it dams the headwaters of a small brook which is not critical in terms of salmon producing potential. It does prevent the movement of trout into the lake, however, once they have moved downstream through the sluice gates.

POLLUTION

No serious degree of pollution was in evidence on the East River Sheet Harbour during the time of the survey.

PREDATOR BIRDS

Only on one occasion during the survey were mergansers seen and at this time only two were seen over the lower reaches of the river. Two Kingfishers were seen in about the same general area on another occasion.

EXPECTED MORTALITIES THROUGH TURBINES

At Ruth Falls on the East River, power is produced by three Francis type turbines, two units operating at 400 R.P.M.'s. producing 2,500 K.V.A. and one operating at 360 R.P.M.'s. producing 3,300 K.V.A. These machines operate on a static head of 109 feet.

At Malay Falls, there are also three Francis type turbines each operating at a static head of 41 feet, using 225 R.P.M. generators to produce 1,500 K.V.A. each.

Mortality studies⁷ were conducted at the Cushman No. 2 hydro-electric development at the North Fork of the Skokomish River at Potlatch, Mason County, Washington, U.S.A.

Used in the tests were silver and spring salmon and steelhead trout - about 590 in all. Tests were run on mortalities at four specific turbine gate openings (resulting in various turbine efficiencies - optimum turbine efficiency at 92% at gate opening of 72% at high, medium, and low tailwater elevations). As a result of these tests, it was shown that the average mortality from all tests was about 33%. It was concluded that turbine characteristics bear a great influence on the mortalities, particularly as turbine efficiency is lowered. Some injury was recorded as resulting from such things as blade design and clearance. While these studies have no direct relationship to mortalities occurring at the East River plants, it does suggest that mortalities, particularly the combined mortalities at Malay and Ruth Falls, would be quite high.

DISCUSSION

It appears that the main obstacles to the reclamation of East River as a salmon stream are two power dams and eleven upriver storage dams.

At Ruth Falls, the fishway provides for the passage of anadromous fish upstream but no such adequate facilities exist to provide safe movement of fish downstream. Because of the large draw at the canal on the left bank, most descending fish enter the canal rather than the fishway which is located over 600 feet away on the opposite bank.

At Malay Falls, there exists a complete barrier to the upstream movement of anadromous fish, although fish may descend through the plant turbines.

At Marshall Falls, the storage dam is also a barrier to the ascent of anadromous fish. The dam is equipped with an electrically operated gate which is remotely controlled from Ruth Falls. Fish can descend the river at this dam safely through the open gate. On the right bank of the stream, a number of spill dams extend at intervals to the west of the main dam. Their purpose is to hold water at the low side of the flowage. These dams are barriers to the ascent of fish except in very highwater. Fish can escape over the spillways under similar conditions.

The remaining storage dams are listed here in order of their importance -

- 1) Anti dam, ✓
- 2) Union dam, ✓
- 3) Ten Mile Lake dam,
- 4) Mulgrave Lake dam, ✓
- 5) Como Lake dam, ✓
- 6) Rocky Lake dam,
- 7) Governor Lake dam,
- 8) Grassy Lake dam,
- 9) Frasher Lake dam, and
- 10) Sloan's Lake dam.

Dams 1-5 are considered of strategic importance if the river is to be opened up. The remaining dams, 6-10 inclusive, are dams on headwater lakes above which there is no important salmon water.

CONCLUSIONS

It is concluded from the survey that almost 400,000 square yards of good nursery potential and 315,000 square yards of spawning potential existed, mostly unused, on the Fifteen Mile Stream of the East River system.

Further, many thousands of square yards of nursery and spawning potential exist on the Twelve, Ten, and Seven Mile tributary streams of the system.

It is concluded also that in order to utilize the potential of the Fifteen Mile Stream adequate provision must be made for the passage of fish beyond Malay, Marshall, and Anti dams.

It is concluded also that where water diversion canals exist for power purposes, additional safe means must be provided for the passage of young salmon and other anadromous species downstream.

Finally, it was readily apparent during the survey that an adequate system of water regulation will have to be set up to provide sufficient water for nursery areas and also adequate water to facilitate upstream movements of fish between Ruth Falls dam and tidewater.

RECOMMENDATIONS

It is recommended that a bio-engineering survey of the river system, and particularly the Fifteen Mile Stream, be made to determine the number and nature of the fish passing facilities required. The survey to include not only the exact type and number but also the economic and engineering feasibility of the same.

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