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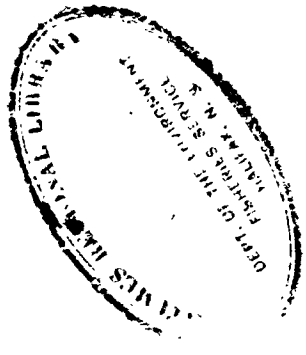
Ecology of the Saint John River Basin

V. Status of Estuary Fisheries



by

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ECOLOGY OF THE SAINT JOHN RIVER BASIN

V. STATUS OF ESTUARY FISHERIES

for

The Saint John River Basin Board

by

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1.0 INTRODUCTION

This report, the second in a series describing the Fisheries Task of the Saint John River Basin Study, is a compilation of relevant information relating to fisheries, both recreational and commercial, within the estuary of the Saint John River. The estuary proper is defined as that portion of the basin which is exposed to the flow and ebb of tide. In the Saint John River this tidal influence extends to McKinley Ferry, a point several hundred yards downstream from the Mactaquac Power development. The entire drainage basin below this point is considered in this report, even though the upstream reaches of the tributaries entering the estuary are not under tidal influence (Fig. 1).

The report consists of a review of all existing fisheries and the management procedures which have been applied to those fisheries. Using a survey completed during 1971 as a basis, the possibilities of other fisheries are explored. In addition, all major tributaries are assessed as to their potential production of Atlantic salmon. In view of the recent alarm with respect to mercury concentrations in various freshwater fish, samples of fish from the estuary were analyzed and the results are presented herein.

2.0 USES

2.1 Present Use

211 Commercial

Of the 54 species of fish, including freshwater, marine, anadromous and catadromous forms, found in the Saint John estuary, 11 are fished commercially (Table 1). Of these 11, 2 species, the American smelt, Osmerus mordax, and the common white sucker, Catostomus commersoni, contribute only marginally (i.e. total landed value less than $1,000), and then only in occasional years. As well, 2 other species, the blueback herring, Alosa aestivalis, and the shortnose sturgeon, Acipenser brevirostrum, are not distinguished from species which they resemble closely (the alewife, Alosa pseudoharengus, and the Atlantic sturgeon, Acipenser oxyrhynchus, respectively) and thus separate commercial figures are not available for them.

Figures 2 - 8 present catch statistics in graphical form for the seven remaining species, in terms of both weight and value upon landing, over the past ten years. (A more complete historical treatment of the commercial fisheries will be presented in Fisheries Economics Task by Morse & DeWolfe). It is apparent that a major change in the pattern of the commercial fisheries has taken place over this period.

.1 American Eel

The landings of the American eel, Anguilla rostrata,

the only catadromous form in the fishery, have increased dramatically over the past 4 years, such that it is now the second most important species in the estuary (Fig. 2). This increase is due to a vastly increased effort over the corresponding period in response to a market demand, and probably does not reflect a real increase in the population. There is every indication that this species is extremely plentiful and that the commercial fishery has not yet begun to limit the population. However, the fishery should be closely watched, for the eel has a freshwater stage of 5 - 10 years before migrating to sea to reproduce, and the eel in the Saint John has only been exploited heavily during the past 4 years. Thus the high takes of the past few years will not yet be reflected in diminished returns if indeed the magnitude of the fishery has reduced the spawning escapement significantly.

.2 Alewife (Gaspereau)

The alewife, Alosa pseudoharengus, has paralleled the eel in its rapid ascent to prominence amongst the commercial fisheries of the estuary. Always the basis of a sizeable fishery, the landings of the past two years (Fig. 3) have multiplied such that the value of this fishery is more than quadruple the combined value of all others taken within the estuary. This increase represents a real increase in population of the alewife, since the effort involved has remained constant over the period concerned. While these large catches

may decrease in the future, such a decrease will not be a result of over-fishing, but more probably a downward fluctuation toward that level which has been sustained in the past.

The current market demand for alewife is based on its use in the manufacture of pet food. However, studies at the special products unit of the Freshwater Institute of the Fisheries Research Board, at Winnipeg, have indicated that, when suitably canned, the alewife is tastier than some of its relatives in the herring family. It thus exhibits potential as a gourmet item for human consumption.

In view of the importance of this anadromous fish to the estuarial fisheries, it would be desirable to investigate thoroughly the conditions of its existence in the Saint John River, and the factors contributing to its well-being.

.3 American Shad

The American shad, Alosa sapidissima, a close relative of the alewife, has contributed in a very fluctuating way to the commercial fishery over the past ten years (Fig. 4), but it has never formed a major part of the fishery. In contrast to the alewife, which is fished at or close to its spawning grounds, the shad is taken enroute to spawning areas further upriver, beyond the estuary. The flooding of the Mactaquac headpond may have had a detrimental effect upon the spawning success of these upstream migrants. While the number

of adults passed through the fishway at Mactaquac Dam during the first 3 years of its operation was fairly constant, that number was halved in the 4th year (Table 2). Since the shad matures and returns to freshwater to spawn in 4-5 years, this reduction may reflect reduced spawning success caused by the alteration of habitat behind the dam both during and after its construction.

The life history and ecology of this species is presently under investigation as a joint research programme by the Resource Development Branch, Fisheries Service, Department of the Environment, and McGill University. This investigation should provide valuable knowledge regarding the habits and requirements of this fish in the Saint John River.

.4 Atlantic Salmon

Over the past 10 years, the commercial catches of Atlantic Salmon, Salmo salar, fluctuated wildly, and last year settled at an extremely low level (Fig. 5). The history of the general decline of the salmon in the Saint John River, particularly in the upper reaches, has been elucidated by Dominy (1971). It is apparent that production of salmon by the estuarial tributaries is also well below maximum potential (Section 3.0). The recently announced 6-year ban of commercial fishing in the Saint John River and off its mouth, and

of the Port-aux-Basques (Newfoundland) fishery, together with a phasing out of the Danish fishing in the Davis Strait over the next 4 years, can be expected to augment spawning stocks in the river considerably.

.5 Striped Bass

The striped bass, Morone saxatilis, is in the northern-most limit of its range along the New Brunswick coast. It is not extremely abundant in the lower Saint John, although it moves into the lower estuary during the winter months prior to its migration in early summer to the head of tide to spawn. It is fished commercially in Belleisle Bay during these winter months, although the fishery is not a major one. This fishery has remained reasonably constant during the past decade, with one peak catch in 1966 (Fig.6). When statistics are presented on an annual basis, they tend to smooth fluctuations which occur, since the striped bass season extends from about December 20 to early March. Although this represents only a slight intersection with the calendar year for which statistics are compiled, the catch in that portion of the season falling in December is large in proportion to the total season catch. Thus actual fluctuations in seasonal catch are greater than those shown by annual catch totals.

The peak catch in 1966 reflects an increase in effort

during that season, as shown by the number of licenses issued (Table 3). However, in 1968, when a high number of licences were issued, there was no corresponding increase in catch. Thus, while seasonal or annual fluctuations may reflect the effort involved, they probably reflect the abundance, at least to some extent.

.6 Atlantic Sturgeon

The Atlantic sturgeon, Acipenser oxyrhynchus, constitutes a minor fishery in the Long Reach area of the lower Saint John estuary. Both the catch and its value have increased in recent years, but the fishery is not significant (Fig. 7). The 1971 survey found sturgeon throughout the estuary, with the greatest concentration (over 50% of the total) in the area presently being fished (Table 4). The species seems plentiful and could probably support a greater fishing effort.

.7 Chain Pickerel

The chain pickerel, Esox niger, the only purely freshwater species contributing to the commercial fisheries of the estuary, is the basis of an insignificant fishery which has gradually declined during the past 10 years (Fig. 8). The fish is used mainly as bait for wildlife trapping during the winter months, although it is also used to some extent for human consumption.

212 Sport

Almost the entire sports fishing effort in the estuary is directed towards salmonids with both the Atlantic salmon and the Speckled (brook) trout, Salvelinus fontinalis, receiving much attention. Unfortunately there are no records of the number of rod-days expended in fishing for trout, and thus, although the effort with respect to salmon is known, there is no way of comparing the two. The remainder of the angling effort is concentrated on 2 unrelated basses, the anadromous striped bass and the freshwater smallmouth black bass, Micropterus dolomieui, with a few other spiny-rayed fishes such as the white perch, (Morone americanus), the yellow perch, (Perca flavescens), and the pumpkinseed (Lepomis gibbosus) receiving some attention. The rainbow smelt, Osmerus mordax, is the object of a small winter ice-fishery on Kennebecasis Bay. The red hake, Urophycis chuss, is also fished in this area year-round.

.1 Atlantic salmon

The angling catch in the Saint John estuary has risen considerably over the past 3 years (Fig. 9), although this cannot be interpreted as a reflection of increasing stocks. The increase is almost entirely due to a relocation of effort from the Tobique River system, a tributary of the upper Saint John, to the Nashwaak River, a tributary of the estuary. In fact, the Nashwaak River is presently in danger

of being over-fished (cf. Section 3.1.3). Angling catches in the estuary may increase over the next few years, following the ban on commercial fishing, and the ban on angling in the Saint John River does not involve the estuarial tributaries, where between 75% and 90% of the entire estuarial catch of salmon in the past three years has been taken. The productive pools at the head of tide have been eliminated by this ban, however.

The statistics used to show trends (Fig. 9) were taken from records compiled by the Protection Branch of the Fisheries Service, Department of the Environment. These statistics are, at best, "guesstimates" of the actual take, since the reliability of the reporting procedure varies between sources. Another estimate of salmon catches, based on data returns from cooperative anglers, has been prepared by the Fish and Wildlife Branch, New Brunswick Department of Natural Resources for the past 3 years (Fig. 9, Table 5). The reliability of these statistics is a function of, and varies directly with, the proportion of cooperative anglers to total anglers licensed, (a ratio which has ranged from .43 in 1969 to .80 in 1971), but nevertheless they would appear to be a more accurate reflection of the actual condition.

.2 Speckled trout

The speckled trout, in terms of number caught, is by far the most heavily exploited sport fish in the estuary. Within the past decade, the more recent years have shown higher takes, with 50,000 fish angled in 1971 (Fig.10). Occurring in cool, clean streams and lakes, it has ample habitat amongst the tributary streams of the estuary. In addition, populations in many areas are augmented by artifical introductions from federal trout hatcheries in response to advice from the provincial fisheries agency.

Speckled trout may run to sea as an escape from undesirable freshwater conditions, but they usually remain within the general influence of the home river. When at sea, the growth rate is greater than it is in fresh water. Sea-run trout are anadromous, however, and they return to fresh-water to spawn. Sea-run speckled trout are fished in early summer in the Nerepis River.

Records of trout catches are strictly "guesstimates", and, since the emphasis of the Protection Branch is on salmon, these records are probably gathered in a much more haphazard way. While no reliability can be attached to the absolute numbers involved, however, these records can be expected to reflect trends - as such, they are of limited value.

.3 Striped bass

A sizeable sport fishery for striped bass has been popular in the lower Saint John estuary, particularly in the area of Reversing Falls, and in the pools at the head of tide in which these fish were known to spawn. However, since the construction of the Mactaquac Dam, these spawning areas have been subject to frequent fluctuations in water level due to variable power demands, and very few fish have been taken (Fig.11). Their reduction is reflected in the number of fish passed over the dam by the fishway facility (Table 2). While this downward trend may be just a natural fluctuation of the sort for which the species is noted, it may also be due to the disturbance of the spawning areas caused by variations in water flow through the power facility.

The angling fishery at Reversing Falls declined to virtually nothing in 1971. However, the commercial fishery in Belleisle Bay, while experiencing a decline from the previous year, was still reasonably good.

The life history of the striped bass in the Saint John River is presently being investigated as a joint project of the Resource Development Branch of the Fisheries Service, Department of the Environment of Canada, and Acadia University. Hopefully the causes of the population fluctuation will be identified.

.4 Smallmouth Black Bass

The only other fish for which catch records have been maintained is the smallmouth black bass, and these records indicate that it is only marginally sought after (Fig.12). There has been a decline in catch over the past decade, although apparently there are some areas such as the Oromocto River system which support large populations and where angler interest is reasonably high.

2.2 Future

221 Commercial

While it is risky to venture into the areas of economics and marketing with insufficient expertise, it seems useful nevertheless to draw attention to resources which might be exploited, and/or exploited in different ways than at present.

.1 Alewife (Gaspereau)

Mention has already been made of a process of canning gaspereau as a gourmet item (Section 2.211.2). Such a use of a plentiful resource might bring a much higher return to the fisherman than the present use as pet food and lobster bait.

.2 American Eel

Despite the abundance of eels, and the increasing catches of recent years, there does not seem to be any local

demand for the end product. Virtually all eels caught in the Saint John River are exported. If a local interest could be created, the demand for the resource might be appreciably increased, and this demand could probably be met by present stocks.

.3 Lake Whitefish

A survey carried out in 1971 and extended into 1972 (Section 6.4) revealed a concentrated spawning run of lake whitefish (Coregonus clupeaformis) in the freshwater portion of the estuary, particularly in Grand Lake. These fish persisted in the lake from late September to at least mid-February. While it is not known at present whether the population is sufficient to support a sustained commercial fishery, further investigation should clarify the situation.

.4 White Sucker

The common white sucker is plentiful throughout the freshwater portion of the estuary, and can be taken easily in gill or trap nets. It has been sporadically fished in small quantities in the past, but at present there is no interest.

Recently the Freshwater Institute of the Fisheries Research Board of Canada (at Winnipeg) together with the Freshwater Fish Marketing Corporation, have perfected a process for deboning and reconstituting suckers into fish-sticks aimed at the fast-food industry and the retail markets.

Initial market tests of the product, brand-named Fischimo, have been highly successful.

While stocks in the Saint John estuary alone may not be sufficient to support a large-scale fishery, when taken together with fish from other areas, such an operation may prove feasible. It should be noted that the above process is not limited to suckers, but can be applied to a variety of so-called "rough" or "coarse" fish.

222 Sport

The 1971 survey has shown that there are a variety and abundance of fish in the estuary which are virtually ignored by anglers. This is not surprising, considering the alternative in years past - the Atlantic Salmon, a unique natural resource cherished by anglers and gourmets alike. Extreme measures controlling commercial and sport fishing have been recently instituted with the object of reviving this fast-diminishing resource. It is to be hoped that these measures are successful.

However, it would be naive to concentrate all attention on the salmon to the exclusion of all else, particularly in light of the prediction of pending eutrophication of the estuary (see reports of the Aquatic Ecology Task, Saint John River Basin Study). The Saint John River angler should be made aware of the existence of fish which, while in no way comparable to the salmon, can and do provide excellent sport fishing in many areas. Unfortunately, these fish are commonly

thought of as "trash" fish, a rather nebulous concept perpetuated by ignorance.

The fish listed below are all extremely edible and easily filleted, and are best referred to as "pan-fried" fish. They can be caught by a variety of angling methods (still-fishing, fly-fishing, trolling or casting) and generally they provide a good measure of "sport" in the taking, particularly the larger ones.

.1 Smallmouth Black Bass

It has been said of the smallmouth that, pound for pound, it is the fightingest fish in North America. In many areas of the continent, it is the premier sport fish, but there is very little local interest in New Brunswick. Many areas of the freshwater portion of the estuary, including tributaries like the Oromocto River System, and the main stem itself, are prime smallmouth fishing grounds. In this area 1 1/2 lb. fish are not uncommon, but much smaller fish still provide top action to the angler.

.2 Chain Pickerel

This voracious feeder can be caught on any type of bait, and provides good action on the end of a line. Specimens up to 2 lbs. are common. It is found in all the quieter, weedy tributaries of the river, as well as being abundant along the weedy shore areas of the main stem. It is strictly freshwater.

.3 Yellow Perch

This species is abundant in weedy areas of the freshwater portion of the estuary. While specimens up to 1 lb. have been taken, the average size is less than 1/2 lb. Larger fish can be expected to provide good angling.

.4 White Perch

The white perch is at home in both brackish and fresh water, although the majority were found in the freshwater portion of the Saint John estuary. It is the most plentiful of the 4 species mentioned, and its average size is 1/2 lb.

.5 Lake Whitefish

The 1971 survey also revealed the presence in the estuary in late fall and winter of the lake whitefish. While not of the pan-fried variety, this fish provides exquisite eating, and is fished enthusiastically by sportsmen further west. The most popular form of fishing is during winter, through the ice. The entire procedure is well-described by MacCrimmon and Skobe (1970). It has not yet been determined to what extent the whitefish remains in the estuary over winter, but the possibility of establishing a winter ice-fishery on Grand Lake is distinct. At present there is no exploitation of this species as a sport fish. Angler education again seems to be an essential prerequisite to establishing such a fishery.

3.0 POTENTIAL OF ESTUARIAL TRIBUTARIES AS REARING AREAS FOR ATLANTIC SALMON.

3.1 Sources of data

In view of the generally deteriorating water quality in the main stem of the river above Mactaquac Dam, an attempt has been made to assess the salmon-rearing capabilities of the various tributaries feeding the estuary. This assessment, of necessity, took the form of compilation and evaluation of existing information, since the effort involved in a comprehensive survey could not be expended. Much of this information exists in the form of Manuscript Reports prepared by the Fish Culture Branch of the Conservation and Development Service, Canada Department of Fisheries, during the years 1954 and 1955. Further information was collected by consultation with various personnel from both the federal and provincial fisheries services who have first-hand familiarity with the systems in question.

The surveys carried out in the mid-50's were based on two criteria: spawning area and nursery area. In some of the reports, quantitative estimates of these criteria were given; in others, they were described only in a qualitative way. It is the general concensus of opinion among biologists familiar with the area, however, that the

amount of nursery area is the limiting factor in the salmon production of any particular stream. This view is supported by the work of Elson (1957b) and Jones (1970), who planted varying numbers of underyearlings in the same (in different years) or similar (in the same year) streams, respectively, and found nearly identical levels of production in later stages. This may suggest that, when all other factors are equal, population growth is density-dependent, at least when eggs and/or under yearlings are present in numbers beyond some maximum level, which is the carrying capacity of the stream, and which is determined by the available nursery area. With this in mind, only nursery areas will be treated quantitatively in this report.

The final stage in the fresh-water portion of the life cycle of the Atlantic Salmon is the smolt. Many investigators have established levels of smolt production for typical salmon streams. Elson (1957a, b) found levels of 1-2 smolt per 100 sq. yds. for the Pollett and North West Miramichi rivers in New Brunswick when there was no control of merganser predation, and 5-6 smolts per 100 sq. yds. when merganser predation was controlled by limiting the density of mergansers to one bird per 10 mi long, 10 yd wide section of stream. Meister (1962), in Cove Brook, Maine gives a value of 3 smolts per 100 yds., and Egglishaw (1970) found 13.1 smolts per 100 sq. yds. (an average over 3 years) in

Shelligan Burn, Scotland. Estimates of possible smolt production have been made using Elson's (1962a) figures for streams with no merganser control, under the assumption that such streams most closely resemble the streams under discussion.

Estimates of smolt production can be confirmed in several ways. The most reliable and direct method is by means of a smolt counting fence - however, no such fence has ever been used on any of the tributaries in question. Thus, indirect methods must be used. For some of these tributaries, parr densities have been established - these can be converted to smolt production if the survival rate is known. Also, the smolt production can be estimated by back-calculation from known adult returns, if the smolt-to-adult survival rate is known. Such adult returns can be derived accurately by means of an adult counting fence, or approximately by means of angling records (it is estimated that anglers take 1/4 of the total adults available.)

.1 Keswick River System.

The main river is approximately 36 miles long, with a gentle to medium gradient. There is extensive spawning area in the middle third of the river, with smaller areas scattered throughout the remainder and in tributaries. The entire system has abundant nursery area, and there are many suitable pools to hold adults during their migration to spawning sites.

There are no serious sources of pollution in this system, and the quality of the water is generally excellent.

The available nursery area has been estimated as 865,000 sq. yds. Such an area could be expected to produce 12,975 (8,650-17,300) smolts, provided sufficient eggs were deposited. These smolts in turn would result in an adult return to the river of 1040 (430-1900) fish. To ensure adequate egg deposition (200 eggs/100 sq. yds.) to maintain such a production, approximately 216 females (10 lbs each, with 800 eggs/lb) must spawn successfully. It is obvious that there would be a considerable surplus of fish available to the angling fishery if all conditions are met optimally.

The Keswick River has been stocked with fingerlings (underyearlings) in the past (Table 6). Over the years 1947 to 1971 the system was stocked at varying rates, with the average being nearly 130,000 over the years 1952-1956. Stocking of this magnitude should have made optimum use of the available nursery area, but unfortunately there was no follow-up program,neither by means of a parr population check nor by means of an adult counting fence.

Recent electroseining surveys indicate that there is a sizeable run established in the system. Densities estimated over the years 1968-1971 show 4.8, 6.6, 5.2, and 4.9 large parr / 100 sq. yds., respectively (Hyatt, 1969; Semple, 1972). These figures suggest that the production of the river is only about 1/2 of its full capacity. (Elson, 1962, estimates 10 large parr per 100 sq. yds. yields maximum smolt production).

There has never been any angling pressure on the system - records over the past 25 years show no salmon taken from the river. There have been reports of late-run salmon in the river after the close of the angling season - these apparently have become more numerous since the completion of the Mactaquac Dam. However, these reports are unverified at present. The fish in question have also been reported as "lake whitefish" (Coregonus clupeaformis). There has been speculation that the dam would deflect spawning runs into the Keswick, but as yet there is no concrete evidence that this has happened.

.2 Nashwaaksis Stream

This stream, with its 3 branches, totals about 30 mi in length, and presents some possibility for producing salmon. The mouth of the stream has in the past presented a barrier to salmon because of heavy municipal pollution, but this situation has recently been alleviated. The anticipated deflection of salmon into downstream tributaries by Mactaquac Dam has not materialized in this stream. At this time there is no indication that salmon utilize the stream.

The available nursery area has been estimated at 88,000 sq. yds. (Saunders, 1972), and smolt production could probably be maintained by the introduction of juveniles on a continuing basis. The productive capacity of the

nursery area is estimated at 1320 (880-1760) smolts, which would yield 106 (44-194) adults. Such a production would require introduction of the order of 17,600 underyearlings. However, the value of this stream for angling would be limited as there are very few suitable holding pools for returning adults.

.3 Nashwaak River System

This system is one which offers much promise in terms of salmon production. The river itself stretches for 70 miles, and tributaries add another 141 miles to its reaches. There are no major obstructions to salmon passage along the river's course, and municipal pollution is minimal. New Brunswick's only remaining pulpwood drive is still carried out annually from a point above Stanley, but the extent of this drive has diminished in recent years, and there is every reason to anticipate its cessation in the near future. Thus there will be no deterents to the optimum use of this system by the Atlantic salmon.

There is an abundance of excellent spawning and nursery area throughout the system, particularly along the middle and upper sections of the main river and in the lower sections of the main tributaries. Numerous minor tributaries also provide ample nursery areas. There are ample holding pools throughout the system, with many excellent angling pools in the upper half of the main river.

The nursery area has been estimated as 4,863,000 sq. yds. Such an area could be expected to produce a smolt run of approximately 73,000 (48,600-97,300), which in turn could provide 5840 (2430-10,700) returning adults.

The river was stocked with juveniles in varying amounts (20,000-256,500) over the period 1947-71 (Table 7). However, there is no indication of how effectively these fish contributed to the total population. All that can be said is that, at maximum, the smolt production from the stocking could have reached about 25% of the estimated carrying capacity of the system. 1/

The Nashwaak has only recently attracted salmon anglers to any large extent. Historically, by far the major proportion of the angling effort in the entire Saint John basin was expended in the Tobique River system. However, this fishery declined drastically following the construction of the Tobique hydro-electric dam and the commencement of DDT forest spraying in 1953. The Nashwaak,

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1/ All calculations are based on the assumption that the freshwater stage encompasses 3+ years. However, in both the Keswick and Nashwaak rivers a considerable proportion of the juveniles leave the freshwater as 2+ smolts. Since the mortality rate from egg to smolt is a function of the time spent in freshwater, those fish leaving the streams after 2+ years have a survival rate 50% higher than those leaving after 3+ years. Thus fewer spawning adults and/or introduced juveniles would be required to utilize optimally the available rearing area.

long virtually ignored, has received much greater attention from anglers as a result, particularly in the last three years, when salmon catches have increased dramatically (see Table 5). Again, it has been suggested that this increase is a result of fish being deflected by Mactaquac Dam into the downstream tributaries. However, it is more likely that the increase reflects greatly increased angling pressure.

Considering the concentration of effort in the past few years, the total angling catch may be closer to 1/3 than 1/4 of the total run. Using these two proportions to establish a range, the total run of spawners in the last two years may be estimated at 3600-4800 fish. If the angling catch is close to 1/3 of the total run, then it is close to becoming a factor in limiting the production of the system. In order to maintain full capacity, just over 1200 females must spawn successfully. Angling records show that grilse (1 sea-year adults) form at least 50% of the total catch, and in the Saint John grilse are 97.4% male (Carey, 1970). Thus there are approximately 1800 spawners: of these, about 2/3, or 1200 are female (Carey, 1970). If the angling pressure increases significantly, then it will begin to limit escapement and thus production.

Electroseining surveys conducted during 1968-1971 have shown, on the average, large parr densities of 6.6, 8.3, 7.7 and 4.4 per 100 sq. yds., respectively. Thus it

would appear that, although parr densities are relatively high, the production is not at the level of optimum utilization of nursery area.

It will be possible to obtain an accurage record of the run into the Nashwaak, and hence the spawning escapement, by means of a counting fence which is presently under construction and which should be operational in 1972. This will allow precise limits to be set on the angling catch, if it is shown that the present level is in fact threatening sufficient escapement.

.4 Salmon River System

The Salmon River stretches for approximately 60 miles before emptying into the North East arm of Grand Lake. It has some good spawning areas scattered throughout the headwaters and tributaries in the upper regions, and exceptionally good spawning areas along the middle portion of the main river as well as along two tributaries in that region, Little Forks Brook and Big Forks Brook. Beyond the entrance of the latter, much of the river is too deep and slow-moving to be utilized by salmon. However, a main tributary further downstream, the Gaspereau River, offers some promise as a salmon producer.

An adult counting fence was operated on the Salmon River some distance above the confluence with the Gaspereau, during the 1960's. The following discussion refers only to

that area upstream from this fence -- the Gaspereau will be discussed separately.

The initial stream investigation did not estimate the amount of spawning area or nursery area present in the system. However, a similar survey conducted by the provincial fisheries agency estimated the available nursery area as 684,000 sq. yds. Such an area could produce, on the average, 10,260 smolts (range 6,840-13,680) which could in turn result in a spawning run of 821 adults (range 342-1,505). The production of such a run would require an initial egg deposition of 1,368,000 (based on the optimum rate derived by Elson, 1962, of 200 eggs/100 sq. yds.), which in turn would necessitate the successful spawning of 188 females (the average Saint John female in 1969 contained 7265 eggs [Carey, 1970]).

Tabulations of the salmon runs in the Salmon River, as counted at the fence, are shown in Table 15 for the four years in which it was operational. It is obvious that the number of spawners is far below the level which would make maximum use of the available nursery area.

The counting fence results also showed that the run in the Salmon River is composed of fall-run fish. Females comprise 73% of this run (Carey, 1970). Amongst grilse in the Saint John only 2.6% are female, with an average egg capacity of 3080 (Carey, 1970).

Applying these figures to the known escapements of 1964 and 1965, estimates of the smolt production and adult return can be determined, and compared with known returns in 1969 and 1970 (grilse return to freshwater 5 years after they are spawned, while full-fledged salmon return after 6 years.) Thus, in 1964, 50 female salmon and 1 female grilse deposited a total of 366,330 eggs. Using Elson's (1962) survival figures, this can be expected to yield an adult return totalling 169 fish (range 70-324). The actual return was 179 fish, composed of 74 grilse in 1969 and 105 salmon in 1970. Similarly, in 1965, 29 female salmon deposited 210,685 eggs, which might be expected to return 97 adults (range 40-186) to the river. While there are no adult returns available for 1971, only 21 grilse were recorded in 1970.

The general agreement between the hypothetical and actual returns lend some credibility to the use of figures in the manner outlined. However, it is well to remember that estimates of nursery areas are of necessity subjective estimates, and as such it is difficult to know how reliable they are. An exercise such as the above seems to indicate that the productive capacity of the system is being utilized only in part, but more accurate indicators are desirable.

A case in point, reflecting the subjective nature of salmon potential investigation, is that of the Gaspereau River, the largest tributary of the Salmon River. A report

of the Canada Department of Fisheries states that "in general, neither the Gaspereau River nor its branches appear to be very suitable for salmon spawning, although a small number of salmon regularly do spawn there". Conversely, a recent survey by the provincial fisheries service led to the conclusion that the Gaspereau River had excellent potential as a salmon producing river. It was estimated that the system had 1,450,000 sq. yds. of good nursery area and could produce 4-5 times the number of salmon sustainable by the Salmon River system, thus attracting up to 7% of the total salmon angling effort in the province.

Discrepancies of this sort must be resolved before any positive management techniques can be applied. There has been no angling reported from either the Salmon River or the Gaspereau River, but there have been reports of severe poaching at the mouth of the Gaspereau, suggesting that the river does indeed support a larger salmon population than was originally realized.

.5 Canaan River system.

The Canaan River is a wide, shallow and slow running river which expands into a deep section of "dead" water as it becomes Washademoak Lake. The middle section of the system and its tributaries present much suitable spawning and nursery areas, but movement of adults may be severely

limited by extremely shallow stretches of water. Although no quantitative analysis has been carried out, it is suggested that the system has a considerable capacity for production of salmon given water conditions of sufficient height.

There are no angling records from this system, and very little investigation of any sort has been carried out. Hyatt (1969) reported large parr densities of 3.1 and 0.4 per 100 sq. yds in 1968 and 1969, respectively, but these are based on single determinations only. While indicating that salmon do use the system as a spawning ground, they cannot be taken as accurate reflections of the parr density throughout the system.

Local gaspereau fishermen are known to take salmon in their nets during their spring fishing, and reports of poaching from fishery officers and local inhabitants are numerous. This indicates that there may be a sizeable salmon run into the river.

.6 Kennebecasis River System

The Kennebecasis system provides extensive spawning and nursery areas for Atlantic salmon, and there are numerous excellent holding pools. Although no quantitative estimates of available nursery area have been made, it would appear from descriptions and map analysis that well over 1,000,000 square yards are present.

While angling pressure on the Kennebecasis has never been intense, records over the past 10 years indicate that salmon do make use of some portions of the system at least (Table 5). A counting fence in operation during 1965 recorded 211 salmon ascending the river, hardly enough to utilize all the available nursery area. A spot check in 1968 (Hyatt, 1969) showed a large parr density of only 1.9/100 sq. yds., thus confirming that nursery areas are under-populated.

A major population centre at Sussex may interfere considerably with the passage of salmon through the system, and thus contribute to the low populations. Poaching pressure and pollution load from such a centre must certainly keep the population below the level expected for such an abundance of nursery area.

.7 Hammond River System.

There is at present no information available regarding nursery areas in the system. Angling records show some catches from 1962-1965 which point to a run of some magnitude, but there have been no fish recorded from the river since that time (Table 5).

.8 Oromocto River System.

This system is comprised mainly of slow-moving waters over muddy bottom - generally it is a poor salmon

habitat. There have been no recorded instances of salmon taken from this system.

.9 Nerepis River System.

The Nerepis system has much weedy, muddy bottom around the mouth of the river, and is generally not considered as a salmon river. However, there have frequently been complaints regarding poaching operations on the system, apparently with respect to late-run salmon. That the river is not totally inhospitable to salmonids is evidenced by a significant sea-trout run in the early summer.

3.2 Hatchery Stocking

Tables 6-13 show the stocking records for the various tributary systems. In some cases the stocking pattern has coincided with recommendations contained in the various survey reports: in other cases, there seems to be no correlation. Stocking in the Salmon River and in the Kennebecasis River have generally been responsive to survey reports, at least for some years following the completion of the surveys. However, plantings in the Keswick and Nashwaak rivers actually decreased following the surveys, despite the fact that both of these rivers showed excellent potential. The Canaan River, although it showed reasonable

spawning and rearing areas, was virtually ignored, and the Hammond River, although it was not surveyed, has received plantings only recently. The Gaspereau River has received plantings in one year only. The Oromocto, on the other hand, has been stocked liberally over a 10 year period despite the fact that no survey was done on the system, and that the prevailing opinion among biologists familiar with the system is that it is not a potentially productive salmon river.

3.3 Summary

It is apparent that, in general, the estuarial tributaries of the Saint John River produce salmon at a rate below their maximum potential. That this portion of the system is capable of contributing significantly to the total salmon production of the river is borne out by the following quote from the 1959 Annual Summary of the Department of Fisheries: "the heavy commercial salmon catch was largely taken from bumper crops which have originated from the tidal basin tributaries of the lower Saint John system". In recent years, however, such bumper crops have not materialized.

It is likely that, with present commercial and angling restrictions, with judicious planting of hatchery "culls", and with development of the proposed "semi-natural rearing habitats" (Section 4.23.1), the contribution of these tidal basin tributaries to the entire Saint John River production will be measurably increased.

4.0 MANAGEMENT PROCEDURES

4.1 Jurisdiction[1/]

Under the British North America Act of 1867, legislative jurisdiction with respect to fisheries was assigned to the Federal authority. The pertinent portion of section 91 reads as follows:

> " 91 ..... the exclusive Legislative Authority of the Parliament of Canada, extends to all matters coming within the Classes of Subjects next herinafter enumerated; that is to say,
>
> 12 Sea Coast and Inland Fisheries".

The Parliament of Canada immediately assumed the responsibility of management of the fisheries but it was almost inevitable that, as a result of this action, there would be some impact on Provincial jurisdiction involving the question of "property and civil rights". This culminated in a reference to the Privy Council in 1898 which, amongst other things, decided:

- There is a broad distinction between proprietary rights and legislative jurisdiction.
- There is no presumption that because Legislative jurisdiction was vested in the Parliament of Canada, proprietary rights were transferred to it.

1/Adopted from: (1) Maritime Provinces Water Resources Study, 1969, Appendix IV, Water demands for Fish (2) Report on a Study of the Control of Angling Water in New Brunswick, 1971. N.B. Department of Natural Resources.

- Section 91 of the British North America Act did not convey to the Dominion of Canada any proprietary rights in relation to fisheries.
- The power to legislate in relation to fisheries does necessarily ..... enable the legislature so empowered to affect proprietary rights.
- The enactment of fishery regulations and restrictions is within the exclusive competence of the Dominion legislature and is not within the legislative powers of the Provincial legislatures.

It is obvious that with legislative jurisdiction for fisheries resting with the Federal authority and proprietary rights and interests either vested in the Province or subject to Provincial jurisdiction, administration of the fisheries was and could still be very complex. Over the years difficulties have been resolved by transferring to those Provinces which desired it, the authority to administer the inland and non-tidal fisheries in which they had an interest and which, as property, were subject to provincial laws relating to property, bearing in mind that the exclusive legislative authority for fisheries as such, both coastal and inland, rested solely with the Federal authority.

New Brunswick has not requested such transfer of authority but it does in some instances exert the right

under provincial law to require a licence to fish and to collect the resulting revenues. With this exception, the enactment and administration of laws relating to fisheries in New Brunswick remains with the Federal authority.

The separation of jurisdiction may be summarized in the following way:

411 Federal

(a) protection of the fishery against illegal acts and procedures,

(b) fishery management,

(c) supervision of research activities of the Fisheries Research Board of Canada,

(d) establishment of dates of all fishing seasons,

(e) establishment of fish catch and size limits,

(f) control of licensing in National Parks.

412 New Brunswick

The province supplements the federal protective service by hiring fish wardens during the angling season and by assigning Department of Natural Resources field personnel to river/lake patrolling on an "as available" basis. Also, this department employs two fishery biologists who are assigned to such tasks as technical liaison with the federal authority on the inland fishery, stream and lake surveys, compilation of statistics, and fishery

management. The New Brunswick jurisdiction includes:

(a) establishment of policy regarding the issuing of angling licenses except on National Parks' waters,

(b) modification of inland fishing season dates, as deemed appropriate, provided the open seasons do not exceed those fixed by federal authority,

(c) establishment of policy regarding fishing privileges,

(d) establishing and implementing taxation policies on fishing properties, and

(e) prescribing the mode in which private fisheries may be conveyed or passed down.

1. Authority to Prosecute

While the province maintains 10 Wildlife Protection Officers and 340 Rangers in the field, these men have no authority to prosecute violators of the federal fisheries statutes, although they are empowered to confiscate equipment. Such seizures and related evidence must be turned over to federal officials for prosecution. This has often led to less than satisfactory results, which in turn has resulted in diminished credibility in the enforcement function of the provincial officers in the eyes of offenders and potential offenders.

4.2 Federal Management Procedures

421 Commercial

In the case of those fish taken commercially, common management practices have been applied for many years. Such practices are based on intimate knowledge of the species involved and include the closure of certain seasons and certain areas to fishing to allow spawning, and the imposition of net-size and gear-type restrictions to allow fish to reach maturity. The details of these regulations as they pertain to individual species and areas within the Saint John River estuary are itemized in the New Brunswick Fishery Regulations, Office Consolidation, 1971, and will not be repeated here. These regulations are enforced by the Conservation and Protection Branch of the Fisheries Service, Canada Department of the Environment.

Commercial fishermen using nets of any kind must first acquire a licence for those nets.

1. Salmon

A more detailed account of procedures relating to the Atlantic salmon is in order considering the magnitude of the effort expended towards its conservation in the Saint John River basin. As a result of increasingly adverse conditions for the salmon in the Saint John River,

culminated by the construction of the Mactaquac hydro-power development in 1967-68, artificial means were devised to maintain and augment the natural salmon run. These means include the fish collection facilities at Mactaquac Dam, the overland fish transportation system, and the fish culture establishment below the dam. Of the total salmon run reaching the fishway, approximately 1,000 selected fish are used as broodstock for the hatchery while the remainder is transferred upriver, mainly to the Tobique River, to allow angling and natural reproduction.

Prior to 1969, the seasonal restriction on commercial fishing for salmon in the Saint John River estuary was a complete closure from August 16 to May 14 next, inclusive, with a weekend closure for the remainder of the year. However, progressively more stringent restrictions have been applied since then to ensure sufficient escapement for the hatchery and for natural production. In 1969 the fisheries could operate 2 days weekly until mid-June, 3 days weekly for the 3rd week in June, and for the regular 5 days thereafter. In 1970 and 1971, the closure consisted of a staggered 2 week period which banned all commercial fishing in the Bay of Fundy and Saint John Harbour area for the 2nd and 3rd week in June, and in the area above Saint John Harbour for the 3rd and 4th week in June. In 1972, the entire Saint John commercial salmon fishery will be closed.

422 Sport

As has been pointed out, the bulk of angling effort in the Saint John estuary is directed towards the Atlantic salmon and the speckled trout. Closed seasons are in force with respect to these species. As well, bag limits are set during open seasons. Similar restrictions apply to the smallmouth black bass, which is also subject to a size limitation. All other species are exempt from any restrictions other than the limitation that angling for any fish is prohibited in non-tidal waters frequented by sport fish for which closed seasons are in force.

1. Salmon

Prior to 1970, the entire estuary was subject to seasonal limits only. In 1970 and 1971, as part of a concerted attempt to ensure adequate escapement for both hatchery and natural spawning requirements, angling in the main river and its tributaries, except the Nashwaak and Keswick rivers, was banned for the last week in June and the first week in July. In 1972, angling in the main river was banned altogether, thus ensuring that all salmon moving upstream which do not ascend estuarial tributaries reach the facilities at Mactaquac Dam. The estuarial tributaries, however, remain open to angling from May 15 to October 15, with the exception of the

Nashwaak River from the bridge at Stanley to its source and the Keswick River, which are open from May 15 to September 15. Various bag limits are in effect as well.

2. Trout

The speckled trout can be fished throughout the estuary from April 15 to September 15, and the bag limit is a generous 20 fish per day. While this limit may seem somewhat extravagant at first glance, it is well to remember that the natural reproduction of this species is heavily supplemented by artificial means (Table 16).

3. Smallmouth Black Bass

The open season for smallmouth black bass extends from May 15 to September 30 in the Saint John estuary, with a bag limit of 15 fish of 10 inches minimum length. At present these regulations are adequate - however, if the fishing pressure should increase in the future by an order of magnitude, then more stringent restrictions should be adopted. The smallmouth spawns when water temperature reaches about 64°F, and the fry are protected by the male for about 2 weeks, until they are reasonably self-sufficient. The open season should not begin until this period has passed (spawning temperature in the upper layers of Mactaquac headpond is reached between the middle and the end of June) if angling for the species intensifies

significantly. Similarly, the bag limit should be reduced.

423 Hatchery Contribution

Until very recently, by far the greatest portion of the effort of federal fisheries management was directed towards the artificial propagation of Atlantic salmon and speckled trout to supplement natural populations (two exotic species of trout, the brown trout, Salmo trutta, and the rainbow trout, Salmo gairdneri, were introduced and have become established in a few scattered areas, but the effort involved was minor). The basic concept of the program remained unchanged for many years - Atlantic salmon and speckled trout were reared to fry or fingerling level and then were released into natural waters. Trout are still raised in this manner.

The philosophy with respect to salmon has been altered considerably within the past decade. Recognizing that survival in the freshwater stage (egg to smolt, about .384% -.768%, Elson, 1962) under natural conditions could be vastly improved upon under artificial conditions, the hatcheries, in 1965, began retaining fingerlings until they reached the smolt stage, and releasing them as they became ready to migrate to sea. At the Mactaquac hatchery, survival from egg to smolt is approximately 60%, and it has been estimated that this survival can be improved further to 70%.

However, returns from this program in terms of adult fish have been very low, (0.1% for Mactaquac releases), and this, coupled with similar experience from other areas of the world, has cast doubt upon the efficacy of the entire approach. At present, a comprehensive evaluation of the hatchery program is in progress: this evaluation will determine the future of artificial propagation of Atlantic salmon in the Maritime region.

1. Mactaquac Fish Culture Station

During the past two decades the salmon stocks of the Saint John have declined drastically, as a result of the increasing number of hydro power dams and the increasing intensity of industrial pollution. In order to supplement the dwindling salmon production of the headwaters (notably the Tobique River system), a large hatchery became operational concurrent with the completion of Mactaquac Hydro power dam. This hatchery depends upon the fishway at the dam for its broodstock. By an absurdity of site choice, this hatchery is also partially dependent upon the very water which it had been built to overcome.

The percentage of adult fish returning to the Saint John to smolts released by the hatchery has been extremely low, about 0.1%. This compares to 8 $\pm$ 3% returns from wild populations. This low success has been attributed

to a condition known as "fin rot" from which Mactaquac smolts suffer extensively, and which places them at a competitive disadvantage in relation to wild smolts. There is reason to believe that this condition is caused in the main by the poor quality of the water on which the hatchery is dependent and to which the juvenile salmon are exposed during their extended stay in the artificial environment (The majority of juveniles at Mactaquac smoltify in 2 years).

This problem is being attacked in three ways. Firstly, a determined effort is being made to elucidate the etiology of the disease, so that corrective measures may be taken if possible. Secondly, an attempt is being made to reduce the time of exposure to poor water quality by contracting the egg-to-smolt interval from 2 years to 1 year. Such a programme has been successful at the Yarmouth Fish Culture Station, which does not have poor water conditions. Thirdly, a concept of "semi-natural" rearing ponds is being instituted. This concept would make use of excellent water conditions such as exist in the Keswick River system, by diverting water into enclosed, artificially created ponds where the fry can be provided with food and protection, and yet be as close as possible to natural conditions.

A selective programme is being pursued as well to strengthen and otherwise improve the stock being produced at the hatchery.

2. Plantings in the Saint John Estuary

Records of Atlantic salmon fry, fingerling and smolt plantings in the Saint John River estuarial basin over the past 25 years (where available) are shown in Taoles 6-14. These records reflect the change in philosophy of hatchery production, for in the early '60's both the frequency and the magnitude of plantings decreased. Six hatcheries contributed to the plantings: Florenceville, Saint John,Miramichi and, more recently, Mactaquac, Cobequid and Charlo. Although the Mactaquac hatchery is devoted to the production of smolts, at various times populations in holding ponds are reduced to decrease the density, thus optimizing conditions for those fish remaining. Those fish removed are known as "culls" and are released at various points within the basin.

Plantings of speckled trout are presented in Table 16. These plantings, while originating from federal fish culture stations (Florenceville and Saint John), are made, in part at least, on the advice of the provincial fisheries agency, and thus represent a cooperative effort.

424 Interaction with other Resource Users

Various agencies are active within the province to ensure that other resource users do not alter the

aquatic environment to such an extent as to make it inhospitable to existing fish life.

1. Conservation and Protection Branch, Fisheries Service, Canada Department of Environment *

In addition to enforcement and enumeration duties, the Fisheries Officers of this branch carry out important functions with regard to maintaining a healthy environment for fish. Streams are surveyed to check for man-made or natural obstructions such as logging debris, changes in features of waterfalls or rapids, and stream diversions harmful to fish runs. Streams are also checked for pollution by such sources as domestic sewage, herbicides, pesticides and mining and manufacturing effluents.

2. Habitat Protection Section, Resource Development Branch, Fisheries Service, Canada Department of the Environment *

The Fisheries Act of Canada prohibits the dumping into water of slash, stumps and other debris, destruction of eggs or fry of fish on the spawning grounds, obstruction of mainstem channels, and dumping into water of any substance which may render its quality deleterious to fish life. These practices originated with forest-based industries, which are prominent in the Saint John estuary basin.

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* Adapted from "A Position Paper on the Inland Fisheries of New Brunswick", Canada Department of Environment, Fisheries Service, Halifax, N.S., 1972.

The Habitat Protection Section is particularly alert to environmental manipulations which may affect the fishery resource and habitat. All stream alteration applications are examined by staff biologists and engineers, and result in recommendations so as to minimize effects detrimental to fish. The Section investigates effects of stream alteration, log driving and road construction on fish population. As well, a major effort is expended in removing natural obstructions from valuable salmon-producing streams.

3. Environmental Protection Service, Canada Department of the Environment

The newly-created Environmental Protection Service has responsibility for monitoring industrial effluents and enforcing compliance with national standards of maximum allowable pollution loads. This service has a staff of biologists, chemists, physiologists and engineers which investigates the effects of various effluents on aquatic organisms and establishes the levels which can be tolerated - it also recommends processes within existing technology to maintain those levels. A main focus of EPS is the Saint John River Basin.

4.3 New Brunswick Management Procedures

431 Angling Licenses

At present all non-residents fishing in New Brunswick waters must acquire an angling license no matter what species is sought, while residents require a license only for salmon. This universal licensing for salmon angling has made possible a compilation of catch data for that species (Section 2.12.1). However, no reliable statistics exist for other species.

Those statistics which do exist for speckled trout, striped bass and smallmouth black bass are rather haphazardly collected. It is possible that spiny-rayed fishes will become more prominent in the fishery in future although the speckled trout presently is the dominant species taken. Reliable records of catches must be available to ensure effective management - such statistics can be gathered most efficiently and most accurately by those means now employed for salmon. This censusing method could effectively be applied to any species which became prominent in the angling fishery, and should be applied to speckled trout as soon as possible. Such application would require universal licensing of all anglers with respect to major sport fish. The elimination of the resident license for all species, instituted in 1965 and dropped in 1971, before the recently developed angler

census (for salmon) could be extended to all species, was a retrograde step. The information which would accrue from such a system is essential to sound fisheries management.

432 Categories of Angling Water

1. Tidal Waters

The public has the right to fish (within governmental regulations) in all tidal waters up to the point where the tide ceases to flow and ebb. The granting of land over which tidal water flows and ebbs does not automatically carry with it the exclusive right to fish in that water.

2. Non Tidal Waters

Non-tidal angling water is classified as being of one of 5 categories.

(a) Privately Owned (Riparian)

An owner's riparian rights include, amongst others, the right to fishing in the water under which he owns the land. Riparian rights were granted from 1784 to 1884, but those in existence when such conveyance was withdrawn were not revoked, and exist to this day.

Many such rights within the Saint John River estuarial drainage basin, particularly along the upper Nashwaak system, are in the hands of various forest products firms,

and the position of the general public in regard to the angling opportunities on these properties is entirely dependent upon the personal attitudes of the owners. Generally, however, such waters have been made available to the public.

Until recently, salmon angling on the Nashwaak River has been undistinguished, and the private owners (mostly local farmers and other rural residents) have not bothered to any extent to exercise their riparian right to exclude anglers. Lately, however, salmon catches have markedly increased (Sections 2.12.1, 2.1.3). Together with the decline of good salmon angling elsewhere, this has created an upsurge of interest in Nashwaak frontage; it has been speculated that, except for 20 miles of Crown frontage above Stanley, this river will soon be largely owned by non-Canadians. As there are 38 miles of riparian ownership along the Nashwaak system, the probability of a considerable reduction in the amount of angling water available to the general public is evident.

(b) Crown Leased

The province leases exclusive fishing rights in selected areas to private individuals, companies, clubs, associations and outfitters. These leases are purchased at public auction, and carry an annual rental fee: they

are either for a fixed term of 10 years, or renewable annually over a period of 10 years. The mileage of Crown water under angling lease increased from inception of the practice in 1883 until 1922, after which each auction has seen a decrease in mileage of water offered by the Province.

At present there are no Crown leased waters in the Saint John estuarial drainage basin, the last existing lease (in South Oromocto Lake) being withdrawn from auction on March 31, 1972.

(c) Crown Open

There are many hundreds of miles of salmon and trout waters on Crown lands which are open to the general public. In addition, such waters as are open by virtue of land owners not being granted riparian rights, despite the fact that the water may flow entirely or in part over their land, are termed Crown open waters. An owner may restrict access to such water if the access route crosses his land. A considerable portion of the waters of the tributary systems to the Saint John estuary fall within this latter designation.

(d) Crown Reserve

There are approximately 86 miles of waters on Crown land wherein the number of rods at any one time

is specifically controlled (these in addition to Crown open waters). However, there are no such waters in the Saint John estuary drainage basin.

(e) Crown Closed

Approximately 90 miles of stream water on Crown land is closed to all forms of fishing, and maintained as sanctuaries of spawning and nursing of salmon and trout. The estuarial tributaries of the Saint John do not contain such waters.

433 Interaction with other Resource Users

1. Forest Protection Limited

This provincial crown corporation, a consortium of government and forest products companies, is responsible for all budworm-control spraying operations within the province. All biological assessment is carried out by various federal agencies. At present, there is no legislation on the books to actually control spray levels: an interdepartmental committee exists which reviews spray programs as set forth by Forest Protection Limited, but it has no authority to regulate or approve such programs - it is dependent upon goodwill and persuasion to achieve its ends. To date, Forest Protection Limited, has proved sensitive to requests and recommendations from the committee. Safety levels with respect to various sprays have

been established and the spraying program has not exceeded these levels. However, independent operators and agricultural counties can and do spray in addition to Forest Protection Limited, and thus the safety levels may be exceeded in some areas.

The predominant spray in use in New Brunswick currently is Fenitrothion, an organophosphate insecticide which has replaced D.D.T. The latter was used from 1952 to 1968 and was extremely detrimental to salmonids. Several other insecticides, all carbamates (Matacil, Zectran and Lannate), have also been used on an experimental basis in the past few years.

Fenitrothion has displayed no lethal effects of any consequence and has been judged safe with respect to salmonids. Those sub-lethal effects which have occurred are exhibited only at concentrations so high as not to be attained in nature. There has been a recent report (Saunders, 1972) of aberrant migrational behaviour amongst young salmonids, however, which may be related to exposure to Fenitrothion.

There is a serious obstacle to the quantification of safety levels, spray concentrations, etc. The spray has not been recognized by the U.S. Surgeon-General's Department, and thus there are no rigid and well-defined requirements in its manufacture, as there were in the case of D.D.T. There is variation between

different manufacturers, as well as variation between lots from the same manufacturer.

Within the Saint John River estuarial basin, there is heavy budworm infestation in the softwood areas (balsam fir and red spruce) on either side of the main river valley, although the valley itself is agricultural. There is also an area of heavy infestation in the upper Nashwaak River drainage. These regions will be sprayed this summer (1972) and some will receive a double application.

2. New Brunswick Department of Fisheries and Environment

The Environment Branch of the New Brunswick Department of Fisheries and Environment carries out intermittent analysis of municipal and industrial effluents. It is presently involved in a comprehensive study of the water quality of the Grand Lake drainage area.

5.0 MERCURY CONTENT

All those species in the estuary which conceivably could be utilized for human consumption and which were reasonably abundant were analyzed for mercury content.[1] In addition, the analytical results of an intensive study of the mercury concentrations in eels in the Saint John estuary were made available.[2] The results of these analysis are reported by Keachie (1972). Suffice it to say that, amongst freshwater species, the level of contamination reflects the trophic level of the species - secondary carnivores such as chain pickerel, American eel, striped bass, smallmouth black bass, yellow perch and white perch are highest, followed by primary carnivores and herbivores such as white sucker, lake whitefish, Atlantic sturgeon and shortnose sturgeon. Anadromous fish such as Atlantic salmon, American shad and gaspereau, and marine species such as yellowtail flounder, red hake and tomcod are very low. Exceptions to this are the

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1 This analysis was carried out through the auspices of Mr. K.B. Swansburg, Chief, Inspection District, Black's Harbour, N.B., and the Environmental and Quality Control Laboratory, Halifax, N.S. Additional samples were analyzed by the Inland Waters Branch of the Water Quality Division, Moncton, N.B. All are agencies of Canada Department of the Environment.

2 This study, still in progress, is being conducted by Mr. K.B. Swansburg, Chief, Inspection District, Black's Harbour, N.B.

dogfish and the smelt, both secondary carnivores (see Table 17).

Of those fish tested, the concentrations of mercury in eels is much above the accepted safety level of 0.5 ppm. Although only 3 striped bass were analyzed, these were also considerably above the accepted level. There should be further testing of striped bass to increase the reliability of the determination. It may be assumed that the study now in progress (Swansburg) will lead to appropriate recommendations with respect to these 2 species.

6.0 RESULTS OF 1971 SURVEY

6.1 Distribution

The details of this survey were described in the first report of this series (Meth, 1971). The distribution of the various species was also given in that report. Table 4 gives the distribution of species caught in gillnets at each station in the survey. Table 18 compares the distribution of species occurring in the mainstem of the river with the distribution of the tributary systems. It is obvious that some species are found almost entirely in the mainstem (smelt, alewife, both species of sturgeon, and shad), some almost exclusively in the tributaries (pumpkinseed, golden shiner, fallfish and chain pickerel), and some are distributed throughout (whitefish, white perch, yellow perch, white sucker and tomcod). This may be deceptive, however. Some of those species apparently restricted to the tributaries prefer the shallow, slow moving weedy water found in such areas (i.e., pumpkinseed and chain pickerel in French Lake). While these conditions also occur to some extent along the banks of the mainstem, they were not sampled. Another distributional distinction, of course, is the different species composition in the brackish and fresh water sections of the estuary, as outlined in the previous report.

6.2 Technical Data

Technical data, such as growth rates, size and age at maturity, length-weight relationships, and condition factors for the various species will be presented in a separate report. This data will form the basis for management techniques such as limiting the size of a species which may be taken, should such restrictions become necessary in the future.

However, a few observations can be made at this point.

1. White Perch

There is considerable divergence between white perch in the tributaries and those in the mainstem, with the mainstem population being significantly heavier at comparable length. In addition, males in both populations are heavier than females of the same length, although they mature at the same length. Tributary fish seem to mature at a larger size than do mainstem fish.

2. Yellow Perch

Yellow perch in the tributaries are mature at a very small size by comparison with those in the mainstem.

3. White Sucker

There is no difference in growth between sexes in this species, although suckers in the mainstem are much heavier than the tributary populations at similar lengths. Tributary fish also seem to mature at a considerably smaller size.

6.3 Academic Interest

During the course of the investigation, several points came to light which are of considerable academic interest, even though they have no direct management implications. These are summarized below.

1. Atlantic Sturgeon

This species has generally been considered an anadromous fish. However, its presence in the freshwater portion of the estuary from July through February (its normal spawning period is May and June) suggests that the species is a permanent freshwater dweller in the Saint John. However, most of the specimens were relatively small (less than 60 cm. in length) and immature, and thus may represent the freshwater period of growth characteristic of these fish before they enter the sea. Age and growth rate have not been established for this species as yet, and thus the question is unresolved.

2. Short-nose Sturgeon

The largest short-nose sturgeon on record from Canadian waters is 68.6 cm (27 in). However, several fish exceeding this size were taken in the lower estuary at Glenwood and at Westfield, the largest being 119.1 cm. (46.9 in) and weighing 12.25 kg. (27.0 lbs).

3. Atlantic Menhaden

The Menhaden, Brevoortia tyrannus, has been reported from the Saint John estuary only once (Gorham, 1970) although there are some isolated reports from Saint John harbour. Leim and Scott (1966) refer to it as a stray in Canadian waters. However, it does not seem uncommon as far up the estuary as Westfield.

4. Longnose Sucker

While common in the upper reaches of the basin, the longnose sucker, Catostomus catostomus, has not been reported from estuarial waters. However, 3 specimens were taken from Grand Lake during various netting operations in that area.

5. Nine-spine Stickleback

There are many records of this species, Pungitius pungitius, in the headwaters of the system, but a specimen

collected at McKinley Ferry represents the furthest downstream record to date.

6.4 Lake Whitefish

During the latter part of the 1971 survey, in late September and October, a concentrated run of lake whitefish appeared in the mainstem and tributaries of the freshwater portion of the estuary. This appearance coincides with a report of a run of 'gizzard fish' (as the whitefish is locally known) in the Keswick River, and with a record of a run observed at the Salmon River adult salmon counting fence between October 11 and November 8, 1969 (Smith, 1970).

Additional surveying was carried out in Grand Lake and the mainstem Saint John at Oromocto - this showed that the fish were still present in dense concentrations in the tributary system after they had ceased to appear in the main river. All fish examined at this time were fully mature, and it may be assumed that their appearance is a spawning run into tributaries of the Saint John. Whitefish have been known to spawn in both lakes and rivers. It is not known whether this population spawns in Grand Lake, but its appearance in the Keswick and Salmon rivers indicate that it does spawn in these.

Whitefish were not present in Grand Lake or the mainstem during the summer months. It is not known from

where the spawning run originates. Whitefish have been known to run to sea in more northerly latitudes - this may be one possibility. Another possibility is suggested by the capture of a single specimen in Belleisle Bay in mid-August - this deep cool body of water is compatible with whitefish habits.

Spot-checks were made in Grand Lake at monthly intervals from November, 1971 to February, 1972. These indicated the presence of whitefish in the lake over this period.

Further research should be carried out to determine the origins of this population, and also to determine whether it can support a commercial and/or sport fishery.

7.0 RECOMMENDATIONS

A number of recommendations can be made as a result of the foregoing analysis of the fisheries of the Saint John River estuarial basin. While most of these pertain exclusively to the Saint John, a few have broader implications which may be applied to the province as a whole.

.1 Biology of the alewife

The biology of the alewife in the estuary should be investigated, in view of its importance as a commercial species. In fact, there is some question as to whether the "gaspereau" run is one species (See Meth, 1971).

.2 Market possibility of the alewife

The feasibility of marketing alewives as a product other than pet food should be investigated. The possibility of canning alewives as a gourmet item has been demonstrated. The abundance of this species throughout the Atlantic region makes this possibility attractive at first glance.

.3 Levels of eel catches

Commercial eel catches should be closely monitored over the next few years, since the recent upsurge in fishing effort may lead to population declines. Catch quotas may have to be instituted.

.4 Market possibility of "rough" fish

"Rough" fish (e.g. suckers) have recently been transformed into marketable products in western Canada. The possibility of a similar operation in the Atlantic region should be investigated.

.5 Potential fishery for lake whitefish

The unexpected occurrence of lake whitefish in the estuary in considerable abundance suggests that this species may support a sport and/or commercial fishery. While the present survey will continue to collect data with respect to this species during 1972, it may not provide sufficient knowledge on which to base management decisions. If such is the case, then further investigation is in order.

.6 Improve angling catch data

The investigation of sport catch data has brought to light the paucity of reliable figures with respect to all species but salmon. Catch data is crucial to effective management, and efforts should be initiated to collect such data on all species of angling interest. A universal license requirement, with a returnable catch data questionnaire, is the most convenient method of collecting such data.

.7 Biology of the smallmouth black bass

The smallmouth black bass may well become a more

dominant species in the sport fishery of the estuary. The biology of this species in the Saint John River should be studied more intensively than was possible during the cursory survey conducted in 1971.

.8 Salmon over-fishing threat in the Nashwaak River.

Angling pressure on the salmon population in the Nashwaak River is close to the over-fishing level. It may be necessary to limit the amount of fishing on this system if pressure continues to go up as it has in the past few years. Electroseining surveys and the newly established adult counting fence can be utilized to help establish such quotas.

.9 Revocation of riparian rights along the Nashwaak River.

The recent upsurge of angling in the Nashwaak may lead to a considerable reduction in the amount of angling water available to the general public, due to land transfers and increased interest in the exercise of long-standing riparian rights. While such proceedings may relieve incipient over-fishing pressures, other management procedures are available to achieve this as effectively. It is felt that fishing rights in this river, now the greatest producer of salmon to the angler in the Saint John River Basin, should not be controlled by a select few, to the exclusion of the general public, particularly since the majority of recent land transfers have been to non-Canadians. The revocation of riparian rights

in this river should be given serious consideration.

.10 Log-driving in the Nashwaak River.

The detrimental effects of poor logging practices and log-driving on stream-dwelling eggs and juvenile fish are well known. The continued driving practice in the Nashwaak River poses an unnecessary obstacle to the reproductive success of Atlantic salmon. It should be discontinued as soon as possible.

.11 Planting of hatchery "culls".

The release of hatchery "culls" (salmon fry and fingerlings) should be in those areas which are most promising in terms of nursery available and which are not supporting optimum parr populations.

.12 Semi-natural salmon rearing potential.

The "semi-natural" habitat approach to rearing salmon to the smolt stage should be encouraged within the Saint John estuary.

.13 Provincial authority to prosecute.

Provincial wildlife protection officers and rangers should be vested with the authority to prosecute directly in the case of violations of the federal fishery statutes.

.14 Budworm spray program control.

There should be a body with the vested authority to review and regulate spruce budworm spray programs throughout New Brunswick.

.15 Mercury contamination.

The incidence of mercury contamination in striped bass should be investigated in greater detail. Other fishes which offer actual or potential fisheries should also be investigated in statistically significant quantities.

.16

The public, both resident and tourist, should be made aware of the existence and sporting nature of fish, other than Atlantic salmon and speckled trout, which abound in the estuary.

8.0 ACKNOWLEDGMENTS

Special thanks are due Mr. James R. Skelding for his conscientious and tireless efforts in the field, in the laboratory, and at the desk, all of which contributed greatly to various stages in the compilation of this report.

The advice and encouragement of Mr. C. L. Dominy is acknowledged. Mr. Dominy also critically read the manuscript.

Thanks are extended to Mr. K. Smith who revised Table II following a painstaking resumé of individual catch records from Mactaquac Fishway.

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TABLE 1. Species of fish occurring in the Saint John River Estuary and their uses.

SPECIES	OCCURRENCE				USE	
	BRACKISH	FRESH	COMMON	UNCOMMON	SPORT	COMMERCIAL
Petromyzon marinus	x	x	x			
Squalus acanthias	x			x		
Raja ocellata	x			x		
Raja radiata	x			x		
Acipenser brevirostrum	x	x	x			x
Acipenser oxyrhynchus	x	x	x			x
Alosa aestivalis	x	A	?	x		x
Alosa pseudoharengus	x	A	x			x
Alosa sapidissima	x	A	x		x	x
Brevoortia tyrannus	x			x		
Clupea harengus	x			x		
Coregonus clupeaformis	x	A	x		x	x
Salmo salar	x	A	x		x	x
Salvelinus fontinalis	x	x	x		x	
Osmerus mordax	x	A	x		x	x
Esox niger		x	x		x	x
Catostomus catostomus		x		x		
Catostomus commersoni		x	x			x

TABLE 1 (cont'd)

SPECIES	OCCURRENCE				USE	
	BRACKISH	FRESH	COMMON	UNCOMMON	SPORT	COMMERCIAL
Couesius plumbeus		x		x		
Notemigonus crysoleucas		x	x			
Notropis heterolepis		x		x		
Phoxinus eos		x		x		
Phoxinus neogaeus		x		x		
Rhinichthyes atratulus		x	x			
Semotilus atromaculatus		x	x			
Semotilus corporalis		x	x			
Ictalurus nebulosus		x	x			
Anguilla rostrata	x	x	x			
Fundulus diaphanus	x	x	x			
Syngnathus fuscus	x			x		
Apeltes quadracus	x	x	x			
Culaea inconstans		x		x		
Gasterosteus oculeatus	x		x			
Pungitius pungitius	x	x		x		
Gadus morhua	x			x		
Lota lota		x		x		
Microgadus tomcod	x	A	x		x	
Urophycis chuss	x		x		x	
Morone americanus	x	x	x			

TABLE 1. (cont'd)

SPECIES	OCCURRENCE				USE	
	BRACKISH	FRESH	COMMON	UNCOMMON	SPORT	COMMERCIAL
Morone saxatilis	x	A	x		x	x
Lepomis auritus		x		x		
Lepomis gibbosus		x	x			
Micropterus dolomieui		x		x		
Perca flavescens		x	x			
Peprilus triacanthus	x			x		
Menidia menidia	x		x			
Sebastes marinus	x			x		
Sebastes mentella	x			x		
Cottus cognatus		x	x			
Cyclopterus lumpus	x			x		
Hippoglossus hippoglossus	x			x		
Limanda ferruginea	x			x		
Lophius americanus	x			x		
Totals (54)	34	37	29	25	8	10

Footnote: A = Anadromous

Table II Species and numbers of fish passed through the fishway facility at Mactaquac Dam

Species	Year			
	1968	1969	1970	1971
Sebago	11	4	35	25
Salmon	1,954	4,321	5,417	4,200
Shad	38,838	37,449	36,437	15,834
Alewife	22,122	106,288	84,505	396,065
White Sucker	4,818	4,731	2,479	3,570
Chain Pickerel	27	123	480	282
White Perch)				500
)	520*	13,770	2,062*	
Yellow Perch)				3,548
Striped Bass	872	52	127	13
Smallmouth Bl Bass	6	90	40	84
Lake Whitefish	2,440	1,168	575	15
Speckled Trout	1,052	500	128	47
Lamprey	8,691	5,088	1,046	1,786

* White Perch, Yellow Perch and "Chub" combined

Table III Number of nets (licences) fished for striped bass in Belleisle Bay, 1962-1971.

Year	Number of nets
1962	78
1963	75
1964	20
1965	90
1966	101
1967	57
1968	107
1969	80
1970	129
1971	91

Table IV Distribution of species caught in gill nets at each sampling station in estuarial survey, 1971

NOTES: The number under each species is the total number caught during the survey. Under each location are three catches representing each of 3 sampling dates, followed by the proportion that each catch constitutes of the total number caught at that station, expressed as a percent.

The bottom line presents the total number of that species caught at that station, followed by the proportion which that total constitutes of the entire catch of that species over the entire survey, expressed as a percent.

TABLE IV

SAINT JOHN RIVER BASIN STUDY - FISHERIES TASK - ESTUARIAL FISH, 1971 - SPECIES ANALYSIS - F. F. METH

********** DISTRIBUTION WITH RESPECT TO LOCATION AND CATCH TIME **********

	WESTFIELD		GLENWOOD		EVANDALE		GAGETOWN		OROMOCTO		K.BECASIS		BELLEISLE		WASHADEM.		P.CESS PK		NEWCASTLE		FRENCH LK	
COREGONUS							1	6.3	13	72.2			1	100.0	7	87.5	1	100.0	2	5.6		
CLUPEAFORMIS							15	93.8	5	27.8					1	12.5			34	94.4		
80							16	20.0	18	22.5			1	1.2	8	10.0	1	1.2	36	45.0		
MORONE			8	100.0	10	33.3	2	25.0	25	19.2			3	100.0	6	14.3	12	66.7	47	51.6	2	18.2
AMERICANUS					20	66.7	6	75.0	105	80.8					14	33.3	6	33.3	44	48.4	4	36.4
															22	52.4					5	45.5
341			8	2.3	30	8.8	8	2.3	130	38.1			3	.9	42	12.3	18	5.3	91	26.7	11	3.2
PERCA							1	12.5	6	42.9					13	41.9	2	100.0	3	30.0	3	30.0
FLAVESCENS							7	87.5	7	50.0					16	51.6			1	10.0	2	20.0
									1	7.1					2	6.5			6	60.0	5	50.0
75							8	10.7	14	18.7					31	41.3	2	2.7	10	13.3	10	13.3
OSMERUS	79	27.2	19	54.3	2	100.0	6	100.0			4	26.7	3	60.0	1	100.0	1	50.0				
MORDAX	166	57.2	16	45.7							3	20.0	2	40.0			1	50.0				
	45	15.5									8	53.3										
356	290	81.5	35	9.8	2	.6	6	1.7			15	4.2	5	1.4	1	.3	2	.6				
ALOSA	40	71.4	4	100.0											1	100.0						
PSEUDOHARENGUS	16	28.6																				
61	56	91.8	4	6.6											1	1.6						
CATOSTOMUS					49	86.0	25	51.0	22	38.6			7	100.0	21	44.7	12	38.7	25	37.3	36	49.3
COMMERSONI					7	12.3	10	20.4	24	42.1					12	25.5	9	29.0	32	47.8	14	19.2
					1	1.8	14	28.6	11	19.3					14	29.8	10	32.3	10	14.9	23	31.5
388					57	14.7	49	12.6	57	14.7			7	1.8	47	12.1	31	8.0	67	17.3	73	18.8
LEPOMIS							1	100.0	1	100.0									1	100.0	16	84.2
GIBBOSUS																					1	5.3
																					2	10.5
22							1	4.5	1	4.5									1	4.5	19	86.4
NOTEMIGONUS															1	100.0					18	100.0
CRYSOLEUCAS																						
19															1	5.3					18	94.7

TABLE IV

SAINT JOHN RIVER BASIN STUDY - FISHERIES TASK - ESTUARIAL FISH, 1971 - SPECIES ANALYSIS - F. F. METH

********** DISTRIBUTION WITH RESPECT TO LOCATION AND CATCH TIME **********

	WESTFIELD		GLENWOOD		EVANDALE		GAGETOWN		OROMOCTO		K.BECASIS		BELLEISLE		WASHADEM.		P.CESS PK		NEWCASTLE		FRENCH LK	
COREGONUS							1	6.3	13	72.2			1	100.0	7	87.5	1	100.0	2	5.6		
CLUPEAFORMIS							15	93.8	5	27.8					1	12.5			34	94.4		
80							16	20.0	18	22.5			1	1.2	8	10.0	1	1.2	36	45.0		
MORONE			8	100.0	10	33.3	2	25.0	25	19.2			3	100.0	6	14.3	12	66.7	47	51.6	2	18.2
AMERICANUS					20	66.7	6	75.0	105	80.8					14	33.3	6	33.3	44	48.4	4	36.4
															22	52.4					5	45.5
341			8	2.3	30	8.8	8	2.3	130	38.1			3	.9	42	12.3	18	5.3	91	26.7	11	3.2
PERCA							1	12.5	6	42.9					13	41.9	2	100.0	3	30.0	3	30.0
FLAVESCENS							7	87.5	7	50.0					16	51.6			1	10.0	2	20.0
									1	7.1					2	6.5			6	60.0	5	50.0
75							8	10.7	14	18.7					31	41.3	2	2.7	10	13.3	10	13.3
OSMERUS	79	27.2	19	54.3	2	100.0	6	100.0			4	26.7	3	60.0	1	100.0	1	50.0				
MORDAX	166	57.2	16	45.7							3	20.0	2	40.0			1	50.0				
	45	15.5									8	53.3										
356	290	81.5	35	9.8	2	.6	6	1.7			15	4.2	5	1.4	1	.3	2	.6				
ALOSA	40	71.4	4	100.0											1	100.0						
PSEUDOHARENGUS	16	28.6																				
61	56	91.8	4	6.6											1	1.6						
CATOSTOMUS					49	86.0	25	51.0	22	38.6			7	100.0	21	44.7	12	38.7	25	37.3	36	49.3
COMMERSONI					7	12.3	10	20.4	24	42.1					12	25.5	9	29.0	32	47.8	14	19.2
					1	1.8	14	28.6	11	19.3					14	29.8	10	32.3	10	14.9	23	31.5
388					57	14.7	49	12.6	57	14.7			7	1.8	47	12.1	31	8.0	67	17.3	73	18.8
LEPOMIS							1	100.0	1	100.0									1	100.0	16	84.2
GIBBOSUS																					1	5.3
																					2	10.5
22							1	4.5	1	4.5									1	4.5	19	86.4
NOTEMIGONUS															1	100.0					18	100.0
CRYSOLEUCAS																						
19															1	5.3					18	94.7

TABLE IV (concl.)

	WESTFIELD	GLENWOOD	EVANDALE	GAGETOWN	OROMOCTO	K.BECASIS	BELLEISLE	WASHADEM.	P.CESS PK	NEWCASTLE	FRENCH LK
ICTALURAS NEBULOSUS											2 33.3 4 66.7
6											6 100.0
COUESIUS PLUMBEUS								1 33.3 2 66.7	1 100.0		
4								3 75.0	1 25.0		
NOTROPIS CORNUTUS								4 100.0			
4								4 100.0			
ALOSA AESTIVALIS	1 33.3 2 66.7										
3	3 100.0										
LOTA LOTA			1 100.0	1 100.0							
2			1 50.0	1 50.0							
MICROGADUS TOMCOD	2 6.5 7 22.6 22 71.0	1 50.0 1 50.0	3 100.0	4 100.0		3 25.0 9 75.0					
52	31 59.6	2 3.8	3 5.8	4 7.7		12 23.1					
ANGUILLA ROSTRATA		1 100.0		1 100.0							
2		1 50.0		1 50.0							
SALMO SALAR				1 100.0							
1				1 100.0							

Table V. Atlantic Salmon Angling Catches in the Saint John River Estuary (main stem and tributaries).

River	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
MAIN STEM	133*	81*	255*	93*	338*	114*	69	157 (354)[a]	139 (317)[a]	164 (401)[a]
KESWICK	-	-	-	-	-	-	-	-	-	-
NASHWAAK	177	448	209	212	471	356	190	456 (1337)[ab]	1214 (1665)[ab]	1256 (970)[a]
SALMON	-	-	-	-	-	-	-	-	-	-
GASPEREAU	-	-	-	-	-	-	-	-	-	-
CANAAN	-	-	-	-	-	-	-	-	-	-
BELLEISLE	-	-	-	-	-	-	-	-	-	-
KENNEB'S	14	64	32	29	17	52	-	88	24 (7)[ab]	10 (25)[a]
HAMMOND	80	20	50	40	-	-	-	-	(14)[ab]	(70)[a]
NEREPIS	-	-	-	-	-	-	-	-	-	-
OROMOCTO	-	-	-	-	-	-	-	-	-	-
TOTALS	404	613	546	374	826	522	259	701 (1691)[c]	1377 (2003)[c]	1430 (1466)[c]

a - Provincial Government Records

b - Black Salmon not Included

c - Total, using Provincial Catch Figures

* - Includes all of York County, although very few fish were taken above the head of tide.

TABLES VI TO XIV

(Salmon stocking records)

KEY TO FISH CULTURE STATIONS

CH : Charlo

FH : Florenceville

MI : Miramichi

SJ : Saint John

YH : Yarmouth

CO : Cobequid

Table VI Atlantic salmon stocking in the Keswick River System, 1947-1971

Year	No. Fry, Fingerlings, Yearlings	No. Smolt	Hatchery	Genetic Stock
1947	25,000			
1948	50,000			
1949	100,000			
1950	35,000			
1951	70,000			
1952	140,000			
1953	120,000			
1954	120,000		FH	
	42,000		SJ	
1955	130,000		FH	
1956	92,750		FH	
1960	40,000		FH	
1961	31,200		FH	
1963	49,500		FH	
1971	58,840		SJ	St. John R.

Table VII Atlantic salmon stocking in the Nashwaak River System, 1947-1971

Year	No. Fry Fingerlings, Yearlings	No. Smolt	Hatchery	Genetic Stock
1947	70,000			
1948	65,000			
1949	45,000			
1950	41,500			
1951	150,000			
1952	180,000			
1953	61,500			
1954	155,000		FH	
	101,500		SJ	
1955	60,000		FH	
1956	53,000		FH	
1957	63,000		FH	
1958	32,000		FH	
1959	20,000		FH	
1960	23,500		FH	
1961	76,800		FH	
1963	133,400		FH	
1967		352	SJ	
1968	30,273		SJ	
1969		2,550	FH	
1971	68,240		SJ	St. John R.

Table VIII Atlantic salmon stocking in the Salmon River System, 1954-1961

Year	No. Fry Fingerlings, Yearlings	No. Smolt	Hatchery	Genetic Stock
1954	58,600		SJ	
1955	150,000		MI	
1956	150,000		MI	
1957	121,000		MI	
1958	129,000		MI	
1959	142,000		MI	
1960	152,000		MI	
1963	30,000		SJ	
1964	64,000		SJ	
1967	76,988		SJ	
1968	28,141		SJ	

Table IX Atlantic salmon stocking in the Gaspereau River System, 1954-1971

Year	No. Fry, Fingerlings, Yearlings	No. Smolt	Hatchery	Genetic Stock
1963	10,000		SJ	

Table X Atlantic salmon stocking in the Canaan River System, 1954-1971

Year	No. Fry, Fingerlings, Yearlings	No. Smolt	Hatchery	Genetic Stock
1955	28,490		SJ	
1970	28,960		SJ	St. John R.

Table XI Atlantic salmon stocking in the Kennebecasis River System, 1954-1971

Year	No. Fry, Fingerlings, Yearlings	No. Smolt	Hatchery	Genetic Stock
1954	121,800		SJ	
1955	84,730		SJ	
1956	70,038		SJ	
1957	149,900		SJ	
1958	28,000		SJ	
1959	142,968		SJ	
1960	124,000		SJ	
1961	51,800		SJ	
1963	168,000		SJ	
1964	38,335		SJ	
1967	44,180		SJ	
1968	6,622		SJ	
1971	8,325		CH	
	133,100		SJ	St. John R.

Table XII Atlantic Salmon stocking in the Hammond River System, 1954-1971

Year	No. Fry, Fingerlings, Yearlings	No. Smolt	Hatchery	Genetic Stock
1963	36,000	1,470	SJ	
1964	32,000		SJ	
1965	14,493		SJ	
1966	31,948		SJ	
1967	83,551		SJ	
1968	11,195		SJ	
1971	86,745		SJ	St. John R.

Table XIII Atlantic salmon stocking in the Oromocto River System, 1954-1971

Year	No. Fry, Fingerlings, Yearlings	No. Smolt	Hatchery	Genetic Stock
1954	74,320		SJ	
1955	49,950		SJ	
1956	6,040		SJ	
1957	141,400		SJ	
1958	5,000		SJ	
1959	72,840		SJ	
1960	76,458		SJ	
1961	54,000		SJ	
1962	8,000		SJ	
1963	35,000		SJ	
1964	37,700		SJ	

Table XIV Atlantic salmon stocking in the main stem of the Saint John River, 1954-1971

Year	No. Fry, Fingerlings, Yearlings	No. Smolt	Hatchery	Genetic Stock
1963	40,000		SJ	
1969	1,335		SJ	St. John R.
	4,985 (Yearling Smolt)	165,198	MA	St. John R.
1970	91,389		YH	St. John R.
		6,550	CO	
		348,354	MA	St. John R.
1971	64,707		YH	St. John R.
	171,006		YH	St. John R.
		109,444	MA	St. John R.

NOTE: This table does not include fish released in York County (except at Mactaquac), St. John County or the Bay of Fundy.

Table XV Composition of salmon spawning runs in Salmon River for the years indicated

Year	Grilse	Salmon	Total
1964	40	69	109
1965	10	40	50
1969	74	39	113
1970	21	105	126

TABLE XVI. SPECKLED TROUT STOCKING RECORDS FOR THE LOWER SAINT JOHN RIVER AND TRIBUTARIES

YEAR	RIVER																							
	BELLEISLE		CANAAN		GASPEREAU		HAMMOND		KENNEBECASIS		KESWICK		NASHWAAK		NASHWAAKSIS		NEREPIS		OROMOCTO		SALMON		SAINT JOHN*	
1954	-		SJ	123600	SJ	6500	SJ	98850	SJ	253499	FH	500	FH	47100	FH	20500	SJ	48000	SJ	98583	SJ	62600	SJ	191700
1955	SJ	2880	SJ	376000	SJ	7525	SJ	157600	SJ	392620		-	FH	89000	FH	30500	SJ	10000	SJ	320700	SJ	54025	SJ	170735
1956	-		SJ	72000	SJ	75500	SJ	30500	SJ	170600		-	FH	96800	FH	30200	SJ	15000	SJ FH	239600) 500)	SJ	70000	SJ	292000
1957	SJ	40000	SJ	40000	SJ	24300	SJ	149324	SJ	472836		-	FH	54850		-	SJ	4000	SJ	145294	SJ	148742	SJ	196022
1958	-		SJ	25000	SJ	39340	SJ	94800	SJ	354200		-	FH	97500	FH	28000		-	SJ	152000	SJ	65800	SJ	137300
1959	SJ	90000	SJ	80000	SJ	600	SJ	303450	SJ	641045	FH	20095	FH	38500	FH	4500		-	SJ	480000	SJ	226780	SJ	13405
1960	SJ	76000		-	SJ	26510	SJ	256400	SJ	533560	FH	23320	FH	66300		-	SJ	24960	SJ	179480	SJ	196000	SJ	274000
1961	-		SJ	136000	SJ	2142	SJ	249318	SJ	895570	FH	3600	FH	35130		-	SJ	8000	SJ	275800	SJ	16484	SJ FH	286042 13200
1962	SJ	25000		-	SJ	31150	SJ	115200	SJ	288500	FH	38410	FH	102895	FH	14220		-	SJ FH	147300) 2000)	SJ	104000	SJ FH	190950 35910
1963	SJ	35000	SJ	30000	SJ	80500	SJ	121900	SJ	561450	FH	109945	FH	142143	FH	28100	SJ	3500	SJ FH	10800) 1600)	SJ	230950	SJ	216150
1964	SJ	11000	SJ	35000	SJ	6200	SJ	170450	SJ	654650	FH	75750	FH	85515	FH	5375		-	SJ	533750	SJ	32100	SJ FH	149800 5000
1965	SJ	12500	SJ	23400	SJ	31200	SJ	148290	SJ	463710	FH	35680	FH	113820	FH	5100		-	SJ	345480	SJ	128775	SJ	244475
1966	SJ	19000	SJ	29000	SJ	28000	SJ	121600	SJ	515750	FH	57510	FH	110130	FH	9340		-	SJ	306500	SJ	561250	SJ	140000
1967	SJ	12000	SJ	6000	SJ	21210	SJ	65006	SJ	361210		-	FH	3960		-		-	SJ	45750	SJ	130200	SJ	44208
1968	SJ	80000	SJ	110000	SJ	50500	SJ	160980	SJ	738552	FH	1500	FH	2470		-		-	SJ	82750	SJ	250000	SJ	122508
1969	SJ	4700	SJ	4325	SJ	648	SJ	6683	SJ	47065	SJ	3219	FH SJ	640 10478)	SJ	1000		-	SJ	12909	SJ	4808	SJ	6678
1970	SJ	14,300	SJ	22400		-	SJ	35810	SJ	178340	SJ	4950	FH SJ	990 8850)	SJ	1000		-	SJ	18582	SJ	7260	SJ	24080
1971	SJ	45,780	SJ	68720	SJ	3000	SJ	80973	SJ	481059	SJ	63090	FH SJ	600 15440)		-		-	SJ	19740	SJ	6000	SJ	27800

* Includes main stem and minor tributaries

TABLE XVII. MERCURY CONCENTRATIONS (PPM) IN FISH OF THE SAINT JOHN RIVER ESTUARY
(Numbers in brackets represent the number of determinations)

SPECIES	LOCATION										
	Bay of Fundy off Lorneville	Saint John Harbour	Westfield	Glenwood	KENNEBECASIS BAY & RIVER	BELLEISLE BAY	GAGETOWN	JEMSEG RIVER	GRAND LAKE	OROMOCTO	MCKINLEY FERRY & MACTAQUAC FISHWAY
Squalus acanthias	0.40(2)										
Acipenser brevirostrum				0.25(1)							
Acipenser oxythynchus				0.24(6)							0.67(2)
Alosa pseudoharengus		0.10(4)									
Alosa sapidissima		0.10(4)									
Coregonus clupeaformis							0.52(1)		0.22(1)	0.42(1)	
Salmo salar	0.08(7)		0.08(1)								
Osmerus mordax			0.43(1)				0.79(1)				
Esox niger									0.69(1) 0.75*		1.48
Catostomus commersoni							0.29(1)		0.26(1) 0.11**	0.42(1) 0.22**	0.32(1)
Anguilla rostrata			0.92(17)	1.49(6)	0.75(16)	0.75(4)	0.66(14)	0.68(15)	0.55(29	0.82(24)	0.94(64)
Microgadus tomcod			0.15(1)				0.10(1)				
Urophycis chuss			0.11(1)								
Morone americanus							0.58(1)		0.26(1) 0.40**	0.42**	
Morone saxatilis		1.6			1.7(2)						
Micropterus dolomieui										0.74	
Perca flavescens									1.05*	0.73(1) 0.46**	
Limanda ferruginea			0.16(1)								

* Zitko et al, 1971
** Water Quality Division, Water Management Service

TABLE XVIII. Distribution by main stem and tributaries of fish taken during the estuarial survey, 1971. In each case, the number and percent of fish in each location is given. Species taken in numbers less than 10 are not included.

SPECIES	SAINT JOHN RIVER	TRIBUTARIES	TOTAL
Coregonus clupeaformis	34 42.5	46 57.5	80
Morone americanus	176 51.6	165 48.4	341
Perca flavescens	22 29.3	53 70.7	75
Osmerus mordax	333 93.5	23 6.5	356
Alosa pseudoharengus	60 98.4	1 1.6	61
Catostomus commersoni	163 42.0	225 58.0	388
Lepomis gibbosus	2 9.1	20 90.9	22
Notemigonus crysoleucas	0 0.0	19 100.0	19
Semotilus corporalis	0 0.0	21 100.0	21
Acipenser oxyrhynchus	133 98.5	2 1.5	135
Acipenser brevirostrum	66 97.1	2 2.9	68
Alosa sapidissima	13 92.9	1 7.1	14
Esox niger	0 0.0	37 100.0	37
Microgadus tomcod	40 76.9	12 23.1	52

FIGURES

Fig. 1 Location map of the lower Saint John River Basin

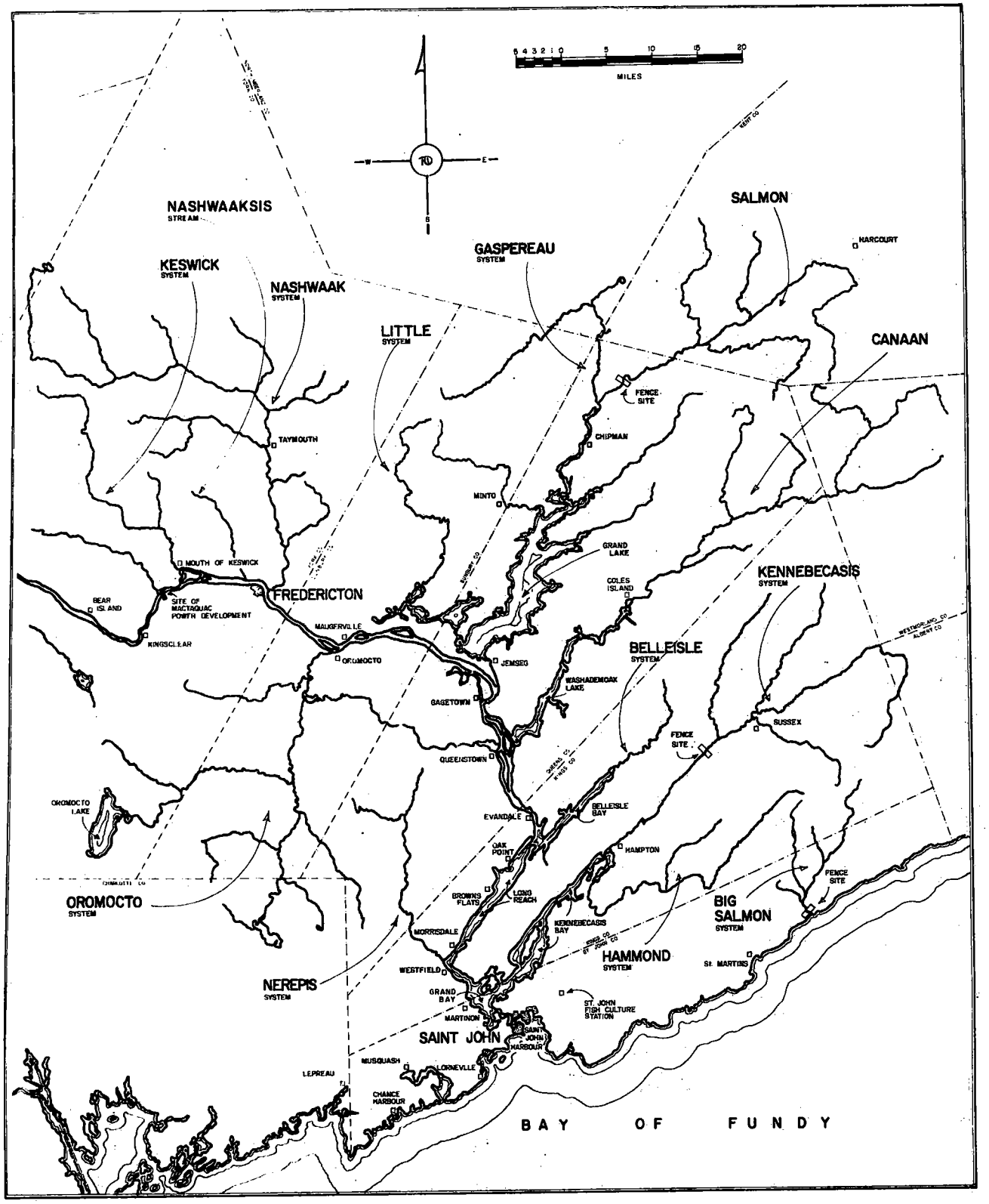

Fig. 2 Commercial landings of American eel in the Saint John River estuary, 1962-1971.

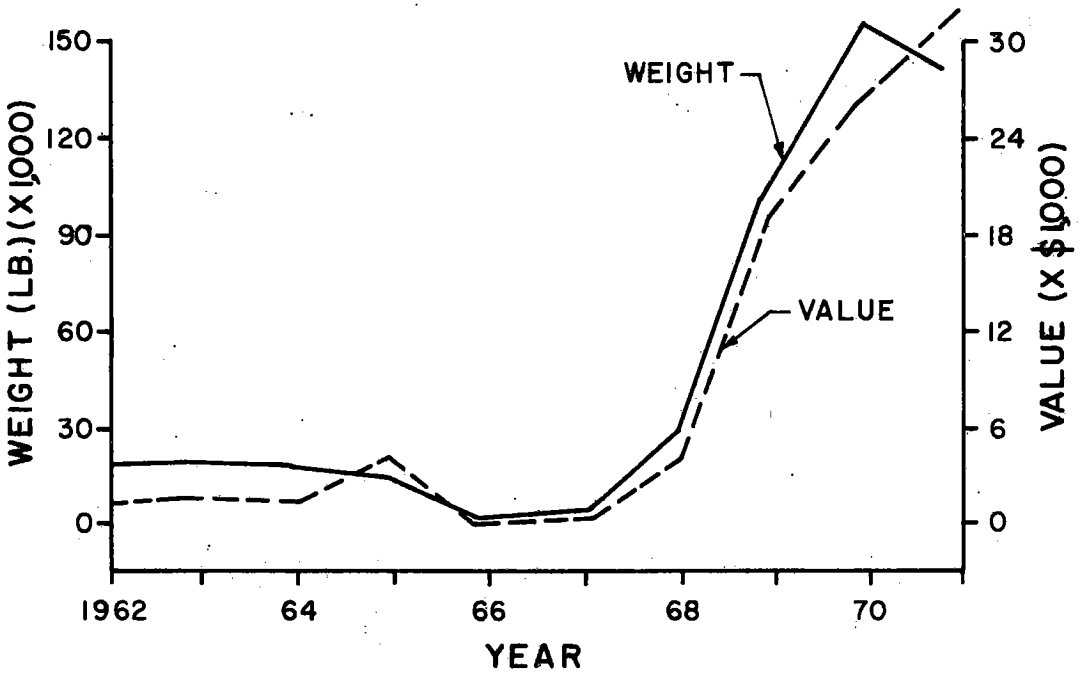

Fig. 3 Commercial landings of alewives in the Saint John River estuary, 1962-1971.

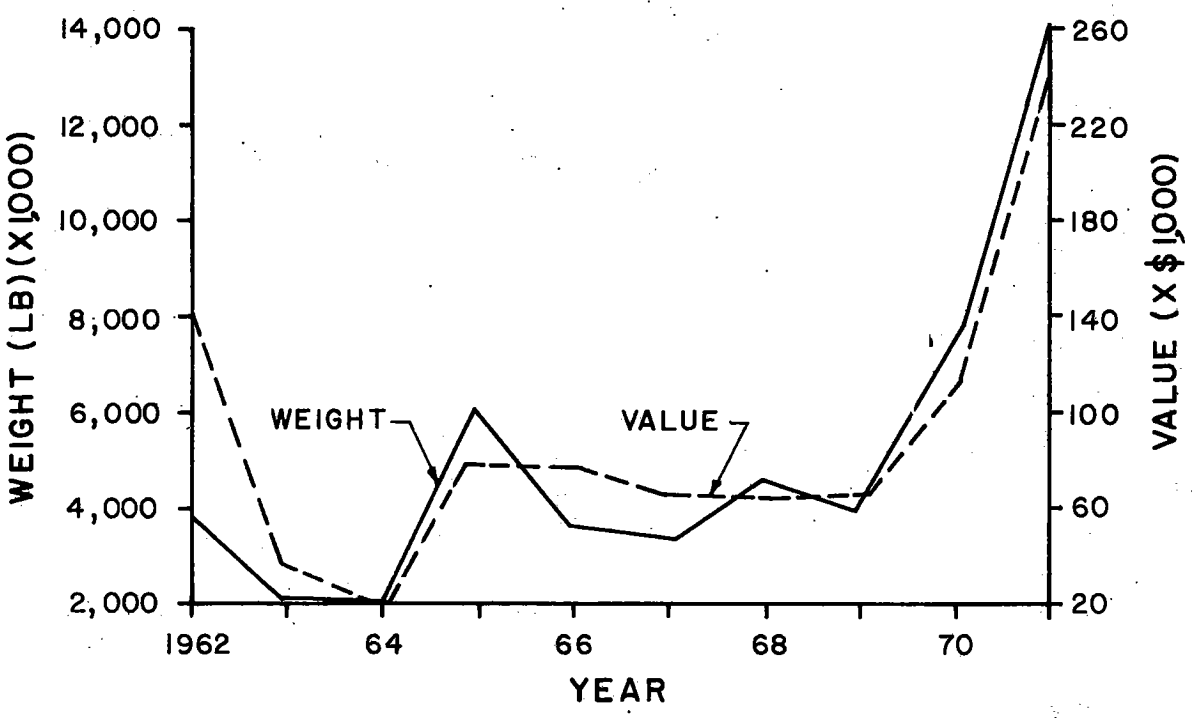

Fig. 4 Commercial landings of American shad in the Saint John River estuary, 1962-1971.

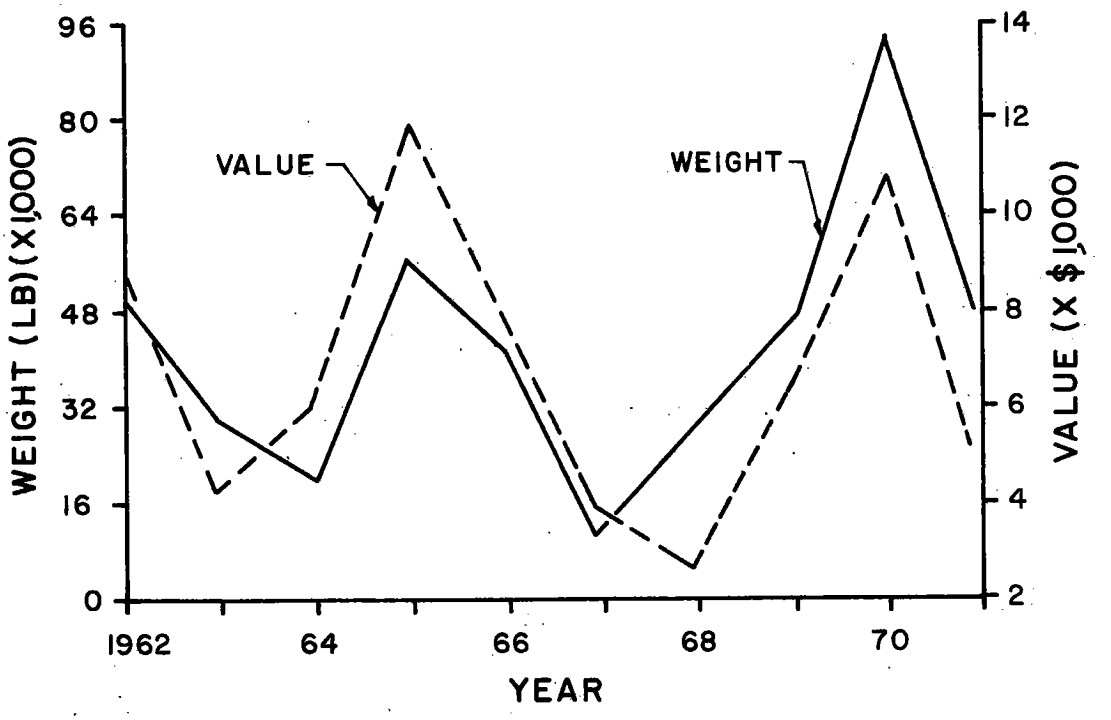

Fig. 5 Commercial landings of Atlantic salmon in the Saint John River estuary, 1962-1971.

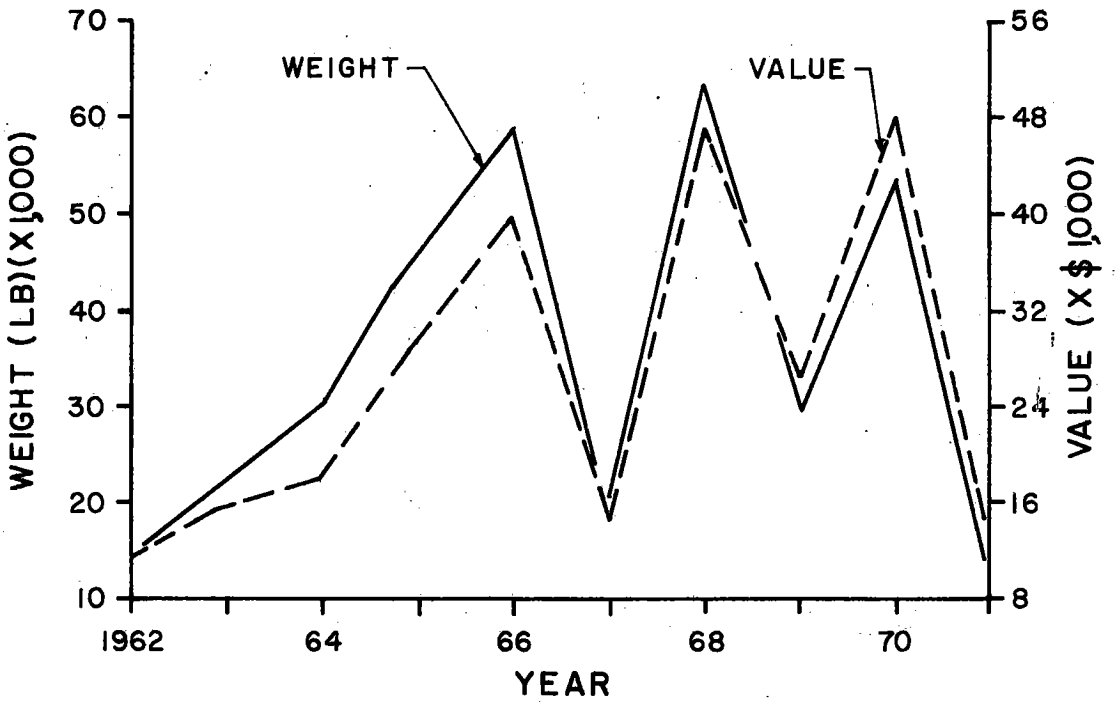

Fig. 6 Commercial landings of Striped bass in the Saint John River estuary, 1962-1971.

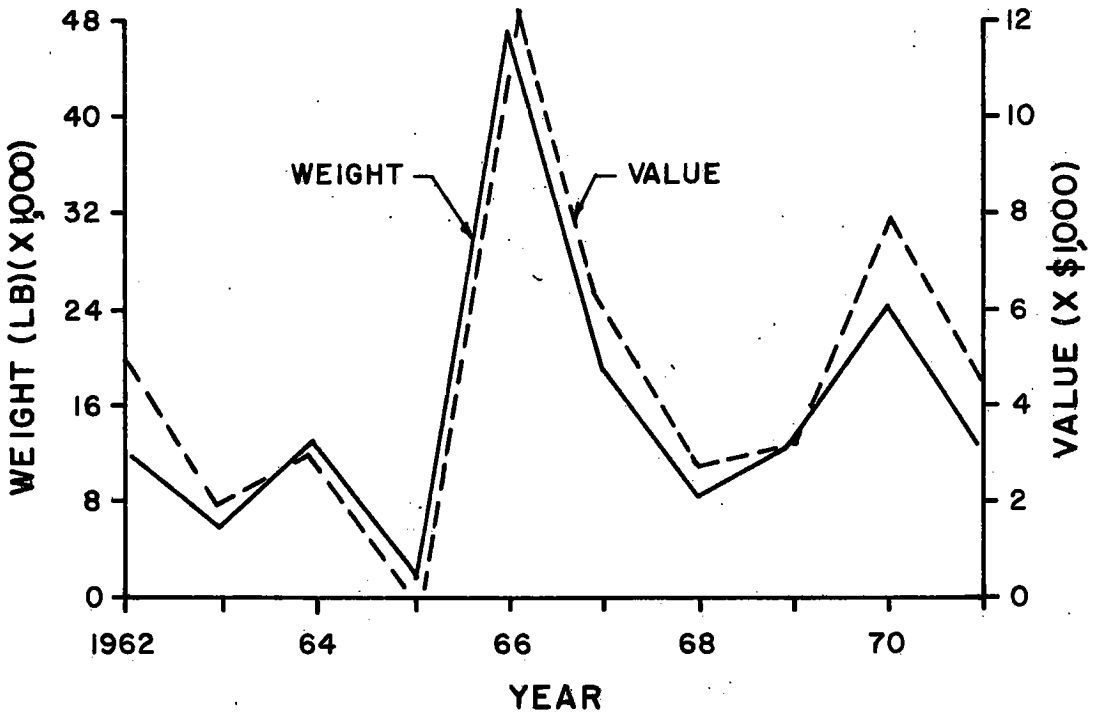

Fig. 7 Commercial landings of Atlantic sturgeon (including caviar) in the Saint John River estuary, 1962-1971.

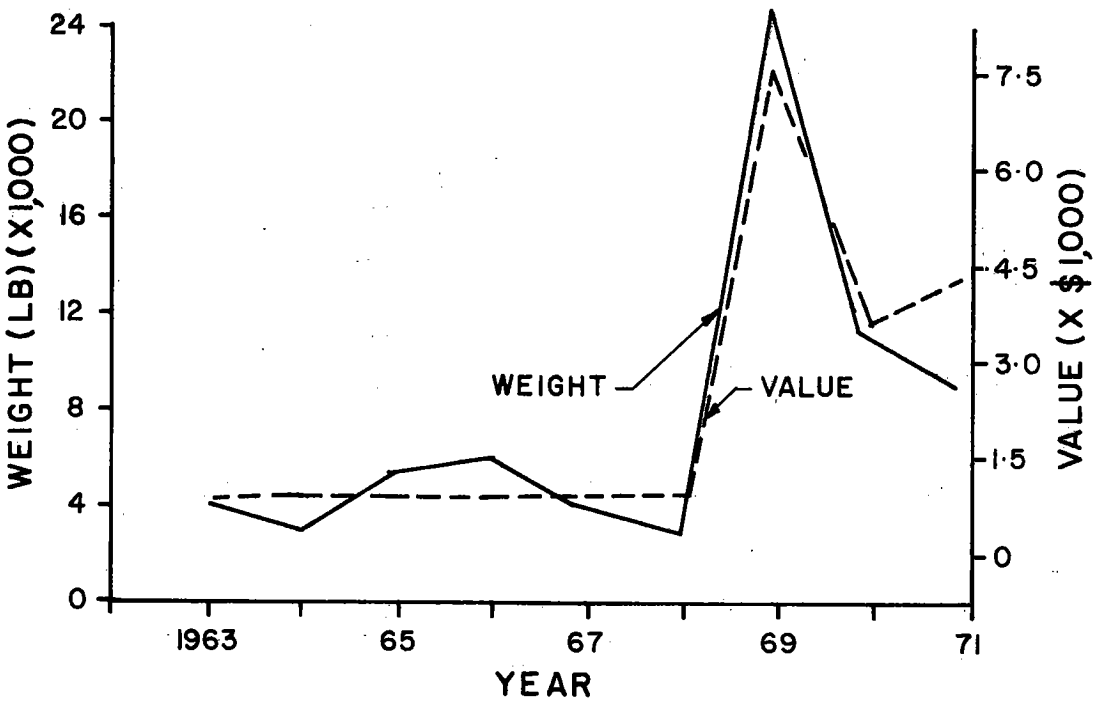

Fig. 8 Commercial landings of Chain Pickerel in the Saint John River Estuary, 1962-1971.

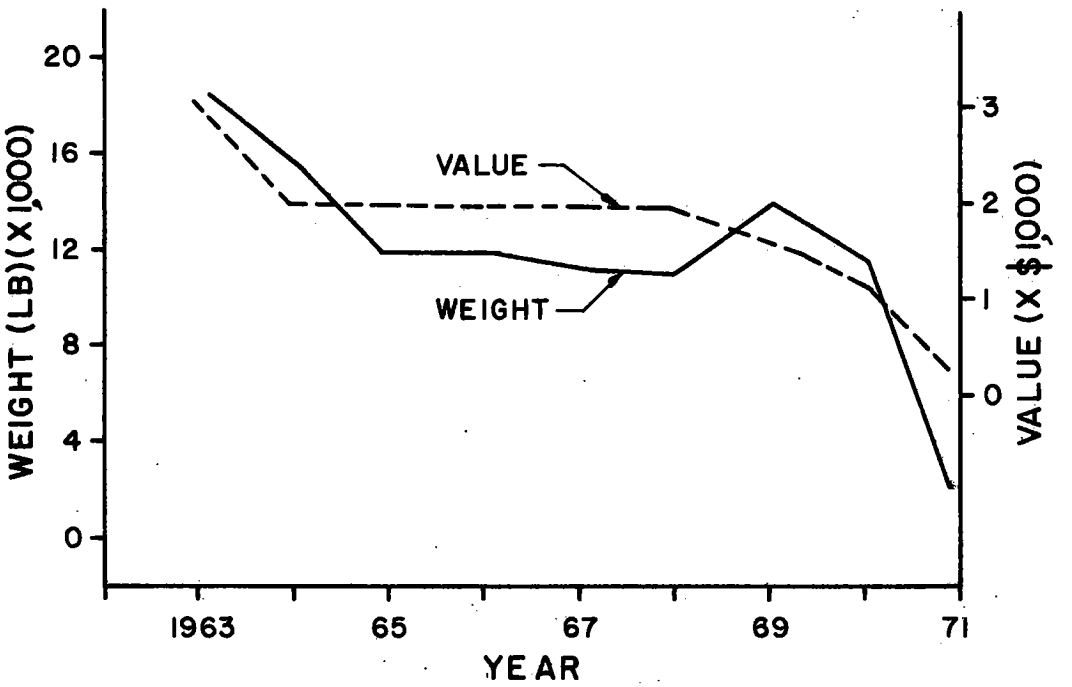

Fig. 9 Number of Atlantic salmon angled in the lower Saint John River Basin, 1962-1971.

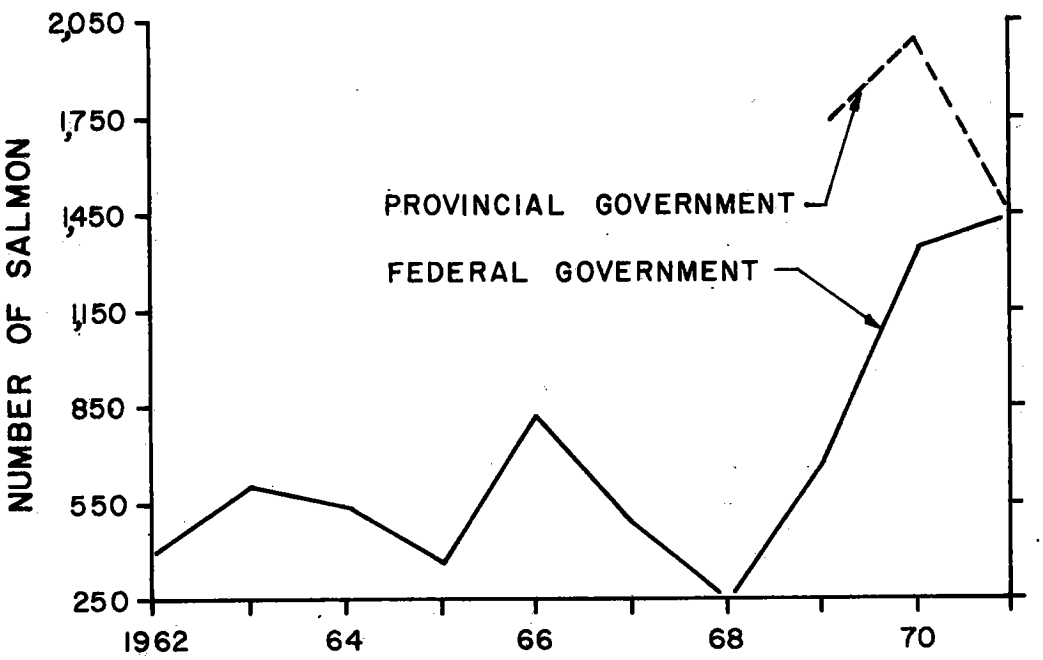

Fig. 10 Number of Speckled Trout angled in the lower Saint John River Basin, 1962-1971.

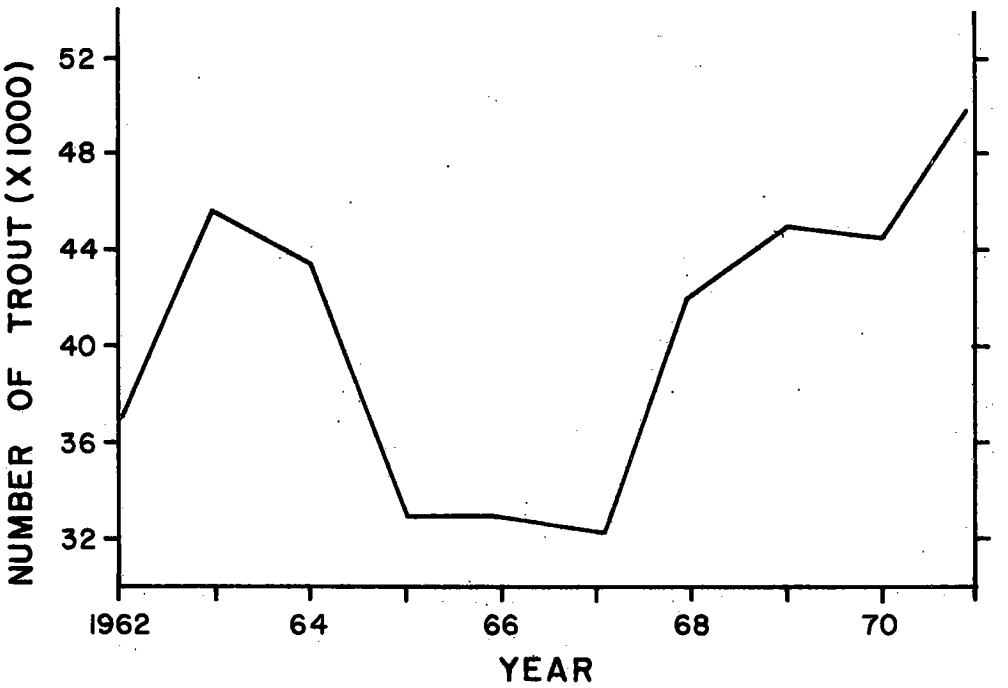

Fig. 11 Number of Striped Bass angled in the lower Saint John River Basin, 1962-1971.

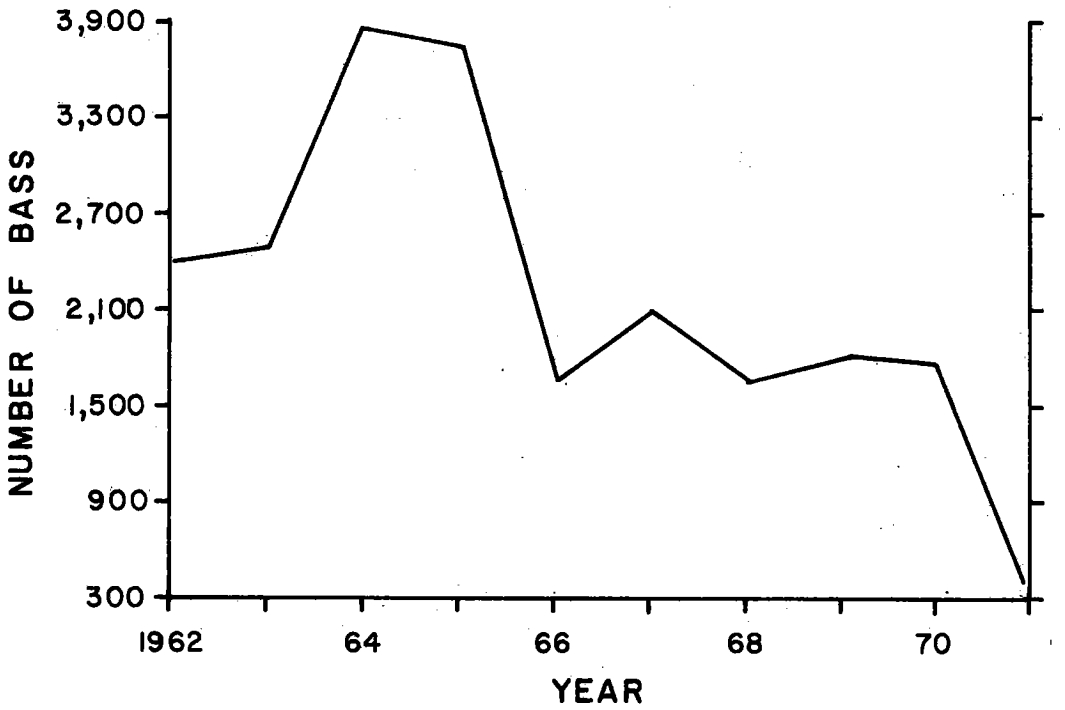

Fig. 12 Number of Smallmouth Black Bass angled in the lower Saint John River Basin, 1962-1971.