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MATAMEK ANNUAL REPORT FOR 1977

by

R. John Gibson

WOODS HOLE OCEANOGRAPHIC INSTITUTION
Woods Hole, Massachusetts 02543

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TECHNICAL REPORT

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ABSTRACT

This is a report describing activities associated with the Matamek program in 1977. Research was conducted on biological, chemical and physical factors related to salmonid production in Matamek River and Matamek Lake. Canadian universities, the Quebec government and Woods Hole Oceanographic Institution cooperated in the program.

Key words: 1. Salmonid ecology
2. Boreal limnology

Salmon leaping the 1st falls. Photo by G.R. Kremer.

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Introduction

The Matamek Research Station has a history of early scientific endeavors, but research on Atlantic salmon began in 1967. At that time the Woods Hole Oceanographic Institution received the property and supporting funds through the generosity of Mr. J. Seward Johnson. A historical perspective is therefore now possible for our research, and a good background of data from which we can plan future research. Through our publications, seminars and presentations at conferences we are recognized internationally in scientific circles and are frequently consulted by management biologists. A suitable decennial event, and a major accomplishment since last year's annual report, was the presentation of papers at a half day session devoted to Matamek at the Canadian Conference for Fisheries Research, held in Ottawa, January 1978, and supported by the Canadian Fisheries Research Board and Department of Fisheries and Environment. The abstracts of these papers are reproduced in this report. This was a successful event and many favorable comments were received.

The research can be divided into two five year periods. The first five years, from 1967 to 1972, could be considered as mainly exploratory. Dr. Geoffrey Power with colleagues and students from the University of Waterloo made fishery surveys of lakes and streams within the watershed, and later extended this to representative salmon rivers along the North Shore. Species distribution, basic ecology of the salmonids, and production and population estimates of brook

trout were made in representative waters of the Matamek basin. Experimental introductions of salmon were made in the fishless areas. Plankton communities and interactions in fishless lakes and in lakes with differing fish communities were also studied.

In 1973 the scope of the research was broadened, and scientists from several universities and from the Woods Hole Oceanographic Institution have been involved since that time. The objectives outlined in 1973 have largely been accomplished. These have given us insights into studies we are continuing, and have suggested important problems for future research. We have now some estimate of the size and composition of the adult salmon run. Estimates have been made of the annual smolt run, and these are improving with new techniques and with more experience. From our smolt tagging operations we have had returns from adults in the river and from the commercial fisheries at sea. The salmon parr and brook trout populations have been estimated in representative sections of the river. These have revealed some surprising findings, a major one being that although parr are most numerous in rapids and close to fast water, as would be expected from other work, they are common in deep slow areas in what has been regarded as unsuitable habitat. It appears that the distribution of salmon parr and trout is as greatly affected by other fish species and the availability of food as by the physical water conditions. The Matamek River, like many others along the North Shore, and in Labrador and Newfoundland, has few piscine competitors or predators

of salmon parr, which can therefore occupy a wider range of habitat then would be expected from other studies. These rivers are therefore able to produce more salmon than might be expected from the habitat. In the absence of parr, as upstream from the fourth falls, trout occupy the faster water reaches, and their diet in mid-summer when food is sparse is more similar to that of parr than that of the trout where the two species co-exist. Behavioral and competitive interactions and habitat preferences have been studied both in the field and in stream tanks. Aggressive behavior of salmon parr is affected by water velocity, temperature, and amount of food. Salmon parr are most aggressive in fast water, and anatomical and physiological differences give them the competitive advantage over trout in fast water enabling them to displace trout in this sort of habitat when food is in short supply. Also, where parr are abundant, the population structure of the trout is changed, and the yearling trout, which are about the size of two year old parr, make up only about 30% of the trout population, compared to 70% of the trout population where there are no parr or where they are sparse. Some work on interactions with the other fish species has been started, but has yet to be thoroughly studied. The biomass of the salmonids decreases spectacularly from upstream down, most likely related to the amount of filter feeding insects, which are abundant near the lake, but decrease in a similar way to the fish biomass towards the estuary. Studies on the invertebrates in the main river and in tributaries are under way to show the relative contribution of nutrients from the lake, the decreases in

insects and plankton at stations downriver, changes in the amounts and assemblages of insects through the season and at different locations, and their preferred habitats. The limnology of Matamek Lake and its effects on the river are being studied by scientists from the University of Waterloo and University of Quebec (INRS-eau). An interesting discovery is that the lake does not have the effect of decreasing production downstream, as is the case in most other studies, but production of invertebrates and fish is greater below the lake than in the tributary streams. Nutrients decrease in the river from the lake towards the sea, whereas studies elsewhere have shown an increase downriver. The ecosystem of these northern rivers appears to be quite different from those studied further south. Streams and rivers are generally heterotrophic, or simply, food sources from outside the stream are more important than those from algae and higher plants within the stream. Other studies have found the main sources are from leaves and leachates from riparian vegetation, and lake influence is small. However, in boreal areas leaf fall from deciduous trees is much less and decomposition slower. Also the Matamek River has in general an eroding substratum, so that much of the organic debris may be flushed from the river. Matamek Lake evidently provides the most important source of nutrients for the invertebrates in Matamek River. Why Matamek Lake generates more food sources than would be expected is under investigation. River production varies with size, and smaller rivers are generally more productive. However,

rivers with lakes on the North Shore of the Gulf produce faster growing salmon parr, and preliminary investigations suggest that aquatic invertebrates are more abundant in these habitats than in rivers without lakes, especially filter feeding insects. These appear to be the major food items of the parr in rivers with lakes, and may account for the better growth there. Further studies in this field will enable us to describe the main parameters that could be used for classifying salmonid rivers and predicting production in boreal areas.

We are also interested in what are the physical factors limiting production of salmonids. Northern rivers have relatively greater ranges of water discharge than rivers further south. Lowest water levels occur in late winter and in late summer and a huge discharge occurs in early spring. Questions being considered are: What is the lowest discharge necessary in winter to provide sufficient flow for incubation of the eggs in the gravel, and what is the lowest discharge of water in the summer necessary to provide suitable habitat for salmonids and for the organisms on which they feed? Scientists from the University of Laval (Centreau) are working on this problem. There appears to be a super-abundance of aquatic insects in the spring, and this is when most of the fish growth occurs, but in late summer food is sparse, although very small aquatic insects are available for the fry. Is it the available food at this time that limits the fish populations, and do the less well fed fish die over winter?

Figure 1. A conceptual model of the ecosystem in the Matamek River. The vertical length represents distance from Matamek Lake. Width of the columns represents biomass and the arrows between trophic levels indicate energy pathways.

The answers have important considerations for hydro-electric development. For example, we have found that there is little feeding and activity of the fish below 9°C. Most of the annual discharge of northern rivers is before water temperatures reach this level, so could most of the spring discharge in these areas be taken for hydro-electric development without damaging the biological system, or would this affect development of the invertebrates or cause sedimentation of riffle areas? It is conceivable that if located above the limit of salmon migration an impoundment could be beneficial if more water could be released in the summer than the normal minimum flow. Food sources might be increased and temperatures more suitable for salmon growth maintained if water were retained and released at appropriate times. Cutting of conifers may not be harmful as long as sufficient vegetation is left to prevent erosion and access roads are kept to a minimum. Perhaps unlimited trout fishing could increase parr production. Exploitation of the North Shore of the Gulf is proceeding rapidly, so these questions should soon be answered. The road has been extended east of the River Moisie, allowing access as far as Havre St. Pierre. Extensive timber cutting is already underway east of Port Cartier. Some salmon rivers have been dammed and lost, and the remaining major salmon rivers will soon be affected by hydro-electric development. It is to be hoped that there will be compromises from these large industries, and that our research can provide the information needed to make wise decisions.

There are other projects at Matamek related to the main program. The smolt migration has been related to time of year, temperature and discharge over several years, and in stream tanks smolt behavior has been compared with that of parr. The habitat preferred by parr, as related to water velocity, depth, cover, and substrate, has been studied in stream tanks, and this will provide useful information for construction of rearing channels. Investigators from the University of Sherbrooke have developed at Matamek a method of assessing salmonid habitat from aerial photographs, a valuable tool for these wilderness areas. Investigators from the University of Quebec at Chicoutimi have studied marine invertebrates in a nearby cove. We are sea ranching brook trout and perhaps aquaculture projects may be started in the near future. Species composition and amounts of invertebrates are being studied in streams changed by road construction. A fertilization experiment is being conducted in a bay of Matamek Lake, and stream fertilization experiments may be undertaken. Introduction of exotic species is a popular management procedure, yet the effects are little known, so in a stream tank in Woods Hole the behavior and interactions of salmon parr, brook trout, coho salmon and steelhead trout are being studied.

In the next five years a thorough study of the ecosystem of the river will probably be made, with an integrated study by fishery ecologists, physiologists, invertebrate zoologists, microbiologists, chemists, and botanists, so that our conceptual model of the ecosystem

can be replaced with a mathematical and dynamic model. Other river systems may be included, so that production of salmon rivers in boreal areas can be predicted from their characteristics, interactions better understood, and changes due to disturbances of the environment anticipated.

Most ecosystems are now under heavy stress, due to fishing, pollution, or habitat changes, and fishery management usually aims at the pristine conditions. Matamek provides a most unusual opportunity to provide information on what these conditions are in boreal areas. The Quebec Ministry of Tourism, Fish and Game has declared the Matamek basin a fish and game reserve, so it remains unexploited, except for controlled scientific sampling. We are most grateful for the continued support and the assistance given us in many ways by the Quebec government.

R. John Gibson
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INTRODUCTION

La Recherche Scientifique à la Station de la Matamek est ancienne, mais c'est en 1967 qu'on y entrepris la recherche sur le saumon de l'Atlantique. A cette époque l'Institution Océanographique de Woods Hole recut la propriété ainsi que le support financier à son fonctionnement, grâce à la générosité de Mr. J. Seward Johnson. Une perspective historique s'ouvre alors à notre recherche, tandis qu'en second plan nous allons pouvoir disposer d'une bonne source de données sur lesquelles on établire la recherche future.

Par nos publications, séminaires et conférences nous avons été connus dans les cercles scientifiques à l'échelle internationale, et nous avons été souvent consultés par des biologistes chargés de programmes d'aménagement. Un évènement décennal, en même temps qu'une réalisation importante depuis le rapport annuel de l'an dernier, mérite d'être mentionné ici. Ce fut la présentation d'articles scientifiques, lors d'une session d'une demi journée consacrée à la Matamek, à la Conférence Canadienne de la Recherche pour les Pêcheries. Cette conférence eut lieu à Ottawa en Janvier 1978, et était supportée par l'Office de la Recherche des Pêcheries Canadiennes et le Département de la Pêche et de l'Environnement. Les résumés des articles qui furent présentés sont inclus dans ce rapport. Cet évènement fut couronné de succès et suscita de nombreux commentaires favorables.

La recherche entreprise à la Matamek peut être divisée en deux périodes de cinq ans. Les cinq premières années, de 1967 à 1972, seront surtout considérées comme exploratrices. Le Dr. Geoffrey Power assisté de collègues et d'étudiants de l'Université de Waterloo, consacrèrent cette première période

à l'étude des poissons dans les lacs et les rivières du bassin de la Matamek. Plus tard, le long de la Côte Nord, ils étendirent cette étude aux rivières à saumons représentatives de ce bassin. La distribution des espèces de poissons, l'écologie de base des salmonidés et les estimées de production et de population des truites de rivière furent faites dans ces eaux représentatives. De façon expérimentale des saumons furent introduits dans des endroits non poissonneux. Des études furent aussi faites sur les communautés de plancton et les interactions dans des lacs sans poissons ainsi que dans des lacs possédant des communautés de poissons différents.

En 1973 l'étendue de la recherche s'élargit avec la participation de chercheurs de l'Institution Océanographique de Woods Hole et de plusieurs Universités. Les objectifs esquissés en 1973 ont été largement réalisés depuis. Ils nous ont donné des idées exactes pour les études que nous poursuivons, et nous ont suggéré des problèmes importants concernant notre recherche future. Nous possédons maintenant quelques estimées sur le nombre et la composition de la migration du saumon adulte. D'autres estimées ont été faites sur la migration du saumon adulte. D'autres estimées ont été faites sur la migration annuelle du saumoneau. Grâce à des techniques récentes et une plus grande expérience on continue d'améliorer ces estimées. Certains des saumoneaux que nous avions marqués sont revenus, adultes, dans la rivière. Pour d'autres des renseignements les concernant nous ont été fournis par la pêche commerciale en mer. Des populations de tacons de saumon et des populations de truites de rivière furent estimées en certaines sections représentatives de la rivière. On a pu en tirer des conclusions assez surprenantes. La

principale étant que les tacons, bien que plus nombreux à proximité des rapides ou dans ces derniers, comme il le fut démontré dans d'autres travaux, se trouvent également dans des endroits calmes et profonds qui leur étaient jusqu'alors considérés comme habitat peu propice. Il semblerait que la distribution des tacons et des truites soit autant affectée par les autres espèces de poisson et la quantité de nourriture disponible que par les conditions physiques de l'eau. La rivière Matamek, comme bien d'autres rivières de la Côte Nord, ainsi que celles du Labrador ou de Terre Neuve, a peu de compétiteurs ou de prédateurs du tacon. Ce dernier peut donc occuper un territoire plus étendu qu'on ne pourrait le supposer d'après d'autres études. On peut alors déduire que ces rivières seraient aptes à produire d'avantage de saumons. Aux endroits où les tacons sont absents, comme au dessus des quatrièmes chutes par exemple, les truites occupent les abords des rapides et, au milieu de l'été lorsque la nourriture se fait plus rare, leur régime ressemble d'avantage à celui des tacons qu'à celui des truites là où les deux espèces cohabitent. Le comportement, les interactions compétitives et les préférences d'habitat ont été étudié à la fois sur le terrain et dans les bassins d'observation. L'agressivité du tacon de saumon se trouve modifiée selon la vélocité de l'eau, la température et la quantité de nourriture. Les tacons sont plus agressifs dans les eaux rapides. Leur différence anatomique et physiologique leur donne l'avantage sur les truites, leur permettant en eau courante de déplacer ces dernières lorsque la nourriture se raréfie. Aux endroits où les tacons sont nombreux la population des truites se trouve modifiée, et les truites d'un an qui sont à l'eu près de la même taille que les tacons de deux

ans ne représentent environ que 30% de la population, comparés aux 70% de la population de truites où les tacons sont rares ou absents. On a commencé quelques travaux sur les interactions avec les autres espèces de poissons, mais ce sujet doit encore être approfondi.

La biomasse des salmonidés décroît de façon spectaculaire d'amont en aval de la rivière, ce qui est probablement en rapport avec la quantité d'insectes filtreurs (filter feeding insects). Ceux-ci, très abondants à proximité du lac, diminuent proportionnellement à la biomasse du poisson plus on se rapproche de l'estuaire. On a entrepris des études sur les invertébrés de la rivière et de ses ruisseaux tributaires afin de démontrer, la contribution du lac dans l'apport des substances nutritives, la diminution du nombre des insectes et du plancton au fur et à mesure que l'on s'approche de l'embouchure, ainsi que dans la quantité et les compositions d'insectes au cours de la saison, en divers endroits, et selon leur habitat préférentiel. Des chercheurs de l'Université de Waterloo et de l'Université du Québec (INRS-eau) ont étudié la limnologie du Lac Matamek et ses effets possibles sur la rivière. Il est intéressant d'apprendre que la Lac n'a pas d'effet sur la diminution du poisson en aval, comme dans bien des cas mentionnés dans d'autres travaux, mais la production des invertébrés et du poisson est plus grande au dessous du Lac que dans les ruisseaux tributaires. Les substances nutritives décroissent donc d'amont en aval de la rivière, tandis que des études réalisées en d'autres régions témoignent du contraire. Il semblerait que le système écologique des rivières nordiques soit bien différent de celui des cours d'eau situés plus au sud.

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Ruisseaux et rivières sont généralement hétérotrophiques, ou tout simplement, les sources de nourriture de provenance extérieure au ruisseau sont plus importantes que celles apportées par les algues et autres plus grandes plantes croissant dans l'eau. D'autres recherches ont démontré que les principales sources nutritives provenaient des feuilles et de la dissolution des végétations riveraines, de telle sorte que l'influence d'un lac est minime. Cependant dans les régions boréales la chute des feuilles provenant d'arbres caducs est peu importante et leur décomposition plus lente. De plus comme la rivière Matamek a en général un lit exposé à l'érosion, une grande partie des débris organiques risquent d'être chassés de la rivière. Il semble évident que le Lac Matamek soit la source nutritive principale pour les invertébrés de la rivière. On cherche actuellement à savoir pourquoi le Lac serait une source si importante en éléments nutritifs. La production d'une rivière varie selon son importance, et en général les petites rivières sont plus productives que les grandes. Cependant sur la Côte Nord du Glofe du St. Laurent, les rivières possédant des lacs produisent des tacons de saumon qui croissent plus rapidement et des recherches préliminaires suggèrent que les invertébrés aquatiques, en particulier les insectes filtreurs, sont plus abondants dans ces habitats que dans les rivières dépourvues de lacs. Or ces insectes semblent représenter la majeure partie de la nourriture des tacons dans les rivières que ont des lacs, ce qui expliquerait la meilleure croissance de ces poissons en ces endroits. De plus amples recherches en ce domaine permettront de décrire les principaux paramètres pouvant servir à classifier les rivières à salmonidés,

et prédire leur production dans les régions boréales.

Nous aimerions aussi savoir quels sont les facteurs physiques qui semblent limiter la production des salmonidés. Les rivières du nord ont une superficie relativement plus grande et un débit plus important que les rivières situées plus au sud. Les niveaux d'eau les plus bas sont en fin d'hiver et en fin d'été, tandis qu'une crue importante a lieu au début du printemps. Les questions que se posent sont les suivantes: Quel est en hiver le débit le plus faible nécessaire à assurer une irrigation suffisante à l'incubation des oeufs dans la gravelle, et quel est en été le débit le plus bas nécessaire à assurer un habitat adéquat aux salmonidés ainsi qu'aux organismes dont ils se nourrissent? Des chercheurs de l'Université Laval (Centreau) étudient ce problème.

Il semble y avoir une super-abondance d'insectes aquatiques au printemps, et cela correspond à la plus forte phase de croissance du poisson, tandis qu'en fin d'été la nourriture est plus rare, bien qu'il y ait encore de très petits insectes d'eau pour les alevins. Est-ce la quantité de nourriture disponible à cette époque qui limite les populations de poissons, et on peut aussi se demander si les poissons moins bien nourris meurent pendant l'hiver? Les réponses à ces questions peuvent amener à d'importantes considérations en ce qui concerne le développement hydro-electrique. Par exemple on a pu observer que les poissons sont moins actifs et se nourrissent peu à une température au dessous de 9°C. Or la majeure partie de la décharge annuelle des rivières nordiques se fait avant que la température de l'eau n'atteigne ce niveau. On peut donc se demander si la crue de

printemps peut être utilisée pour le développement hydro-électrique sans endommager le système biologique, ou sans affecter le développement des invertébrés, ou encore, causer la sédimentation des haut fonds? Peut-on concevoir qu'une retenue d'eau, qui serait située au dessus de la limite des zones migratoires du saumon, permettrait l'été d'augmenter le débit minimum normal de la rivière. Si, en des moments opportuns on pouvait retenir ou libérer cette eau, les sources de nourriture pourraient se trouver augmentées en même temps que les températures favorables à la croissance du saumon seraient maintenues. Les coupes de conifères ne sont pas préjudiciables tant que l'on conserve une végétation suffisante pour éviter l'érosion et que les routes d'accès restent limitées à un minimum. Peut être que la pêche libre des truites augmenterait la production des tacons. L'exploitation de la Côte Nord du Golfe avance rapidement, et à toutes ces questions il y aura bientôt des réponses. La route a été prolongée à l'est de la rivière Moisie jusqu'à Havre St. Pierre. Des coupes de bois intensives sont déjà entreprises à l'est de port Cartier. La construction de barrages a causé la perte de certaines rivières à saumon, et celles qui restent seront bientôt affectées par le développement hydro-electrique. Espérons que l'on pourra arriver à des compromis avec ces grosses industries et que notre recherche procurera les informations nécessaires à prendre de sages décisions.

D'autres projets en cours sont associés au programme principal de la Matamek. Chaque année on a noté l'époque de la migration des saumoneaux, la température et l'importance de la décharge des eaux, et on a comparé le

comportement des saumoneaux avec celui des tacons dans les bassins d'observation. On a également observé l'habitat préféré du tacon selon l'influence de la vitesse de l'eau, de la profondeur, du couvert et de la composition du sol. Cette étude fournira les informations nécessaires pour l'aménagement d'habitat naturels dans la rivière. Des chercheurs de l'Université de Sherbrooke ont mis au point à la Matamek une façon d'évaluer l'habitat des salmonidés à partir de photos aériennes. Cette méthode constitue un atout précieux dans ces régions sauvages. L'étude des invertébrés marins a été faite dans une anse de la côte par des chercheurs de l'Université de Québec à Chicoutimi. On a élevé des truites de rivière dans la mer et peut être des projets d'aquaculture pourront-ils être entrepris prochainement. On étudie la composition des espèces d'invertébrés et leur nombre dans des ruisseaux ayant été modifiés par la construction de la route. Une expérience de fertilisation est en cours dans une baie du lac Matamek, et on pense étendre cette fertilisation expérimentale à certains ruisseaux. L'introduction d'espèces exotiques est une méthode couramment utilisée dans les programmes d'aménagement, cependant les résultats sont encore peu connus, c'est pourquoi on continue d'étudier le comportement et les interactions des tacons, des truites de rivière, des saumons coho et des truites "steelhead" dans un bassin d'observation à Woods Hole.

Dans les cinq prochaines années une étude approfondie de l'écosystème de la rivière sera probablement faite. Un programme commun réunira les écologistes de la pêche, les physiologistes, les zoologistes des invertébrés, les microbiologistes, les chimistes et les botanistes. De cette façon le

modèle conceptuel de l'écosystème actuel pourra évoluer vers un modèle mathématique et dynamique. On pourra y inclure d'autres systèmes de cours d'eau, et ainsi prédire, dans les régions boréales, la production des rivières à saumon selon leur caractéristiques. Les interactions seront mieux comprises et on pourra anticiper les changements résultant des perturbations de l'environnement.

La plupart des écosystèmes subissent actuellement de lourdes pressions de la part de la pêche, de la pollution ou des changements de l'habitat, et normalement le but de l'aménagement poissonnier est de retourner aux conditions primitives. La Matamek est un endroit par excellence susceptible de fournir des renseignements sur ce que sont ces conditions dans les régions boréales. Le Ministère du Tourisme de la Chasse et de la Pêche du Québec a déclaré le bassin de la Matamek, Réserve de Chasse et Pêche, de sorte que ce bassin reste inexploité, à l'exception de la prise d'échantillons à des fins scientifiques. Nous sommes très reconnaissants au Gouvernement du Québec pour l'aide et l'appui continuel qu'il nous a donné à maintes reprises.

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The salmon leaping at the 1st falls. Photo by F.G. Whoriskey.

SALMONID STUDIES

Population estimates were continued of salmon parr, brook trout and suckers below the 2nd and 3rd falls, and samples were taken at the 4th falls and in the Muskrat River. We have now several years data, which have given us useful insights into the ecology and interactions of brook trout and salmon parr. The population estimates below the 2nd falls are shown in Table 1. The population estimate of salmon parr/ha at the 3rd falls study area was: 1+, 650 (310-1500); 2+, 1240 (770-2110). Their sizes are shown in Table 2. The size distributions of parr and trout at the 2nd falls in 1977 are shown in figures 2 and 3. The sizes of the salmon parr have increased with the decrease in numbers over the last few years (fig. 4), but nevertheless the biomass has decreased. The percent of precocious male parr appears to have increased in recent years (Table 3), but may have decreased again at the 2nd falls with the increase in numbers. These changes have affected the age and sex composition of the smolt run (R. J. Gibson, J. du Cons. 1978, 38(2): 1-7). Trout are now being removed from below the second falls in the 1978 season, and the effect on the salmon parr without the possible competition from trout will be followed. The trout are being released in the estuary for a sea ranching experiment.

There was an increase in numbers of parr in 1977. For the first time since population estimates were started, yearling parr below the 2nd falls were more numerous than two year olds, and are the progeny of the adult salmon escapement in 1975. The estimate of the adults

Table 1. Population Structures of Salmon Parr and Trout Below the 2nd Falls.

Year	Age	SALMON		TROUT		
		Number of Individuals (95% range)	Biomass kg/ha	Number of Individuals (95% range)	Total Biomass kg	Biomass/5.7 (= kgms/ha)
1977	1+	690(510-920)	4.5	290(150-590)	5.2	
	2+	430(320-600)	9.3	310(200-430)	12.7	
	3+	9		130(90-120)	10.5	7.3
	4+			60(40- 90)	12.8	
1976	1+	140(110-200)	1.6	20(10- 40)	0.3	
	2+	230(220-260)	5.8	250(200-310)	12.5	
	3+	90(40-190)	4.4	90(70-120)	9.7	5.8
	4+			70(50- 90)	10.4	
1974	1+	260(200-360)	1.2	400(220-810)	6.1	
	2+	450(350-630)	7.8	400(320-540)	15.4	
	3+	150(60-380)	4.1	140(110-190)	12.5	7.9
	4+			80(50-130)	11.1	
1973	1+	510(300-1660)	2.4	300(130-750)	3.5	
	2+	1750(1420-2290)	27.2	560(380-860)	19.7	
	3+	20(10-50)	1.1	180(140-230)	15.4	8.1
	4+			50(30- 80)	7.7	
1972		2020 } (1700-2510)		870 } (770-990)		
1971	1+	410(240-1290)	4.7	410(240-1290)	4.7	
	2+	560(480- 710)	18.7	560(480- 710)	18.7	7.5
	3+	100(80- 125)	8.5	100(80- 125)	8.5	
	4+	70(60- 90)	11.1	70(60- 90)	11.1	

Table 2. The sizes of salmon parr sampled in 1977.
The standard error is given in brackets.

<u>Age</u>	<u>1+</u>		<u>2+</u>		<u>3+</u>	
	<u>F.L.(cm)</u>	<u>Wt.(g)</u>	<u>F.L.(cm)</u>	<u>Wt.(g)</u>	<u>F.L.(cm)</u>	<u>Wt.(g)</u>
4th falls	9.9 (0.33)	11.5 (0.62)	13.0 (0.13)	28.7 (0.78)	17.0 (0.43)	63.3 (4.76)
3rd falls	8.8 (0.32)	7.7 (0.72)	12.7 (0.12)	23.5 (0.63)		
2nd falls	8.2 (0.13)	6.6 (0.36)	12.2 (0.22)	21.3 (1.23)

Figure 2. The size distribution of salmon parr below the second falls.

Figure 3. The size distribution of brook trout below the second falls.

Figure 4. The change in size of salmon parr below the second falls. The bar on each column represents the standard error about the mean.

Table 3.

% PRECOCIOUS MALE PARR.
(NUMBERS OF MALES IN THE SAMPLES
ARE GIVEN IN BRACKETS)

LOCATION OF FALLS	1967			1975		
	1+	2+	3+	1+	2+	3+
2 nd	0 (36)	19 (33)	34 (9)	0 (1)	40 (12)	100 (3)
3 rd	8 (71)	57 (55)	100 (3)	38 (8)	89 (18)	100 (6)
4 th	45 (8)	75 (19)	100 (11)	100 (3)	100 (16)	100 (2)
-7-						
LOCATION OF FALLS	1976			1977		
	1+	2+	3+	1+	2+	3+
2 nd	5 (21)	47 (15)	83 (12)	0 (18)	27 (19)	
3 rd	0 (4)	64 (11)	100 (3)	0 (5)	75 (28)	
4 th				0 (2)	100 (14)	100 (7)

that year was 30 salmon and 130 grilse, resulting in about 160,000 eggs for the river. In 1977 there were also more two year old parr than in 1976. This does not follow from the low number of yearlings the previous year. However, the spawning areas are above the 2nd falls, and the population of parr below the 2nd falls relies on immigration from upriver. This is dependent on such conditions as population density and water conditions. There is little movement of salmon parr in the summer, but parr freely move around and are easy to catch in passive gear in June, so in the Matamek this may be the time of their immigration to new areas. The fry may move more in July or August, as "Centreau" investigators have found a correlation between low summer water levels and numbers of yearling parr below the 2nd falls the following year.

In contrast to the changes in the parr population, the sizes of the trout, their density and their population structure does not appear to have changed over the last few years. The most striking feature of the trout population structure at the 2nd falls is the relatively low number of yearlings, which comprise less than 40% of the population. This is also the case below the 3rd falls (Table 4). However, at the 4th and 5th falls, where there are no parr, or where they are few, the yearling brook trout comprise about 70% of the population. Severest interactions between salmon parr and trout would be expected with the younger age classes of trout, as they are then closer in size. When food is in short supply salmon parr displace

Table 4. The population structure of brook trout at four locations in the Matamek River. Population numbers are indiv/ha, except at the 3rd falls(*), where distances of movement were not measured.

<u>Falls</u>	<u>Year</u>	<u>1+</u>	<u>2+</u>	<u>3+</u>	<u>>3+</u>
5	1971	4130(3430-5188) 70%	1000(720-1600) 17%	710(520-1300) 12%	60(40-170) 1%
4	1975	500(350-750) 73%	120(80-180) 17%	50(30-70) 7%	20(10-40) 3%
3*	1976	70(30-170) 23%	210(150-290) 70%	20(10-40) 7%	<10
	1977	70(30-180) 16%	240(160-370) 55%	100(50-220) 23%	30(10-60) 7%
2	1971	410(240-1290) 36%	560(480-710) 49%	100(80-130) 9%	70(60-90) 6%
	1977	290(150-590) 37%	310(200-430) 39%	130(90-120) 16%	60(40-90) 8%

trout from fast water areas, by both competition and aggression (R. J. Gibson, 1973. Internat. Atl. Salmon Foundn. Spec. Publ. Ser. 4(1): 181-202). Both brook trout and salmon parr appear to be more aggressive in fast water than in slow (fig. 5). Both species tend therefore to be territorial when holding station in moderate flow, but be less aggressive and have a more roaming type of behavior in pools. In the absence of one species the other can occupy both rapids and pool areas, but when parr and brook trout occur together, and food is in short supply, brook trout occur more frequently in pools, and parr in rapids. This distribution is illustrated in figure 6.

Smolt were caught between June 3rd-30th. Two hundred and eighteen smolt were tagged, 74 below the 2nd falls, and 144 in the estuary. Only one smolt tagged below the 2nd falls was recaptured, three days later, in the estuary, so a population estimate by this method was not possible. However, the previous year 252 parr over 10 cm long (fork length) had been fin clipped at various locations upriver. Recaptures gave a smolt population estimate of 1580 (820-3330). This does not account for over wintering mortality, so the figure should be lower. This, plus the difficulty in capturing smolts, indicates the smolt population was low, which would be expected from the low population of 2+ parr the previous year. In the estuary 56 of the smolt tagged there were recaptured in subsequent seine hauls, from one to three times, from one to 10 days after tagging, with an average interval of three days. If untagged smolts behave in the

EXPERIMENT NOS.

Figure 5. The aggression of salmon parr related to water velocity.

Figure 6. The theoretical habitat distribution of salmon parr, trout, and a pool dwelling competitor (e.g. a minnow). Temperature, location of food, shade and substrate have not been taken into consideration. With a competitor, the niche becomes more restricted, preferred areas may not be used, and the biomass of the species is reduced. X = usual preferred location.

same way, this indicates that they spend a few days in the estuary before migrating to sea. The mean fork length of the smolt tagged at the second falls was 14.5 cm (range 11.2-20.5), and in the estuary, 14.9 cm (10.7-19.7). As in other years, the smolt migration started at the second falls with a water temperature of 9°C, around June 10th, and the main migration apparently was on the 12th and 13th, at a water temperature of about 10°C. This peaked very rapidly, and unfortunately we missed the beginning of the run in the estuary (fig. 7). Temperatures are shown in figure 8 and water levels in figure 9.

Tag returns to date are shown in Table 5. These show a total recap of 1.5%, and a range of 0.8% (1976) to 2.8% (1977). This is similar to tag returns elsewhere, but it should be borne in mind that not all returning salmon can yet be examined, and that all tags from the commercial fishery are not returned.

It was impossible to get a population estimate of the adult salmon, as the fishway did not function. Only one grilse was captured, on July 11th. It was recaptured in the trap net above the second falls on July 24th. It was a male, 48.6 cm in fork length, weighing 1.25 kg. Between July 14 and Aug. 29, 23 salmon and six grilse were caught in the trap net. The salmon had a mean fork length of 70.5 cm and the grilse 50.1 cm; 77% of the salmon and 50% of the grilse had net marks. Three female salmon and two males were sent to the hatchery at Tadoussac. The progeny have since this time been released in the area below the 5th falls, in a small stream between the 4th and 5th

Figure 7. Smolts caught by seine net in the estuary, 1977.

Figure 8.

Figure 9.

TABLE 5. TAG RETURNS TO DATE OF SMOLT TAGGED AT MATAMEK

<u>TAG NO.</u>	<u>PLACE OF CAPTURE</u>	<u>CAPTURE DATE</u>	<u>DATE TAGGED</u>	<u>FORK LENGTH OF SMOLT (CM)</u>
PQ 23071	Matamek River	75-07-17	74-06-21	14.7
PQ 23584	Harbour Le Cou, Newfoundland	75-07-10	74-06-29	15.8
PQ 23011	Old Bonaventure, T. Bay, Nfld.	76-06-18	74-06-26	15.8
PQ 23559	Matamek River	76-06-18	74-06-29	13.7
PQ 23732	Matamek River	76-08-15	75-06-21	15.4
PQ 24295	Matamek River	76-08-23	75-06-17	16.1
PQ 24254	Burgeo, Nfld.	76-07-15	75-06-17	14.4
PQ 23112	Hopedale, Lab.	76-09-01	75-06-14	14.7
PQ 23796	Fogo D., Nfld.	77-06-02	75-06-18	15.3
PQ 24625	Channel Port aux Basques, Nfld.	78-06-??	76-06-19	16.1
PQ 24378	Burgeo, Nfld.	78-05-31	76-06-12	15.8
PQ 24655	Burnt Island, Newfoundland	78-06-13	76-06-19	15.8
PQ 24842	Harbour Deep, Newfoundland	78-07-??	77-06-13	16.3
PQ 24772	Matamek River	78-07-19	77-06-17	14.1
PQ 24840	Matamek River	78-07-17	77-06-13	14.3
PQ 24894	Matamek River	78-09-13	77-06-16	13.1
PQ 24882	Snook's Head, Newfoundland	78-07-25	77-06-15	15.3
PQ 24898	Gooseberry Cove, T. Bay, Nfld.	78-07-10	77-06-16	14.3

falls, and in the upper reaches of the Tchinicaman River, a fishless area. The fry below the 5th falls have been observed and are surviving well. These introductions will add to our knowledge of salmon and trout interactions. The population structure, size and distribution of trout below the 5th falls have been studied without the presence of salmon, so any changes can be followed. If a landlocked population of salmon survives in the stream and small lakes of the upper Tchinicaman River, their growth, production and distribution can be compared with salmon co-existing with other species and with production of trout, without salmon. Adult salmon were put below the 5th falls in 1976, but no salmon fry were found there in 1977, and the adults may have drifted back over the 4th falls before spawning.

At the 1st falls the salmon are able to ascend only when the flow is low, and they appear to do this at the center of the falls. However, they will use the easiest route, and in years of relatively high water, as in 1975, sufficient water passes through the fishway for a number to use it. The accompanying photographs, taken July 20th, 1977, illustrate the problems with the fishway. The outflow is quite insignificant compared to the cascade next to it, so that few fish would be attracted into the first compartment. The cascade was created by a gully made during construction and which must divert a significant proportion of the river in July. This probably decreases the flow down the center of the falls, allowing

earlier ascent for the fish there. The lower two compartments leak badly, and all three lower compartments should have concrete floors. A shallow rock sill exists at the top of the falls just downstream from the inflow at the upper end of the fishway, and a wall, about three feet high, should be built from about one foot downstream from the start of the raised section of the wall of the fishway, across to the middle of the falls. This would have four useful effects:

- 1) flow would be diverted from the gully, which creates the cascade by the fish entrance;
- 2) the height of water would be raised at the inflow end of the fishway, and therefore the volume of water increased through the fishway;
- 3) more water would be diverted down the center of the falls, prolonging the time of difficult migration up the falls, and therefore encouraging fish to use the fish counting ladder;
- 4) some protection would be given the wall at right angles to the base of the fall, which forms the upstream wall to the lower three basins.

A start on improvements has been made in time for the 1978 season, and the gully plugged with rocks, so that the cascade by the fish entrance has decreased. This has also raised the water level at the inflow, improving the water intake. A concrete floor has been made in the lowest compartment. The lip of the outflow was broken, and this has been repaired. Fish are now using the fishladder, and further modifications will allow more accurate population estimates.

R.J. Gibson; F.G. Whoriskey, Jr.; T.A. Dickson; H. Maclean

The fishladder during high water.

The fish entrance at low water. The water discharged from the orifice, to the mid-right of the photograph, is negligible compared to the chute at the side.

A closer view of the fish entrance during low water,
and the cascade at the side.

The gully to the side of the fishway.

The upstream end of the fishway. A wall built from the raised portion out to the rock seen at the far right would have the effects mentioned in the text.

Moisie and Corneille Sampling

F. G. Whoriskey, Jr., and R. J. Gibson

A number of changes in the growth patterns of the Atlantic salmon stock of the Matamek River have become evident over the course of investigations conducted since 1967. These changes include a decrease in the number of smolts produced by the river each year, a change in the age structure pattern of the migrating smolts from a predominately 3+ year class smoltification to a migration pattern of ~20% 2+ smolts and ~80% 3+ smolts, estimates indicating decreasing numbers of parr in the river, and a decrease in the number of adults returning to spawn in the river each year (Gibson, 1978).

Concomitant with the changes of numbers of parr at the second falls has been a change in the growth patterns of the 1+, 2+, and 3+ parr age classes in this area. In these classes there have been trends towards an increase in mean fork length and mean weight over the period 1967-1976 (Table 1). It is felt that due to decreasing numbers of salmon parr in the river (possibly due to decreased adult escapement) a relative abundance of food exists for the parr that are left. The increased abundance of food has in turn elevated the growth rate of the parr in the 2nd falls study area.

The Matamek data suggest that a possible indicator of depletion of salmon stocks in rivers of the North Coast may lie in changes of mean fork length and mean weight of the parr year classes. The salmon parr of a number of North Shore rivers have been previously studied

(Scheifer, 1971; Randall, 1975). We chose two of these previously studied rivers to sample to see if changes in growth trends have occurred that are similar to those observed in the Matamek.

The rivers sampled were the Corneille River approximately 140 miles east of the Matamek, and the Moisie River, about four miles west of the Matamek. The Corneille River is physically very similar to the Matamek River in having small size, similar flow patterns, and in having a large lake draining into the lower section of the river. The Moisie River has the greatest amount of suitable salmon parr habitat of the North Shore rivers. It is a very large river characterized by wide expanses of medium flow water with gravel and cobble substrate. The water chemistry of the North Shore rivers is generally similar.

Samples from both the Moisie River and Corneille River were taken in the first week of September, 1977. Corneille fish were all taken by angling due to difficult seining conditions. Samples came from just below the large lake outlet, and from an area about 0.4 miles upstream from the river's junction with the Gulf of St. Lawrence. The sample from the Moisie River was taken immediately in front of the Moisie Salmon Club by seining and angling.

Data from the two rivers covering 1969, 1970 and 1978 are presented in Table 2. We were unable to take any fish from the 0+ and 1+ year classes in the Corneille, nor the 3+ year class in the Moisie. The data seem to indicate that there has been no appreciable change

of growth rate of the 2+ year class in the Corneille. There does seem to be a trend towards increased growth rates in the Moisie River for the 0+, 1+ and 2+ year classes.

It would appear that in the Corneille River, the river most similar to the Matamek River and most likely to mirror the Matamek changes, the changes have not occurred. However, all samples were considered together. At the Corneille it was noted that the growth rate of the parr from the outlet was considerably more rapid than the growth rate from the lower river section (Table 3), so that samples from the two areas should be considered separately. Although the sample is small, the dramatic difference between the size of fish at the same year class from the outlet and lower river are evident. One possible explanation is that the lake provides a rich food source for filter feeding insects, which in turn supply an elevated food supply to the fish. A similar situation occurs in the Matamek River.

Stomach contents of the samples were examined, but not carefully analysed. Stomachs from the Corneille River were usually from 1/4 to 1/2 full. One contained about 10% of terrestrial insects, but the others contained only hydropsychid larvae and/or case building trichopteran larvae. The samples from the Moisie River were also from 1/4 to 1/2 full, but all of them contained only terrestrial insects. Further studies on the amounts, type and nutrient value of invertebrates eaten by parr through the growing season in rivers which give different growth rates would no doubt shed light on the relative salmon

production of North Shore rivers.

The growth rate changes in the Moisie, though of interest, must be viewed with considerable care due to the smallness of the sample in relation to the size of the river, and in light of the lack of growth rate change in the Corneille.

We are grateful to Mr. Mitch Campbell, Manager of the Moisie Salmon Club, and Mr. John B. Claxton of the Corneille Salmon Club for permitting us to take these samples.

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Table 1. The size of juvenile salmon from below the 2nd falls (Matamek River) in years measured since 1967, sampled in August. The standard error of the mean is given in brackets. (Data in 1967 from Scheifer, 1971, Ph.D thesis, University of Waterloo. (Table from Gibson, 1976.)

Age		<u>1967</u>	<u>1971</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>
0+	F.L.(cm.)	3.5(0.94)	3.9(0.08)	4.3(0.18)	4.3(0.10)	4.0(0.05)	4.4(0.06)
	Wt.(g.)	-	-	0.7(0.11)	-	-	-
1+	F.L.(cm.)	7.2(0.34)	8.0(0.10)	7.6(0.18)	7.6(0.13)	8.8(0.45)	9.8(0.18)
	Wt.(g.)	4.5	5.6(0.11)	4.7(0.35)	4.8(0.26)	7.5(1.16)	10.5(0.51)
2+	F.L.(cm.)	10.5(0.16)	11.6(0.10)	11.5(0.21)	11.8(0.22)	12.7(0.17)	12.8(0.14)
	Wt.(g.)	12.9(0.16)	16.4(0.45)	15.5(0.49)	17.2(0.92)	22.0(0.82)	23.5(0.78)
3+	F.L.(cm.)	12.6(1.40)	15.8(0.27)	-	-	14.9(0.41)	15.7(0.30)
	Wt.(g.)	21.5(1.15)	49.1(2.70)	-	-	40.7(2.48)	48.8(3.33)

Table 2. Corneille and Moisie River salmon parr. Deviation expressed as 95% confidence limit about the mean. 1969 and 1970 data from Schiefer, 1971.

	<u>1969</u>	<u>1970</u>	<u>1977</u>
<u>Corneille</u>			
0+ F.L.(cm.)	3.7 $\pm$ 0.5	4.2 $\pm$ 0.3	-
0+ Wt.(gm.)	-	-	-
1+ F.L.(cm.)	9.7 $\pm$ 0.9	9.9 $\pm$ 0.2	-
1+ Wt.(gm.)	-	11.5 $\pm$ 0.9	-
2+ F.L.(cm.)	13.9 $\pm$ 0.6	14.9 $\pm$ 0.6	13.7 $\pm$ 0.8
2+ Wt.(gm.)	-	36.1 $\pm$ 4.2	31.2 $\pm$ 8.2
3+ F.L.(cm.)	-	-	-
3+ Wt.(gm.)	-	-	-
<u>Moisie</u>			
0+ F.L.(cm.)	3.5 $\pm$ 0.3	3.4 $\pm$ 0.1	4.4 $\pm$ 0.1
0+ Wt.(gm.)	-	-	-
1+ F.L.(cm.)	6.4 $\pm$ 0.5	6.7 $\pm$ 0.4	7.4 $\pm$ 0.4
1+ Wt.(gm.)	-	-	4.4 $\pm$ 0.7
2+ F.L.(cm.)	9.5 $\pm$ 0.5	9.7 $\pm$ 0.3	10.5 $\pm$ 0.4
2+ Wt.(gm.)	-	8.0 $\pm$ 0.7	12.3 $\pm$ 1.4
3+ F.L.(cm.)	-	11.4 $\pm$ 0.4	-
3+ Wt.(gm.)	-	-	-

Table 3. Corneille River 1978 salmon parr (2+) sample by area.

	<u>F.L. cm.</u>	<u>wt.(gms.)</u>	<u>Number of fish in sample</u>	<u>% mat. male</u>	<u>M/F</u>
<u>Corneille</u>					
Outlet	16.3 <u>±</u> 1.9	55.9 <u>±</u> 23.9	6	66%	1.0
<u>Area I</u>					
Lower River	12.9 <u>±</u> 0.2	23.0 <u>±</u> 1.4	18	12.5%	0.8

Behavioral Interactions of Exotic Salmonids.

R. J. Gibson

Observations have now been completed on behavioral interactions of Atlantic salmon parr, brook trout, coho salmon and steelhead trout in a stream tank at the Woods Hole Oceanographic Institution. This experimental stream offers choices of fast, medium and slow flows, and temperature can be controlled. Experiments were conducted at 7°C, 15°C and 20°C.

Data are being analyzed, but preliminary analyses suggest that size is more important in dominance than species. However, generally Atlantic salmon parr were more aggressive than coho or brook trout. Steelhead trout were very aggressive, and would be more serious competitors of salmon parr than coho. In all four species the number of agonistic acts increased with temperature.

In natural stream conditions exploitation of food resources may be a more important mechanism of competition than agonistic behavior in causing interactive segregation or displacement.

The stream tank at the 2nd falls.

Comparative Growth of *Salvelinus fontinalis* and
juvenile *Salmo salar* in the Matamek River

T. A. Dickson and R. J. Gibson

Introduction

In the Matamek River growth of the brook trout is faster than that of the salmon parr, so that yearling trout are approximately the size of two year old parr. Nevertheless, unlike apparently the situation in Europe with brown trout, parr have the competitive advantage over brook trout in running water of medium and fast flow (Gibson, 1973). Despite their smaller size, parr are more numerous than the trout, and the biomass and production of the two species where they co-habit in the Matamek River appears similar. The adaptive advantage of this situation can be seen. Salmon can do their growing to maturity at sea, so it is more advantageous to send the biomass of smolts to sea in as many "bits" as possible, at a large enough size to overcome excessively high predation. However, the trout stay in the river, and it is advantageous for them to grow large quickly, to reduce predation but also to reach maturity as soon as possible, and lay many eggs. The two species have similar habitat requirements and occupy the same trophic level. Interesting questions arise as to how the two species share the resource, and what mechanisms are responsible for the differential growth rates. When salmon parr were introduced in a fishless stream in the Matamek system, their growth was much greater than that of brook trout in the system downstream, so the capacity for greater growth in the Matamek

River is present (Matamek Annual Report for 1976). Factors which will be considered in this study are: 1) relative food intake; 2) relative metabolism; 3) possibility of a growth hormone at some time of year, perhaps advantageous to one species over the other; and 4) behavior.

The first summer's research had two main objectives. The first, to determine if the quality and quantity of food limited the growth. In the Matamek River June is the main period of growth, which correlates well with the period of greatest food in the river (Gibson and Galbraith, 1975). Similar situations with brook trout have been documented before (Logan, 1963; Gerking, 1962; and Benson, 1953).

The second objective was to determine if territorial behavior and interactions affected growth. Keenleyside (1962) found that salmon set up feeding territories. Gibson (1973) stated that trout were less aggressive. Chapman (1966) states it is common for fluvial salmonids to regulate density by "space food" requirements, but that this breaks down when food is abundant.

Methods and Materials

The three flumes at the 2nd falls were used. Water depth (~ 48.5 cm.) and area for each flume (~ 5.0 m x 1.5 m) were constant throughout the experiments. Each flume had a sand and gravel (~ 8.0 cm depth) bottom, with rocks dispersed throughout. One quarter of the surface area was darkened by a shade cover.

The two outside flumes had an observation glass wall along one side,

no observations could be made on the center flume.

In each experiment the same number of fish were introduced in each flume, all trout in one, all salmon in another, and the third had 50% species mixture. The species were rotated to another flume with each new experiment (Table 1).

The water current was kept similar in all three flumes by monitoring volume outflow of each.

The water temperature was taken daily.

The fish were anaesthetised with MS-222, then individually weighed, measured, and branded, as in Gibson (1973). All fish were introduced to a flume at the same time or special note was made of replacements for mortalities added later. At the end of an experiment the weighing and measuring was repeated. This was done in the early morning for experiment #4, #5, and #6 when the water was coldest, to reduce mortality.

The food was given twice daily, morning and evening, except for the last 12 hours of an experiment. This latter was to ensure empty stomachs, so only growth would be weighed. The food was put in the water above the upstream screen for each flume and left to drift through the flume.

Shrimp, peeled and finely chopped, was the main food given. During experiment #1 blackfly larvae were added to the flumes five times. Occasionally chopped liver was also used as a food source.

For experiments #1 and #6, 60 grams of shrimp was given per flume per day, this allows approximately 4.3 g/fish/day. The ration was the same per fish for experiments #4 and #5.

Behavioral observations were not made until the fish had settled into the new flume, usually after five days. Each experiment had 10 observations made on the two outside flumes. At the start of each observation the position of each fish was recorded. Then the displacing agonistic acts were observed, and recorded on a tape recorder for a 15 minute period. This was done a maximum of twice daily, at well separated periods. The agonistic acts recorded are those described by Gibson (1977).

Results

When food was unlimited, growth continued all summer at a similar rate till the middle of September. In experiment #6 (September 15-30), the average high water temperature was 54.9°F (s.d. 2.06°F). This is below the optimum range for trout, of 55°F - 66°F (Fry, 1951), and possibly for salmon.

At high density both species schooled, forming a dominance hierarchy. The growth in each flume followed the dominance hierarchy (Table 3). With salmon any territory formed was broken down by repeated attacks of other fish. For example, in experiment #1, Δh, a salmon, defended a territory for observations 1-5, but in observations 6-10 was part of the school in that area. Production per flume for both species was higher at the high density.

At low density the trout remained non-territorial (schooling or wandering). The growth followed the dominance hierarchy (Table 3). The salmon become very territorial at low density and the growth was

mainly in the dominant fish (Table 3). The subordinate fish showed little or no growth. Kawanabe found similar results with the "ayu" (*Plecoglossus altivelis*). At high density ayu all grew at the same rate, and production was higher, than when they were territorial, at a lower density. At low density the territorial fish grew well, but the non-territorial fish very poorly.

The distance to the nearest neighbor was further at low density for the salmon than at high density. This was not so for the trout.

The growth of the salmon seemed to be similar in the all salmon tank or the 50% mixed tank. The greater variability of the average growth rates from the mixed tanks could be due to the small sample sizes. More replications are needed before statistical analysis of the growth data and the behavior data, can be completed.

An interesting behavior related to weather was recorded twice during the summer experiments. During heavy rain all the fish grouped at the upstream screens, apparently endeavoring to migrate upriver. On one occasion this corresponded with an increased catch of both species in fyke nets set in the river.

Table 1. Particulars of each experiment.

Exp. #	Date of Experiment		# days long	# of each species/flume	Average fork length (cm.) (stan. dev.)		Temperature (°F) (stan. dev.)		Current (cm./sec.) (stan. dev.)	
	Start	Finish			Salmon	Trout	Maximum	Minimum	Front	Back
1	19/6/77	9/7/77	20	Flume #1	Alone		63.05	58.19	8.39	--
				(4)T* (6)S**	10.07	11.34	(4.39)	(4.13)	(3.14)	--
				Flume #2	(0.55)	(0.57)				
				(8)T	Mixed					
6	15/9/77	30/9/77	15	Flume #3	10.53	11.2				
				(13)S	(0.38)	(0.26)				
				Flume #1	Alone		54.88	51.75	18.03	11.15
				(6)T (8)S	13.0	13.5	(2.06)	(1.48)	(7.24)	(4.43)
4	16/8/77	31/8/77	15	Flume #2	(0.625)	(1.23)				
				(13)T	Mixed					
				Flume #2	12.5	12.4				
				(12)S	(0.753)	(0.678)				
5	1/9/77	15/9/77	14	Flume #1	Alone		63.19	59.81	12.1	6.51
				(6)T	12.43	12.92	(1.47)	(0.834)	(2.23)	(1.05)
				Flume #2	(0.22)	(0.643)				
				(4)S	Mixed					
5	1/9/77	15/9/77	14	Flume #3	12.43	12.4				
				(3)S (3)T	(0.116)	(0.46)				
				Flume #1	Alone		61.13	58.27	18.54	10.53
				(6)S	12.9	13.88	(1.81)	(1.87)	(5.57)	(3.55)
5	1/9/77	15/9/77	14	Flume #2	(0.378)	(0.769)				
				(3)S (3)T	Mixed					
				Flume #3	12.8	13.9				
				(6)T	(0.529)	(0.709)				

*T = trout

**S = salmon

Table 2. Summary of the mean distance to the nearest neighbor for trout and salmon by experiment (standard deviation in brackets).

<u>Experiment #</u>		<u>Salmon (cm)</u>	<u>Trout (cm)</u>
1	mixed	50.3 (19.2)	57.0 (15.7)
6	alone	39.4 (21.7)	- -
	mixed	28.0 (4.8)	31.0 (3.8)
4	alone	-	45.9 (21.7)
	mixed	77.1 (1.1)	69.7 (16.0)
5	alone	65.4 (17.5)	51.3 (32.8)

Table 3. Summary of growth from experiment 4.

A. TROUT

<u>Fish</u>	<u>Start Fork Length (cm.)</u>	<u>Start Weight (g.)</u>	<u>Percent Increase of F.L.</u>	<u>Percent Increase in Wt.</u>	<u>Behavior Interactions Percent Wins</u>	<u>Nearest Neighbor (cm)</u>
Lh	13.2	31.1	9.85	21.22	71.4	3.49
Lt	11.7	21.0	6.84	13.33	10.7	1.47
Td	12.9	27.5	4.65	-1.45	19.6	1.51
Tt	13.6	31.7	7.35	19.87	40	1.69
Vh	13.1	26.2	6.11	14.50	85.1	4.24
-t	13.0	29.2	7.69	8.22	27.8	2.29

B. SALMON

Δd	12.5	29.0	0.80	-6.55	-	-
td	12.3	24.0	0.81	0.42	-	-
Oh	12.7	27.7	3.15	0	-	-
Ih	12.2	23.7	9.02	22.36	-	-

C. SALMON AND TROUT

Δh	12.5	23.5	7.2	27.66	66.0	4.07
Hd	12.3	22.6	0.81	9.73	45.5	4.18
Ot	12.5	25.7	0.80	-5.05	19.2	4.08
-t	12.5	24.8	12.8	45.97	29.6	4.64
Th	12.8	27.1	14.06	42.44	83.5	3.56
Lt	11.9	23.0	10.92	35.22	17.6	2.96

Table 4. Summary of growth from experiment 6, mixed flume trout and salmon.

A. TROUT

<u>Fish</u>	<u>Start Fork Length (cm.)</u>	<u>Start Weight (g.)</u>	<u>Percent Increase of F.L.</u>	<u>Percent Increase in Wt.</u>	<u>Behavior Interactions Percent Wins</u>	<u>Nearest Neighbor (cm)</u>
11h	12.3	19.0	5.69	12.11	50.0	1.70
Th	12.0	17.5	5.00	33.14	80.6	1.45
At	12.6	18.4	4.76	32.07	69.7	1.55
11d	12.0	19.2	0.83	-10.94	12.5	1.54
It	13.6	31.4	1.47	-16.88	85.7	2.03

B. SALMON

Oh	12.8	23.5	-.78	-9.36	16.2	1.5
ot	12.0	20.3	3.33	0	0.0	1.5
Nd	12.3	19.8	6.50	30.30	11.1	1.72
tt	12.6	21.1	3.97	24.64	8.3	1.67
Id	11.0	14.3	6.36	34.97	12.5	1.85
Ad	13.1	22.7	2.29	26.43	20.0	1.08
It	13.4	25.6	2.99	22.26	58.3	1.39
Ih	12.9	21.6	2.33	24.07	47.1	1.23

Table 5. Summary of average growth/fish/experiment of the flumes with salmon only.

<u>Exp. #</u>	<u>Average †/day/fish</u>		<u>Average % †/fish/experiment</u>	
	<u>Weight (g.)</u>	<u>Fork Length (cm.)</u>	<u>Weight</u>	<u>Fork Length</u>
1	*.52	.07	84.64	13.25
6	.04	.02	1.79	2.64
4	.21	.02	16.23	3.45
5	.19	.02	10.25	2.96
[3	.26	.03	29.28	5.57]

(* on only a sample of n = 3)

Table 6. Summary of average growth/fish/experiment of the flumes with mixed species, for salmon.

<u>Exp. #</u>	<u>Average †/day/fish</u>		<u>Average % †/fish/experiment</u>	
	<u>Weight (g.)</u>	<u>Fork Length (cm.)</u>	<u>Weight</u>	<u>Fork Length</u>
1	.27	.03	46.22	6.45
6	.30	.03	19.16	3.37
4	.16	.02	10.78	2.94
5	.24	0	-11.96	0
[3	.53	.07	69.01	12.53]

Table 7. Summary of average growth/fish/experiment of the flumes with only trout.

<u>Exp. #</u>	<u>Average ↑/day/fish</u>		<u>Average % ↑/fish/experiment</u>	
	<u>Weight (g.)</u>	<u>Fork Length (cm.)</u>	<u>Weight</u>	<u>Fork Length</u>
1	.37	.05	48.15	7.60
6	.11	.02	8.80	3.28
4	.23	.06	12.62	7.05
5	.30	.07	19.63	7.31
[3	.53	.07	69.01	12.53]

Table 8. Summary of average growth/fish/experiment of the flumes with mixed species, for trout.

<u>Exp. #</u>	<u>Average ↑/day/fish</u>		<u>Average % ↑/fish/experiment</u>	
	<u>Weight (g.)</u>	<u>Fork Length (cm.)</u>	<u>Weight</u>	<u>Fork Length</u>
1	.47	.05	71.68	10.26
6	.08	.02	9.9	3.55
4	.68	.10	41.21	12.59
5	.18	.06	7.38	6.68
[3	.46	.05	62.08	10.08]

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RUNNING WATER INVERTEBRATES

Basket samplers were placed in the Matamek River at various locations from the outlet of Matamek Lake to below the second falls, and the insects collected at intervals between May and October. The invertebrates are being analyzed for taxonomic groups, numbers and biomass. The insect assemblages and quantities will be related to proximity of the lake, water velocity, and season. Fish were also collected nearby the samplers, to indicate their use of the available insects.

Basket samplers were also placed in roadside streams above and below areas where the habitat has been changed by road construction. There were changes in water temperature and substrate, and the insect communities and their amounts will be related to these changes. Recovery of the streams may be followed in succeeding years.

R. J. Gibson, F. G. Whoriskey, Jr., Jean-Yves Charette, Martha Windsor.

The No. 1 stream, caused by blasting a new outlet of a lake to drain it. Water velocity is being measured at the site of a basket sampler.

Placing a basket sampler in the Matamek River at the outlet of the lake.

No. 2 stream downstream from the culvert.

The No. 2 stream emerging from the forest, and running over an unshaded portion before entering a culvert under the new road.

The Abstract of a report from the University of Laval (Centre de Recherches sur l'eau), by Marcel Frenette, Pierre Julien, Mario Caron, André Gagnon, and Michel Caron.

Caractéristiques d'écoulement en relation avec la productivité
et la survie des salmonidés dans la rivière Matamek

Les études réalisées en 1977 avaient pour but de déterminer l'importance des conditions d'écoulement (débits extrêmes) en relation avec la productivité et la survie des salmonidés dans la rivière Matamek, en vue de prédire éventuellement l'impact de l'utilisation du territoire sur les rivières à saumon de la Côte Nord, soit par exemple: l'impact des aménagements hydro-électriques, de l'exploitation forestière, etc...

Plus précisément, l'objectif général de recherche, basé sur un programme de deux ans, vise à définir les conditions critiques d'écoulement relatives à quatre périodes distinctes:

- période de frai
- période de nutrition des juvéniles
- période de migration des juvéniles et des adultes
- période de pêche sportive

L'approche utilisée pour obtenir les conditions minimales et maximales acceptables consiste à faire les corrélations entre les données hydrologiques, hydrauliques et sédimentologiques et les données biologiques, compte tenu de l'ensemble des besoins au point de vue habitats des salmonidés.

Au cours de l'année 1977, des études statistiques des débits minima,

moyens et maxima sur une base annuelle, saisonnière et mensuelle ont été effectuées à deux stations: sortie du lac Matamek et embouchure de la rivière. La corrélation de ces données avec les données biologiques telles: 1) le départ des saumoneaux en juin; 2) la migration des saumons adultes en juillet et août; 3) la percolation dans les nids de frai en hiver; 4) la quantité de plancton sortant du lac Matamek en été, fera l'objet du programme d'étude de 1978.

Du côté hydrodynamique, l'étude consiste à faire des observations in situ de la géométrie hydraulique de la rivière (surface, profondeur, largeur, rayon hydraulique, périmètre mouillé et vitesses d'écoulement) en fonction de la variation du débit, en vue de définir les conditions critiques d'écoulement pouvant affecter les habitats des saumons et truites (adultes et juvéniles).

Cette partie de recherche, a fait l'objet d'études particulières au cours de l'été 1977, eu égard au tronçon compris entre la 2ième et la 3ième chute, mais doit être étendue à l'ensemble de la rivière, soit de l'embouchure à la sortie du lac Matamek en 1978.

The outlet of Matamek Lake. The river flows out to the left and the lake can be seen beyond the opening in the middle distance.

Nature and Fate of the Plankton in
Matamek River, Québec

Principal Investigator: J.C.H. Carter

II ABSTRACT

Zooplankton was monitored over successive 48-hour periods with fine mesh nets at the bases of five falls and one rapids on the lower Matamek River (length 9.6 km), Québec, from early June to early October, 1977. Data derived from the analyses of samples will be used to determine changes in species composition and numbers at each station on the river through the season as well as the total biomass of zooplankton carried by the river on a monthly and seasonal basis.

III BACKGROUND

Limnetic plankton in lake outflows may make an important contribution to the food supply of rivers (Cushing 1964) although the amount of plankton will normally decrease rapidly with distance from the lake (Ruttner 1956, Ward 1975). It has been found that much of the plankton is eliminated by falls and rapids (Hartman 1965), probably through force of impact against the rocks. Apparently the chances of surviving the numerous obstacles are higher in certain groups, rotifers, diatoms and blue green algae (Reif 1939). Of the crustaceans Bosmina has been known to last for relatively long distances and Hynes (1970) suggests that this may be due to its rounded shape.

Plankton is probably an important link in the food web of the Matamek River. Because of its deep colour and limited light penetration distribution of both phytoplankton and zooplankton in Lake Matamek is almost wholly confined to the uppermost waters even at mid day (Duthie unpublished data, Pope 1973) thus increasing the chances of capture by the outflow to the Matamek River. The relationship between invertebrate drift and production of salmonids in the Matamek River has been demonstrated by Gibson and Galbraith (1975). While trout and juvenile salmon in the river feed mainly upon insect larvae, the plankton originating in Lake Matamek probably comprises a significant fraction of the food of the net-spinning Trichoptera and so are of ultimate importance to the salmonids (Gibson 1973).

IV STATUS OF RESEARCH

During the summer of 1977 zooplankton samples were collected at the base of each of the five major falls on the lower Matamek River (Fig. 1). In addition samples were also taken at the base of the small rapids at the outlet of Lake Matamek while a few vertical hauls were taken within the lake itself, near the outlet. In all a total of 366 samples were collected.

Drift monitors on the reverse funnel plan were used. Each consisted of an aluminum hopper with an opening at the upstream end of 2.5 x 20 cm and an opening 20 x 20 cm at the rear. The rear end was fitted with a tapering net of nylon mesh 1.5 m long and with a pore size of 64 μ . This was thus capable of trapping even the smallest zooplankters. When clogging was suspected the depth of the opening at the upstream end was reduced to 6 cm by taping off the top and bottom areas of the opening.

One monitor was placed at the most convenient place beneath each falls (or the outlet rapids) and emptied at approximately 48-hour intervals. They were periodically moved as the water level changed. Current speed was determined at each collection with an Ott current meter. Sampling commenced early June and terminated early October.

To date the 71 samples from July at the stations beneath the five major falls have been analyzed. Zooplankters were divided into three categories: Bosmina longirostris, which comprised about 95% of all Cladocera; calanoid copepodites and adults, which comprised about 95% of all copepods, there being very few nauplii or cyclopoid copepods at this time of year; Rotifera, of which the chief were Keratella cochlearis and K. canadensis with lesser numbers of Asplanchna sp., Brachionus sp. and Trichocera multicrotus. In each case the numbers of animals were adjusted to a water velocity of 30 cm/second over 48 hours (= 259.2 m³). Dotted lines in the following figures indicate that

intervening samples were discarded.

B. longirostris shows a continuous numerical decrease from the 5th through 2nd falls, the most pronounced decline being between the 5th and 4th falls (Fig. 2). The highest numbers at most stations occurred about July 10.

Calanoid copepods had highest numbers at the 5th falls but there were also quite a few at the 4th and 3rd falls (Fig. 3). Curiously the numerical peaks at each of the upper three falls did not coincide in time. No animals were found at the 2nd falls which is understandable since the greatest distance occurs between the 3rd and 2nd falls.

The Rotifera show a curious pattern (Fig. 4). By far the greatest numbers were found at the 1st falls. The obvious explanation is that rotifers are entering the main river from sources other than Lake Matamek, and most notably from the Muskrat River, between the 2nd and 1st falls.

Fig. 1

Fig. 2

Bosmina longirostris

Fig. 3

Calanoida

Fig. 4

Rotifera

V OBJECTIVES OF PROPOSED RESEARCH

Purpose of the study is to determine the numbers of individuals per unit volume of the major taxa passing successive points during 48 hour intervals in the Matamek River as it descends 9.6 km from Lake Matamek to the Gulf of the St. Lawrence. By assigning a mean weight to each of the various taxa, and by using the data on water discharge in the Matamek River at present being worked out by Centre de recherche sur l'eau, Université Laval, it will then be possible to calculate within reasonable limits the total biomass of zooplankton passing down the river on a monthly and seasonal basis. This information will be very relevant to any future invertebrate studies on the Matamek River. To my knowledge no study of this kind has previously been carried out on a salmon river in North America.

VI PLAN OF PROPOSED RESEARCH

Sampling procedure, now completed, was outlined in IV. Project now requires only analysis of remaining zooplankton samples.

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PROGRESS REPORT ON PHYTOPLANKTON PRIMARY PRODUCTIVITY AND RELATED
RESEARCH CARRIED OUT AT MATAMEK UNDER WHOI GRANT AWARDED TO:-

Dr. H.C. Duthie,
Department of Biology,
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The principal research was conducted by Ph.D. candidate Mr. P. Ross on ultraplankton-zooplankton dynamics in Lake Matamek. The objectives of the 1977 proposal were fully met and are reported separately herein. The triple-labelling and grazing experiments are highly innovative and are producing very significant results.

Four other ancilliary projects were also carried out in the Matamek watershed. 1) Several visits were made to the upland lakes Gallienne and Randin for the purpose of monitoring phytoplankton, chlorophyll and water chemistry. These lakes have been under continuous observation since 1974 and the accumulated data will be used for detecting long term trends in the watershed and as a control against possible future perturbations in the watershed. 2) Total phosphorus samples were collected regularly in Baie Philippe and its inflowing streams. The samples have all been analysed and a phosphorus budget for the bay is nearing completion. This budget will be used to estimate the fertilization needed to achieve a 5 - 10 fold phosphorus increase in 1978. 3) Preliminary observations were begun on the biology of the two large "ponds" below the outlet of Matamek Lake. It has been suggested that the higher condition factor and pos-

sibly productivity of fish below the fifth falls is due to the generation of particulate food (for stream invertebrates) in the ponds. Primary productivity experiments were performed and plankton, chlorophyll and water samples collected by Betsy Alkenbrack. Results are incomplete. The study will be continued in 1978. 4) Six series of whole water samples collected below each of the five falls by Dr. Carter's assistant are being analysed quantitatively for algae. Preliminary results indicate a decline in algae downstream from Matamek Lake, and a maximum at all stations in spring. This work provides a link between research in the lake and the river and will be continued in 1978.

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Preliminary results of an investigation of the phytoplankton, primary production, and ultraplankton-zooplankton dynamics at Matamek Research Station in 1977.

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Ongoing measurements of biomass and production of the phytoplankton and of the role of the ultraplankton were continued. Investigations into the feeding selectivity of the zooplankton were begun.

I - PHYTOPLANKTON (including the ultraplankton)

A) SPECIES AND BIOMASS

Samples were collected at regular intervals from lakes C-22, Gallienne and Randin, and from three stations in Lake Matamek. The 1976 samples have all been counted. Table I shows the nature of the phytoplankton community for a typical mid-summer sampling date.

Over the 1976 sampling season the ultraplankton (phytoplankton smaller than 15 μm in the maximum dimension, mainly groups 4 and 6 in Table I) accounted for an average of 45% of the total phytoplankton biomass (Fig. 1). This is a very high percentage for lakes, supporting our hypothesis that the ultraplankton are especially important in oligotrophic, carbon-poor lakes such as those of the Matamek region.

B) PLANT PIGMENTS

Samples for chlorophyll analysis were collected as in 1976 (see 1976 progress report.) Analysis of the 1977 samples is not complete.

II- PRIMARY PRODUCTION

The ^{14}C -uptake experiments were performed at the three Lake Matamek stations, one in the main part of the east basin, called EB, another in the northern basin of Baie Philippe, called UBP, and a third in the southern basin of Baie Philippe, called LBP. Daily production values for the whole phytoplankton community were comparable to those of the previous year (see 1976 report).

In each experiment, the phytoplankton were separated into three size classes: those smaller than $15\ \mu\text{m}$ (the ultraplankton), those between 15 and $64\ \mu\text{m}$ in size (the larger nanoplankton), and those larger than $64\ \mu\text{m}$ (the net-plankton). As in 1976, the ultraplankton accounted for approximately 75% of the total production, and almost all of the remainder was contributed by the larger nanoplankton, with the net-plankton production being negligible.

This contribution of 75% is much greater than would be expected from the fraction of the biomass that the ultraplankton comprise (Fig. 1). This lends further support to the hypothesis that the ultraplankton are especially important as producers in lakes of the Matamek type.

III - ULTRAPLANKTON-ZOOPLANKTON DYNAMICS

A) ZOOPLANKTON

Samples were collected in weekly vertical hauls at the three Lake Matamek stations, EB, UBP and LBP. Enumeration has not been completed.

B) FEEDING SELECTIVITY OF ZOOPLANKTON

The phytoplankton were separated by screens into the same three size classes for the feeding experiments. Each size class was then grown on a different radioisotope, ^{14}C , ^3H , or ^{32}P . After labelling, the size classes were recombined and used as the food source in a

Haney grazing chamber.

In one series of experiments the zooplankton were allowed to graze for five minutes. For a typical experiment of this type, the fraction of ultraplankton in the food source of Bosmina longirostris was about 75%, (Fig.1) although they comprised only 45% of the food supplied. Thus, as with production, the ultraplankton contribute more food than expected from their biomass. This lends support to another hypothesis central to this study, that the ultraplankton provide proportionally more food to the pelagic primary consumers than do the larger size classes. However, the selectivity for ultraplankton may vary with the size of the grazer. In the calanoid copepod Diaptomus minutus the proportion of ultraplankton ingested, although greater than 70% throughout, decreases slightly in the more advanced instars (Fig. 3), suggesting that the older stages may be able to use more of the larger phytoplankton because their mouth parts are larger. (In this analysis the two larger size classes of phytoplankton are treated together, as 'larger than 15 μm ').

In another series of experiments the length of grazing time was varied from one minute to twelve minutes. Theoretically the total amount of food ingested, and thus the amount of isotope accumulated, should increase as a linear function of grazing time until the gut-passage time is reached. After this time the slope of the function should change, since some of the ingested isotope is now being excreted. During the initial period the slope would correspond to the ingestion rate, while the slope during the latter period would represent the assimilation rate and the point of inflection would be an estimate of the gut-passage time.

In B. longirostris, the ultraplankton portion of the food source seems

to fit the theoretical model (Fig. 4). A well-defined inflection exists, and both the ingestion-rate and the assimilation-rate functions are significantly linear with very high fractions of explained variance (r^2). In the larger phytoplankton, however, the inflection is still evident but the linearity of the assimilation function is questionable (Fig. 5). Although the correlation coefficient is significant, only 10% of the variance is explained. This suggests that assimilation of ingested ultraplankton may be much more efficient than that of the larger size classes, lending further support to the hypothesis that the ultraplankton are more important as a zooplankton food source than previously believed.

Further experiments are now being analyzed for other species of zooplankton grazers. In 1978 we hope to gather more data to support the two above-mentioned hypotheses, and to test a third: that eutrophication will decrease the importance of the ultraplankton. To this end, the impoundment and fertilization of LBP will begin just after ice-out.

TABLES AND FIGURES

Table I: An analysis of the phytoplankton community in the top two meters at station EB in Lake Matamek on 17/07/76. The code for the groups (second column) is: 1 - Cyanophyceae, 2 - Chlorophyceae, 3 - Euglenophyceae, 4 - Chrysophyceae, 5 - Bacillariophyceae, 6 - Cryptophyceae, and 7 - Dinophyceae.

Figure 1: The share of the ultraplankton in total phytoplankton production (solid line) and in biomass (dotted line) at station EB in Lake Matamek over the summer of 1976.

Figure 2: The share of the ultraplankton as a fraction of total phytoplankton biomass, production, and ingestion by Bosmina longirostris at station LBP in Lake Matamek on 08/07/77.

Figure 3: The share of ultraplankton (open) and larger phytoplankton (shaded) in the food ration of different instars of Diaptomus minutus at station LBP in Lake Matamek on 08/07/77.

Figure 4: The accumulation of radioactivity from labelled ultraplankton as a function of the length of grazing period for Bosmina longirostris at station LBP in Lake Matamek on 29/08/77. The Pearson product-moment correlation coefficients before and after gut-passage time are given.

Figure 5: The accumulation of radioactivity from labelled larger phytoplankton as a function of the length of grazing period for Bosmina longirostris at station LBP in Lake Matamek on 29/08/77. The Pearson product-moment correlation coefficients before and after gut-passage time are given.

EXPERIMENT 80: MATAMEK EAST 17 JULY 1976

DEPTH	GROUP	GENUS	SPECIES	CELLS L-1	MG M-3	TOT MG GROUP	GROUP %
0.0	1	MERISMOPEDIA	TENUISSIMA	0.292E7	1.148E0		
0.0	1	CHROOCOCCUS	SPECIES	0.102E5	2.564E-1		
						1.405E0	1.548
0.0	2	ANKISTRODESMUS	FALCATUS V ACICUL.	0.493E5	1.307E0		
0.0	2	GLOEOCOCCUS	GELATINOSA	0.238E5	2.523E-1		
0.0	2	SELENASTRUM	MINUTUM	0.102E5	5.407E-1		
0.0	2	ARTHRODESMUS	INCUS	0.340E4	5.222E0		
0.0	2	SCHIZOCLAMYS	COMPACTA	0.680E4	3.338E-1		
0.0	2	STAUSTRUM	MEGACANTHUM	0.170E4	3.560E0		
0.0	2	ANKISTRODESMUS	FALCATUS V MIRABIL.	0.170E4	3.204E-1		
0.0	2	CHLAMYDOMONAS	GLOEOPARA	0.136E5	1.495E1		
0.0	2	KIRCHNERIELLA	OBESA	0.680E4	3.560E-2		
0.0	2	SCENEDESMUS	BIJUGA V IRREGULAR.	0.136E5	1.282E-1		
						2.665E1	29.38
0.0	4	MALLOMONAS	PUMILLO	0.340E4	9.647E0		
0.0	4	DINOBYRON	SPECIES A	0.510E4	1.009E0		
0.0	4	MALLOMONAS	SPECIES B	0.510E4	5.007E-1		
0.0	4	DINOBYRON	DIVERGENS	0.680E4	1.346E0		
0.0	4	MALLOMONAS	ACAROIDES	0.170E4	3.076E0		
0.0	4	DINOBYRON	CAMPANULOSTIPITUM	0.170E4	1.923E-1		
0.0	4	MALLOMONAS	SPECIES A	0.170E4	8.412E-2		
0.0	4	CHROMULINA	SPECIES A	0.116E6	1.226E0		
0.0	4	CHROMULINA	SPECIES B	0.408E5	2.003E0		
0.0	4	OCHROMONAS	SPECIES A	0.204E5	1.730E0		
0.0	4	CHRYSOPLYKOS	SKUJAI	0.680E4	4.673E-1		
0.0	4	CHRYSOCHROMULINA	PARVA	0.680E4	9.613E-2		
0.0	4	PSEUDOKEPHYRION	OBLIQUUM	0.340E5	1.068E0		
0.0	4	PSEUDOKEPHYRION	CONICUM	0.680E4	9.613E-2		
						2.254E1	24.85
0.0	5	RHIZOSOLENIA	ERIENSIS	0.248E6	2.105E1		
0.0	5	SYNEDRA	ACUS V RADIANS	0.510E4	1.410E0		
0.0	5	ASTERIONELLA	FORMOSA	0.340E4	8.225E-1		
0.0	5	TABELLARIA	FENESTRATA	0.170E4	2.611E0		
0.0	5	MELOSIRA	ISLANDICA	0.170E4	8.545E-1		
						2.675E1	29.49
0.0	6	CRYPTOMONAS	PYRENOIDIFERA	0.170E4	5.561E-1		
0.0	6	CRYPTOMONAS	OVATA	0.170E4	6.409E0		
0.0	6	RHODOMONAS	MINUTA	0.272E5	4.614E0		
0.0	6	KATABLEPHARIS	OVALIS	0.408E5	1.794E0		
						1.337E1	14.74

TOTAL MG THIS DEPTH= 9.0726E1
TOTAL CELLS PER LITRE= 3.6533E6

TABLE 1

(Groups: 1=Cyanophyceae; 2= Chlorophyceae; 4= Chrysophyceae; 5= Bacillariophyceae;
6=Cryptophyceae)

Ultraplankton share in: biomass---X---
production—o—

Fig. 1

ULTRAPLANKTON SHARE IN:

1.00

0.75

0.50

0.25

0

biomass production B. long.
food of

Fig. 2

Diaptomus minutus shaded: cells > 15 μ m
 open: cells < 15 μ m

N1 - N3 N4 - N6 C1 - C3

fraction of food ration

1.00—
 0.75—
 0.50—
 0.25—

Bosmina longirostris

cells < 15 μ m

Fig. 4

Fig. 5

IV. PROGRESS REPORT ON ZOOBENTHIC STUDIES AT LAKE MATAMEK

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M.E. Alkenbrach, and N. Hague

Macrobenthos sampling

During 1977, quantitative seasonal data was gathered for evaluating population dynamics of benthic organisms and estimating macrobenthic standing stocks in the west basin of Lake Matamek. To obtain such information, eight primary sampling stations were established, based on differences in the fauna, as indicated by the pilot survey of 1976. As illustrated in Figure 1 (p. 9), sampling was concentrated largely in the profundal, including three deep stations (one at 95m in the basin bottom, one at 70m on the mud slopes, and another in a depression at 40m) and four shallow ones (including individual stations in the inlet region, outlet zone, sheltered east side, and wind-exposed east side).

At each of these stations, and one in the littoral, four tall (15cm x 15cm x 22.5cm) Ekman grab samples were collected, at six intervals from May to October. In addition, the two deep depression communities (stations 6 and 8) were sampled through the ice, once in January and again in March of last year.

A transect of shallow stations (A - E, Figure 1) was also established to represent the littoral and sublittoral areas of the basin. These stations were sampled three times during the May through October period. During the same time, ancillary benthic samples were also collected from individual stations in the upper and lower basins of Baie Phillippe, and in two of the ponds connecting the Matamek River below the lake outlet, in conjunction with ongoing primary production in these areas (Ross and Duthie, this report).

FIGURE 1 - BATHYMETRIC REGIONS OF MATAMEK LAKE SHOWING LOCATION OF BENTHIC SAMPLING STATIONS

Some slightly different procedures were adopted for processing benthic samples in 1977 than in the previous year. Use of a fine (200 μ) mesh in sieving was continued, but the problem of clogging, due to the fine detrital nature of the sediments, was solved by utilising a new sieve design. The standard benthic pail sieve (Fremling, 1961) was modified by replacing the flat metal screening with a special nylon mesh bag (of the same mesh size, about one foot in depth, and sewn with canvas seams and a wide canvas rim, the latter of which was made to fit tightly around, and was bolted to, the pail base). Because of the greater surface area and flexibility of the mesh, sieving with this device (as compared to the standard one): reduced sieving time from about one half-hour to five minutes per grab sample; facilitated an easier transfer of sediments during processing; and resulted in considerably less fragmentation of soft-bodied organisms, such as the Oligochaeta.

Installation of a pump to deliver water from Matamek Lake to the lake 'laboratory' allowed further processing of samples in the field this summer. As a result, sucrose floatations could be conducted on live benthic samples, ensuring a greater efficiency of organism removal (Kajak, Dusoge, and Prejs, 1968). Three floatation were done on each sample, following the procedure recommended by Anderson (1959). The efficiency of the floatation technique was evaluated by sorting, under low stereoscope power, the unfloated sediments, as well as the floated portion, of one sample from each station. In all cases, at least 80 percent of the organisms were recovered in the floated portion, and in most samples, efficiency was greater than 90 percent.

Immediately following floatation, both floated and unfloated fractions were preserved in five percent, neutral formalin, prepared from filtered habitat water; rose bengal stain was added to enable easier recognition of organisms from the debris (Williams and Williams, 1974). The unfloated portion

was later sorted in white enamel pans for Pisidium and case-dwelling Trichoptera, since these were not successfully recovered by the floatation technique. In between sampling periods, floated samples were transported to Matamek Station, via the weekly supply plane, for later sorting under 6x stereoscope power. Organisms were counted upon removal and placed in vials for later weighing and identification. After at least three months preservation in formalin, a wet weight of the total fauna in each sample was measured, using a centrifuge technique.

Because of the highly organic nature of the bottom deposits, floated fractions were relatively large (as much as one liter per grab), and consequently, much of the past year has been spent separating animals from debris. Presently, the organisms from all but the August and September samples have been picked out, partially identified, counted and weighed.

Table 1 (p. 12) contains a general summary of the findings thus far. For this purpose, stations have been grouped into various zones according to depth, except for the inlet and outlet stations, which have been treated separately because of their elevated productivities. Average standing stocks (numbers and biomass) for each zone were estimated by averaging the data from stations within each zone, with respect to samples collected in January and March (stations 6 and 8 only), and during May, July and September (all stations). By weighting these values for the proportion of basin area in each zone (determined by planimetry), average macrobenthic densities for the basin were estimated to be in the area of 2800 organisms/m² and 26 kg/ha.

In comparison to benthic standing stocks of other oligotrophic lakes in the literature (reviewed by Johnson, in Brinkhurst, 1974), these estimates appear to be high with respect to numbers, but low relative to biomass. These somewhat anomalous conditions are probably an artifact of greater underesti-

Table 1 - Distribution of zoobenthos relative to different zones in Lake Matamek

Zone	Depth (m)	% of lake area	Characteristic organisms	Relative Abundance in % of numbers	Average standing stock estimates	
					no./m ²	kg/ha
Littoral	0-3	5	high diversity; largely aquatic insects	Chironomidae - 50 Oligochaeta - 25 Nematoda - 20	12286	47.5
Sublittoral	3-10	10	<u>Pisidium</u> <u>Sialis</u> <u>Chaoborus</u> Ceratopogonidae	Chironomidae - 60 Oligochaeta - 10 Nematoda - 5 Ostracoda - 5 <u>Pisidium</u> - 5	8570	60.5
Shallow Profundal	10-40	27.5	<u>Chironomus</u> <u>Tubificidae</u> Ostracoda	Chironomidae - 45 Oligochaeta - 15 Nematoda - 20 Ostracoda - 15	1925	18.4
Deep Profundal	40-100	55	low diversity; <u>Tubificidae</u> <u>Chironomus</u>	Chironomidae - 20 Oligochaeta - 75	1367	17.7
Inlets	10-30	2	<u>Chironomus</u> <u>Tubificidae</u> Ostracoda	Chironomidae - 40 Oligochaeta - 25 Nematoda - 10 Ostracoda - 25	4447	100.
Outlet	10-30	0.5	<u>Chironomus</u>	Chironomidae - 85 Oligochaeta - 5 Nematoda - 5	2794	145.
Total mean standing stock estimates (weighted for area in each zone)					2855	25.9

mation of numbers in earlier studies, due to the use of coarse meshes in sieving. This is illustrated by Haedrich's earlier work on the Lake Matamek benthos, in which, using a coarser sieve mesh (1mm), he found numerical faunal densities to be about one-tenth of our estimates. On the other hand, the low benthic biomass estimate for Lake Matamek (relative to those for most other lakes studied) should reflect some real differences, and provides further evidence of the low productivity of lakes in the Matamek system.

Distribution of numbers and biomass with respect to time followed patterns more or less typical of the benthos of northern lakes. On the average, numbers increased with the recruitment of new broods across the summer, from a low in late spring to a high in the fall; biomass decreased from a maximum in late spring to a midsummer minimum (following the spring and early summer emergence pulse), and peaked again in the autumn (Figure 2, p. 14). Standing stocks were found to be highly variable spatially, as well, even within given stations or areas, as illustrated by the wide confidence intervals for biomass estimates plotted in Figure 3 (p. 15).

Presumably, much of this variation should be related to the unequal distribution of food materials in the benthos. Not surprisingly, the highest benthic biomass densities within the lake occurred in the inlet and outlet regions (Figure 4, p. 16), where food conditions would be more favorable. This was particularly evident in the inlet area, where dense packets of detrital leaf material were found to support high standing stocks of Tubificidae, Ostracoda and Chironomus.

A quite different situation was found in the outlet region. Unusually dense aggregations of Chironomus (4th instar larvae and pupae) were supported here in the spring (averaging over $7000/m^2$ in numbers and 400 kg/ha in biomass); but, following emergence, standing stocks remained low throughout the

Figure 2 - Temporal changes in average zoobenthic standing stocks in the west basin of Matamek Lake during the summer of 1977

FIGURE 3 - TEMPORAL CHANGES IN ZOOBENTHIC BIOMASS ESTIMATES FOR SELECTED STATIONS IN MATAMEK LAKE

● - mean of four replicate Ekman grab samples

I - 95% confidence limits for estimates - derived from log transformed data.

Figure 4 - Temporal changes in mean zoobenthic biomass of samples from the inlet and outlet areas of Matamek Lake, during the summer of 1977

summer. Although many questions remain to be answered (e.g. how, when, and why the chironomids come to clump there), it would be surprising if this phenomenon were not related to favorable trophic conditions in this area. Furthermore, it is likely that the outlet benthic fauna, in contrast to the inlet zoobenthos, is nourished largely on autochthonously-derived organic matter, as planktonic production is enhanced by upwelling in this region.

On the other hand, extremely low benthic standing stocks in the deep profundal slopes probably reflects poor food conditions, perhaps as a consequence of the movement of benthic materials down the slopes. Macrozoobenthic standing stocks in these areas averaged less than 200 organisms/m² and 7 kg/ha, in contrast to profundal basin-bottom communities, where faunal densities were nearly five times as high (Figure 3, p. 15). Differences were particularly evident in the Tubificidae, which dominated the basin-bottom communities, but were scarce or absent from the slope samples.

Hopefully, some of the conditions contributing to such differences will be elucidated by analyses of sediments from these areas, as proposed in Section VI.

Ancillary research

Prior to field-sieving, microbenthos samples were collected off the top of undisturbed grab samples (three samples from each of two grabs per station on each sampling date) with a 10cc plastic syringe, as described in Edmondson and Winberg (1971). Samples were transferred directly from syringes into vials containing five percent formalin, for later sorting under 100x stereoscope power, in the manner described by Stanczykowska (1966).

Dissolved oxygen concentrations at the mud-water interface were also measured prior to field sieving, at each station, during each sampling interval. Measurements were made with a YSI oxygen meter, by stirring the probe in the interstitial water at the top of each grab, until a maximum reading was obtained. Though crude, such measurements revealed that oxygen was not lacking near the bottom throughout the summer (no less than 50% saturation was observed). The temperature of the mud was also measured in samples throughout the program.

Emergence traps were placed at various stations and tended daily during the summer. Eight funnel traps of plexiglass (similar to ones described by Mundie, in Edmondson and Winberg, 1971) were submerged in the deep profundal and sublittoral, while floating box traps (design of Morgan, in Edmondson and Winberg, 1971) were used in the littoral. Although the traps collected emerging adult insects and their pupal exuviae fairly well, the fauna was too sparse to allow quantitative estimation of emergence in any lake area. However, the specimens collected, particularly the chironomids, will be useful in species identifications and for evaluating life histories of benthic organisms.

V. OBJECTIVES OF PROPOSED RESEARCH

The objectives of the zoobenthos research program are summarised in the following points:

- 1) To provide a taxonomic and ecological description of the Lake Matamek zoobenthos (i.e. the species present, their distributions, relative abundances and life histories, the community structure, etc.), and thus provide the first such information on the benthic biota of North Shore lakes.
- 2) To estimate standing stocks (numbers and biomass) of zoobenthos in the west basin and relate this to the productivity of other trophic levels in the lake.
- 3) To evaluate the above aspects of the Lake Matamek zoobenthos with respect to some general properties of lakes in this region, particularly the humic influence, and compare these aspects with lakes of varying features elsewhere in the world.
- 4) To examine local factors (content of bottom deposits, depth, wind exposure, temperature, etc.) contributing to spatial and temporal variability in the composition and productivity of benthic communities within the lake.

VI. PLAN OF PROPOSED RESEARCH

The study program for 1978 is essentially directed toward completion of the survey work outlined last year, culminating in a final report, in the form of an M.Sc. Thesis, analysing the information gathered during the two years of benthic research at Lake Matamek.

Most of this year will be spent finishing the lab work generated by the 1977 sampling program. At the present time, the organisms from about two-thirds of the nearly 500 grab samples collected have been sorted, counted and weighed. In addition to the remaining grab samples, over 500 microbenthos samples (see Section IV.) remain to be processed.

Taxonomic examination of these organisms, particularly the chironomids, is also to be completed. Most of the chironomids sorted from the bottom samples will be slide-mounted for identification to genera. Identification of some chironomids to species may be facilitated by several means, including: examination of adults collected from emergence traps, rearing samples and light traps; a visit to Dr. D.R. Oliver's lab in Ottawa to verify identifications; and from results of karyotypic analyses of Chironomus larvae sent to Dr. J.E. Sublette at New Mexico State.

Other benthic organisms (mainly the Nematoda, Oligochaeta, Pisidium, Copepoda, Cladocera and Ostracoda) also need to be further identified (to species where possible).

Due to the large amount of lab work remaining, a considerably less extensive sampling program is planned for 1978. All field work would be conducted during a brief (two to three week) period in the spring (immediately following the ice melt). At this time, sampling efforts will be focused on several areas, as described below.

Firstly, a set of samples would be collected from the same stations utilised in 1977, so that, along with a series of samples collected this winter (during February) and those prior to it, two full years of data would be available for analysis of life histories and examination of temporal variation in faunal distribution and standing stocks.

Also during this time, a more thorough survey (more samples collected over a larger area) of the lake outlet zoobenthos would be undertaken, to obtain more information on the unusually high densities of Chironomus in this area, as observed from last spring's collections. More extensive sampling in the deep profundal is also planned to better assess differences between slope and basin-bottom benthic communities (see Section IV.).

If time permits, profundal sediment samples would also be analysed for factors contributing to such variability. This would involve investigations into the quality and quantity of detrital food material in the sediments, including: analysis of variation in the amounts of soft (degradable) plant material (mostly leaf tissue) in sediments of different areas in the lake; identification of specific detrital components (using a microscope); and measurement of the protein content of sediments by the Kaushik method (Kaushik and Hynes, 1971). The latter data should provide an indication of the microbial activity in the profundal detritus, which, in view of the low pH, high carbon content and low benthic standing stocks in the sediments, we would expect to be relatively poor. Although some microbiological research would be useful here (e.g. estimates of bacterial and fungal standing stocks and decomposition rates), the above information, along with the geochemical data of Ouellet (1976), should help to characterise the Lake Matamek sediments as a habitat and food source for the benthos, and thus provide a basis for comparison with conditions in the benthos of other lakes in the literature.

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VERIFICATIONS DES TRAVAUX ANTERIEURS
D'HYDROMORPHOLOGIE SUR LA RIVIERE
MATAMEK

Par

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1. INTRODUCTION

La recherche de travaux dans le domaine des caractéristiques physiques des rivières à saumon et de la détermination du potentiel de frayères nous a permis d'entrer en contact avec diverses recherches additionnelles tant sur la côte atlantique que sur la côte pacifique.

Quelques travaux de la côte du Pacifique ont montré que nous étions sur la bonne voie. Par exemple WALTERS (1977, p. 261) nous expose:

"A key feature of almost all fisheries management situation is uncertainty. Rarely do we see decision or plans whose consequences can be predicted with great accuracy; even after allowing for essentially unpredicted effects of random environmental factors, we often find that the average response remains uncertain due to lack of understanding about basic functional mechanisms and interactions."

A partir de cet état de fait, de 1973 à 1975 ont été tenues une série d'ateliers de travail en Colombie-Britannique et on en est arrivé à une procédure en quatre étapes aboutissant à des projets de restauration artificielle. La première étape recommandée est tout simplement un levé des sites potentiels de développement. Dans la même ligne de pensée CHAMBERLIN (1977) présente une proposition de cartographie des caractéristiques des cours d'eau au 1:50,000: type de poissons, hydrologie, morphologie, sédiments, pentes, végétation et climat. Assez fortuitement il propose lui aussi une classification biophysique multiscalaire selon les niveaux de perception désirés. De plus, Pêches et Environnement Canada a accordé en 1975 un contrat à la Pacific Salmon Society de Vancouver pour "Inventory of potential spawning habitats in the Pender Harbour area." Ce type de projet est exactement ce que nous préconisons pour la

côte de l'Atlantique. En dernier lieu, un autre contrat de Pêches et Environnement Canada a été passé avec la Pacific Survey Corporation de Vancouver pour "Aerial survey of herring spawning areas to obtain high resolution colour and infrared photographs of herring spawning substrate for the purpose of mapping." C'est exactement ce type d'approche par télédétection que nous préconisons pour le saumon.

Sur la côte ouest de l'Atlantique aucun travail semblable n'a été entrepris à notre connaissance sauf le nôtre (DUBOIS & CLAVET, 1977a). Ce type de levés intéresse cependant le Ministère du Tourisme, de la Chasse et de la Pêche du Québec (POMERLEAU, 1977), c'est la raison pour laquelle nous avons accepté de révéifier la méthode sur la rivière Saint-Jean en Gaspésie (DUBOIS & CLAVET, 1977b). Sur la côte est de l'Atlantique MILLS (1973) a utilisé la méthode d'inventaire de HERRINGTON & DUNHAM (1967) pour les tributaires de la rivière Tweed en Ecosse. Cette méthode de terrain comprend moins de paramètres que la nôtre et est basée sur des levés de 10m de longueur à tous les 200m.

Le présent rapport comprend deux sections:

- 1) vérification des paramètres hydromorphologiques, 2) vérifications sur le bassin de la rivière Matamek.

2. VERIFICATION DES PARAMETRES HYDROMORPHOLOGIQUES

2.1 Paramètres reliés aux berges

Les paramètres semblent adéquats sauf dans le cas de la végétation où il faudrait ajouter un pourcentage de recouvrement des couronnes d'arbres selon CHAMBERLIN (1977) et MILLS (1973). L'ombrage favorise des eaux plus fraîches. CHAMBERLIN (1977) propose aussi de localiser préci-

sément tout tributaire et nous proposons même d'ajouter les sources; il propose aussi d'indiquer la hauteur des obstacles.

2.2 Paramètres reliés au lit

Selon MILLS (1973) la largeur n'a aucune importance au-delà d'un minimum de 3m; nous avons déjà prévu cette limite. CHAMBERLIN (1977) propose de localiser la présence de débris végétaux qui peuvent changer les caractéristiques du lit. Des exemples courants sont les arbres à demi-déracinés sur les berges d'érosion et les embâcles d'arbres. CHAMBERLIN (1977), MILLS (1973) et OUELLET (1977) attachent une importance à la pente du profil en long du cours d'eau. MILLS (1973) nous dit que la pente ne doit pas dépasser 3% et OUELLET (1977) nous donne comme exemple de pentes douces les pentes de 0.14 à 0.3% des rivières d'Anticosti.

La plupart des chercheurs définissent leurs limites de classes de sédiments; les nôtres sont:

- Argile-silts (0-2 μ et 2-50 μ)
- Sable (50 μ - 2mm)
- Gravier (2mm - 10cm)
- Galets-blocs (>10cm)

ANDREWS & GEEN (1960) ainsi que BURNER (1951) font remarquer que la dimension des sédiments est fonction de la taille des femelles. BURNER (1951) insiste sur le fait qu'il ne doit pas y avoir plus de 10% d'argile et de silts. MILLS (1973) a remarqué en Ecosse qu'il y avait une relation étroite entre la présence de silts et l'absence de moustiques. POMERLEAU (1977) va jusqu'à dire qu'à Anticosti la production d'un cours d'eau en moustiques est plus importante plus la granulométrie des sédiments est grossière. Ces larves de moustiques sont généralement la nourriture des tacons.

Fait curieux, personne ne semble accorder d'importance à la végétation aquatique...

Enfin, nous devons à l'avenir indiquer les limites d'estuaires (influence des marées) aux basses et hautes eaux. OUELLET (1977) touche à ce problème à Anticosti où, parfois, des estuaires trop petits (largeur, longueur ou profondeur) créent des difficultés de séjour pour le saumon qui cherche à s'adapter lentement aux changements de type d'eau en montant ou en descendant. De plus, le saumon ne fraie jamais dans les estuaires.

2.3 Les paramètres hydrologiques et physico-chimiques

Les paramètres qui suivent semblent être les plus importants mais peu d'entre eux sont pertinents lorsque les levés sont faits en dehors du temps de migration et de frai. L'exemple typique est la vitesse de l'eau et le débit qui varient beaucoup. ANDREWS & GEEN (1960) et OUELLET (1977) reconnaissant que la migration est souvent liée au débit surtout sur les cours d'eau peu profonds. Même si elle varie moins la température de l'eau est une donnée essentielle. BURNER (1951) mentionne que le saumon du Pacifique ne fraie qu'entre 40°F et 62°F. ANDREWS & GEEN (1960) mentionnent entre 59°F et 68°F pour la migration et entre 40°F et 62°F pour le frai avec une moyenne idéale à 50°F. Les conditions climatiques exercent un effet considérable dans trois cas. Dans les deux premiers cas liés aux débits d'étiage, la température de l'eau s'accroît plus que la normale dans les eaux "résiduelles" ou peu profondes. D'une façon générale, plus la température de l'eau est élevée, plus la consommation d'énergie du poisson est grande et donc plus grands sont la mortalité et le parasitisme (ANDREWS & GEEN, 1960). Les grandes sections de rivières directement sur le substratum rocheux sont un cas semblable où, en plus, il n'y a pas de nourriture pour les tacons (OUELLET, 1977). Le troisième cas est lié à la présence de lacs sur le cours d'eau. SCHIEFER (1972) fait remarquer que cette présence est bénéfique en général (autre dans les cas précédents) puisque la saison de croissance

est allongée. En effet, les eaux superficielles des lacs se réchauffent plus vite que dans les cours d'eau et donc ces eaux sont plus chaudes de bonne heure au printemps et plus tard l'automne. Comme la rivière draine les eaux chaudes de surface cette constatation prévaut aussi pour cette dernière. OUELLET (1977) fait remarquer la limpidité de l'eau à Anticosti contrairement à la Côte-Nord. Dans notre rapport sur la rivière Saint-Jean en Gaspésie nous faisons remarquer que cette transparence est parfois un handicap pour la photo-interprétation des fosses peu profondes. Dans son rapport, OUELLET (1977) mentionne des estimés ou des mesures de pH, de conductivité, de couleur et de contenu en minéraux de l'eau. MILLS (1973) ne se sert que du pH et de l'alkalinité en Ecosse. Il a remarqué que le pH se situe entre 7.3 et 8.8 tandis que l'alkalinité se situe en 14 et 206 ppm. ANDREWS & GEEN (1960) en Colombie-Britannique remarquent que le pH et le contenu en oxygène ne semblent avoir aucune influence sur les migrations du sockeye à condition qu'il y ait au moins 5ppm d'oxygène. Ils rapportent que le saumon est plus sensible au contenu en dioxyde de carbone comme la plupart des poissons. Il semblerait même que les oeufs pourraient vivre quelques jours à l'air libre; est-ce vrai à tous les stades?

2.4 Zones favorables au frai du saumon

Nous retenons la suggestion de CLAY (1961) qui mentionne toujours la longueur et la superficie approximatives des frayères.

3. VERIFICATION SUR LE BASSIN DE LA RIVIERE MATAMEK

3.1 Buts des travaux

Ces travaux avaient pour but de vérifier dans le détail les sites potentiels de frayères levés pendant les étés 1975 et 1976 (DUBOIS et CLAVET, 1977a), alors que nous faisions en même temps la cartographie géomorphologique

du bassin et alors que nos recherches ne nous avaient pas encore permis de déterminer tous les paramètres hydromorphologiques. Entre autre, il fallait vérifier si certains sites n'étaient pas colmatés par des silts et si l'épaisseur de matériaux favorables était suffisante. Ces vérifications devaient servir à établir une fois pour toute le degré de confiance de notre méthode de photo-interprétation avec un minimum de travaux de terrain versus l'expertise de sites.

3.2 Difficultés

Nos bonnes intentions se sont butées à un manque de fonds dès le départ, ce qui ne nous a permis d'aller sur le terrain qu'en juillet grâce à un fond de dépannage de l'Université de Sherbrooke.

Malheureusement à ce moment-là les rivières sont en étiage et, n'ayant pu nous servir d'un petit zodiac (comme par les années passées) puisqu'il était déjà affecté à une autre équipe, nous n'avons pu que visiter à pied le 1er site de la rivière aux Rats-Musqués, le site du ruisseau du lac Thom et les 3 sites de la basse rivière Matamek.

Par la suite Serge Tremblay devait demeurer à Matamek et nous faire signe lorsque la rivière serait de nouveau navigable suite à une hausse prévue des eaux. Il devait pendant ce temps faire des recherches bibliographiques à la station de Matamek et s'initier à l'expertise de frayères sur la basse Matamek avec l'accord du chargé de projet de CENTREAU, Pierre Julien.

Ces travaux n'ont pu être menés à bien à cause d'une série de situations malheureuses qui n'ont pas permis que Serge Tremblay continue les travaux à Matamek. Daniel Clavet a tout de même été autorisé à faire quelques vérifications vers la fin de l'été, mais sans zodiac, c'est ainsi

qu'il a réussi à visiter les deux premiers sites de la haute Matamek.

Le résultat de tout ceci est une perte d'énergie, de temps et d'argent qui ne s'est soldée que par la visite de 7 sites potentiels de frayères sur une possibilité de 15.

3.3 Résultats

Sur les 7 sites potentiels visités, 2 seulement ne sont pas favorables; ce sont ceux du ruisseau du lac Thom et le 1er site de la rivière aux Rats-Musqués. Le premier n'est pas favorable à cause de l'étroitesse de l'embouchure qui est en plus envahie par les aulnes et le deuxième à cause de la présence de beaucoup de sable et de son colmatage par des silts tel que prévu dans DUBOIS et CLAVET (1977a).

Les 5 autres sites sont identiques à notre première interprétation, il n'y a aucune présence de silts et l'épaisseur de matériaux favorables (gravier, galets et sable) est suffisante.

En conclusion, 71% des sites visités correspondent aux normes.

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SEASONAL VARIATION IN THE ABUNDANCE OF
ESTUARINE FISHES
IN THE MATAMEK RIVER
ESTUARY, QUEBEC

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Seining in the Matamek estuary.

Counting fish from a seine haul in the Matamek estuary.

An estuary is a body of water in which river water mixes with and measurably dilutes sea water (Reid 1961), it is a changing environment affected to varying degrees by both the salt and fresh water bodies. This results in a seasonally changing fish population, which has been noted in a few eastern North American estuaries (Dahlberg and Odum 1970; Hoff and Ibara 1977; Haedrich and Haedrich 1974; McErlean, O'Connor, Mihursky, and Gibson 1973; Pearcy and Richards 1962). Seasonal variation has been found to be significant over one season, but the variation was not significantly similar in following years. Although estuaries support the largest fish stocks (Haedrich and Hall 1976), the tributaries of the Gulf of St. Lawrence remain undocumented. This report describes experiments conducted June through September 1977 in the Matamek River estuary (Fig. 1), to document changes in the fish species present.

Seine hauls were conducted in four pools (Fig. 1) using a 30.5 m (6.35 mm square measure mesh) beach seine, at high tides only. The two inner pools (1A and 1B) are influenced by the river (surface salinity zero). The outer pools (2 and 3) are open to the Gulf of St. Lawrence (increased salinity, lower temperature, and greater wave action than the inner pools). After each haul the fish were counted by species and a representative sample of each species was taken. Species were identified using Leim and Scott (1966). The fish in the sample were weighed and measured (fork length), sex and maturity recorded, stomach fullness and contents observed, and key scales taken.

Only four fish species were present May through September (Table 1). The fish were divided into areas of habitation as set forth by Pearcy and Richards (1962), showing the greater number of outer estuary species. From the data, seven sampling days (Table 2) were chosen for statistical analysis. All recent studies (Dahlberg and Odum 1970; Hoff and Ibara 1977; Haedrich and Haedrich 1974; McErlean, O'Connor, Mihursky, and Gibson 1973) use the Shannon-Weiner Index of Diversity. As the exact number of species present (Pielou 1969) and the number of each are unknown, we must use the following form of the index ($\bar{H}$) (Pielou 1966a and 1966b).

$$\bar{H} = - \sum_{i=1}^S P_i \log P_i$$

where

P_i = proportion of individuals in the i^{th} species

S = number of species caught

Species richness (D) (Margalef 1969) and species evenness (J) (Pielou 1966a) were calculated as species diversity ($\bar{H}$) confounds these two factors.

$$D = (S - 1)/\log N$$

where: S = number of species caught

N = number of individuals caught (total)

$$J = \bar{H}/\log S$$

where $\bar{H}$ = the estimator of the Shannon - Weiner Function

S = the number of species caught

Percent similarity depicts the changes between the individual samples (Whittaker and Fairbanks 1958).

$$PS = 100 (1.0 - 0.5 \sum_{i=1}^S |P_{ia} - P_{ib}|)$$

where: P_{ia} = the percentage of species "i" in sample "a"

P_{ib} = the percentage of species "i" in sample "b"

S = the number of species caught

All the logs used in the calculations were natural logs ($\log_e$).

The variation between samples was significant (≤ 0.05) for pools 2 and 3 (this strong seasonal variation is depicted in Figure 2), but less significant for pools 1A and 1B. The greatest correlation with the species diversity ($\bar{H}$) in pools 2 and 3 was species evenness (J) ($r_{\bar{H}} = 0.961$), species richness was also significantly correlated ($r_{\bar{H}} = 0.855$) (Table 2). This suggests large numbers of different species were caught in successive sampling periods (eg. salmon smolts in the spring or sea trout in the fall). The percent similarity (PS) stresses the differences between the samples (Table 2) (pools 2 and 3, samples 2 and 3, PS = 22.1%, the low similarity is due to the capture of spawning three spine sticklebacks, blackspotted sticklebacks, and the migrating smolts). The correlations calculated for pools 1A and 1B were not as significant (the most significant was species richness (D) ($r_{\bar{H}} = 0.778$)).

From the literature, the controlling factor of seasonal variation in fish populations is the water temperature (Dahlberg and Odum 1970; Norden 1966; Recksiek and McCleave 1973; Targett and McCleave 1974). A secondary controlling factor is the salinity in the estuary (Gunter 1938; Hoff and Ibara 1977).

Latitudinal gradients have been documented for many other taxocenes (Krebs 1972). There are 16 fish species present in the Matamek River estuary (May through September), which is comparable to other northern estuaries. The Colville River, which drains into the Arctic Ocean, has 20 species present of which 10 are definitely present in the estuary (Kogl and Schell 1975). The Cambell River, on Vancouver Island, has 29 species in or near the estuary (not all are estuary species) (Bell and Thompson 1977). These estuaries are not as rich as southern estuaries; Massachusetts, 54 species in the Slocum River (Hoff and Ibara 1977), Connecticut, 59 species in the Mystic River (Pearcy and Richards 1962), Georgia, 70 species in the Sapelo and St. Catherines Sounds (Dahlberg and Odum 1970), Louisiana, 84 species in Vermilion Bay (Gunter 1938). Pianka (1966) decided that the observed variation was best explained by a combination of the theories (time, predation, climatic stability, spacial heterogeneity, competition, and productivity).

Although this is only a limited study on an unexploited estuary, it does point out that our estuaries should be protected and managed carefully. Many of the migrant species using the estuary nursery are important as marine commercial species, fluvial sport species, or food

for those species. To effectively manage these areas will involve more intensive studies to assess populations and possible levels of exploitation. This should take the form of following species diversity indices ($\bar{H}$, J, and D) throughout several years.

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Table 1. Occurrence of fish species by region of the estuary. (+ - species present May through September)

Inner estuary only

+ *Salmo salar* (parr)
Pungitius pungitius
Anguilla rostrata
Catastomus catastomus
Alosa pseudoharengus

Mainly inner estuary

Salmo salar (smolts)

Outer estuary only

+ *Ammodytes americanus*
Osmerus mordax
Clupea harengus harengus

Mainly outer estuary

+ *Gasterosteus aculeatus*
+ *Microgadus tomcod*
Gasterosteus wheatlandi
Salvelinus fontinalis
Liopsetta putnami
Pseudopleuronectes americanus

Outer extent of estuary

Mallotus villosus
Cyclopterus lumpus (seen another year)

Table 2. Species diversity index (H), with contributing factors.

TABLE 2A. Pools 2 and 3.

SEINE HAUL #	DATE	TIME	$\bar{H}$	P.S*	S*	N*	J*	D*
1	20/VI	5:00	0.62		3	136	0.56	0.41
				75.85				
2	20/VI	17:00	0.91		8	409	0.44	1.16
				22.10				
3	24/VI	19:00	1.63		7	33	0.84	1.72
				60.85				
4	5/VII	17:30	1.49		6	13	0.83	1.95
				7.84				
5	19/VII	16:00	0.02		3	2104	0.01	0.26
				96.37				
6	2/VII	16:00	0.21		4	208	0.15	0.56
				14.98				
7	27/VII	13:00	1.37		5	119	0.85	0.84
	$r_{\bar{H}}$				.684	-.67	.961	.855

TABLE 2B. Pools 1A and 1B.

SEINE HAUL #	DATE	TIME	$\bar{H}$	P.S.	S	N	J	D
1	20/VI	5:00	1.24		4	14	0.89	1.14
				71.48				
2	20/VI	17:00	1.08		3	36	0.98	0.56
				53.65				
3	24/VI	19:00	1.48		5	16	0.92	1.44
				61.31				
4	5/VII	17:30	1.53		7	21	0.79	1.97
				30.20				
5	19/VII	16:00	1.22		4	9	0.88	1.37
				22.26				
6	2/VII	16:00	0.69		3	13	0.63	0.78
				20.01				
7	27/VIII	13:00	1.34		4	5	0.97	1.86
	$r_{\bar{H}}$				.79	-.06	.545	.778

*S = the number of species caught; N = the number of individuals caught (total);
J = the species evenness index; D = the species richness index. P.S. = the percent
similarity between each sample is given.

ESTUARY OF THE MATAMEK RIVER

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3

1B

1A

2

Figure 1.

Estuary of the Matamek River, Quebec, showing the pools (1A, 1B, 2, 3) in which the seine hauls were conducted. (From Frenette, 1975.)

SCALE 1:1200

Figure 2.
Seasonal variation in the species diversity index
($\bar{H}$) for the Matamek River estuary.
($\bar{H}$ = Nats of information)

Program for the session devoted to Matamek at the 31st Annual Meeting of the Canadian Conference for Fisheries Research held in Ottawa, 1978.

Wednesday, January 4, 1400-1700 h

Research on the Matamek River and its Tributaries in Quebec
an Integrated Study Applied to Trout-Salmon Habitat

Convener:

R. John Gibson
Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543

- 1400 Introduction to the Matamek Symposium.
G. Power, Centre d'Etudes Nordiques, Univ. Laval.
- 1415 Critical flow conditions versus productivity and survival of salmonids in the Matamek River.
M. Frenette, Centreau, Univ. Laval.
- 1430 Salmonid populations of the Matamek River, and factors affecting their distribution, numbers, and growth.
R. J. Gibson, Woods Hole Oceanographic Institution.
- 1445 A morphometric study of brook trout, *Salvelinus fontinalis*, in the Matamek River Basin.
R. L. Haedrich, Woods Hole Oceanographic Institution.
- 1500-1515 COFFEE
- 1515 The physical and chemical characteristics of the Matamek Lake and River system on the Quebec North Shore.
H. G. Jones, INRS-eau, Univ. of Quebec at Quebec.
- 1530 Trophic-dynamics aspects of the ultraplankton in a Canadian Shield Lake. P. E. Ross and H. C. Duthie, Univ. of Waterloo.
- 1545 Population dynamics of *Diaptomus minutus* (Copepoda: Calanoida) in a small lake of the Matamek River System.
J. J. Boers and J. C. H. Carter.

- 1600 Preliminary observations on the zoobenthic standing
crop of Matamek Lake.
G. R. Kreamer and A. D. Harrison, Univ. of Waterloo.
- 1615 Some paleolimnological and surface bottom geochemical
aspects of Matamek Lake.
M. Ouellet, INRS-eau, Univ. of Quebec.
- 1630 Questions and discussion.

Introduction to the Matamek Symposium

G. Power
Centre d'Etudes Nordiques
Univ. Laval

Abstract

A brief history of the research station, from its beginnings in the 1930's with the Matamek conference on biological cycles, to its recent acquisition by Woods Hole Oceanographic Institution. A quick tour of the facilities and the watershed and a summary of the preliminary fisheries projects, will set the stage for the papers to follow. These cover a broad range of interests all relating to the ecology and productivity of north-shore, Gulf of St. Lawrence, watersheds.

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WOODS HOLE OCEANOGRAPHIC INSTITUTION

MATAMEK RESEARCH REPORT

BY

MARCEL FRENETTE, D.SC. ING.

LAVAL UNIVERSITY

DECEMBER 1977

"CRITICAL FLOW CONDITIONS VERSUS
PRODUCTIVITY AND SURVIVAL OF SALMONIDS IN MATAMEK RIVER"

ABSTRACT

The programme done in 1977 aims with the continuation of investigation of the Matamek River in order to define the critical flow condition to assure the productivity and the survival of salmonids instream. Extrapolation of these results would later on permit to predict the impacts of land use on salmon rivers, for instance hydro power development, deforestation, etc.

The objective was to define the instream water requirements according to four basic levels:

- spawning flow
- survival flow
- migration flow
- capture by anglers

The approach used to derive minimum and maximum acceptable flow consisted in correlation study of hydrological, hydraulic, sedimentological with biological data and needs or protection of fish habitats.

Statistical studies of minimum, mean and maximum quantities of flow for annual, seasonal and monthly periods have been done for two stations: outlet of Lake Matamek and near the mouth of the river. The biological aspects of these studies, such as critical requirements to induce smolt to leave in June, to allow adults to migrate upriver in July and August, to provide percolation in the salmon redds during winter and amount of plankton leaving the lake in summer, can now be correlated.

The hydrodynamic aspect consisted in the field observation of hydraulic geometry (area, depth, width, hydraulic radius, wet perimeter) and velocity related to the variation of flow discharge in order to define critical requirements to provide suitable habitats for juvenile and adult salmon.

Deeper investigation in sedimentology permitted the determination of threshold conditions for the river and the stability of redds during high flood.

RÉSUMÉ

"Conditions critiques d'écoulement en relation avec la productivité et la survie des salmonidés dans la Rivière Matamek"

Les études réalisées en 1977 sur la Rivière Matamek visaient à déterminer les conditions critiques d'écoulement (débits extrêmes) en relation avec la productivité et la survie des salmonidés. L'extrapolation de ces résultats doit permettre éventuellement de prédire l'impact de l'utilisation du territoire sur les rivières à saumon, soit par exemple: l'impact des aménagements hydro-électriques, de l'exploitation forestière, etc.

Plus précisément, l'objectif visait à définir les conditions d'écoulement relatives à quatre périodes de base:

- période de frai
- période de nutrition des juvéniles
- période de migration des juvéniles et adultes
- période de pêche sportive

L'approche utilisée pour obtenir les conditions minimales et maximales acceptables consiste à faire les corrélations avec les données hydrologiques, hydrauliques et sédimentologiques et les données biologiques compte tenu de l'ensemble de besoins au point de vue habitat.

Des études statistiques des débits minima, moyens et maxima sur une base annuelle, saisonnière et mensuelle ont été effectuées à deux stations: sortie du lac Matamek et embouchure de la rivière. On peut maintenant établir les corrélations entre les aspects biologiques et les conditions critiques s'y rattachant tels: 1) le départ des saumoneaux en juin; 2) la migration des saumons adultes en juillet et août; 3) la percolation dans les nids de frai en hiver; 4) la quantité de plancton sortant du lac Matamek en été. Cette dernière partie du travail biologique reste à compléter.

L'aspect hydrodynamique consistait à observer in situ la géométrie hydraulique (surface, profondeur, largeur, rayon hydraulique, périmètre mouillé) et les vitesses d'écoulement reliées à la variation de débit en vue de définir les conditions critiques d'écoulement pouvant affecter les habitats des saumons adultes et juvéniles.

Une recherche plus approfondie en sédimentologie a permis de déterminer les conditions du début d'entraînement pour la rivière ainsi que la stabilité des lits de frai en période de crue.

Salmonid populations of the Matamek River and factors
affecting their distribution, numbers and growth.

R. John Gibson
Woods Hole Oceanographic Institution

The Matamek River on the North Shore of the Gulf of St. Lawrence is 10 km long and drains a lake and river system 684 km^2 in area, and has a mean annual discharge of 475 cfs (average range 40-2500 cfs). Brook trout are distributed throughout the river, but salmon occur only in the 5.9 km downstream from an impassable falls (the fourth from the sea). Population estimates have been made at several locations downstream from the 5th falls, which is 6.7 km from the sea. The salmonid biomass is higher upriver (178 kg/ha at the 5th falls), decreasing towards the sea (21 kg/ha at the second falls, 2.4 km from the sea). This appears to be related to a similar change in amounts of aquatic invertebrates. The major source of allochthonous nutrients in this river appears to be from the lake. Where brook trout and juvenile salmon co-exist, there is much overlap of habitat in June and early July, after which there is considerable segregation, with salmon parr being most common in rapids and close to fast water, and trout being more common in deeper and slower water. At the 5th falls, without the presence of salmon parr, brook trout remain close to rapids all summer. The mechanisms of this interactive segregation are probably both competition and aggression. When aquatic invertebrates are abundant as in June, food of the two species is similar, but when food is sparse, as in August, trout at the 2nd falls feed more on terrestrial

invertebrates than the parr, whereas the food of brook trout at the 5th falls was more similar to that of the parr at the 2nd falls than the trout. Salmon parr in the summer are most numerous in rubble and gravel areas with medium flow, at densities of about 2000/ha. However, they are common also in deep slow sections, at about 500/ha, possibly because there are relatively few piscine predators and competitors. Salmon parr populations have decreased in the last 10 years, for which there has been compensatory growth proportion of male parr are maturing. The number of smolts has decreased, about 20% now emigrate at 2+, none previously were found to emigrate at this age. The majority still emigrate at 3+. The sex ratio has changed from 1:1, with a greater number now being females. Brook trout populations and growth appears to have remained stable. Where salmon parr are abundant, yearling trout, which are about the size of two year old parr, comprise about 30% of the trout population, but in areas where there are no parr, or where they are sparse, the population consists of about 70% of yearlings. Salmon parr therefore appear to have the competitive advantage over small trout in some areas, and stocks of older trout in these locations may mainly be derived from immigration.

A Morphometric Study of Brook Trout, *Salvelinus fontinalis*,
in the Matamek River Basin

Richard L. Haedrich

Woods Hole Oceanographic Institution, Woods Hole, MA 02543 U.S.A.

Brook trout are the most widely occurring fishes in the Matamek River system. Since productivity and habitat vary a great deal within this range, it was expected that local populations might show morphological differences in response to the variation. Eighteen characters were measured on 244 specimens obtained in August 1975 and 1976 from eight locales; limited data from two additional locales were obtained from the literature. Properties were examined both individually, using basic statistics, and collectively, using discriminant function analysis. In general, populations were indistinguishable except for those from below the large Lake Matamek and from the sea. The population at the fifth fall, about 1.5 km below Lake Matamek, had condition factors significantly higher (mean $K = 1.3$) than those from elsewhere in freshwater (mean $K = 1.0$), including below another smaller lake. Fish from the sea, a non-breeding population, had mean $K = 1.1$. From other work, it is known that the fifth falls region is relatively rich, with greater insect drift and higher trout biomass than further down the river. But the ultimate cause of this enrichment, reflected in the high condition factors, remains unknown.

Dynamique des éléments nutritifs
dans la rivière Matamek Québec

H. G. Jones

INRS-eau University of Québec at Québec

Une analyse systématique de la rivière Matamek entre le lac Matamek et le fleuve St-Laurent, a permis de diviser cette partie du réseau hydraulique du bassin en cinq (5) sous-systèmes dont les interfaces sont représentées par les cinq (5) chutes. La campagne de l'été 1976 nous a fourni des données sur les entrées et des sorties hydrauliques de chaque sous-système des divers états des éléments nutritifs et autres facteurs microbiologiques.

Une synthèse des résultats préliminaires (ATP, chlorophylle, C.N particulaire, P Total, N inorganique, organique etc...) démontre d'une part, une diminution globale de biomasse en suspension dans le parcours des eaux entre le lac et l'embouchure de la rivière et, d'autre part, un changement concomitant dans la forme des éléments nutritifs.

Les observations rapportant aux cycles de variation dans ces derniers ont permis d'avancer un nombre d'hypothèses pour décrire le comportement des éléments nutritifs dans la rivière.

P. E. ROSS and H.C. DUTHIE

Trophic-Dynamic aspects of the Ultraplankton in a Canadian Shield Lake

ABSTRACT

The ultraplankton (phytoplankton less than 10 μm in their greatest dimension) account for an average of 40% of the total phytoplankton biomass in Lake Matamek. However, they account for 70% of the phytoplankton production and are the most important phytoplankton food source for the zooplankton. Evidence suggests that they are retained in the gut of Bosmina longirostris longer than larger algae ingested.

Population dynamics of Diaptomus minutus (Copepoda: Calanoida) in a small lake of the Matamek River System.

J.J. Boers and J.C.H. Carter

Department of Biology
University of Waterloo
Waterloo, Ontario

ABSTRACT

A study of the life history of the calanoid copepod Diaptomus minutus Lilljeborg in C22, a small lake of the Matamek River System, demonstrated that instar duration times of the nauplii and younger copepodites were considerably shorter than those previously determined elsewhere. It is hypothesized that these differences may be attributable to the abundance of nanoplankters characteristic of highly oligotrophic waters.

PRELIMINARY OBSERVATIONS ON THE ZOOBENTHIC STANDING CROP OF
LAKE MATAMEK, NORTHERN QUEBEC. G. R. Kreamer and A. D. Harrison,
Department of Biology, University of Waterloo.

The annual mean benthic standing crop of the west basin of Lake Matamek was estimated from over 200 Ekman grab samples collected in January and March and May through October of 1977. Enumeration and wet weight estimates were averaged for stations within different lake zones (deep and shallow profundal, sublittoral and littoral). Accounting for the proportion of lake bottom area within each zone, the standing crop was estimated to be in the area of 2500 organisms and 2.1 grams per square meter. The distribution of numbers and biomass were found to be highly heterogeneous in all lake zones, both spatially and temporally. Tubificidae (Annelida: Oligochaeta) and Chironomus (Diptera: Chironomidae) were the dominant infaunal profundal inhabitants. Along with these, Chaoborus (Diptera: Chaoboridae), Ceratopogonidae (Diptera), Sialis (Megaloptera: Sialidae) and Pisidium (Bivalvia: Sphaeriidae) were important in the sublittoral. A diversity of oligochaete, chironomid and other insect species occupied the littoral areas. Maximum numbers (50000/m²) occurred in the macrophyte zone during early August. Maximum biomass (42gm/m²) was observed in samples from a depth of 15m at the lake outlet in late May, resulting from extreme clumping of pupae and fourth instar larvae of Chironomus prior to emergence. Minimum biomass (0.25gm/m²) and numbers (500/m²) were found in samples from the deep mud slopes of the basin throughout the summer. Such estimates characterize the Lake Matamek benthos as one of the least productive of natural lakes in the world, a feature which should be typical of the large number of deep, oligotrophic, polyhumic lakes of the Canadian shield, which as yet have been scarcely studied.

CANADIAN COMMITTEE ON FRESHWATER FISHERIES RESEARCH (CCFFR).

Ottawa, January 1978.

Some paleolimnological and surface bottom geochemical
aspects of Matamek Lake.

Marcel Ouellet
Institut National de la Recherche Scientifique
Université du Québec

Sediment cores of over 10 m long taken from ice cover within the Matamek river basin were stratigraphically studied for both their pollen grain and composition of geochemically important elements.

The palynological study of the lowest horizon of the core, taken at a depth of 100 m of water in the central part of Lake Matamek, revealed that a vegetation consisting mainly of shrubs like Alnus Crispa was rapidly replaced by a spruce forest about 8,000 years ago. This coniferous vegetation has maintained itself with minor fluctuations up to the present time.

Several cores studied for their geochemical characteristics show a sharp increase in lead content near the surface sediments. This increase which started about one hundred years ago is believed to be the result of long-range airborne from urban and industrial centers.

The chemical analysis of 128 surface sediment samples have demonstrated significant interrelationships between water depth and the geographical distribution of C, Cu and Pb within the lacustrine basin.

Furthermore several kilometers of low-frequency subbottom profiling have shown the effects of erosion by the continental glaciers on the central basin of Lake Matamek. Fluvio-glacial sediments up to 50 m thick lie over the bedrock of the lake.

A male finback whale drifted into shore at Matamek on June 26, 1977. Its total length was 59 feet. It was badly lacerated on the left lateral and dorsal side and had probably been hit by a ship.

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BUDGET SUMMARY - 1977

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University of Laval Marcel Frennette	\$ 8,700	--
University of Waterloo John Carter	\$10,480	\$ 4,100 University of Waterloo 3,000 National Research Council \$ 7,100
University of Waterloo Hamish Duthie	\$11,394	\$ 3,100 University of Waterloo 4,788 National Research Council \$ 7,888
University of Waterloo Arthur Harrison	\$12,162	\$ 6,012 University of Waterloo
Woods Hole Oceanographic Institution R. John Gibson	\$68,189	\$13,800 NOAA-Office of Sea Grant 10,000 Government of Quebec \$23,800
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