MARINE RESOURCES
OF
KOUCHIBOUGUAC NATIONAL PARK

APPLIED OCEAN SYSTEMS LIMITED
10 AKERLEY BOULEVARD, BOX 787
DARTMOUTH, NOVA SCOTIA, CANADA

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D. G. PATRIQUIN AND C. R. BUTLER

APPLIED OCEAN SYSTEMS LIMITED
10 AKERLEY BOULEVARD, BOX 787
DARTMOUTH, NOVA SCOTIA, CANADA

Date: Fri, 3 Feb 2012 09:22:22 -0400 [02/03/12 09:22:22 AST]
From: Eric.Tremblay@pc.gc.ca
To: patriqui@Dal.Ca
Subject: Request to post report on Kouchbouguac marine resources

M. Patriquin,

We strongly support the web publication of your report on Kouchibouguac National Park's marines resources. This report has been useful to many researchers and students working in Kouchibouguac over the years and being on the web will make it more acessible. Base lines studies like yours are crucial in our understanding of long term ecosystem trends.

Cheers

Eric Tremblay
Ecosystem Scientist| Scientifique des écosystèmes
Parc national Kouchibouguac | Kouchibouguac National Park
Parcs Canada | Parks Canada
186 route 117 | 186 road 117
Kouchibouguac, NB E4X 2P1
eric.tremblay@pc.gc.ca
Téléphone | Telephone 506-876-2443
Télécopieur | Fax 506-876-4802
Gouvernement du Canada | Government of Canada

100 ans, Soyez de la fête! | 100 years, Come Celebrate!

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ACKNOWLEDGEMENTS

We wish to thank the Kouchibouguac National Park wardens for assisting us during this study. Their cooperation and help were very much appreciated.

The field work was conducted with the assistance of B. Challis, M. LaBerge and S. Woods. Ingram Gidney of Sandy Cove, N.S., provided advice and assistance in regard to the use of fishing nets and traps.

Dr. T. Edelstein of the National Research Council identified some of our algal specimens and we express our thanks and appreciation.

We also wish to thank Environment Canada, Inland Waters Directorate for providing us with the tide records for Rustico, P.E.1.

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I. INTRODUCTION

The main attraction of Kouchibouguac National Park (Figure 1) is the lagoonal system with its sand bars and dune landscapes. These lagoons and the rivers and streams flowing into them have traditionally been fished by local residents and in the future will be visited by millions of tourists. This report is intended to provide a broad scientific basis for managing the marine (estuarine) resources of Kouchibouguac National Park. A limnology inventory carried out by the Canadian Wildlife Service during 1975/76 is complementary to this study and overlaps with it where anadramous and catadramous fish are concerned.

The "state of the art" with respect to (1) estuarine-type systems, and (2) production of marine resources has not progressed to the level where such a study can be conducted according to well defined, generally accepted pathways or principles. Particularly in a survey as this, one where financial and manpower resources are very limited and a report is required within a short interval, choices have to be made between various possible approaches to studying the system and these choices are inevitably, in part, subjective.

We argued, and are grateful to Parks Canada for accepting our argument, that the most cost efficient way of gathering the desired information would be to study the system intensively over the summer season rather than following the alternative of more restricted, intermittent sampling through the year. This approach has permitted emphasis on spatial relationships which are unique to the system. Knowing these, seasonal variations in the system can be reasonably well predicted or at least the components which deserve special attention through the year can be singled out and studied independently. As well, by referring to known physiological tolerances, distributions of key indication organisms may reveal spatial and temporal characteristics of the system which are directly measured only with great effort and expense. We contended also that changes in spatial structures (e.g. distribution of a species) are more readily observed and are more sensitive indications of change in the system than are quantitative characteristics (e.g. numbers of a particular species per unit area).

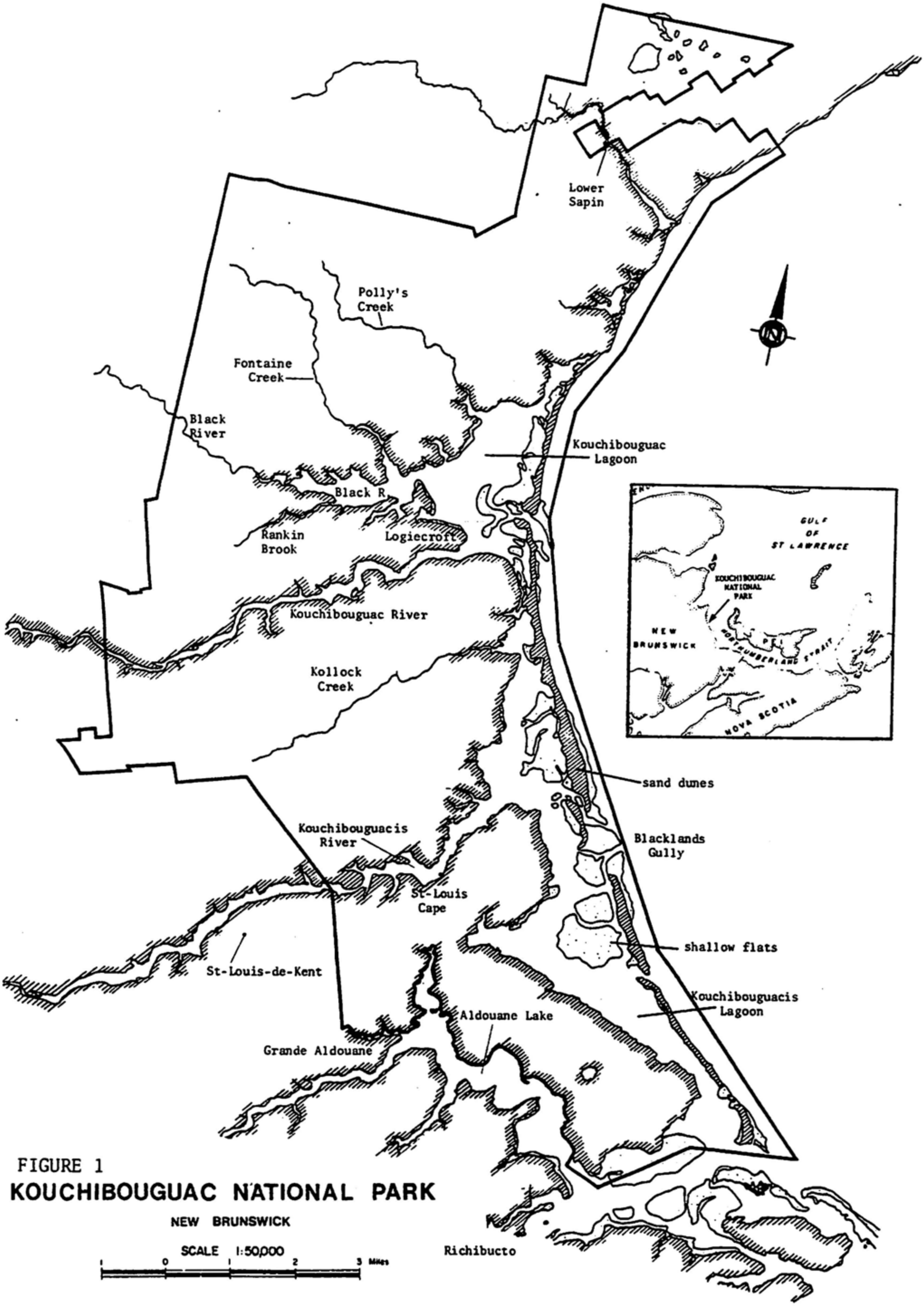


FIGURE 1
KOUCHIBOUGUAC NATIONAL PARK
NEW BRUNSWICK

The emphasis of the study has been, as requested by Parks Canada, on the edible species. A thorough understanding of the population dynamics of any one species requires, however, some examination of other components of the system and of the properties of the system as a whole. Modelling techniques are not yet capable of describing these properties (Mann, 1975). Essentially, our approach has been that of a naturalist with the initial emphasis on unbiased observation. As for the naturalist, our interpretations are necessarily somewhat subjective. Perhaps the best indication that they are not entirely so, however, is that our final conclusions concerning the system are far different from those we had anticipated.

Organization of the Report:

We have reviewed at the beginning of the report some general characteristics of estuarine system (section II. A and B). This is included to provide appropriate background for those not familiar with estuarine systems; it is not intended to be a comprehensive review. This is followed by a review of literature pertaining directly to the marine resources of Kouchibouguac Park (section II. C). In section III, the results of the survey are presented. This is divided into three subsections: The Physical Environment (III. 1), the Biological Environment (III. 2), and the Exploitable Resources (III. 3). Where appropriate, background information for individual species is provided. Section IV is a summary and in section V, we attempt to present an overview of the system in the context of management considerations. Specific recommendations have been submitted separately.

II. LITERATURE REVIEW

II. A THE GENERAL CHARACTERISTICS OF ESTUARINE SYSTEMS - PHYSICAL

Kouchibouguac System as an Estuary: The Kouchibouguac Lagoon and rivers system is an "estuary" system as defined by Pritchard (1967).

> "An estuary is a semi-enclosed coastal body of water which has a free connection with the open sea and within which sea water is measurably diluted with fresh water derived from land drainage."

Geomorphological Classification of Estuaries: On the basis of their geomorphology, three subdivisions of estuaries are commonly recognized: (1) drowned river valleys, (2) fjord-type estuaries, and (3) bar-built estuaries.

The first type is usually an elongated indenture of the coastline with a river flowing into the upper end. The second type refers to glacially cut fjords with deep basins and a shallow sill at the mouth. Bar-built estuaries, of which the Kouchibouguac system is an example, are found "when offshore barrier sand islands or spits build above sea level and extend between headlands in a chain, broken by one or more inlets" (Pritchard, 1967). Such estuaries are elongated parallel to the coastline.

The lower valleys of rivers flowing into a bar built estuary may have been drowned by rising sea level and hence such a system may be a composite of types (1) and (3). The Kouchibouguac system is such a case consisting of the outer lagoon or embayment oriented along the coastline and the inner indentures of the river valleys.

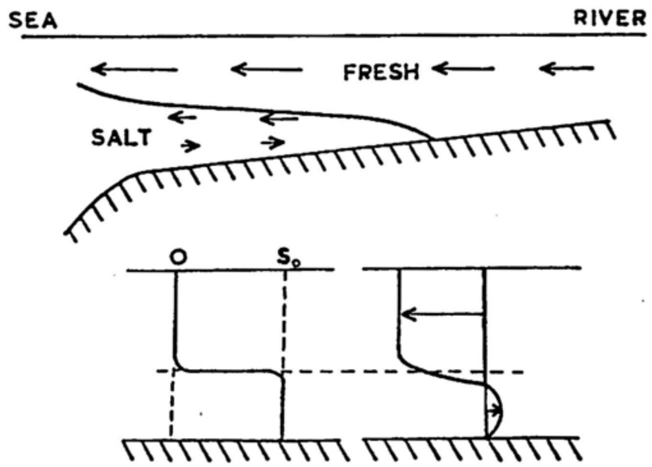
Circulation In Estuaries: Estuaries may be classified according to the physical characteristics of the circulation.

It is appropriate to consider the following four types (Bowden, 1967). Some factors of each type apply to the Kouchibouguac Estuary.

(1) The salt wedge circulation is characteristic of the coastal plain-type estuaries in which river flow is large compared to tidal flow. In such a system, the seawater entering the estuary as a salt water "wedge" below the seaward moving fresh water layers. In the absence of friction, the interface between the salt wedge and upper fresh water layer would be horizontal and extend upstream to the point where the bottom was at near sea level.

(1) The salt wedge circulation(cont.)

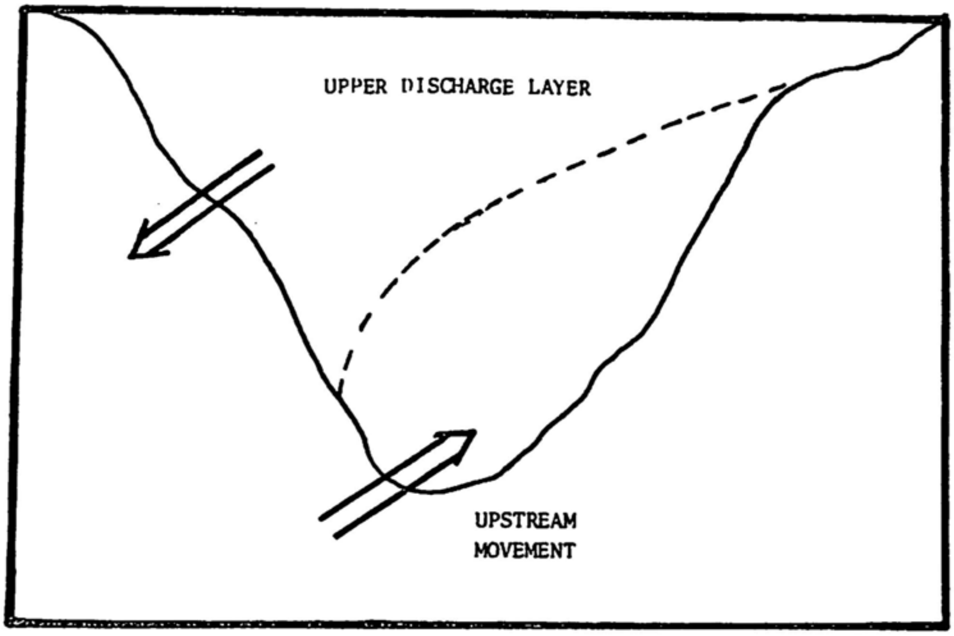
However, because of frictional drag between the two layers, the interface slopes slightly downward in the upriver direction. The magnitude of the frictional drag depends on the velocity in the upper layers (actually on the difference in velocities between the upper and lower layers) and the position of the wedge will be further upstream when river outflow is high than when it is low.



Salt wedge estuary: above—section along estuary; below—typical salinity and velocity profiles. After Bowden (1967)

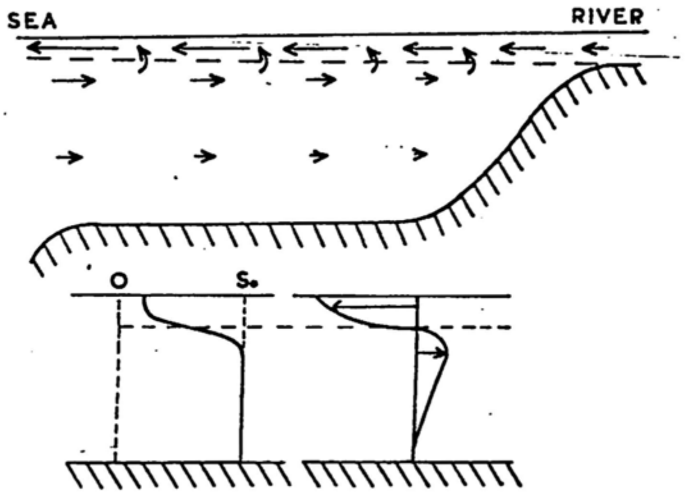
The steep density gradient between the two layers (salt water is heavier than fresh water) reduces mixing to a low level, and the salinity throughout the wedge is close to that of full strength seawater.

Coriolis force (the tendency of flowing streams moving horizontally to move towards the right in the northern hemisphere and to the left in the southern hemisphere because of the earth's rotation) causes the interface to slope downwards to the right.



Salt wedge interface slopes downward to right (facing downstream)

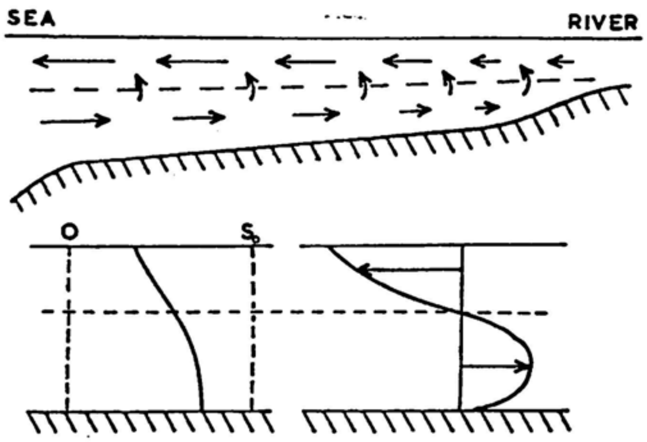
(2) Two layer flow with entrainment - Where the velocity of the seaward-moving layer exceeds a certain value, internal waves at the density interface between the surface layer and bottom layer (waves form at density interfaces such as the sea surface) break into the surface layer with resultant "entrainment" or seawater in the surface layer and gradually increasing salinity of the surface layer as it moves seaward. This also results in an increased volume flow in the surface layer but not an increased depth of the surface layer. Loss of salt water into the upper layer is compensated for by flow of seawater into the wedge, and this flow is directed upstream at all positions within the wedge.



Two-layer flow with entrainment: above—section along estuary; below—typical salinity and velocity profiles. After Bowden (1967)

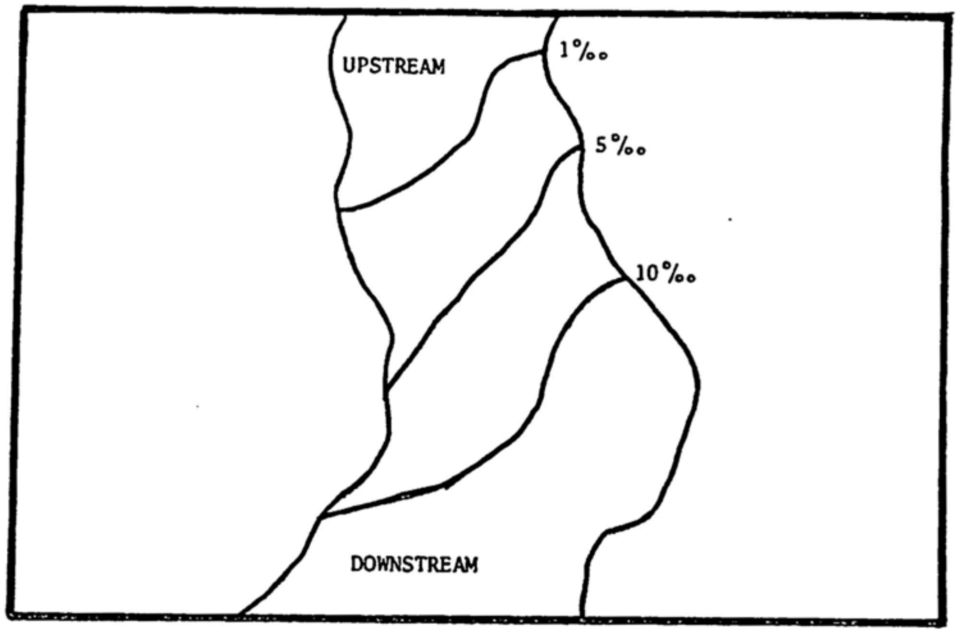
Entrainment is a one way process - seawater moves into the surface layer, but fresh water does not move into the seawater layer. Usually, however, some mixing does occur; that is, fresh water also moves down, and an intermediate layer of increasing salinity, the Halocline, is formed. Tidal currents increase this mixing; the water of the wedge or deep layer, however, retains its high salinity.

(3) <u>Two layer flow with vertical mixing</u> - When tidal currents are significant in comparison to river outflow and when the estuary is comparatively shallow, vertical mixing extends throughout the depth of the water column resulting in the type of structure illustrated below. There are still two layers with respect to flow, but no marked interface in the salinity profile. The salinity gradient is greatest at the level of no net flow.



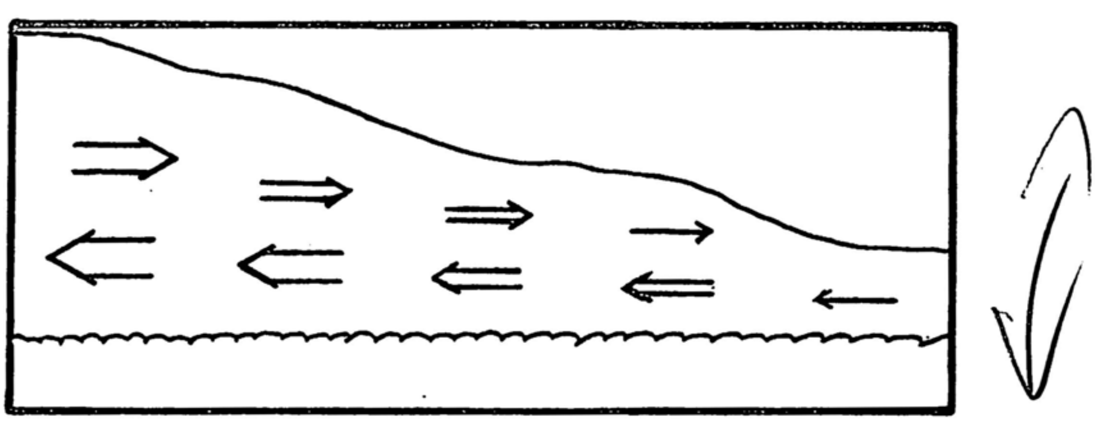
Partially mixed estuary with entrainment and mixing; above—section along estuary; below—typical salinity and velocity profiles. After Bowden (1967)

The degree of stratification is such that systems increase with increasing values of the ratio of amplitude of tidal currents-to-river flow, and the difference in salinity between the surface and bottom varies accordingly from less than 1 ‰ (0.1% salt) to 10 ‰. The volume of flow in such systems, because of the mixing, may be many times that of river discharge. For the James River (U.K.) estuary, for example, the discharge (outflow) is about 20 times the river inflow while the upstream flow is about 19 times the river inflow (i.e., to balance the discharge minus river inflow). Because of Coriolis force, these systems are "tilted" somewhat with upper layer flows in greater volume and greater depth on the left hand side of the estuary (looking upstream) and the surface isohalines (lines of equal salinity) are correspondingly displaced.



Displacement of surface isohalines resulting from Coriollis force

An important consequence of entrainment-mixing phenomena in estuaries, implicated in the above discussions, is that the total quantity of water flowing past each point increases enormously towards the ocean. This is illustrated diagramatically below.



(4) Vertically homogenous estuaries result where mixing induced by tidal motion is sufficient to completely overcome the stability resulting from fresh water inflow and salinity is uniform from surface to bottom. Salinity decreases from the mouth to the head of the estuary and in relatively wide estuaries, the salinity on the right side (looking seaward) will be greater than salinity on the left side. Similarly, there will be no variation in water movement with depth; but in wide estuaries, there may be a net seaward flow on the right side.

In shallow, bar-built estuaries such as the Kouchibouguac Lagoon system, tidal currents are significant only through the inlets between the barrier islands and tidal amplitudes are generally small. However, winds in the lagoon system may be sufficient to produce vertical homogenity in the lagoonal, shallow part of the estuary system. Similarly, the wind may be the most important factor determining the current and circulation within the lagoon.

Tides in Estuaries: This is a complex topic; four generalities, however, concerning tidal phenomena in estuaries should be noted:

(1) In bar-built estuaries such as the Kouchibouguac system, tidal velocities at inlets are large; but because of the narrowness of the inlet, the total volume of water flowing in and out with the tide will be relatively small, and the tidal rise and fall as well as the tidal currents will be greatly reduced within the estuary.

(2) The duration of the flood tide is generally shorter than that of the ebb tide.

(3) The lagoonal tidal cycle has the same period as that of the ocean outside; however, the lagoon tide lags the ocean tide cycle by a period determined by the size of the lagoon opening seaward.

(4) Tidal currents predominate the water circulation in estuaries.

Flushing of Estuaries: "Flushing time" is a parameter of estuarine circulation of importance with respect to discharge of pollutants. The limits of application of this parameter to discharge problems should be appreciated. Flushing refers to the composite process discussed above whereby fresh water within the estuary is reviewed. The flushing time, t, is the time taken to remove the accumulated volume of fresh water present in the estuary, F; $t = F/R$ where R is the rate of influx of fresh water into the system.

Flushing of Estuaries: (cont.)

Estimation of the flushing time requires a knowledge of the river flow and of the salinity distribution in the estuary; fresh water content at any point is given by: $f = \frac{So - S}{So}$ where So is the salinity of seawater outside of the estuary. Total fresh water in the estuary is estimated by integrating (summing) the values for individual points through the estuary.

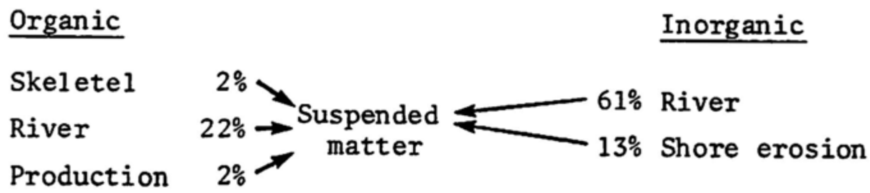
The flushing time so estimated is applicable to considerations of pollutant discharge only if the pollutant is introduced into the estuary in the same way as fresh water enters the system; for example, at the head of the estuary. If the pollutant is introduced elsewhere, the flushing time for that pollutant may differ significantly from that for fresh water in the system.

The length of the flushing time decreases with increasing river discharge, but not proportionally to river discharge, because with increasing discharge, F (the total fresh water content of the estuary) also increases with discharge. Thus, an eight-fold increase in discharge, for example, may only result in a two-fold decrease in flushing time (Bowden, 1967).

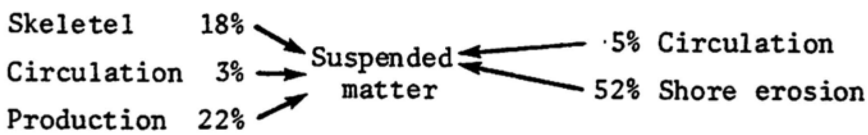
Sediments in Estuaries (Sources: Dyer, 1971; Stevenson, 1974, Carriker, 1967)

(1) Suspended Matter - Estuarine systems are characteristically turbid. This turbidity is a product of the interplay of various sources of sediment (watershed, off inlet shores, biological production) reworking and scouring of sediments by currents and waves, the estuarine circulation (which tends to entrain particles within the estuarine system), the mixing of fresh and salt water and consequent flocculation of linear particles, and the presence of relatively quiet sedimentation areas provided by widening of the estuarine basis near the sea, and created by plants (eelgrass). In most estuaries, the bulk of the sediment is derived from the watersheds, with some from the sea. Biological production may account for a substantial fraction of the suspended matter, which includes both organic and inorganic materials. The following budget has been calculated for contributions of various sources to suspended sediments in Chesapeake Bay:

Upper Chesapeake Bay



Middle Chesapeake Bay



As can be seen, the river contributes the major fraction in the upper estuary and shore erosion the minimum fraction in the lower estuary; the organic contribution increase lower down in the estuary (data quoted in Pyer, 1971).

In upper parts of estuaries, the suspended sediment concentrations may be related mainly to discharge, while in the lower parts tidal range may be more important. Where tidal currents predominate there are usually large variations in the suspended sediment concentrations according to the phase of the tide , the variations being more pronounced at depth then at the surface. Peaks in concentration may occur with both ebb and flood currents following a slight lag. In many estuaries this seems to be a natural background of 10-20 mg/ℓ suspended sediment of about 3-4 μ in size at all stages of the tide (total concentration might vary from 20 to 100 mg/ℓ near the bottom over a tidal cycle and by less than 20 mg/ℓ near the surface).

Characteristically the highest concentration of suspended sediment occurs in the low salinity, upper portion of the estuary- this turbidity maximum is maintained by the estuarine circulation forming a semi-closed system; particles entering from the river settle into the bottom landward flowing layer and are carried back up the estuary and mixed into the surface layer again by tidal action. However the net sediment transport will of course be downstream.

(2) Grain Sizes, Organic Constituents and Manner of Deposition - The following remarks on distribution of grain sizes, organic constituents and manner of deposition are quoted verbatim from Stevenson (1972).

> "Distribution of Grain Sizes. The coarsest sediment in most estuaries is on the barrier or bay-mouth bar, and consists of sand and cobbles. Generally, this material is too coarse to have been transported across the tidal flats, but is derived from erosion of a sea cliff, then transported and deposited by longshore currents and waves. The excellent sorting and absence of much silt and clay may result from the turbulence of the waves.
>
> "The flat portions of the floors of estuaries that are deeper than about 6 m are usually covered by sediment which becomes progressively finer with depth of water. A smooth concentric pattern of sediments may occur, ranging from sand along the shore to fine mud at depth. Such a distribution occurs only where the bottom is relatively flat and current conditions are mild. In estuaries where the deeper areas are extremely irregular, mud occurs only in depression and coarse sediments characterize the shallower bottoms.
>
> "The sediment distribution in shallow areas, mostly the tidal flats, is more complex but usually follows a systematic pattern. Most of the flow of water is confined to well-defined channels which slowly migrate over the tidal flat (as shown by remapping at intervals of several years). The velocity of the water is such that the finer grains are swept out, leaving the coarse sediment in the channel. The areas between the channels consists of poorly sorted mud which becomes finer with distance from the tidal channels. Probably most, but not all, of the reworking of sediment in estuaries takes place on the shallow flats where the ebbing and flooding current erode and redeposit the sediment.
>
> "Organic Constituents. The sediments contain the remains of all phyla of animals and much plant debris. Even though the remains become scattered by scavenging, decomposition, and diagenesis, the organisms still have enriched the sediments in organic matter, calcium carbonate silica, nutrients, and other constituents.

"Sediments in estuaries located in areas where precipitation exceeds evaporation have organic nitrogen contents from 0.2 to 0.6%, and sediments to hypersaline areas below 0.2%. The percentage used to differentiate between these areas, or 0.2% organic nitrogen, corresponds to about 1.7% organic carbon, or 2.9% total organic matter. Phosphorus is also abundant in sediments of normal environments, ranging from 0.1 to 0.4%.

"Calcium carbonate is variable because of the presence or absence of shells and because of solution induced by acidic conditions. In coastal bays in temperate and arctic regions, calcium carbonate ranges between 0 and 6%, whereas in bays of tropical regions it is 10-47%.

"Manner of Deposition. In the tidal section of a fresh-water river, a transition takes place and the distribution of sediments may be quite variable and confused. When the estuary proper is reached, there is some admixture of sea salts, and where the net upstream flow in lower layers occurs, there is a distinct change in sediment distribution. Finer sediments tend to be deposited in the channel (the reverse of conditions commonly found in river channels). In most streams, the bulk of suspended material probably is silt which is deposited directly out of suspension. Clay sizes, however, may be deposited through flocculation. The clays then fall to the deeper floors of the estuaries. Sediment may also travel down rivers at or near the surface in large floating floccules containing organic debris. When these settle to the bottom or are stranded by lowering water level, they are held by capillary action. Near the mouth of the estuary, coarser sediments are again found in the channel as a result of wave action and because much of the silt load has already been deposited in the channel further upstream."

(3) Organism - sediment interactions - Various flora and fauna play important roles in sedimentary cycles in estuaries, as sources of organic and inorganic materials, varying in size from a few microns to centimeters in size, by actively filtering out suspended materials (contributing to clarity), as stabilizers of the bottom, by erecting baffles (areas of semi-motionless water), and as sediment "traps". "Mats" of algae and protozoans are particularly important in the last mentioned respect; particles deposited on the sediment surface at slack water are entrapped by growing filaments or by mucilage and are held against subsequent increased water motion. In turn, the distribution and feeding

of many animals are affected in well defined ways by the nature of both the suspended and deposited sediments; these aspects will be reviewed in appropriate sections below.

II. LITERATURE REVIEW (cont.)

II. B THE GENERAL CHARACTERISTICS OF ESTUARINE SYSTEMS - BIOLOGICAL

It is impossible to adequately review the voluminous topic of the biology of estuaries and all of its ramifications. The following is a summary of some of the more important factors or valid generalizations concerning estuaries based largely on treatments in Emery and Stevenson (1957), Odum (1971), Douglas and Stroud (1971), Carriker (1967), and the author's (D.P.) own familiarity with these systems. The material is not specifically referenced except where a new or unique opinion/observation is involved. The summary is given largely in point form for the sake of efficiency in presentation and is biased towards considerations pertinent to the Kouchibouguac estuarine system. More details concerning specific organisms are given in the main text of this report.

Colonization of Estuaries

(1) Estuarine fauna and flora are recruited principally from the sea with only a few components from fresh water environments.

(2) The number of species in estuaries compared with the sea is greatly reduced, but the number of individuals is often large, associated both with low interspecific competition and high primary productivity.

(3) Estuarine organisms must adapt to a wider range of fluctuations in environmental factors than in the sea or fresh water. Colonization may be determined by several factors (e.g. salinity, substrate, and turbidity) but the limits of distribution may be controlled by one factor and drastic changes in such a factor (e.g. salinity) may have catastrophic effects on a population.

(4) "In general, penetration of estuaries (and also of the Baltic) by marine and, conversely, fresh water organisms is a function of the rate and magnitude of tidal change rather than of the actual salinity gradient. That is, marine organisms occur much farther upstream, and fresh water organisms much nearer the sea, in an estuary where tides are small and the gradient relatively stable, than in an estuary with a large tidal range and rapidly changing gradients. This means that the minimum number of species is to be expected in that part of the estuary where the salinity variation is greatest. ... A corallary to this is the greater

penetration of marine species in estuaries of lower gradient, although the salinity may also be lower, but more constant, as in Randers Fjord (Denmark), where tidal action is greatly reduced". ... (Emery et al, 1957)

The Animal Component

Animals occurring in estuaries may be classified into several categories:

(i) Stragglers and wanderers (mobile forms) which come in and leave with the tide "or at least move downstream from the head of an estuary with the tide".

(ii) Seasonal migrants which enter the estuary to spawn or pass through it on the way to spawn. These include anadramous species such as the alewife, salmon, bass, and the catadramous (going to the sea to spawn) eel.

(iii) Those migrating as young into an estuary to feed.

(iv) The estuarine component, living permanently in the estuary. It is this component that determines the characteristic "estuarine facies". This component includes a diverse array of molluscs, small fish, annelid worms and crustecea, frequently more abundant in estuaries than in the sea or in fresh water. They occur as infauna, epifauna and nekton (free swimming).

The Plant Component

The estuarine flora is characterized by:

(a) A marshland angiosperm component about its fringes; at these latitudes, _Spartina_ species and _Carex_ species are predominant.

(b) Submerged angiosperms - these include eelgrass, _Zostera marina_, distributed towards the marine end of the estuarine system and widgeon grass _Ruppia maritima_, distributed towards the fresh water ends of the estuary.

(c) Green algae predominating in higher zones and near river mouths.

(d) Brown and red algae occurring is subtidal and lower parts of estuaries.

(e) Mat-forming algae, mostly greens and blue-greens occurring in the mid to upper parts of the estuary.

(f) Epiphytic algae, including green, brown and red filamentation forms are common on the submerged angiosperms.

(g) A phytoplankton component which varies greatly in abundance according to seasonal changes in nutrients; these are generally less abundant at the head of the tide than towards the sea because of the greater turbidity there.

(h) Diatoms are often present in great abundance on the mud surface and as epiphytes or macrophytes (seaweeds and angiosperms).

Recruitment in Estuaries

The anadramous fish, which spawn at the head of estuaries or above the head of the tide and whose young at some stage migrate to sea, are well known for their remarkable ability to return to the place of their birth from sites 1000 or more miles away.

Each fish has this ability to return to its place of origin. The planktonic, passively distributed larvae of invertebrates, however, are much more at the mercy of currents and large numbers of larvae must be produced in order to insure that, on the average, one (or two) will return to its place of origin and grow up to an adult. The net seaward flow in estuaries tends to displace larvae from their adult populations.

The likelihood of a larva returning to the site or region of its origin will vary in different areas according to the overall current regime. While the larvae are unable to make significant lateral movement as are fish, they are able to alter their vertical distribution either diurnally or at different metamorphic stages and thus take advantage of differences in directions of currents at different depths. This is not an individually determined movement as in fish but rather a pattern of behavior selected for on the population level; and invariant over short periods of time, but alterable through genetic selection over longer periods of time. Thus, for many species, the early larval stages swim in the surface waters where food is relatively abundant, all the while being carried seaward (or possibly in a clockwise circular motion within the estuary). Later stages settle on the bottom and are carried back towards the estuary by upstream lift in the deeper waters. Diurnal vertical migration, up in the daytime and down at night, may also serve to minimize the seaward drift while allowing the larvae to remain in more productive surface waters during the day.

These patterns of behavior are characteristic of coastal as well as estuarine invertebrates, as coastal forms also face the same basic problem: seaward drift of larval stages in the surface waters.

Adult stocks of invertebrates with larval stages in estuaries may be maintained by (i) immigration of adults from coastal areas, (ii) settlement of larvae originating from adult stocks elsewhere (i.e. coastal areas), and (iii) retention of larvae within the estuarine system. For species which are largely restricted to estuaries, (iii) will be the only mechanism of recruitment, while for species found as well outside of the estuaries, mechanisms (i) and a (ii) may be adequate to maintain the estuarine stocks. It has, in fact, been found that larvae species which are heavily dependent on estuarine habitats tend to be more abundant in the lower layer of the water column where net transport is upstream, while such distribution and adaptation are not observed for migrating species (e.g. crabs) not restricted to estuary habitat (Sandifer, 1975).

Thus, some populations in estuaries will be largely recruited from populations outside of the estuary, and the well-being of the estuarine population will be highly dependent on factors outside of the estuary, while other populations will be recruited from the estuarine population itself and be relatively independent of conditions outside of the estuaries.

Another factor influencing recruitment by either of these mechanisms is the mortality rate of the larval stages. In fact, recent work points to this stage (larval) as being the most critical factor in determining the size of the adult population, for many invertebrates and fish (not including the catadramous and anadramous species) of commercial significance. Sutcliffe (1972) examined the relationship between commercial landings of clams, lobster, halibut, and haddock for the province of Quebec and discharge of the St. Lawrence River, utilizing statistics available in the literature.

For all species, he found highly significant positive correlations when lag periods were equivalent to the ages at which the species were taken commercially. That is to say, catches of halibut for example were highly correlated with runoff 8 years prior to the catch year, an interval equivalent to the mean age at which the fish enters the fishery. The implications of these relationships is that survival in the first year is correlated with river flow. Sutcliffe (1973) tested this implication by examining the relationship between abundance of larvae in the Northumberland Strait, for which data was available for a period of 14 years, and river outflow. He found no correlation with St. Lawrence River data, but a high correlation with river outflow data for the Miramichi, one of the largest rivers in the general area of the larval sampling. He also found that the best correlation was between runoff for the month of June and larval stage I production. Re-examing data for adult lobster and for halibut, he found that adult stocks could be more highly correlated with a specific month of discharge than for the annual discharge, thus identifying the most critical times of year for these effects. The mechanism behind these correlations is not completely elucidated but seems to involve a sequence:

runoff ⟶ upwelling ⟶ increased primary production ⟶
⟶ effect on larval stages

i.e. when runnoff is greatest, there is greater induced upwelling, greater primary productivity, and greater larval survival.

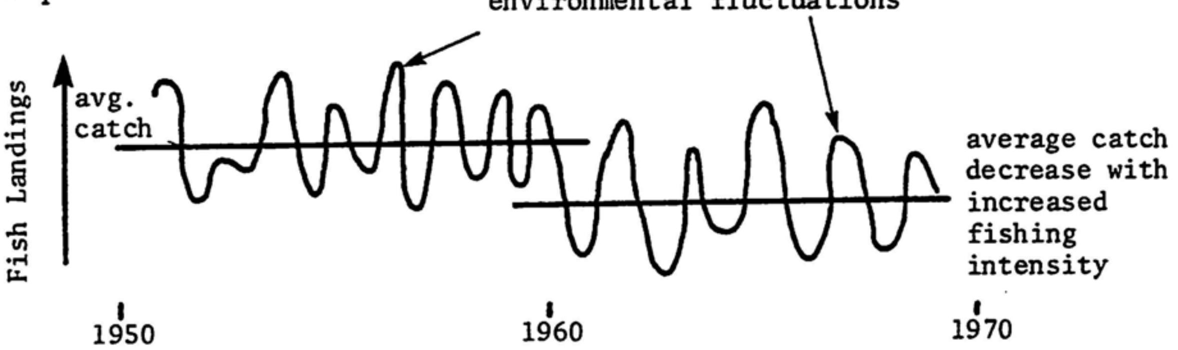
There relationships are of fundamental significance in at least two respects:

(i) For species in which such a relationship is observed, abundances (commercial catches) can be predicted ahead of time by an interval equivalent to the age at which the fish or invertebrate is taken into the fishery with a high degree of accuracy; and,

(ii) They imply that it is the larval stage rather than availability of food in the adult stage or, to a certain extent, the size of the adult reproductive stock that determines the size of the adult population.

With respect to the size of the adult reproductive stock, it has been shown that overall catches of fish have decreased with the intensive fishing of the '60's and '70's (Sutcliffe, personal communication and in press). These changes are superimposed on variations associated with environmental factors.

Example:



The most important implication of this type of thing for the Kouchibouguac system is that it implies that fluctuations in abundances of species with larval stages, and particularly for species which are recruited largely from populations outside of the lagoon system, may be determined largely by environmental variables outside of the Park. As yet, much has be to learned about the entire mechanism, however, and it must not be presumed a priori that this is so, particularly for a relatively isolated system such as the Kouchibouguac system.

Organisms and Sedimentation

A number of organisms play a key role in the sedimentary regime of estuaries:

(1) Mats of filamentous algae and/or diatoms stabilize the surface of sediments increasing the threshold required for disturbance of the sediment and also "trap" sediment particles passing by the bottom.

(2) Macrophytes, chiefly eelgrass, create a "baffle"; i.e., create semi-stagnant conditions encouraging accumulation of sediments. Growth of rhizomes of eelgrass also bind the sediment further stabilizing it.

(3) Molluscs, crab, annelid worms, and some crustecea rework the sediment through their burrowing activities.

(4) Mussels and oysters build up large monolithic structures or "reefs".

(5) Various filter feeders, but especially the bivalves filter particles out of the water, contributing to its clarity.

Nutrients, Oxygen, pH and Primary Productivity

Primary productivity in estuaries is very high, normally being in the range 10,000-25,000 kcal/m^2-yr., comparable to the most highly productive agricultural systems. Continental shelf waters have primary productivity in the range 500-3,000 kcal/m^2-yr. and open ocean waters, less than 1000 kcal/m^2-yr. (Odum, 1971).

Angiosperm, including marsh grasses and eelgrass, are commonly the main primary producers in shallow estuaries. The slow decay of these plants results in a continuous supply of food throughout the year.

Contributing to the high primary productivity are:

(i) The relative shallowness of the estuaries (such as Kouchibouguac) keeps photosynthesizing organisms in zones of high light intensity.

(ii) Contribution of nutrients from runoff.

(iii) The estuarine circulation continuously moves nutrients from deeper areas and from the sea into the euphotic zone.

(iv) Sulfate reduction in sediments results in release of phosphate from iron phosphate compounds (Wood, 1965).

(v) Anaerobic environments in the sediments encourage bacterial nitrogen fixation, particularly in association with roots of eelgrass (Patriquin and Knowles, 1972).

(vi) Reworking of sediments by burrowers recirculates nutrients deposited in the sediments.

In general, marine systems and estuaries are nitrogen limited. Nitrogen fixation occurs in response to this deficiency, and part of the success of seagrasses in these kind of systems is associated with the nitrogen-fixing activity of their roots. Blue-green algae occurring as epiphytes and as mats on the sediment surface may also fix nitrogen. High primary productivity may be reflected by large diurnal changes in the oxygen content of esturine waters, particulary where eelgrass occurs in abundance and large seasonal variations may occur correlated with periods of growth and decay of these plants. Because of the large amounts of organic material produced in estuarine systems and deposited in sediments, and because of the restricted circulation in sediments: estuarine sediments are generally anaerobic within a few millimeters of the sediment surface and organic material in the sediments is oxidized largely via sulfate reduction (Wood, 1965). These conditions (diurnal and seasonal fluctuations in water column oxygen and productional sulfide in the sediments) where they are intense, may create conditions inhospitable for many organisms, particularly those of harvestable significance for man.

These factors may also result in diurnal and seasonal changes in water column and sediment pH; however, seawater systems are relatively well buffered and the pH, except in shallow isolated pools, is generally maintained within the range 6.9 to 8.4 and unlike oxygen, is not normally a limiting factor for estuarine organisms.

Food Chains in Estuaries

Estuaries are characterized by very high primary productivity and, as well, a diversity of "producer types" including macrophytes (seaweeds, seagrasses, and marsh grasses),"benthic microphytes" and phytoplankton. These plants provide a virtual year-round source of food; even though production is low in winter, the great masses of macrophyte vegetation produced during the summer decay slowly, thus "buffering" the food supply.

Generally, two basic types of "food chains" are distinguished: "grazing food chains" in which green plants are eaten directly by a herbivore, and "detritus food chains" in which the plant material is first decomposed by microorganisms which are in turn eaten by detritivores.

Grazing:

Plant ⟶ Herbivore ⟶ Carnivore

Detritus:

Plant ⟶ Bacteria and Fungi ⟶ Detritivore ⟶ Carnivore

"Detritus" refers to particles of plant material in varying stages of decomposition. In the detritus food chain, several steps or transfers may be involved before the food energy is transferred to organisms (e.g. fish) utilized by man, for example.

Plant ⟶ Bacteria ⟶ ciliates ⟶ Microinvertebrates ⟶
Macroinvertebrates ⟶ Fish ⟶ Man

Since there is a substantial loss of energy with each transfer (about 90%), this implies that a much greater quantity of the primary producer is required to produce a pound of fish than would occur in a grazing food chain.

In spite of this, there are few fish in estuarine systems which feed directly on the macrophytes - generally the main primary producers - and detritus food chains generally predominate over grazing food chains in estuaries. Macrophyte-based systems are generally characterized by broad-based relatively stable biomass pyramids; i.e., the greatest biomass is associated with the first trophic level (plants), and consumers further removed from the first trophic level have proportionally smaller biomass. In marine grazing food chains, on the other hand, in which the primary production is carried out largely by very small organisms with a high turnover rate; the consumer biomass may be larger than the producer biomass.

The dynamics of detritus-type food chains are complex and there are very basic questions concerning it that remain unanswered in spite of a great deal of research; for example, how much energy is transferred via soluable organic compounds; which friction of detritus is utilized by "detritivores"; what are the particle sizes ingested by detritus feeders; what is involved in nitrogen enrichment of detritus?

The composition of food in the gut of an animal does not necessarily give an accurate picture of what is being utilized - detritus or plant material itself may be picked up only incidentally. It is generally accepted that detritus-feeding invertebrates are actively feeding only on the microorganisms on the plant bacteria particles. The plant material passes through the gut, fecal pellets are recolonized by microorganisms, and the process is repeated. Actual ingestion of the plant material by the animal, however, plays an important role in the process by further breaking it up: thereby increasing the surface area available for attact by microorganisms. Although there can be little doubt that macrophytes in estuaries are important and major sources of food, the exact pathways involved in these transfers are uncertain.

In Figure 2 below is given a food web for common species in Bideford River, P.E.I., taken from Thomas (1970). Most of the more abundant and common species in the Kouchibouguac Park system are included in this Figure. The 'feeding types' are defined on the following page.

Decomposers - bacteria, fungi, decomposing plant and animal materials

Deposit feeders - ingest sediment without carrying out elaborate sorting

Detritus feeders - actively sort organic material from the surface of the sediment

Browsers - these browse over the surface of sediments, plants and rocks removing attached diatoms and sometimes stripping off bits of macrophyte material

Filter feeders - these filter out particles from the water, including detritus particles, phytoplankton and zooplankton

Omnivores - eat both plants (including detritus) and animals

Predators (Carnivores) - eat other animals

Such schemes provide a useful, qualitative description of feeding activities, but are difficult to quantify because (i) incomplete information for many animals; and (ii) food habits may vary according to the availability of food.

It is probably true that food is rarely a limiting factor for animals in estuarine systems, these being the most productive of all ecosystems; thus, while knowledge of feeding habits is valuable from the point of view of understanding the distribution of animals, other factors, physical and physiological, are of much greater importance in determining their abundance.

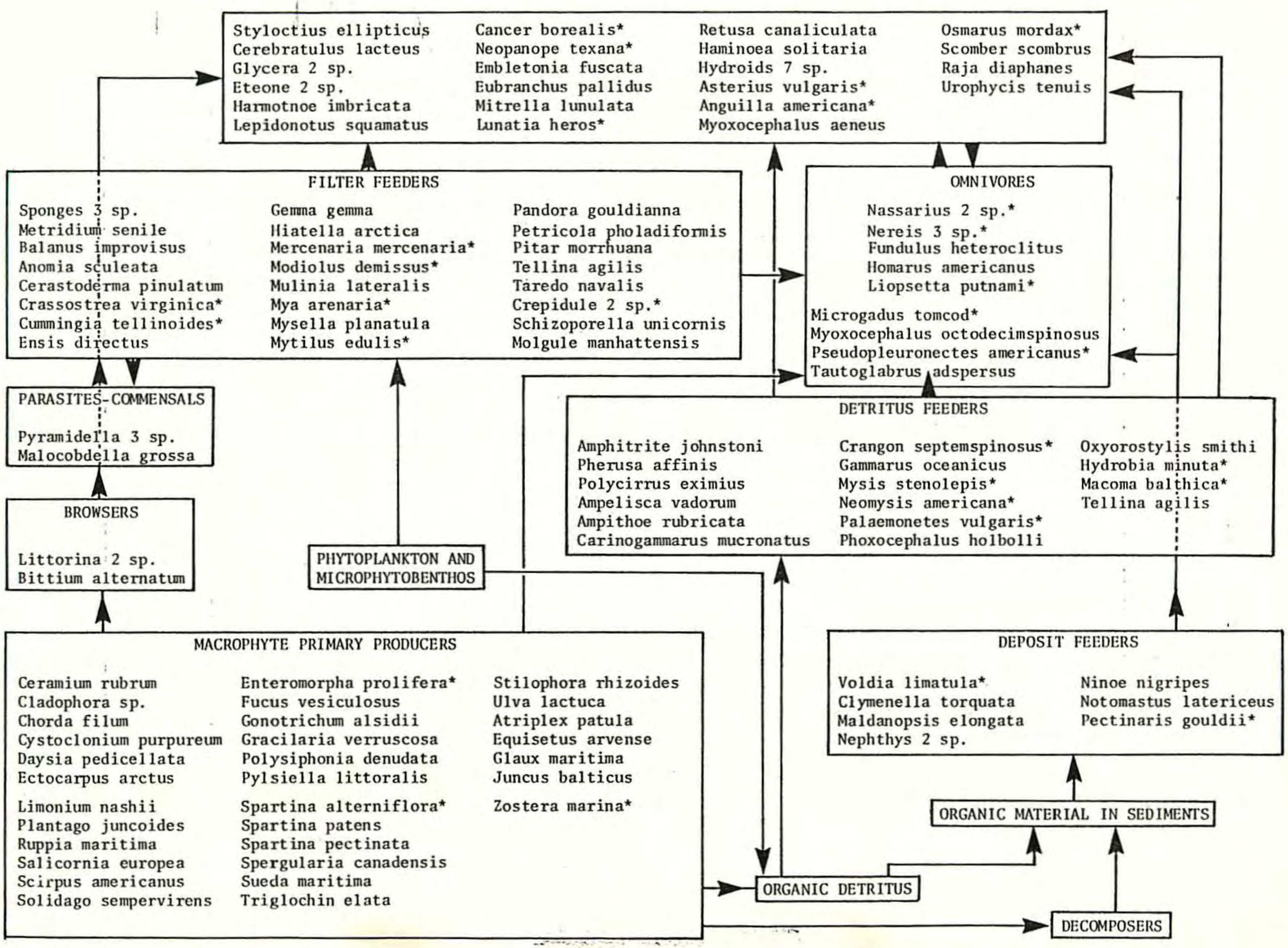


FIGURE 2 Food Web for Common Benthos and Their Predators in Bideford River (Thomas, 1970). The universal return pathway from all groups to the decomposers is ommitted.

Mass Mortalities of Estuarine Fauna - Mass mortalities of one species or several to many species of estuarine fauna have been recorded. Eelgrass, Zostera marina, disappeared from large areas of the North Atlantic in the early 1930's and did not begin to return in abundance until the late '50's and the '60's. The cause of this mortality is disputed; the most current study (Rasmussen, 1973) shows that it was correlated with marine climatic changes.

In the late '50's, a disease almost eliminated oyster production in New Brunswick and Nova Scotia; the effects of this are still being felt (Medcof, 1961).

Quahogs and soft-shelled clams have suffered serious mortalities at various places and times associated with predation, disease or environmental conditions (reviewed by Dickie and Medcof, 1963).

Intrusion of low salinity water into normally deeper saline water at Bideford, P. E. I., as a result of mixing caused by up-estuary gale resulted in extensive mortalities of American eels, common starfish, moon snail, several infaunal bivalves, and lobster (Thomas and White, 1969). For some of these species, normally quite tolerant of low salinities, the rapid changes apparently did not allow sufficient time for acclimitization.

Exchange Between Estuaries or Inlets and the Sea - Estuaries may influence biological and physical processes well beyond what is geologically recognized as "the estuary". Flow of a low density layer (which may be many times greater in volume than the input of fresh water) may create upwelling well beyond the structural limits of the estuary. As well, there may be a net export of N, P, and C from the estuary: and this export may support marine life beyond the geological limits of the estuary. River water and seawater flowing into the estuary carries nutrients which, in the estuary are incorporated into particulate material, carbon coming from the atmosphere and energy from the sun. Depending on the exact nature of geological and biological processes in the estuary, there may also be a net movement of phosphorus from the sediments into the water column (Barsdate et al, 1974; Wood, 1965) and conversion of atmospheric nitrogen, N_2, to combined nitorgen via nitrogen fixation (Patriquin and Knowles, 1972; Stewart, 1967). These materials (C, N, P) will be exported in differing quantities and differing forms according to the biology and physical oceanography of the system. Some systems, for example, "export" substantial amounts of phosporous (Barsdate et al, 1974); others mainly nitrogen or organic carbon (Mann, 1975). Too little is known at the moment about these processes to properly evaluate or generalize upon their quantitative significance beyond the estuary.

As well, as we have discussed above many estuarine organisms spend part of their life history outside the estuary. In some systems, seasonal 'visitors' from the sea may feed extensively in the estuary. In summary, the estuarine system is far from a closed one, being influenced by and influencing in turn the adjacent sea in important ways.

II. C REVIEW OF LITERATURE ON THE MARINE RESOURCES OF KOUCHIBOUGUAC NATIONAL PARK

There are no published scientific studies of which we are aware concerning biological resources of the Park waters, although considerable work has been done in Kouchibouguac Bay (pertinent material has been indicated as appropriate through the report). Most of the background information available to us before our studies began was contained in reports solicited by Parks Canada. We review here only the parts of these reports directly pertinent to the marine resources survey. In addition to the material reviewed, mention should be made of the following reports:

1) Atlantic Resource Planners Limited, 1975. Bio-physical land synthesis and mapping Kouchibouguac National Park. Report submitted to Parks Canada (low level oblique view aerial photographs in this report include the marine (estuarine) sector of the Park).

2) W. B. Watson, 1973. The climate of Kouchibouguac National Park, New Brunswick. Atmospheric Environment Service, Canada Department of the Environment, Published in Applied Meteorology REC-5-73.

3) D. C. Ambler, 1975. Hydrological Inventory of Kouchibouguac National Park, New Brunswick, Canada. Report of Inland Waters Directorate, Water Resources Branch, Halifax, Canada.

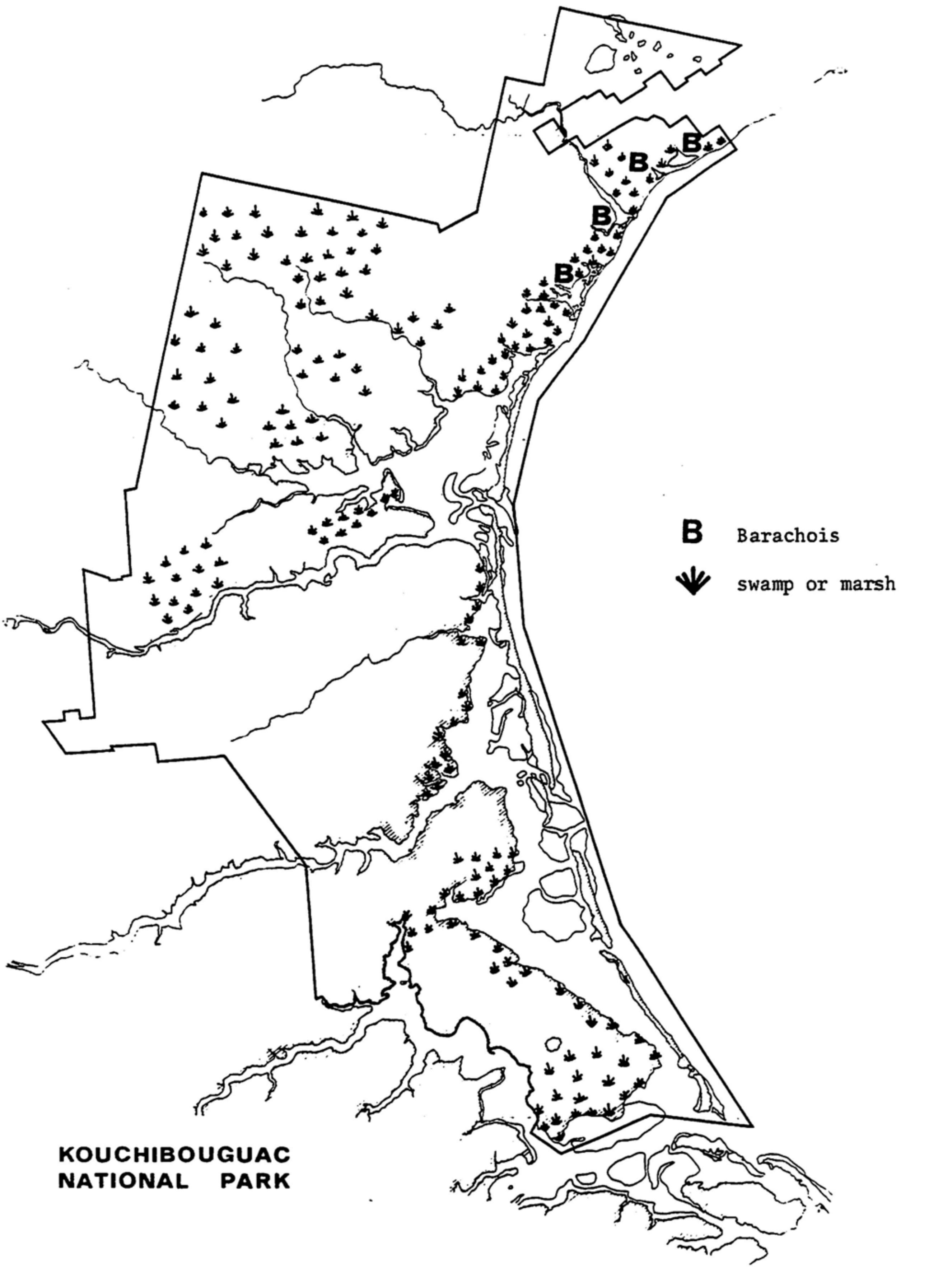
<u>Physiography and Vegetation of the Coastal Land Types</u> - Watson (1971) recognized four land types within the Park:

I. Forested shallow plain of marine deposits
II. Bogs and heath barrens
III. Permanent rivers and streams, river marsh and lake
IV. The coastal zone

The components of the coastl zone he listed as:

1) Coastal heaths
2) Barachois
3) Sand bars
4) Salt Marshes and salt meadows
5) Tidal lagoons

FIGURE 3 Map showing occurrence of Barachois and marsh or swamp in Park. Most of the coastline marshes are flooded by seawater only at the highest tides.



Description of the coastal heaths is outside of the context of this review. A few remarks are made below concerning the Barachois and salt marshes and salt meadows.

"Barachois" refers to tidal ponds open to the sea by narrow entrances or closed off temporarily or permanently by barriers created by action of waves of sand, gravel, shingle, etc. There are four barachois in the Park, all in the northeastern sector (Figure 3). The two lying north of Lower Sapin are semi-tidal wetlands; one of these is currently closed off from the sea, but the low sand barrier might be removed at a high tide combined with an onshore wind. The other two barachois include the mouth of the Portage River, and the area referred to a "Northern Lagoon". The last is at present fresh water. These barachois are reportedly used as resting places for ducks and teal. Fertility is apparently low and waterfowl food scarce. Their possible interest to Park visitors lies in their "wilderness and remote aspect" (Watson, 1971).

True salt marshes and salt meadows occupy relatively small areas of the Park. Watson (1971) refers to salt marshes in the following areas:

(i) At the head of Kouchibouguac Lagoon

(ii) Directly north of the mouth of Kouchibouguac River

(iii) North of Collander Beach, composing part of the Kollock Creek estuary

(iv) Small saline wetlands along Kouchibouguacis Lagoon

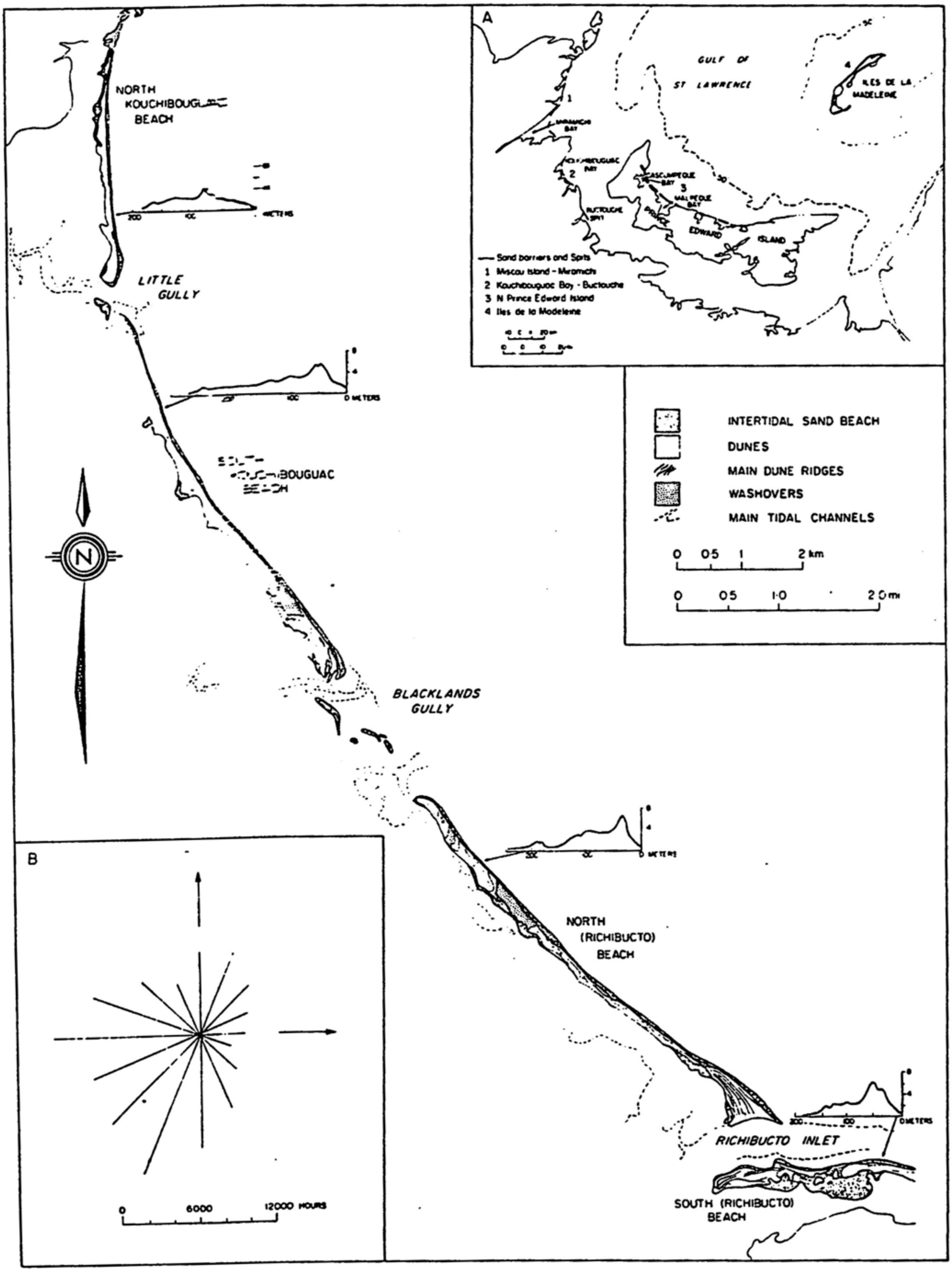
The inferred area of these marshes is indicated on Figure 3. Watson (1971) mentions _Spartina pectinata_ as being the main salt marsh vegetation of (ii). _S. pectinata_ typically occupies that part of the tidal zone flooded only at spring tides or less frequently.

The barrier islands and sand spits themselves on the adjacent Kouchibouguac Bay sediments have been the subject of a number of geological studies reported in the scientific literature, e.g. Bryant and McCann 1973; Greenwood and Davidson-Arnott, 1972; Kranck, 1967, 1962. A comprehensive report on the physiography and vegetation of the beach and sand dune coastline of the Park was prepared by McCann et al, 1973 some of which is reported in the scientific literature by Bryant and McCann (1973).

The following, quoted directly from those works, summarizes points pertinent to the marine resources study:

> "The main sand beaches of the southern part of the Gulf of St. Lawrence consist of four very large systems of spits and barrier islands (Figure 4). The first is the broken, subdued but complex series of spits and islands extending along the New Brunswick coast from Miscou Island south into the Miramichi River estuary. Second is the simplified but well developed barrier island and spit system of Kouchibouguac Bay, New Brunswick, which continues southwards into Buctouche spit. Third is the well developed, extensive system of the north coast of Prince Edward Island, which starts in the west with barrier islands across Cascumpeque and Malpeque Bays and grades into the less complex islands and spits of Cavendish and Rustico. The last large system occurs in Iles de la Madeleine, where long spits and barriers link a series of rock islands.
>
> "The Kouchibouguac system, because of its topographical simplicity and limited fetch window to the northeast, is an uncomplicated representation of the southern Gulf of St. Lawrence beaches. It consists of 29 km of sand beaches running in a gentle arc southeast to northwest (Figure 4). The system is broken in the south by Richibucto Inlet, in the north by Little Gulley, and in the middle by a series of intermittent and semi-stable inlets known as Blacklands Gulley. This system, like others in the southern Gulf, overlies Pennsylvanian sandstones, which have supplied most of the sands as a result of erosion during the recent rise in sea level (Kranck 1972). The area is subject to a mean tidal range of 0.67 m and is usually ice bound from mid December to mid April (Forward 1954). Though the predominant winds in this area are west and southwest (Figure 4), the dominant or storm winds are northeasterly. The bay itself is exposed to northeast winds only 10.4% of the time and only 28.3% of all winds generate waves affecting the beaches after wave refraction. Because of the winter ice conditions, the limited fetch window and the small percentage of winds affecting the bay, the varrier island system is in low energy environment.
>
> "The islands that have developed in this environment are simple (Figure 4). The general trend is for the islands to decrease in width, height and complexity northwards. The barrier islands average 200 to 300 m in width, usually with only one major dune ridge, which rarely exceeds 8 m above lowest low water. At present these ridges are uniform, with only local evidence of blowouts and wave dissected cuts, but they have been eroded into a cliff along the southern section of the bay. The beaches themselves are cuspate, ranging in width from 15 to 60 m. In

FIGURE 4 The barrier islands of Kouchibouguac Bay. Insert A: Sand barrier systems of the southern part of the Gulf of St. Lawrence. Insert B: Wind rose for Summerside, P.E.I., 1956-1970. From Bryant and McCann, 1973.



summer they are usually windswept by the predominate southwest winds, so that texturally the ocean beach and dune sands are well sorted and similar in size (1.2 to 1.6 ϕ). There is a similar uniformity of sand across the lagoon beaches, since there have been frequent inputs of sand from the ocean beach during storms, both through the inlets or as washover debris. The three major inlets that dissect this system have remained stable in position for the last 165 yr opposite the three major estuaries whose tide waters extend 20 km inland. The lagoons range in depth from 1 to 6 m, and average 600 m in width. The rivers emptying into the lagoons have very little discharge in summer, consequently the inlet form is entirely maintained by tidal currents flooding into and ebbing from the lagoons."

"Despite the low energy- environment occupied by these barrier islands there is strong evidence indicating that change is the dominant feature of the system." (Bryant and McCann, 1973)

"The barrier island is one of the most dynamic coastal landforms and is subject to continual change in configuration and topography as a result of wind and wave action. An account of past changes, based on old maps, since 1807, sequential air photography since 1930 and field survey, provides a basis for considering the present condition and future changes. It is clear that the barrier island system has been breached many times by wave action during storms, that the shoreline is undergoing overall landward retreat and that the areas round the three major inlets (Richibucto Inlet, Blacklands Gully and Little Gully) have seen the greatest changes, though the general position of the inlets themselves has remained relatively constant. The present condition of change, with accumulation in some areas and erosion in others, is thus a normal condition andy any stability is only short term. The older dune areas of North Kouchibouguac Beach, the higher dunes of South Kouchibouguac Beach and the southern part of North Kouchibouguac Beach, together with the lagoon area, are likely to remain stable for the next 25-30 years, if the vegetation cover is not reduced by increased visitor activity.

"The main process acting on the barrier islands is wave action and the most important waves are short period storm waves (<8 sec) from the north-northeast and east: the main seasons for destructive wave attack are early spring and fall. The prevailing offshore winds from west and southwest are important in the summer. In the inlets tidal currents must be strong enough to flush out accumulating sediment if the channels are to remain relatively stable: only Richibucto Inlet, controlled to some degree by breakwalls, possesses the criteria of stability.

"The vegetation of the barrier islands proper can be classified into three types - dune vegetation, salt marsh vegetation and freshwater marsh vegetation. The main species of the dunes which occupy the greater part of the islands, are Ammophila breviligulata, Hudsonia tormentosa, Lathyrus japonicus and a series of important lichens: an advanced successional stage with Myrica pensylvanica and Arctostaphylos Usa-Ursi only occurs on the barrier island of North Richibucto Beach. The main species of the salt marsh which occurs in the intertidal zone on the lagoon side of the islands, are Limonium carolinianum, Puccinellia maritima and Spartina alterniflora." (McCann et al, 1973)

Bathymetry of Lagoons and Rivers - No detailed bathymetric data for the lagoons and estuaries of the Kouchibouguac Park area are available. The Gulf of St. Lawrence Pilot cautions that local knowledge is required for entrance into these areas. Bowen and Rivard (1972) describe the Kouchibouguac Lagoon as averaging 3-4' depth, with deeper water occurring in the main channel (25'), river channel (10') and west side of the sand bars (15'). Shallow flats occur extensively inside the sand bars.

Tides - Mean tide and large tide ranges reported (Canadian Hydrographic Service Tide Tables) for Point Sabin, Richibucto Bar and Richibucto Head respectively are 3.0 and 4.6', 2.4 and 3.5', and 2.4 and 4.1'. No data area available for the Kouchibouguac Park area itself.

Circulation - Some observations on salinity and temperature stratification in the Kouchibouguac Lagoon and River are reported by Bowen and Rivard (1972) for two dates in the summer of 1971. Data for selected stations are plotted in Figure 5. These data indicate a marine influence right up to the dam in the Kouchibouguac River (approximately 8.7 miles from the mouth) with a halocline occurring between 1 and 4'. A typically estuarine circulation with seaward movement of low salinity water over higher salinity water moving upstream is apparent. Variations in tidal range and river discharge (Figure 6) can be expected to affect this structure. The Kouchibouguacis and Portage Rivers are described as being "tidal" for their full lengths in the Park.

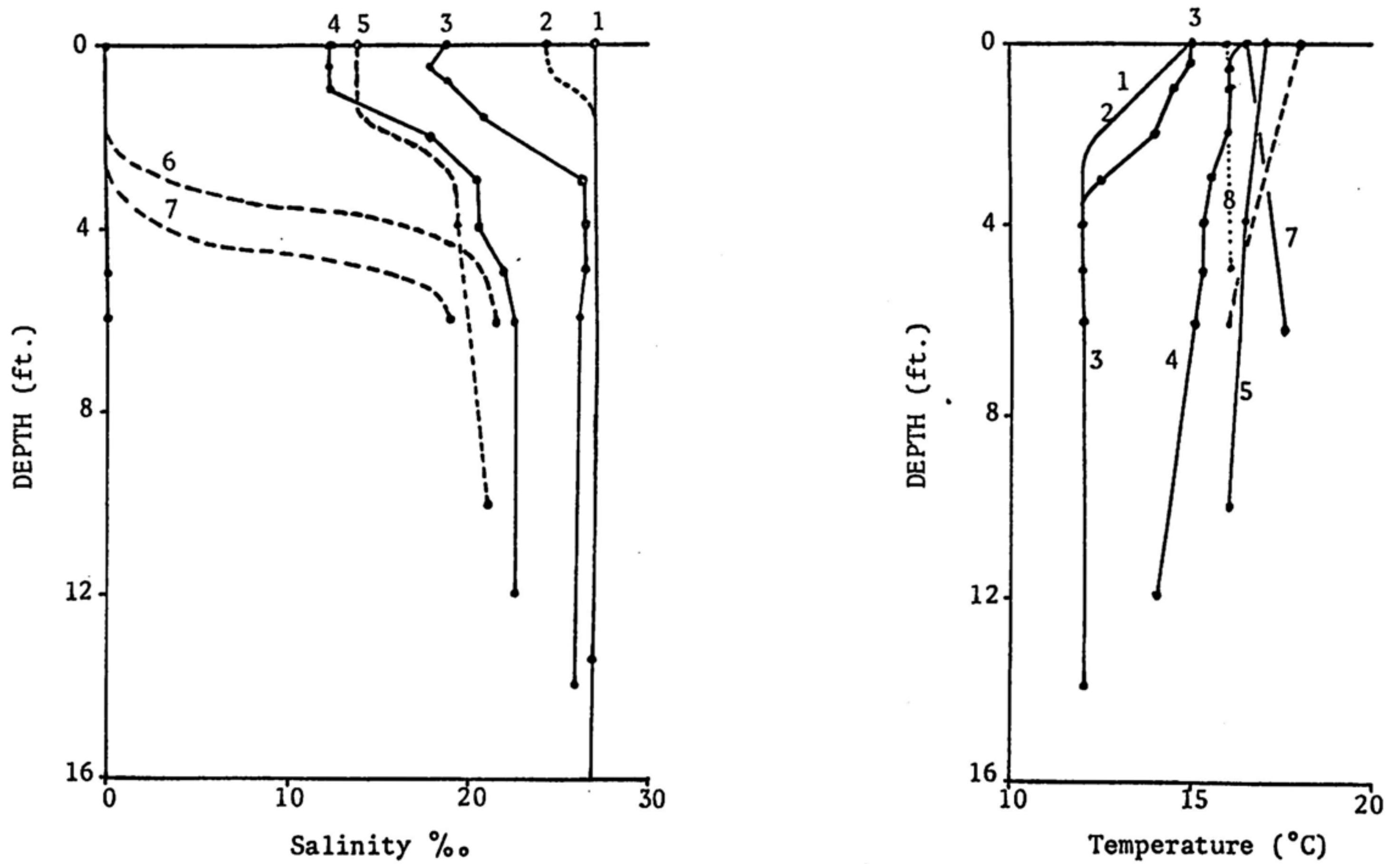


FIGURE 5 Salinity and Temperature Profiles June 27-28, 1971, Kouchibouguac Bay to dam to Kouchibouguac River. Numbers represent increasing distance upstream (1 Kouchibouguac Bay; 2 Little Gulley; 3-7 at 3/4 to 8.6 miles from Logiecroft; 8 above dam). Plotted from data of Bowen and Rivard.

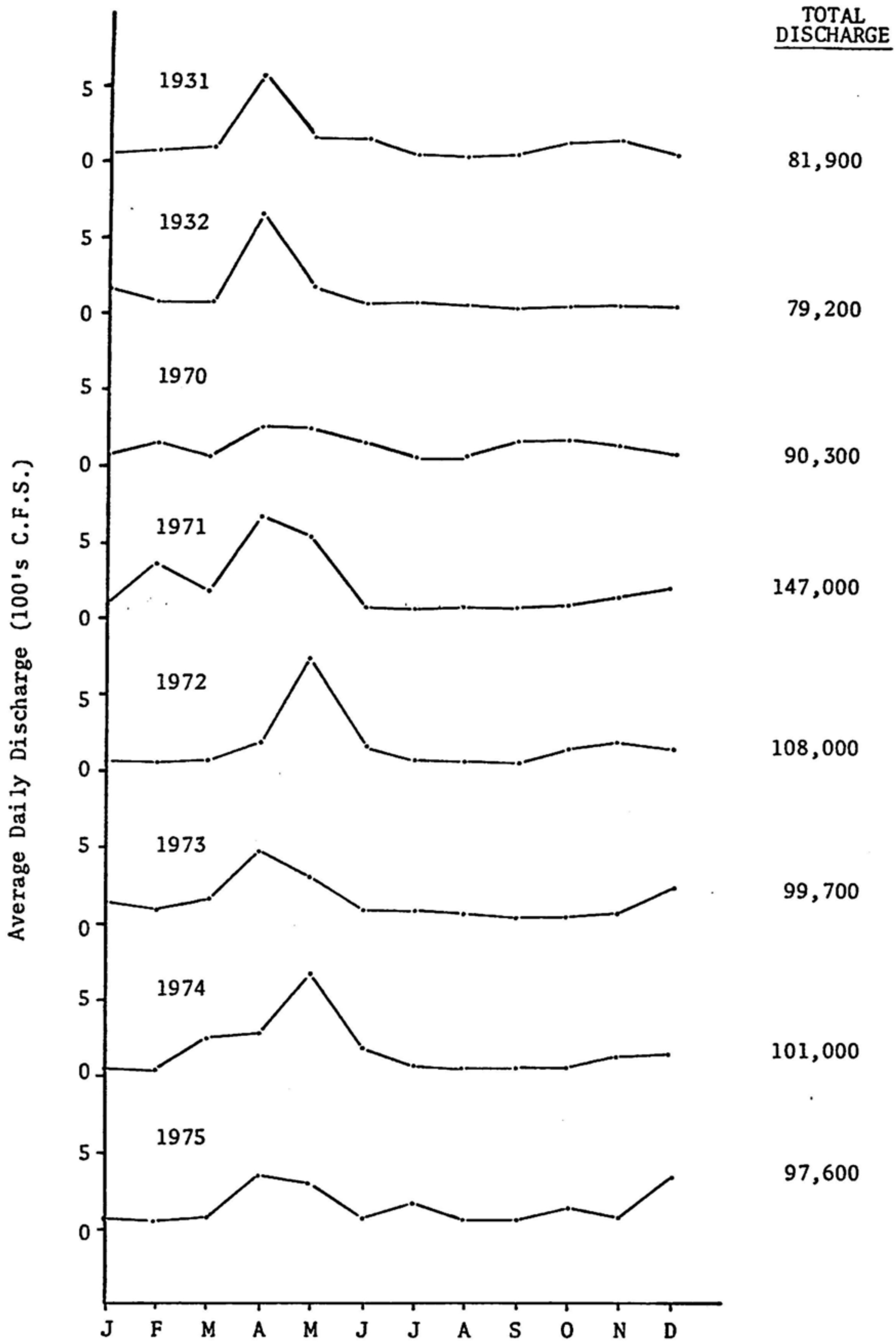


FIGURE 6 MONTHLY DISCHARGE KOUCHIBOUGUAC RIVER - ACADIEVILLE
(Source: Environment Canada)

Seaweeds

Lee and Sutherland (1972) conducted a one week survey of beach habitat seaweeds at the end of May, 1971. These authors give a list of seaweeds occurring on an open exposed coast off Point Sabin Centre, but as this lies outside of the Park boundaries, these observations are not discussed here. Only five algal species are reported as common in the lagoon system (intertidal to wading depth). These are:

Species	Occurrence mid to low intertidal	Subtidal (wading)
GREEN ALGAE		
Enteromorpha flexuosa subsp. paradoxa (Dillw.) Blid.	+	+
E. intestinalis (L.) Link		+
Capsosiphon fulvescens (C. Ag.) Setch. & Gardn.	+	+
BROWN ALGAE		
Pilayella littoralis (L.) Kjellm.	+	+
Fucus distichus subsp. edentatus (De la Pyl.) Pow.	+	+
RED ALGAE		
Polyides rotundus (Huds.)		+

All except P. rotundus are species growing close to the low water level. E. intestinalis and C. fulvescens are characteristic of areas where there is some fresh water input (possibly through seepage). P. littoralis occurs as an epiphyte on Fucus. Ulva lactuca L. was reported to be a common "drift" alga in the lagoon. A larger number of species occur as drift algae on the seaward side of the sand dunes.

Development of a rich algal flora in the lagoon is probably limited primarily by the lack of hard bottom. More species than these can be expected to be found when subtidal locales are examined. The marine angiosperm, Zostera, occurs extensively on flats on the leeward sides of the sand bars and is likely the main primary producer in this system.

Invertebrates - Bowen and Rivard (1972) surveyed the invertebrate fauna in the lagoon, on the surfside of the sand bars, and to a lesser extent in the rivers of the Kouchibouguac system. They utilized shovels, dipnets, seines, skin diving and grabs; samples were screened through 1/4 to 1/16" sieves. Their data are summarized in Table 1. Two coelenterates (not benthic), 12 annelids, 1 nemertean, 27 molluscs, 7 species were found only on the surfside, 9 only in the lagoonal area, and the remainder (11) in both locales. Both the range and stability of the salinity is a key factor governing distributions in such areas; they refer to the following examples of distributions governed primarily by salinity.

Species common surfside but not penetrating the lagoon (high salinity requirements)

sand dollar
blood sea star
daisy brittle sea star
green sea urchin

Species occurring surfside and in lagoon, but falling off abruptly at river mouth

rock crab
hermit crab
common rock barnacle
clam worm
moon snail

Species occurring commonly in lagoon and most of river (12-26 ‰ sal.) soft shelled clam (seaward distribution is limited by factors other than salinity)

Species common to all three areas

sand shrimp

Species restricted to lower salinities (less than 15 ‰)

Gammarus lawrencianus

Bowen and Rivard suggest that the oyster, *C. virginica*, may have once occupied parts of the Kouchibouguac River and believe there is some evidence to suggest that it may have been decimated by pulp mill efflunet in past years. They suggest that oyster beds might be successfully re-introduced. Parks officers report that oyster colonies are to be found adjacent to Logiecroft (Kouchibouguac River) and on the shoreward sides of the lagoon near Black River and Kouchibouguacis River.

Bowen and Rivard (1972) consider the major food resources to be:

soft shelled clam
lobster
blue mussel
rock crab
edible periwinkle (*L. littorea*)

Of these, the soft shelled clam is the most important. The lobster is abundant surfside from about two fathoms into deeper water, occurring less frequently in the lagoon. An artificial reef was established in Kouchibouguac Bay in 1965 to attract lobsters (Scarratt, 1968); the current status of lobsters on this reef has not been reported. In the lagoon itself, it seems there is not much potential for lobsters.

Fishes - A list of fishes reported (Bowen and Rivard, 1972; Gruchy and Gruchy, 1969) to occur in the estuaries of Kouchibouguac Park is given in Table 2. Of these, msot of the anadramous species (including alewife, shad, salmon, white perch and striped bass) and the brook trout (not truly anadramous, but frequently going to sea during periods of increasing temperature in the spring) are commonly caught by angling.

Angling Streams - A summary of comments of Gruchy and Gruchy (1969) and Watson (1971) on the suitability of the three rivers and five main streams in the Park for angling is given in Table 3. The gist of their remarks is that the Kouchibouguac, Kouchibouguacis, and Portage Rivers are or could be attractive to anglers during spawning runs of trout, salmon and striped bass. Of the five streams, only Rankin Brook and Black River are suitable for angling at present and are esthetically attractive. Gruchy and Gruchy (1969) suggest impoundments might improve angling on Kollock Creek (impoundment suggested just west of road and flooding valley behind), and possibly on the smallish Fontaine Creek and Polly's Creek. A number of small streams originating close to the lagoons are capable of supporting only small game fish and minnows.

The only data available on fish that have been caught in the Park are the following cited by Watson (1971) (communication from Mr. Alan Madden) for the Kouchibouguac River:

Brook Trout	April to June	Abundant	Average 11-13"; wt. 1/4-6 lbs.
Salmon	April and May Sept. to Nov.	Common	Average 30-36"; (except grilse)
Striped Bass	April to Nov.	Abundant	Average 16-20"; wt. to 15+ lbs.

Alewife	June	Abundant
White Sucker	May and June	Abundant
American Eel	All year	Common-Abundant

Birds - Watson (1971) presents a list of bird species associated with fresh water wetlands, streams, and the coastal zone of the Park taken from his own observations and observations of the New Brunswick Museum. Bowen and Rivard (1972) considered the following to be important bird predators in the food web of Kouchibouguac Lagoon:

Great Blue Heron
American Bittern
Herring Gull
Belted Kingfisher
Common merganser
Gannet (but not cited in Watson's list)
Osprey
Cormorant
Terns, sandpipers, ducks, geese

The following waterfowl have been observed in large numbers in the Kouchibouguac Lagoon during aerial surveys by CWS, 1966-70, summarized by Watson (1971):

Canada Geese
Black Duck
Green winged teal
Blue winged teal
Scaup
Goldeneye
Eider
Scooter
Merganser
Cormorant
Great Blue Heron

TABLE I Summary of Observations of Bowen and Rivard on invertebrates of Kouchibouguac National Park.

Species	Occurrence			Feeding
	Surf.	Lag.	Abund.	Type
COELENTERATA				
Aurelia aurita (Lamarak) Moon Jellyfish	+	+	i	Carn.
Cyanea capillata (Peron and LeSueur) var. arctica Pink Jellyfish	+	+	c	Carn.
ANNULATA				
Pectinaria gouldii Verrill Trumpet Worm		+mf		FF
Clymenella torquata (teidy)	?	?	?	FF
Diopatra capraea (Bosc) Plumed Worm		+	i	Carn.
Glycera dibranchiata (Ehleus) Beck Thrower	+	+	c	Carn.
Nepthys bucera (Ehlers)	+	+	c	Carn.
Nereis virens (Saars)	+	+	c	Carn.
Nepthys caecae (Febricius)	+int		c	--
Nichomache lumbricalis (Fabricus) Bamboo Worm	+	+	i	Carn.
Ophelia limacina (Rathke)		+mf	i	--
Spiofilicornis (O. F. Muller)		+	c	
Spirorbis borealis (Doudin) Northern Coil Worm	+		i	FF
Nerinides agilis	+		i	Carn.
NEMERTEA				
Cerebratulus lacteus Ribbon Worm	+		i	--
BRYOZOA				
Conopeum reticulum (Linnaeus)		+ha	c	FF
Electra pilosa (Linnaeus)	+sw		c	FF
Hippothoa hyalina (Linnaeus)	+sw		c	FF
MOLLUSCA				
Acmaea testudinalis (Müller) Tortoise limpet	+	+	i	Herb.
Crepidula fornicata (Linnaeus) Back Shell	+so		i	--
Ensis directus (Conrad) Common Razor Clam		+mf	i	FF

Species	Occurrence Surf.	Lag.	Abund.	Feeding Type
MOLLUSCA				
Gemma gemma (Totten) Amethyst Gem Clam	+	+	i	FF
Hiatella arctica (Linnaeus) Arctic Saxicare	+dw		i	--
Hydrobia minuta (Totten) Salt Marsh Spire		+	i	--
Littorina littorea (Linnaeus)	+	+	rc	herb.
Littorina saxatilis (Olivi) Northern Rough Periwinkle		+	c	herb.
Littorina obtosata (Linnaeus)		+	i	herb.
Lunatia heros (Say) Common Northern Moon	+	+	c	Carn.
Macoma baltica (Linnaeus) Little Macoma		+	i	FF
Mesodesma arcticum Conrad		+mf	c	FF
Modiolus demissa plicatulus Atlantic Ribbed Mussel	+	+	c	FF
Modiolus modiolus (Linnaeus) Horse Mussel		+so	i	FF
Mya arenaria (Linnaeus) Soft Shell Clam		+mf	rc	FF
Mytilus edulis (Linnaeus) Blue (edible) mussel	+	+	rc	FF
Nassarius obsoletus (Say) Eastern Mud Snail		+	rc	Carn.
Nassarius trivittatus (Say) New England Basket Shell	+		i	Carn.
Odostomia trifida (Totten) 3-lined Odostome		+p	c	--
Petricola pholadiformis (Lamarck) False Angel Wing	+so		i	--
Pitar morrhuana (Linsley) Morrhuc Venus	+so	+so	i	FF
Placopecten magellanicus (Gmelin) Giant Scallop	+so,dw		i	--
Siliqua costata (Say) Ribbed Pod Shell	+so		i	FF
Spisula solidissima Atlantic Surf Clam	+		i	FF
Tellina agilis (Stimpson) Dwarf Jellin	+	+	c	FF
Venus mercenaria (Linnaeus) Northern Quahog	+so	+so	i	FF
Zirphaea crispata (Linnaeus)		+	i	FF
ANTHROPODA				
Balanus improvisus Darwin Common Rock Barnacle	+pi	+pi	c	FF
Cancer irroratus (Say) Common Rock Crab	+	+	rc	Carn.,Scav.
Crangon septemspinosa (Say) Sand Shrimp	+	+ri	c	Scav.
Gammarus lawrencianus Bausfield		ri	c	--
Gammarus oceanicus Segerstrale	+	+	c	--
Homarus americanus (M.-E.) American Lobster	+	+	c,surf.	Carn.,Scav.
Idotea baltica (Pallas)		+tp	i	Scav.

Species	Occurrence Surf.	Lag.	Abund.	Feeding Type
ANTHROPODA				
Idotea phosphorea (Harger)		+tp	i	Scav.
Mysis stenolepis (Smith)	+	+	c,Avg.	--
Paguris acadicnus Benedict Hermit Crab	+	+	c	Carn.,Scav.
Talorchestia megalophthclma (Bate) Beach Hopper	+su,be		rc	--
Talorchestia longicornis (Say) Beach Hopper		+be,su	rc	--
ECHINODERMA				
Asterias vulgaris (Verill) Purple Starfish	+dw	+lg,dw	c	--
Echinarachnius parma (Lamarck) Sand Dollar	+dw		c	--
Henricia sanquinolenta (Müller) Blood Sea Star	+dw		i	--
Ophiopholis aculeata (Linnateus) Daisy Brittle Star	+dw		i	--
Strongylocentrotus droebrachiensis (Müller) Green Sea Urchin	+dw		i	--

LEGEND

i = infrequent
c = common
mf = mudflats
ha = hard bottom
sw = on seaweeds
dw = deep water
p = on plants
so = shells only
pi = pilings
ri = river also
su = supratidal
be = beach
lg = Little Gulley
ro = rocky substrate

Carn. = carniverous
FF = filter feeder
Scav. = scavenger
herb. = herbivore

TABLE II Fishes Reported to Ocean in Estuaric Sector of Kouchibouguac Park

Skates

Raja erinacea (Little skate)

Herrings

Alosa pseudoharengus (Alewife)
Alosa sapidissima (Shad)

Salmon and Trout

Salmo salar (Atlantic salmon)
Salvelinus fontinalis (Brook Trout)

Smelts

Mallotus villosus (Capelin)
Osmerus mordax (American smelt)

True Eels

Anguilla rostrata (American eel)

Killifishes

Fundulus heteroclitus (Mummichog)

Sticklebacks

Apeltes quandracus (four-spine)
Gasterosteus aculeatus (three-spine)
Gasterosteus wheatlandi (Blackspotted)
Pungitius pungitius (Nine-spine)

Cods

Microgadus tomcod (Tomcod)

Basses

Roccus americanus (White perch)
Roccus saxatilis (Striped bass)

Sand Lances

Ammodytes americanus (American snad lance)

Mackerals

Scomber scombrus (Atlantic mackeral)

Silver sides

Menidia menidia (Atlantic silverside)

Sculpins

Hemitripterus americanus (sea raven)
Myoxocephalus aenus (Grubby)
Myoxocephalus octodecemspinosus (Longhorm sculpin)

Flatfishes

Pseudopleuronectes americanus

TABLE III Summary of Literature (Gruchy and Gruchy, 1969 ; Watson, 1971)
Comments on suitability of rivers and streams for angling

System	Headwater	Marine Influence	Topography, Vegetation	Suitability for Angling
Kouchibouguac River	Outside Park Boundary	Tidal Beyond Park Boundary	Open water with 1 small fresh water marsh. Very shallow. Rocks and dead heads present. Slightly stained water. Low velocity. Shoreline cleared fields and woodlots. River mouth with *Juncus* and *Typha*.	Suitable for small craft. Angling during runs of trout, salmon and striped bass. Accessible. Management to improve angling not considered possible.
Kouchibouguacis	Outside	Tidal in Park	Maximum depth not greater than 10'. Shoreline mainly abandoned cleared fields. Near mouth, banks part of low-lying bogs or heath. Gradient gentle within Park slightly strained. No silt load observed. Open water.	As above
Portage River	Outside	Tidal in Park	Marshy except near highway.	As above
Kollock Creek	Inside	Mainly tidal	Marshy. 10' width and not greater than 3' depth most of length. Upstream, pines line bank. Dense brush most areas.	Could support angling fish but accessibility is difficult. Suggest dam west of road to flood marshy valley behind might improve angling. Scenic.
Rankin Brook	Largely Outside	Tidal Estuary upper reaches?	Flows through marshy regions. Forest edge dense.	Probably supports reasonable trout population. Canoes; very scenic. Presently suitable for angling.
Black River	Largely Outside	Flows into Kouchibouguac Lagoon. Fresh water above estuary?	Marshy several 100 yds. west of Claire Fontaine but above estuary bottom firm and covered with gravel, small boulders. 40' width most of length; greater than 5' depth in areas. Swiftest stream of Park.	Evidently well fished; very attractive. Presently suitable for angling.

TABLE III (cont.)

System	Headwater	Marine Influence	Topography, Vegetation	Suitability for Angling
Fontaine Creek	Outside	Partially Tidal	Greater than 8' wide; 12-18" depth. Flows through shallow gulleys densely covered with alders and willows. Dense marsh areas.	Large fish probably present only during runs (trout). Too small to attract anglers. Impoundments might improve angling.
Polly's Creek	Inside	As above	As above	As above

III. THE RESOURCES: A SURVEY

1. The Physical Environment

1(i) Tide Data

A tide recorder was installed at the Logiecroft Wharf concurrent with the bathymetric survey. The recorder was an Ott float and stillwell unit and was susceptible to tampering causing some breaks in the record. All information was analyzed and plotted with the tide record at Rustico, Prince Edward Island for the months of June through August (Figure 7) . The Rustico water levels were plotted from hourly observations.

Because of the type of system there are undoubtedly considerable differences in the tide height and lag throughout lagoons. A considerably long period monitoring station would be needed to establish these anomolies. Such differences were observed by the field party e.g. slack water upriver and flooding tide at the Logiecroft station.

Tide information is referred to the lowest water level recorded because a mean low water level could not be obtained over one short season. No attempt was made to compensate for differences around the system. All corrections applied are referred to the station at Logiecroft.

The tide record in the Kouchibouguac Lagoon was quite similar to that at Rustico. It did however lag by periods of nearly 3 hours and was always lower in magnitude varying between 39 and 97 percent of the magnitude at Rustico for the major node (July 15 and July 24 respectively).

The tide record obtained was semi-diurnal in nature as could be expected from the tide pattern outside the lagoon system (Rustico, Shediac, etc). It appears that the lagoon tide followed the sea tide closest when the magnitude of the major mode was very high and the minor mode was relatively small.

Current data (below, Figures 23 and 24) suggest that the southern lagoon flushes more rapidly then the northern lagoon. The currents at the Kelly's Beach Narrows area being toward the northern lagoon on flooding tides and towards the southern lagoon on falling tides. These exchanges as well as "wind tides" may be the reason for the somewhat irregular nature of the tides at Logiecroft in comparison to Rustico.

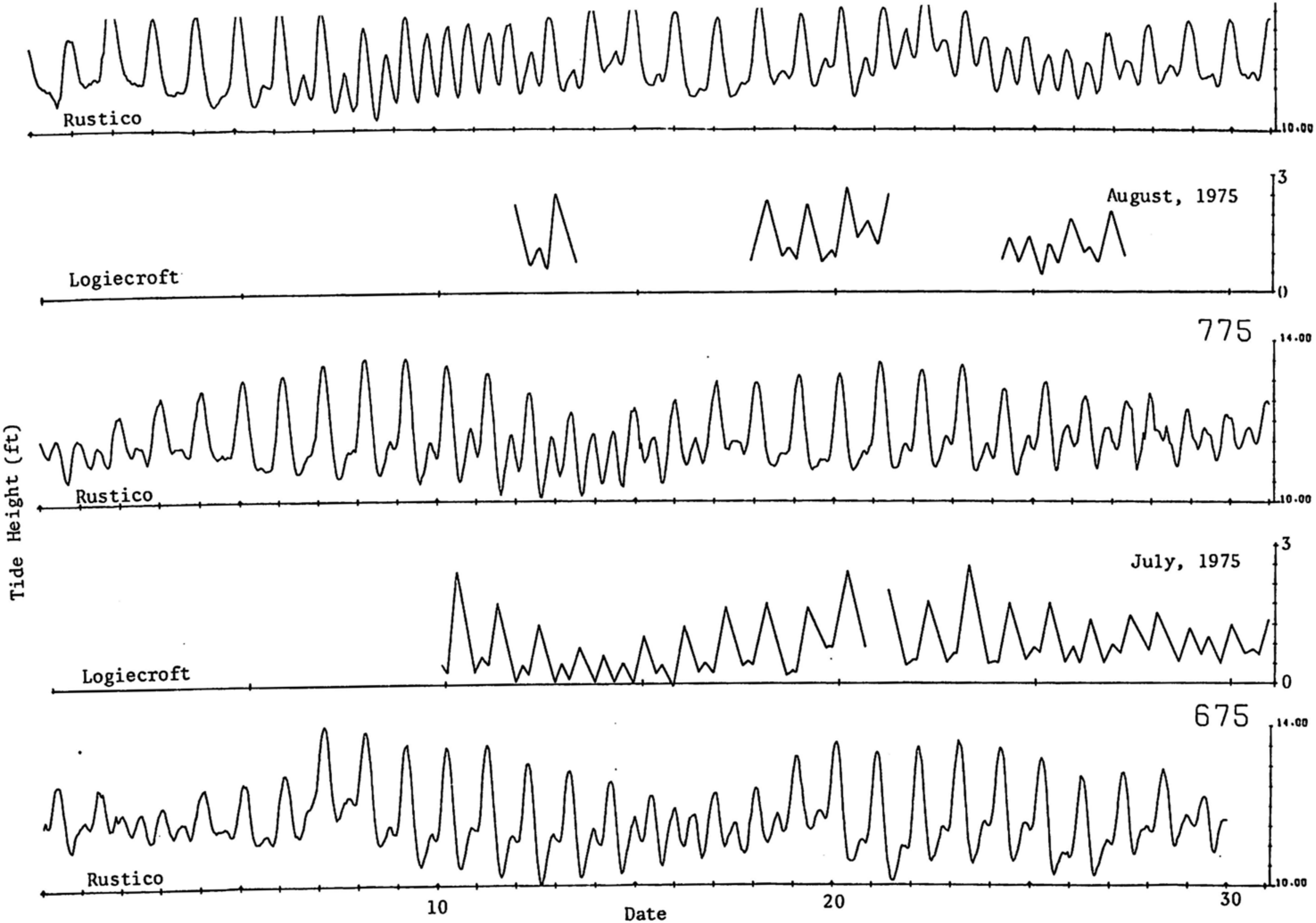


FIGURE 7 Tide record at Logiecroft, N.B. and Rustico, P.E.I., June-August 1975.

III. 1(ii) Bathymetry

Bathymetric data was obtained during the latter half of July and throughout August in conjunction with other activities. Depths are referred to lowest low water observed during the period of the observations. Without simultaneous tide records at several different points in the system, such corrections can only be approximate (estimated maximum error, ±10 cm).

Positioning was obtained by compass sights on prominent points of land or structures around the system. Details of channel meander were obtained from aerial photographs (National Air Photo Library Serial No. A30953) and plotted onto work maps to facilitate field depth data collections.

Sufficient depth information was obtained to enable characterization of the major topographic features of the system. The channels are marked and channel depths are identified separately to other data. Spot depth observations are also included on the map (Figure 8). The main features are:

(1) "Mud flats" inside of the dune bars with an average depth of about 29 cm and maximum depth of 55 cm.

(2) Channels in lagoons in rivers with depths up to 6.2 meters.

(3) "Deep spots" in the vicinity of the narrows between the 2 lagoons with depths of 1-2 m.

(4) Over the remainder of the lagoon, the average depth is 58 cm, and all depths are less than 1 m.

Figures 9, 10 and 11 illustrate these topographic features and the associated flora and fauna.

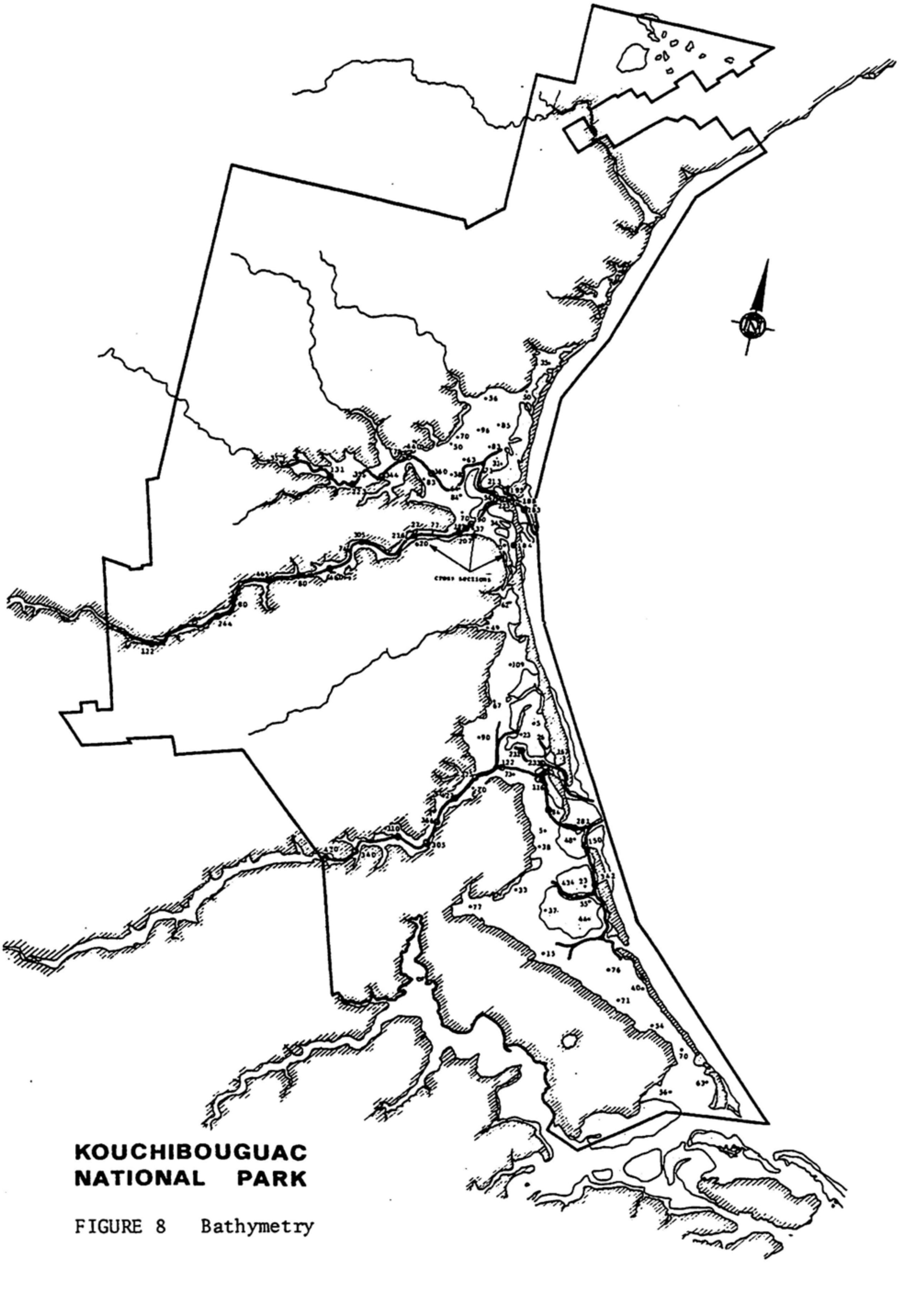


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FIGURE 8 Bathymetry

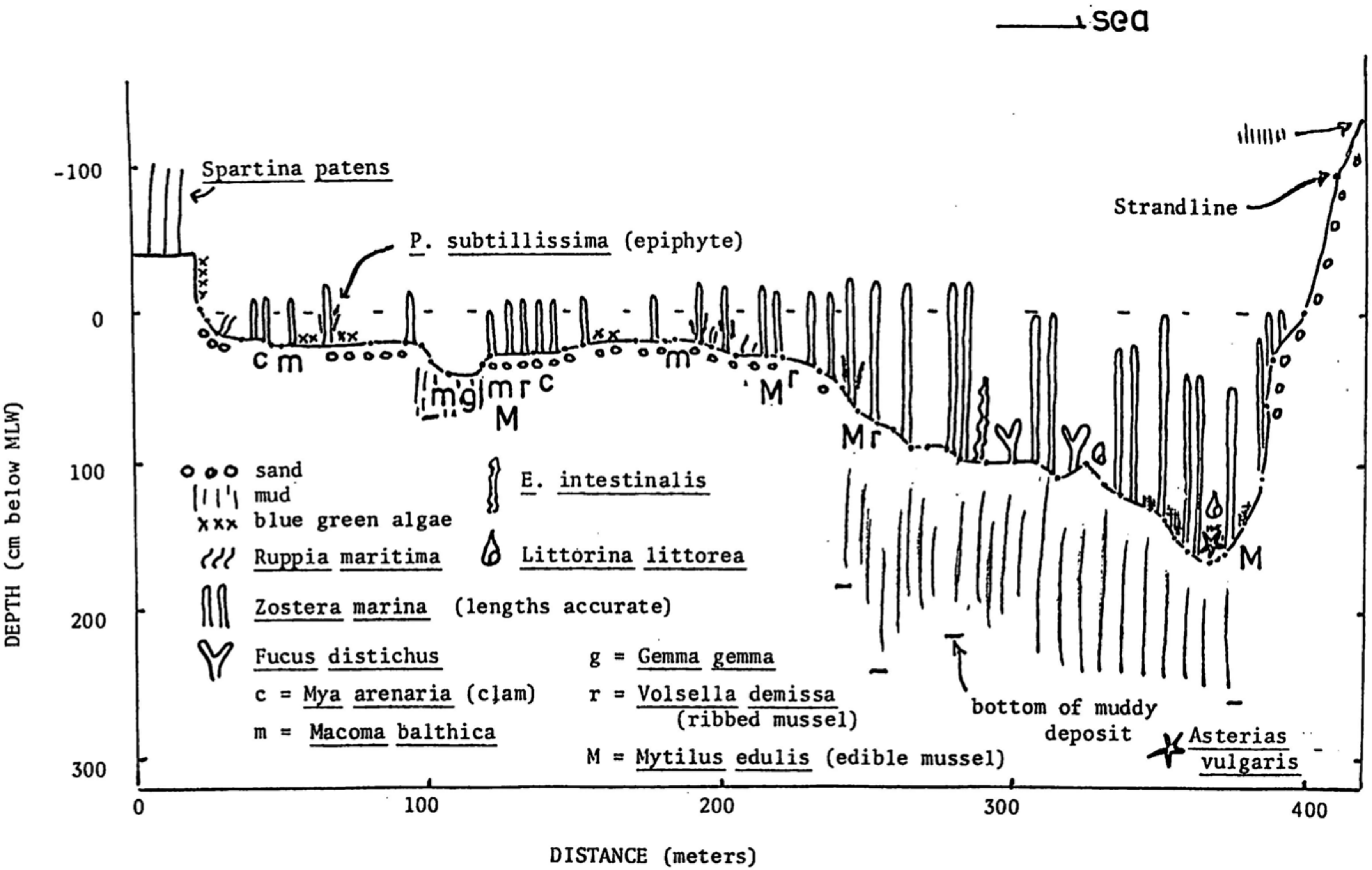

Figure 9. Profile across southern sector of Kouchibouguac Lagoon. Depths are + 20 cm relative to bathymetric map.

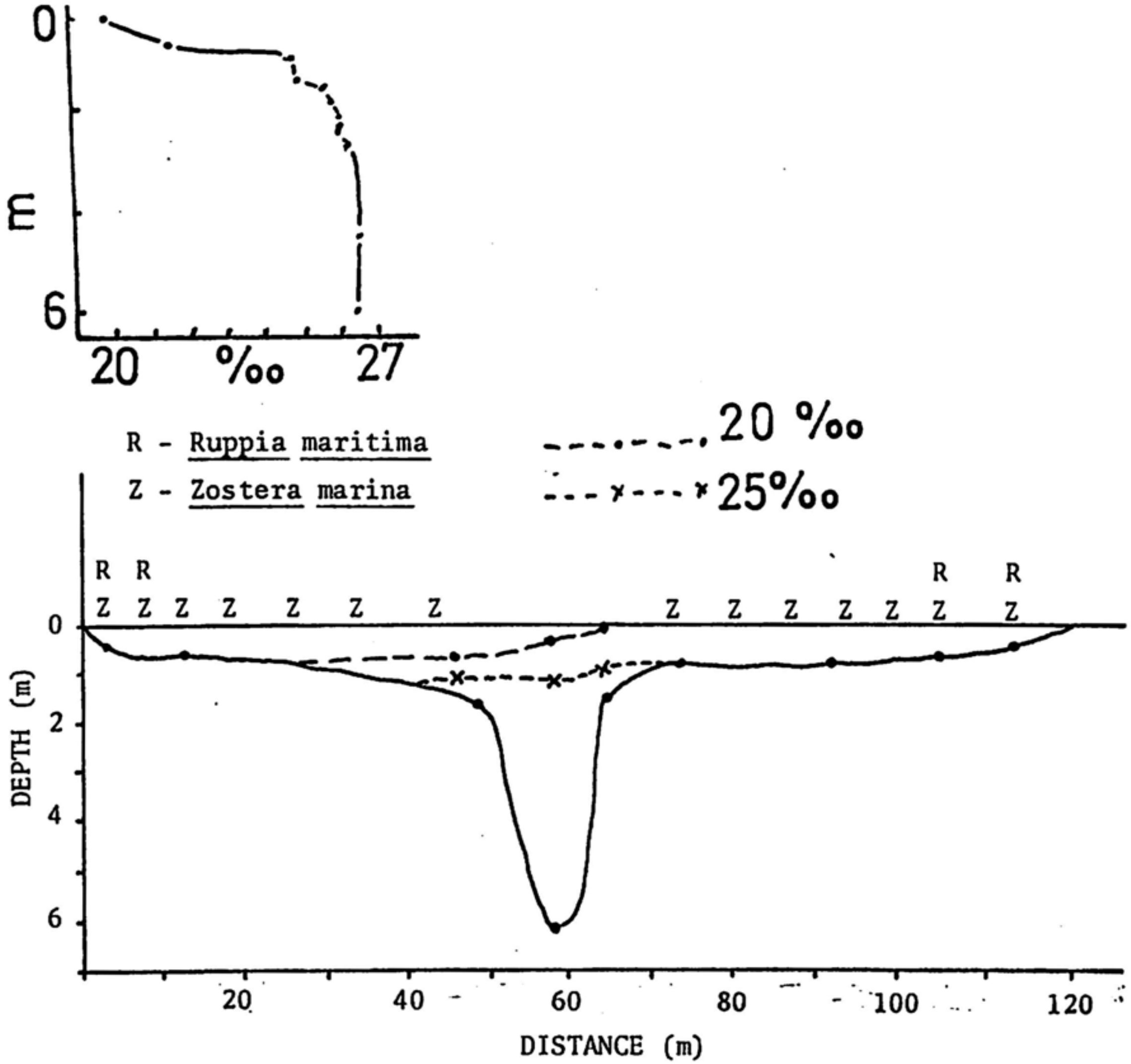

FIGURE 10 Profile Across Kouchibouguac River, looking seaward August 26, 1975. Salinity structure and distribution of Zostera (Z) and Ruppia (R) are indicated.

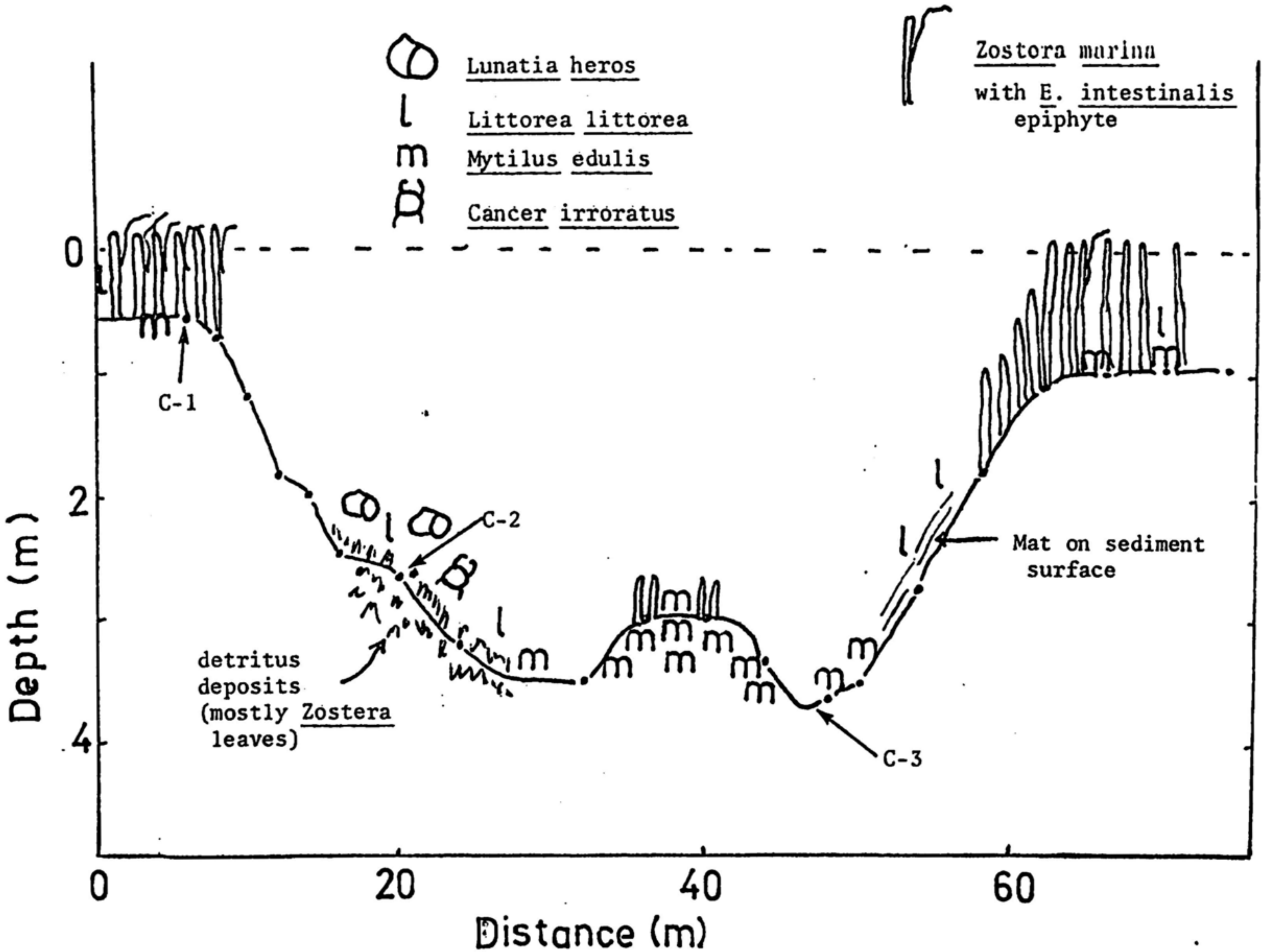

Figure 11. Profile across Kouchibouguac channel, mid lagoon area, looking seaward

III. 1(iii) Salinity, Temperature and Circulation

DATA

With a working crew of three people, and a broadly oriented program to carry out, we quite obviously could not attempt to obtain detailed spatial and temporal observations on salinity, temperature and currents. However, by taking salinity, temperature and current observations at the various biological observation stations through the summer, and following this up with salinity-temperature profiles of the main channels on a single occasion, and 24 h temperature, salinity and current observations at a selected point, we have been able at least to get a qualitative impression of the circulation patterns. Surface water samples were taken in a bucket of water and deep water samples with a Nisken bottle, or by hand as convenient at the biological stations. Temperatures were measured with a laboratory thermometer, and salinity samples were later analyzed by use of a precision conductance salinometer ($\pm$0.003°/₀₀)system standardized against "Eau de Mer Normale" (Strictland and Parsons, 1974).

Currents were measured by use of small drogues or with floats. The time taken to traverse 2 m was recorded. Over the period August 22 to August 26 salinity and temperature measurements of river profiles and over a 24 hour period at one point were measured with a Beckman RS5 Inductive Salinometer and currents were measured with a Braincon recording current meter.

The original temperature, salinity and current data are given in Tables 4 through 10 . Mid channel temperature and salinity profiles are plotted in Figures 13 to 17.[1] The 24 hour temperature/salinity and tide height data are plotted in Figure 19, and the current data for these stations in Figures 20 to 22. Currents observed at the biological stations are plotted for ebbing and flooding tides in Figures 23 and 24. On Figure 25 surface temperatures, all points (except the profile and 24 hour station data) are plotted against the date. Surface salinity data are plotted by date in Figure 26 with upriver, near shore and lagoonal stations distinguished.

[1] Positions of profiles are given in Figure 12.

COMMENTS

Salinity and Currents

For the areas of the rivers within the Park boundaries, the degree of salinity stratification in the 3 major rivers increased in the order Black River - Kouchibouguacis River - Kouchibouguac River (Figures 13,15 and 17). The percent of the Northumberland Strait composite drainage encompassed by these 3 rivers increases in the same order, viz 0.17%, 6.78% and 23.47% (Hooper, 1974), and thus the differences in stratification probably reflect comparable differences in the volumes of river outflow. Some caution is required on interpretation of the profiles in this manner however as equivalent portions of the river systems were not examined (only those portions within the Park boundaries were examined).

The Kouchibouguac River salinity profiles approach those characteristic of a salt-wedge type estuary; the surface layers become progressively more saline in the seaward direction while the lower layer waters and salinity close to that of the adjacent seawater (approximately 28 ‰). The profiles are complicated somewhat by change in the tide during the period of observation (extending from 1200 hours to 1432 hours). Thus surface salinities decreased up the river to station 7 and stations 4, 5 and 6 are characterized by a low salinity SURFACE LAYER - HALOCLINE- HIGH SALINITY DEEP LAYER profiles with little change in salinity between 0 and 2 feet. At station 7, however, the salinity changed by 9.6 ‰ between 0 and 2 feet and at stations 8 and 9 higher surface salinities occurred there in the previous 4 stations. It is apparent that towards low tide stratification decreases. Thus the degree of entrainment of saltwater into the upper layers changes with phase of the tide. At least in the lower parts of the river the currents at 1 m changed 180° with ebb and flood tides (Figures 20 to 22); salinity and temperature varied accoringly (Figure 19).

For what appears to be comparable (to the Kouchibouguac River) areas of the Black River, and the Kouchibouguacis River (Figure 12 - map with locations of profiles), the deep layer salinities decreased to a greater extent proceeding up the rivers than in the Kouchibouguac River, and the difference in salinity (ΔS) between the surface and bottom water tended to be more consistent than in the Kouchibouguac River - these profiles tend towards the partially mixed estuarine structure, the Black River more so than the Kouchibouguacis River. (All 3 rivers were surveyed during a period of falling tide and thus can be at least roughly compared; the Kouchibouguac River was surveyed later in the falling tide than were the other two).

More strongly stratified structures can be expected during other periods of the year. Surface salinities near both the mouth of the Kouchibouguac River and near the Park boundary reached values less than 5 ‰ before July 16, but not thereafter (to August 27).

In all 3 rivers the degree of stratification decreased towards the sea, as would be expected. Surface salinities within the lagoonal area over the summer were generally within the range 20-30 ‰, while they varied over a much larger range in the river areas (Figure 26). In the shallow lagoonal waters, there is little stratification (see data in Table 4). Thus almost the full range of estuarine type circulations - from the salt wedge type to vertically homogeneous is represented in the Kouchibouguac estuarine system.

As would be expected on the basis of these salinity observations, currents in the rivers and in the channels leading from the rivers through the sand dune were generally strong and regularly reversing with the tides (Figure 22) while in the broad lagoonal expanses they were generally weak and irregular (Figures 23 to 24). Over broad expanses of the Kouchibouguac Lagoon, the eelgrass canopy appears to be particularly effective in baffling water movements; in July and August when leaves reached the surface, large areas were observed completely motionless while wave ripples occurred outside the eelgrass stands; orange peels thrown in the water at one dense eelgrass area did not move at all for over a 12 hour period.

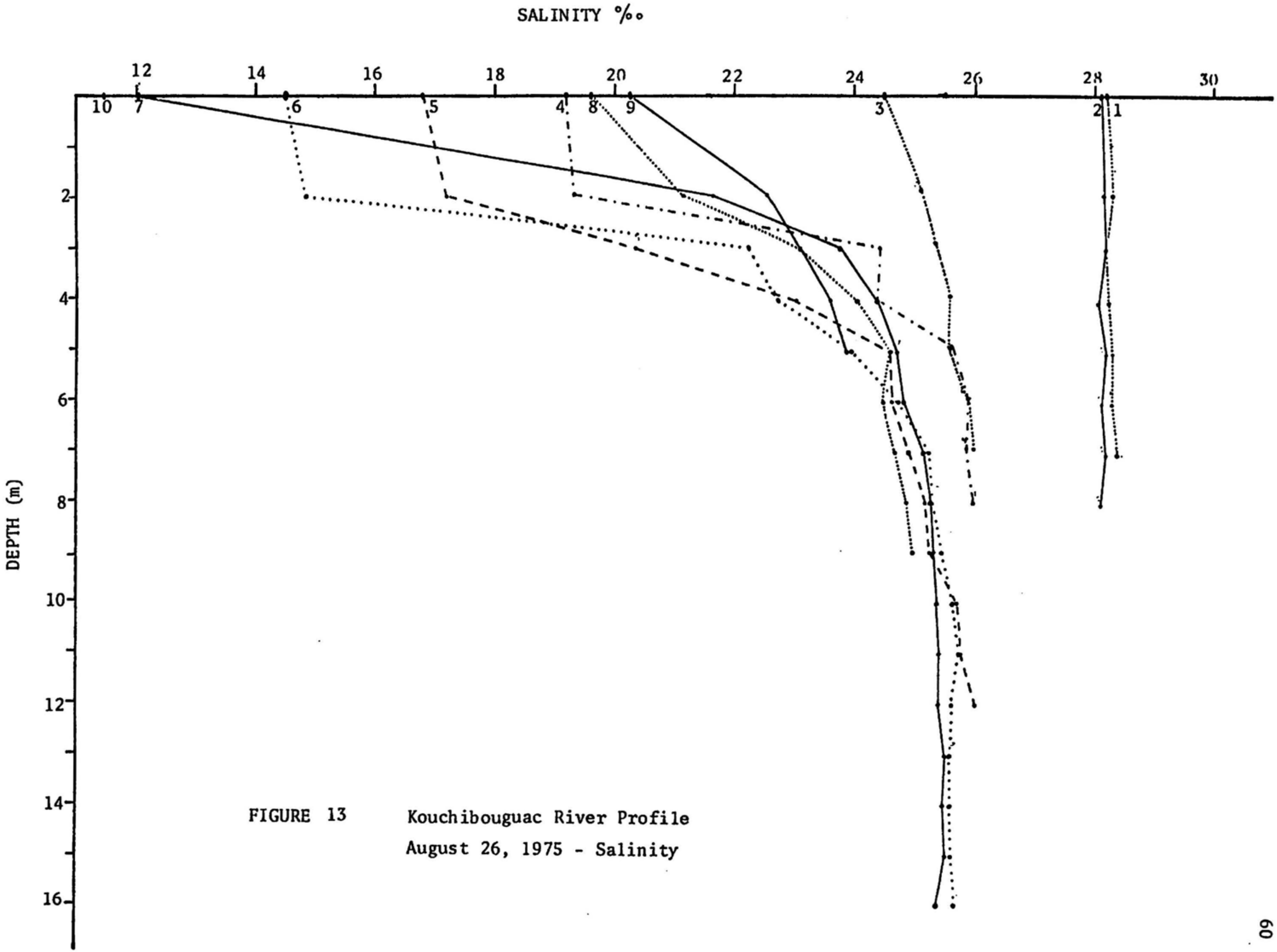

FIGURE 13 Kouchibouguac River Profile
August 26, 1975 - Salinity

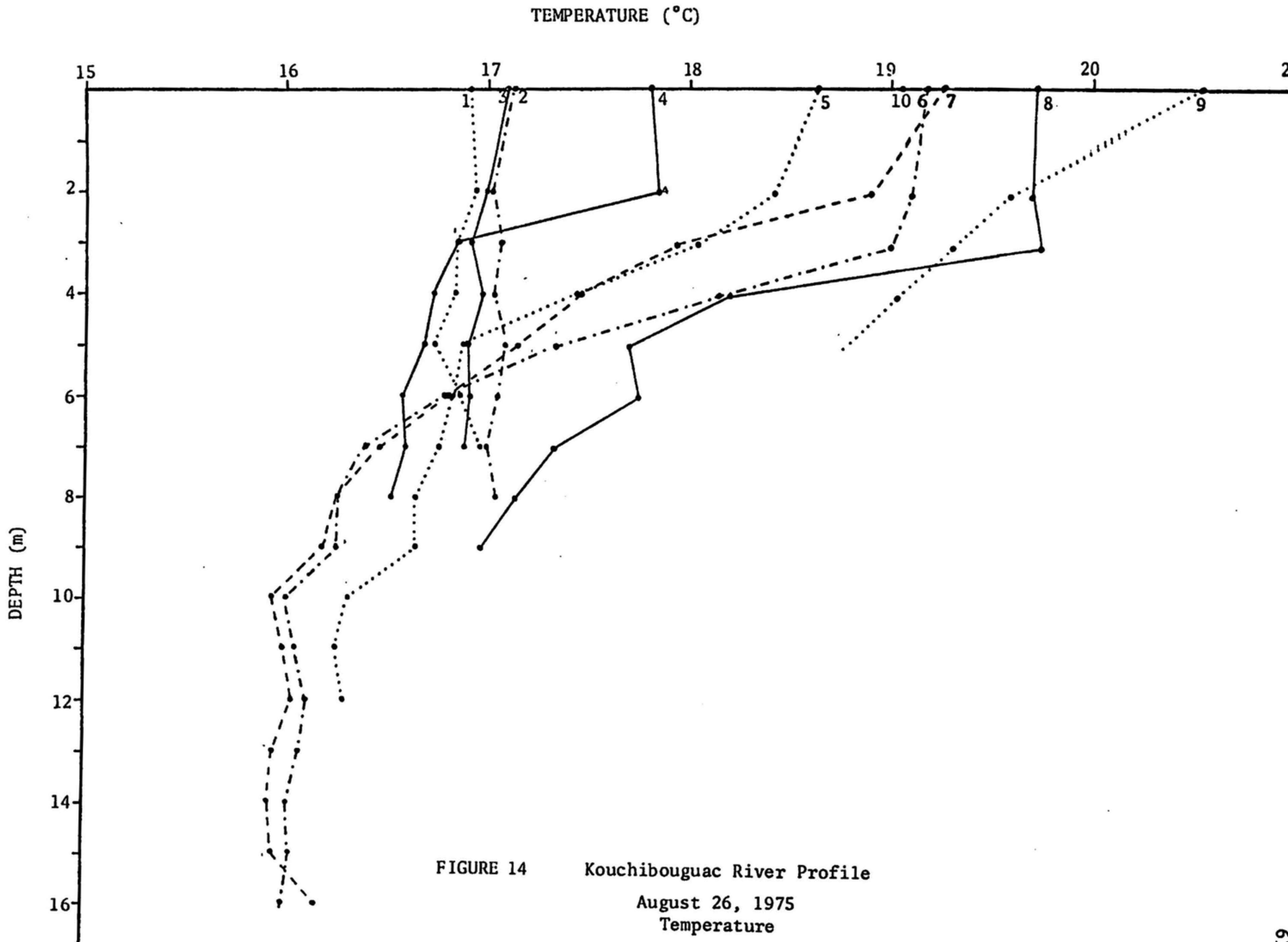

FIGURE 14 Kouchibouguac River Profile
August 26, 1975
Temperature

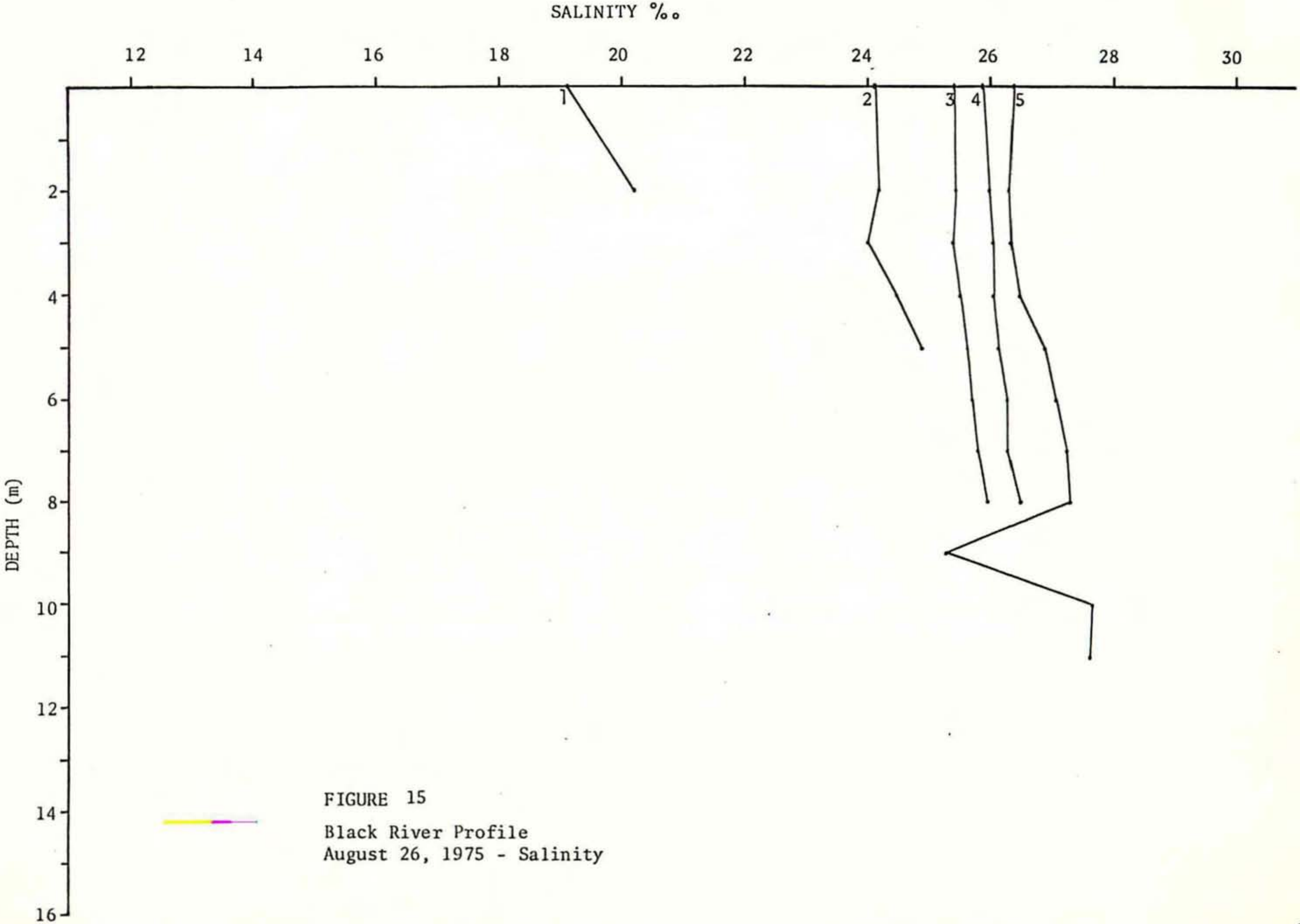

FIGURE 15

Black River Profile
August 26, 1975 - Salinity

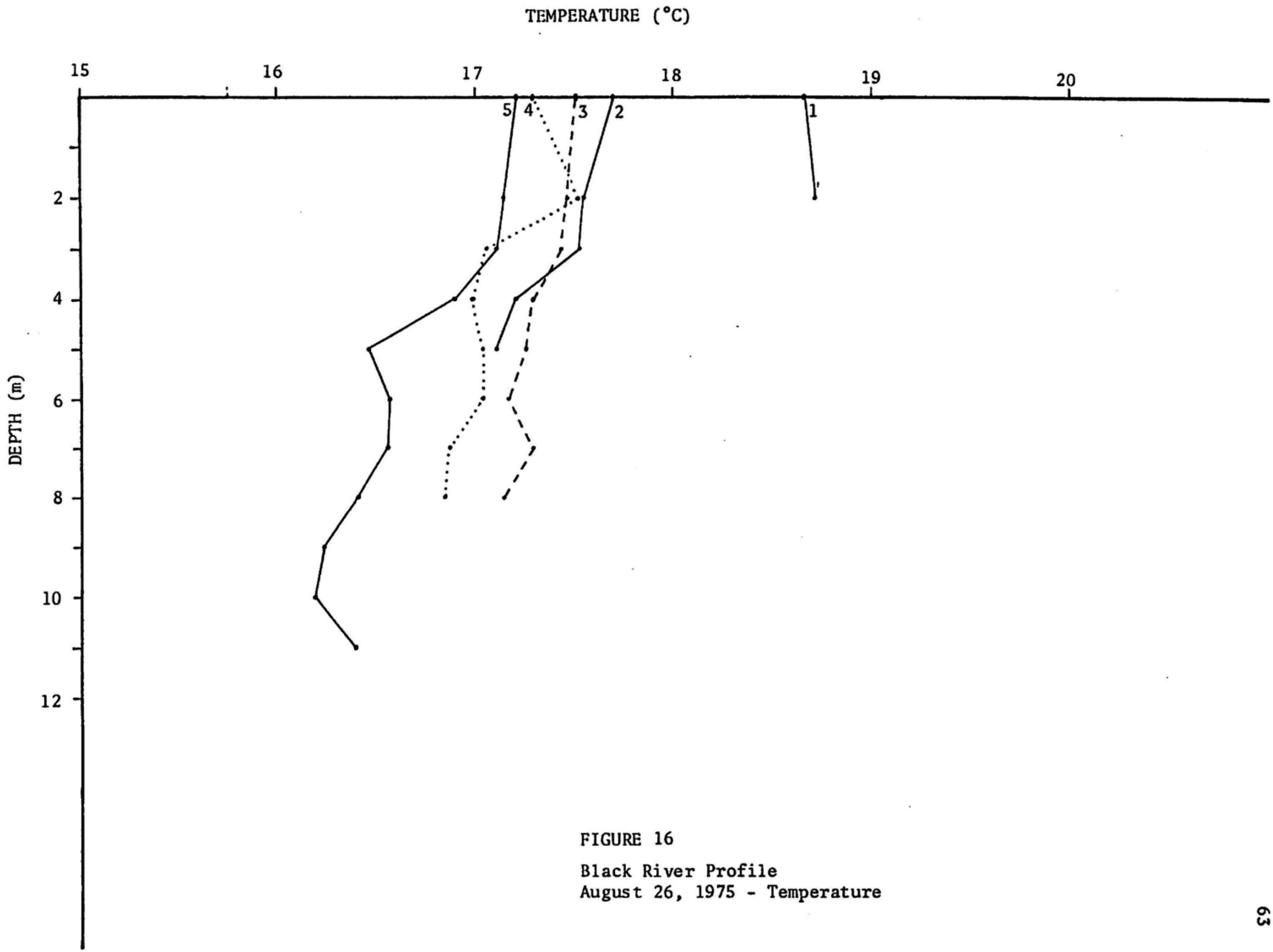

FIGURE 16

Black River Profile
August 26, 1975 - Temperature

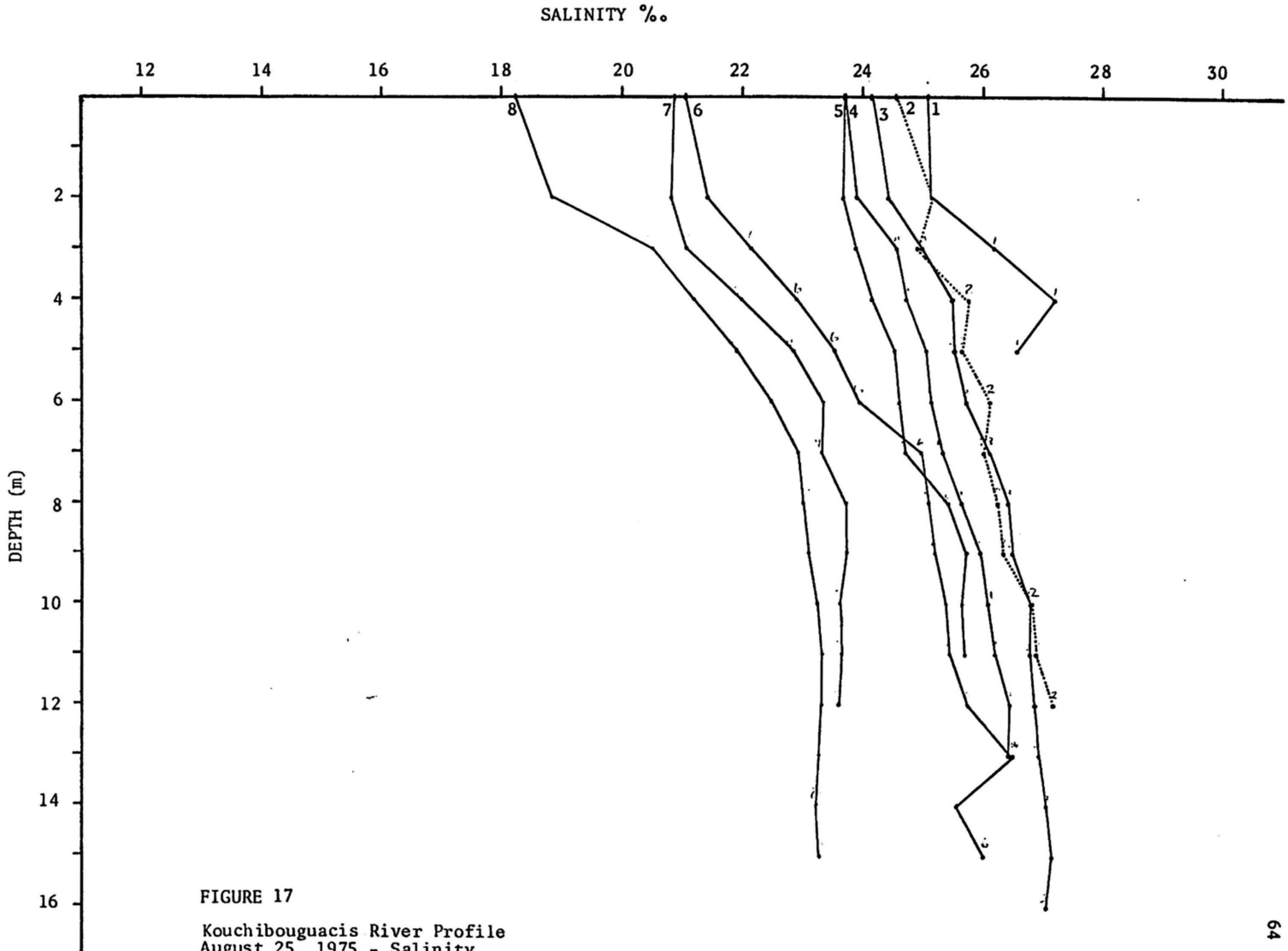

FIGURE 17

Kouchibouguacis River Profile
August 25, 1975 - Salinity

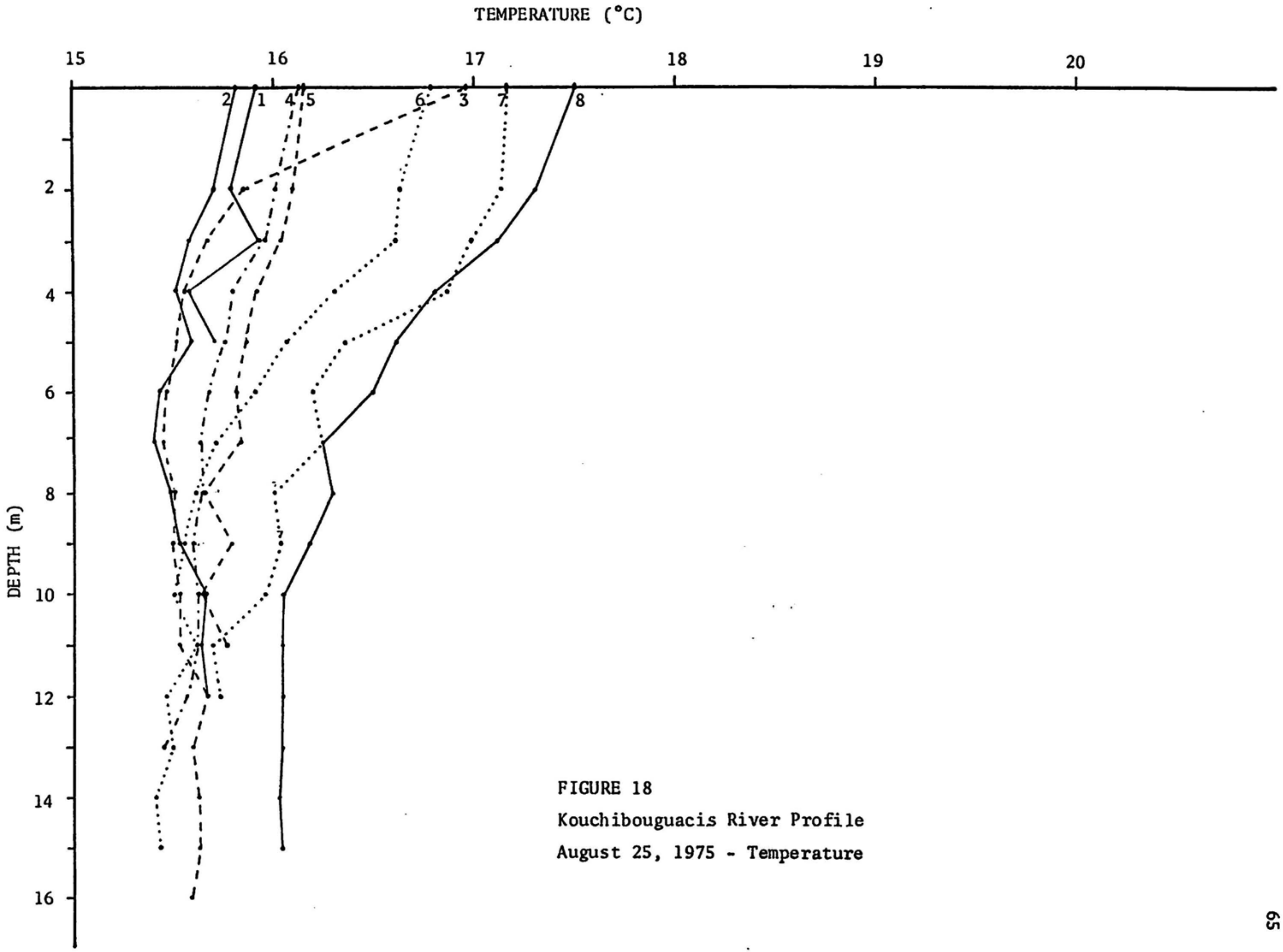

FIGURE 18
Kouchibouguacis River Profile
August 25, 1975 - Temperature

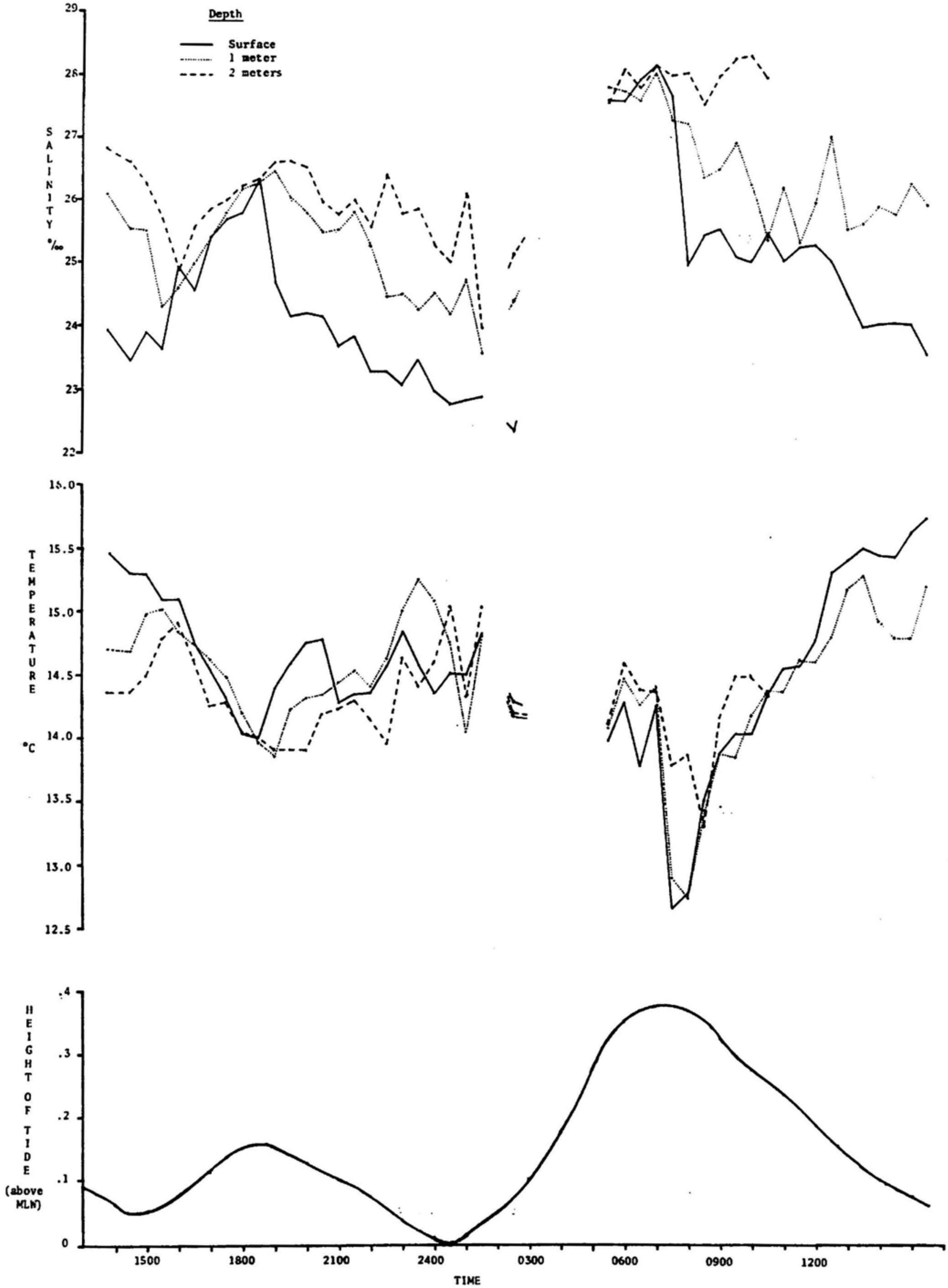

FIGURE 19 Temperature, Salinity and Tide Data in Kouchibouguac River on August 22-23, 1975.

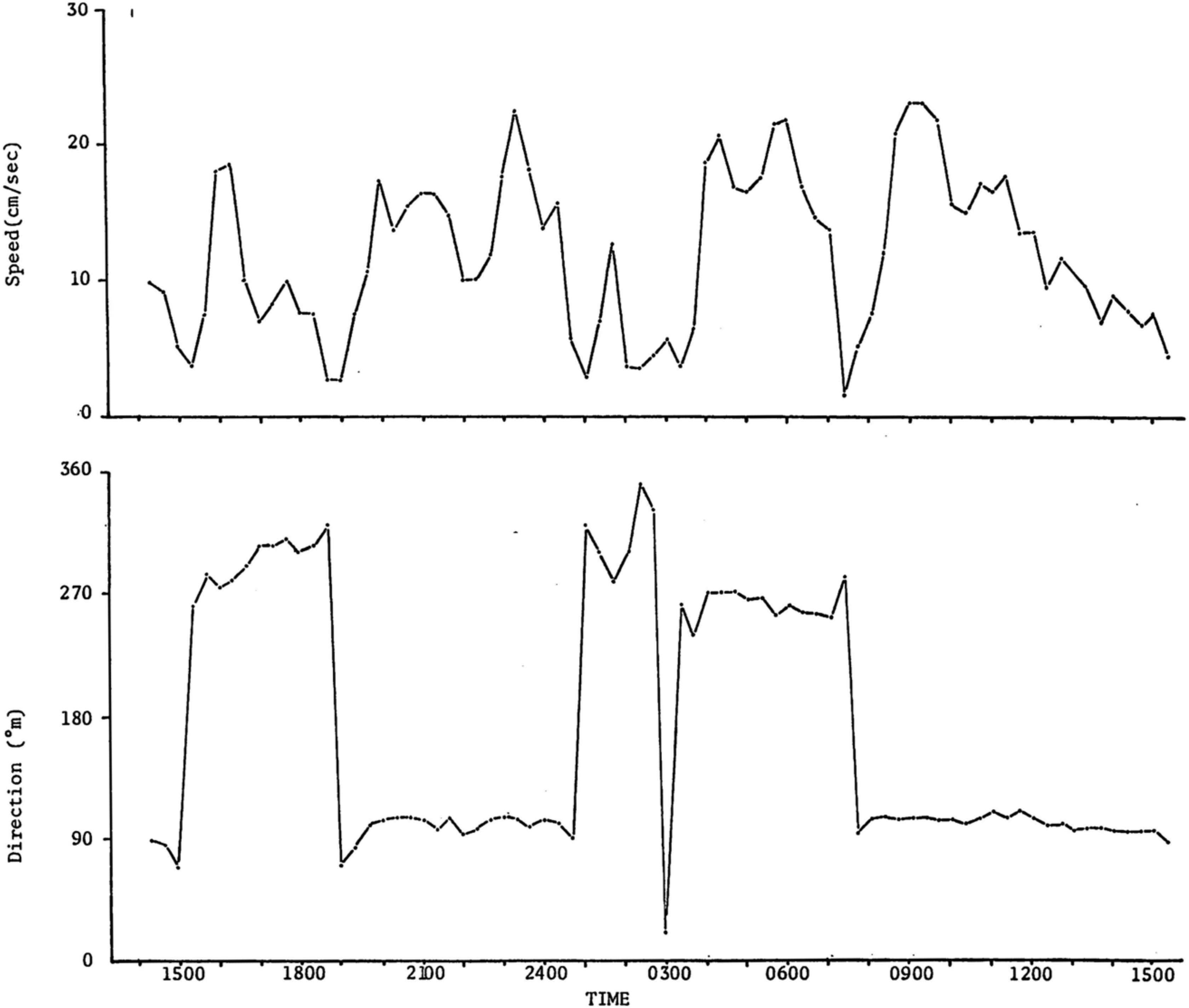

FIGURE 20 Water Current Velocity on Kouchibouguac River August 22-23, 1975 (Depth 1 meter)

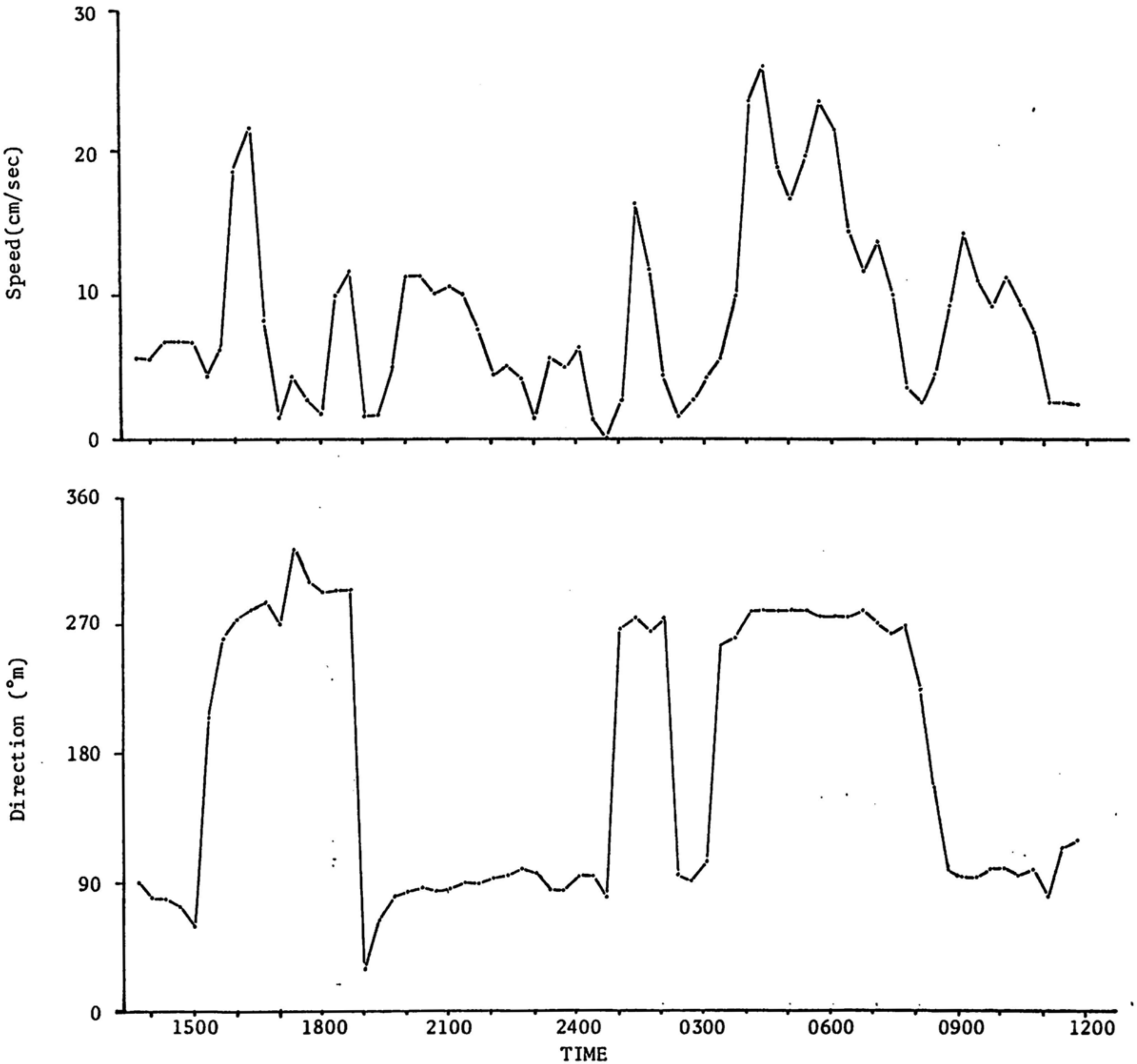

FIGURE 21 Water Current Velocity on Kouchibouguac River August 22-23, 1975 (depth 2 meters)

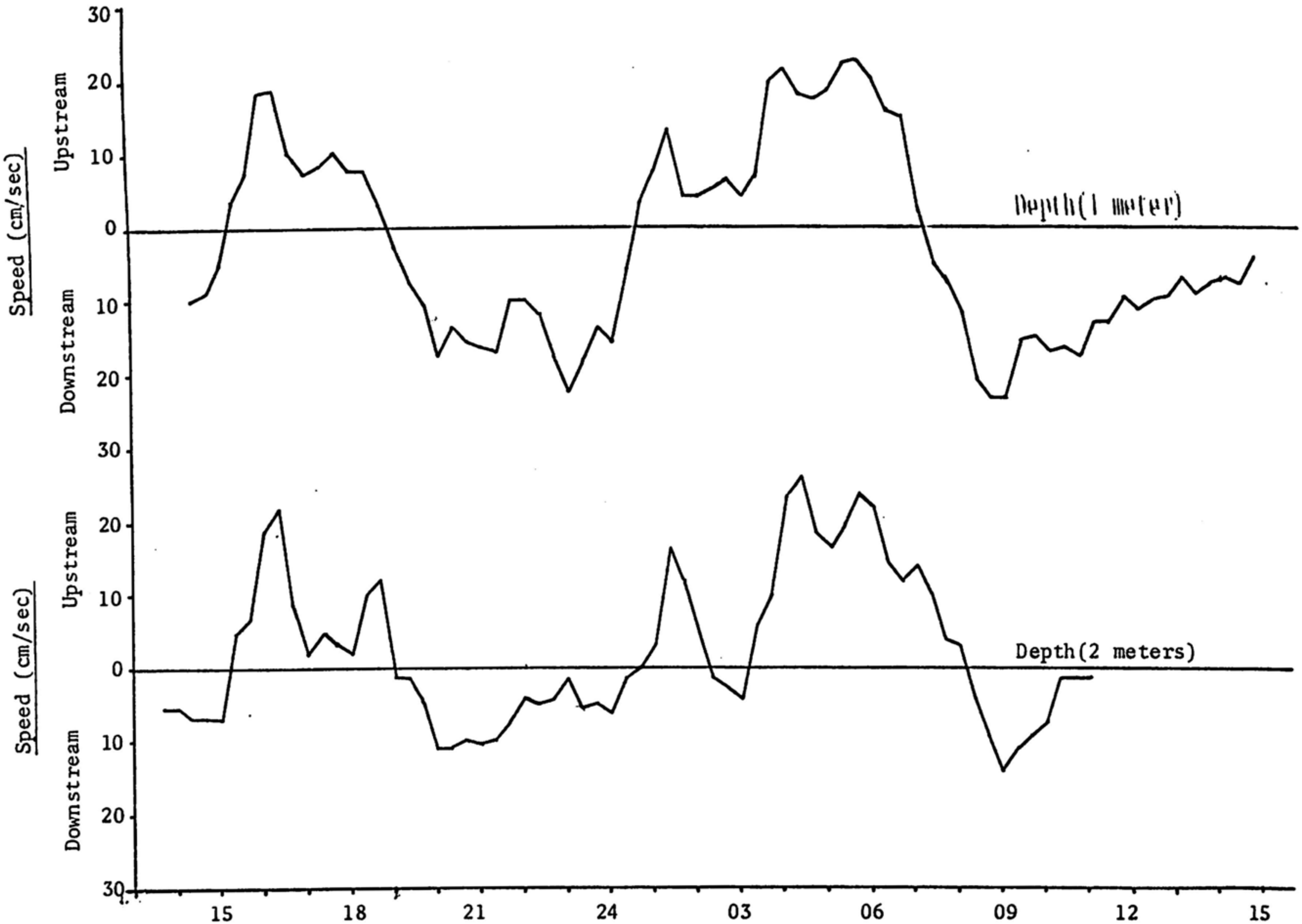

FIGURE 22 Current Velocity Showing Upstream and Downstream Distribution

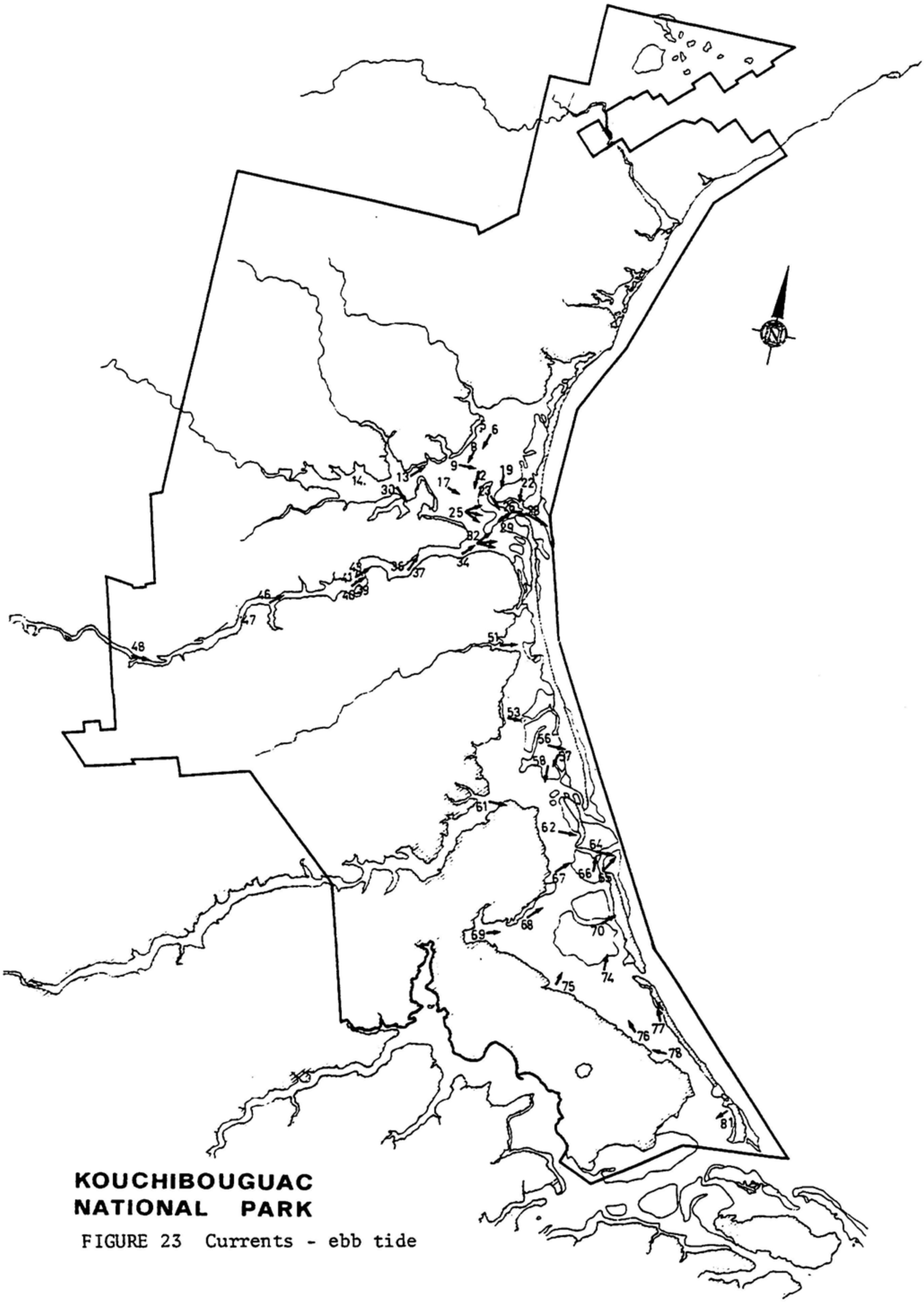

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FIGURE 23 Currents - ebb tide

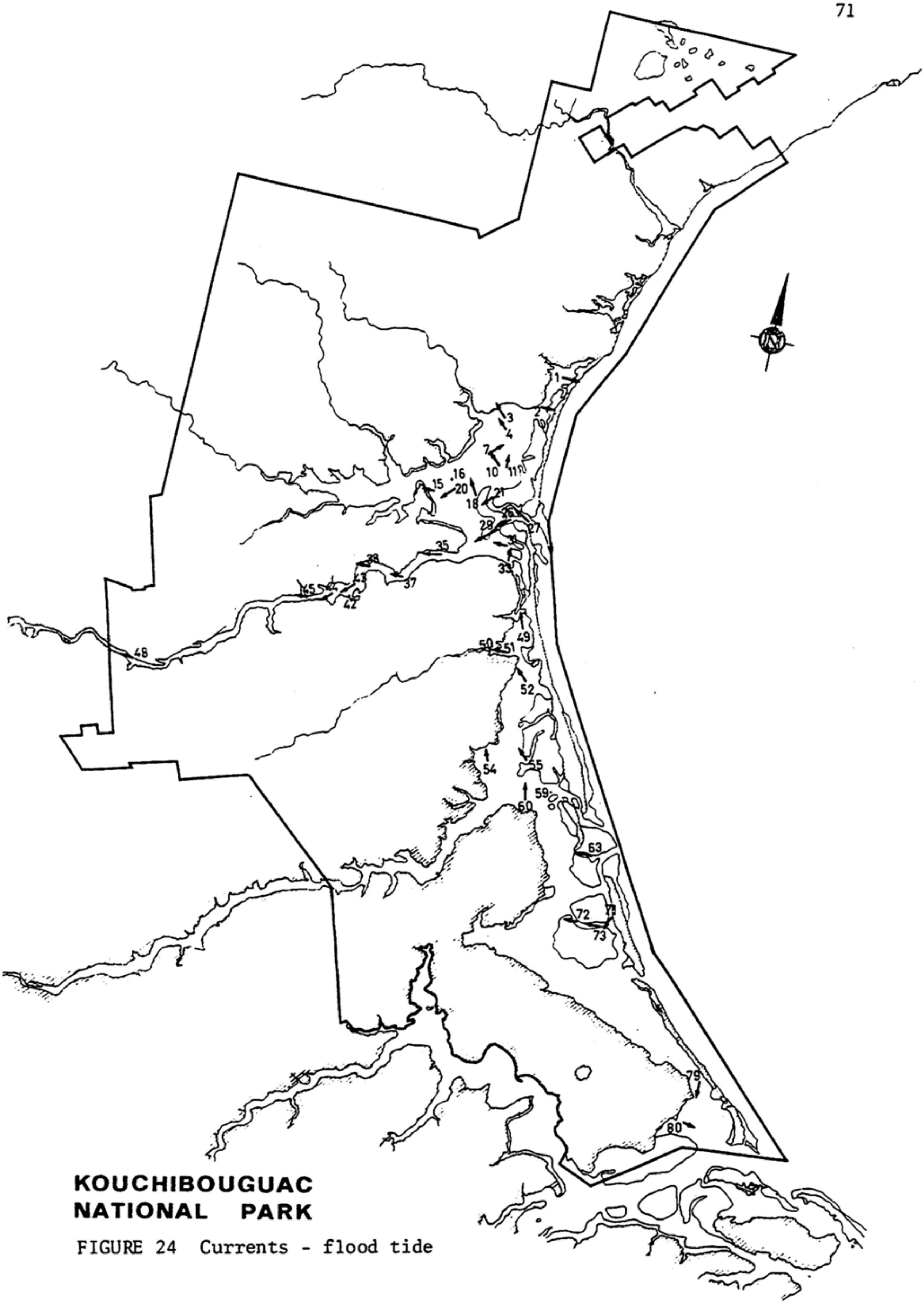

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FIGURE 24 Currents - flood tide

FIGURE 25 Water surface temperature, 1975, all biological stations included

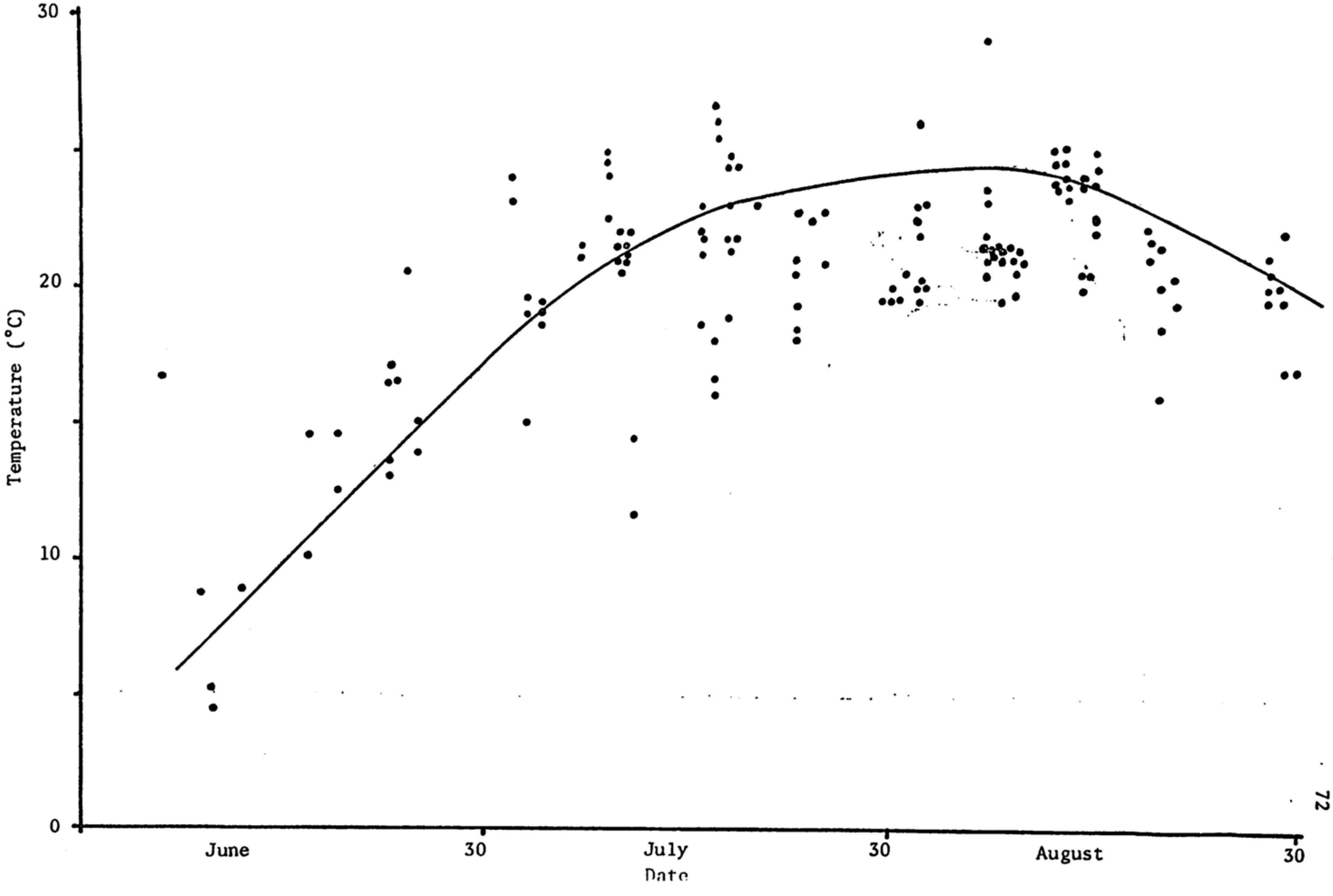


FIGURE 26 Water surface salinities 1975 biological stations.

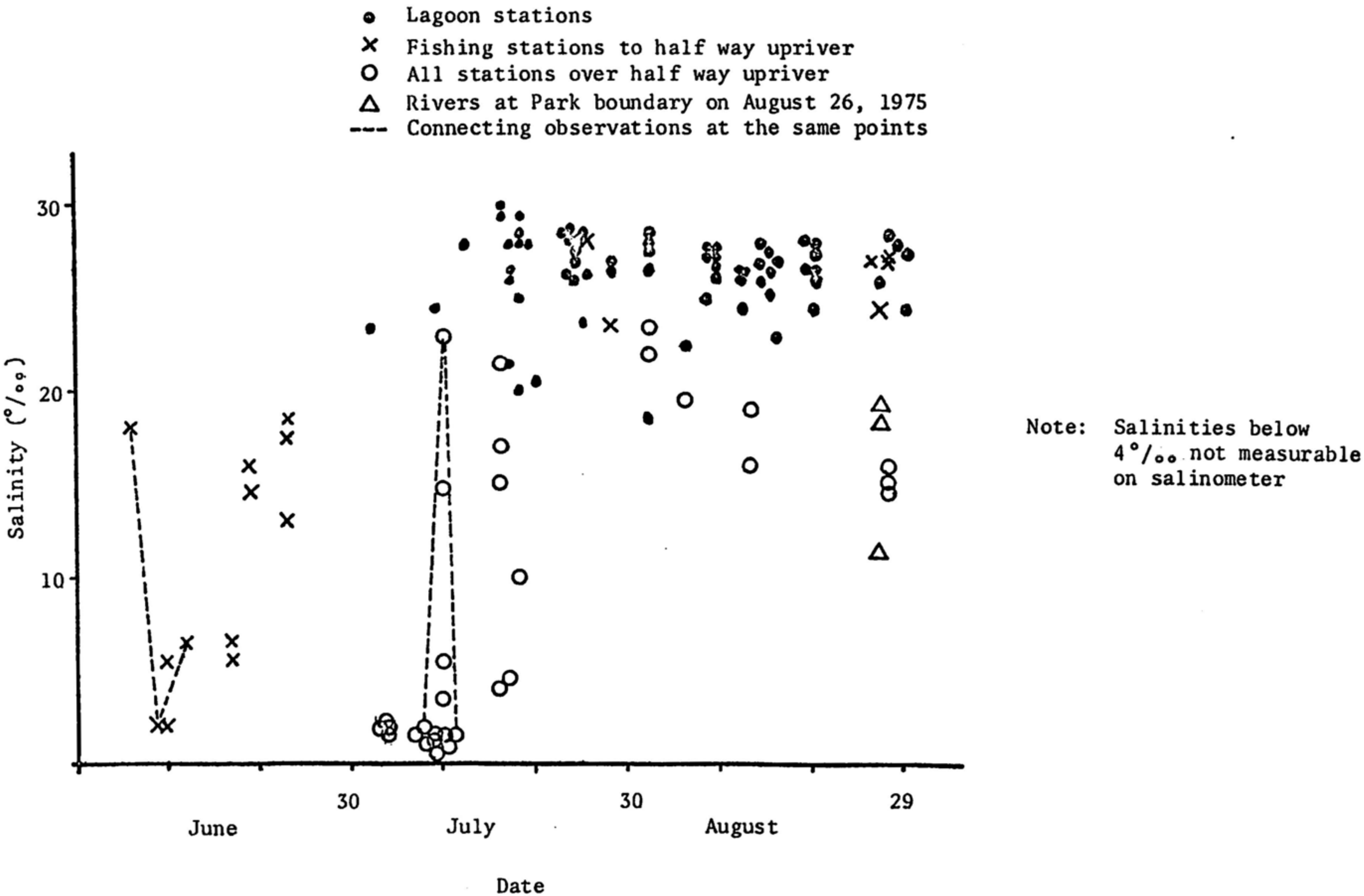


TABLE 4 Temperature-salinity data - biological stations

Sample No. and date	Location	Salinity	Uncorrected Depth (cm)	Time	Temperature (°C)
1-6-6-75	F-2	19.933			12.5
2-6-6-75	F-2	21.620	S	1215	16.8
3-6-6-75	F-2		220	1215	15.5
1-9-6-75	F-4		S	1145	7.5
2-9-6-75	F-4	FW	240	1145	
3-9-6-75	F-2	FW	S	1310	
4-9-6-75	F-2	FW	150	1310	
A-9-6-75	F-4	FW	S		
B-9-6-75	F-4	FW	B		
C-9-6-75	F-2	FW	S		
D-9-6-75	F-2	FW	B		
1-10-6-75	F-2	5.311	S	1030	4.5
2-10-6-75	F-4	FW	S	1130	
1-12-6-75	F-2	6.408	S	1210	8.0
2-12-6-75	F-2	21.196	145	1210	6.0
1-17-6-75	F-5	5.623	S	1635	14.5
2-17-6-75	F-5	12.495	256	1635	14.5
3-17-6-75	F-6	6.866	S	1645	10.0
4-17-6-75	F-6	12.872	110	1645	
7-17-6-75	T	6.571			
8-17-6-75	T	6.594			
1-19-6-75	F-8	14.858	S	1050	14.5
2-19-6-75	F-8	18.143	180	1050	11.5
3-19-6-75	F-7	15.966	S	1120	12.5
4-19-6-75	F-7	17.265	155	1120	12.0
1-23-6-75	F-9	13.106	S	1140	13.0
2-23-6-75	F-9	25.072	290	1140	13.0
3-23-6-75	F-10		S	1200	13.5
4-23-6-75	F-10		210	1200	12.5
5-23-6-75	F-11	17.668	S	1500	17.0
6-23-6-75	F-11	18.981	170	1500	16.5
7-23-6-75	F-12	18.323	S	1545	16.5
8-23-6-75	F-12	19.008	190	1545	16.0
3-26-6-75	F-14		S	1140	15.0
4-26-6-75	F-14		110	1140	14.0
5-26-6-75	F-13		S	1225	14.0
6-26-6-75	F-13		60	1225	15.0
1- 2-7-75	B-1	23.451	S	1130	23.0
2- 2-7-75	B-1	23.794	35	1130	23.0
3- 2-7-75	B-1	22.916	S	1200	24.0
1- 3-7-75	F-16	FW	S	1140	19.5
2- 3-7-75	F-16	FW	120	1140	19.0
3- 3-7-75	F-15	FW	S	1150	19.0
4- 3-7-75	F-15	12.673	130	1150	19.0
1- 4-7-75	F-16	FW	S	1045	19.0
2- 4-7-75	F-16	FW	110	1045	19.0
3- 4-7-75	F-15	FW	S	1055	18.75
4- 4-7-75	F-15	9.790	124	1055	19.0
1- 7-7-75	F-16	FW	S	1005	21.5
2- 7-7-75	F-16	5.696	122	1005	21.5
3- 7-7-75	F-15	FW	S	1035	21.0
4- 7-7-75	F-15	18.934	125	1035	21.5
2- 8-7-75	B-2	25.456	70	1500	26.5
3- 8-7-75	B-2	25.292	15	1500	26.5
1- 9-7-75	F-15	FW	S	1320	24.0
2- 9-7-75	F-15	FW	96	1320	23.5
3- 9-7-75	F-16	FW	S	1330	24.5
4- 9-7-75	F-16	FW	100	1330	23.5
5- 9-7-75	F-17	FW	S	1400	24.75
6- 9-7-75	F-17	FW	100	1400	24.0
7- 9-7-75	L-3	24.035	S	2145	22.5
8- 9-7-75	L-3	24.985	280	2145	22.5
1-10-7-75	F-15	23.325	S	0925	22.0
2-10-7-75	F-15	25.027	160	0925	21.5
3-10-7-75	F-16	FW	S	0930	22.0
4-10-7-75	F-16	18.820	150	0930	21.5

Sample No. and date	Location	Salinity	Uncorrected Depth (cm)	Time	Temperature (°C)	Sample No. and date	Location	Salinity	Uncorrected Depth (cm)	Time	Temperature (°C)
5-10-7-75	F-17	FW	S	0950	21.5	6-17-7-75	F-18	23.209	120	0930	20.5
6-10-7-75	F-17	21.202	140	0950	21.5	7-17-7-75	P-2	27.632	S	1515	26.5
9-10-7-75	F-15	18.663	120	1100	21.5	8-17-7-75	P-2	27.610	60	1515	26.6
10-10-7-75	F-15	14.910	S	1100	22.5	9-17-7-75	P-7	26.994	S	1630	26.0
11-10-7-75	F-15	FW	S	0030	21.0	10-17-7-75	P-7	26.991	100	1630	26.0
12-10-7-75	F-15	FW	110	0030	22.0	11-17-7-75	P-7	26.328	S	1645	25.5
13-10-7-75	F-15	FW	S	0200	20.5	12-17-7-75	P-7	26.374	60	1645	25.0
14-10-7-75	F-15	12.318	106	0200	21.0	1-18-7-75	P-6	27.193	S	1010	21.25
15-10-7-75	F-15	3.524	S	0300	21.5	2-18-7-75	P-6	28.630	34	1010	13.5
16-10-7-75	F-15	16.326	115	0300	22.0	3-18-7-75	P-9	27.545	S	1050	21.75
17-10-7-75	F-15	5.365	S	0530	21.25	4-18-7-75	P-9	27.541	80	1050	21.75
18-10-7-75	F-15	16.892	150	0530	22.25	5-18-7-75	P-19	28.187	S	1145	18.75
19-10-7-75	F-15		S	0730	21.0	6-18-7-75	P-19	28.114	68	1145	18.75
20-10-7-75	F-15		175	0730	22.0	7-18-7-75	P-13	25.027	S	1225	22.25
1-11-7-75	L-1	28.177	S	0915	14.5	8-18-7-75	P-13	25.098	88	1225	17.5
2-11-7-75	L-1	28.136	260	0915	14.0	9-18-7-75	P-21	27.724	S	1330	21.5
1-16-7-75	F-19	3.837	S	1110	21.75	10-18-7-75	P-21	27.724	40	1330	21.5
2-16-7-75	F-19	16.728	64	1110	21.50	11-18-7-75	P-24	20.029	S	1409	23.0
3-16-7-75	F-17	21.464	S	1120	22.0	12-18-7-75	P-24	21.060	85	1409	21.5
4-16-7-75	F-17	16.830	86	1120	20.5	13-18-7-75	P-26	17.060	S	1520	24.5
5-16-7-75	F-18	3.816	S	1130	21.25	14-18-7-75	P-26	17.731	84	1520	24.5
6-16-7-75	F-18	23.053	124	1130	20.5	15-18-7-75	P-27	15.725	S	1400	24.5
7-16-7-75	P-23		S	1880	23.0	16-18-7-75	P-27	15.825	90	1400	24.0
8-16-7-75	P-23		60	1880	23.0	17-18-7-75	P-28	10.406	S	1635	24.5
9-16-7-76	L-1	28.697	S	2015	18.5	18-18-7-75	P-28	12.610	90	1635	24.5
10-16-7-75	L-1	28.789	220	2105	13.5	1-20-7-75	L-2	20.822	S	1430	23.0
11-16-7-75	L-1	29.086	S	2100	11.5	2-20-7-75	L-2	21.098	194	1430	23.0
12-16-7-75	L-1	29.143	194	2100	11.5	1-22-7-75	C-23	28.648	S	1200	17.0
1-17-7-75	N-1	27.916	S	0705	16.5	2-22-7-75	C-4	26.545	S	1300	24.5
2-17-7-75	N-1	28.003	115	0705	16.0	3-22-7-75	C-37	28.191	S	1415	20.5
3-17-7-75	N-2	21.464	S	0750	18.0	5-22-7-75	C-5	27.032	S	1600	
4-17-7-75	N-2	21.489	70	0750	18.5	1-23-7-75	P-38	26.179	S	1015	18.0
5-17-7-75	F-18	4.480	S	0930	22.0	2-23-7-75	P-38	26.165	110	1015	18.0

Sample No. and date	Location	Salinity	Uncorrected Depth (cm)	Time	Temperature (°C)	Sample No. and date	Location	Salinity	Uncorrected Depth (cm)	Time	Temperature (°C)
3-23-7-75	P-32	28.502	S	1105	18.0	1-28-7-75	B-3	26.738	20	1000	16.5
4-23-7-75	P-32	28.440	100	1105	18.0	2-28-7-75	B-3	26.808	60	1000	16.5
5-23-7-75	P-34	28.460	S	1140	18.25	3-28-7-75	B-1	26.870	15	1145	18.5
6-23-7-75	P-34	28.480	34	1140	18.25	4-28-7-75	B-1	27.241	60	1145	18.5
7-23-7-75	P-43	28.454	S	1225	19.25	1-30-7-75	F-20		S	1130	19.5
8-23-7-75	P-43	28.773	60	1225	19.25	2-30-7-75	F-20		92	1130	19.5
9-23-7-75	P-46	28.646	S	1250	20.5	3-30-7-75	F-16		S	1140	19.5
10-23-7-75	P-46	28.645	55	1250	20.5	4-30-7-75	F-16	9.810	110	1140	19.5
11-23-7-75	C-6	28.302	S	1310	24.2	5-30-7-75	F-15		S	1200	19.5
12-23-7-75	C-35	28.766	S	1405	26.0	6-30-7-75	F-15		105	1200	19.5
13-23-7-75	P-48	28.344	S	1505	21.0	1-31-7-75	F-16		S	1005	20.5
14-23-7-75	P-48	28.346	40	1505	21.0	2-31-7-75	F-16		112	1005	20.0
15-23-7-75	C-36		S	1555	25.0	1- 1-8-75	N-1	26.824	S	0615	20.0
1-24-7-75	P-54	27.852	S	1030	22.5	2- 1-8-75	N-1	27.056	115	0615	20.0
2-24-7-75	P-54	28.163	80	1030	22.0	3- 1-8-75	N-2	17.558	S	0638	19.5
3-24-7-75	C-7	27.793	S	1105	24.0	4- 1-8-75	N-2		78	0638	19.5
4-24-7-75	C-19	27.929	S	1150	24.25	5- 1-8-75	L-4	27.566	S	1045	20.0
5-24-7-75	P-57	28.298	S	1225	22.5	6- 1-8-75	L-4	27.596	230	1045	20.0
6-24-7-75	P-57	28.233	90	1225	22.5	7- 1-8-75	L-5	26.984	S	1115	20.0
7-24-7-75	P-58	26.151	S	1300	24.5	8- 1-8-75	L-5	26.063	95	1115	20.0
8-24-7-75	P-58	26.158	90	1300	24.5	9- 1-8-75	P-10	28.123	S	1140	22.5
9-24-7-75	C-18	26.775	S	1330	26.5	10- 1-8-75	P-10	28.121	50	1140	22.5
10-24-7-75	C-34	26.926	S	1410	25.5	11- 1-8-75	P-8		S	1220	22.0
11-24-7-75	P-60	27.326	S	1505	24.0	12- 1-8-75	P-8	28.192	100	1220	22.0
12-24-7-75	P-60	27.334	90	1505	24.0	13- 1-8-75	P-3	27.729	S	1310	23.0
1-25-7-75	P-30	26.337	S	0948	23.0	14- 1-8-75	P-3	27.701	70	1310	23.0
2-25-7-75	P-30	26.577	92	0948	22.5	15- 1-8-75	P-18	22.299	S	1410	26.5
5-25-7-75	L-2	23.876	S	1500	20.75	16- 1-8-75	P-18	22.421	40	1410	25.0
6-25-7-75	L-2	21.572	210	1500	20.0	17- 1-8-75	P-15	23.835	S	1455	23.0
7-25-7-75	L-3	28.453	S	1535	22.75	18- 1-8-75	P-15		80	1455	23.0
8-25-7-75	L-3	28.454	280	1535	22.75	1- 6-8-75	F-21		S	1225	21.5
9-25-7-75	C-1	25.970	S	1615	28.0	2- 6-8-75	F-21		S	1225	21.5
1-26-7-75	C-26	26.976	S	1000	21.5	3- 6-8-75	F-23		S	1300	21.75
3-26-7-75	C-27	24.088	S	1515	22.5	4- 6-8-75	F-23	10.152	104	1300	21.5

Sample No. and date	Location	Salinity	Uncorrected Depth (cm)	Time	Temperature (°C)	Sample No. and date	Location	Salinity	Uncorrected Depth (cm)	Time	Temperature (°C)
5- 6-8-75	F-22		S	1310	21.5	8-11-8-75	P-29	26.637	82	1535	25.0
6- 6-8-75	F-22	21.506	400	1310	20.5	9-11-8-75	P-31	26.658	S	1620	25.0
7- 6-8-75	L-6		S	1415	21.0	10-11-8-75	P-31	26.854	120	1620	25.0
8- 6-8-75	L-6		110	1415	19.75	11-11-8-75	P-33	26.467	S	1655	24.5
9- 6-8-75	L-7	22.485	S	1430	20.5	12-11-8-75	P-33	26.471	100	1655	24.5
10-66-8-75	L-7	22.628	80	1430	20.5	13-11-8-75	P-37	24.818	S	1730	24.0
5- 7-8-75	F-21		S	1140	21.25	14-11-8-75	P-37	24.808	81	1730	23.75
6- 7-8-75	F-21		154	1140	20.5	1-12-8-75	F-24	16.268	S	1010	23.25
7- 7-8-75	F-22		S	1100	21.5	2-12-8-75	F-24	24.473	350	1010	22.0
8- 7-8-75	F-22	22.863	500	1100	20.0	3-12-8-75	F-25	19.996	S	1030	23.75
9- 7-8-75	F-23		S	1120	21.25	4-12-8-75	F-25	24.089	550	1030	21.5
10- 7-8-75	F-23	21.878	175	1120	20.5	5-12-8-75	C-17	23.736	S	1535	25.0
11- 7-8-75	P-1	27.749	S	1305	21.0	6-12-8-75	C-20	27.074	S	1730	
12- 7-8-75	P-1	27.756	40	1305	21.0	1-13-8-75	L-10		S	1010	20.0
13- 7-8-75	P-5	25.017	S	1420	21.5	2-13-8-75	L-10	27.331	260	1010	20.0
14- 7-8-75	P-5	25.077	100	1420	21.0	3-13-8-75	L-11	27.039	S	1035	20.5
1- 8-8-75	L-8	27.848	S	1020	20.5	4-13-8-75	L-11	27.024	250	1035	20.5
2- 8-8-75	L-8	27.817	305	1020	19.5	5-13-8-75	P-52	27.414	S	1050	20.5
3- 8-8-75	L-9	27.601	S	1045	19.75	6-13-8-75	P-52	27.364	55	1050	20.5
4- 8-8-75	L-9	27.666	183	1045	19.5	7-13-8-75	P-55	28.001	S	1135	
5- 8-8-75	P-53	27.322	S	1205	21.0	8-13-8-75	P-55	28.014	100	1135	
6- 8-8-75	P-53	27.309	46	1205	21.0	9-13-8-75	P-47	27.999	S	1235	23.75
7- 8-8-75	P-50	27.409	S	1235	21.0	10-13-8-75	P-47	27.998	104	1235	23.75
8- 8-8-75	P-50	27.442	56	1235	20.75	11-13-8-75	P-35	26.624	S	1335	24.0
9- 8-8-75	P-45	27.631	S	1310	21.5	12-13-8-75	P-35	26.687	48	1335	23.75
10- 8-8-75	P-45	27.586	47	1310	21.5	13-13-8-75	P-36	27.447	S	1410	23.75
11- 8-8-75	P-41	26.602	S	1415	21.5	14-13-8-75	P-36	27.422	44	1410	23.75
12- 8-8-75	P-41	26.675	80	1415	21.5	15-13-8-75	C-28	25.419	S	1715	24.75
1-11-8-75	F-24	14.154	S	1130	23.75	16-13-8-75	C-8	26.545	S	1805	25.0
2-11-8-75	F-24		400	1130	22.0	1-14-8-75	L-12	25.717	S	1030	22.5
3-11-8-75	F-25		S	1230	24.0	2-14-8-75	L-12	25.870	350	1030	22.5
4-11-8-75	F-25		650	1230	20.5	3-14-8-75	L-13	27.050	S	1110	22.0
5-11-8-75	F-26		S	1250	24.25	4-14-8-75	L-13	27.103	B	1110	22.0
6-11-8-75	F-26	25.948	650	1250	20.5	5-14-8-75	C-9	23.541	S	1000	24.5
7-11-8-75	P-29	26.658	S	1535	25.0	6-14-8-75	C-29	25.837	S	1310	23.5

Sample No. and date	Location	Salinity	Uncorrected Depth (cm)	Time	Temperature (°C)
1-15-8-75	N-1	26.050	125	0630	19.0
2-15-8-75	N-1	27.048	75	0630	19.25
3-15-8-75	N-1	27.050	35	0630	19.25
4-15-8-75	N-1	27.030	S	0630	19.25
5-15-8-75	N-2	23.525	110	0654	20.0
6-15-8-75	N-2	23.505	80	0654	20.25
7-15-8-75	N-2	23.518	40	0654	20.25
8-15-8-75	N-2	23.541	S	0654	20.25
9-15-8-75	C-11	26.845	S	0930	21.0
10-15-8-75	C-13	26.746	S	1015	20.5
11-15-8-75	C-31	27.225	S	1100	20.25
12-15-8-75	C-33	27.085	S	1200	
13-15-8-75	C-14	25.867	S	1320	
1-18-8-75	C-32	26.050	S	1030	21.5
2-19-8-75	C-12	28.486	S	1140	20.75
3-18-8-75	P-4	28.016	S	1240	22.25
4-18-8-75	P-56	27.028	88	1240	22.0
5-18-8-75	P-59	26.942	S	1310	21.0
6-18-8-75	P-59	26.919	86	1310	21.0
7-18-8-75	P-61	26.892	S	1335	21.75
8-18-8-75	P-61	26.556	70	1335	21.75
9-18-8-75	C-30	27.370	S	1435	22.25
10-18-8-75	C-10	27.940	S	1510	22.25
11-18-8-75	C-21	26.255	S	1510	22.75
4-19-8-75	P-16	24.583	S	1340	21.5
5-19-8-75	P-16	24.69-	366	1340	21.5
7-19-8-75	P-9	28.100	S	1430	16.0
8-19-8-75	P-9	25.930	488	1430	21.5
9-19-8-75	P-20	26.122	S	1540	20.0
4-25-8-75	B-4	28.133	80	1400	
5-25-8-75	B-5	28.011	60	1440	
6-25-8-75	B-6	27.129	85	1530	
5-26-8-75	P-22	26.002	S	1525	
6-26-8-75	P-22	27.001	61	1525	

Sample No. and date	Location	Salinity	Uncorrected Depth (cm)	Time	Temperature (°C)
1-27-8-75	F-26	16.223	S	1015	19.5
2-27-8-75	F-26	25.833	716	1015	18.75
3-27-8-75	F-24	15.266	S	1050	20.0
4-27-8-75	F-24	25.261	488	1050	18.5
5-27-8-75	F-23	14.963	S	1100	20.0
6-27-8-75	F-23	15.519	96	1100	20.0
7-27-8-75	C-25	27.987	S	1435	22.25
8-27-8-75	C-2	27.920	S	1520	21.25
9-27-8-75	C-24	27.037	S	1610	23.25
10-27-8-75	P-4	28.435	S	1645	20.5
11-27-8-75	P-4	28.397	110	1645	20.5
12-27-8-75	P-12	27.029	S	1715	21.25
13-27-8-75	P-12	26.983	68	1715	21.25
14-27-8-75	B-8	27.009	45	1715	
15-27-8-75	B-9	27.122	50	1530	
16-27-8-75	B-10	19.757	85	1700	
4-28-8-75	P-51	28.077	S	1505	19.5
5-28-8-75	P-44	27.977	S	1540	18.5
1-29-8-75	N-1	27.353	S	0325	17.0
1-29-8-75	N-1	27.423	90	0325	17.0
3-29-8-75	N-1	27.442	60	0325	17.0
4-29-8-75	N-1	27.288	30	0325	17.0
5-29-8-75	N-2	24.748	S	0340	17.0
6-29-8-75	N-2	24.435	30	0340	17.0
7-29-8-75	N-2	24.412	60	0340	17.5
8-29-8-75	N-2	24.549	90	0340	17.0
1-2-11-75	F-20	6.852	S	1029	6.5
2-2-11-75	F-20	11.068	S	1029	7.5
3-2-11-75	F-16	4.643	S	1130	6.75
4-2-11-75	F-16	8.437	S	1130	7.0
1-3-11-75	F-20	FW	S	1029	
2-3-11-75	F-20	FW	S	1029	
3-3-11-75	F-16	FW	S	1045	5.25
4-3-11-75	F-16	FW	S	1045	5.0
1-4-11-75	F-20	FW	S	0915	7.5
2-4-11-75	F-16	3.074	S	0915	7.0
3-4-11-75	F-16	2.964	S	0930	7.0
4-4-11-75	F-16	3.065	S	0930	7.0

Legend:
B - Beach Seine
C - Clam Station
F - Fishing Station
L - Lobster Station
N - Chemical Nutrient
P - Point Station
T - Fish Trap

TABLE 5
26/8/75

Salinity-Temperature Profiles

KOUCHIBOUGUAC RIVER

Time	Stn. No.	Conductivity	Salinity	Temperature	Depth
1200	1	37.78	28.20	16.92	Surface
	1	37.78	28.27	16.94	2 ft.
	1	37.78	28.17	16.82	3 ft.
	1	37.78	28.23	16.84	4 ft.
	1	37.78	28.29	16.74	5 ft.
	1	37.78	28.30	16.87	6 ft.
1205	1	37.78	28.42	16.97	7 ft.
1208	2	37.77	28.12	17.14	Surface
	2	37.77	28.14	17.02	2 ft.
	2	37.77	28.19	17.07	3 ft.
	2	37.77	28.04	17.03	4 ft.
	2	37.77	28.19	17.09	5 ft.
	2	37.77	28.11	17.05	6 ft.
	2	37.77	28.18	17.00	7 ft.
1211	2	37.77	28.10	17.05	8 ft.
1214	3	33.43	24.51	17.11	Surface
	3	34.10	25.10	17.00	2 ft.
	3	34.25	25.33	16.92	3 ft.
	3	34.68	25.56	16.98	4 ft.
	3	34.65	25.57	16.90	5 ft.
	3	34.91	25.87	16.91	6 ft.
1219	3	34.91	25.94	16.89	7 ft.
1225	4	27.14	19.23	17.81	Surface
	4	27.50	19.30	17.85	2 ft.
	4	33.15	24.43	16.85	3 ft.
	4	32.94	24.33	16.73	4 ft.
	4	34.24	25.61	16.68	5 ft.
	4	34.62	25.86	16.58	6 ft.
	4	34.62	25.82	16.60	7 ft.
1230	4	34.91	25.96	16.53	8 ft.
1245	5	24.36	16.78	18.63	Surface
	5	24.92	17.17	18.43	2 ft.
	5	28.61	20.30	18.03	3 ft.
	5	31.78	23.00	17.43	4 ft.
	5	33.21	24.57	16.88	5 ft.
	5	33.36	24.60	16.81	6 ft.
	5	33.56	24.86	16.77	7 ft.
	5	33.87	25.17	16.65	8 ft.
	5	33.98	25.25	16.65	9 ft.
	5	34.42	25.71	16.31	10 ft.
	5	34.42	25.77	16.25	11 ft.
1252	5	34.73	26.02	1630	12 ft.

Time	Stn. No.	Conductivity	Salinity	Temperature	Depth
1306	6	21.59	14.49	19.18	Surface
	6	21.86	14.81	19.11	2 ft.
	6	31.81	22.22	19.00	3 ft.
	6	31.81	22.69	18.13	4 ft.
	6	32.97	23.92	17.34	5 ft.
	6	33.38	24.72	16.82	6 ft.
	6	33.73	25.21	16.40	7 ft.
	6	33.76	25.25	16.26	8 ft.
	6	33.97	25.44	16.26	9 ft.
	6	33.97	25.63	16.01	10 ft.
	6	33.97	25.75	16.06	11 ft.
	6	33.97	25.63	16.11	12 ft.
	6	33.97	25.60	16.08	13 ft.
	6	33.97	25.61	16.02	14 ft.
	6	33.97	25.64	16.03	15 ft.
1315	6	33.97	25.67	16.00	16 ft.
1317	7	18.27	12.04	19.26	Surface
	7	30.87	21.62	18.89	2 ft.
	7	32.82	23.73	17.94	3 ft.
	7	33.34	24.38	17.46	4 ft.
	7	33.51	24.68	17.15	5 ft.
	7	33.51	24.79	16.79	6 ft.
	7	33.70	25.15	16.47	7 ft.
	7	33.70	25.28	16.27	8 ft.
	7	33.70	25.30	16.19	9 ft.
	7	33.70	25.38	15.94	10 ft.
	7	33.70	25.42	16.00	11 ft.
	7	33.70	25.41	16.04	12 ft.
	7	33.70	25.52	15.95	13 ft.
	7	33.70	25.49	15.92	14 ft.
	7	33.70	25.51	15.95	15 ft.
1326	7	33.70	25.40	16.17	16 ft.
1333	8	28.55	19.58	19.73	Surface
	8	30.70	21.13	19.70	2 ft.
	8	32.88	23.09	19.73	3 ft.
	8	33.49	24.01	18.19	4 ft.
	8	33.81	24.56	17.70	5 ft.
	8	33.81	24.54	17.75	6 ft.
	8	33.81	24.66	17.34	7 ft.
	8	33.81	24.84	17.13	8 ft.
1337	8	33.81	24.97	16.97	9 ft.
1348	9	29.90	20.25	20.54	Surface
	9	32.56	22.60	19.59	2 ft.
	9	32.99	23.07	19.31	3 ft.
	9	33.37	23.56	19.02	4 ft.
1351	9	33.56	23.80	18.76	5 ft.
1356-1358	10	17.45	11.45	19.06	Surface
1420	XR1	28.31	19.21	20.08	Surface
1432	XR2	27.45	18.47	20.60	Surface

Time	Stn. No.	Conductivity	Salinity	Temperature	Depth
1439	XR3	27.75	19.16	18.96	Surface
	XR3	27.90	19.32	18.99	2 ft.
	XR3	31.96	23.11	17.67	3 ft.
	XR3	33.91	25.11	16.80	4 ft.
	XR3	34.20	25.31	16.87	5 ft.
1445	XR4	28.47	19.81	18.99	Surface
	XR4	30.32	21.54	18.24	2 ft.
	XR4	33.62	24.84	17.01	3 ft.
	XR4	33.85	24.98	16.77	4 ft.
	XR4	34.35	25.59	16.69	5 ft.
	XR4	34.77	25.80	16.91	6 ft.
	XR4	34.96	26.00	16.86	7 ft.
	XR4	34.96	26.01	16.68	8 ft.
	XR4	35.23	26.37	16.80	9 ft.
	XR4	35.50	26.47	16.71	10 ft.
	XR4	35.50	26.48	16.77	11 ft.
	XR4	35.50	26.63	16.80	12 ft.
	XR4	35.50	26.65	16.71	13 ft.
	XR4	35.50	26.56	16.71	14 ft.
	XR4	35.50	26.66	16.65	15 ft.
	XR4	35.50	26.63	16.59	16 ft.
	XR4	35.50	26.67	16.56	17 ft.
	XR4	35.50	26.67	16.62	18 ft.
	XR4	35.50	26.72	16.66	19 ft.
	XR4	35.50	26.59	16.56	20 ft.
	XR4	35.50	26.63	16.60	21 ft.
1456	XR5	29.34	20.50	18.83	Surface
	XR5	32.87	23.78	17.76	2 ft.
	XR5	34.07	25.07	17.35	3 ft.
	XR5	34.80	25.61	17.19	4 ft.
1501	XR6	31.34	21.49	20.56	Surface
	XR6	33.34	23.71	18.99	2 ft.
1508	XR7	31.93	21.80	20.78	Surface
	XR7	33.68	22.99	20.28	2 ft.
1511	XR8	35.19	24.11	20.79	Surface
1513	XR9	33.83	23.65	19.55	Surface

TABLE 6 Salinity-Temperature Profiles

26/8/75 BLACK RIVER

Time	Stn. No.	Conductivity	Salinity	Temperature	Depth
1050	1	27.43	19.11	18.66	Surface
1053	1	28.71	20.21	18.71	2 ft.
1111	2	33.20	24.13	17.69	Surface
	2	33.20	24.19	17.54	2 ft.
	2	32.99	24.00	17.52	3 ft.
	2	33.52	24.55	17.20	4 ft.
1115	2	33.84	24.88	17.10	5 ft.
1121	3	34.56	25.40	17.50	Surface
	3	34.56	25.43	17.47	2 ft.
	3	34.56	25.39	17.43	3 ft.
	3	34.68	25.50	17.28	4 ft.
	3	34.76	25.62	17.25	5 ft.
	3	34.86	25.71	17.16	6 ft.
	3	35.12	25.80	17.28	7 ft.
1125	3	35.12	25.95	17.14	8 ft.
1130	4	35.23	25.88	17.28	Surface
	4	35.36	25.99	17.51	2 ft.
	4	35.35	26.05	17.05	3 ft.
	4	35.35	26.05	16.98	4 ft.
	4	35.35	26.13	17.03	5 ft.
	4	35.46	26.27	17.03	6 ft.
	4	35.58	26.28	16.86	7 ft.
1134	4	35.55	26.49	16.84	8 ft.
1138	5	35.83	26.39	17.20	Surface
	5	35.70	26.30	17.14	2 ft.
	5	35.70	26.33	17.10	3 ft.
	5	35.70	26.47	16.88	4 ft.
	5	36.04	26.85	16.45	5 ft.
	5	36.19	27.06	16.56	6 ft.
	5	36.30	27.24	16.55	7 ft.
	5	36.39	27.38	16.40	8 ft.
	5	33.86	25.28	16.23	9 ft.
	5	36.69	27.66	16.18	10 ft.
1144	5	36.69	27.63	16.39	11 ft.

TABLE 7 Salinity-Temperature Profiles

25/8/75 KOUCHIBOUGUACIS RIVER

Time	Stn. No.	Conductivity	Salinity	Temperature	Depth
1110	1	33.13	25.06	15.91	Surface
	1	33.20	25.14	15.79	2 ft.
	1	34.50	26.16	15.93	3 ft.
	1	35.63	27.18	15.58	4 ft.
1118	1	34.77	26.53	15.71	5 ft.
1122	2	32.51	24.61	15.82	Surface
	2	33.12	25.15	15.71	2 ft.
	2	32.94	24.89	15.58	3 ft.
	2	33.75	25.75	15.51	4 ft.
	2	33.48	25.61	15.59	5 ft.
	2	34.03	26.09	15.43	6 ft.
	2	34.03	26.00	15.41	7 ft.
	2	34.25	26.24	15.49	8 ft.
	2	34.47	26.30	15.53	9 ft.
	2	35.10	26.82	15.67	10 ft.
	2	35.23	26.88	15.64	11 ft.
1129	2	35.58	27.18	15.67	12 ft.
1134	3	32.15	24.13	16.97	Surface
	3	32.33	24.40	15.86	2 ft.
	3	32.99	24.99	15.67	3 ft.
	3	33.35	25.47	15.56	4 ft.
	3	33.55	25.50	15.54	5 ft.
	3	33.71	25.71	15.47	6 ft.
	3	34.07	26.10	15.45	7 ft.
	3	34.51	26.41	15.51	8 ft.
	3	34.80	26.49	15.50	9 ft.
	3	34.97	26.80	15.53	10 ft.
	3	35.04	26.79	15.53	11 ft.
	3	35.10	26.85	15.67	12 ft.
	3	35.28	26.97	15.60	13 ft.
	3	35.39	27.08	15.63	14 ft.
	3	35.55	27.19	15.63	15 ft.
1144	3	35.46	27.09	15.59	16 ft.
1148	4	31.63	23.68	16.13	Surface
	4	32.06	23.89	16.01	2 ft.
	4	32.67	24.53	15.96	3 ft.
	4	32.68	24.70	15.80	4 ft.
	4	32.98	25.03	15.76	5 ft.
	4	33.17	25.15	15.68	6 ft.
	4	33.39	25.33	15.64	7 ft.
	4	33.62	25.64	15.65	8 ft.
	4	34.10	25.94	15.60	9 ft.

Time	Stn. No.	Conductivity	Salinity	Temperature	Depth
	4	34.27	26.08	15.63	10 ft.
	4	34.44	26.21	15.62	11 ft.
	4	34.60	26.45	15.57	12 ft.
1156	4	34.60	26.46	15.45	13 ft.
1200	5	31.65	23.67	16.16	Surface
	5	31.58	23.67	16.10	2 ft.
	5	31.92	23.85	16.04	3 ft.
	5	32.21	24.15	15.92	4 ft.
	5	32.59	24.52	15.87	5 ft.
	5	32.69	24.59	15.82	6 ft.
	5	32.81	24.68	15.84	7 ft.
	5	33.48	25.41	15.66	8 ft.
	5	33.76	25.71	15.79	9 ft.
	5	33.80	25.65	15.66	10 ft.
1206	5	33.83	25.72	15.77	11 ft.
1211	6	29.00	21.04	16.79	Surface
	6	29.32	21.40	16.63	2 ft.
	6	30.20	22.10	16.61	3 ft.
	6	30.91	22.86	16.31	4 ft.
	6	31.51	23.51	16.07	5 ft.
	6	32.06	23.93	15.91	6 ft.
	6	33.07	24.97	15.72	7 ft.
	6	33.15	25.07	15.62	8 ft.
	6	33.21	25.20	15.56	9 ft.
	6	33.45	25.40	15.51	10 ft.
	6	33.53	25.45	15.62	11 ft.
	6	33.79	25.75	15.47	12 ft.
	6	34.78	26.53	15.50	13 ft.
	6	33.59	25.60	15.42	14 ft.
1220	6	34.22	26.05	15.44	15 ft.
1225	7	28.92	20.83	17.18	Surface
	7	28.85	20.79	17.14	2 ft.
	7	28.99	21.05	16.99	3 ft.
	7	30.15	21.95	16.87	4 ft.
	7	30.89	22.81	16.36	5 ft.
	7	31.44	23.33	16.20	6 ft.
	7	31.44	23.30	16.25	7 ft.
	7	31.79	23.70	16.01	8 ft.
	7	31.77	23.72	16.03	9 ft.
	7	31.64	23.63	15.96	10 ft.
	7	32.73	24.65	15.70	11 ft.
1230	7	32.73	24.61	15.74	12 ft.
1237	8	25.73	18.20	17.51	Surface
	8	26.49	18.80	17.31	2 ft.
	8	28.49	20.48	17.12	3 ft.
	8	29.17	21.18	16.81	4 ft.
	8	29.96	21.86	16.61	5 ft.
	8	30.51	22.45	16.50	6 ft.
	8	31.11	22.89	16.25	7 ft.

Time	Stn. No.	Conductivity	Salinity	Temperature	Depth
	8	31.11	23.00	16.30	8 ft.
	8	31.11	23.09	16.18	9 ft.
	8	31.20	23.24	16.05	10 ft.
	8	31.31	23.32	16.05	11 ft.
	8	33.27	23.33	16.05	12 ft.
	8	31.27	23.30	16.05	13 ft.
	8	31.37	23.25	16.03	14 ft.
1245	8	3137	23.39	16.05	15 ft.

TABLE 8 SALINITY-TEMPERATURE DATA

KOUCHIBOUGUAC RIVER CHANNEL - LOGIECROFT

August 22/23, 1975

Time	Depth	Conductivity	Salinity	Temperature	Description
1350	Surface	31.37	23.92	15.45	Overcast and raining
	1m	33.43	26.06	14.71	Winds: northwest at Beaufort, force 4
	2m	34.09	26.79	14.36	
1430	Surface	31.14	23.45	15.29	
	1m	33.04	25.51	14.69	
	2m	33.95	26.60	14.36	
1500	Surface	31.61	23.90	15.28	
	1m	33.24	25.49	14.97	
	2m	33.71	26.23	14.49	
1530	Surface	30.98	23.63	15.09	
	1m	31.75	24.31	15.01	
	2m	33.20	25.68	14.78	
1600	Surface	31.62	24.94	15.09	
	1m	32.05	24.60	14.84	
	2m	32.22	24.89	14.91	
1630	Surface	31.90	24.57	14.76	
	1m	32.34	24.97	14.77	
	2m	32.77	25.54	14.62	
1700	Surface	32.63	25.40	14.53	
	1m	32.82	25.40	14.62	
	2m	33.05	25.81	14.25	
1730	Surface	32.90	25.68	14.32	
	1m	33.07	25.77	14.48	
	2m	33.19	25.97	14.28	
1800	Surface	32.80	25.80	14.02	
	1m	33.27	26.16	14.20	
	2m	33.37	26.21	14.04	
1830	Surface	33.34	26.31	14.00	
	1m	33.34	26.24	13.96	
	2m	33.39	26.31	14.00	
	3m	33.95	27.00	13.81	
1900	Surface	31.82	24.68	14.39	
	1m	33.46	26.45	13.85	
	2m	33.66	26.59	13.90	
	3m	33.95	26.94	13.81	
1930	Surface	31.32	24.16	14.58	
	1m	33.23	26.01	14.22	
	2m	33.69	26.61	13.90	
2000	Surface	31.50	24.20	14.75	
	1m	33.00	25.77	14.32	
	2m	33.72	26.50	13.90	
2030	Surface	31.50	24.15	14.77	Rain ceased; Winds: northwest at
	1m	32.80	25.47	14.35	Beaufort, Force 1
	2m	33.13	25.93	14.19	
2100	Surface	30.94	23.68	14.28	
	1m	32.70	25.53	14.44	
	2m	33.01	25.75	14.23	

SALINITY-TEMPERATURE DATA

Time	Depth	Conductivity	Salinity	Temperature	Description
2130	Surface	30.81	23.83	14.35	
	1m	33.23	25.79	14.53	
	2m	33.26	25.99	14.30	
2200	Surface	30.13	23.27	14.36	
	1m	32.64	25.27	14.41	
	2m	32.81	25.56	14.17	
2230	Surface	30.28	23.26	14.57	
	1m	31.88	24.47	14.75	
	2m	33.59	26.40	13.95	
2300	Surface	30.32	23.06	14.84	
	1m	32.26	24.51	15.01	
	2m	33.18	25.77	14.63	
2330	Surface	30.48	23.46	14.57	
	1m	31.98	24.27	15.26	
	2m	33.18	25.84	14.41	
0000	Surface	29.84	22.98	14.37	
	1m	32.28	24.54	15.09	
	2m	32.86	25.28	14.60	
0030	Surface	29.80	22.77	14.51	
	1m	31.76	24.20	14.76	
	2m	32.59	25.01	15.04	
0100	Surface	29.88	22.84	14.51	
	1m	32.02	24.74	14.05	
	2m	33.30	26.10	14.33	
0130	Surface	30.16	22.89	14.83	
	1m	30.75	23.56	14.82	
	2m	31.65	23.97	15.03	
0200					
0230	Surface	31.52	24.37	14.17	
	1m	14.17	24.41	14.29	
	2m	32.38	25.14	14.20	
0530	Surface	35.00	27.64	13.97	
	1m	35.23	27.84	14.07	
	2m	35.26	27.59	14.11	
0600	Surface	.	27.65	14.28	
	1m	35.49	27.77	14.47	
	2m	35.80	28.13	14.59	
0630	Surface	35.58	27.97	13.78	
	1m	35.35	27.62	14.26	
	2m	35.39	27.84	14.38	
0700	Surface	35.91	28.21	14.26	
	1m	35.67	28.05	14.41	
	2m	35.99	28.21	14.37	
0730	Surface	33.68	27.71	12.41	Zostera accumulated around surface
	1m	33.87	27.31	12.89	Current meter was removed
	2m	35.15	28.04	13.77	
0800	Surface	31.04	24.99	12.77	
	1m	33.48	27.26	12.73	
	2m	35.33	28.07	13.86	Clear skys
0830	Surface	31.97	25.45	13.50	Winds: north northwest at Beaufort Force 4
	1m	33.07	26.39	13.43	
	2m	34.50	27.57	13.29	

SALINITY-TEMPERATURE DATA

Time	Depth	Conductivity	Salinity	Temperature	Description
0900	Surface	32.21	25.55	13.87	
	1m	33.39	26.51	13.87	
	2m	35.41	28.02	14.16	
0930	Surface	31.86	25.14	14.03	
	1m	32.70	26.95	13.84	
	2m	35.93	28.31	14.49	
1000	Surface	32.06	25.07	14.03	
	1m	33.30	26.27	14.18	
	2m	36.07	28.36	14.49	
1030	Surface	32.52	25.50	14.35	
	1m	32.56	25.39	14.37	
	2m	35.68	28.00	14.34	
1100	Surface	32.20	25.06	14.54	Moved off Channel to the south
	1m	33.38	26.24	14.36	Water depth approx. 1.75m causing
1130	Surface	32.57	25.27	14.57	interference with current meters.
	1m	32.77	25.35	14.67	Bottom meter tilted severely.
1200	Surface	32.58	25.31	14.77	Bottom current meter removed at
	1m	33.38	25.99	14.72	1200Z 23-8-75. Tide receding.
1230	Surface	32.86	25.06	15.31	Cumnulus clouds.
	1m	34.69	27.07	14.80	Occasionally cloudy period
1300	Surface	32.13	24.54	15.39	Winds: north at Beaufort Scale 5
	1m	33.44	25.56	15.18	
1330	Surface	31.95	24.02	15.50	
	1m	33.35	25.65	15.28	
1400	Surface	31.88	24.07	15.44	
	1m	33.59	25.93	14.92	
1430	Surface	31.90	24.08	15.45	
	1m	33.50	25.80	14.79	
1500	Surface	31.90	24.05	15.64	
	1m	34.01	26.31	14.79	
1530	Surface	31.45	23.57	15.75	
	1m	33.85	25.96	15.19	

Top (or surface)
Current meter stopped at 1550Z,
23-8-75

TABLE 9 Surface Current Velocities - Flood and Ebb Tide
Kouchibouguac National Park, 1975

Current Stn. No.	Tide*	Time/Date	Distance(cm)	Time (sec)	Speed (cm/sec)	Direction(°M)
1	F	1305/7/8	200	10	20.00	090
2	F	1515/17/7	180	60	3.00	090
3	F	1310/1/8	200	12	16.67	315
4	F	1645/27/8	200	32	6.25	315
5	F	1630/17/7	0	0	0	0
6	F	1420/7/8	200	15	13.33	199
7	F	1110/14/8	200	12	16.67	045
8	E	1010/18/7	200	25	8.00	198
9	E	1645/17/7	200	20	10.00	090
10	F	1220/1/8	200	17	11.76	319
11	F	1140/1/8	200	35	5.71	360
12	F	1050/18/7	200	20	10.00	180
13	E	1455/1/8	200	13	15.38	046
14	E	1410/1/8	0	0	0	0
15	F	1225/18/7	200	25	8.00	270
16	F	1715/27/8	0	0	0	0
17	F	1030/14/8	200	17	11.76	112
18	F	1140/19/8	1000	45	22.22	339
19	E	1115/1/8	100	60	1.67	180
20	F	1000/7/8	200	18	15.38	226
21	F	1143/18/7	200	48	4.17	225
22	E	1535/25/7	200	20	10.00	180
23	E	1045/1/8	200	10	20.00	134
24	F	1010/7/8	200	25	8.00	132
25	E	0705/17/7	250	80	3.13	045
25	E	0625/18/8	200	12	16.67	045
25	E	0325/29/8	200	12	16.67	090
25	E	0615/1/8	200	16	12.50	113
26	E	1430/20/7	1000	40	25.00	090
26	F	2015/16/7	1000	20	50.00	225
27	F	1540/19/8	1000	70	14.25	300
28	E	1225/19/8	1000	8	125.00	112
29	E	1500/25/7	1000	30	33.33	045
29	F	2100/16/7	1000	18	55.56	225
30	E	1340/19/8	1000	60	16.67	135
31	F	1330/18/7	200	23	8.70	270
32	E	0750/17/7	310	60	5.17	045
32	E	0340/29/8	200	13	15.38	045
32	E	0654/15/8	200	9	22.22	067
32	E	0638/1/8	200	8	11.11	090
33	F	1430/6/8	200	22	9.09	360
34	E	1415/6/8	200	7	28.57	040
35	F	1409/18/7	200	18	11.11	246
36	E	1015/27/8	200	7	28.57	047
37	F	1030/12/8	100	45	2.22	270
37	E	1230/11/8	200	7	28.57	023
38	F	1520/18/7	200	27	7.41	270
39	E	1120/7/8	200	17	11.76	020

Current Stn. No.	Tide*	Time/Date	Distance(cm)	Time (sec)	Speed (cm/sec)	Direction(°M)
40	E	1100/27/8	200	12	16.67	046
41	E	1050/27/8	200	9	22.22	045
42	E	1100/7/8	0	0	0	0
43	E	1010/12/8	200	24	8.33	045
43	F	1130/11/8	200	14	14.29	225
44	F	1140/7/8	200	28	7.14	223
45	F	1400/18/7	200	70	2.86	270
46	E	1225/6/8	200	8	25.00	045
46	E	1310/6/8	200	14	14.29	045
47	E	1635/18/7	0	0	0	0
48	F	0330/10/7	100	70	1.43	287
48	F	0530/10/7	100	45	2.22	287
48	F	0730/10/7	100	25	4.00	287
48	F	1005/31/7	200	18	11.11	046
48	E	1210/30/7	1000	55	18.18	090
48	F	0200/10/7	100	120	.83	104
48	F	0920/17/7	1000	80	12.50	104
49	F	1535/11/8	200	16	12.50	337
50	F	1836/6/8	40	23	1.74	270
50	F	1915/28/8	100	13	7.69	270
51	F	1721/6/8	40	15	2.67	270
51	F	1845/28/8	100	18	5.56	270
51	E	1406/10/7	100	12	8.33	075
51	E	0948/25/7	200	11	18.18	075
52	F	1620/11/8	200	18	11.11	315
53	E	1105/28/7	200	40	5.00	090
54	F	1655/11/8	200	19	10.53	337
55	F	1335/13/8	200	34	5.88	314
56	E	1140/23/7	200	10	20.00	090
57	E	1410/13/8	200	26	7.69	195
58	E	1035/13/8	200	17	11.76	180
59	E	1010/13/8	0	0	0	0
60	F	1730/11/8	200	12	16.67	339
61	E	1015/23/7	200	17	11.76	090
62	E	1415/8/8	200	20	10.00	090
63	E	1540/28/8	200	13	15.38	270
64	E	1020/8/8	200	4	50.00	090
65	E	1020/8/8	200	4	50.00	028
66	E	1310/8/8	200	23	8.70	360
67	E	1225/23/7	200	15	13.33	046
68	E	1250/23/7	200	20	10.00	046
69	E	1235/13/8	175	60	2.92	068
70	E	1505/23/7	200	20	10.00	045
71	F	1515/28/8	200	15	13.33	197
72	F	1505/28/8	200	23	8.70	270
73	F	1235/8/8	200	12	16.67	270
74	E	1205/8/8	200	11	18.18	360
75	E	1030/24/7	100	40	2.50	022
76	E	1240/18/8	200	30	6.67	339
77	E	1225/24/7	200	25	8.00	316
78	E	1330/24/7	200	23	8.70	270
79	F	1330/8/8	200	15	13.33	180
80	F	1335/18/8	200	38	5.26	112
81	E	1505/24/7	200	27	7.41	224

* F - Flood
E - Ebb

TABLE 10 Water Current Velocity Observations - Kouchibouguac River Near Logiecroft
August 22-August 23, 1975

Date	Time	Depth 1 meter Direction	Depth 1 meter Speed	Depth 2 meters Direction	Depth 2 meters Speed
22/8	1340			090	5.7
	1400			080	5.7
	1420	090	10.0	080	6.9
	1440	085	9.2	075	6.9
	1500	070	5.1	060	6.9
	1520	260	3.7	205	4.4
	1540	285	7.5	260	6.3
	1600	275	18.0	275	18.6
	1620	280	18.6	280	21.7
	1640	290	10.0	285	8.2
	1700	305	6.9	270	1.6
	1720	305	8.2	325	4.4
	1740	310	10.0	300	2.8
	1800	300	7.5	295	1.6
	1820	305	7.5	295	10.0
	1840	320	2.8	295	11.8
	1900	070	2.8	030	1.6
	1920	083	7.5	065	1.6
	1940	100	10.6	080	5.1
	2000	102	17.4	085	11.2
	2020	106	13.7	088	11.2
	2040	106	15.5	085	10.0
	2100	105	16.2	088	10.6
	2120	098	16.2	090	10.0
	2140	105	14.9	090	7.5
	2200	095	10.0	093	4.4
	2220	097	10.0	095	5.1
	2240	102	11.8	100	4.4
	2300	105	17.4	097	1.6
	2320	102	22.3	085	5.7
	2340	100	18.0	086	5.1
	2400	102	13.7	095	6.3
23/8	0020	101	15.5	093	1.6
	0400	090	5.7	080	0.0
	0100	320	2.8	265	2.8
	0120	300	6.9	275	16.2
	0140	280	12.5	265	11.8
	0200	300	3.7	275	4.4
	0220	350	3.7	095	1.6
23/8	0240	330	4.4	090	2.8
	0300	020	5.7	105	4.4
	0320	260	3.7	255	5.7
	0340	240	6.3	260	10.0
	0400	270	18.6	280	23.5
	0420	270	20.5	280	26.0
	0440	270	16.8	280	18.6
	0500	265	16.2	280	16.8
	0520	265	17.4	280	19.8
	0540	255	21.1	275	23.5
	0600	260	21.7	275	21.7
	0620	255	16.8	275	14.3
	0640	255	14.3	280	11.8
	0700	250	13.7	270	13.7
	0720	280	1.6	265	10.0
	0740	093	5.1	270	3.7
	0800	105	7.5	225	2.8
	0820	105	11.8	155	4.4
	0840	103	20.5	100	9.4
	0900	103	22.9	095	14.3
	0920	105	22.9	095	11.2
	0940	102	21.7	100	9.4
	1000	102	15.5	100	11.2
	1020	100	14.9	095	9.4
	1040	104	16.8	100	7.5
	1100	110	16.2	080	1.6
	1120	106	17.4	115	1.6
	1140	110	13.1	120	1.6
	1200	105	13.1		
	1220	100	9.4		
	1240	100	11.2		
	1300	097	10.0		
	1320	098	9.4		
	1340	098	6.9		
	1400	095	8.8		
	1420	095	7.5		
	1440	095	6.9		
	1500	095	7.5		
	1520	088	4.4		

III 1(iv) Sediments

Sediment samples were taken through the lagoon at positions shown in Figure 27 , at selected clam stations (refer to Figures 11 and 44 for locations), and at three position or a traverse across a channel (Figure 9 above). The samples were taken in 10 cm lengths of 1 1/2" I. D. cellulose acetate tubing inserted into the sediment by hand and closed at the top before withdrawing. They were subsequently transferred to plastic bags, and selected samples were analyzed for particle size characteristics by standard sedimentological techniques.

Samples in bags were subjectively described as "sand" or "mud". In Figure 27 , the occurrence of thus described sand and mud substrates is shown and the presence or absence of vegetation is also indicated (in general, sediments might be expected to be better sorted and coarser in the absence of the "baffling" effect associated with macrophytes - (Ginsburg and Lowenstam, 1957). One substrate type not falling into the "mud" or "sand" category is the "bare, compacted" type; this type occurs commonly on the bottoms of channels and is exceedingly difficult to penetrate by hand. All beach sediments (from clam stations) were of the "sand" type.

In Table 11 is given a summary of statistics for 20 samples representative of the various subjectively described bottom types. These statistics demonstrate that the qualitative descriptions were meaningful, these descriptions agreeing with the verbal description of quantitive sediment characteristics (Folk, 1965). Data for the individual sediment samples are given in Appendix 1.

The most striking feature revealed by the sedimentological studies is the predominance of "sandy" sediments in the southern lagoon as opposed to the predominance of muddy sediments in the northern lagoon. This may reflect a greater suspended sediments load in the northern lagoon associated with the greater number of streams entering that lagoon and possibly an overall "higher energy" environment in the southern lagoon. Current measurements did not indicate the latter, but that lagoon might be subject to a somewhat higher degree of wave action, being more broadly oriented along the coast than is the northern lagoon.

Sediments described as "muddy" in the lagoon are, in general very soft and one sinks quickly into them to a depth of 50 cm or more. They also contain large amounts of decaying macrophyte vegetation and are sulfidic.

The sediments described as 'compacted' from the channel bottoms contain a high proportion of sand with significant amounts of silt and clay (#11, Table 11). "Compacted" sediments in the channels appear to be most common in regions of highest current velocities, at Little Gulley for example, and in these areas are sufficiently stable and adhesive that lobsters are able to burrow in them. Over most of the channels, the sediments are "muddy", soft, and highly organic and covered with a brownish mat which is probably composed in large part of diatoms. This mat is important in that it increases the velocities required for suspension of the contained sediments.

Beaches around the lagoons are generally characterized by moderately well sorted sands.

The occurrence of eelgrass throughout the lagoon must be a major factor allowing accumulation of five grained sediments in the lagoons.

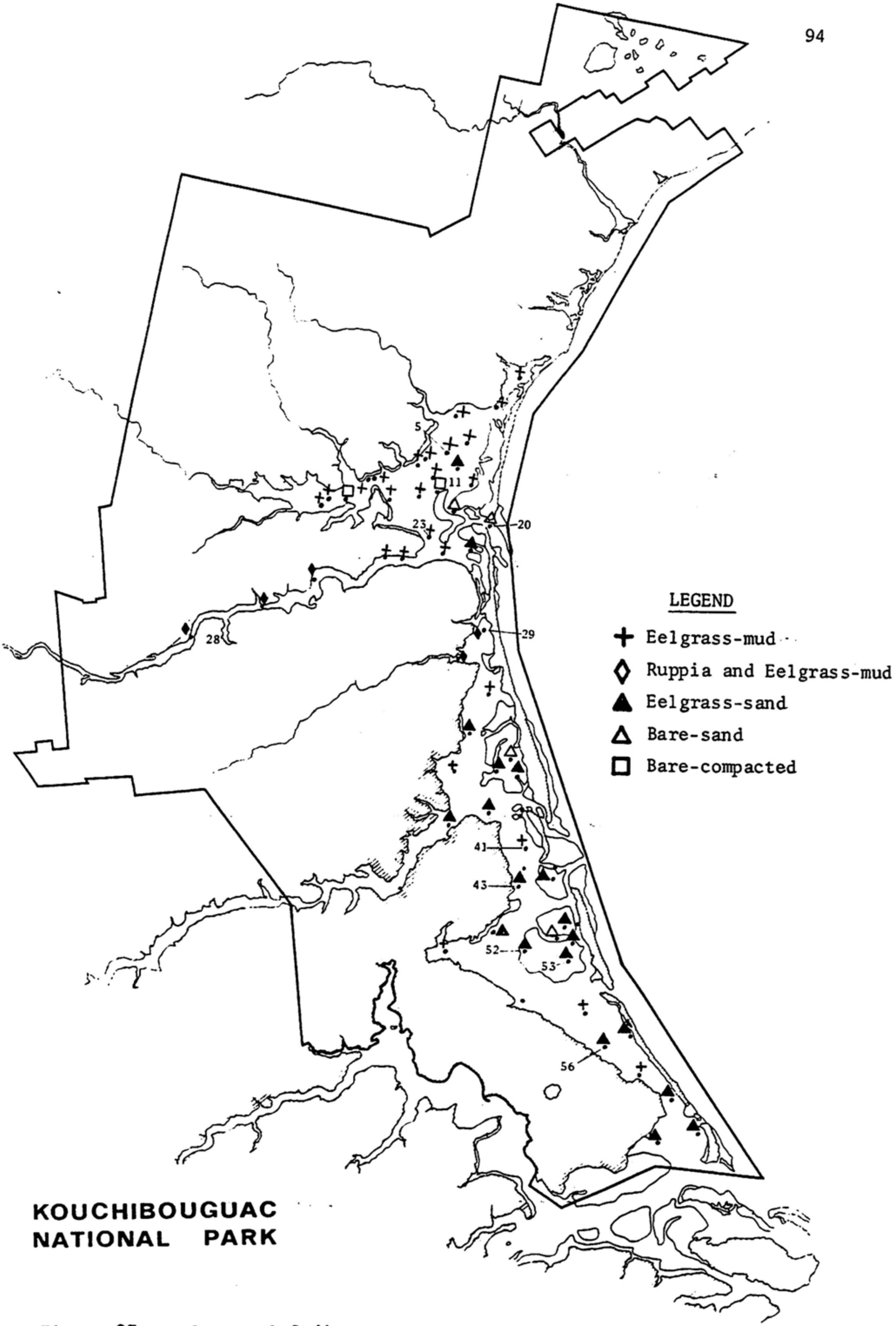
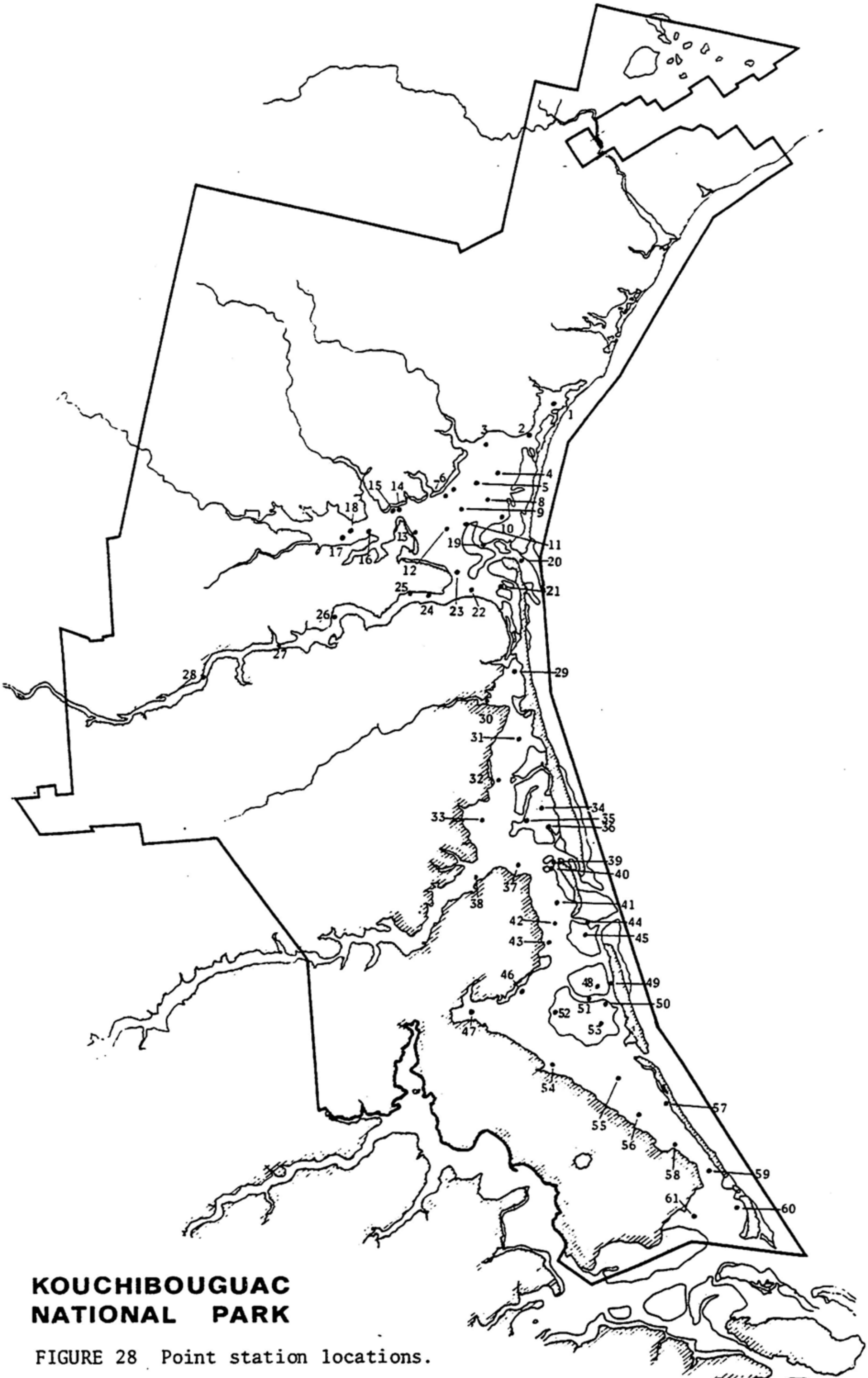


Figure 27 Lagoonal Sediments



KOUCHIBOUGUAC NATIONAL PARK

FIGURE 28 Point station locations.

TABLE 11 Summary of Grain Size Characteristics of Sediments

	Bottom Type Sample Description	Statistical Summary									Verbal Description			
		Gravel	Sand	Silt	Clay	MZ	SK	SD	KG	KGI	Texture	Sorting	Skewners	Kurbosis
11	Channel, compacted sediment	0.03	88.32	7.27	4.38	3.12	0.57	1.02	3.00	0.75	Slightly gravelly sand	Poor	Strongly fine	very leptokurtic
C-2	Channel, mud	2.58	43.50	37.60	15.33	5.16	0.51	2.86	1.60	0.62	Slightly gravelly, sandy mud	Very poor	Strongly fine	very leptokurtic
C-3	Channel, bare mud	0.00	63.38	21.84	14.77	4.72	0.69	2.66	1.68	0.63	Sandy mud	Very poor	Strongly fine	very leptokurtic
20	Channel, sand	1.41	98.59	0.00	0.00	1.12	-0.15	0.51	1.17	0.54	Slightly gravelly sand	Moderately well	Coarse	leptokurtic
43	Zostera sand	1.10	98.90	0.00	0.00	1.47	0.03	0.53	1.24	0.55	Slightly gravelly sand	Moderately well	Near symmetrical	leptokurtic
52	Zostera sand	2.58	97.42	0.00	0.00	1.80	0.07	0.53	1.26	0.56	Slightly gravelly sand	Moderately well	Near symmetrical	leptokurtic
53	Zostera sand	0.27	99.73	0.00	0.00	1.90	0.23	0.62	1.30	0.56	Slightly gravelly sand	Moderately well	Fine	leptokurtic
56	Zostera sand	0.55	99.45	0.00	0.00	1.65	0.00	0.73	1.23	0.55	Slightly gravelly sand	Moderately well	Near symmetrical	leptokurtic
P-7	Zostera mud	0.02	99.98	0.00	0.00	1.94	0.20	0.50	1.15	0.54	Slightly gravelly sand	Well	Near symmetrical	leptokurtic
28	Zostera-Ruppia mud	0.00	12.79	44.94	42.27	7.82	0.16	3.45	0.86	0.46	Sandy mud	Very poor	Fine	platykurtic
29	Zostera-Ruppia mud	0.00	39.00	36.60	24.41	5.74	0.26	3.77	0.92	0.48	Sandy mud	Very poor	Fine	mesokurtic
5	Zostera mud	0.00	18.82	52.20	28.98	6.76	0.40	3.29	0.95	0.49	Sandy mud	Very poor	Strongly fine	mesokurtic
23	Zostera mud	1.65	51.65	26.61	20.07	4.88	0.47	3.67	1.02	0.51	Slightly gravelly, sandy mud	Very poor	Strongly fine	mesokurtic
41	Zostera mud	3.29	25.00	46.05	25.65	6.36	0.30	3.51	1.10	0.52	Slightly gravelly, sandy mud	Very poor	Strongly fine	mesokurtic
C-1	Zostera mud	5.78	69.49	16.94	7.79	3.75	0.22	2.66	4.71	0.82	Gravelly, muddy sand	Very poor	Fine	extremely leptokurtic
P-3	Beach sand (vertical clam stn)	0.14	99.86	0.00	0.00	1.86	0.07	0.47	1.14	0.53	Slightly gravelly sand	Moderately well	Near symmetrical	mesokurtic
KB	Beach sand	0.82	99.18	0.00	0.00	1.36	-0.09	0.52	0.98	0.49	Slightly gravelly sand	Moderately well	Fine	leptokurtic
TI	Beach sand	0.11	99.89	0.00	0.00	1.73	0.13	0.65	1.21	0.55	Slightly gravelly sand	Moderately well	Fine	leptokurtic
9	Beach sand	0.23	99.77	0.00	0.00	1.76	0.13	0.56	1.12	0.53	Slightly gravelly sand	Well	Near symmetrical	leptokurtic
37	Beach sand	0.02	99.98	0.00	0.00	1.78	0.05	0.49	1.18	0.54				

2. The Biological Environment

2(i) The major communities

The objectives of the studies as described in this section were essentially:

(i) to map the distribution of main community or biofacies types and of key, indicator species.

(ii) to determine the more abundant and common flora and invertebrate fauna.

(iii) to determine the most abundant "small fish" (i.e., those not caught in gill nets).

(iv) to characterize the growth and production of eelgrass.

(v) to obtain basic information on nutrient and oxygen levels in lagoonal waters during the summer.

The basic program for these studies consisted of sampling and observations at 61 lagoon stations pinpointed on a map before the field trips and distributed to give representation of the lagoon as a whole (i.e., without reference to special features or subenvironments), and at ten additional stations chosen to provide some representation of the channels leading from the rivers (they occupy only a small fraction of the total lagoon area) and of the rivers above the lagoon. At all except for a few of these stations, all of the following observations and samples were taken.

(1) temperature, salinity and current data (reported above)

(2) core of bottom sediments (reported above)

(3) Three shovelfulls of bottom (approximately 225 cm^2 area each) were sieved through 1 mm mesh sieve and retained infauna were preserved for later identification.

(4) Where eelgrass occurred, 1 or 2 quadrat areas (25 x 25 cm) were cut at substrate level and the bed weight determined.

(5) One or two observers stationed over an area of approximately 100 m^2 recorded all conspicuous epifauna, flora, and nekton; and appropriate collections were made where possible.

In addition, separate effects were made to determine the limits of Zostera and Ruppia distributions, clam distributions, and the occurrences of mussel and oyster beds, and of irish moss. Separate studies on small fish, eelgrass growth and nutrients and oxygen are described in appropriate sections following.

The Major Lagoon Communities or Biofacies

We are defining a community in the sense of Shelford (Odomon, 1971) as "an assemblage with unity of taxonomic composition and a relatively uniform appearance", and we include the physiography and sediment characteristics as characters to be included under "uniform appearance". Thus the term, "biofacies" might be more appropriate. We had expected to find greater obvious diversity than we did. It seemed important from the point of view of easy application of whatever criteria we used to define the different biofacies that they be readily distinguishable by visual observation (i.e. by qualitative rather than quantitative characteristics).

On this basis, we define five major biofacies which are discretely distributed:

I. *Ruppia*-mud
II. *Ruppia*-*Zostera*-mud
III. *Zostera*
IV. Channels
V. Beaches

three subdivisions of the *Zostera* biofacies which occur in a "patchwork" type distribution with the *Zostera* biofacies:

Zostera-mud
Zostera-sand
Bare sand

and four subdivisions of the channel biofacies:

Channel-compacted sediment
Channel-muddy sand
Channel-mussel beds
Channel-marine sandy zone

The marine sandy zone of channels occurs in the region of openings to the sea and is characterized by strong currents and transitory well-sorted sand cover over rock or compacted sediment bottom. Mussel beds occur as indicated in Figure 29; and over the remainder of the channels muddy sand or compacted sediments occur, the latter apparently in regions of particularly strong currents. The *Zostera* subdivision were indicated in Figure 27 occurrence of channels in Figure 8, and *Ruppia* and *Zostera* distributions are shown in Figure 30.

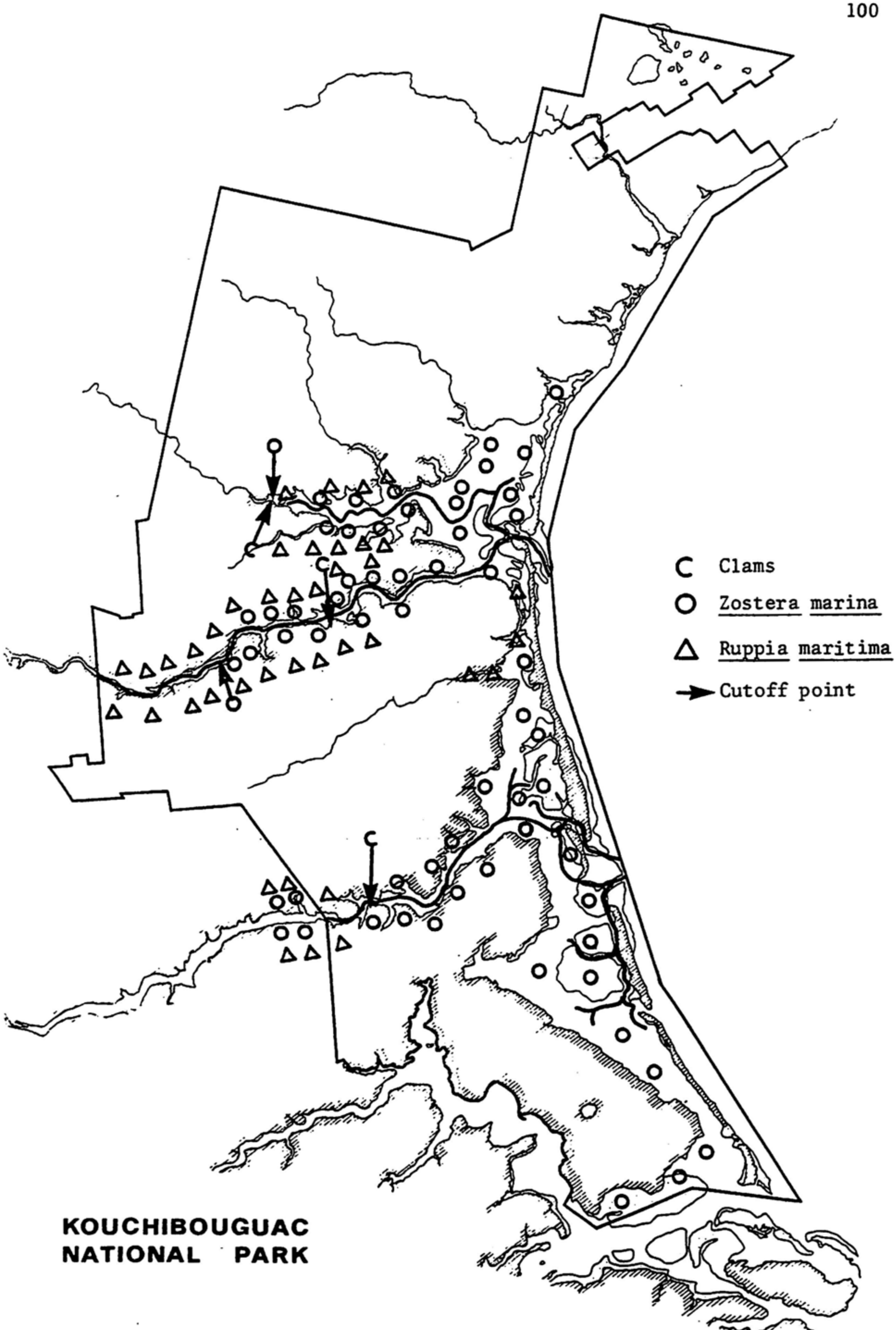


FIGURE 30 Distribution of Ruppia maritima and Zostera marina; See text for details of upriver distribution
Upriver limits of clam (C) and Zostera distribution as indicated.

The most striking and obvious basic feature of the lagoonal system as whole is the uniform distribution of eelgrass, Zostera marina throughout it except in the channels. Zostera-mud biofacies predominate, as was noted above, in the northern lagoon, and Zostera-sand biofacies in the southern lagoon. Near shore and up the rivers, Zostera is mixed with Ruppia in mud substrates and gives way to pure stands of Ruppia in mud. Bare sand biofacies occur intermittently in Zostera stands through the lagoons, more commonly in the southern lagoon. Figure 11 illustrates the flora and mollusc fauna distribution across a section at the southern end of Kouchibouguac Lagoon encompassing bare sand, Zostera sand, Zostera mud, and beach biofacies. Minor amounts of Ruppia occur in the shallower areas of this profile, in sand substrates. Figures 10 and 11 illustrate profile across channels in Kouchibouguac River and in Kouchibouguac Lagoon.

III 2(ii) Infauna and Epifauna

We did not attempt to obtain exhaustive species collections for the infaunal and epifaunal organisms; rather we were concerned with defining or describing communities on the basis of observations on the more common and conspicuous species. Bowen and Rivard (1972) provide a detailed list of fauna from the lagoon (Table 1, above).

DATA

Data on the major faunal components for Ruppia-Zostera, Zostera-mud Zostera-sand, and Bare sand biofacies of the lagoons are summarized in Tables 12 through 15. Channel areas were examined separately from the shallow biofacies, and a general description of the channel biofacies is given below.

Channel biofacies

Channels-occurrence of biofacies subdivisions:

The most commonly occurring channel biofacies is the "muddy-sand" type; "marine sand zones" occur in the vicinity of breaks through the sand bars, "mussel beds" occur as shown in Figure 29, and "compacted-sediment" biofacies occur in some channels near river mouths and irregularly elsewhere.

Muddy-sand biofacies:

The sediment in muddy-sand biofacies is generally very soft and highly organic. The surface of the sediment is commonly held together by a thin "brownish mat", possibly made up of diatoms, but the exact nature was not determined. This mat appears to make the sediment surface hydrodynamically smooth, thus minimizing turbulence and sediment suspension. It is easily broken and when this is done, the fine sediment particles are brought into suspension. Accumulations of eelgrass and green algal debris are common in muddy-sand biofacies; the common and conspicuous epifauna include:

(i) the gastropods Littorina littorea
L. saxatilis (occasional
Lunatia heros

occasional clumps of a few individuals of the mussels:

Mytilus edulis
Volsella demissus

(ii) polychaete egg masses were observed issuing from the bottoms in some areas; species were not determined.

(iii) the starfish, *Asterias vulgaris* - many small individuals, a few cm across, are attached to dead eelgrass leaves; larger individuals occur also but not frequently. Few were found larger than about 4-5 cm. Starfish are not found in eelgrass far from the channels except as very small individuals.

(iv) the crab, *Cancer irroratus*, was generally very abundant in this biofacies - not immediately observed, but when bait is put out, they emerge in large numbers from the mud. The soft muds of the channels appear to be particularly good habitats for these crabs.

Compacted-Sediment Biofacies:

Compacted-sediment biofacies are hard to penetrate by hand; they appear to occur in areas of particularly strong currents, but this would have to have been confirmed by more detailed observations. Two areas where we observed compacted sediments were (1) near the mouth of Black River and (2) in Little Gulley - the latter area had a transient sand cover over the top and is classified in the marine sandy zone.

Other than occasional starfish and *Littorina*, few animals were observed on the compacted-sediment biofacies.

The Marine Sandy Zone:

A unique area exists in the passage at Little Gulley between the dunes. This area is relatively shallow (mostly about 2 m), currents are intense, and the bottom consists of rocks and compacted sediment with transient sand cover; extensive mussel beds occur in some areas. Moon snails (Lunatia heros), barnacles, crab, and lobster are common and abundant in some areas. Lobsters are particularly abundant where accompacted sediment bottom occurs, as they burrow into this.

Various red and brown algae, including *Laminaria* and *Fucus* and others, and the green seaweed, *Ulva lactuca*, are common here.

Mussel Bed Biofacies:

Distribution of this biofacies is shown in Figure 29, and a typical profile across one sand biofacies is shown in Figure 11
Further details are given in section III 3(ii)b.

COMMENTS - GENERAL

The biofacies listed in Tables 12 through 15 comprise more than 90% of the lagoonal area.

In general, the occurrence of organisms in those biofacies and differences between the biofacies are consistent with observations elsewhere (summarized in Tables 16 and 17 for bivalves and gastropods).

Organisms common on all four biofacies (Ruppia-Zostera, Zostera-mud Zostera-sand, Bare sand) include:

- Mytilus edulis
- Modiolus demissa plicatus
- Mya arenaria
- Macoma balthica
- Hydrobia minuta
- Littorina sexatilis
- Nassarius obsoletus
- Odostomia trifida
- Nereis virens

Organisms notably absent from the Ruppia-Zostera biofacies, but present in others include:

- Littorina littorea
- Lunatia heros
- Nassarious trivittatus
- Glycera dibranchiata and other worms
- Cancer irroratus
- Crangon septemspinosa

For at least some of these, this absence probably reflects low salinities at some times of the year or intermittently following rains.

Organisms restricted to or much more common on sand (Zostera-sand, bare sand biofacies include:

- Crassostrea virginica
- Gemma gemma
- several polychaete species
- Cancer irroratus
- Crangon septemspinosa

COMMENTS - MOLLUSCS

Overall, the most abundant epifaunal bivalve was Mytilus edulis, and the most abundant infaunal bivalve was Macoma balthica. However, the Zostera beds in particular cannot be considered a prime habitat for M. edulis [see section III 3(ii)]. In Danish waters, M. edulis increased in general abundance following destruction of eelgrass in the '30's.

Littorina littorea is by far the most common and abundant gastropod in the eelgrass beds and in the lagoon system as a whole, occurring on Zostera-mud, Zostera-sand, bare sand, and channel biofacies: but notably absent from the Ruppia-Zostera biofacies - its lower salinity limit is relatively high (Table 17) in comparison to other molluscs, and its absence from the Ruppia-Zostera biofacies may reflect this. This species and the other two Littorinas are herbivores feeding on algae growths by a rasping tongue or radula. On Zostera leaves, they probably eat the attached small filamentous algae and microscopic diatoms rather than the eelgrass itself. They may also be incidental carnivores (Caddy, 1973). L. Littorea biology is discussed in more detail in section III 3. Hydrobia minuta and Odostomia trifida presumably feed on epiphytes on Zostera as well. The two Nassarius species are anatomically predatory species capable of boring through shells of gastropods and bivalves, but N. obsoleta at least is known to feed mainly on benthic diatoms and detritus (Pratt, 1973). Together, the gastropods occurring on Zostera leaves may amount to many thousands per m^2. The young of Mytilus edulis are also abundant on Zostera during the summer. The mollusc fauna of the eelgrass blades is a most conspicuous one. How important it is as a source of food for higher trophic levels, however, is uncertain.

Rasmussen (1973) suspects that the gastropod fauna of eelgrass leaves is not a major food source for higher trophic levels; more important, he believes, are the crustaceans which tend to move to more open areas at night to feed and are subject to predation there.

Lunatia heros, the moon snail, is the largest gastropod occurring in the Park. This is a predatory species which feeds on other molluscs. According to Thomas (1970), it is relatively intolerant of lowered salinity and penetrates the estuary only to a limited extent. Certainly, we observed it to be fairly abundant in the channels in the lagoons and more so there than elsewhere - the same was observed for the starfish, Asterias vulgaris ... limited penetration of estuaries by these two predatory species is condidered to be a factor allowing development of large populations of mussels in estuaries.

COMMENTS - INFAUNAL WORMS

Nereis virens, was the most abundant and most common infaunal "worm" (Table 14) as it commonly is in shallow river and estuarine situations. It is a large worm reaching 40 or more cm in length and a voracious feeder, feeding on a variety of lower marine animals, but also will scavenge (feed on dead animal and plant remains) and even feed on sand with high contents of organic matter (Rasmussen, 1973). It constructs a tube in the sediment, which it leaves regularly, particularly at night when it leaves to feed and may then be eaten by fish. This worm is well known for mass "swarming" occurring during spawning periods, at full or new moons, at night. Nereis virens is a major prey species for fish in Bideford River (Thomas, 1970). Glycera dibranchiata (bloodworms) is another large species (to about 20 cm in length) which is anatomically and structurely a raptorial (adapted to siezing prey) feeder, but which may feed as a deposit feeder as well.

The bloodworm is described as being"a common member of the intertidal fauna of soft muddy beaches but it is also reported to be abundant below low water mark in some areas"(Klawe and Dickie, 1957). Numbers we observed (Table 14) are comparable to densities given by Klawe and Dickie,(1975). Unlike the clam worm, the species does not appear to leave the bottom regularly. They do leave at the time of spawning, but whether or not swarming occurs as for N. virens is uncertain (Klawe and Dickie, 1957). Both N. virens and G. dibranchiata are taken commercially in some areas, being utilized as bait worms. Species of polychaetes other than these two were abundant only on the Bare sand biofacies (Table 14).

COMMENTS - CRUSTACEA

The eelgrass beds are characterized by an abundance of isopods amphipods and mysids. The two isopods, Idotea phosphorea and Idotea baltica were common on the leaves of Zostera, and on seaweeds. These species eat vegetation, notably Fucus and the members of the genus commonly swarm at nights (Rasmussen, 1973).

TABLE 12 Occurrence of bivalves at Point Stations and Clam Stations expressed as percentage of stations in which the species was observed. Number of stations = Ruppia-Zostera 5, Zostera-mud 27 (23 for infauna), Zostera-sand 13, Bare sand 4, Clam Stations 37. Some density data are given for the two most abundant in infaunal species at bottom of table.

	BIOFACIES				
	Ruppia-Zostera	Zostera-Mud	Zostera-Sand	Bare Sand	Clam Stns.
EPIFAUNAL BIVALVES:					
Mytilus edulis (edible mussel)	20%	70%	54%	25%	0
Modiolus demissa plicatus (ribbed mussel)	60	26	23	25	0
Crassostrea virginica (oyster)	0	0	15	25	0
INFAUNAL BIVALVES:					
Mya arenaria (soft-shelled clam)	20	43	39	50	100
Petricolia pholadiformis (false angel wing)	9	8	0	0	0
Macoma balthica (little macoma)	80	87	77	75	59
Gemma gemma (gem clam)	0	0	8	50	71
Tellina agilis (dwarf tellin)	0	0	0	0	3
Venus mercenaria (quahog)	0	0	8	0	0
Densities (No./m^2)					
Mya arenaria	12(0-59)	15(0-69)	46(0-294)	33(0-89)	--
Macoma baltica	280(0-533)	247(0-1150)	183(0-485)	140(0-340)	--

TABLE 13 Occurrence of the more common and conspicuous gastropods at Point Stations. Expressed as percentage of stations in which gastropod was observed. Numbers of stations as in Table 12.

Species	Ruppia-Zostera	Zostera-Mud	Zostera-Sand	Bare Sand
Acmaea testudinalis (tortoise limpet)	0%	2%	0%	0%
Crepidula fornicata (boat shell)	0	26	0	0
Hydrobia minuta (salt marsh spire)	80	63	54	50
Littorina littorea (common periwinkle)	0	59	54	75
Littorina saxatilis (rough periwinkle)	0	30	0	25
Lunatia heros (moon snail)	0	7	15	25
Nassarius obsoletus (mud snail)	20	15	31	50
Nassarius trivittatus (basket shell)	0	30	8	25
Odostomia trifida (Odostome)	20	33	23	25

TABLE 14 Occurrence of polychaetes and other "worms" at Point Stations. Expressed as percentage of stations in which species was observed (infauna samples). See Table 12 for numbers of stations. Density data given at bottom of table.

Species	Ruppia-Zostera	Zostera-Mud	Zostera-Sand	Bare Sand
Nereia virens (clam worm)	80%	96%	92%	75%
Glycera dibranchiata (beck-thrower)	0	26	15	25
Nepthys bucera	0	13	8	25
Maldanidae sp.	0	13	8	50
Polynoidae sp.	0	9	0	0
Ophelia limacina	0	4	0	25
Unid. polychaete	20	0	8	75
Unid. polychaete	0	0	8	0
Sipunculoid, unid.	0	13	23	0
Nemertean, unid.	0	0	0	50
Densities (No./m^2)				
Nereis virens	35.5(0-133)	74(0-207)	57(0-237)	30(0-59)
Glycera dibranchiata	0	4(0-15)	2(0-15)	7(0-29)
All other polychaetes	3(0-15)	7	7	52
Sipunculoid	0	2	3	0
Nemertean	0	0	0	7

TABLE 15 Occurrence of crustaceans (conspicuous) and echuroids (starfish) at Point Stations. See Table for numbers of stations.

Species	Ruppia-Zostera	Zostera-Mud	Zostera-Sand	Bare Sand
Balanus improvisus (barnacle)	--%	4%	8%	--%
Cancer irroratus (rock crab)	--	22	54	50
Crangon septemspinosa (sand shrimp)	--	26	100	75
Gammarus sp.	--	30	15	--
Idotea phosphorea (isopod)	--	13	8	--
Idotea baltica (isopod)	--	13	8	--
Mysis stenolepis (Mysid)	--	26	31	--
Paguris acadiensis (hermit crab)	--	7	--	--
Asterias vulgaris (Purple starfish)	--	15	8	--

TABLE 16 Habits of bivalves (Pratt, 1973; Miner, 1950)

Species	Size	Vertical Distribution	Salinity (adults)	Substrate	Feeding
Mytilus edulis (edible mussel)	6.5 mm	intertidal to subtidal	minimum tolerated about 4 ‰	mud, sand, other mussels, requires something stable on which to attach young on eelgrass, seaweeds	filter feeder
Modiolus demissa plicata (ribbed mussel)	6.5 mm	common in intertidal	euryhaline	mud and sand	
Crassostrea virginica (oyster)	to about 250 mm	subtidal at these intertides	3-40 ‰	rock bottom or semi hard mud, shifting sand and soft mud unsuitable	filter feeder
Mya arenaria (soft shelled clam)	to 130 mm	intertidal, shallow subtidal	lower limit about 4 ‰	sandy bottom preferred	filter feeder
Petricolia pholadiformis (false angel wing)	50 mm	most common in intertidal	euryhaline	common on muddy shores and in salt marshes, burrows soft rocks	
Macoma balthica (little macoma)	30 mm	intertidal to deep water	meso and oligo-haline (typ. 5-15 ‰	mud and sand	deposit feeder
Gemma gemma (gem clam)	5 mm	shallow, shores intertidal		sandy shores	filter feeder
Venus mercenaria (quahog)	90 mm	intertidal, shallow		sandy and muddy bottoms	filter feeder

TABLE 17 Habits of gastropods (Pratt, 1973; Miner, 1950)

Species	Size	Vertical Distribution	Salinity (adults)	Substrate	Feeding
Acmaea testudinalis (tortoise limpet)	12 mm	intertidal shallow water		eelgrass	herbiverous
Crepidula fornicata (boat shell)	38 mm	shallow water to moderate depths		usually adhering to each other and to other shells	filter feeder
Hydrobia minuta (salt marsh spire)	3½ mm	shallow water, intertidal marshes	euryhaline	seaweeds, eelgrass pools, mud and sand bottom	herbiverous detritus feeder
Littorina littorea (common periwinkle)	25 mm	intertidal to subtidal	12 ‰ lower limit	rock, gravel, mud bottoms or eelgrass	herbiverous
Littorina saxatilis (rough periwinkle)	10 mm	most common between mid tide and extreme high water	limited estuarine	as for L. littorea	herbiverous
Lunatia heros (moon snail)	90 mm	low intertidal to subtidal (30 f)	confined to lower parts of estuaries cannot survive low salinities	mud, sand, will burrow	Predatory Drills into bivalves
Nassarius obsoletus (mud snail)	25 mm	intertidal, shallow subtidal	common in brackish	muddy areas, on eelgrass	scavenger predators, detritus feeders (bore holes in bivalves)
Nassarius trivittatus (basket shell)	15 mm	shallow subtidal	common in brackish water	prefers sandy bottoms over muddy on eelgrass	as for N. obsoletus
Odostomia trifida (Odostome)	5 mm	low tide area	common in brackish water	under stones, drift wood at low tide on eelgrass	

A Gammarus species was the most common amphipod. Members of the genus are herbivorus and omnivorus. Mysis stenelopsis a detritus feeder, is commonly abundant in eelgrass beds elsewhere. The crustaceans of the eelgrass beds usually move out of the eelgrass beds at night for feeding, and where they descend into channels, may be an important component in the export of organic materials from these systems (Thomas, 1970). They may produce several fast-growing generations in the growing season, and because of the high productivity and mobility they are of major importance as feed for fish (Rasmussen, 1973). The figures for frequency of occurrence of the above mentioned crustaceans (Table 15) are probably underestimates of their true frequency. Undoubtedly, more detailed examination would have recorded frequencies approaching 100% for most of these species.

The barnacle, Balanus improvisus occurs on the leaves of eelgrass.

The sand shrimp, Crangon septemspinosa was notably more abundant in sandy biofacies (Zostera-sand, Bare sand) then in muddy biofacies. This is consistent with observations elsewhere (e.g. Thomas, 1970, Pratt, 1973). It is an omnivore and scavenger and is a major source of food for fishes in the Park (Table 21), as it is elsewhere (Thomas, 1970, deSylva et al 1962).

Crabs (C. Irroratus) were common in the eelgrass beds, more so in the sandy substrates. In the dense eelgrass stands their freedom to move about and burrow into the bottom is restricted. Highest concentrations of crabs occur in the soft muddy-sand biofacies of channels (see also section III 3).

COMMENTS - THE EELGRASS EPIPHYTE COMMUNITY

We have not attempted to examine in any detail the epiphyte floral and faunal community of the eelgrass leaves. We have noted the larger more conspicuous species - including the isopods, the barnacle, Balanus improvisus, young mussels and gastropods, as discussed above, and also the macrophyte algae [section III 2(iv)]. In addition, there occurs a great variety of micro and macrofauna - protozoans, ciliates flagellates, foraminifers, nematodes, polychaetes, rotifers, tardigrades copepods, and ostracods, sessile encrusting bryozoans, serpulids, hydroids, blue green algae and daitoms (Pratt, 1973, Kikuchi and Peres 1973).

III. 2(iii) Small Fish

Mr. Bradford Challis, one of the field workers for this survey worked up the data and did independent studies on small fish (under the direction of D. Patriquin) for an Honors Biology thesis at Dalhousie University. His data and calculations are included below.

BACKGROUND

"Small fish", and by these we mean fish of maximum lengths less than 20 cm, are frequently important items in the diet of larger estuarine fish such a tomcod, trout, and bass (Leim and Scott, 1966). Habits of these fish are summarized in Table

DATA COLLECTION

Fish were captured with a 30 m by 1.9 m - 1/4 inch mesh beach seine which was run out from shore in locales indicated in Figure 31. The area enclosed by the seine sweep was estimated as 707 m^2.

Visual observations (underwater) on the occurrence of small fish were made at 48 sites through the lagoons during the course of point station studies, which took about 20 minutes per site. Minnow traps were also set at 16 sites through the lagoon and were left for one to several hours.

Lengths were measured for entire samples or subsamples of fish for most catches shortly after the fish were captured. Otoliths were removed from mummichogs in the field.

RESULTS

Summary of Seine Catches and Visual Observations:

Numbers of the various species taken in the seine hauls are given in Table 19. In addition to "small fish", occasional tomcod and smooth flounder were taken. Large numbers of sand shrimp, *Crangon septemspinosa*, were taken in some seine hauls.

Some representative length-frequency data are illustrated in Figure 32. These include lengths for the sand lance, Ammodytes americanus, picked up by hand from vegetation-free sandy bottom near the mouth of the Kouchibouguac River. This was the only species observed visually which was not caught in beach seines. They were observed at only one other location, also on sandy bottom.

Mummichogs (F. heteroclitus) and silversides (M. menidia) were the two species caught in largest numbers. Mummichogs were caught in greater numbers where the seine extends over muddy bottoms, and silversides in greater numbers where the seine covered only sandy bottoms (Table 19). In general, visual observations (Figure 31) agreed with this; silversides were observed more commonly where sandy sediments predominated, notably in the southern lagoon, and Fundulus spp. (F. heteroclitus and F. diaphanus were not distinguished in visual observations) where muddy sediments predominated. Sticklebacks (all species) were observed generally through the lagoons. Catches in the minnow traps were generally low, and are not reported. No species other than those observed visually or taken in seines were taken in the minnow traps.

Growth Rates of F. hetroclitus and M. menidia:

Ages of mummichogs were estimated by (i) separation of polymodal length frequencies (Figure 33) according to the technique of Cassie (1963), and (ii) counts of annual rings on otoliths (Fritz and Garside, 1975). The oldest individuals indicated by both techniques were 6 years of age. Average growth rate to age IV indicated by these two techniques is very close to that reported by Fritz and Garside (1975) for mummichogs from Petpeswick Inlet, Nova Scotia (Figure 34).

Separation of polymodal length frequencies for silversides (Figure 35) indicates the occurrence of at least four age classes, possibly five, in the seine catches. Studies by Merriman (1941) showed that silversides in Connecticut waters reach a length of about 2 cm in August following the first year of growth (spawning in the spring). A few individuals of 1.8 cm in length were taken in our seine catches and probably represent the age I year class. The three size classes of Figure 35 presumably represent ages II to IV. The average growth rates indicated by the separation of polymodal length frequencies is shown in Figure 34.

Stomach Contents of F. heteroclitus and M. menidia:

The percentages of 20 mummichogs and 20 silversides examined in which different food items were found are given in Table 20. Both species appear to have been feeding extensively on insects and large crustacea. White mushy material found in all silverside stomachs may have been digested zooplankton. Eelgrass fragments, and polychaete remains occurred commonly in mummichog stomachs but not in silverside stomachs.

Occurrence of Small Fish in Stomachs of Larger Predators:

In Table 21, data are given on the occurrence of small fish and sand shrimp in the stomachs of larger predator fish caught in the Park. Although the data are limited, they do suggest that the larger predator fish were feeding more extensively on sand lances and silversides, fish associated mainly with more open sandy bottoms. Sand shrimp (Crangon septem spinosa) were common in the stomachs of the larger fish, and this species also shows a preference for more open sandy bottoms (observed at 7/27 eelgrass-mud sites and at 16/17 eelgrass-sand or bare sand sites).

COMMENTS

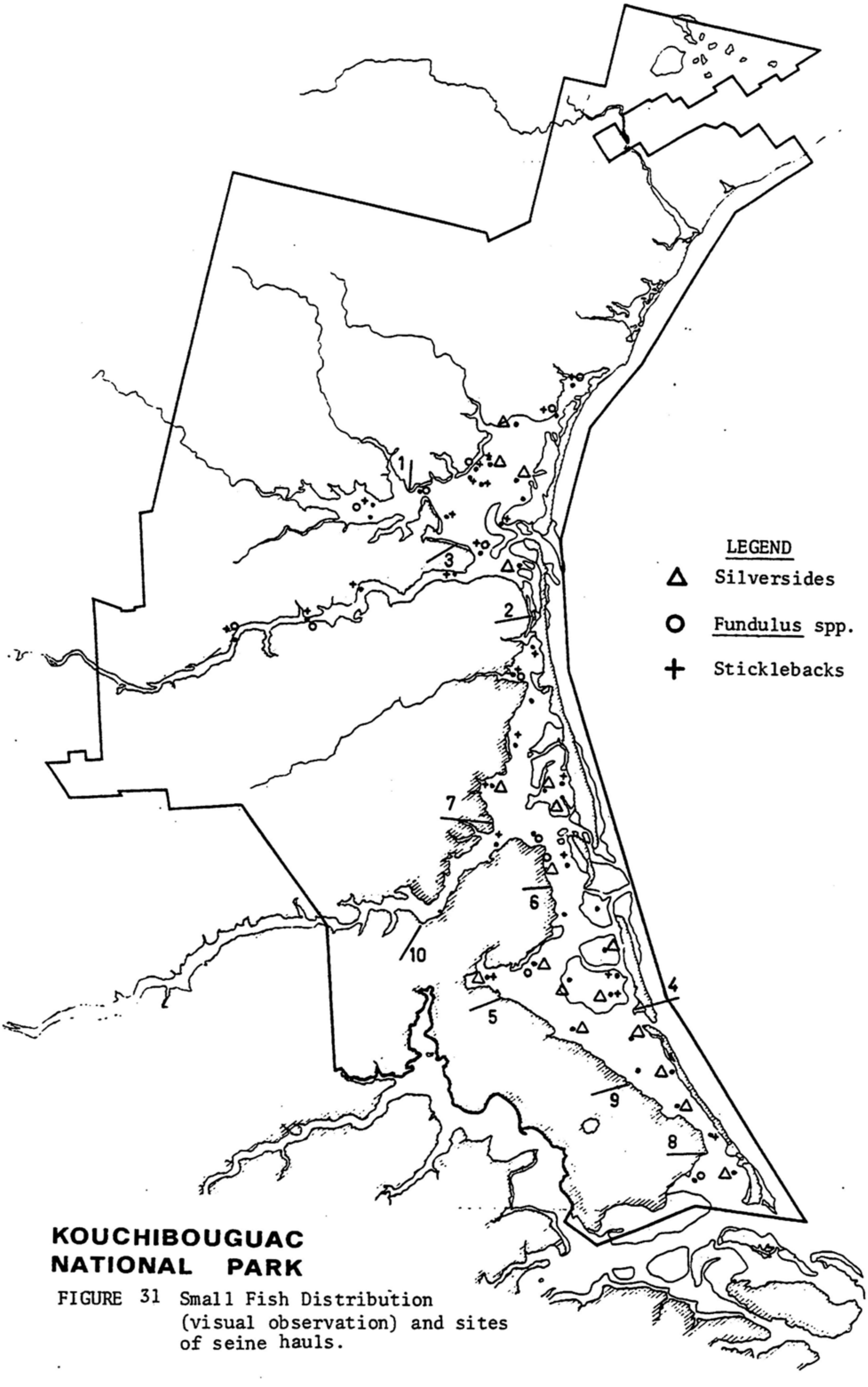
Visual observations and beach seine catches indicate that four species of stickleback, two Fundulus species, the sand lance, and Atlantic silversides are the predominant small fish in the Kouchibouguac Park lagoons. Numerically, mummichogs and silversides were the most abundant fish taken. The seine was selective for sizes above about 5 cm in length for Fundulus spp. and M. menidia and above about 2 cm in length for sticklebacks, and the numbers taken may be accordingly biased. Of these small fish, silversides and sand lances were most commonly observed in stomachs of larger predators. No small fish other than those taken in the beach seine or observed visually were observed in the stomachs of the larger predator fish taken in the lagoons. Beach seining and visual observations thus seem to give a good indication of the small fish available as food for larger fish.

Visual observations and beach seine catches suggest that mummichogs are most abundant over muddy bottoms and silversides over sandy bottoms. The predominance of small fish associated with sand bottoms (silversides and sand lances) in the stomachs of the larger predatory fish suggests that the latter feed mainly in the more open, sandy areas rather than in the dense, muddy eelgrass regions. That the lack of mummichogs in the stomachs of these larger fish did not represent discrimination against these fish is indicated by Thomas' (MS, 1970) observations on prey species in the Bideford River, P.E.I. estuarine system where mummichogs and silversides occurred in equivalent proportions (21% each) of stomachs of predator species. The Bideford River system is deeper, and the larger fish presumably have easier access to the fish in eelgrass beds that they do in the Kouchibouguac Park lagoons. On the shallow, muddy bottoms in the Kouchibouguac lagoons eelgrass turions occur in densities averaging $1400/m^2$, and the blades extend to the water surface forming what must be an almost inpenetrable thicket to larger fish. Large diurnal fluctuations in oxygen in the dense eelgrass stands [section III. 2(vi)] may also be a factor restricting foraging by the larger species. In general, these observations support the contention (Rasmussen, 1973) that dense eelgrass growth, particularly in shallow, semi-stagnant situations (created in part by the eelgrass) is inhospitable for many "desitable" species because of the assoicated adverse physical (space) chemical (oxygen), and sedimentary (accumulations of fine grained sediments) conditions. The mummichog, with its tolerance of low oxygen conditions, is particularly well adapted to the dense eelgrass stands.

Collections of fish were not obtained up the rivers, but it can be guessed that F. heteroclitus (killifish) and the three-spine stickleback predominate in the lower salinity areas.

In agreement with literature reports for this general area (Scott and Crossman, 1973), maximum sizes of mummichogs in the Kouchibouguac Park Lagoon exceeded those of more southerly locations (Atlantic coast of Nova Scotia, Gulf of Maine). Growth rate to age IV of mummichogs in Kouchibouguac Park is comparable to that reported for mummichogs in Petpeswick Inlet, Nova Scotia (Fritz and Garside, 1975); the greater maximum size of mummichogs in Kouchibouguac Park in comparison to more southerly locations seems to represent greater longevity of mummichogs rather than substantially higher growth rates. Items observed in the stomachs of mummichogs in Kouchibouguac Park are consistent with the general description of this fish as an omniverous feeder (Scott and Crossman, 1973).

Except for the study of Merriman (1941) on the growth of silversides during their first year, there do not appear to be any other reports on growth rate of this species. Maximum length of silversides in the Delaware estuary (de Sylva et al, 1962) is comparable to that at Kouchibouguac. Copepods are quoted as being a predominant food item for silversides in the Delaware River estuary. In Kouchibouguac, larger crustaceans and insects also appear to be important food items. De Sylva et al (1962) remarked that "The Atlantic Silverside, *Menidia menidia*, ranked first in year-round abundance and probable importance as a forage fish of the Delaware Bay shore zone". This fish appears equally important in the Kouchibouguac lagoons, but its apparent preference for open, sandy areas may lead to decreasing abundance in future years if, as we suspect, eelgrass and muddy bottoms become more prevalent; mummichogs would be expected to become correspondingly more abundant.



KOUCHIBOUGUAC NATIONAL PARK

FIGURE 31 Small Fish Distribution (visual observation) and sites of seine hauls.

TABLE 18 Summary of Habits of Small Fish (Leim and Scott, 1966)

Species	Habitat	Spawning	Food
Atlantic Silversides	Shore waters and estuaries; remain through winter	Spawn in June; eggs adhere to sand and week; hatch in about 10 days	Plankton, mysids, shrimp, marine worms
Killifish	Fresh water species which is salt water tolerant		Omniverous
Mummichog	Estuaries and brackish water; often in small pools; very tolerant of low oxygen; will bury in mud	Shallow water; mid-summer adhere to objects; hatch 9-18 days	Omniverous
Three-spine Stickleback	Shore fish, fresh and salt water	Spawns in fresh water; male builds nest and defends it, June or July	Copepods, isopods, small fish
Four-spine Stickleback	Coastal waters, sometimes in fresh water	Spawns in fresh water; male builds nest and defends it, June or July	Copepods, isopods, small fish
Nine-spine stickleback	Tolerant of fresh and brackish water	Spawns in fresh or slightly brackish water in summer; as above	
Black-spotted Stickleback	Marine; often semi-pelagic		

TABLE 19 Fish Taken in Beach Seines

s = sand
Z = Zostera marina (eelgrass)
m = mud
r = rocks

NUMBERS OF EACH SPECIES

Site	1	1	2	3	1	4	5	6	7	8	9	10
Date	2/7/75	2/7/75	8/7/75	28/7/75	28/7/75	25/8/75	25/8/75	25/8/75	26/8/75	27/8/75	27/8/75	27/8/75
Bottom	s,Z+m	s,Z+m	s,Z+m	s	s,Z+m	s	s,Z	s,r	s,Z	s	s	s,Z+m
Fundulus heteroclitus (mummichog)					134		108	11	66			134
Fundulus diaphanus (banded killifish)					28				22			32
Total Fundulus	129[1]	1172[1]	28[1]		162		108	11	88	8[1]	6[1]	168
Menidia menidia (Atlantic silversides)		28	21	42	54	45	127	601	210	35	20	24
Gasterosteus whealandi (Blackspotted stickleback)	11	20	37	1	2						1	
Gasterosteus aculeatus (threespine stickleback)	7	28	73		2				1			1
Apeltes quadracus (fourspine stickleback)	9	17	115		3		5		25		2	4
Pungitius pungitius (ninespine stickleback)	1	2	2	1			1					
Liopsetta putnami (smooth flounder)		4	6				1		5		1	1
Microgadus tomcod (tomcod)			4									

[1] Species not distinguished

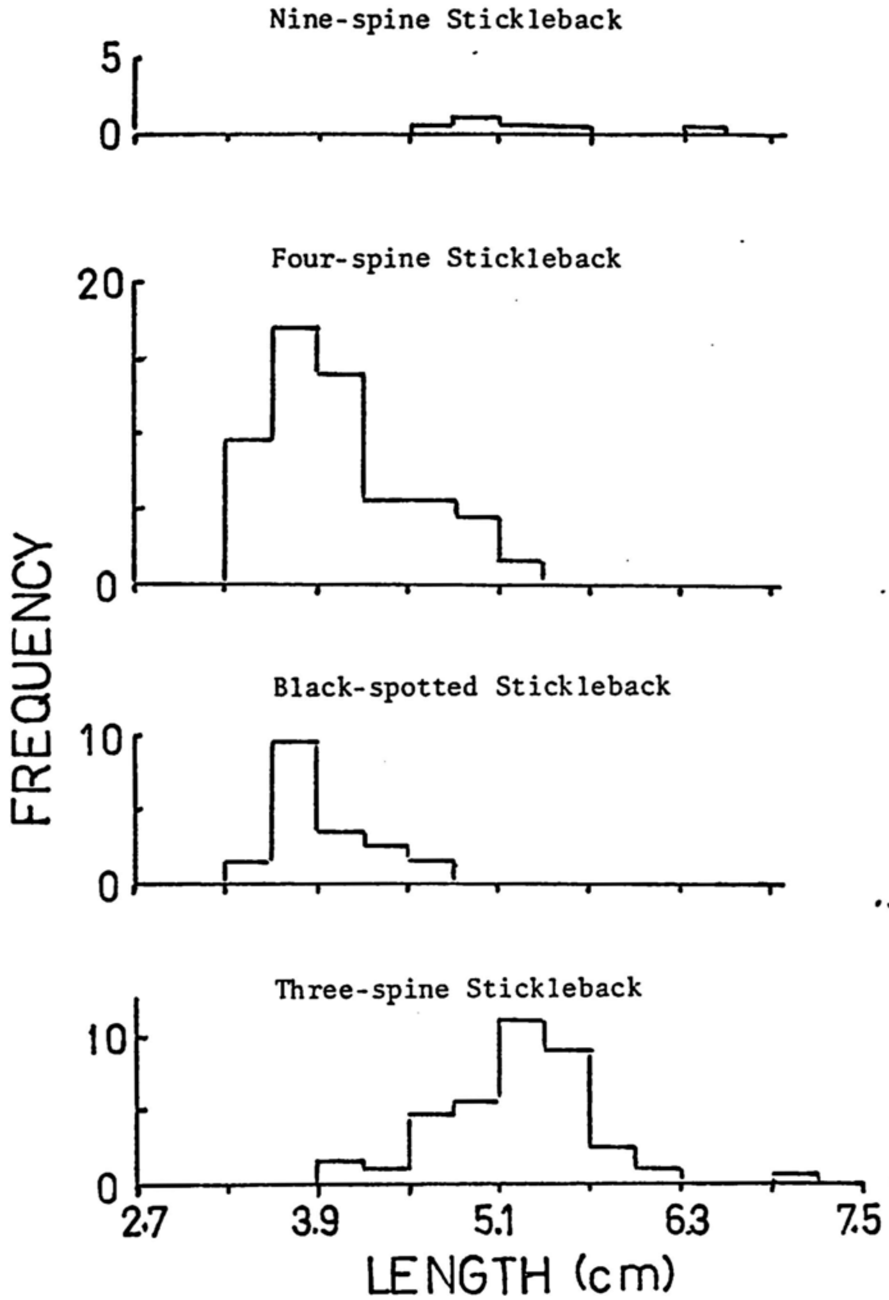


FIGURE 32 Length-Frequency Distributions for Small Fish

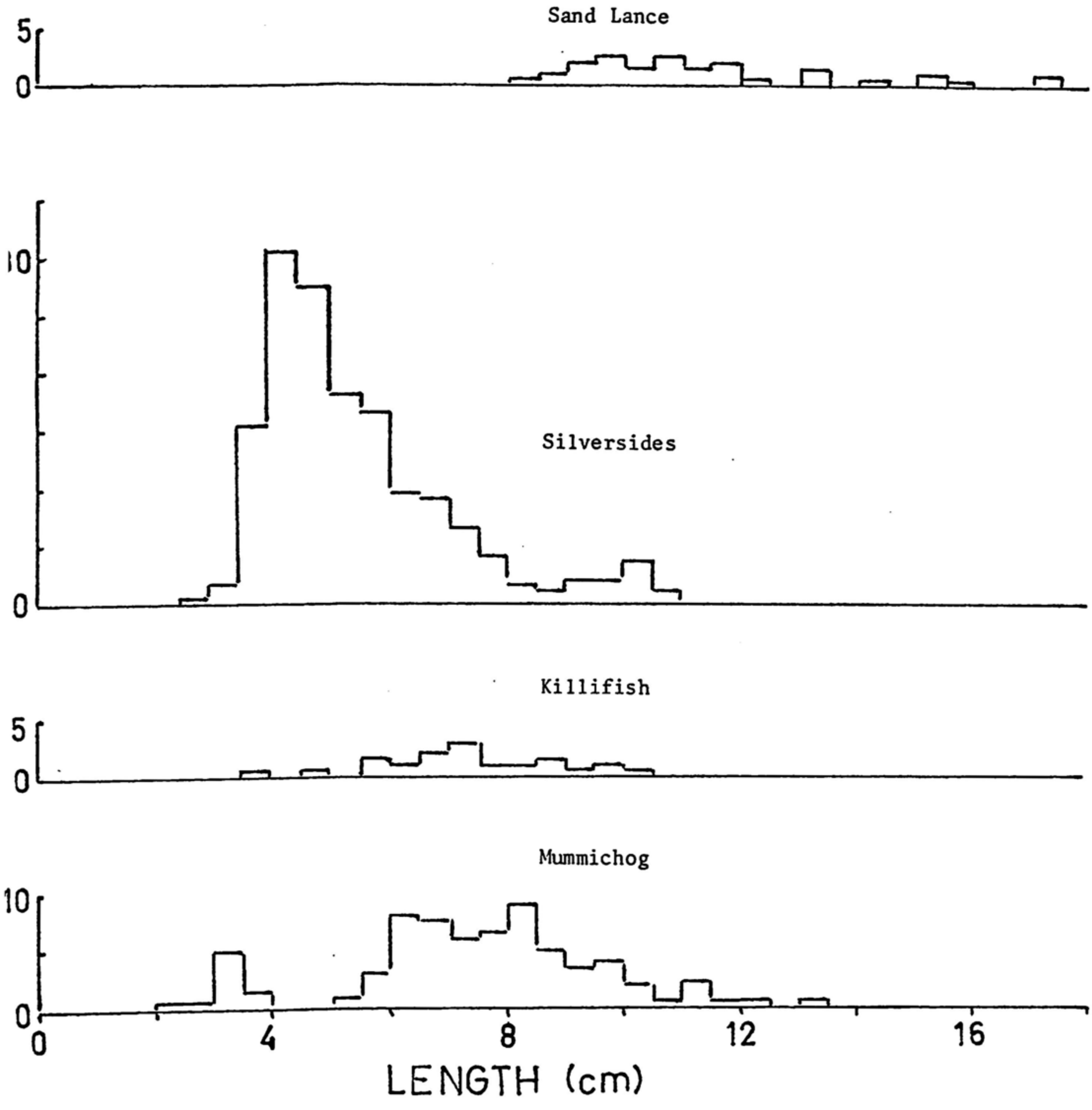


FIGURE 32 (cont.) Length-Frequency Distributions for Small Fish

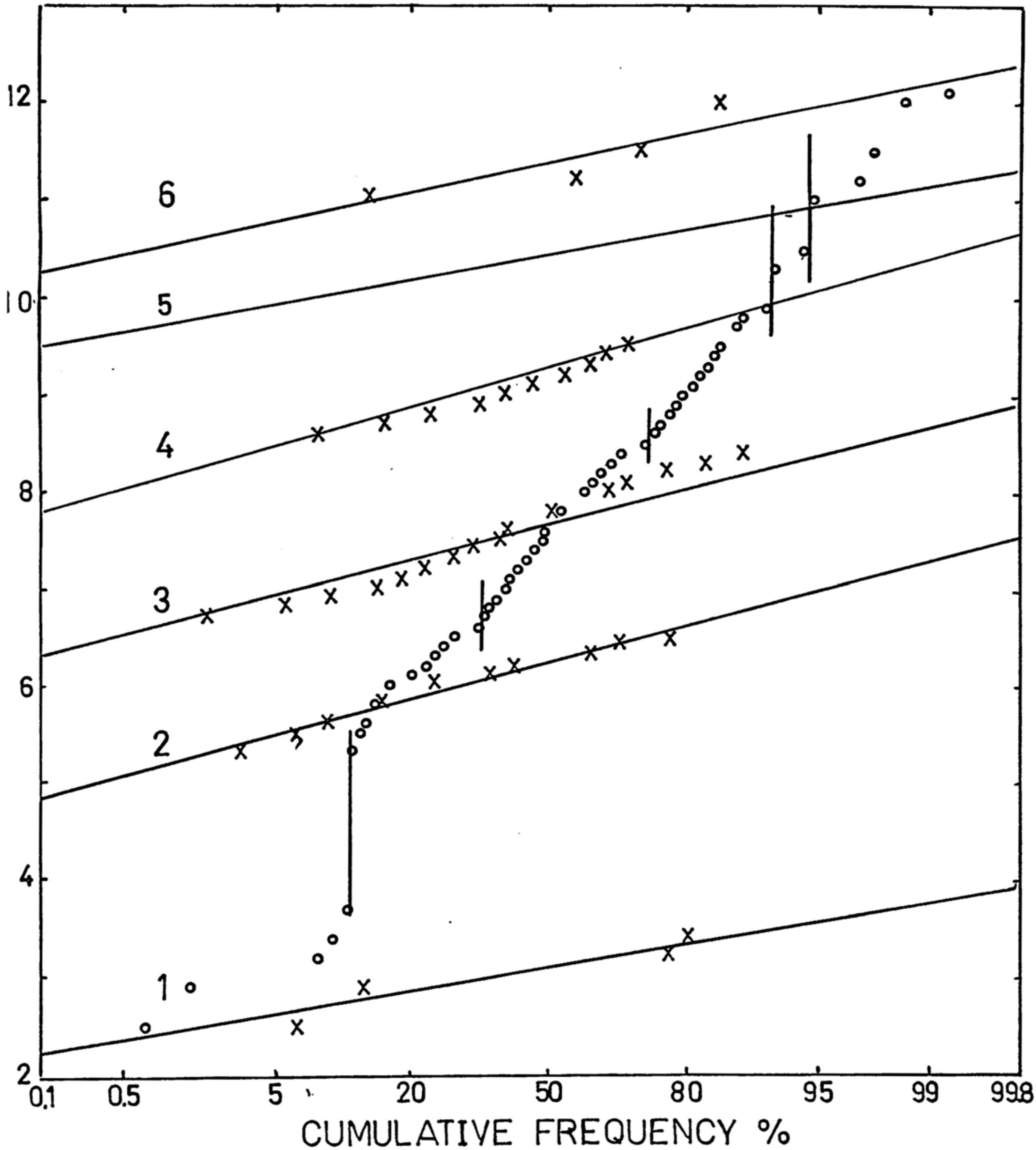


FIGURE 33 Graphic Separation of Polymodal Length-Frequencies by Probability Coordinates (Cassie, 1963) for Mummichog

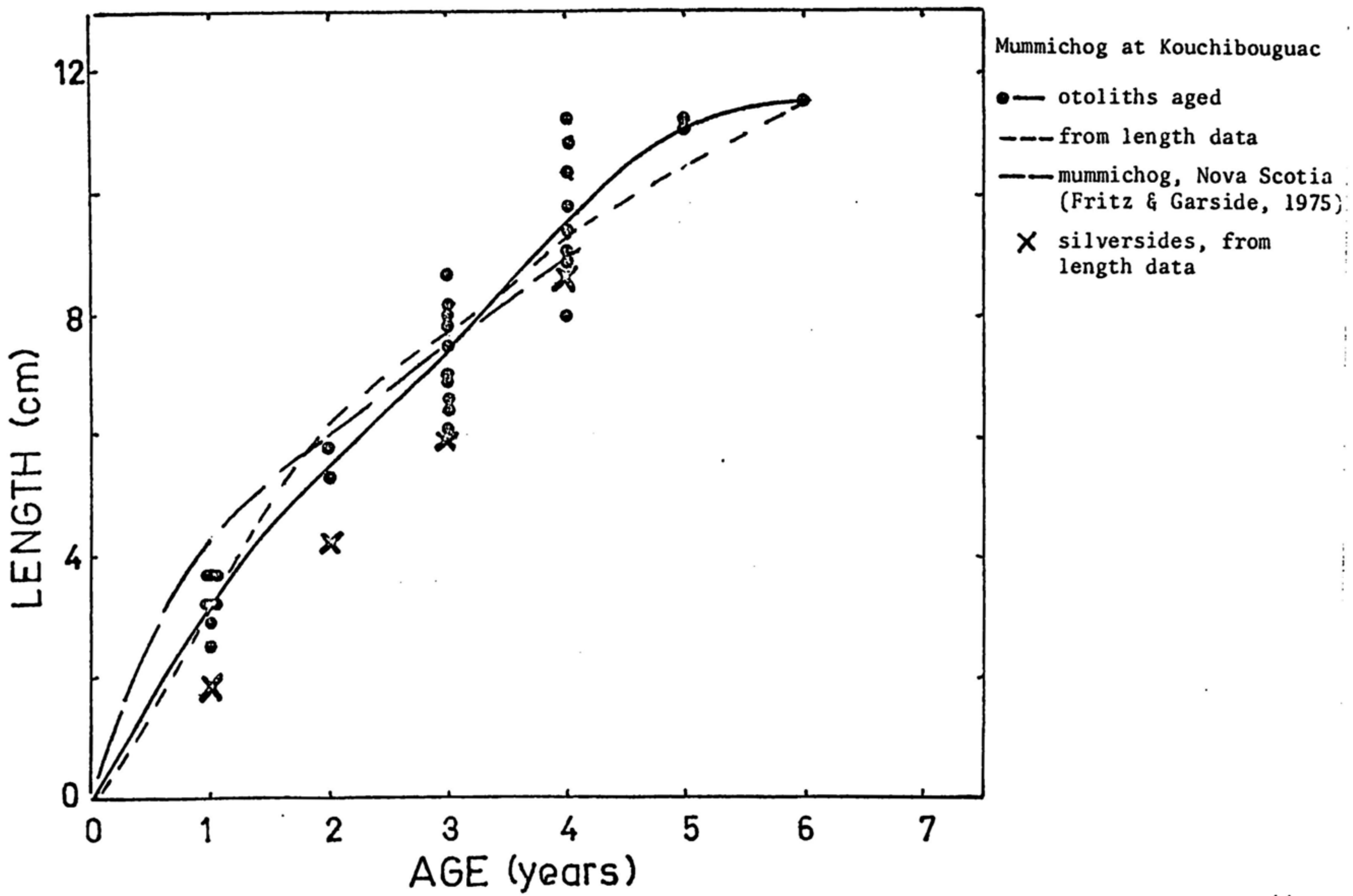


FIGURE 34 Growth Rates of Mummichog and Silversides

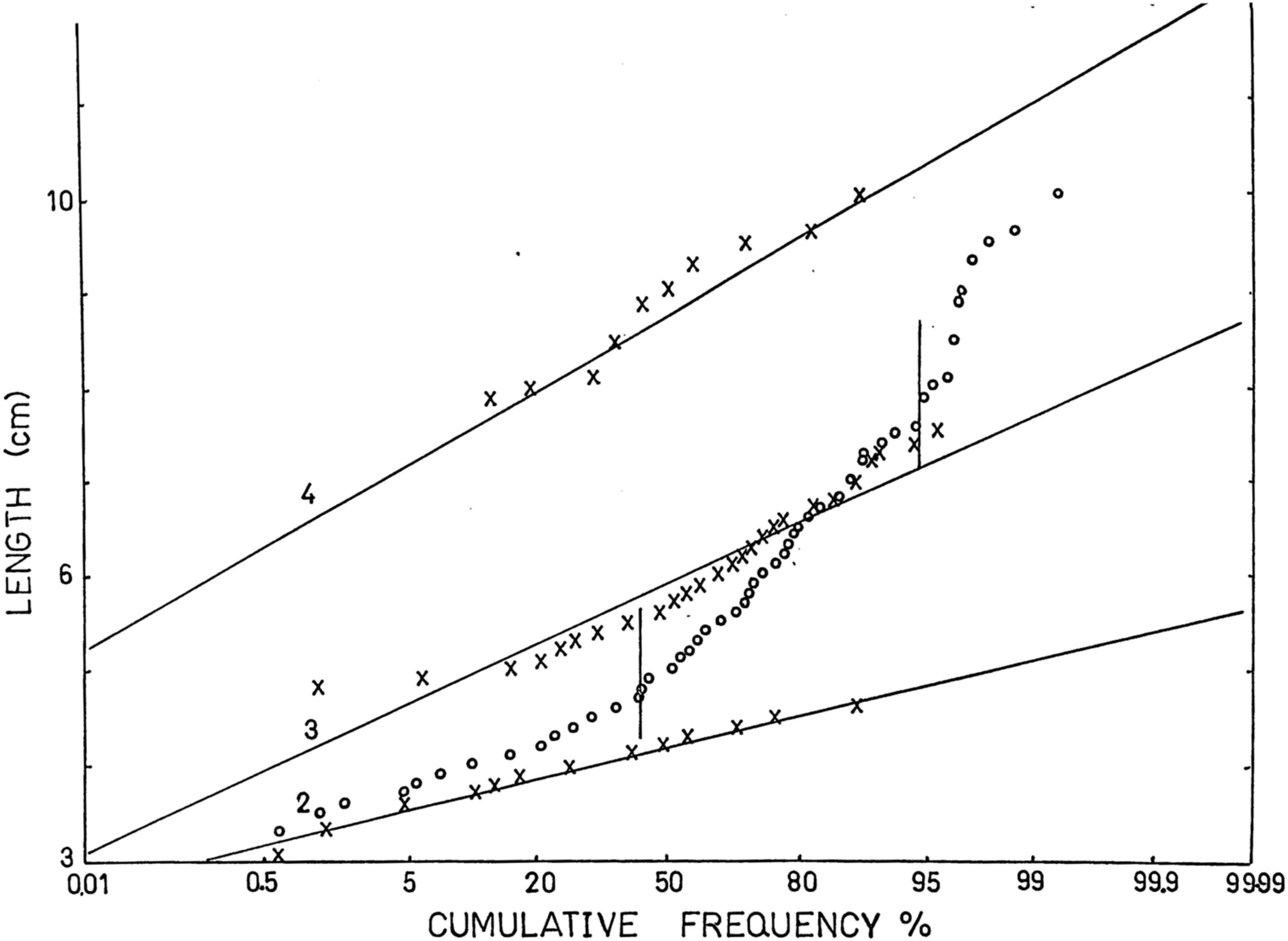


FIGURE 35 Graphic Separation of Polymodal Length-Frequencies by Probability Coordinates (Cassie, 1963) for Silversides

TABLE 20 Occurrence of Various Food Items in Stomachs of 20 Mummichogs and 20 Silversides

	No. of Individuals in which Food Item was Observed	
Food Item	Mummichog	Silverside
polychaetes	14	3
crustacea (large)	10*	15*
gastropods	3+	0
clam siphons	0	2
insects	5	14
small fish	2	3++
eelgrass	12	0

* *C. septemspinosa*, isopods, amphipods

\+ *Hydrobia minuta* mainly

++ one recognizable as stickleback

TABLE 21 Occurrence of Small Fish and Sand Shrimp in Stomachs of Larger Predator Fish Caught June through August, 1975; and on one Occasion, in November, 1975

		No. of Stomachs Containing Given Small Fish and Sand Shrimp				
Species	No. Stomachs Examined	Sand Shrimp	Silversides	Sand Lance	Mummichog	Sticklebacks
Striped Bass	20	4	3	2	1	
Brook Trout	4		3			
Smelt	2			2		
Tomcod	58	3	2		1	1

III. B. 2 (iv) Algal Flora

DATA

The distributions of brown and red (excluding Polysiphonia subtilissima) algal species within the lagoon and up the Kouchibouguac River are shown in Figure 36, and of P. subtilissima (which occurs as an epiphyte on Zostera), green algae, and blue green algal mats on the sediment surface in Figure 37. In Table 22, observed habits of these algae are compared to habits reported in the literature.

COMMENTS

Occurrence and Distribution

Except for Polysiphonia subtilissima, the brown and red algae are restricted to the lagoon.

Polysiphonia subtilissima and Enteromorpha intestinalis occur well up the rivers. This distribution is consistent with their reported occurrence in brackish waters. Dr. J. McLachlan of the National Research Council Laboratory in Halifax expressed interest in our finding of Gracilaria foliifera in the Park waters, as it has not been previously recorded from New Brunswick. It occurred at most sites examined in the southern part of the Kouchibouguacis Lagoon (Figure 36).

Fucus distritus is the most common and widespread of the brown and red seaweeds in the lagoon.

Ahnfeltic plicata and Gracilaria foliifera were common in sections of the lagoons where they occur, but each was found only in one lagoon (Figure 36). Several other species were also found in only one of the two lagoons (Figure 36) but within the lagoons were not common.

Blue green algal "mats" occur on the sediment surface notably on sandy sediments (See Figures 3 and 27).

Other epiphytes besides P. subtilissima occur on Zostera but we did not attempt to make detailed observations on these. Blue green algae are common epiphytes in some areas.

Many of the species we collected were not reported by Lee and Sutherland (1972). In addition to the species we recorded Lee and Sutherland (1972) reported the presence of Capsosiphon fulvescens Pilayella littoralis in the lagoonal system.

Habits

Most of these species were observed free-floating as well as attached. When the seaweeds were attached, they were mainly attached to a small object (a pebble or mollusc shell) and would be easily removed. Free floating brown and red algae were particularly prominent over "pot holes", eroded, grass-free 1-3 m^2 depressions in the eelgrass beds; elsewhere they lay semi-motionless between the blades of Zostera, providing glimmers of contrast against the green background of eelgrass.

A free floating habit appeared to be "normal" for most of the species, Laminaria saccharina however, was observed to be decaying where it occurred unattached - it was presumably washed in from Little Gulley. Free drifting Ulva lactuea may likewise have been washed in from Little Gulley. Both of these species are characteristic of more exposed situations (Table 22). On the whole, the brown and red algae occurring in the lagoon are intertidal or shallow water species. Polyoides rotundus , however, is described as being "primarily a plant of deep water" (Taylor, 1957).

Biomass

We did not measure biomass of the algae. However, it was apparent that none of the red and brown algae with the exception of P. subtilissima, constituted a major proportion of the macrophyte biomass when compared to Zostera marina. The green alga E. intestinalis is certainly a major primary producer in the river system where it forms "clouds of brownish filaments covering the bottom and extending to the surface". Chaetomorpha linum is likewise very abundant where it occurs (Figure 37)(in the lagoon) forming large clumps en masses entangled with Zostera and Fucus. Polysiphonia subtilissima which occurs primarily as an epiphyte on Z. marina also appeared to be quantitatively important. Small gastropods (Hychobia minuta and others) are abundant in the green algal masses. Enteromorpha intestinalis is a major contributor to the suspended masses of plant material that occur in the channel waters in June and July (see discussion in section III. 2(v) - Erosion and Loss of Z. marina).

In general, green algae decay faster than does eelgrass (Burkholder and Doheny, 1968), and the decaying masses of green algae must create large oxygen deficits. The bottom underneath such masses is black at the surface, indicating sulfate reduction (and production of hydrogen sulfide). This is undoubtedly a factor limiting distribution of (or casing death of) some epifaunal and infaunal organisms in the eelgrass beds.

TABLE 22 Reported Habits of Seaweeds (Taylor, 1957) and Observed Habits in Kouchibouguac Park

	Seasonal Occurrence	Habit	Park Habit
GREEN ALGAE:			
Chaetomorpha linum	throughout the year	often entagled with coarse algae from moderate depths	unattached clumps or entagled with *Fucus* and *Zostera*
Enteromorpha intestinalis	throughout most of the year	some forms floating occur in brackish water	"clouds of brownish filaments covering bottom and extending to surface" in rivers
E. linza	late spring and summer	on rocks and woodwork in upper intertidal zone	attached to rock on beach
E. flexuosa	throughout the summer	on rocks and woodwork in sheltered locales near low-tide line	grass-like tufts on bottom
Rhizoclonium sp.			occur in ball-like masses
Ulva lactuca	throughout the year	on woodwork, rocks on coarse algae in moderately exposed situations	attached (Little Gulley) as drift in lagoon
BROWN ALGAE:			
Chorda filum	annual; fruiting late summer to autumn	on stones and shells in somewhat sheltered locations below and near low-tide level	attached
Chordaria flagelliformis	forms sporangia throughout year	growing on rocks and wookwork	attached
*Fucus distichus**	perennial	upper and middle parts of rocky shores	attached and unattached
Leminaria saccharina	perennial	plant of the subtidal; growing on rocks	unattached, decaying in lagoon; attached in Little Gulley

	Seasonal Occurrence	Habit	Park Habit
Sphaerotrichia divaricata	common in summer months	on coarse algae; one variety found in sheltered bays, particularly polluted ones	attached clump
Pilayella littoralis	becomes rare late in season	common on rocks, coarse algae or often objects in shallow water	unattached, lying on bottom
Stilophora rhizodes	vegetating and fruiting most luxuriently toward end of summer	plants of quiet, rather warm protected bays, loosely attached at bases of Zostera, algae and other objects or loose and drifting	unattached, drifting
RED ALGAE:			
Ahnfeltia plicata	perennial, fruiting in winter	growing on stones in low tide pools, in rock crevices and on protected faces of boulders and cliffs	unattached clumps
Gracilaria foliifera	matures late summer to autumn	on shells and stones in quiet bays and salt marsh ditches, in water very shallow at low tide	attached and unattached; entangled with eelgrass and as drift
Polyides rotundus		primarily a plant of deep water	drift
Polysiphonia subtilissima		a plant of muddy shores, salt marsh ditches and estuaries, often extending up large tidal rivers beyond marine admixture	chiefly as epiphyte on Zostera; in rivers and lagoons, also as drift

* From Boney (1966)

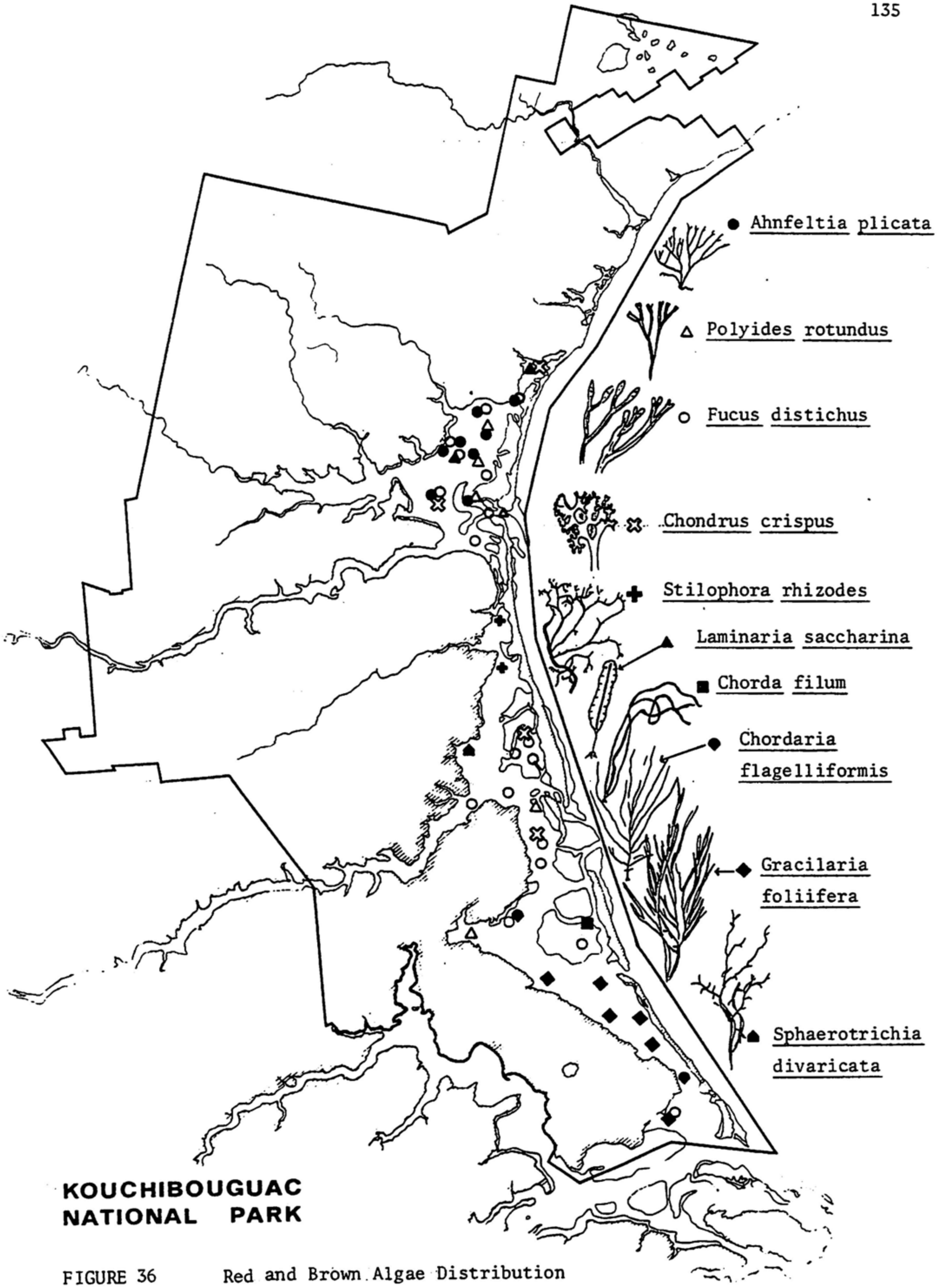
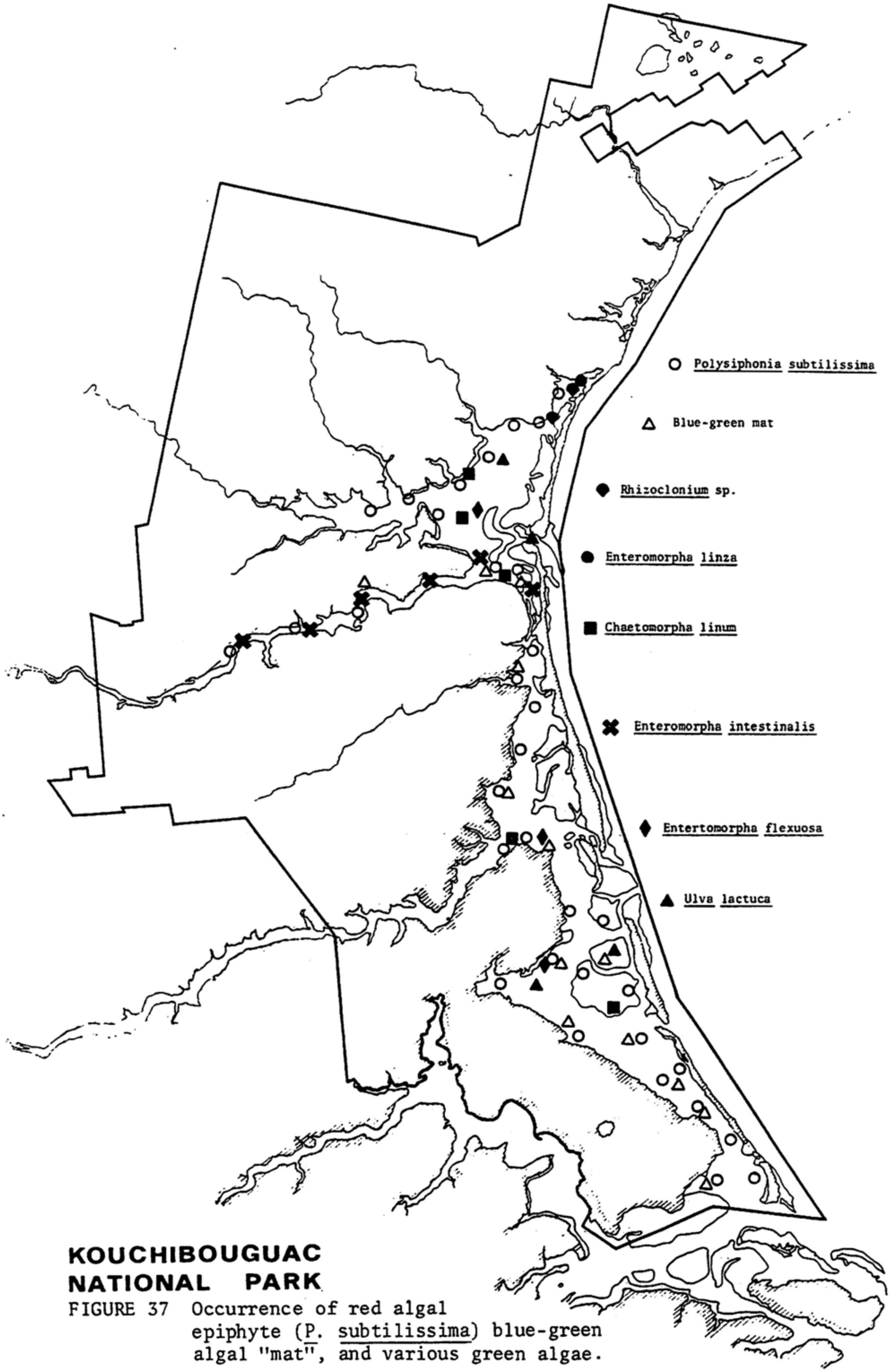


FIGURE 36 Red and Brown Algae Distribution



KOUCHIBOUGUAC NATIONAL PARK

FIGURE 37 Occurrence of red algal epiphyte (P. subtilissima) blue-green algal "mat", and various green algae.

III. 2 (v) The Submerged Angiosperms

BACKGROUND

Angiosperms include emergent forms such as the marsh grasses and submerged fish such as widgeon grass, Ruppia maritima, and eelgrass, Zostera marina, are frequently the major primary producers in estuaries. Intertidal marshes are not extensive in the Kouchibouguac system (section II. C). As noted above, the most striking biotic feature of the lagoonal system is the continuous distribution of eelgrass throughout. Ruppia maritima occurs at the fringes of the lagoon and becomes increasingly common towards the head of the tide in rivers. Some aspects of the biology and ecology of these angiosperms is summarized below (Phillips, 1960; Hartog, 1970; Rasmussen, 1973; Setchell, 1929; McRoy, 1973;

Ruppia maritima:

Distribution - R. maritima is widely distributed in brackish waters from the Maritimes to the Gulf states and occurs as well in alkaline lakes, ponds, and streams inland.

Morphology - Leaves and roots arise from nearly every node on a rhizome (underground stem) located 2-5 cm below the substrate surface. The rhizome may branch profusely. Flowering branches grow vertically. Leaves come directly from the rhizome node (ie., no separate stalk); 2-4 leaves generally being observed at each node. Leaves are typically 5-10 cm in length and are very thin (1 mm & less). Flowering plants may grow to 60 or more cm in height and form dense matted beds. Both vegetative growth and sexual reproduction are considered important in lateral spread of this plant.

Salinity and Temperature - This plant seems to prefer brackish water of less than 25 ‰ ; it is believed to require salinities of less than 28 ‰ to flower. The plant is widespread geographically and is not a stenothermic species (i.e., the temperatures required for growth and reproduction vary between races and area). It is generally true that plants increase rapidly when water warms in the spring and progression to anthesis and seed production occurs with rising temperatures. Seeds probably remain dormant through the winter and germinate in the spring. It is not clear from the literature whether rhizomes overwinter and produce new growth in the spring.

Zostera marina:

Distribution - Z. marina is widely distributed in the Northern Pacific and Northern Atlantic (on both European and North American coasts), and extends into the Arctic Circle.

Morphology, Flowering, Production - Strap-like leaves about 1/2 cm in width and up to 1 m or more in length arise from the apex of a horizontally spreading rhizome. Roots are produced at each node of the rhizome. The rhizome may branch at almost every node but generally only 1 or 2 branches are produced in a season. The apex of the main axis of a branching system usually, but not always, grows upwards and produces a flowering branch. Following anthesis and fruit formation, this branch breaks away and growth along the axis ceases. Lateral branches then behave as main axes the following year, producing one or more lateral branches and a flowering branch which again breaks away after fruit formation. (The rhizomes overwinter and continue to grow even at temperatures down to 2° C) Studies by the author (D. Patriquin) have shown that a new leaf is produced on each axis about every 8 days at temperatures of 22° C; this interval increases regularly with decreasing temperatures to about 35 days at 2° C. Below 2° C, growth stops or is very slow. Over one year, one axis will produce from 17-24 leaves. Since only 3-5 leaves are generally observed present at any one time, it is apparent that production of new leaves and loss of leaves is a continuous process. Development of terminal, flowering shoots is initiated in the spring; and in Nova Scotia, reaches the stage of mature fruit formation by July. Seeds, carried away by detached flowering shoots, are shed on site; and dropping to the bottom, germinate in the spring. Seed dispersal is important in the establishment of new Zostera beds, but once a clump of Zostera is established, lateral growth of rhizomes may be the main means of extending the clump laterally.

Roots and Nutrient Uptake - Roots of Zostera marina are functional in the uptake of nutrients; leaves are as well, but the sediments appear to be the primary site of nutrient uptake. Sediments in Zostera beds may have high concentrations of phosphate because of the release of phosphate from insoluble Fe- phosphates under conditions of sulfate reduction (Wood, 1965).

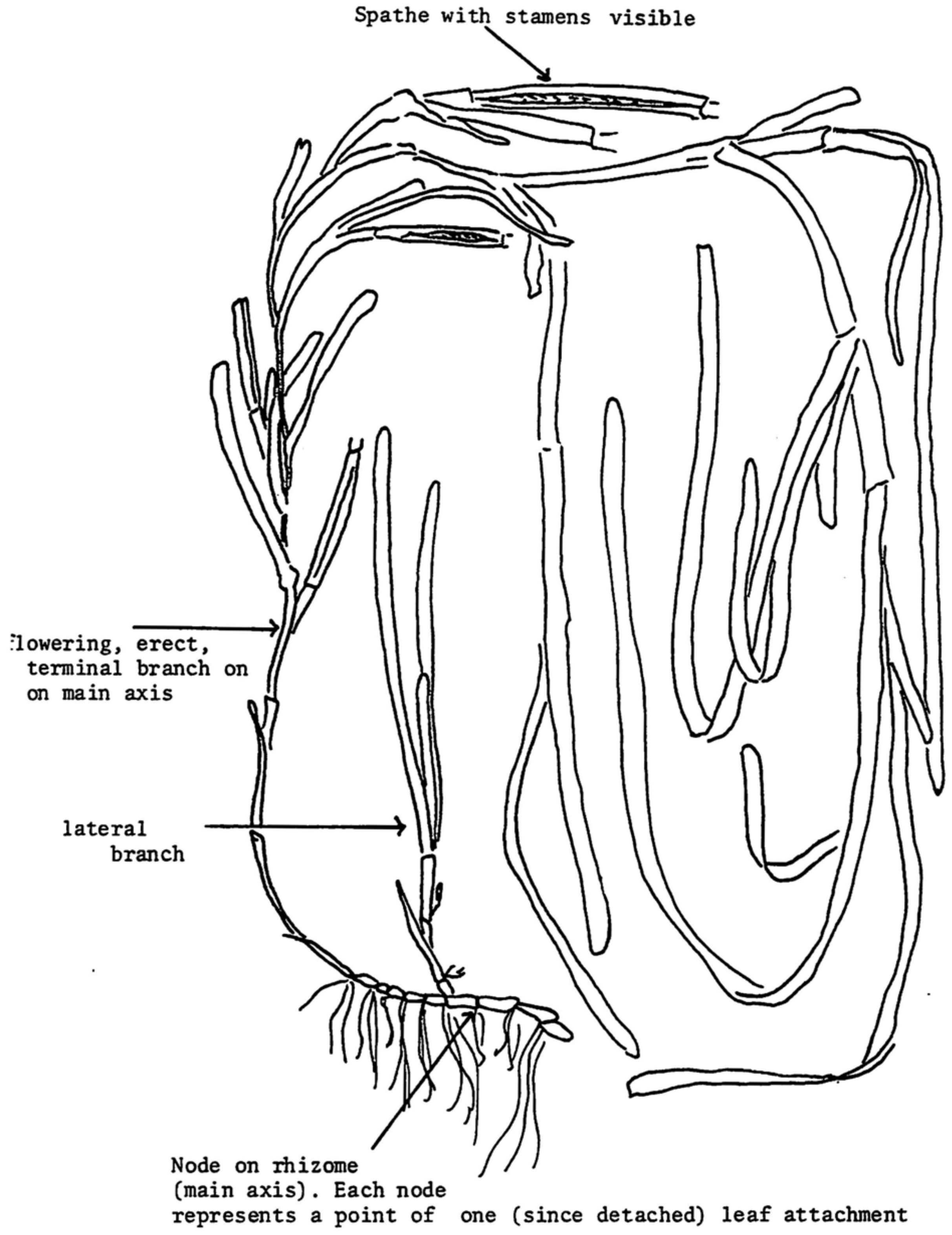


Figure 38 Drawing of flowering Zostera marina specimen (after Setchell, 1929)

As well, the low PO_2 of the substrate and provision of energy sources by roots of Zostera encourages nitrogen fixation (conversion of nitrogen gas to ammonium) in association with roots (Patriquin and Knowles, 1972). Ability to utilize sedimentary nutrients and the occurrence of nitrogen-fixing activity associated with the roots are undoubtedly factors contributing to the high primary production (next section) of Zostera.

Vertical Distribution and Substrate - Z. marina is primarily a sublittoral (below the intertidal) form which may penetrate to some extent into the intertidal belt. It occurs on soft mud as well as on firm sand and on bottoms of gravel mixed with sand. In estuarine waters, it is generally limited to depths of less than 3 m, but in clear waters may occur to depths as great as 30 m. The "baffling effect" (slowing down of water movement) created by leaves of Zostera encourages settlement of fine-grained sediment in Zostera beds.

Salinity, Temperature - Zostera marina occurs in salinities of full strength seawater down to about 5-7 ‰. Older studies (Setchell, 1929) seemed to indicate definite temperature intervals for vegetative growth (10-15°C) and reproductive development (15-20° C), but these do not hold for Z. marina currently growing in Nova Scotia waters where growth continues even at temperatures down to 2° C, and development of flowering stems has been observed at temperatures less than 5° C. Temperatures above 25-30° C cause death of the plants including rhizomes, and the summer insolation is likely the prime factor limiting invasion of the intertidal zone.

Production and Use as a Source of Food - Primary production by Z. marina is generally very high. Standing stocks (mass of leaves) are typically in the range of 100-300 g dry material/m^2 with values as high as 5157 g/m^2 being recorded. Estimates of production are somewhat difficult to obtain because growth of new leaves and loss of old leaves occur simultaneously. Multiplying the maximum standing crop by two probably gives a reasonable approximation to total annual production. Leaves of Z. marina commonly support an extensive epiphyte (attached plant) flora including diatoms, blue-green algae, green algae, and a few red and brown algal species. Primary production by the epiphytes is believed to be comparable to that associated with the plant itself. Many of the small crustaceans and gastropods occurring on Zostera leaves graze the attached material rather than the plant itself.

Few animals feed directly on Z. marina itself, and even for those that do, it is uncertain to what extent they utilize the plant material itself as opposed to the attached microflora and smaller invertebrates and plants. Some waterfowl, notably the Black Brant, do appear to feed directly on Zostera. Most of the primary production by Zostera, however, is made available to higher trophic levels through a detrital food chain (Section II. B). The exact significance of Z. marina as a food base in estuarine-type systems is somewhat controversial. Peterson postulated in the '20's that Zostera marina was the basis of life in Danish waters. However, when in the 1930's Zostera disappeared from Danish waters, the expected catastrophic decline of fisheries in these waters did not occur. A few species; e.g., Black Brant, did disappear but by and large there was little effect on the fisheries. Increased phytoplankton and seaweed production resulting from greater nutrient availability for the phytoplankton and seaweed following death of the eelgrass may have been one factor balancing the loss of eelgrass. This is discussed further below.

Destruction of Eelgrass in the '30's and its Effects - In 1931 and 1932, a severe, nearly catastrophic decline in Zostera occurred all over the North Atlantic and it is only since the late '50's that Zostera has begun to re-establish itself in the areas it once colonized. Local residents in the Kouchibouguac region report that Zostera began to grow in the lagoon only about 15 years ago (they also do not recall any drastic differences in lagoonal fisheries between the current time and when Z. marina was absent) presumably following its decline there in the '30's.

The reasons for this epidemic dying off Zostera remain obscure. The slime mould, Labyrinthula macrocystis was associated with the dying eelgrass and was at one time thought to be responsible for its death. However, it is now generally believed that this association was an effect and not the cause of the die-back of Zostera.

Rasmussen (1973) has presented good evidence that destruction of eelgrass was associated with a period of warm summers and exceptionally mild winters. Z. marina occurring in brackish water (less than 12-15 ‰) was apparently immune to the 'disease'; Rasmussen suggests that this was due to conditions there being optimal for growth of Zostera marina. In any case restricted local populations did survive, forming the stock for eventual recolonization - this recolonization is still in process.

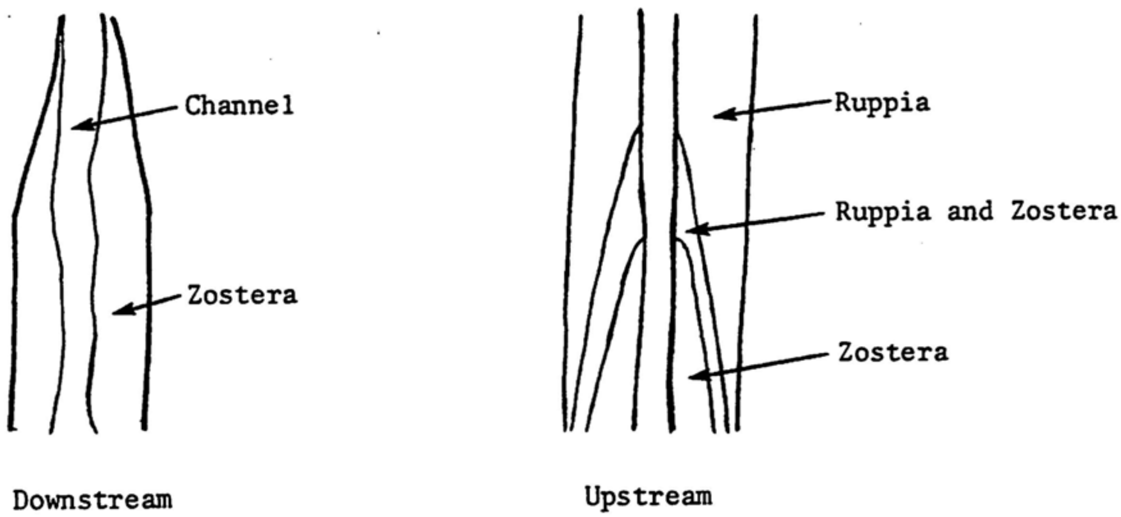
Rasmussen's (1973) work represents the most exhaustive study of the changes associated with eelgrass destruction. The most striking effect was on the sedimentary and current regimes; bottoms became coarser according to the strength of the currents, and bars built up where they had not previously existed. Deposits of fine mud once adjacent to Zostera beds changed from low oxygen, black sulfidic oozes to more brownish (oxidized), less foul-smelling muds with higher numbers of invertebrate species than previously. For one area, he describes the following changes: "Generally speaking, the Zostera destruction caused a fundamental change in the substratum of the animal communities on the slope. Formerly, the slope was dominated by an eelgrass epifauna with a very poor infauna underneath. Afterwards came another sort of epifauna on stones and algae, mainly on Fucus species. At the same time in the now more sand bottom came a new infauna, richer both in number of species and specimen". In general he noted that "where prior to the 1930's, the bottom fauna was dominated by burrowing species (deposit-feeders), the now unprotected open shores show a dominance of species such as Mytilus, Balanus, etc., animal species with high oxygen demands and dependent on a rich surplus of plankton organisms and suspended matter (filter feeding)". Rasmussen notes that oxygen tensions in dense Zostera beds not subjected to much tidal action or currents may vary from anoxic to supersaturation, and the fauna is accordingly limited to species able to withstand low oxygen tensions. When Zostera occurs intertidally or in regions of currents, however, a rich fauna may be associated with it. He comments that while there may be a high production of some relatively immobile forms closely associated with Z. marina such as rissoid snails, it is the mobile crustaceans utilizing the Zostera mainly as a shelter during the daytime and migrating to the shallow slope areas at night for feeding that are of major importance as food for fish of commercial importance such as eels, flounders, etc. These latter species are not dependent on eelgrass properly but may live in any benthic macrovegetation; e.g., Fucus, etc. In spite of the striking predominance of Zostera in coastal systems during the years of its affluence, he summarizes his conclusion with respect to the productivity of the Zostera region begore and after 1933 as follows:

"Although we still lack the quantitative aspect, the composition of the animal communities in the slope area (region of previous *Zostera* growth) has definitely changed. Moreover, the yearly production does not seem to have decreased. On the contrary, with the actual increased mass of worm, crustacean, and bivalve species in the bottom, there commonly is a good reason to believe that the production (at higher trophic levels) is higher than before the disappearance of the vast eelgrass meadows." Thus, although there is a high primary production in *Zostera* beds, this is not necessarily reflected in high production at higher trophic levels.

DATA AND COMMENTS

Distribution:

The distributions of Z. marina and R. maritima (Figure 31) were determined during the course of the various studies conducted through the lagoon and up the rivers of the period from June to August. Particular attention was paid to determining the upriver limits of Z. marina. As can be seen, Zostera is distributed continously from the marine end of the system with upstream limits, and R. maritima from the fresh water end of the system with downstream limits. The marine limit of Ruppia distribution is likely determined mainly by competition with Zostera, while the upstream limit of Zostera distribution is likely determined by lower salinity (of literature, above) at least in the mid-river, deeper areas and possibly to some extent by ice erosion towards the shore. It will be noted that the Zostera distribution is wedge-shaped towards the upper parts of the rivers becoming more restricted towards the control, deeper, more saline parts of the river upstream. Ruppia distribution is complementary to this.



There is some overlap in distribution, particularly nearshore in the lower parts of the rivers and in the lagoon (see Figures 9 and 30). The upriver limit to Zostera distribution likely corresponds to regions where salinities do not fall below 5-7 ‰ for prolonged periods. The nearshore upriver limits of clam distribution fall within the regions of pure Ruppia stands. The critical salinity for clams is about 4 ‰ (literature cited in clam section); i.e., roughly in the same area as for Zostera. Surface water salinities at the upriver limits within the Park determined in August were in the range of 12-18 ‰; the biological distributions thus suggest that they must drop to values less than 5-7 ‰ during some periods of the year when run-off is greater. Z. marina is distributed continously through the lagoon except in channels; it may be limited by both currents (bottom stability) and turbidity in the channels. Occasional Zostera, much shorter than that in shallower water, does occur down to 3-4 m in some parts of the channels (Figure 11).

Changes in Standing Crop and Reproductive Development in Kollock Creek:

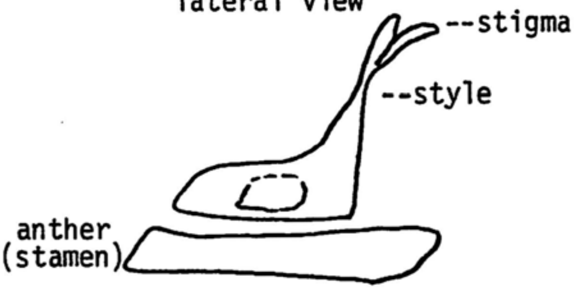
Zostera marina in Kollock Creek was sampled through the season for standing crop and stage of reproductive development. Ten $1/16m^2$ samples of leaves were taken on each occasion, and the wet weight determined. On one occasion, this material was also dried to constant weight to determine the dry-to-wet weight ratio. Flowering stage was classified according to the scheme in Figure 39. Temperature and salinity was also recorded on each occasion. The results are given in Figure 40 and Table 23.

Standing crop (leaves only) increased regularly between June 6 and August 6, from 73.3 g/m^2 dry leaves to 177.6 g/m^2 dry leaves. This increase was accompanied by development of flowering stems, anthesis and mature fruit formation and also occurred during a period of rising temperature (Figure After August 6, standing crop decreased somewhat - this was associated in large part with abscission and loss of flowering stems. On the August 28 sampling, vegetative shoots were largely discolored, apparently dying and covered with epiphytes. This dye-off probably resulted from the high temperatures occurring towards the end of July and in early August (Figure 40).

FIGURE 39 <u>Zostera marina</u>: Stages of Flower Development

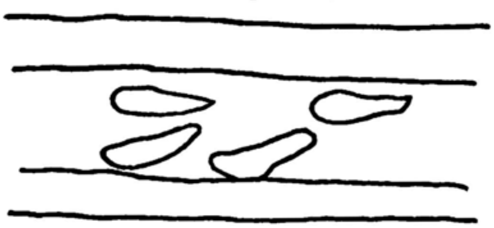
Stage	Description
2	Vegetative phase only
1	Stem elongation
1/0	Flowering leaves (spathe) visible, but enclosed
0	Spathe exposed
1	Immature stamens and pistils in spadix (enclosed in spathe) visible (exposed)
1b	Styles about to project
2	Styles project
3	Stamens project
4	Fruit ripening
4b	Mature fruit
5	Dehiscence

<u>Stage 2</u> - Pistil projecting stage, lateral view

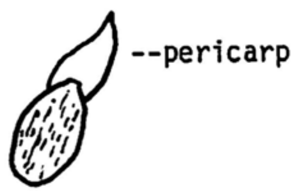


<u>Stage 3</u> - Stamens projecting, sail-like fashion

<u>Stage 4</u> - Fruit ripening, Anthers (stamen) gone, no sigmas present



<u>Stage 4b</u>- Mature fruit; can see ridges on seen through pericarp



<u>Stage 5</u> - Fruit dehiscence, Bubble produced in ovary wall breaks open; seed released

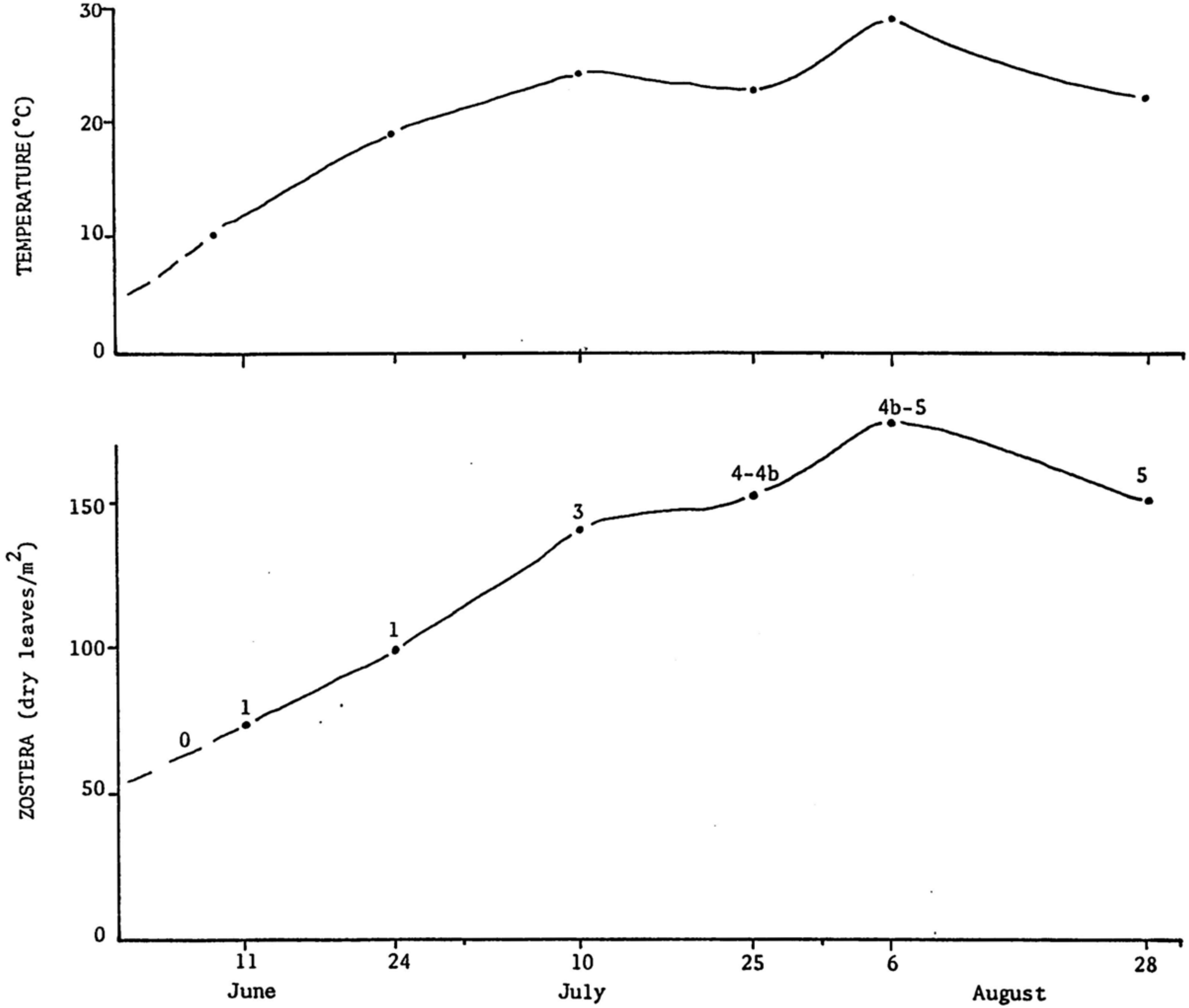


FIGURE 40 *Zostera* Standing Crop - Kollock Creek

TABLE 23 Observations on Zostera marina at Kollock Creek

Date	Surface Temp.	Surface Salin.	Bottom Temp.	Bottom Salin.	Stage*	Standing Crop: Wet Wts. per 1/16 m^2	Standing Crop: Wet Wts. per m^2, avg.	Standing Crop: Cal. Avg. Dry Wt/m^2 ++
June 11	13	<4 ‰	10	<4 ‰	1	15,15,25,40,40, 40,45,50,55,60	6160	733
June 24	21	19.3 ‰	19	22.6 ‰	1	38,43,45,48,50, 50,50,62,64,70	8320	990
July 10	24.5		24		3	48,58,63,69,71, 74,79,82,89,103	11776	1401
July 25	23	26.3 ‰	22.5	26.6 ‰	4-4b	55,63,71,77,78, 80,84,92,99,100	12784	1521
August 6	28	19.9 ‰	28	20.6 ‰	4b-5	69,72,74,83,94, 102,108,109,128	14928	1776
August 28	22	18.8 ‰	22	24.0 ‰	5	59,59,72,74,77, 79,79,89,92,113	12688	1510

* Stage: maximum observed

++ For July 10 samples avg. dry-to-wet weight ratio 0.119 (range 0.109 - 0.131)

Standing Crops and General Observations on Z. marina in the Lagoon:

One or two 1/16 m^2 samples were taken from Point Stations (examined during the period from July 16 to August 28) and the wet weight determined as above (epiphytes were removed). Stage of flowering stem was also determinted for many of these stations (Table 24). There were not large changes in standing crops of Zostera over this period in Kollock Creek and thus these figures are reasonable indications of differences in Zostera production between different points in the lagoon.

There were substantial differences between the standing crops on mud and sand bottoms (Table 25); the standing crops on sand bottoms (including only stations where Zostera was present) on the average being 62% of those on mud bottoms (Table 25). Average standing crops on mud and sand bottoms in the Kouchibouguacis Lagoon were greater than those of equivalent substrates in the Kouchibouguac Lagoon, but the overall average in Kouchibouguacis Lagoon was less than that in Kouchibouguac Lagoon because of the predominance of sand bottoms in the former.

The differences between standing crops on mud and sand bottoms may reflect both better growth on mud bottoms and accumulation of fine sediments following Zostera growth. As was noted in the sediments section, the two lagoons differ with a predominance of sandy sediments in Kouchibouguacis Lagoon and of muddy sediments in Kouchibouguac Lagoon, and this difference is possibly related to the greater fresh water inflow and sediment load in Kouchibouguac Lagoon. As Zostera began growing in this area only within the last 15 years presumably following its decimation in the '30's, it is quite possible that it is only a matter of time before the sediments of the southern lagoon also become predominantly muddy. Circumstantial evidence that sedimentation has increased relatively recently in these lagoons is given by the occurrence of extensive old oyster beds in some areas and the absence of living beds in these same areas today.

Figure 9 shows the occurrence of Zostera and the lengths of the leaves across a transact in the southern part of Kouchibouguac Lagoon. Stands are less dense, and the leaves are shorter on the shallow, sandy flats than in the deeper muddy areas. Limited growth in the flats may be associated in large part with ice scour. In Figure 41, lengths of Zostera blades are plotted against depth (approximately M.L.W.) for this same area. It is evident that at depths of less than 30 cm, the length of Zostera blades is

TABLE 24 Standing Crops and Flowering Stage of <u>Zostera marina</u> at Point Stations

M = mud
S = sand
( )* = estimated

Consecutive Stn. No.	Date	(cm) Depth	Standing Crop Wet/1/16m^2	Standing Crop Dry/m^2	Flowering	Bottom
1	16/7	35	55.6	106.0	4b-5	M
2	17/7	50	79.4,62.5	135.0	4	M
3	17/7	56	25.8	49.0		M
4	18/7	85	(12)*	22.8		M
5	18/7	96	70.1	133.0	5	M
6	18/7	70	83.9,68.1	144.0	4b	M
7	18/7	50	(100)*	190.0		M
8	18/7	83	89.0	169.0	4-5	S
9	18/7	63	63.6	121.0	4b	M
10	18/7	31	125.0	237.0	4-5	M
11	18/7		Absent			M
12	18/7	38	(60)*	114.0		M
13	23/7	83	28.0,41.2	65.7	4b	M
14	23/7	530	Absent			M
15	23/7	78	53.5	102.0		M
16	23/7	344	Absent			S
17	23/7		(100)	190.0		M
18	23/7	18	98.1	186.0		M
19	24/7	56	(5)*	9.5		S
20	24/7	188	Absent			S
21	24/7	34	8.7	16.5		S
22	24/7	37	(100)	190.0		M
23	25/7	70	75.2,14.4	85.1	3	M
24	1/8	77	43.0,55.6	94.0	4b	M
25	1/8	27	(60)*	114.0		M
26	1/8	74	54.0,50.1	99.0	4b	M
27	1/8	80	22.5,26.5	46.6		M
28	1/8	80	(5)*	9.5		M
29	7/8	62	130.0	247.0		M
30	7/8	49	(150)*	285.0		S
31	8/8	109	54.3	103.0		M
32	8/8	67	25.0,10.0	33.2	4	S
33	8/8	90	62.5	119.0	4b-5	M
34	8/8	5	(10)*	19.0		S
35	11/8	23	(5)*	9.5	4b-5	S
36	11/8	26	41.3	78.5	5	S
37	11/8	73	114.5	218.5	4b-5	S
38	11/8	70	33.3,48.8	78.1	3	S
39	13/8	167	Absent			S
40	13/8	116	Absent			S
41	13/8	84	223.3	424.0	4b-5	M
42	13/8	5	(20)*	38.0		
43	13/8	38	13.0	24.7	4	S
44	18/8	281	Absent			S
45	18/8	48	170.0	323.0	4b-5	S
46	18/8	33	11.0	20.9	4	S
47	19/8	77	9.9	18.8		M
48	19/8	23	19.0	36.1	4	S
49	19/8	342	Absent			S
50	19/8	55	186.0	353.0	4b-5	M
51	26/8	434	Absent			S
52	26/8	37	69.1	131.0	5	S
53	26/8	44	49.7	94.4	4b-5	M
54	27/8	5	24.1	45.8	4	S
55	27/8	76	21.4	40.7		M
56	28/8	71	9.3	17.7		S
57	28/8	40	14.4	27.4		S
58	28/8	54	16.0	30.4		M
59	28/8	70	36.0	68.4		S
60	28/8	63	36.5	69.4	4	S
61	28/8	56	39.3	74.7		S

TABLE 25 Summary of *Zostera* standing crop statistics for the 2 lagoons

Facies	Standing Crops			
	$\bar{X}$	SE	Range	N
Northern Lagoon				
Zostera-mud	217	13.9	23 -237	17
Zostera-sand	60.9	54.1	9.5-169	3
Southern Lagoon				
Zostera-mud	148	54.4	18.8-424	8
Zostera-sand	86.7	22.1	9.5-323	18
Both Lagoons				
Zostera-mud	134[1]	19.2	--	25
Zostera-sand	83.0[2]	20.0	--	21

[1,2] Probability of 0.075 that these differences would arise by chance.

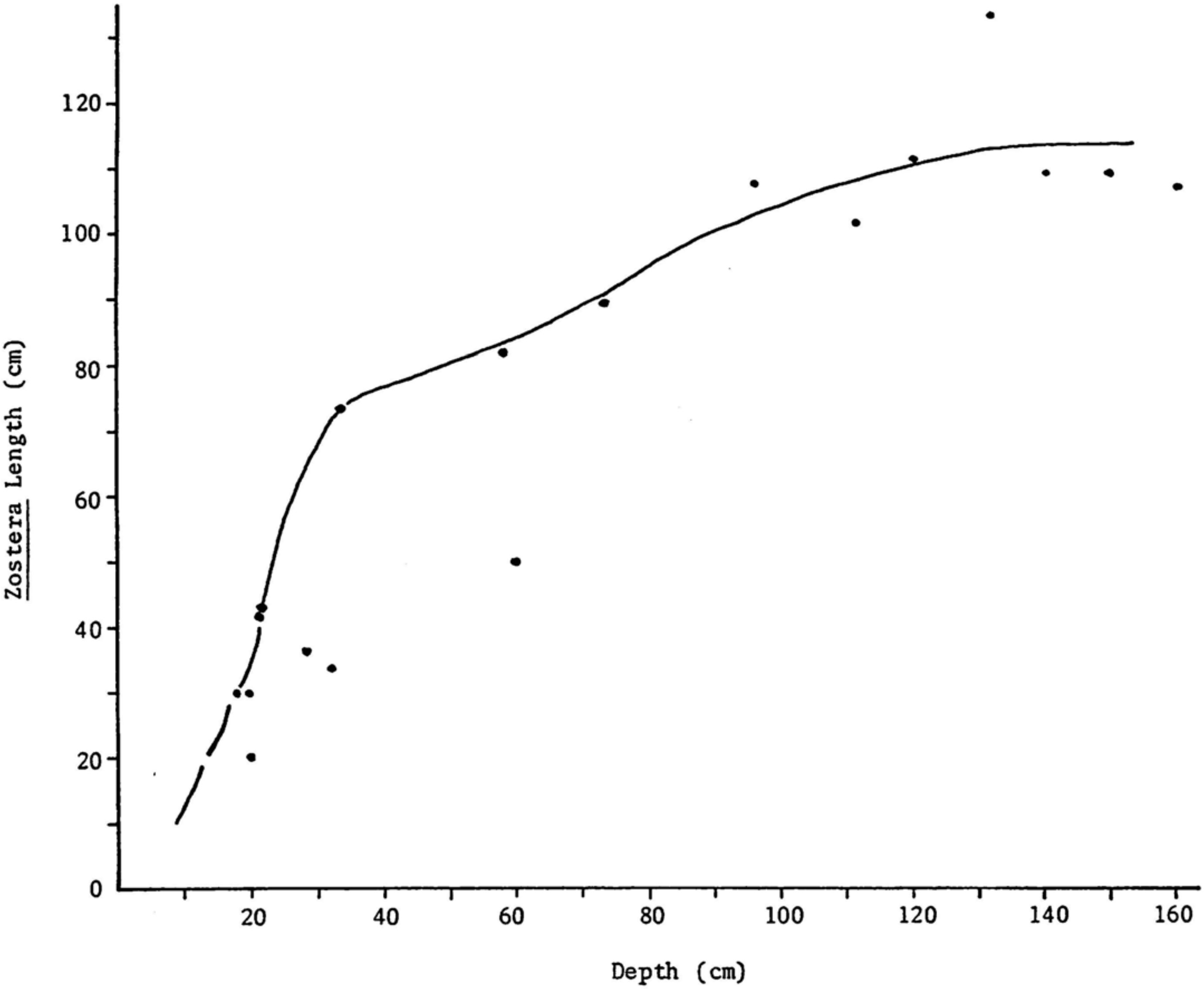


FIGURE 41 *Zostera* Yield

limited by depth of water (presumably an effect of insolation on exposure of leaves), maximum length increasing greatly with increasing depth. Between 30 and 100 cm depth, blades extend to the water surface; but the change in length with depth is less than in the shallow region. At depths greater than about 1 m, they generally do not reach to the water surface, and a maximum blade length of about 100 cm is observed down to 1.6 m depth. At 3 m depth in channels where Zostera occurred (Figure 11), leaves had maximum lengths of 30 cm as opposed to about 1 m length in shallow water (Figure 9).

Erosion and Loss of Z. marina:

Strandlines of shores adjacent to eelgrass beds typically are characterized by heavy accumulations of dead eelgrass. Loss of blades from the plants is a normal phenomenon - as stated in the literature review, the plant produces new leaves at the rhizome apex continuously, and older leaves further back die and break off. At temperatures of about 20° C, the "Plastochrome Interval", the length of time between emergence of successive leaves at the apex is of the order of 8-10 days (Patriquin, unpublished studies). Roughly, then, one leaf will also be lost at each turion every 8-10 days or given an average short density of about 1000 shoots/m^2; i.e., about 100 leaves lost/m^2-day. An unusual feature of the Kouchibouguac system, however, is the prominence of whole, fresh plants in the strandline and free in the water column, particularly during the month of June. The muddy sediments in which Zostera occurs are very "loose" or soft, and Zostera is easily removed by hand and apparently also by the limited wave action that does exist in the lagoon. This phenomenon contributes greatly to the great mass of green material, largely Enteromorpha and Zostera observed in the water column in June which necessitates removal of traps from the rivers by about mid June. We found that fishing with nets became nearly impossible towards the end of June because of the debris accumulated in the nets, and we had to remove our fish trap from the lower Kouchibouguac River for this reason. Some indication of the mass of materials involved is indicated by the following figures for plants removed from 1 m x 1.15 m sections of two nets on the Kouchibouguac River following accumulation over one day (June 25-26, 1975):

From 6 1/2" mesh net: 4.6 kg fresh weight, largely Enteromorpha

From 2 1/2" mesh net: 3.0 kg fresh weight, largely Zostera

Later in the summer, there is less loss presumably because longer leaves provide a better baffle and the looser material has already become removed. Likewise, by August, only dead (not fresh) Zostera was noted in the strand-line. In late July and early August, there is another period of massive loss of Zostera resulting from abscission of flowering stems; these are dead and partially decayed when they are lost, however, and do not form as large a mass in the water column as occurs in June.

As noted above, ice scour may be at least in part responsible for the patchiness of Zostera on the flats. Similarly, "pot holes" observed scattered through Zostera stands at depths of about 1 m and less may result from ice action. The bottoms of these pot holes are usually sandy, differing from the adjacent muddy sediments of the Zostera beds, and attached and unattached brown and red algae frequently occur over the holes. The difference in sediment texture reflects the lack of "baffling" by Zostera blades; the holes are also slightly depressed relative to the eelgrass stabilized sediments, and erosion of the eelgrass mat is sometimes evident at their edges. Similar structures have been observed in other types of seagrass beds, and it appears that although some severe disturbance such as storm waves or ice action is required for their initial formation, "normal" wave action may be sufficient to continue the erosion in the absence of seagrass cover for some time (Patriquin, 1975).

Maturity of Zostera Stands:

The author (D.P.) has observed elsewhere that Zostera rhizomes in regions of new growth branch at almost every node, while in very dense stands, a main axis will branch only once or twice during a year (i.e., 1 or 2 branches per 17-24 nodes). This latter situation is sufficient to maintain constant densities from year to year; i.e., to replace the flowering stem lost while the former situation allows rapid spread of Zostera in uncolonized areas. At typical stands of Zostera in the Kouchibouguac Lagoon where shoot density averaged 1400 shoots/m^2 (106, 117, 60, 86, 64 and 92, counted in 6 1/6 m^2 samples), only one or two branches were observed on main rhizome axes. This suggests these stands have reached a "mature" or climax state and will not increase further in density. It is thus evident, that over large parts of the lagoons, particularly the Kouchibouguac Lagoon, eelgrass growth has reached its maximum; a remarkable phenomenon as the eelgrass began growing in this system only about 15 years ago.

In less dense stands, and at the edges of dense stands adjacent to open areas, five or more branches were observed per main axis indicating that densities are still increasing. Ultimately we can expect the lagoons to be uniformly covered by dense stands but subject to recurrent localized, erosion and regrowth of *Zostera*.

III. 2(vi) Nutrients and Oxygen

Commencing July 17, two stations, station 1 in the mid-Kouchibouguac Lagoon area of dense eelgrass and station 2 at the mouth of the Kouchibouguac River were sampled at two week intervals in the early morning at approximately the midpoint of the falling tide. Depth, currents and temperature were recorded. Surface and bottom water samples for oxygen and nutrient analyses were taken with a Nisken sampler. Oxygen samples were "fixed" on site and later titrated (Strickland and Parsons, 1968); nutrient water samples were transported immediately to a freezer and later analyzed for nitrate and nitrite, ammonium and phosphate (Strickland and Parsons, 1974). These data are given in Table 27.

Nutrient and oxygen samples were also taken during the course of 24 hour current-salinity temperature measurements [section III. 1 (iii)], August 20-21, and at mid-lagoonal (Kouchibouguac) Zostera stand over a 14 hour period on August 22-23. It had been intended to take the measurements at the Zostera stand over a 24 hours period, but the observations were prematurely terminated because of illness of the observer. These data are given in Table 28.

COMMENTS

Oxygen content of the water at the biweekly stations was generally supersaturated (Table 27), reflecting oxygen production by macrophytes, epiphytes and seaweeds (and to a limited extent by phytoplankton). The observations over a 14 hour period at the mid-lagoonal Zostera stand indicate large diurnal fluctuations on oxygen with a peak of 10.16 ml/1 at 1610 hours, and a presumed (extrapolated) minimum of about 2.7 ml/1, well below saturation at the end of the night (Table 28, Figure 42). This estimated minimum is below the critical minimum ('level C') at which "a large portion of a given fish population or fish community may be affected by oxygen"; this level being approximately 3.15 ml/1 for marine non-anadramous species, and 2.80 ml/1 for anadramous species (Davis, 1975). The oxygen measurements at the Zostera stand were taken at about mid-depth (approximately 1/2 m), and concentrations near the bottom might be even lower at the end of the night. Thus, diurnal fluctuations in oxygen may be a factor restricting activity (and occurrence)

COMMENTS (cont.)

of some fish and invertebrates, particularly the "desirable" species which generally have high oxygen requirements in the dense eelgrass stands. Anoxia (total absence of oxygen) can be expected in these stands under the ice in the winter (McRoy, 1969) and to further restrict occurrence of species in the Zostera stands.

As expected, concentrations of inorganic N and P were generally low (Tables 27 and 28). The observed concentrations are comparable to concentrations observed in non-polluted coastal bays and inlets in Nova Scotia during the summer time and are lower than those observed for somewhat polluted estuarine systems (Smayda, 1973). Phosphate concentrations above 0.55 ug-at/l are generally considered non-limiting for marine plant growth (Moore, 1958); the observed concentrations were mostly above this value, and it is likely that nitrogen is the limiting nutrient for primary production in the lagoon (and river) waters as is typical for marine systems. This is also suggested by the fact that nitrate concentrations (nitrate is the generally "preferred" form of nitrogen) were for most samples below the limit of detection (Tables 27 and 28). Also the N/P (atomic) ratio of the water nutrients, averaging 1.1 is very low. Phytoplankton take up N and P in the ratio of about 16:1; the ratio may be lower for eelgrass, perhaps 5:1 for Zostera in the summer (Burkholder and Doheny, 1968). The latter ratio is still above the ratio of the water column nutrients.

Although the observed levels of nutrients in the water column were very low, it is evident from the high primary production in this system that there must be a large reservoir of nutrients and high turnover of these nutrients...in fact light (through self-shading) may be more frequently limiting than nutrients (that is to say adding more nutrients would not necessarily increase the primary production proportionally). Short of an algal "soup", it is difficult to imagine the water column more cluttered by plant growth than it currently is in mid summer. Contribution of nutrients from fresh water is not generally considered to be the most important factor in the nutrient circulation of estuarine systems (although it may be in some cases). The estuarine circulation, carrying bottom water landward, tends to retain detrital material and its associated nutrients in the system, this contributing to an efficient recirculation of nutrients. For marine angiosperms, the sediments appear to be a prime source of nutrients (Patriquin, 1972;

COMMENTS (cont.)

McRoy and Barsdate, 1971). Phosphorus is released from its bound form in sediment particles through preferential precipitation of iron (from iron phosphate) with sulfide in sediments (Wood, 1965). Reducing conditions in the sediments also stimulate nitrogen fixation in the rhizosphere of angiosperms (Patriquin, 1972; Patriquin and Knowles, 1972) and thus the angiosperms via their roots have access to nutrients other than those directly available to phytoplankton and seaweeds. Through direct excretion from the leaves and through death of leaves and subsequent regerberation of nutrients; however, these nutrients are released into the water column and are then available to other plants. In fact, these processes may result in a net export of N and P from estuarine systems (Barsdate et al, 1974; Mann, 1975).

In connection with studies by one of the authors (D. P.) supported by the National Research Council, some data were obtained on nitrogen-fixing activity associated with Z. marina (unpublished studies). For Zostera samples taken from a dense mid Kouchibouguac Lagoon site, the following estimates of nitrogen fixation were obtained:

Sample 1: 1.06 ug N fixed/shoot-day
Sample 2: 0.54 ug N fixed/shoot-day
Sample 3: 0.42 ug N fixed/shoot-day
Sample 4: 3.76 ug N fixed/shoot-day

Given an average shoot density at this stand of 1400 shoots per m^2, these data indicate nitrogen fixation of the order of 2.02 mg N/m^2-day. Net N uptake by Zostera at this time is estimated as of the order of 10-15 mg N/m^2-day. Although the estimated nitrogen fixation rate is not high relative to estimated uptake, the data does indicate occurrence of nitrogen fixation. Further, rates are probably higher earlier in the season (Patriquin, unpublished data). Roots of Ruppia maritima also exhibits high nitrogen-fixing activity (unpublished data). Blue-green algae, occurring as epiphytes on the leaves of Zostera and as mats on the sediment surface [section III. 2·(iii)] may also be sites of nitrogen fixation. Because nitrogen fixation is suppressed by combined nitrogen, occurrence of nitrogen fixation is symptomatic of N deficiency (in the supply of nutrients); thus these observations provide a further indication that nitrogen is the limiting nutrient in this system.

COMMENTS (cont.)

In summary, then, waters of the lagoon are supersaturated with oxygen during the daytime, reflecting high primary productivity and a relatively restricted circulation (or degree of agitation). At night-time, respiratory uptake of oxygen results in correspondingly low oxygen concentrations; and in the eelgrass stands, they may fall below levels considered critical for "desirable" fish. Inorganic N and P levels in the Park waters are very low in the summer reflecting their uptake by plants, and nitrogen is most probably the limiting nutrient. However, it is evident that there must be a vast reservoir of nutrients in the system. A substantial part of this reservoir and net source of nutrients occurs in the sediments. The submerged angiosperms have access to these nutrients (and in fact stimulate their release or formation), and this is likely a major factor in the predominance of these plants in this system. Through direct excretion and death of leaves, the sediment nutrients are transferred to the water column and thus are made available to other plant forms. The estuarine circulation tends to retain these nutrients within the system.

TABLE 27 Oxygen and nutrients at mid lagoonal and river mouth stations July and August. Samples taken 0600 to 0800 hours.

Date	Depth (m)	Temperature	O_2 (ml/l)	Sal.‰	O_2 Sat.%	NH_4-N	NO_3-N	PO_4-P (µg-at/l)
Mid Lagoon Stn.								
17/7/75	0	16.5	8.67	27.9	149	0.51	0.17	0.67
	1.15	16.0	8.55	28.0	146	0.18	0.28	0.65
1/8/75	0	20.0	6.85	26.8	126	0.57	0	3.93
	1.15	20.0	6.85	27.1	126	0.58	0	1.05
15/8/75	0	19.3	4.77	26.0	85	0.73	0	--
	1.25	19.3	4.71	27.0	84	0.81	0	0.86
29/8/75	0	17.0	7.00	27.4	121	0.38	0.16	0.89
	1.20	17.0	6.67	27.4	116	2.31	0.13	0.67
River Mouth Stn.								
17/7/75	0	18.0	7.87	21.5	135	1.17	0.13	0.79
	0.70	18.5	7.97	21.5	137	0.90	0.09	0.87
1/8/75	0	19.5	5.92	17.6	103	1.44	0	0.81
	0.78	19.5	5.82			1.39	0	0.68
15/8/75	0	20.3	5.36	23.5	76	1.28	0	0.76
	1.10	20.3	5.33	23.5	96	1.54	0.08	0.81
29/8/75	0	17.0	6.48	24.5	110	1.42	0.35	0.71
	0.90	17.0	6.57	24.5	112	0.81	0.22	1.41

TABLE 28 Oxygen and nutrients at mid lagoon and river mouth at different times of day

	O_2 (ml/l)	NH_4-N (µg-at/l)	NO_3-N (µg-at/l)	PO_4-P
Zostera Station				
August 20-21, 1975				
1420h	9.42	1.33	0	1.76
1610	10.16	0.37	0	0.62
2000	9.91	0.21	0.04	0.68
2220	8.73	0.66	0	0.70
0030	8.12	1.29	0	0.96
0300	6.20	0.37	0	0.78
River Station				
August 22-23, 1975				
1320h surface	6.56	0.88	0.40	0.63
2 m	6.38	1.00	0.02	0.69
2200 surface	6.38	0.38	0	0.38
2 m	5.58	1.13	0	0.40
1230 surface	--	0.78	0	0.50
1 m	--	0.41	0	--
1530 surface	6.57	1.01	0	0.84
1 m	6.44	1.01	0	0.77

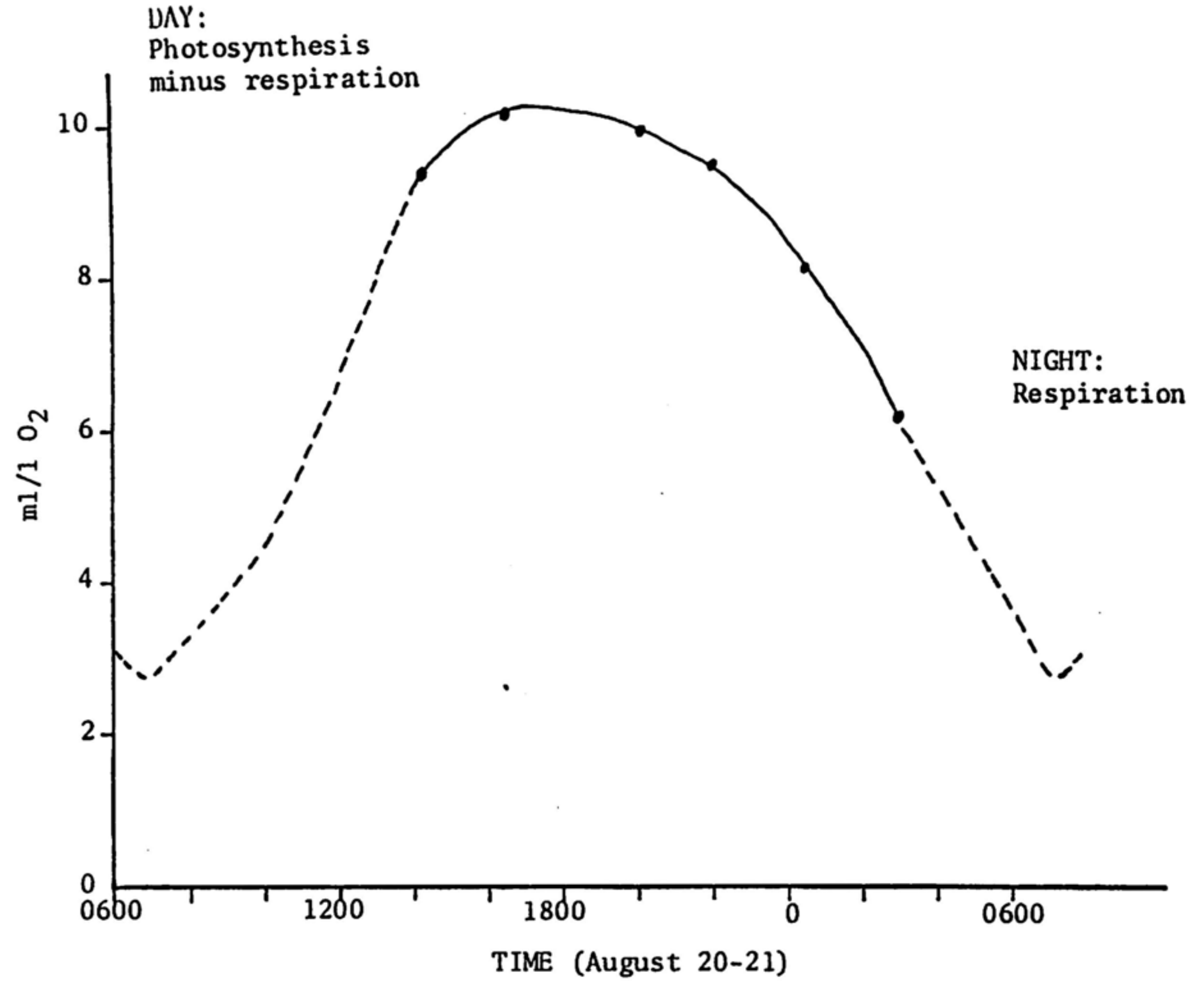


FIGURE 42 Diurnal changes in dissolved oxygen in mid-lagoonal Zostera bed August 20-21, 1975

3. Exploitable Resources

3(i) Shellfish

(i)a Clams

BACKGROUND

Soft shelled clams are certainly the most popular and most utilized natural resource of the Park lagoons and are exploited to an extent that proper management would probably result in significantly increased yields. It is recognized that current regulations elsewhere (where they exist) consisting only of minimum size limits, are inadequate. The Federal/Provincial Atlantic Fisheries Committee, in assessing the status of clam fisheries, has stated the need for "assessment for both inshore and offshore clams with determination of growth rate and natural mortality...there was no concensus on what kind of harvesting work needed to be done but harvesting work did rate top priority" (Anonymous, 1974). We have adopted and modified some of the techniques of Burke and Mann (1974) for the purposes of assessing the current exploitation of clams in the Park, and of predicting the outcome of various possible regulatory systems.

Because our time and personnel were limited, sampling was not as rigorous as might be desired, and we have made some approximations in calculating population parameters. However, this approach was based on reference to more rigorous (although more limited) studies, and the population parameters so calculated are in general agreement with the literature. Our approach has, we think, been successful, and has the advantage that it could be relatively easily adopted in future monitoring of the Park clam population. Furthermore, this approach and the implications of our calculations regarding harvesting schemes may be applicable to other regions and other invertebrate populations as well.

GENERAL BIOLOGY

General Habit - M. arenaria is a soft bottom (as opposed to rock or hard clay) burrower which in growth position lies vertically with the anterior-foot end below the posterior-siphon end above. Exhalent and inhalent siphons are joined at their walls and surrounded by muscle and periostracum, forming a single structure which extends to the sediment surface. On disturbance, this siphon tube contracts leaving a single hole on the sediment surface which clearly marks the locale of each individual.

GENERAL BIOLOGY (cont.)

Vertical Range - M. arenaria occurs in both the littoral and sublittoral region, but the largest individuals and largest numbers are found in the former, principally in the lower half of the tidal range. At Bideford River, the area populated by M. arenaria extends shoreward from the MLW level a distance of about 6 meters, equivalent to a tidal amplitude of 1.5' (range approximately 3') (Newcombe, 1936).

Substratum - Largest individuals and largest numbers are found in hard packed muddy sand. Where mud predominates with a surface layer of soft organic mud and plant debris, Mya is sparse and small (Burke, 1973). Two possible reasons for this, cited by Burke, are (i) feeble currents in the latter area and associated poor food supply, and (ii) clogging of filtering apparatus by fine sand in the latter area. Swan (1952) reports that growth rates in sand are approximately twice those in compact mud-gravel-shell mix; he suggested that abrasion in the latter area may limit growth.

Ice - Rasmussen (1973) believes M. arenaria is able to stand very severe ice conditions. After a very severe winter, Rasmussen found that the only species surviving on shallow water was M. arenaria, about 1/3 of the individuals being alive and in good condition. These were, however, the largest individuals which burrow the deepest.

Salinity - The limiting (lower) salinity for permanent survival is about 4‰ ; below this salinity, feeding apparently stops (Green, 1968). Small clams can survive immersion in fresh water for 30-40 hours; larger clams to about 70 hours (Green, 1968). The zone occupied by M. arenaria generally lies above the halocline and may be subject to very low salinities during spring runoff. During a period of abnormally low salinities at Bideford, P.E.I., mass mortalities of many bivalves occurred, but these did not include M. arenaria (Thomas & White,1969)

Lethal Temperature - Upper lethal temperature at St. Andrew's, N. B., is reported to be 40.6°C (Moore, 1958). Kennedy and Mihursky (1971) give median lethal temperatures (LC 50) for M. arenaria acclimated at 1-30°C in the range of 30-32°C for adults, and approximately 1° higher for younger M. arenaria.

Feeding - Currents of water carried down the inhalent siphon carry dissolved oxygen for respiration and suspended food particles. Older literature emphasizes the importance of plankton as food. Mathiessen (1960) observed that growth rates of young clams in a brackish pond was related to the concentration of flagellates in the phytoplankton. Recent studies have emphasized the probable importance of macrophyte (seaweeds, eelgrass) based detrital food chains in estuarine systems (Mann, 1973) since macrophytes are frequently the

GENERAL BIOLOGY (cont.)

major primary producers in these systems. Rasmussen (1973), on the basis of his field observations, considered that *M. arenaria* "may have a far greater flexibility in its feeding habit than hitherto known and that not only suspended matter but also detritus, diatoms, and other bottom micorganisms play an important role as food. He notes, "At very low tide, the filtration rate of an adult buried *Mya* is high as indicated by a slight "swelling" of the water surface over the exhalent siphon...it can be seen that fine particles from the surrounding bottom layer are sucked in and swallowed by the *Mya* individuals."

Predators - These include carniverous snails (Natica, *Polinices*), green crab, eels, flounders, crabs (including *C. irrotus*), starfish, herring gulls, and man (Caddy et al, 1974; Wenner and Musick, 1975).

Reproduction and Larval Stages - Spawning of *M. arenaria* is reported to occur when the water temperature reaches 10-15°C. Two periods of spawning are reported to occur in more southerly regions; one in May-June and one in September-October in Maryland, but in Canada there is apparently only one period, usually beginning in June (Green, 1968). Eggs and sperm are shed into the water where fertilization takes place, and the larvae spend about two weeks in the plankton before settling. Newly settled larvae have shell lengths in the order of 200 to 300 µ; they attach by a byssus to sand grains or plants and when they reach a length of about 7 mm, the byssus is lost and the clam takes up the adult habit (Green, 1968). At Malpeque Bay, P.E.I., larvae of *M. arenaria* were found by Sullivan (1948) in abundance in the Plankton between May 29 and July 12 during which time the water temperature rose from 10-20° C; larvae continued to be present until August 31. According to Caddy et al (1974), the clams mature at a shell length of around 1 inch.

Age, Growth, Recruitment, and Mortality - Age cohorts of *M. arenaria* can be determined utilizing probability plots of size distributions (Burke and Mann, 1974). Growth rings can be used for individuals up to about 3 winters age, but for older individuals may become unreliable because of erosion of growth rings; disturbance rings may likewise complicate this means of aging.

The only detailed study on population dynamics of M. arenaria appears to be that of Burke (Burke, 1973; Burke and Mann, 1974) on populations in Petpeswick Inlet, Nova Scotia. Size frequency distributions for M. arenaria in Petpeswick Inlet illustrated the presence of two major year classes in the spring withremnants of a third; and in August, newly settled clams appeared with recruitments continuing through November. There was considerable variation in growth or length within cohorts, and apparently also

GENERAL BIOLOGY (cont.)

between cohorts - the size attained by year class I at the end of their second growing season exceeded that of age class II at the beginning of its third season (Figure 43); Burke (1973) considered this die to differences in temperature of food supply. Growth rates were highest in summers. Recruitment appeared to be about the same for each age cohort, as the density/time curves for each cohort appeared to follow one from the other (Figure 43). Mortality occurred mainly in the late summer and fall for older clams, and high mortality probably occurred through the winter for the 0 year class associated with ice conditions and low temperatures. Burke (1973) was uncertain concerning the causes of elimination in older clams. He noted occurrence of borings, probably associated with the carniverous snails Natica and Polinices in some empty shells.

Data on growth and densities for M. arenaria at Bideford, P.E.I. are given by Newcombe (1936). Although these data cannot be directly compared with those of Burke, they seem to indicate higher growth rates at Bideford. Dominant size classes at Bideford were in the range of 35-65 mm, and densities (excluding the 0 year class) were between 200 and $300/m^2$.

Toxicity and Pollution - Paralytic shellfish poisoning (PSP), caused by feeding of the clam on naturally occurring poisonous dinoflagellates, has not in the past been a problem in the Northumberland Straits region.

Pollution of clam beds is associated with untreated urban effluents and has led to closure of many clam beds. Monitoring of pollution in clamming areas is based on coliform counts of the water. The clams filter bacteria out of the water, thus concentrating them and increasing the likelihood of exposure (of the predator, man) to harmful bacteria. If placed in clean water, the clams will eliminate the harmful bacteria within about 2-3 days ("depuration")

Declines in Clam Landings - Current reported landing in the Atlantic Provinces are about 6-8 million pounds annually, compared to about 22 million pounds in 1950. The decrease is attributed to closure of polluted areas, overfishing, and biotic factors. Recovery of eelgrass populations since their declination in the 1930's and associated siltation is cited as one of the biotic factors, but "the major reason for continued low levels of recorded landings is undoubtedly the heavy fishing pressure in the open areas" (Caddy et al, 1974).

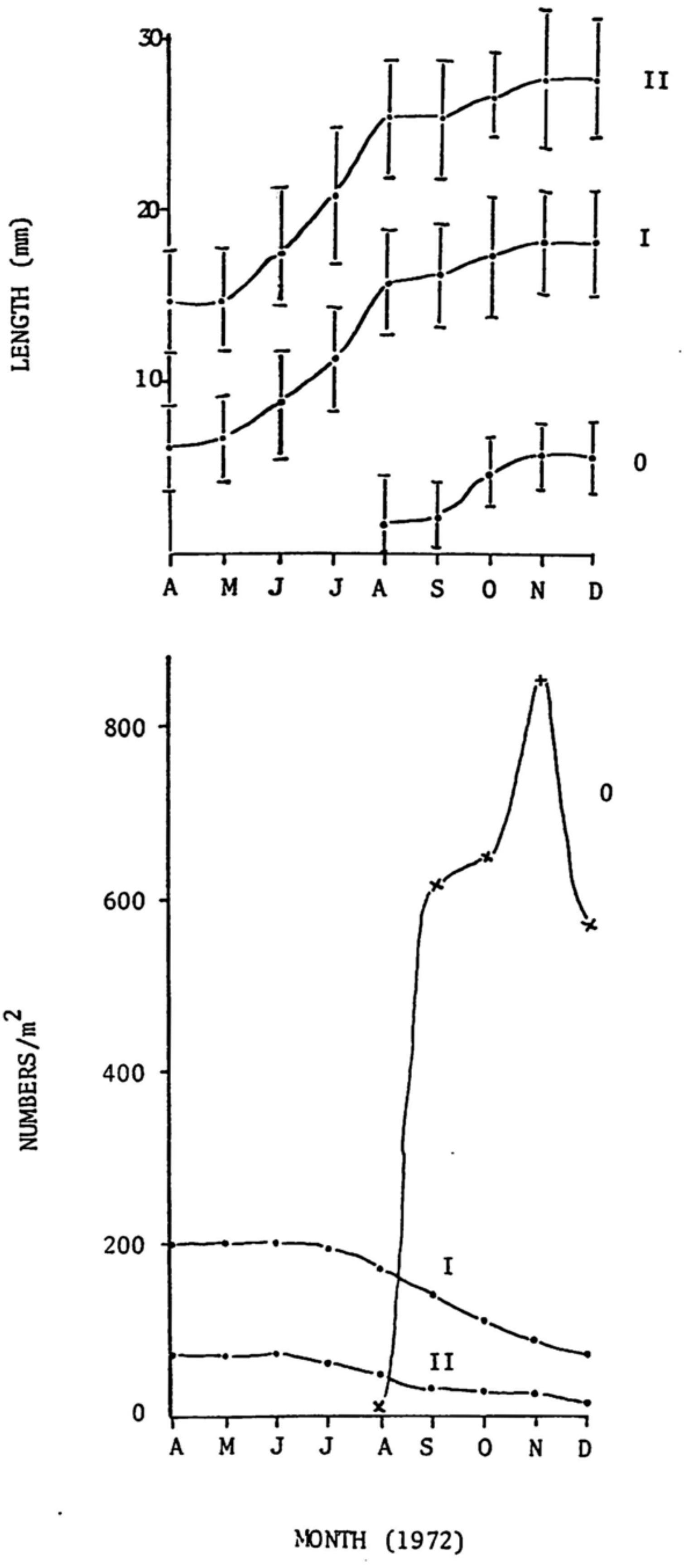


FIGURE 43 Growth and Mortality of Clams at Petpeswick Inlet, N. S. (from Burke, 1973) Roman numerals refer to size-age cohorts

DATA

The clam survey consisted of:

(i) Intensive sampling at an exploited site and at an unexploited site, both optimum habitats to compare population dynamics. Clams were sampled at Kelly's Beach, probably the most intensively harvested area of the entire Park, on two dates according to the sampling scheme of Burke and Mann(1974). The first occasion was June 26, before intensive exploitation occurred, and the second occasion was August 20, after intensive harvesting. It was difficult to find sites of high clam abundance that appeared to be totally unexploited. The Tern Island site was finally selected. Population statistics for this site were determined only at the end of the summer (August 21).

(ii) Sampling across a beach profile to determine (verify the expected) the level of maximum density.

(iii) Sampling of 37 beaches around the perimeters of the two lagoons to determine general abundance and various population parameters.

FIELD METHODS

Clams were sampled by digging up the bottom within the areas prescribed by a 25 x 25 cm quadrat (1/16 m^2). The sample was washed through a 1 mm mesh sieve. During the August samplings, a sub-sample of the top 2 cm of the substrate was also taken and washed through a 0.595 mm mesh sieve to obtain newly settled spat. The samples were preserved for subsequent measurements and age determination.

Sampling at selected "Exploited" and "Unexploited" sites was done according to the scheme of Burke and Mann (1974) except that a 1/16m^2 rather than a 1/20 m^2 quadrat was used, thus sampling scheme consists of taking a total of 64 quadrat samples within a total area of 48 x 40 m.

For the vertical distribution study, seven quadrats were taken at each vertical level sampled.

For the clam survey, 12 or 20 quadrats were taken at each sampling site.

Measurement, Age Determination - Anteroposterior length of all clams taken were measured with a sliding hand micrometer or ruler. Length-frequency distributions were drawn up as shown in the figures in the text. Age cohorts appeared to be readily distinguishable in most of these plots, corresponding to approximately normally distributed lengths within successive size cohorts. The ages inferred by the size distributions were confirmed by examination of growth rings of the clams (about 20% had reasonably distinct annual rings).

FIELD METHODS (cont.)

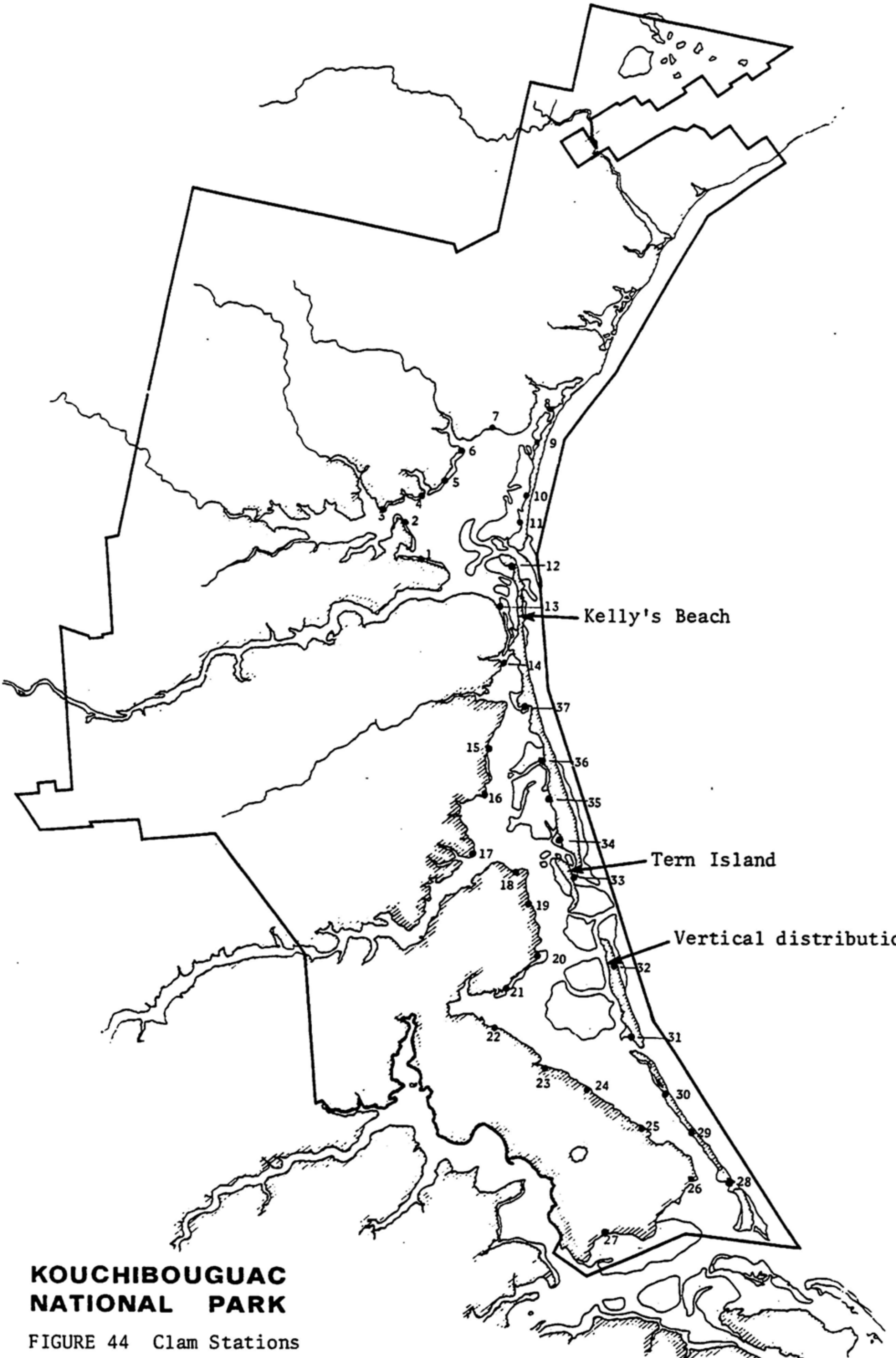
> Modal lengths in each size-age class was taken as representing average length, and the numbers of clams in those sizeable modes as representing relative numbers.

The locales of sampling sites are shown in Figure 44, and size-frequency histograms in Figures 45 through 47. Table 29 summarizes some of the population statistics. Figure 48 shows the numbers of clams across a beach profile. Numbers of clams in subtidal locations were given in Table 12.

COMMENTS

Vertical Distribution: At site 10, the abundance of clams was examined across the beach profile and below near low water in *Zostera* stabilized mud (Figure 48). As was expected, clams were most abundant in the mid-intertidal region. At all other sites, sampling was limited to the intertidal region only. Some data on clam abundance below low water were obtained in the Point Station survey (above, Table 12). These numbers (for three "shovel-fulls", approximately 225 cm^2 area for each shovel-full) indicate densities of 12 to 294/m^2. At only one of the subtidal point station sites was a density greater than 90 clams/m^2, this being in a hard packed sand substrate colonized by eelgrass, at about 1/2 m below MLW. At 40 of the 61 point stations, no clams were taken. Thus, densities are generally low in the subtidal region, probably due in large part to unfavorable muddy substrates associated with eelgrass.

Age, Growth and Recruitment: In general, size-age cohorts are readily distinguishable (Figures 45-47) and examination of clams for annual rings confirmed the age distribution suggested by the size-frequency distributions. The August samples show the appearance of the current year cohort. Burke and Mann (1974) observed continuing recruitment from August to November for Petpeswick Inlet, N. S. clam populations, and this is likely the situation in Kouchibouguac Park as well.



KOUCHIBOUGUAC NATIONAL PARK

FIGURE 44 Clam Stations

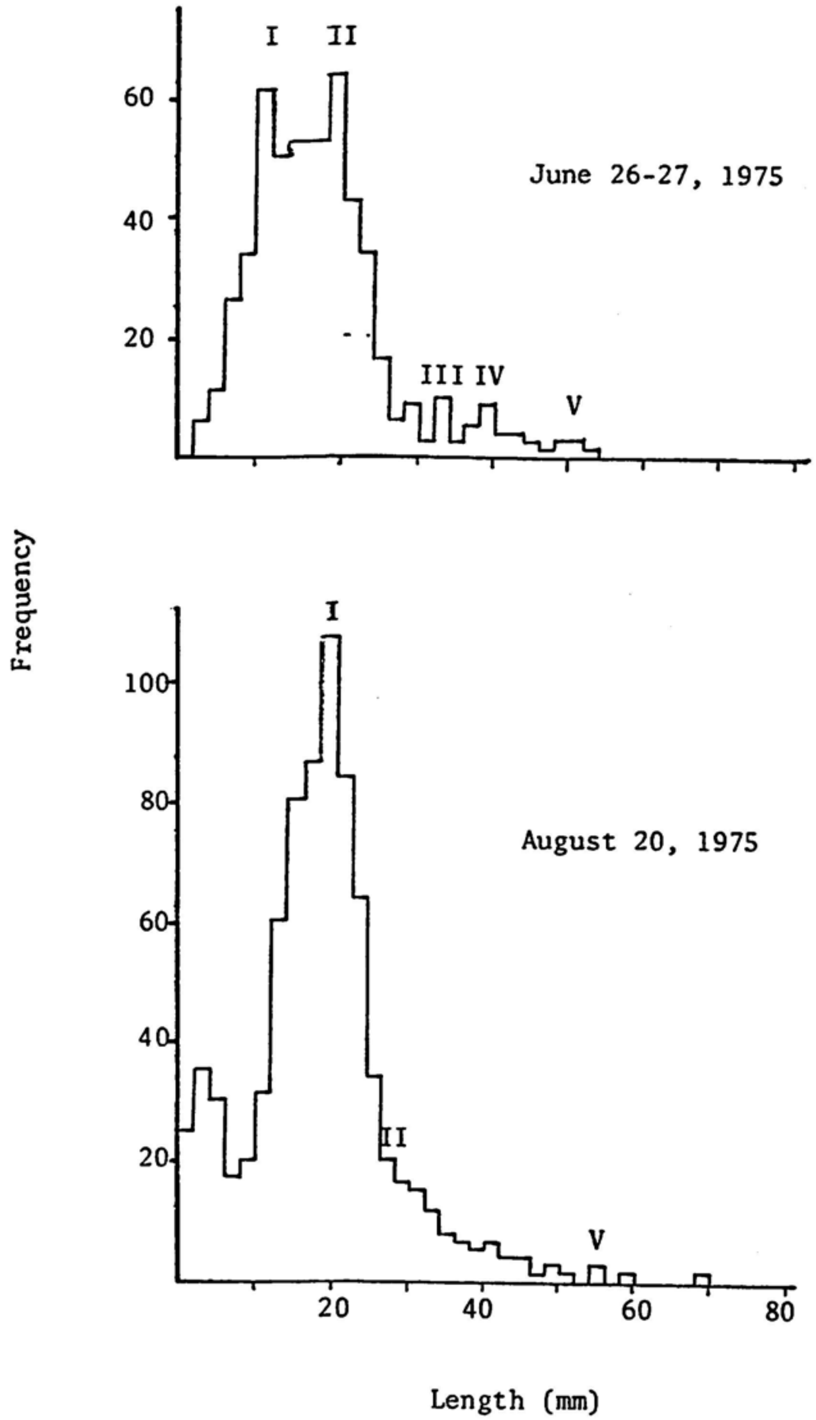


FIGURE 45 Clam Frequency-Length Distribution, Kelly's Beach Exploited Area

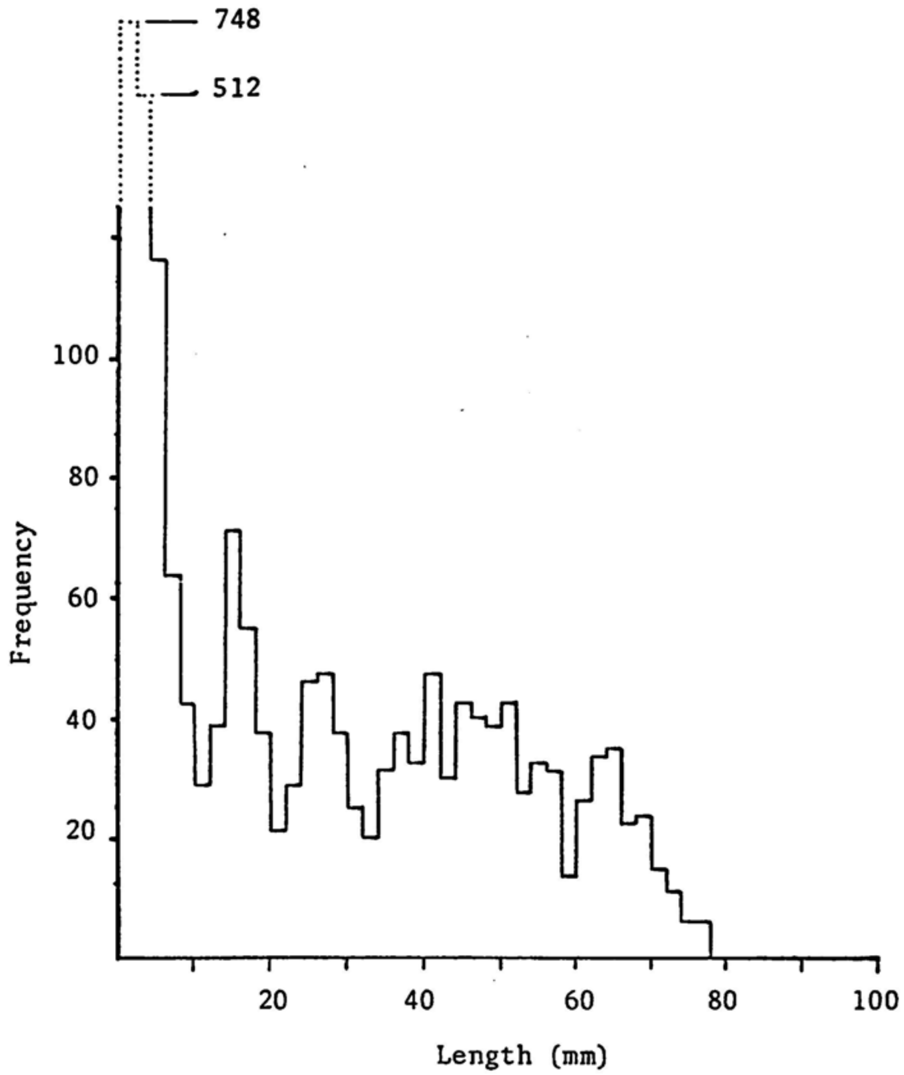


FIGURE 46 Clam Frequency-Length Distribution - Unexploited area, Tern Island, August 21, 1975

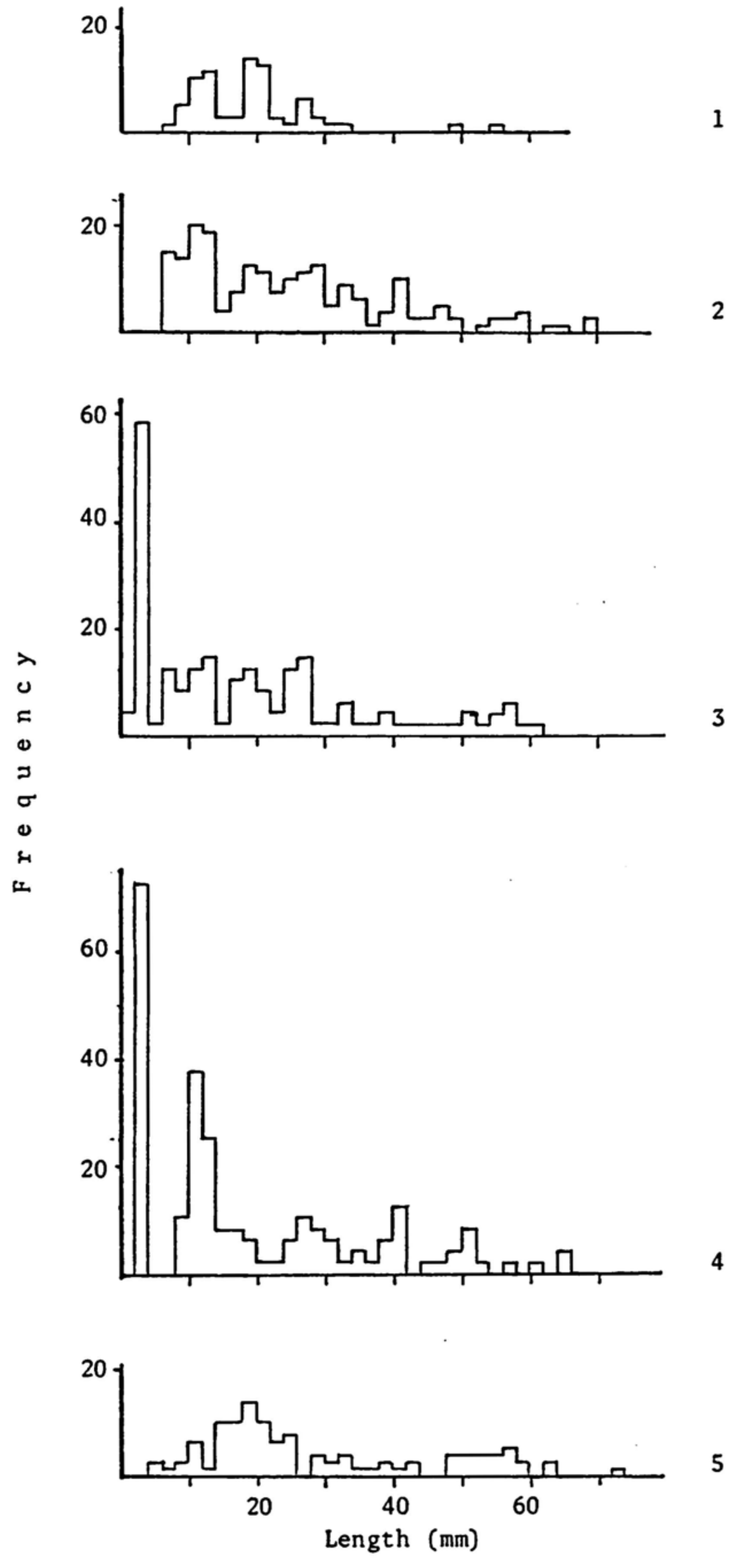


FIGURE 47 Clam Frequency-Length Distributions at Clam Stations

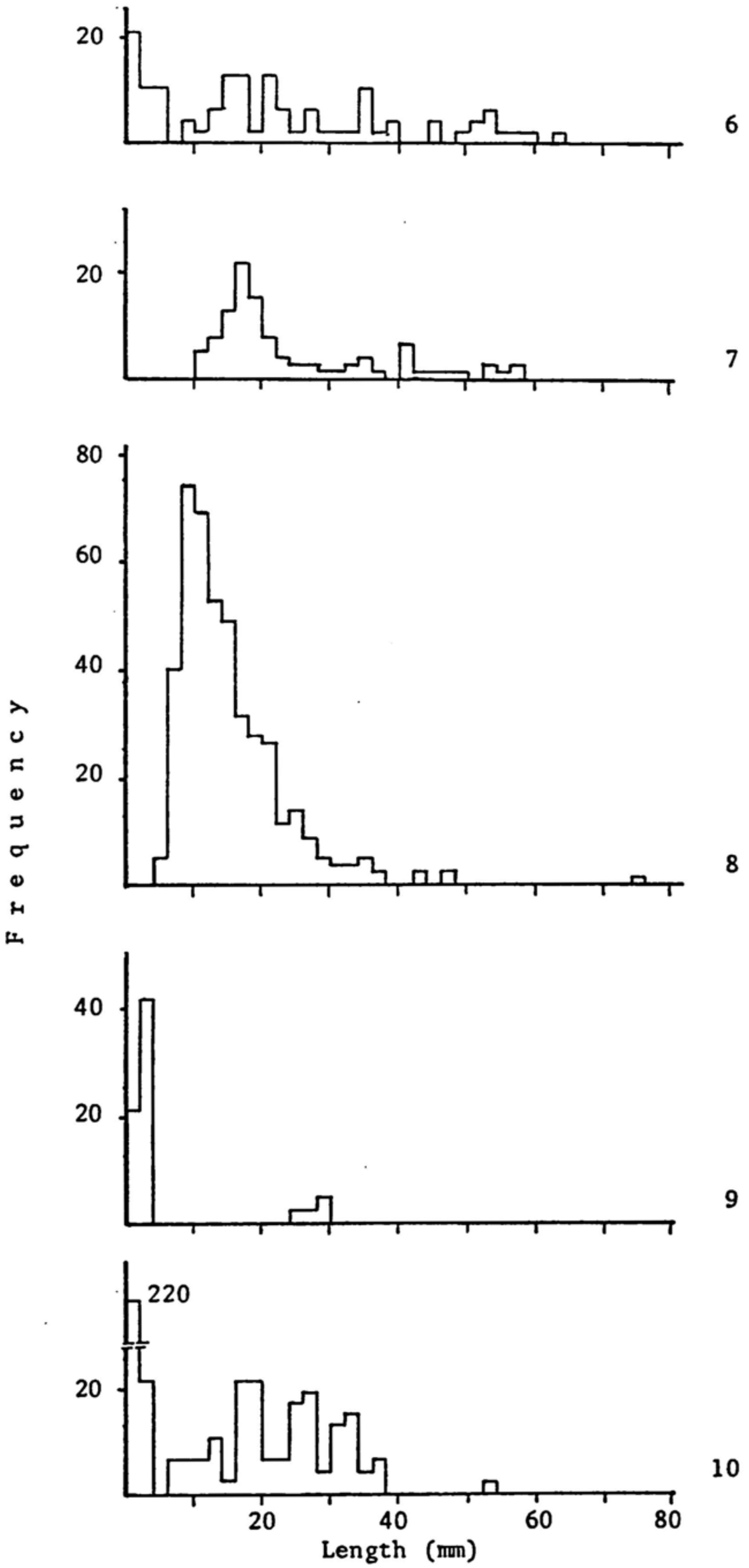


FIGURE 47 Clam Frequency-Length Distributions at Clam Stations

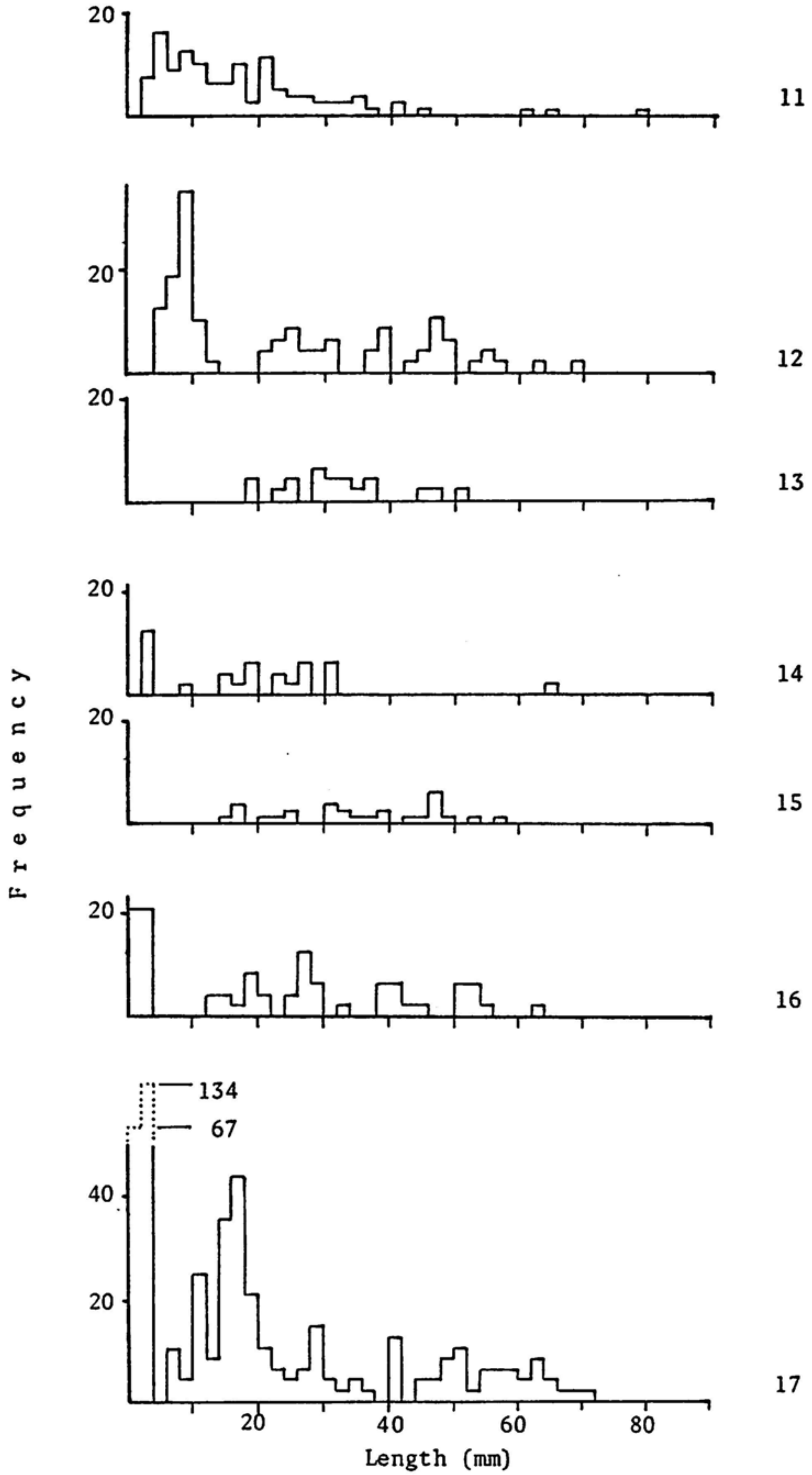


FIGURE 47 Clam Frequency-Length Distributions at Clam Stations

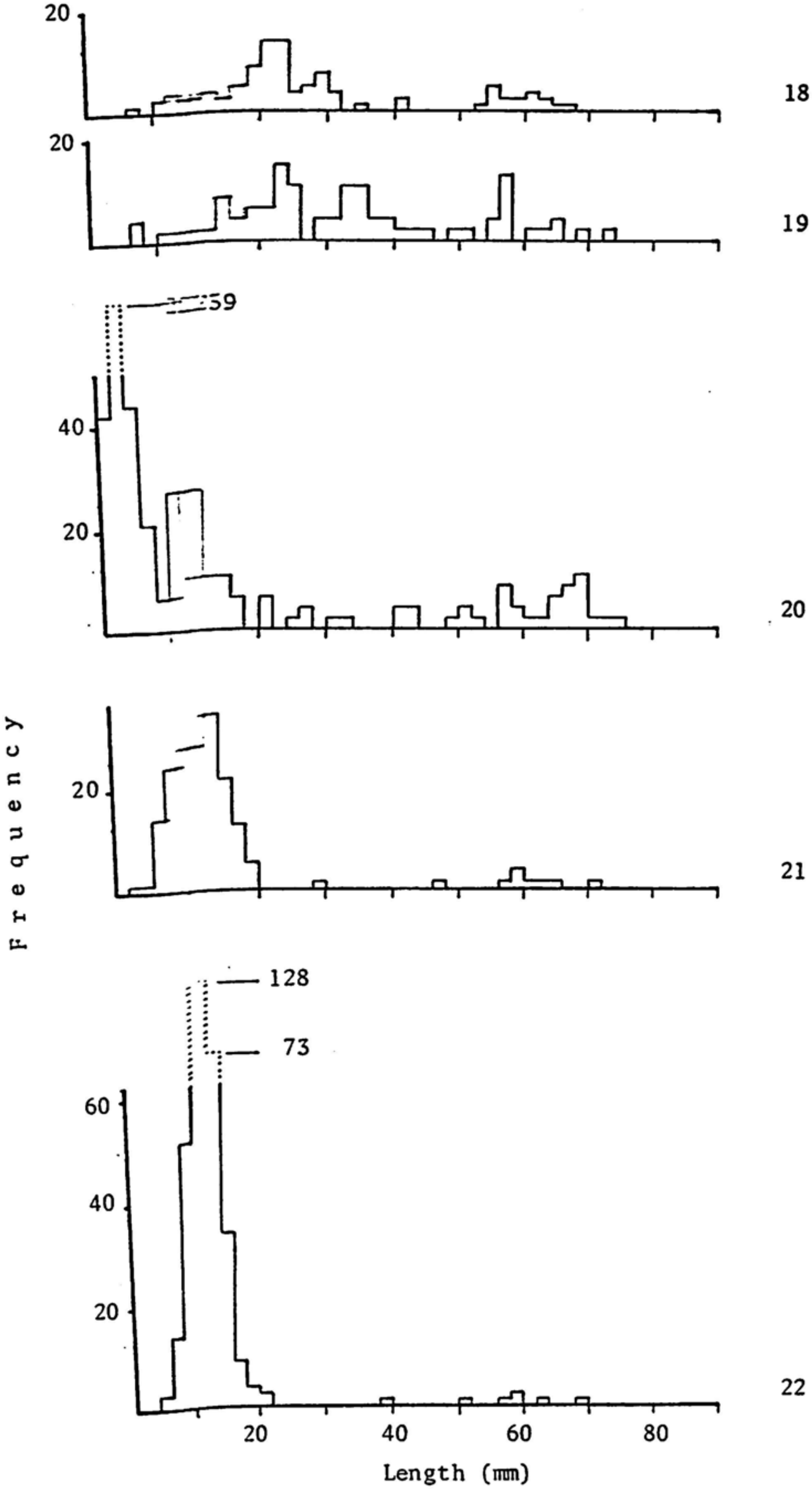


FIGURE 47 Clam Frequency-Length Distributions at Clam Stations

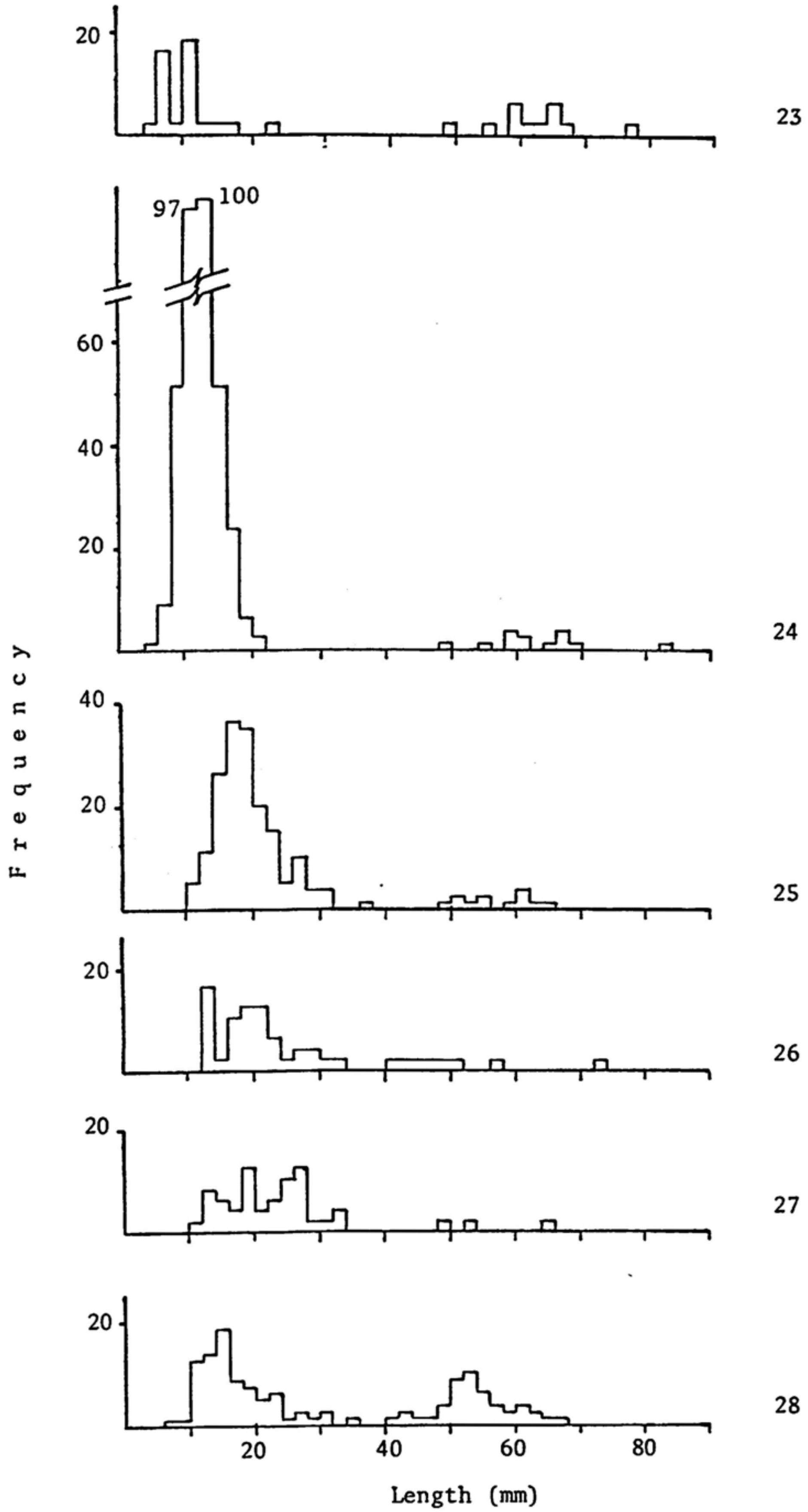


FIGURE 47 Clam Frequency-Length Distributions at Clam Stations

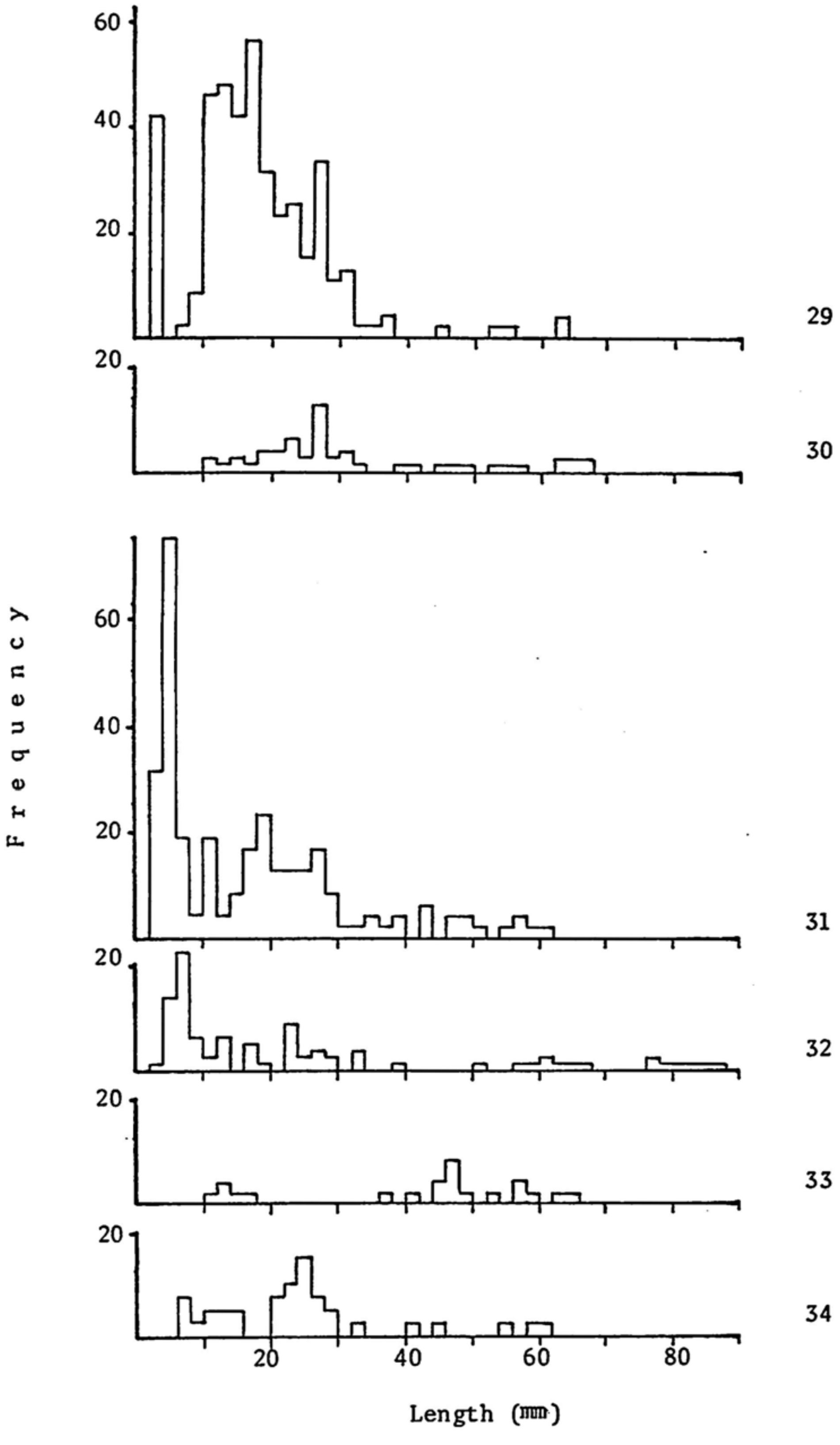


FIGURE 47 Clam Frequency-Length Distributions at Clam Stations

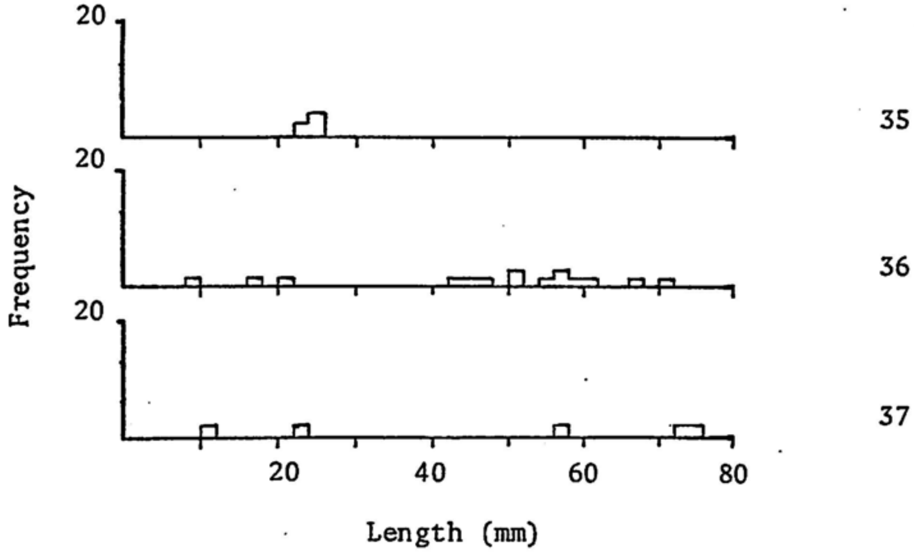


FIGURE 47 Clam Frequency-Length Distributions at Clam Stations

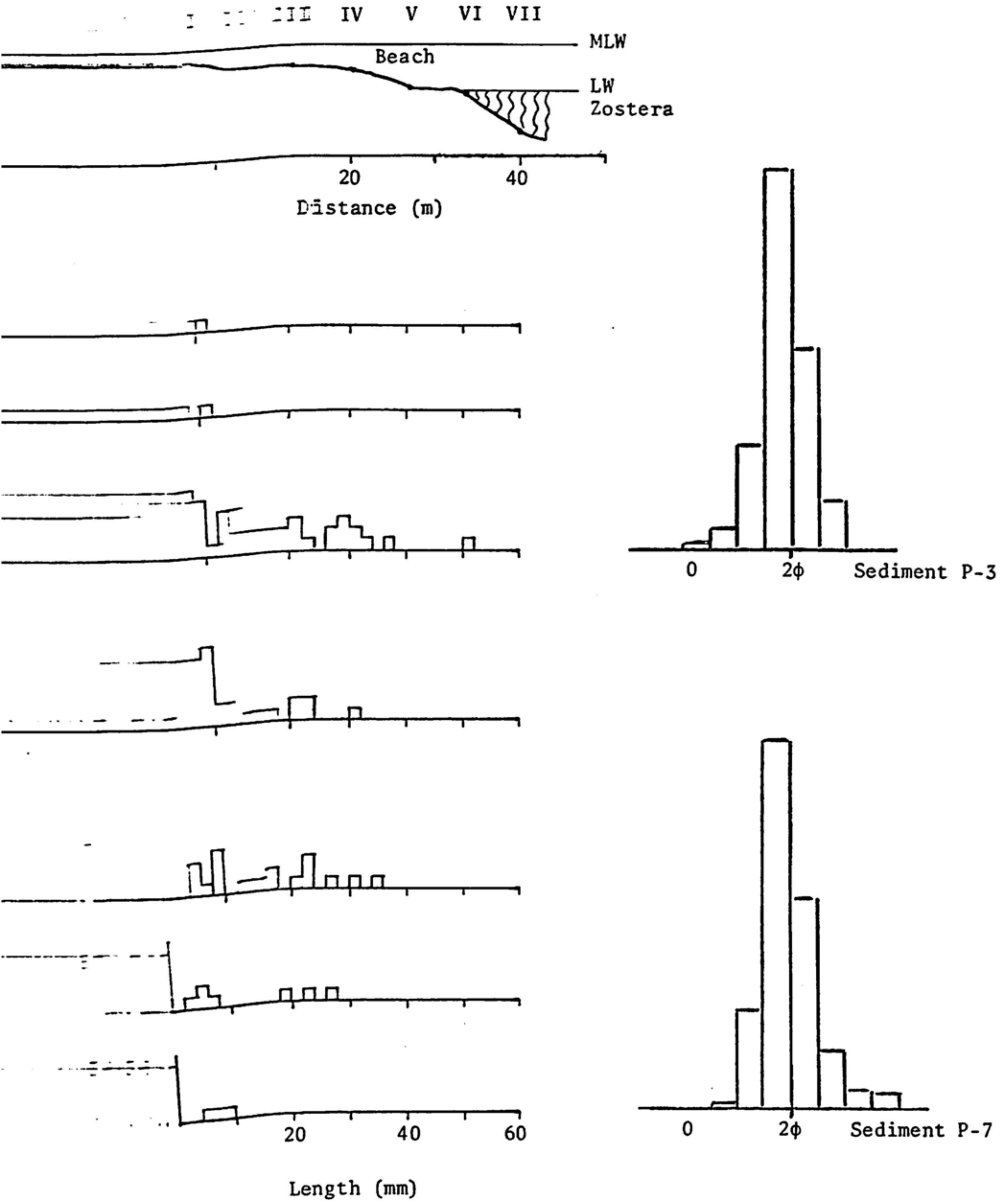


FIGURE 48 Clam Frequency-Length Distributions at different beach levels, July 26, 1975

TABLE 29

Summary Statistics From Clam Survey

Station	Length of Age 2 Mode	Total No.[1] per m²	No.>38[2] or 40mm	No.<18[3] or 20mm	Ratio Total to Nos. >38 or 40mm	No. Newly Settled[4]
1	19	48.8	1.6	29.6	31.0	
2	19	132.0	26.4	58.4	5.0	
3	19	104.0	20.0	52.0	5.2	41.3
4	27	119.0	25.3	62.7	4.7	46.7
5		74.4	20.8	30.4	3.6	
6		73.3	16.0	33.3	4.6	26.7
7		67.2	11.2	39.2	6.0	
8		278.0	4.0	222.0	70.0	
9		5.3	0.0	0.0	H[5]	40.0
10	27	105.0	1.3	50.6	81.0	167.0
11		138.0	4.8	51.2	29.0	
12	25	103.0	24.0	53.3	4.3	0.0
13		24.0	4.0	2.7	6.0	0.0
14		21.3	1.3	9.3	16.0	13.3
15		21.6	9.6	3.2	2.3	
16	27	54.6	20.0	14.6	2.7	
17		183.0	53.3	101.0	3.4	160.0
18		61.0	14.4	15.2	4.2	
19	23	86.7	25.3	21.3	3.4	0.0
20		104.0	41.3	56.0	2.5	261.0
21		97.6	7.2	89.6	14.0	
22		241.0	5.6	234.0	43.0	
23		46.7	16.0	29.3	2.9	0.0
24		261.0	10.4	249.0	25.0	
25		120.0	9.6	72.8	13.0	
26		58.7	10.7	34.7	5.5	0.0
27	27	52.0	4.0	24.0	13.0	
28	23	85.6	32.0	40.8	1.8	
29		237.0	6.7	164.0	35.0	26.7
30		39.2	11.2	7.2	3.5	
31	19	127.0	17.3	68.0	7.3	68.0
32		62.4	11.2	37.6	5.6	
33		26.7	18.7	6.7	1.4	0.0
34		54.4	8.0	16.0	6.8	
35		4.0	0.0	0.0	H	0.0
36		12.0	9.6	1.6	1.3	
37		6.7	4.0	1.3	1.7	0.0
T.I	27	235.0	106.0	59.0	2.2	338.0
K.B(Aug)	27	134.0	3.5	97.2	38.0	18.0

(1) Excluding 0 year class
(2) >38mm for July 21 - 26 samples; 40mm for August 12 - 27 samples
(3) <18mm for July 21 - 26 samples; 20mm for August 12 - 27 samples
(4) Collected only for August samples
(5) H = high (no greater than 38 or 40mm = 0)

Age, Growth and Recruitment (cont.)

Growth rate inferred for the Tern Island population from modal lengths is plotted in Figure 49 together with growth rate data of Burke and Mann (1974). The growth rates in the two areas are very similar, and it is likely that growth during the season is similar in the two areas also (Figure 43, above). Comparison of the age 2 length modes (Table 29) gives some indication of the variation in growth rates for intertidal populations. Growth rates for the exploited (Kelly's Beach) and unexploited sites (Tern Island) appear to be similar.

In general, clams in the Kouchibouguac Park reach harvestable size (1 1/2") in the third or fourth season after settlement.

Mortality: For the samples in which reasonable numbers were taken, there is in general a decrease in numbers at successive size-age cohorts suggesting that year class fluctuations are not great. The decrease in numbers at successive size-age cohorts then can be taken as a reasonable estimate of mortality. Mortality is obviously high in the first year. For the Tern Island population, numbers in the age 0 size mode are 7.5% of those in the I-age size mode; thus, the mortality must be greater than 92.5% (as more 0-year class settlement would be expected). After the first year, the mortality for the Tern Island population appears to be reasonably constant, and between age I and V average 16.3% per year. This is an estimate of natural mortality and is within the range (4-27%) quoted for other populations (Caddy et al, 1974).

Total numbers of clams taken at Kelly's Beach in August were about the same as numbers taken in June (Figure 45) -- this reflects inadequate sampling (in spite of the intensive sampling program) rather than lack of exploitation. The change in the population structure between the June and August samplings clearly demonstrates high mortality for clams above about 20 mm in length. In the June sample, the number in the age 2 (19 mm) mode was slightly greater than the numbers in the Age 1 size (12 mm), while in the August sample the numbers in the age 2 size (27 mm) mode was only 18.6% of the number in the age 1 size mode, indicating a mortality through the summer of about 91.4% for this age class. It is apparent, then, that clams above about 20 mm suffer very high mortality in harvested areas.

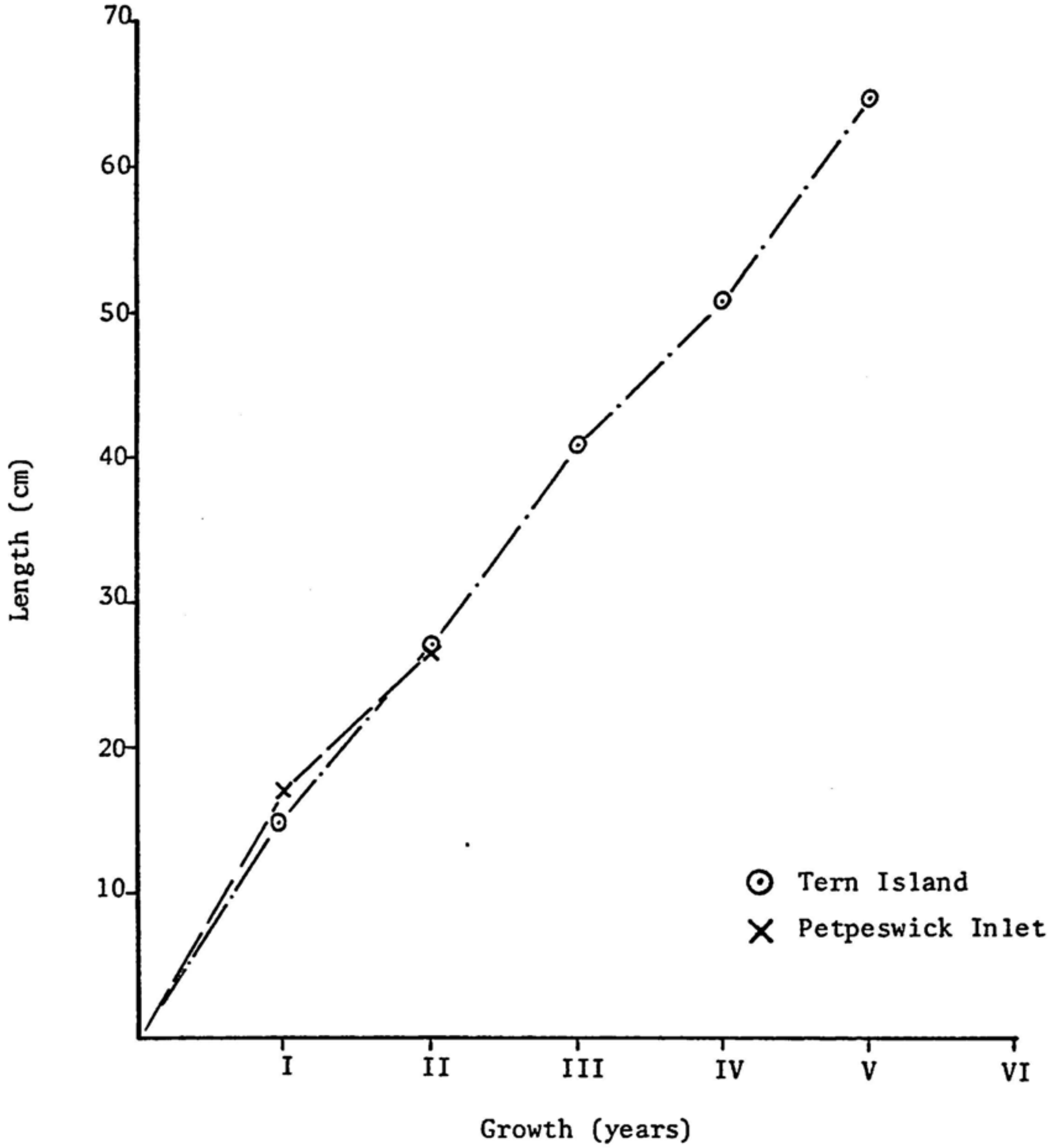


FIGURE 49 Growth rate of clams at Tern Island, N.B. and Petpeswick Inlet, N.S.

The General Abundance and Degree of Exploitation of Clams on Intertidal Beaches: Statistics for the various clam sampling points (Figure 47) are summarized in Table 29. Total numbers of clams, excluding the 0-cohort, varied from 4 to 278/m^2 with only 5 of the 37 sites having numbers greater than 200/m^2. Densities at good clamming sites elsewhere are of the order of 200-300 clams/m^2.

The ratio of total numbers to numbers greater than 38 or 40 mm (some adjustment was made for growth between July and August sampling times) gives some indication of the degree of exploitation, this ratio being 2.2 for the Tern Island population and 38.0 for Kelly's Beach. Ratios greater than about 5 seem to indicate significant harvesting (compare ratios with size-frequency distributions).

By comparison with the Tern Island site, it can be guessed that sites with greater than 50 clams of less than 18 or 20 mm per m^2 are sites of high potential numbers in the absence of harvesting. Eleven of 15 such sites had ratios (total number to number greater than 38 or 40 mm) greater than 5, indicating that the Park clam populations are currently subject to high exploitation. This is attested to by the difficulty of finding an unexploited site (i.e., where there was no evidence of digging for clams) of high clam density.

In Figure 50, the sites examined which appeared to have high potential or high actual clam densities are indicated. This by no means is an exhaustive survey. It does seem to indicate, however, that the best sites are to be found along the lagoon beaches of the dunes and along the landward beaches of the southern part of Kouchibouguacis Lagoon.

Rotation Harvest Schemes - Prediction of Yields: Regulations for taking of soft shell clams where they exist consist of minimum size limits generally set at 1 1/2 or 2". This type of regulation probably does little to conserve clam stocks because clams below these sizes are not popular in any case, and the digging itself will cause some mortality.

Utilizing the population data obtained for Kouchibouguac Park clams and some information given by Burke and Mann, we have attempted to predict the relative yield of clams of sizes 40 mm (about 1 1/2") and greater that would result from rotating harvests with various intervals between harvests (Table 30). This model is based on the following assumptions:

FIGURE 50
Sites Examined (•) with high potential (+)
or high actual (++) clam densities

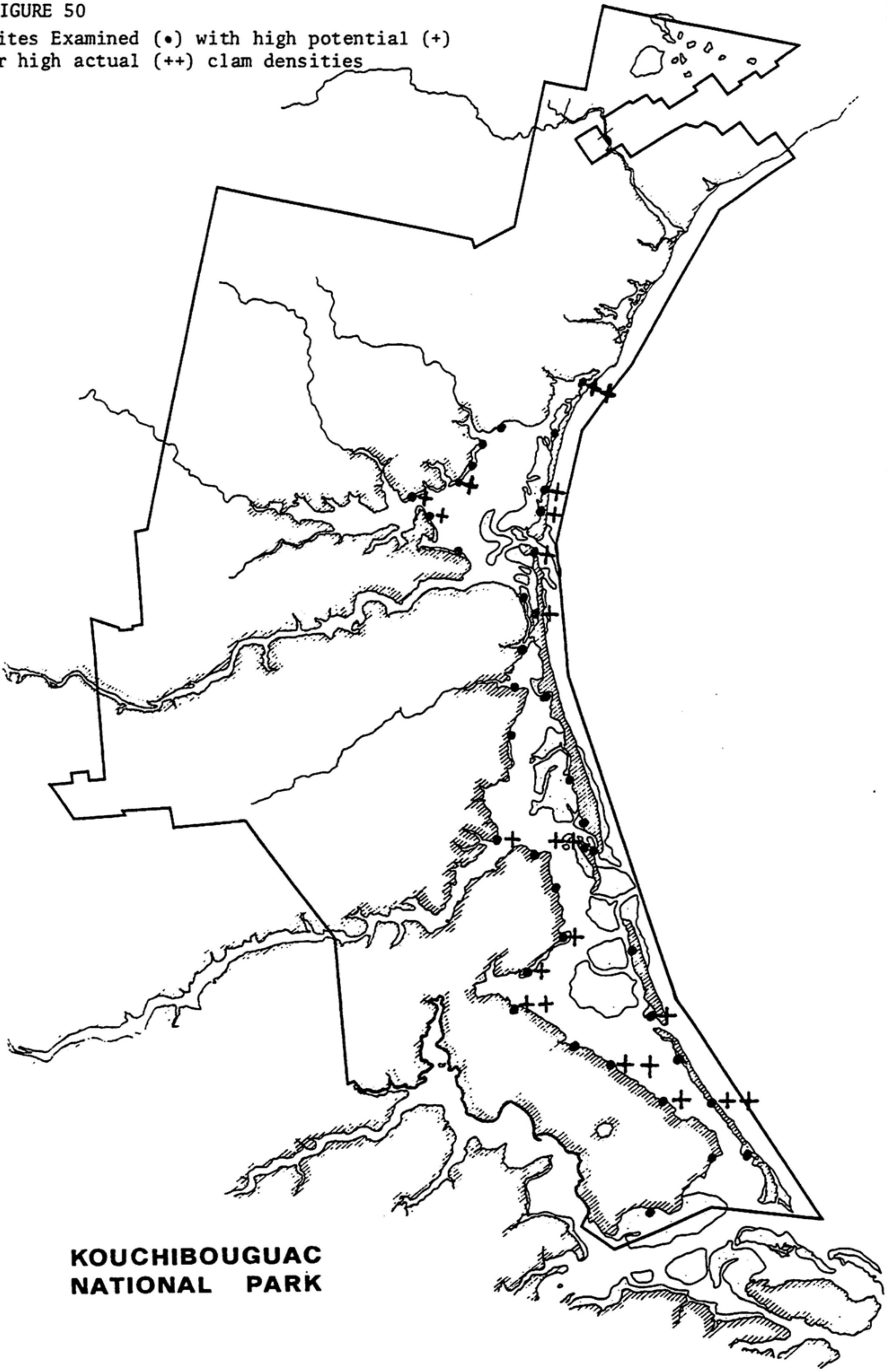


TABLE 30 ROTATION HARVEST SCHEME FOR CLAMS: PREDICTED YIELDS

Harvesting	Relative[1] Numbers of Clams of Different Year Classes at Given Average Sizes at Time of Harvest (mid July) (No./m²)					Relative[1] Total Yields at Harvest for Harvested Areas		Relative[1] Total Yield per Year For All Areas (Harvested and Unharvested Combined)	
	I-VI	III(40mm)	IV(45mm)	V(60mm)	VI(65mm)	(No./m²) No. 40mm	(g/m²) Dry Flesh	(No./m²) No. 40mm	(g/m²) Dry Flesh
Every year	169	5.3	9.2	2.6	0.0	17	0.81	17	0.81
Every 2nd year	222	28.0	8.8	7.7	2.2	47	2.23	24	1.12
Every 3rd year	263	28.0	46.9	7.3	6.4	89	4.30	30	1.43
Every 4th year	295	28.0	46.9	39.3	6.2	120	5.98	30	1.50
Every 5th year	322	28.0	46.9	39.3	32.9	147	7.52	29	1.50

[1]Numbers are actually calculated assuming year class I has 80 clams; this results in 322 clams of all ages for an unexploited population comparable to a "good" clam bed.

Rotation Harvest Schemes - Prediction of Yields (cont.)

1. Year-to-year growth rates are comparable to those of the Tern Island population, and seasonal growth rates are comparable to those given by Burke and Mann (1974). Average sizes at different ages are those estimated for mid-July.

2. Natural mortality rate is 16.3% per year from year I on, except for year VI which is 100%.

3. The natural mortality rate applies to harvested populations for clams less than 20 mm in length.

4. When a site is harvested, the number of clams left the following summer are in proportion to cohort II (which is assumed to have been subject to the natural mortality rate) as are the numbers in the modes for size-age cohorts III, IV, V and VI relative to II for the June Kelly's Beach population (Figure 45); i.e., II:III:IV:V:VI = 100:15.7:13.7:3.92:0

5. Burke's (1973) relations for total dry weight on shell length (July samples, Petpeswick Inlet) and dry flesh weight on dry total weight apply; i.e., $\log W = 2.910 \log L + \log 0.039$
   and $\log W_f = 0.17 \log W + \log 12.790$

The relative numbers generated by this model show substantial increases in total yield with 2 and 3 year rotation schemes but not much increase above this, although the catch per unit effort still increases with longer intervals between harvests.

Two factors not taken into consideration are: (1) there might be substantially greater survival of spat (the 0-cohort) in the absence of harvesting - this would tend to increase the yields with increasing intervals between harvests; (2) increased competition resulting from greater survival of spat might lessen the relative yields with increasing intervals between harvest - this would probably be significant only with the longer interharvest intervals.

These considerations suggest that a three year rotation scheme would be optimal (it would be also easier to enforce than longer rotation schemes). The benefits of imposing a lower size limit (40 mm or 1 1/2") are uncertain, but could only increase the yields.

SUMMARY

1) Clams are generally abundant at intertidal sandy beaches and sparse in the muddy sediments of the lagoon.

2) Growth rates are comparable to those reported for Petpeswick Inlet, N.S., and appear to be less than these for P.E.I. locales. Clams reach harvestible sizes (greater than 1 1/2") at 3 to 4 years of age.

3) There do not appear to be large year class fluctuations (i.e. no dominant year classes) in the clam populations.

4) Spat settlement was observed in August.

5) Natural mortality for age I to VI is estimated at 16.3% per year. In intensively exploited areas, 2 year old clams suffer a greater than 90% mortality.

6) The Park clam population as a whole is subject to a high degree of exploitation.

7) The best clamming areas are along the sand flats inside of the barrier dunes and along the landward beach in the southern part of Kouchibouguacis Lagoon.

8) Calculations based on population data suggest that a three year rotating harvest scheme would result in substantially increased yields as well as much greater catches per unit effort in harvested areas.

III 3 (i)b Blue Mussel (Mytilus edulis L.)

BACKGROUND (Sources: Anonymous, 1974; Mossop, 1972; Sullivan, 1948; Newcombe, 1935; Green, 1968)

Although considered a gourmet item in Europe, the blue mussel is relatively unexploited in Canada - about 270 metric tons per year compared to 250,000 metric tons in Europe (1969) of which 140,000 tons were cultured. Some efforts are currently being made to culture this species in Cape Breton. Kouchibouguac Lagoon is cited as being one of the few sites of harvest of wild stocks in Canada (Caddy, 1974), and what is taken in Canada is apparently utilized mainly by recent immigrants. Development of a market for Canadian mussels appears to depend on encouraging domestic use. Good bottom yields are of the order of 130 lbs/acre, compared to 300 lbs. of beef cattle per acre and up to 50 tons/acre for suspended culture of mussels. The mussel is subject to PSP (Paralyte Shell Poisoning) and sewage poisoning. The same remarks apply to this species as for the clam. Wild stocks are gathered by hand, rake, tonge, or dredge. Predation by starfish is believed to be a major factor limiting distribution and abundance of blue mussels subtidally. Market size is 50 mm. They are in best condition for consumption just before spawning; April, May, and June.

ADULT

- epifaunal bivalve which attaches by byssus threads to solid substrates; may include stones under a layer of mud; larger threads may be made if sedimentation is occurring, newly settled spat may attach to older shells and the mussel bed becomes elevated above surrounding area
- intertidal to about 10 m maximum depth
- cannot survive salinities maintained below 4 ‰. It is able to close shell and withstand short term rapid fluctuations in salinity
- ice cover results in almost 100% mortality. Depth distribution is approximately mid-tide to 9 m or greater
- Upper limit of current flow is approximately 5 knots; most abundant in areas where there is some protection from currents and wave action

ADULT (cont.)

- densities, adults length 50-60mm average about 700/m^2 in uniformly covered areas
- growth of buried individuals in bed lower than those on surface
- Filter feeders; separate small particles from water
- At St. Andrew's, N. B., growing season May to November
- Subtidal populations are able to feed for a greater proportion of time and have higher growth rates
- rings on shells can be used to determine age; some caution required because of erosion of shell, non-defined check marks and false check marks
- *Mossop (1922) reported average growth in length per season at St. Andrew's as 10.8 mm for littoral zone and 14.8 mm for a sublittoral area

Predators - starfish, other gastropods - sea urchins, winkles (*Lunatia heros*), whelks (Buccinium), drills (Thais), fish (cod, eels), birds (gulls, ducks), mammals
Polydora (boring annelid) may be responsible for absence in some sub-tidal areas

- predation probably limits depth of subtidal populations

LIFE HISTORY

Spawning
- when water temperatures are increasing, late spring, early summer
- not continuous; cycles of gametogenesis and genetic liberation, the latter peaking on new and full moons;

↓

Eggs & sperm shed into water

↓

Fertilization

↓

Viliger larva planktonic carried seaward
- growth of larvae influenced by temperature, food, salinity; growth rate falls at salinity <20 ‰
- Malpeque Bay larva abundant end of May to 3rd week in July, 2nd peak in August
- larval period about 4 weeks

↓

Pediveliger larva (with foot)

↓

Settles
- able to delay settling to an extent until suitable substrate found, thus much variation in size
- length 0.4 - 1.0 mm; begins end of July, early August

↓

Attachment
- attach most readily to substrate which includes filaments of algae or eelgrass; prefer mud and gravel substrate. In early stages (in 0.9-1.5 mm) can resorb byssus and be carried to new area of substration unfavorable.
- heavy settlement on old bed may smother and kill old mussels, but generally settlement is away from adults (unable to compete with or are taken in by inhalent current of adults and subsequently die)

↓

Secretes byssus thread
- growth rate at Bideford: Settlement to end of

July	3.6 mm
August	7.5 mm
September	5.8 mm
October	3.2 mm

At end of first year, 10-20 mm in length
- Sexes separate

↓

Ripening of gonads (returns to Spawning)
- When temperature rises above 7°C
- reproductive tissue greatly increases (in the state most palatable - April, May, June)

↓

Redevelopment of gonads begins 2-3 months after spawning

DATA

Aside from observations during the course of the Point Station survey, we specifically looked over wide areas for the existence of "mussel beds"; i.e., continuous cover of mussels over fairly large areas, distribution of continuous or semi-continuous mussel beds. The distribution of such beds is illustrated in Figure 29. Only four such areas were found. The most extensive beds occur in the channel leading from Kouchibouguac River through Little Gulley. Figure 11 shows a profile across the channel and illustrates the elevated nature of the mussel bed. These beds are semi-continuous along this whole distance.

As indicated previously (Table 12), mussels are the most common occurring bivalve in the lagoon. During the summer, large numbers of small mussels representing the current year settlement occur attached to the blades of eelgrass and other macrophytes. In mid-August, the size range of mussels taken from Zostera blades was 7-23 mm.

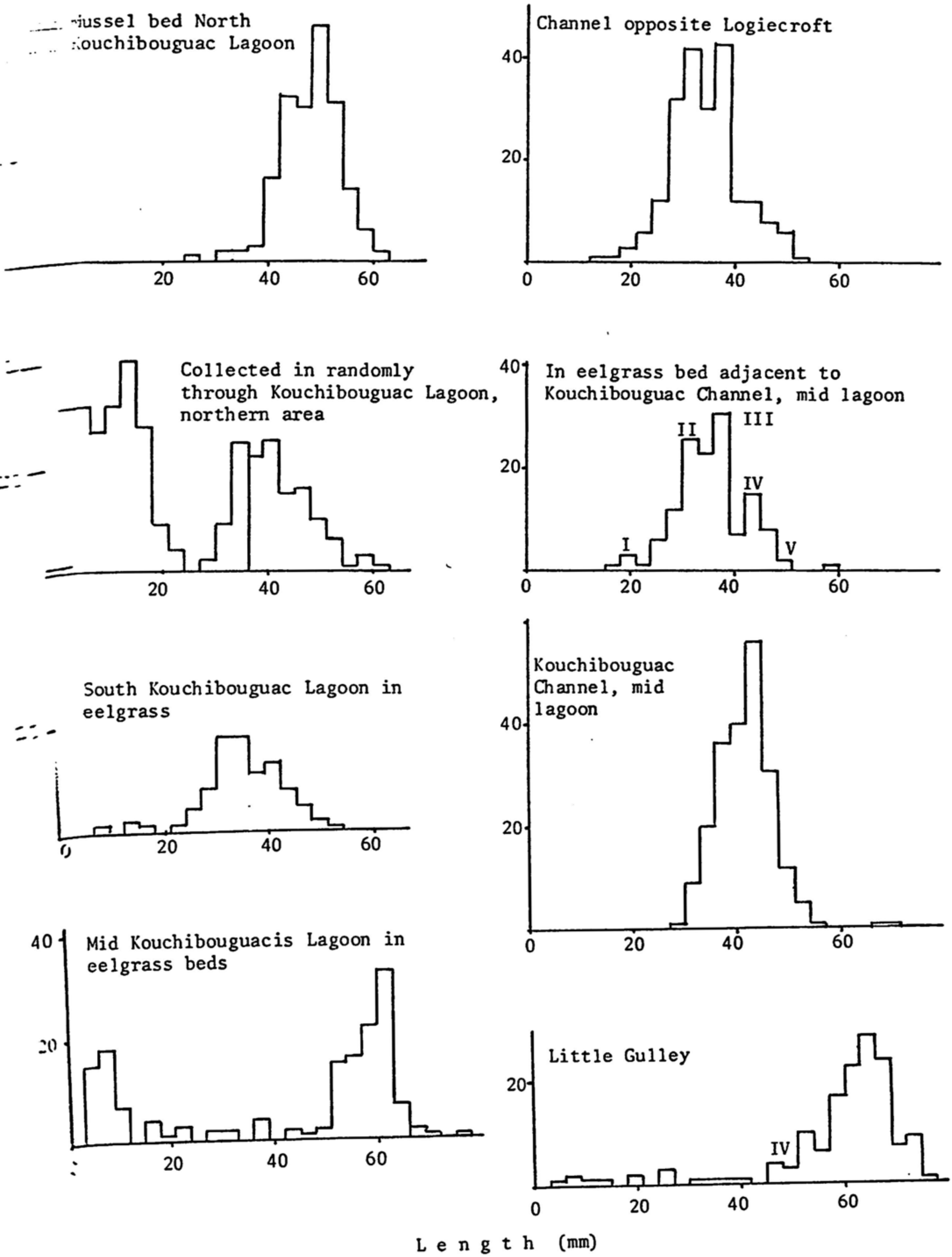
Figure 51 shows size-frequency histograms for 8 samples, 4 taken from mussel beds (Figure 29) and four from discontinous distribution in the eelgrass beds. Only one of the mussel beds had significant numbers of sizes 70 mm and greater. All of the mussel beds except the Little Gulley bed lacked any mussels of the current year size class. As indicated in the life history, this may be associated with intraspecific competition or predation rather than lack of possible settlers. The eelgrass populations, on the other hand, were in general characterized by broader size distributions, presumably as a result of lower competition. Young mussels settle on Zostera in large numbers and probably establish on the bottom in the fall when Zostera die-back is extensive. Mussel concentrations in the Zostera beds are in some places almost continuous; in others, consist of well separated, discrete "clumps", or perhaps only of a few individuals.

Aging of mussels is difficult and size at ages within a population can vary considerably; the uppermost mussels growing fastest. As well as can be determined for both eelgrass bed populations and 'the best appearing' channel population (Little Gulley), mussels reach a length of about 50 mm at 4 years of age (Figure 51)...larger mussel can be expected to be up to 6, 7, and 8 years of age.

COMMENTS

The only significant populations of mussels occur subtidally, and the best 'beds' occur in channels - notably the Kouchibouguac River channel. While large numbers occur throughout the lagoon, as a whole, in eelgrass beds; they would be difficult to harvest there without extensive disruption of the bottom and, in general, do not reach very large sizes. The mussels in eelgrass beds are generally attached only to old seaweed, detritus, etc., and are easily removed. Harvesting would thus be very easy and entire beds could possibly be stripped very quickly. Given the rather slow growth rate of the mussels and the problems of initial establishment of the beds, recovery following extensive harvesting would probably be slow.

FIGURE 51 Mussels Frequency-Length Distribution, 1975. Roman numerals are ages of individual mussels estimated from counts of annual rings.



III 3 (i)c Periwinkles

BACKGROUND (Sources: Caddy et al 1974; Davis, 1971; Hayes, 1929; Rasmussen, 1972)

Periwinkles are popular food items in Europe Canadian landings are between 100,000 to 200,000 lbs. annually, large from the mouth of the Bay of Fundy and from both shores of the St. Lawrence estuary.

ADULT

Occurrence - lives on rocks among small stones on gravel and on wood structures; on submerged plants from about mid-tide level to 2 m or more

- ice kills *Littorina*, but individuals move to deeper water in winter
- optimum temperature about 18° C
- salinity tolerates to as low as about 12 ‰
- withstands considerable drying
- densities to 980/m^2; maximum length 18-38 mm

Feeding - herbivorous, feeding on algae, *Zostera*(?), and detritus, incidental carnivore

Predators, Parasites - *Polydora*; *Lunatia heros*, *Thais*

LIFE HISTORY

Spawns in spring

Egg capsules pelagic, 1-5 eggs/capsule, capsule 1 mm across
Passamaguoddy capsules found in plankton January to August

Hatch at about 6 days

Viliger larva, 10-30 days seaward drift - Require salinities >20‰ for normal development

Settling - June-July (Denmark)

5 mm shell by about 3 months (Denmark)

13 mm 15 months

20 mm 27 months

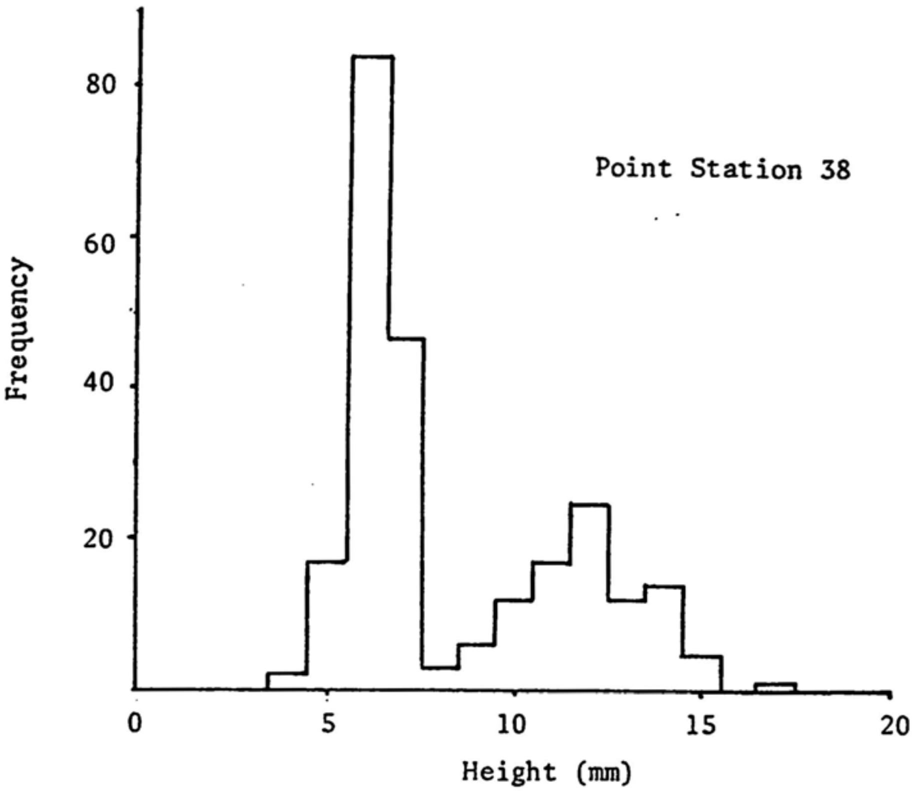
Spawn at 2-3 years of age

DATA

The general occurrence of *Littorina littorea* was observed in the Point Station survey (Table 13) and lengths (heights) were determined for samples from four of the point stations. This snail is the most common gastropod and occurs in high densities (1216/m^2 at one stand). It occurs both on the mud surface and on the eelgrass blades. Length-frequency distributions are shown in Figure 52. Maximum lengths at three of the stations were less than 20 mm; at the other, 23 mm. These distributions appear to include 3 to 4 year classes.

COMMENTS

Common periwinkles are present in high numbers in the Park but are not very large.



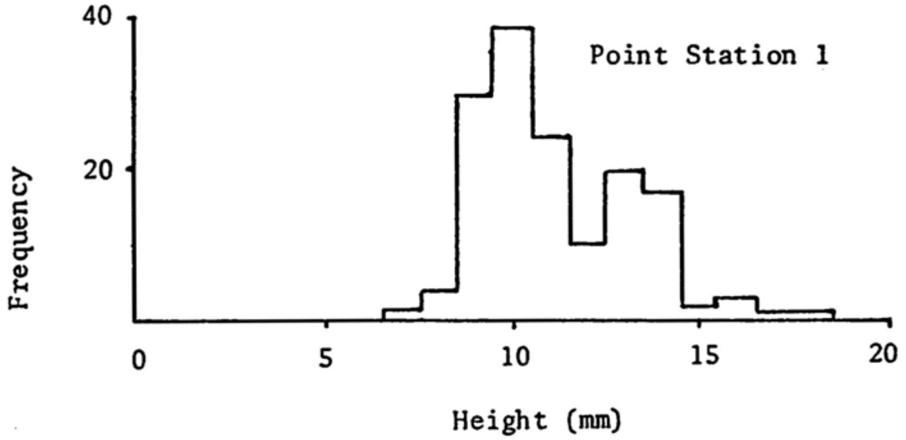
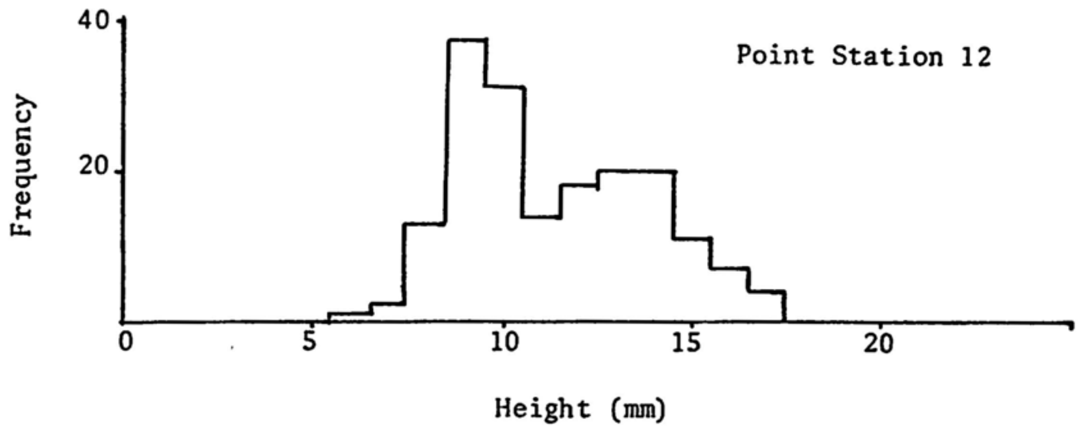


FIGURE 52 Periwinkle Frequency-Height Distributions from 4 point stations



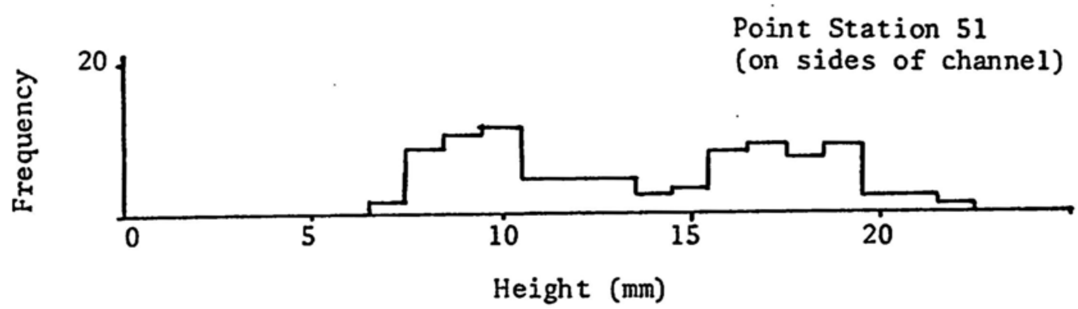


FIGURE 52 Periwinkle Frequency-Height Distribution.

III 3(i)d Oysters

BACKGROUND

In Eastern Canada, oyster populations abound only in sheltered bays, inlets and river mouths. The more open areas are too cold for this species whose greatest production occurs along the Atlantic Coast from the southern New England States to the Gulf of Mexico.

Commercial harvesting of oysters depends greatly on oyster farming. "Spat" (settled larvae) are collected by putting out collectors towards the heads of oyster-producing inlets just before a "spatfall"; this occurring about 3 weeks after spawning. These are reared to "bedding-size" (1½-2") over 1-3 years in shallow water where they can be protected from starfish, and are then transplanted to leased "maturing grounds". The best conditions for the maturing grounds are near the mouths of estuaries where the bottom is level, salinities are high (26-30 ‰) and the water is relatively cool. Maturing to marketable size takes 2-3 years. There are many variations on this scheme and sophisticated science, technology and marketing system technology and marketing system has developed around oyster farming. A detailed account of oyster farming in the Maritimes is given by Medcoff (1961).

Gulf of St. Lawrence oyster populations have been severely hit during two periods in recent history by disease, once in the period 1915-1939, and more recently in the late 50's and 60's. This almost eliminated oyster production in New Brunswick and Nova Scotia. Concerted efforts by the Department of Fisheries to establish disease-resistant stocks seem to have paid off; both natural and harvested oyster populations are regaining their former abundance.

LIFE HISTORY	COMMENTS
Spawning	- when about 25 mm length - occurs early summer when temperatures reach 20°C and greater; intermittent over 4-6 weeks or longer.
↓	
Fertilization	
↓ few hr	
Module trochophore larvae	
↓ 1-2 days	
Free-swimming veliger larva	- secrete beginning of shell; feed on plankton, remain in vicinity of spawning or may be carried away.
↓	
Pediveliger larva	- with foot; tests substrate; searches for suitable substrate (firm, hard, rough surface) - do not settle where there is silt and slime
↓	
Settles ("SPAT") (about 3 weeks after spawning) anchors to substrate (immobile)	- starfish, whelk, moon snail and crabs, prey extensively on young oysters; starfish are greatest problem; oysters are susceptible to starfish of diameters 1½ x the diameter of the oyster. - parasites include blister worms and flat worms; boring sponge attack
↓	
1½ mm at 10 days	- mussel compete with small oysters for space and food - low densities of eelgrass favorable (act as break-water) but high densities harmful because of siltation, smothering by decomposing leaves; interfere with growth
↓	
1½-2" (38-50 mm) at 1-3 years (Bedding size)	- salinity tolerance: 3-40 ‰; in low salinity areas vulnerable in floods - 26-30 ‰ optimal for maturing oysters - filter feeder, feeds on particles 3-4µ size - feeding best at 15-20°C; unable to feed when water temperature less than 4½°C; most growth during the period mid May - September
↓	
3" or 75 mm (marketable size) at 4-7 years	- best oysters for marketing are those growing slowly or at intermediate growth rates without over-crowding

DATA AND COMMENTS

Occasional, individual oysters were picked up at point stations (Table 12 above) but only at those on Zostera-sand or bare sand biofacies (stations 41,43,57). Small beds are reported to occur at the mouth of the Black River and in the southern lagoon as indicated in Figure 29 above. The latter bed is reported to be about 100 by 100 feet in area; 30 oysters collected from there by Denis Godin, a Park warden were between 50 and 88 mm height. Old, dead oyster beds were observed in the southern lagoon and the Kouchibouguac River opposite Logiecroft, and in Kouchibouguac Lagoon above the Black River (Figure 29).

It seems likely that there were once several reasonably large oyster beds in the lagoons and lower parts of the rivers. They may have been killed off by disease - perhaps in the 50's. Their failure to return can be attributed to the growth of Zostera since the late 50's occurring at a time when the oyster population was least viable. Areas particularly suitable for oyster, have also been settled by mussels; this can be observed at the edge of the channel opposite Logiecroft in the Kouchibouguac River.

Some areas of the southern lagoon might make good "maturing grounds" with proper management, but it is unlikely that significant oyster populations will become re-established in the Park otherwise or that artifically established bed would be naturally maintained.

III 3(ii) Other Invertebrates

3(ii)a. Crab (*Cancer irroratus*)

BACKGROUND

In the United States there is a sizable fishery for "rock crabs" which there include *C. irroratus* and *C. borealis* (Saila and Pratt,1973). In the Gulf of St. Lawrence and Northumberland Strait, rock crabs are caught only as a by-product of the lobster fishery (Scarratt and Lowe,1972). Meat is apparently comparable in quality to that of the popular blue crab. Thus, there may be more exploitation of this resource in the Northumberland Strait region in the future. Some efforts in this regard have been made by the New Brunswick Department of Fisheries and Environment (Branch, 1973); see also Anonymous, 1974. The former reference gives information on catching, processing and marketing.

The life history of *C. irroratus* is outlined below (information from Scarratt and Lowe 1972, Krouse 1972, Saila and Pratt 1973, Jeffries 1966; Scarratt and Lowe paper includes data for Kouchibouguac Bay).

ADULT CHARACTERISTICS

Habitat - adapted to sand and mud substrates by its relatively light claws, capability of prolonged walking and ability to bury itself quickly in mud (to escape predators). Optimum temperature for walking about 14°C. Occurs also on hard bottom.

Food - In Kouchibouguac Bay, principal prey include polyschates, mussels, starfish, sea urchins and eelgrass. Prey are taken alive.

Competitors and Predators - Lobsters on rocky bottom prey extensively on predatory fish.

Moulting - probably moults annually once it reaches maturity. Male in winter (February, March); female in summer and fall at time of mating. For female, moults result in about 25% increase in carapace width.

Maximum Size - females not found above 89mm width, probably have a terminal moult. Males in Kouchibouguac Bay to 127mm (carapace width).

Maturity - In June in Kouchibouguac Bay, males with developing gonads were from 50 to 100mm width; ripe males from 69mm upwards. Smallest ripe female in June, 60mm.

MATING AND EARLY LIFE HISTROY

Mating - July to October in Kouchibouguac Bay. Male clasps female 30-40mm smaller across sternum; releases while moulting ——— copulation ——— post copulatory embrace.

↓

Egg Extrusion - probably late fall, winter

↓

Eggs carried externally

↓

Hatch in Spring

↓

Zoea Larva - five larval stages; swim in surface water and are carried seaward.

↓

Megalops Larva

↓

Settles - first crab stage (adult characteristics)

↓

Carried Shoreward - by upstream drift

↓

By fall occurs with adult population - in sizes to 25mm and greater. In Kouchibouguac Bay, crabs less than 65mm occurred only on hard bottom; larger ones move to sand bottom.

↓

Several moults to reach mature adult stage

DATA

Lobster pots, baited with salted fish were set at locations shown in Figure 53 at various times during the period of July 16 to August 28. Data on numbers of crabs and lobsters caught are given in Table 31. A collection was also made by hand on August 19 from Little Gulley, and observations on occurrence of crabs were made during the course of the random points survey (above). Carapace width-frequency distributions are given in Figure 54, and a plot of weight on width in Figure 55. Of the crabs examined (Figure 55), four females (width 4.5, 5.1, 6.3, 6.7cm) and two males (3.5, 4.5cm) were in "new moult" condition.

COMMENTS

Crabs occur throughout the lagoon, but appear to be most abundant and are caught in greatest numbers in the channels. Presumably, the rhizome mat and shoots of Zostera limit the ability of the crab to run and burrow to escape predators.

COMMENTS (cont.)

Numbers caught at various locales (Table 31) are probably related to local abundance rather than to the period over which the trap was set. Direct observations showed that crabs are attracted to the baited traps within minutes of setting and most of those caught are in the traps within 20 minutes.

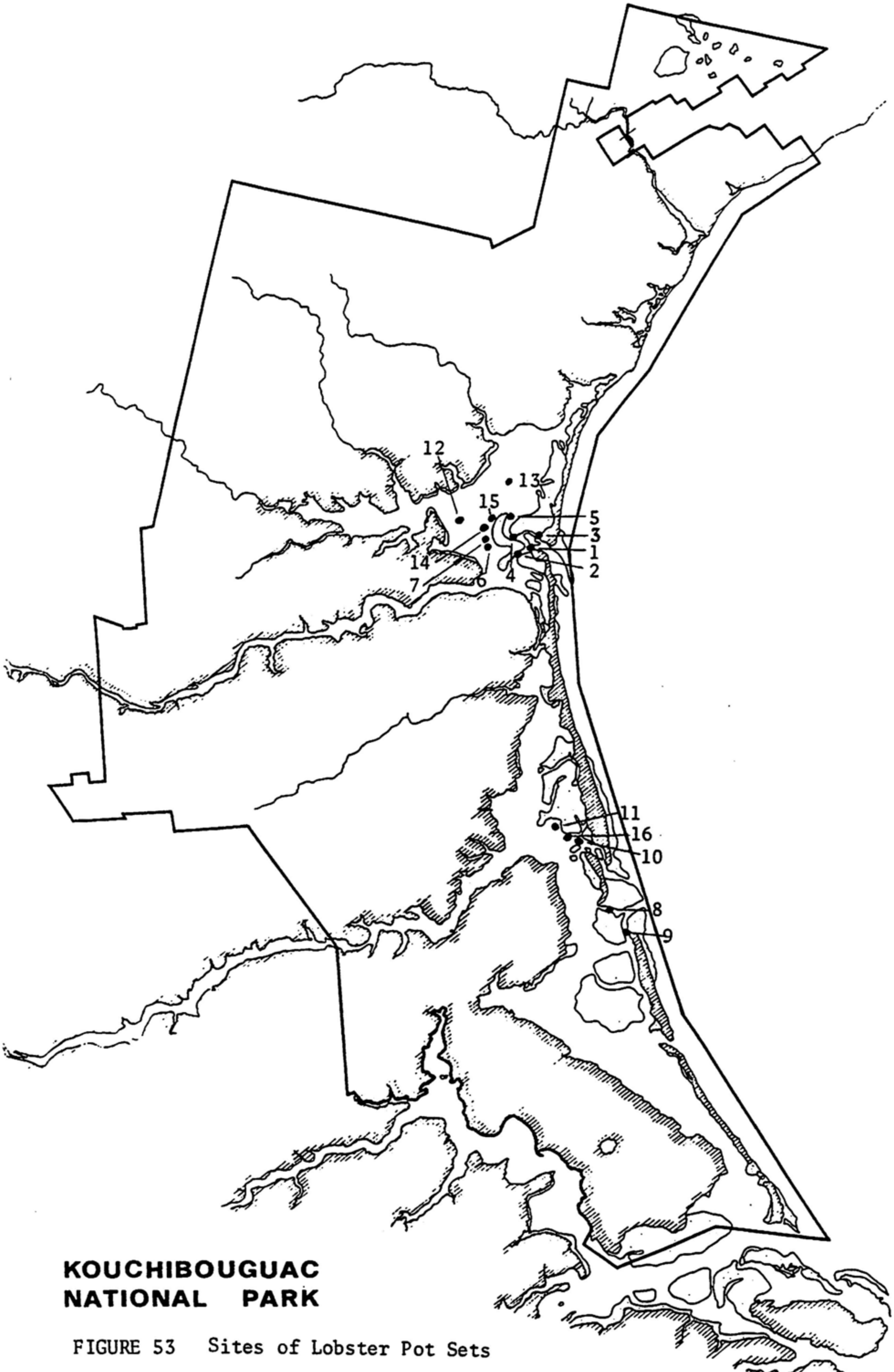
In agreement with Scarratt and Lowe (1972), maximum size for females was about 90 mm; and the maximum size observed for males, 118 mm (258 g) approached the maximum size found in Kouchibouguac Bay (many more examined). Sizes at maturity in the lagoon are thus probably similar to those for the Bay population. The smallest sizes cuaght in our lagoon samples (by hand) were over 30 mm. Scarratt and Lowe (1972) observed crabs under 20 mm in fall samples (end of September) but not in spring samples (June). It is not clear on the basis of the data we have when and how (as larvae or small crabs) the current cohort moves into (or are retained within) the lagoonal system.

Crabs of exploitable sizes (greater than about 85 mm) are probably of the order of 3 to 6 years of age. The lagoonal population may be recruited in large part from offspring of adult populations elsewhere (see discussion of "Recruitment in estuaries in section II A, and large fluctuations in abundance may occur as a result of varying hydrographic conditions outside of the lagoon system. Such fluctuations might occur at intervals of three or more years.

IMPLICATIONS FOR EXPLOITATION, MANAGEMENT

1. Crabs of exploitable sizes occur within the lagoon
2. The areas of fair abundance are relatively restricted (to the channels).
3. The status of the adult reproductive stock in the lagoon may not have much influence on recruitment.
4. Large fluctuations in abundance may occur as a result of normal variation in environmental conditions outside of the lagoon.

5. The crabs move rapidly toward bait, and a much simpler technique than the use of lobster traps could be used to fish the crabs.
6. If a minimum size limit of about 90 mm is set, then females would not be taken.



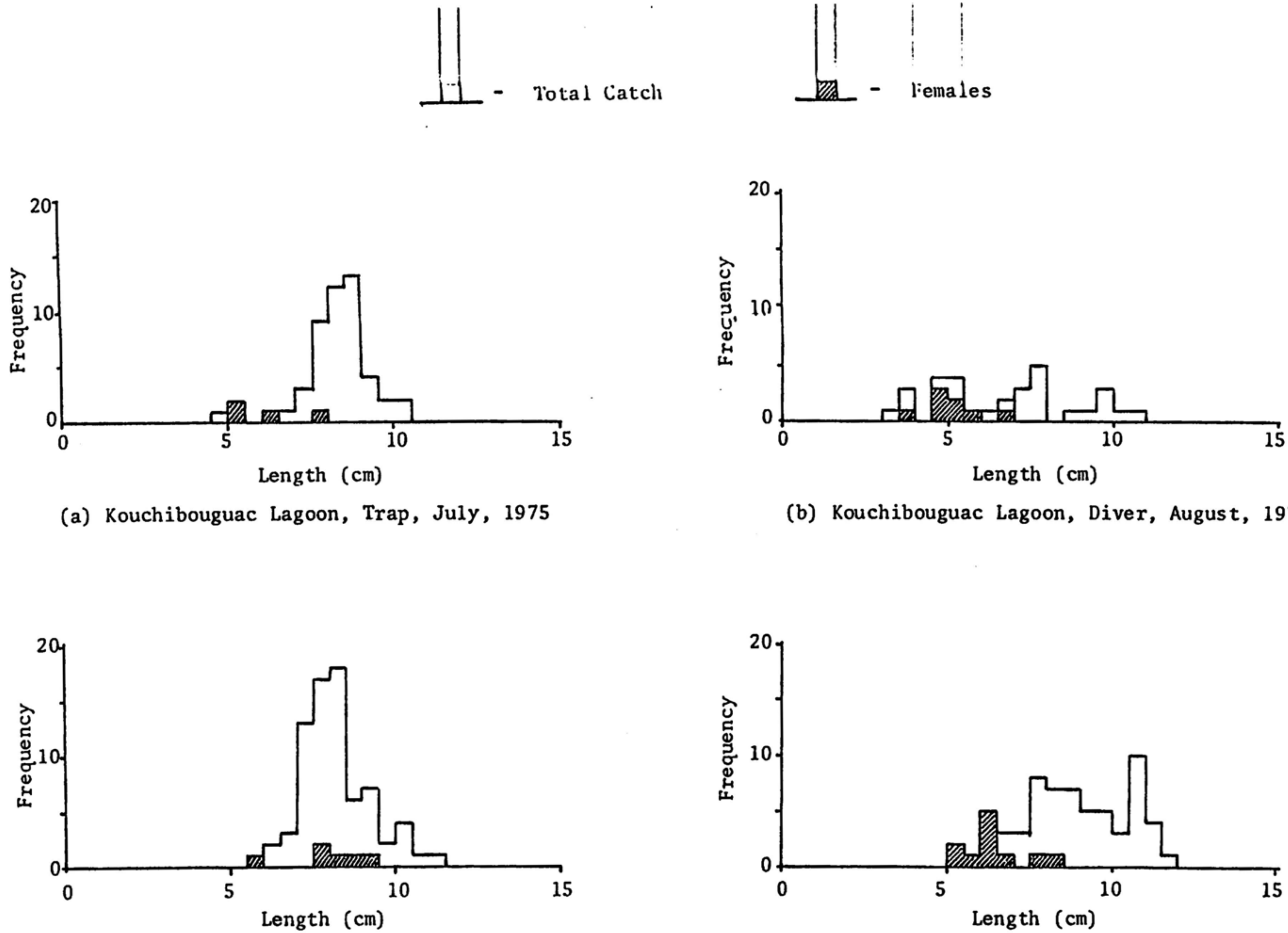
KOUCHIBOUGUAC NATIONAL PARK

FIGURE 53 Sites of Lobster Pot Sets

TABLE 31 Summary of Catches in Lobster Pots d = days; h = hours

Location	Time Left in	Date Picked up	No. Crabs	No. Lobsters
1	7d	July 16	46	
2	4d	20	3	
3	6d	Aug. 1	3	
4	5h	1	7	
5	4h	1	12	2
6	5h	7	1	
7	5h	7	4	3
8	4h	8	2	
9	4h	8	17	
10	9h	13	26	
11	8h	13	48	
12	7h	14	1	
13	6h	14	21	
14	5h	19	*	
15	5h	19	29	1
16	2d	28	16	3

*Catch combined with that of location 15



(a) Kouchibouguac Lagoon, Trap, July, 1975

(b) Kouchibouguac Lagoon, Diver, August, 1975

(c) Kouchibouguac Lagoon, Trap, August, 1975

(d) Kouchibouguacis Lagoon, Trap, August, 1975

FIGURE 54 Rock Crab Frequency-Length Distribution

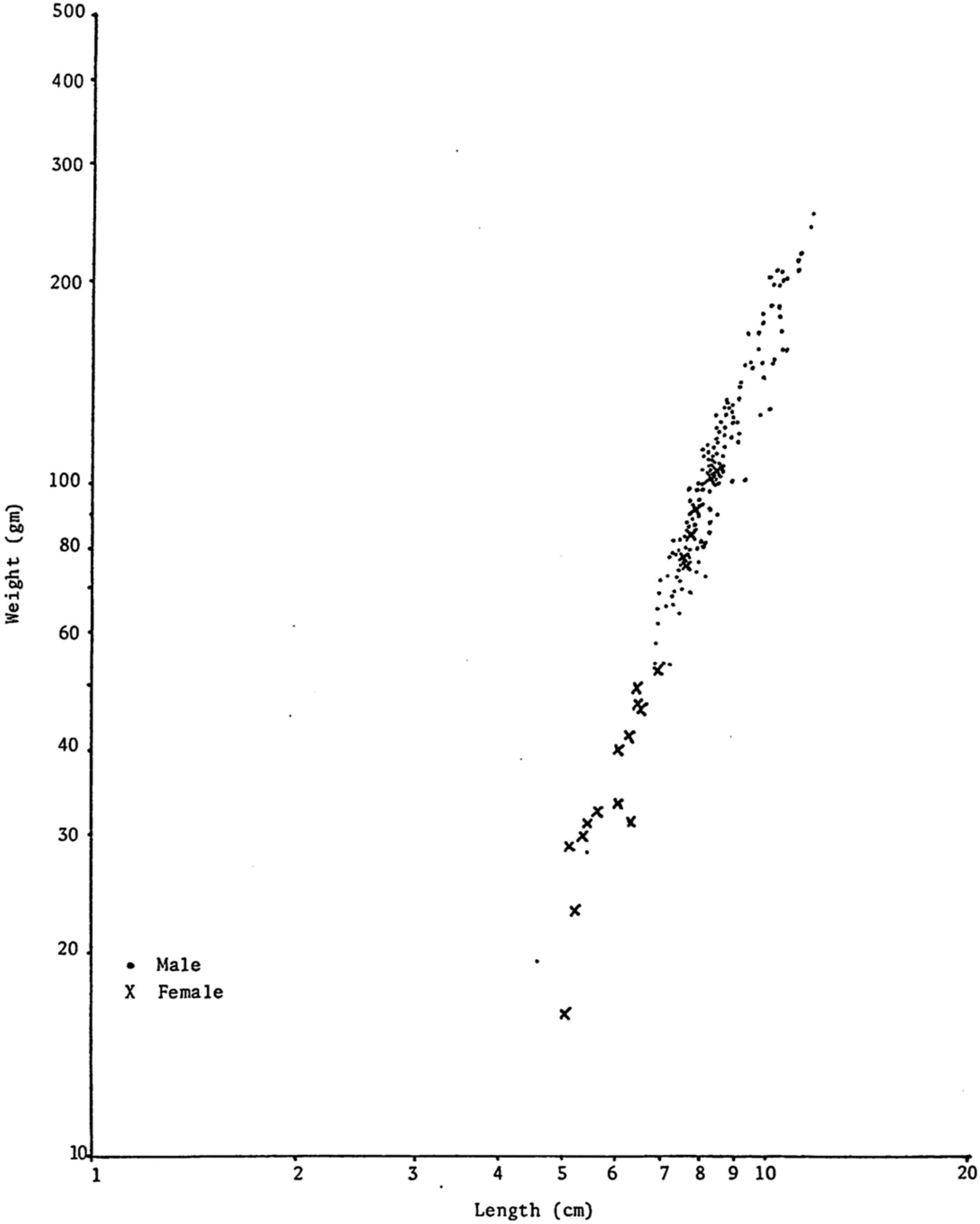


FIGURE 55 Weight-Length Regression of the Rock Crab

III 3(ii) b. Lobster

BACKGROUND

The economic significance of lobster is well known and hardly has to be commented upon here. Some characteristics of the adults and the life history is outlinedbelow (Sources, Rutherford et al, 1967; Scarratt, 1964).

ADULTS:

- most abundant on rocky bottom, low tide to about 25 ft.; offshore populations at 40-400 ft.
- density related to some extend to availability of shelters; require rocks to burrow under of sediment cohesive enough to allow burrowing. Artificially constructed shelters may increase the numbers
- carnivores, chiefly on sea urchins; limited scavenging
- only significant predator seems to be man
- natural mortality 10-15% or greater
- catchability greatest in late spring, summer, and early fall except immediately following moult
- legal size limit 2 1/2"; open season District 8 (Kouchibouguac Bay) is August 10 to October 10.
- Kouchibouguac Bay appears to serve as a nursery area for small lobsters which later move away to other grounds; the breeding stock here does not appear to be large (Scarratt, 1964)

LIFE HISTORY

Hatching
- mid June to end September, Northumberland Strait
- two weeks required for female to hatch complement of eggs

↓

Larvae
- free swimming, newly hatched about 1/3" in length
- swim close to surface in day, descend at night
- dispersed by currents
- moult 3 times first 1-2 months
- about 99% mortality

↓

Fourth Stage
- recognizable as lobster

↓

Sink to bottom
- at end of fourth stage

↓ ← predated on by small fish, crabs and lobsters

Pass winter in stage 6, 7, 8

↓

Year 2, moult 3 times

↓

Year 3, 4, 5
- moult 2 times or less annually
- older moult 1 time/year or 1 time/2 years
- grow about 50% each moult

↓

Maturity
- at about 7" total length (= 2.4" carapace length) Northumberland Strait; 5 years of age, 0.5 lbs. at 7 years of age, approx. 9 1/2" length, 1 lb.

↓

Mating
- within hours after female moulted, shell still soft
- sperm transferred to sperm sac of female

↓

Eggs laid
- early June to September
- fertilized as pass over sperm sac
- become cemented to swimmerets (underside of abdomen)
- 3000 to 75,000 eggs per female

↓

Eggs remain attached 1 year (→ returns to Hatching)

DATA

Catches of lobsters in pots are reported in Table 31 . We suspect there was some poaching of the pots. An additional collection of lobster was obtained by hand in the region of Little Gulley (13 individuals ranging in size from 3.4 to 6.6 cm carapace length). Length, weight, sex, and moulting condition of the combined catches are indicated in Figure 56.

COMMENTS

Lobsters of legal size occur within the Park, chiefly towards the seaward end of channels but also occasionally in channels further into the lagoon. Their limited distribution appears to be related to the limited availability of suitable stable bottom in which burrow. In the region of Little Gulley, much of the bottom is hard-packed clay, and lobsters were observed visually to be very abundant there, in burrows in the clay bottom. Further into the lagoon, the channel bottoms are soft rather than compacted and generally not suitable for lobsters. "Rock" crabs (Cancer irroratus) predominate in these areas.

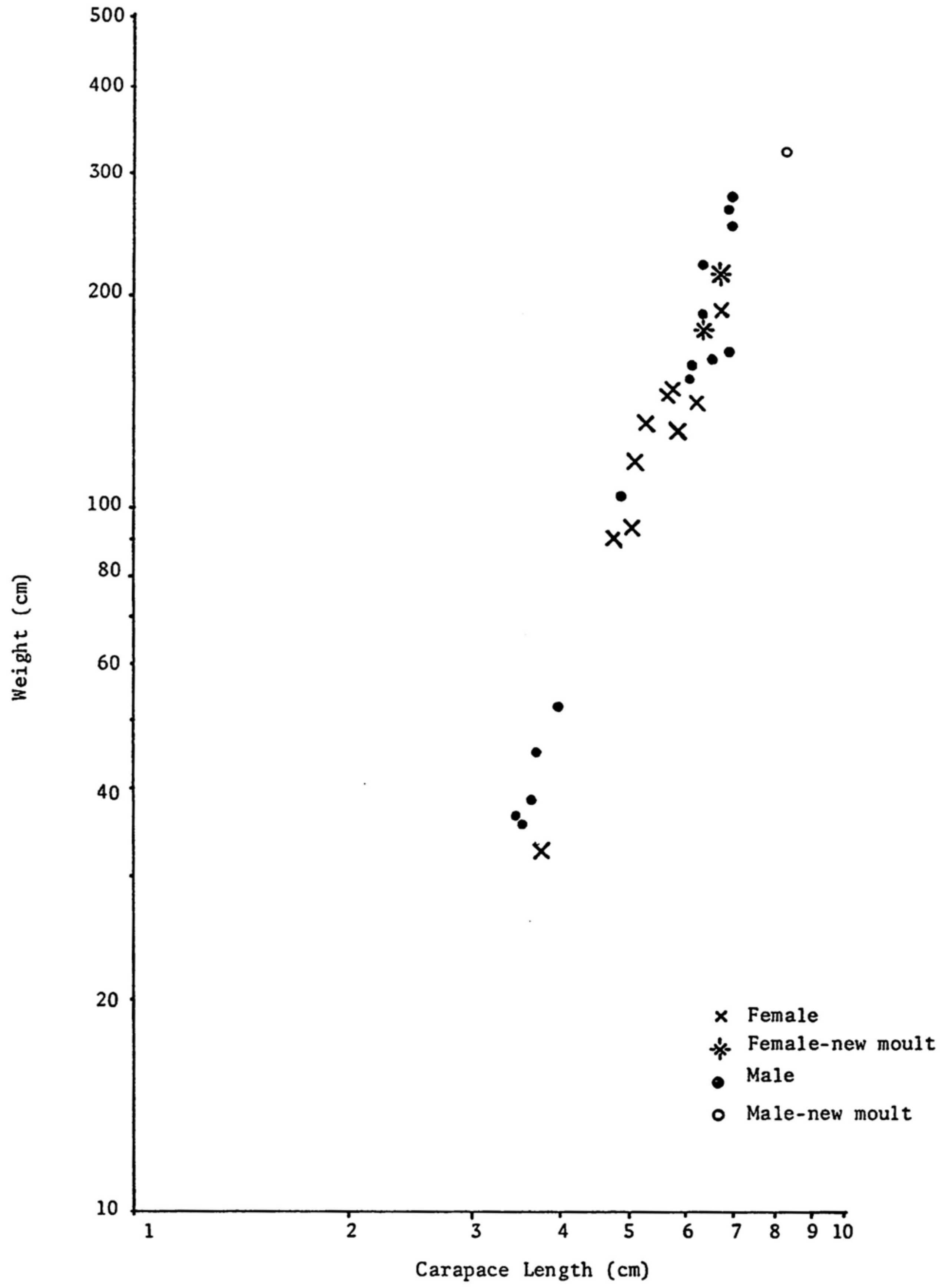


FIGURE 56 Weight-Length Regression for Lobster

III 3(iii) Exploitable Fish

GENERAL BACKGROUND (Sources: Douglas and Stroud, 1971; Leim and Scott, 1966; Saila and Pratt, 1973; McHugh, 1967; Merriman, 1941; McKenzie, 1959)

A large portion of the estuarine fish fauna or "nekton" (the "swimming animals") is composed of species highly prized both by sportsmen and commercial fishermen. These species and others utilize the estuary in a variety of ways, differing according to the portion of the estuary utilized, the time of year it is utilized, how it is utilized, the food eaten, and the stages of the life history at which it is utilized. Most species spend only a portion of their life history in the estuarine system. None of the highly prized species with the possible exception of striped bass are confined to the estuarine system throughout their life history, but they are highly dependent on that phase of their life history spent in the estuary. The most spectacular examples are the anadramous and catadramous which migrate between specific estuarine systems or specific streams and points in the sea up to thousands of miles away. At the other end of the spectrum are casual visitors to the estuary coming from both fresh water and the sea.

Physically, the most vital area of the estuary is that region in the vicinity of the head of the tide. Many species spawn here or pass en masse on their way to spawning grounds above the head of the tide, their young later to pass again through this region. It is in this area, through physical alteration, chemical pollution, and over-fishing, that man has been most destructive.

<u>The Striped Bass as an Example of an "Estuarine Dependent" Species:</u>

The life history of striped bass is frequently cited as a prime example of estuarine dependence. It is one of the great estuarine species of North America distributed from the Gulf of St. Lawrence to the Gulf of Mexico. Individuals as large as 125 pounds have been caught. Of the mid-Atlantic Bight fisheries in the United States, the striped bass fishing ranks third in importance after Atlantic menhaden and summer flounder; but before such fish as the white flounder, black sea bass, mackeral, swordfish and marlin. In the Gulf of St. Lawrence region, large quantities of striped bass were taken at one time, but now are of minor commercial significance. Bass was described as one of the principal fisheries in the Miramichi a hundred years ago when they were caught through the ice with dip nets where they apparently lie in a "half torpid state". Abundance of bass in the Miramichi declined rapidly, and commercial fishing for bass ceased about 25 years ago. Large bass there are more scarce but are taken by angling. The decline was attributed to over-fishing and destruction of young fry. Presumably, the population reached a critical low and may not now return its former abundance.

The life cycle of the striped bass is illustrated in Figure 57. In the spring it spawns near the head of the tide, although some may move further into rivers and some striped bass populations were adapted to fresh water. The semi-buoyant eggs (they neither sink nor rise rapidly in fresh water) concentrate near the bottom, a minimum water velocity of about 30 cm/sec being required to keep them in suspension; if they cling to the bottom, high mortality results from anoxia. Depending on the local conditions, the eggs may be entrained within the river by tidal oscillations or swept into brackish water before hatching which occurs within 2-3 days.

The newly hatched larvae, 2 1/2 mm long, are non-buoyant requiring water currents to keep them off the bottom. They drift downstream past the area of heaviest silt, living off their yolk sac with about 10 days after fertilization when they are about 6 mm length. A young post larvae must then find food or die. Given a suitable food supply (chironomid and leptocurid larvae, shrimp, and planktonic crustacea), the young fry will have assumed adult features within 3-4 weeks after fertilization at which time they are about 36 mm in length. After one year, they reach a length of about 130 mm. As the bass grows, its diet changes from insects, plankton, and small crustacea to include a mixture of large fish and invertebrates; particularly favored are sand shrimp (*Crangon septemspinosa*) and silversides (*Menidia menidia*). The juvenile bass remain in the estuary until two years of age (16-25 cm length) when they assume the habits of adults and migrate to sea. At sea, they generally remain within the region of river influence. Bass may make extensive non-spawning migrations outside of the estuary (details are obscure), but many may stay within the lower open parts of larger estuaries. They tend to avoid the inshore waters in midsummer but return during the fall.

Males are mature at 2-3 years of age, and females at 4-6 years of age. In Canadian waters, the bass may return to the estuaries in the fall and overwinter under the ice prior to spawning (hence, the method of fishing in the Mirimichi in historic times). Tagging information shows there is a tendency, but not an absolute one, to return to the river in which they were spawned.

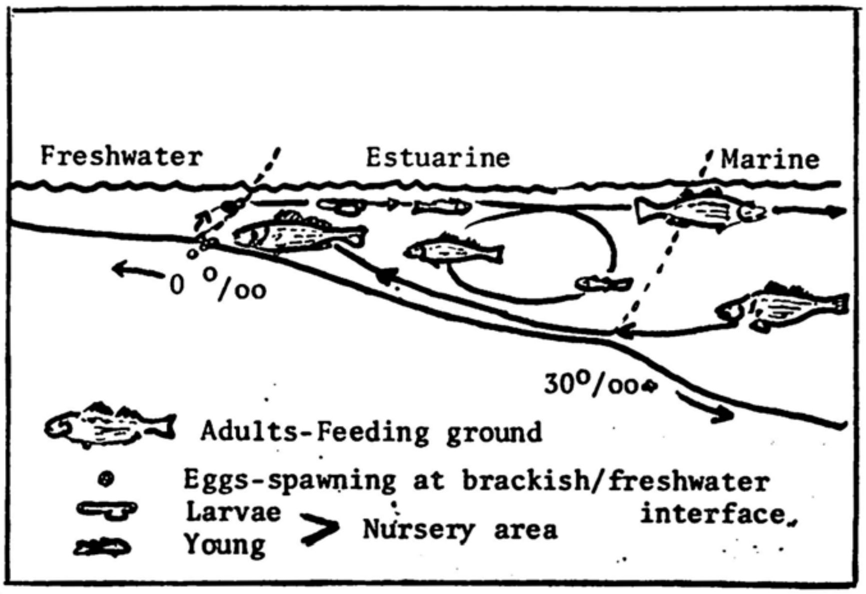


FIGURE 57 Striped bass life cycle

Larger bass are voracious feeders, fish being the predominant food. They do not exhibit preference for one prey over another, taking prey of appropriate size more or less in proportion to abundance. Thus, the composition of stomach contents varies considerably according to locality and season. Prey commonly include alewives, herring, smelt, eels, mummichogs, sand lance, hake, silversides, squid, crabs, polychaete worms and amphipods, and may even include such items as clams, mussels, and snails. Smaller bass may be eaten by other predacious fish such as cod, but mature fish have few natural enemies. They are attacked by internal and external parasites, but they appear to have little influence on their well being. By 4 years of age, the bass reach a length of about 45 cm and thereafter grow at about 7-8 cm/year up to 10 years. Growth rates vary considerably between populations and also between year classes within a population.

There are pronounced year class fluctuations in abundance of bass, and a critical factor appears to be the water flow; thus a correlation coefficient of 0.95 has been found between the number of bass surviving of mean length 1.5" and mean June-July outflow for one system (Chadwick, 1971). The basis of this relationship is not known with certainty - it might reflect suspension of the eggs and larvae, differences in food production, differences in time or site of spawning in relation to water flow. In any case, the relationship exemplifies the quantitative as well as qualitative dependence of this species on the nature of the estuarine system.

The striped bass represents an extreme case of estuarine dependence, being dependent on the estuary for most or all of its life history. The fishes of the estuary can be classified according to their life history in the estuary as follows; examples as they occur in Kouchibouguac are given.

(1) Fresh water fishes that occasionally enter brackish waters: These include for example, the brook trout and longnosed sucker. Trout may vary from not entering brackish water at all to adaptation of a semi-anadramous habit.

(2) Truly estuarine species: The striped bass might be put in this category or perhaps termed "semi-anadramous". Other than bass, there are no species in the Kouchibouguac system of sports or commercial significance that would fall in this category. Some stickleback species and *Fundulus* species (small fish) might be classified here, but all of these are capable of existance in marine or fresh water situations as well. As for other groups of organisms, the question of whether "truly estuarine species" exist is somewhat problematical. Many individuals of small fish do, however, spend their entire life histories in the estuary. Smooth flounder may also be in this category.

(3) Anadramous species: are those spawning in the estuary or above the head of the tide but returning to sea to feed (either as young or at later stages; e.g. salmon smolt). This category includes alewife, shad, salmon and smelt. Juveniles of alewife and shad may spend most of their first summer in the estuary, then depart and do not return until mature. Salmon remain in fresh water until ready to go to sea. Some populations of brook trout behave very much as anadramous or semi-anadramous species - at sea they do not go far from the river influence. Salmon and herring (alewife, shad) may migrate very far from the river. These species are well-known for their extraordinary (and poorly understood) abilities to return to their river of origin for spawning Tomcod should probably be classified as anadramous, but they are not dependent on estuaries for spawning.

(4) Catadramous species: This category includes only the American eel which spawns at sea and whose young are carried, largely passively, back to the coast and migrate upstream well above the head of the tide or remain within the estuary, returning to sea years later when they become mature.

(5) Marine species which pay regular seasonal visits to the estuary, usually as adults: We have not found examples for this system. Species such as cod, pollack, halibut, mackerel may fall in this category in larger (deeper) estuaries elsewhere.

(6) Marine species which use the estuary principally as a nursery ground: We have not found any examples of this type in the Kouchibouguac system. Anchovies and menhadden are examples elsewhere.

(7) Adventitious visitors from the sea: We have not found examples for this system.

In Figure 58, the occurrence and distribution of edible species we have encountered in the Kouchibouguac system diagramed based on our own observations or on information from the literature. Similarly, the seasonal occurrence of these fish is indicated in Figure 59. These schemes may have to be modified somewhat as we obtain further (seasonal) information on fish movements. Two points can be readily appreciated from these diagrams:

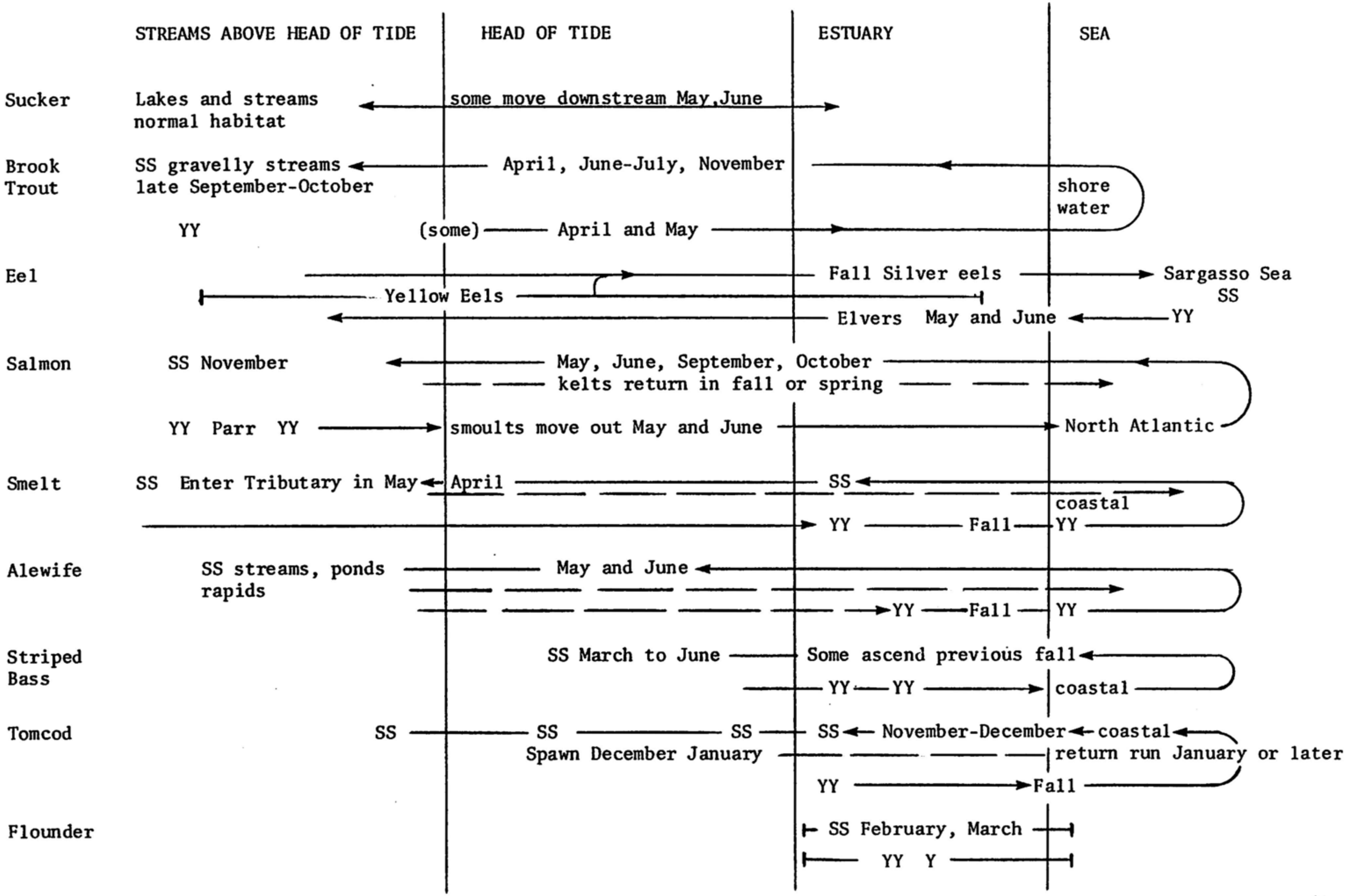


FIGURE 58 Occurrence of edible species in estuary (includes only species caught summer 1975 at Kouchibouguac)

YY = young
SS = spawning

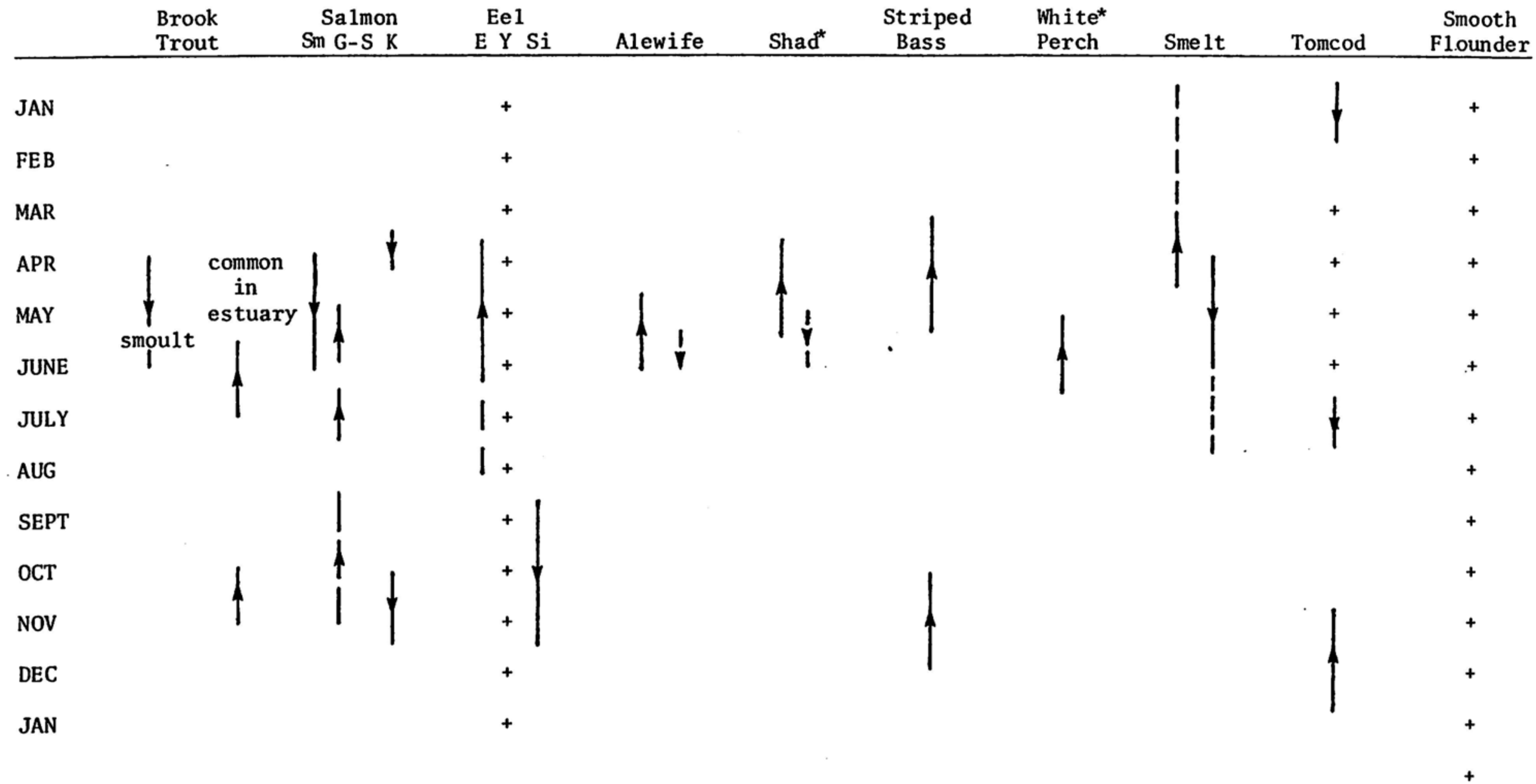


FIGURE 59 Seasonal occurrence of edible fishes in the estuary. Upstream and downstream means indicated.

Sm = Smolt; G-S = Grilse & Salmon; K = Kelts; Y = Yellow Eel; Si = Silver Eel, E = Elver

*We have not caught species with asterisk.

(1) most species spawn at or pass through the head of the tide region, and (2) movements (hence their "catchability") of many species occur in the period from April to June and to a somewhat lesser extent, in the fall. Both are periods of high run-off. The exact times of movement of this anadramous and semi-anadramous species may vary be several weeks year to year, signalled by appropriate water and weather (cloud cover) conditions. When they do move, they generally move in large numbers. The simultaneous movement of many species both simplifies and complicates management: regulations applied to one of the species will almost inevitably have some effect on other species.

FISHING, GENERAL DATA

The Objectives: Our objectives with respect to the edible fishes have been and are (the fishing program is a continuing one) primarily:
(1) to determine the seasonal movements;
(2) to determine the size distribution of the various species as an indication of the status of each population with respect to current exploitation of these species;
(3) to examine the current commercial (legal) fisheries in the Park in order to evaluate both their effects on the "desired" species and on other species caught incidentally to these.

We have not been concerned with determining spawning sites - this aspect is being studies by a Park contract to a C.W.S. group.

FIELD STUDIES (June to August, 1975)

Two local fishermen set a hoop-style eel trap in the Kouchibouguac River in the late spring. We were permitted to have complete access to three of the hauls from the trap, the first of which we subsampled.

Floating gill nets, 50' x 6' of 1 1/2", 2 1/2", 3 1/2", 5 1/2" and 6 1/2" mesh sizes were set in various locations around the lagoon system (see Figure 60). The nets were set out singly or in combinations of two or three anchored with concrete construction blocks. The nets were usually set one morning and then cleaned and raised the next morning.

On June 14, a fish trap with a 150' lead was set on the Kouchibouguac River upstream from Logiecroft Wharf (Figure 60); this was the location where the local fishermen had their eel trap which was removed the same day the trap was set. The trap was lifted after two weeks due to excessive loading by aquatic weeds (Zostera marina, Ruppia maritima, various algae). While in service, the trap was checked and cleaned every few days. The fish caught were identified, measured, and released if still alive.

Temperature, salinity, current, depth, and general weather data were taken for each catch.

Lengths (total or fork length) were determined for most fish caught. On whole catches or subsamples of catches, data was also taken on weight, sex, gonad condition (Table 32), stomach contents, and scales and/or otolith samples were taken. Specimens of the different species were preserved, a color preservative being incorporated with the formalin.

RESULTS, GENERAL, AND COMMENTS

Station descriptions are given in Table 33, except for current data which are included with other current data above. Numbers of individuals of the various species taken are given according to date and gear in Table 34, and a summary of fish catches according to species is given in Table 35. Data for individual fish are given in Appendix C. The last mentioned data are dealt with under species headings in the next section

In general, the occurrence of species through the summer was consistent with what might be expected (period June 6-August 27):

(1) Gaspereau (alewife) was the only species caught during a spawning run, this is June.

(2) Salmon smolt were caught in June.

(3) Only one salmon was caught, on June 9; this individual was "bright" (i.e., returning from sea)

(4) Smelt were caught only in early June.

(5) Occasional brook trout were caught through the period to July 30.

(6) Occasional suckers were caught through the period to June 30.

(7) Yellow eels were caught in early June (traps lifted mid-June; they were visually observed through the lagoon during the entire summer)

(8) Tomcod were caught through to August 7 (see also seine data, Table 19.

(9) Smooth flounder and striped bass were caught through the summer.

We were somewhat surprised that we did not catch more salmon. This might be associated with the unusually dry summer and hence higher temperature and lower freshwater content in the water leaving the lagoon (discouraging migration). To some extent, our results may be biased because of possible poaching of our nets by local residents. No shad, white perch or winter flounder were caught nor did we observe mackerel or capelin in the Park waters during the summer - these species have been reported as present in the system (section II B.).

The data from eel traps suggests these traps may take substantial numbers of small trout, salmon and bass; we require more information on this during May.

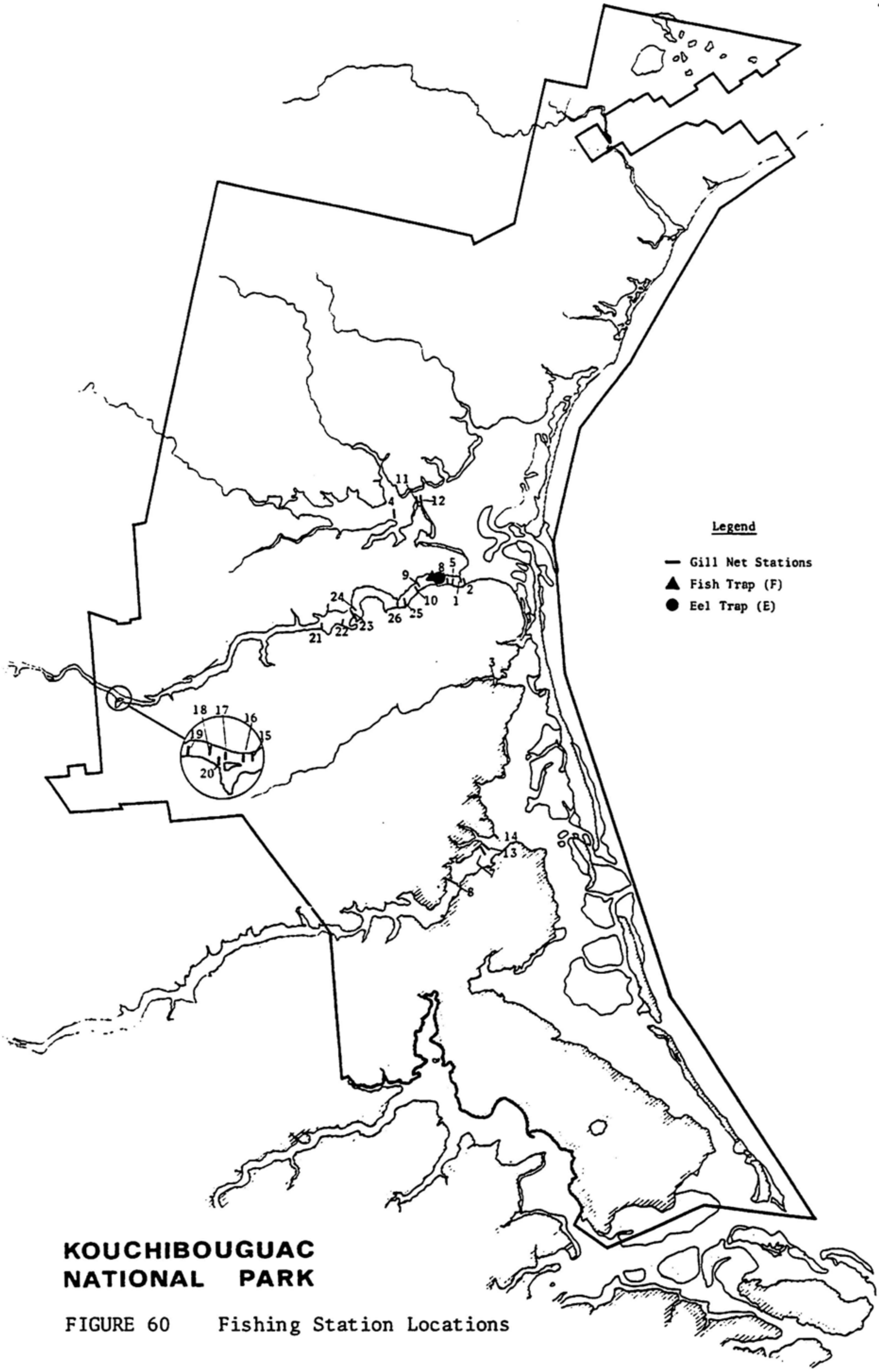


FIGURE 60 Fishing Station Locations

TABLE 32 CLASSIFICATION OF FISH MATURITY
(Nikolsky, 1963)

I. Immature

Young individuals which have not yet engaged in reproduction; gonads of very small size.

II. Resting Stage

Sexual products have not yet begun to develop; gonads of very small size; eggs not distinguishable to the naked eye.

III. Maturation

Eggs distinguishable to the naked eye; a very rapid increase in weight to the gonad is in progress; testes change from transparent to a pale rose color.

IV. Maturity

Sexual products ripe; gonads have achieved their maximum weight, but the sexual products are still not extruded when light pressure is applied.

V. Reproduction

Sexual products are extruded in response to very light pressure on the belly; weight of the gonads decreases repidly from the start of spawning to its completion.

VI. Spent Condition

The sexual products have been discharged; genital aperture inflamed; gonads have the appearance of deflated sacs, the ovaries usually containing a few left-over eggs, and the testes some residual sperm.

II. Resting Stage

Sexual products have been discharged; inflammation around the genital aperture has subsided; gonads of very small size, eggs not distinguishable to the naked eye.

TABLE 33 SUMMARY OF FISH CATCHES - STATION DESCRIPTION

Date	Stn No.	Inner Depth	Outer Depth	Surface T	Surface S	Bottom T	Bottom S	Description
5/6/75	1	230cm	110cm	21.4°C				Sky: partly cloudy Winds: northeast approximately 10 mph Vegetation: Zostera near outer end
28/7/75	1	15cm	60cm	18.5°C	26.870	18.25°C	27.241	Sky: overcast, heavy rain Winds: northeast 4 mph Bottom: sandy with patches of Zostera dense Zostera 7 m beyond reach of Seine
6/6/75	2	>220cm	110cm	18.6°C	21.620	18.2°C		Sky: cloudy Vegetation: inner - Zostera, mussel beds, Fucoid middle- bare, old oyster beds, mussel beds
9/6/75	2	130cm	150cm					Sky: clear Winds: strong east northeast Vegetation: Zostera Bottom: mud
12/6/75	2	110cm	145cm	8.0°C	6.408	6.0°C	21.196	Sky: clear Winds: fair easterly Vegetation: Zostera Bottom: mud
6/6/75	3	50cm	50cm	13.8°C				Sky: cloudy, raining Vegetation: Zostera, Ruppia Bottom: soft mud
28/7/75	3	20cm	60cm	16.5°C	26.738	16.5°C	26.808	Sky: overcast, medium rain Winds: northeast 5 mph Bottom: sand to 50 m from shore; Zostera beyond 50 m

Date	Stn No.	Inner Depth	Outer Depth	Surface T	Surface S	Bottom T	Bottom S	Description
9/6/75	4	80cm	>240cm	7.5°C				Sky: cloudy Winds: strong, east northeast Vegetation: Zostera Bottom: mud
25/8/75	4		80cm		28.133			Sky: cumulus clouds Winds: west 3 mph Bottom: mud flats and hard sand
17/6/75	5	100cm	256cm	14.5°C	5.623		12.495	Sky: mostly clear Winds: 4 - 7 mph northwest Vegetation: Zostera plentiful Bottom: mud
25/8/75	5		60cm		28.011			Sky: cumulus clouds Winds: west 3 mph Bottom: sand, very patchy Zostera
17/6/75	6	90cm	110cm	14.5°C	6.866	10.0°C	12.872	Sky: mostly clear Winds: northwest 4 mph Vegetation: Zostera (plentiful) Bottom: muddy
25/8/75	6		85cm		27.129			Sky: cumulostratus Winds: southeast 3 mph Bottom: sandy, rocky Vegetation: patchy Zostera - Epi gracelaria
19/6/75	7	50cm	155cm	12.5°C	15.966	12.0°C	17.265	Sky: sunny Winds: west northwest 19-24 mph Vegetation: Zostera (patches) Bottom: partially muddy (approx. 4-6") with firm sandy substrate
26/8/75	7		75cm		24.732			Sky: clear, some cumulus clouds Vegetation: sparse Zostera Bottom: sandy

Date	Stn No.	Inner Depth	Outer Depth	Surface T	Surface S	Bottom T	Bottom S	Description
19/6/75	8	55cm	180cm	14.5°C	14.858	11.5°C	18.143	Sky: sunny Winds: west northwest 19-24 mph Vegetation: Zostera (patches) Bottom: partially muddy (approx. 4-6") with firm sandy substrate
27/8/75	8		45cm		27.009			Sky: overcast, cumulus nimbus Winds: west 3 mph Bottom: sandy (prob exposed low tide)
23/6/75	9	120cm	280 to 300cm	13.0°C	13.106	10.0°C	25.072	Sky: partly cloudy Winds: 0-1 mph Vegetation: Zostera (plentiful)
27/8/75	9		50cm		27.122			Sky: overcast, cumulus nimbus Wind: west 3 mph Bottom: sandy (prob exposed low tide) Zostera 50+m beyond outer end
23/6/75	10	110cm	210cm	13.5°C		12.5°C		Sky: partly cloudy Winds: 0-1 mph Vegetation: Zostera (plentiful) Bottom: muddy
27/8/75	10		85cm		19.757			Sky: mainly clear, cumulus clouds Winds: west 2 mph Bottom: sandy to 60 m from shore; Zostera beyond. Seine 20-25 ft. into Zostera
23/6/75	11	70cm	170cm	17.0°C	17.668	16.5°C	18.981	Sky: partly cloudy Winds: 0-1 mph Vegetation: Zostera Bottom: muddy

Date	Stn No.	Inner Depth	Outer Depth	Surface T	Surface S	Bottom T	Bottom S	Description
23/6/75	12	80cm	190cm	16.5°C	18.323	16.0°C	19.008	Sky: partly cloudy Winds: 0-1 mph Vegetation: Zostera Bottom: muddy
26/6/65	13	100cm	60cm	15.0°C		14.0°C		Sky: clear Winds: 1-5 mph Vegetation: Zostera Bottom: Mud/sand substrate
26/6/75	14	100cm	110cm	15.0°C		14.0°C		Sky: clear Winds: 1-5 mph Vegetation: Zostera (patchy) Bottom: hard sand
3/7/75	15	120cm	130cm	19.0°C		19.0°C	12.673	Sky: overcast, drizzle Winds: 0-1 mph Vegetation: Nil Bottom: sandy, hard
4/7/75	15	110cm	124cm	18.75°C		19.0°C	9.790	Sky: clear Winds: 1-3 mph Vegetation: Nil Bottom: sandy, hard
5/7/75	15	120cm	130cm	19.0°C		19.0°C		Sky: nimbostratus Winds: southwest 3-5 mph Vegetation: Nil Bottom: sandy, hard
9/7/75	15	80cm	96cm	24.0°C		23.5°C	15.140	Sky: clear Winds: west Vegetation: Nil Bottom: hard sand

Date	Stn No.	Inner Depth	Outer Depth	Surface T	Surface S	Bottom T	Bottom S	Description
10/7/75	15	150cm	160cm	22.0°C	23.325	21.5°C	25.027	Sky: overcast, nimbostratus clouds Winds: southwest 4-7 mph Vegetation: Nil Bottom: hard sand
30/7/75	15	74cm	105cm	19.5°C		19.5°C		Sky: occasional cumulus clouds Winds: west 8-12 mph Vegetation: Nil Bottom: hard sand
3/7/75	16	80cm	120cm	19.5°C		19.0°C		Sky: overcast, raining Winds: west 8-12 mph Vegetation: Nil Bottom: sandy, hard
4/7/75	16	70cm	110cm	19.0°C		19.0°C		Sky: clear Winds: 1-3 mph Vegetation: Nil Bottom: sandy, hard
5/7/75	16	72cm	104cm	19.0°C		19.0°C	13.208	Sky: nimbostratus clouds Winds: southwest 3-5 mph Vegetation: Nil Bottom: sandy, hard
9/7/75	16	140cm	100cm	24.5°C		23.5°C		Sky: clear Winds: west 1-3 mph Vegetation: Nil Bottom: hard sand
10/7/75	16	168cm	150cm	22.0°C		21.5°C	18.820	Sky: overcast, nimbostratus clouds Winds: southwest 4-7 mph Vegetation: Nil Bottom: hard sand
30/7/75	16	141cm	110cm	19.5°C		19.5°C	9.810	Sky: occasional cumulus clouds Winds: west 8-12 mph Vegetation: Nil Bottom: hard sand
13/7/75	16		112cm	20.5°C		20.0°C		Sky: mainly clear, cirrus on west horizon Winds: west 4-7 mph Vegetation: Nil

Date	Stn No.	Inner Depth	Outer Depth	Surface T	Surface S	Bottom T	Bottom S	Description
9/7/75	17	70cm	100cm	24.75°C		24.0°C		Sky: clear Winds: west 1-3 mph Vegetation: Nil Bottom: hard sand
10/7/75	17	114cm	140cm	21.5°C		21.5°C	21.202	Sky: overcast, nimbostratus clouds Winds: southwest 4-7 mph Vegetation: Nil Bottom: hard sand
		120cm		21.5°C		22.5°C	14.910	102300 Ebb Tide
		110cm		21.0°C		22.0°C	5.517	110030 Ebb Tide
		106cm		20.5°C		21.0°C	12.318	110200 Slack Water
		115cm		21.5°C	3.524	22.0°C	16.326	110330 Flood Tide, drizzle
		150cm		21.25°C	5.365	22.25°C	16.892	110530 Flood Tide, drizzle
		175cm		21.0°C		22.0°C		110730 Flood Tide
16/7/75	17	82cm	86cm	22.0°C	3.159	20.5°C	16.830	Sky: partly overcast, cirrus clouds Winds: west 8-12 mph Vegetation: Nil Bottom: hard sand
16/7/75	18	82cm	124cm	21.25°C	3.816	20.50°C	23.053	Sky: partly overcast, cirrus clouds Winds: west 8-12 mph Vegetation: Nil Bottom: hard sand
16/7/75	19	60cm	64cm	21.75°C	3.837	21.50°C	16.728	Sky: partly overcast, cirrus clouds Winds: west 8-12 mph Vegetation: Nil Bottom: hard sand
30/7/75	20	80cm	92cm	19.5°C		19.5°C		Sky: occasional cumulus clouds Winds: west 8-12 mph Vegetation: Nil Bottom: hard sand

Date	Stn No.	Inner Depth	Outer Depth	Surface T	Surface S	Bottom T	Bottom S	Description
6/8/75	21	78cm	174cm	21.5°C		21.25°C	16.154	061225 Sky: overcast, nimbostratus clouds Winds: northeast 1-3 mph Vegetation: Ruppia and Zostera (inner end) Nil (outer end) Bottom: muddy
	21	100cm	154cm	21.25°C		20.5°C		071040 Sky: cumulus clouds and clearing Wind: north 4-7 mph
6/8/75	22	141cm	400cm	21.5°C		20.5°C	21.506	061310 Sky: overcast, nimbostratus clouds Winds: northeast 1-3 mph Vegetation: Ruppia and Zostera (inner end) Nill (outer end) Bottom: muddy
	22	200cm	500cm	21.50°C		20.0°C	22.863	071100 Sky: cumulus, occasionally sunny Winds: north 2 mph Current: 0
6/8/75	23	84cm	104cm	21.75°C		21.50°C	10.152	061300 Sky: overcast, nimbrostratus clouds Winds: northeast 1-3 mph Vegetation: Ruppia and Zostera throughout site Bottom: muddy
		112cm	175cm	21.25°C		20.5°C	21.878	071120 Sky: cumulus, clearing Wind: north 4-7 mph
27/8/75	23	100cm	96cm	20.0°C	14.963	20.0°C	15.519	Sky: overcast, nimbostratus, cumulonimbus, raining Winds: west 4-7 mph Vegetation: Zostera and Ruppia (inner end) Zostera (outer end by channel) Bottom: muddy, both ends

Date	Stn No.	Inner Depth	Outer Depth	Surface		Bottom		Description
				T	S	T	S	
11/8/75	24	132cm	400cm	23.75°C		22.0°C	14.154	111130 Sky: clear Winds: calm Vegetation: Ruppia and Zostera (inner end) Unknown (outer end) Bottom: muddy sand fairly firm (inner end) muddy (outer end)
		120cm	3.5m	23.25°C	16.268	22.0°C	24.473	121010 Sky: overcast, altostratus clouds Winds: calm
27/8/75	24	102cm	16ft.	20.0°C	15.266	18.5°C	25.261	Sky: overcast, nimbostratus, cumulonimbus, raining Winds: west 4-7 mph Vegetation: Zostera and Ruppia (inner end) Bottom: muddy, both ends
11/8/75	25	100cm	6.5m	24.0°C		20.5°C	111230	111230 Sky: clear Winds: calm Vegetation: Zostera (inner end) Bottom: muddy sand (inner end) unknown (outer end)
		90cm	5.5m	23.75°C	19.996	21.5°C	24.089	121030 Sky: overcast, altostratus clouds Winds: calm
11/8/75	26	96cm	6.5m	24.25°C		20.5°C	25.948	111250 Sky: clear Winds: calm Vegetation: Zostera (inner end) Bottom: sandy, firm (inner end) unknown (outer end)

Date	Stn No.	Inner Depth	Outer Depth	Surface T	Surface S	Bottom T	Bottom S	Description
		88cm	4.5m					121040
27/8/75	26	3.5ft.	23.5ft.	19.5°C	16.223	18.75°C	25.833	Sky: overcast, nimbostratus, cumulonimbus, raining Winds: west 4-7 mph Vegetation: Zostera and Ruppia (inner end) Bottom: sandy gravel (inner end) unknown (outer end)
6/8/75				23.0°C		23.5°C	21.602	
2/7/75		9cm	35cm	23.0°C	23.451	23.0°C	23.794	Sky: sunny Bottom: Zostera patches
8/7/75		15cm	70cm	26.5°C		26.5°C		Sky: sunny Bottom: hard sand near shore Vegetation: Increasing Zostera, soft mud off-shore

TABLE 34 SUMMARY OF FISH CATCHES - BY DATE AND GEAR

Date	Location	Set	Recovered	Gear	Catches
5/6/75	1	051445	060820	1½",2½", 5½" GN	36 Tomcod 6 Smelt 5 Smooth Flounder 1 Striped Bas 2½" 18 Gaspereaux 1 Smelt 5½" 4 Gaspereaux 1 Smooth Flounder hand 1 Mummichog
6/6/75	3	061945	070900	3¼"GN	3¼" 21 Gaspereaux
6/6/75	2	061215	071000	1½",2½", 5½" GN	1½" 1 Smelt 2½" 29 Gaspereaux
9/6/75	2	091310	101030	1½",2½", 5½" GN	16 Gaspereaux 1 Smooth Flounder 1 Atlantic Salmon
9/6/75	4	091145	101130	3¼",6½"GN	9 Gaspereaux 2 Smelt 1 Tomcod
9/6/75	1		091825	FT	Random sample 1/10 catch 56 Tomcod 49 Flounder 11 American Smelt 9 Smolt Salmon 6 Sticklebacks 2 Striped Bass 1 American Eel 1 Sculpin 1 Lamprey Eel
10/6/75				ET	267 Tomcod 193 Smooth Flounder 188 Sticklebacks 80 American Smelt 9 Mummichog 7 Bass 6 Salmon Smolt 5 American Eels 3 Silversides

Date	Location	Set	Recovered	Gear	Catches
10/6/75			101905	ET	129 Tomcod 105 Sticklebacks 62 Smooth Flounder 51 American Smelt 32 Mummichog 17 American Eels 4 Striped Bass 2 Silversides 2 Brook Trout
12/6/75	2	121210	130950	3¼",6½"GN	4 Gaspereaux 1 Brook Trout
14/6/75				FT	15 Flounder 15 Gaspereaux 6 Eels 3 Striped Bass
15/6/75			151030	FT	8 Flounder 3 Mummichog 2 Tomcod
16/6/75				FT	4 Flounder 4 Sticklebacks 4 Tomcod 3 Mummichog 1 Gaspereaux
17/6/75	5	171635	181020	6½",3¼"GN	3¼" 2 Gaspereaux 1 Mummichog
17/6/75				FT	6 Sticklebacks 5 Mummichog 4 Flounder 2 Tomcod 1 American Smelt 1 Striped Bass
17/6/75	6	171645	181045	1½" GN	
18/6/75					1 Mummichog 1 Stickleback

Date	Location	Set	Recovered	Gear	Catches
19/6/75	7	191120	201320	2½",5½"GN	13 Gaspereaux
19/6/75	8	191050	201345	3¼",6½"GN	4 Flounder
19/6/75				FT	7 Sticklebacks 5 Flounder 3 Mummichog 1 Tomcod
23/6/75	11	231500	241030	1½",2½", 3¼" GN	1½" 1 Tomcod 2½" 2 Gaspereaux 3¼" 4 Gaspereaux
23/6/75	12	231545	241100	5½",6½"GN	
23/6/75	9	231140	241145	2½",3¼"GN	1 Smooth Flounder
23/6/75	10	231200	241205	5½",6½"GN	
23/6/75				FT	4 Flounder 4 Sticklebacks 1 Mummichog 1 Smelt
25/6/75				FT	5 Smooth Flounder 1 Tomcod
26/6/75	14	261140	270945	3¼",6½"GN	
26/6/75	13	261225	271010	2½",5½"GN	1 Smooth Flounder
26/6/75				FT	2 Smooth Flounder
3/7/75	16	031140	041040	1½",2½"GN	2½" 36 Gaspereaux 3 Brook Trout 2 Suckers 1 Striped Bass
3/7/75	15	031150	041050	5½"GN	

Date	Location	Set	Recovered	Gear	Catches	
4/7/75	16	041045	051030	1½",2½"GN	2½"	11 Gaspereaux 5 Suckers 2 Brook Trout 1 Flounder
4/7/75	15	041055	051040	5½"GN		
5/7/75	16	051030	071005	1½",2½"GN	2½"	5 Gaspereaux 2 Brook Trout 1 Sucker
5/7/75	15	051040	071035	5½"GN		
9/7/75	15	091320	100925	2½",3¼"GN		
9/7/75	16	091330	100930	5½"GN		
9/7/75	17	091400	100945	2½",3¼"GN		
10/7/75	15	100925	110630	2½"GN		3 Gaspereaux 2 Suckers
10/7/75	16	100930	110645	5½"GN		
10/7/75	17	100950	110700	2½",3¼"GN	2½"	5 Suckers
16/7/75	17	161120	170940	2½",3¼"GN		1 Gaspereaux large number of jelly-fish
16/7/75	18	161130	170955	5½"GN		large number of jelly-fish
16/7/75	19	16110	171010	2½",3¼"GN		1 Gaspereau(half eaten) large number of jelly-fish
30/7/75	20	301130	310955	2½",3¼"GN	 3¼"	14 Suckers 1 Gaspereau

Date	Location	Set	Recovered	Gear	Catches
30/7/75	16	301140	311015	5½"GN	
30/7/75	15	301200	311030	2½",3¼"GN	20 Suckers 3¼" 1 Brook Trout
31/7/75	16				
6/8/75	21	061225	071040	2½",3¼"GN	1 Striped Bass
6/8/75	22	061310	071100	5½"GN	
6/8/75	23	061300	071120	2½"GN	5 Smooth Flounder 1 Striped Bass
11/8/75	24	111130	121010	2½",3¼"GN	2½" 1 Smooth Flounder 3¼" 6 Striped Bass 1 Smooth Flounder
11/8/75	25	111230	121030	2½",3¼"GN	
11/8/75	26	111250	121030	2½",3¼"GN	
27/8/75	26	271015	280940	5½",6½"GN	
27/8/75	24	271015	281015	2½",3¼"GN	3¼" 1 Striped Bass
27/8/75	23	271100	280955	1½"GN	

TABLE 35 Summary of Fish Catches - By Species

	P	L/W	Eel* Trap	Fish Trap	Beach* Seine	Gill Net								Misc.	Total
						2½	2½/3½	3½	5½	1½	6½/3½	1½/2½/5½	2½/5½		
Striped Bass	16	x	14	1		8	2	12		1					38
American Eel		x	29												29
Flounder	1	x	332	33	12	2	7	1	1		3	1	2		394
Gaspereau	132	x	15			88	8	25	2		12	45		1 MT	196
Killifish	3	x			28									3 MT	31
Lamprey Eel			1												1
Mummichog	100	x	41	17	878			1						MT 45,1 H	983
Salmon	1											1			1
Salmon Smolt		x	16												16
American Sand Lances														36 H	36
Sculpin			1												1
Silversides	7	x	5		145									MT 5	155
Smelt	2	x	150	2		1					2	1			156
Sticklebacks - 3	2	x			111										111
- 4	1	x			145									MT 4	149
- 9		x			5									MT 1	6
-81		x			71										71
			300	22											322
Suckers	9	x				15	34								49
Tomcod	56		484	10	5		1			9	1			MT 1	510
Brook Trout	4	x	2			8		2		1	1				14

*These totals are for actual fish handled; some of these samples were sub-samples of collections taken

MT = minnow trap
H = hand

III 3(iii)a Alewife (Alosa pseudoharengus)

BACKGROUND (Sources: Leim and Scott, 1966; McKenzie, 1959; Saila and Pratt, 1973)

The alewife in Gaspereau is an anadramous herring occurring on the Atlantic coast of North America from Newfoundland to South Carolina. It appears to school throughout its life history and is caught in large quantities. It is caught in weirs, gill nets, and by dipping in rapids in streams and rivers. Commerical landings of 'herrings' frequently include the alewife as well as sea herrings (Clupea harengus).

LIFE HISTORY

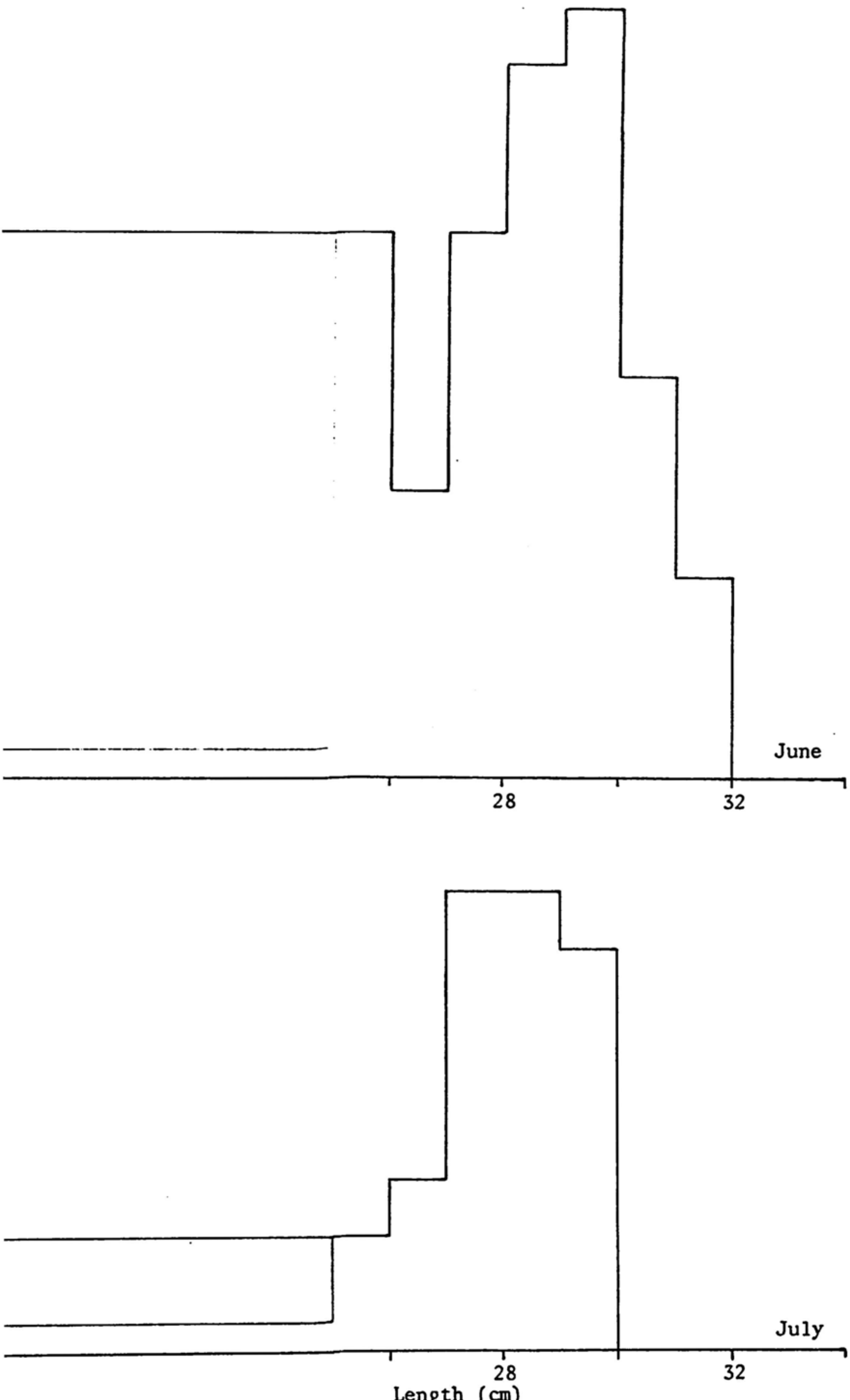
Stage/Activity	Comments
Spawners ascend river May and June	- some evidence adults return to stream of birth; clear sunny days encourage movement; negotiate fishways and rapids easily but do not jump over obstructions; do not eat while on spawning run. 5-year male 18 cm length 5-year female 20 cm length
Spawning Site	above influence of tide; generally described as being in sluggish streams or ponds but in the Miramichi; eggs are found on rapids
Spawning	- When temperatures between 48° and 54° F, eggs broadcast over bottom, temporarily adhesive sticking to detritus, sticks, stones, etc. 60,000 to 100,000 eggs per female. - Adults return to sea; out by August; school on return run
Hatch	- at about 6 days (60° F); fry 5 mm length
Juveniles migrate to sea	- all out by September - Eels, perch and other predators (?)eat fry - Fry to about 5 cm length by August; move day and night
Sea Life	- Little known of this place - Feed on plankton - Remain until sexually mature at 3-4 years of age - May spawn more than once

(Adults: from Spawning back to Sea Life)

DATA AND COMMENTS

Length distributions of alewife caught in June and July are given in Figure 61, and weight-length data are plotted in Figure 62. Data for individual fish are given in Appendix C. Other data are given as described in the general data section above. Fish caught up to June 24, 1975, were in "ripe" condition. Most fish caught in early July were in stage V (reproduction - sexual products extruded in response to light pressure) or spent condition (i.e., returning to sea). Fish were caught mainly in 2 1/2" mesh nets. Stomachs were empty or contained white or green "mush", presumably digested plankton taken at sea.

Our general impression is that these fish are reasonably abundant in the Park system during the month of June. Some alewife are taken in eel traps (Table 35).



...u Frequency-Length Distribution
June-July, 1975

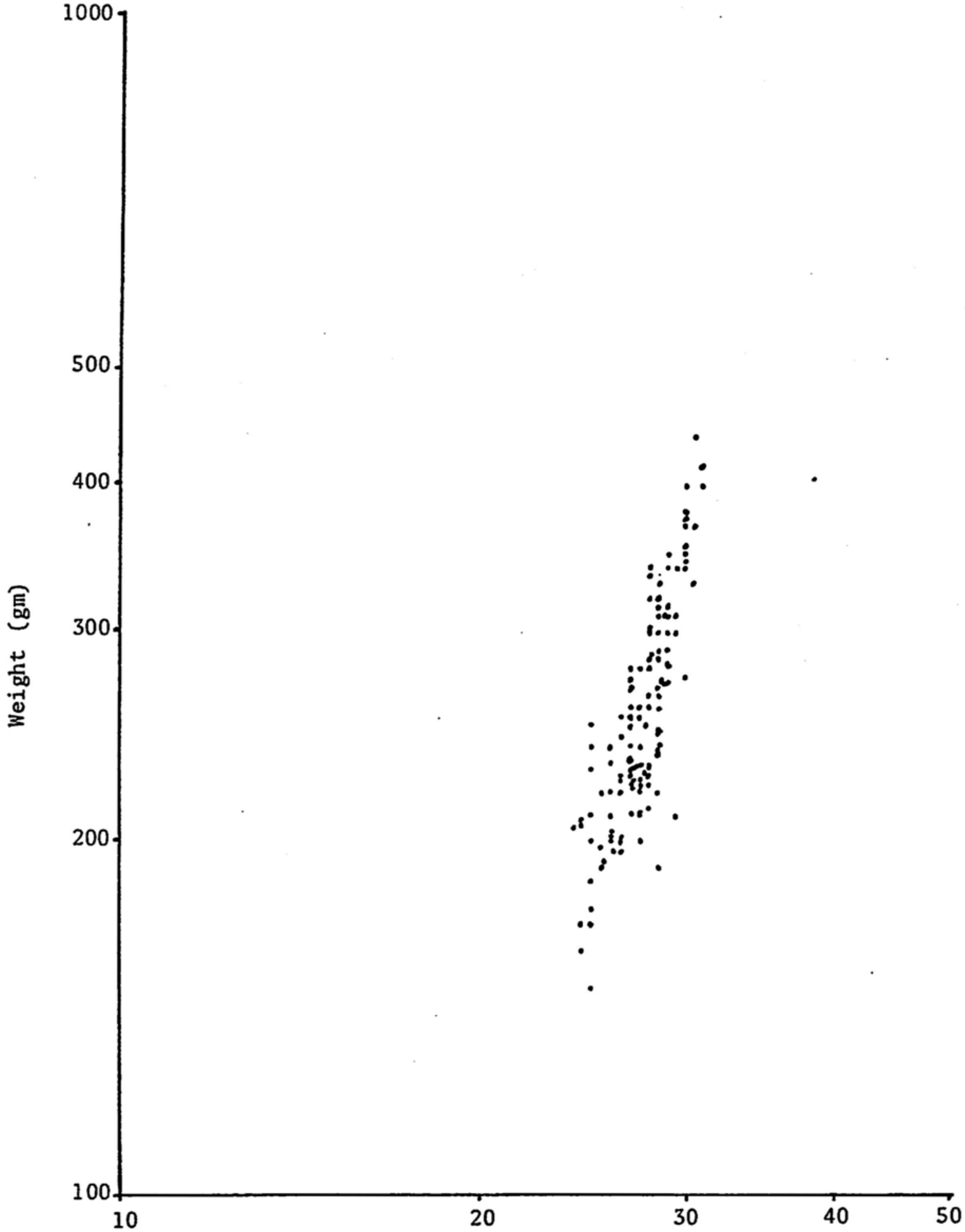


FIGURE 62 Gaspereau Weight-Length Regression

III B. 3(iii)b Striped Bass (Roccus saxatilis)

BACKGROUND (Sources: Leim and Scott, 1966; Saila and Pratt, 1973; Johnson and Koo, 1975; Magnin and Beaulieu, 1967; Talbot, 1966

The striped bass is an anadramous species, as sometimes referred to, semi-anadramous, which migrates to the head of estuaries to spawn and spends the rest of its life in the lower reaches of the estuary or at sea. At one time, large quantities of bass were taken commercially in the St. Lawrence region but are not caught in sufficient quantity in Canada to have much commercial significance although they are still a major angling fish.

LIFE HISTORY

Stage/Activity	Comments
Spawners ascend rivers March to June	- Males mature at 2-3 years of age Females mature at 4-6 years of age
Observed after ice break-up	- appear to return to stream of birth - In St. Lawrence River, spawning migration is is reported to occur in autumn; stay in river all winter and swim to spawning grounds in spring
Spawning sites near head of tide	- Spawning at 58-70° F, 60-65° optimal - high water flow is characteristic of the most productive populations
Semi-buoyant eggs concentrate near bottom	- eggs 1.2-1.5 mm initially; swell to about 3.4 mm
entrained in river or swept into brackish water	- water currents are important in keeping eggs in suspension, minimum velocity of 30.5 cm/sec required (may suffer from anoxia if settled)
Hatching 2 1/2 mm larvae non-buoyant	- hatching in 30 hours at 70-71° F 2-3 days at 64-60° F
Live off yolk	
6 mm length 10-15 days	- must find food or die
36 mm length at 3-4 wks	- resemble adults
100-130 mm at 1 year	
Outer Estuary: 16-25 cm at 2 years; may migrate out of estuary but generally stay within region of estuarine influence	- Adults: - feeding: fishes, crustaceans, molluscs, algae, polychaetes..."eat practically every marine form"; voracious feeders - 3 years, about 35 cm; 4 years, 45 cm Can grow to over 100 lbs 35-50 lb. bass, 8-10 years of age

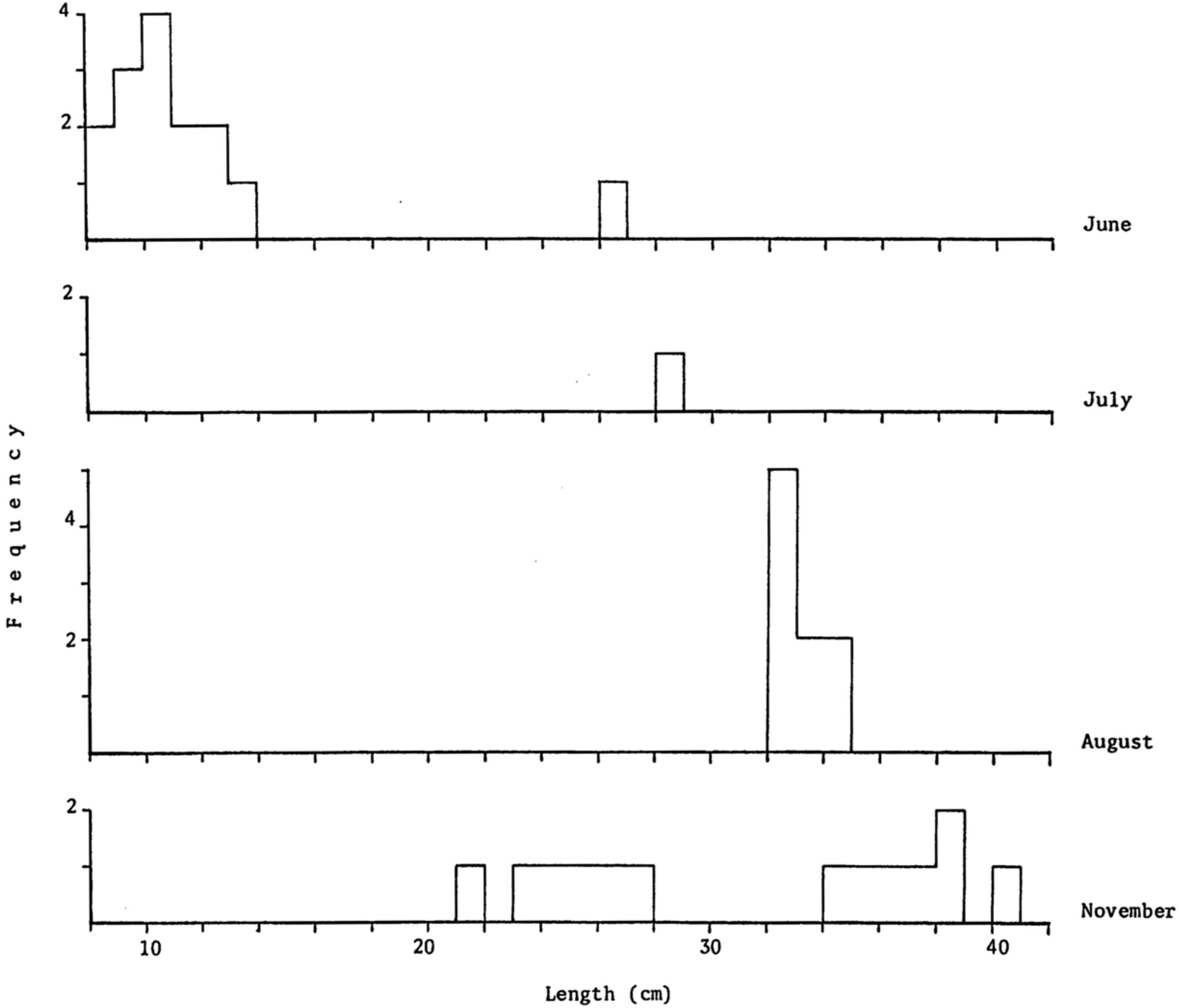


FIGURE 63 Striped Bass Frequency-Length Distribution, 1975

DATA AND COMMENTS

Length distributions of striped bass by month are given in Figure 63; some data for striped bass caught in November in the Kouchibouguac River are also included. Length-weight data are plotted in Figure 64. Data for individual fish are given in Appendix C. Other data are given as described in the general data section above.

The striped bass taken in June were all caught in eel traps, these mostly between 8 and 14 cm in length; one individual was 25.5 cm in length. These fish are presumably 1 and 2 years of age respectively and only the latter might be migrating to sea in 1975. One striped bass 28.4 cm in length was caught in July and nine between the sizes of 28 and 34 cm were caught in August. Striped bass caught in November were up to 42 cm in length; only two of these were in stage III, maturation condition.

In general, these data although limited, concur with observations of McKenzie (1959) for the Miramichi - "large bass have been extremely scarce for some years....some years, quantities of bass 25 to 35 cm long are found in the spring and early summer during the gaspereau and shad spawning season". At least some bass remain in the estuary through the summer. They were feeding largely on sand shrimp, sand lances, and silversides but notably not mummichogs. As discussed in section III. 2 (iii) on small fish, this suggests they do not feed in the denser eelgrass stands. Given the dependence of striped bass on the estuarine system, it thus appears that the Kouchibouguac system is not a particularly good habitat for striped bass. Further data (to be obtained during the spring) on this species are anticipated and are necessary for a more complete assessment, however.

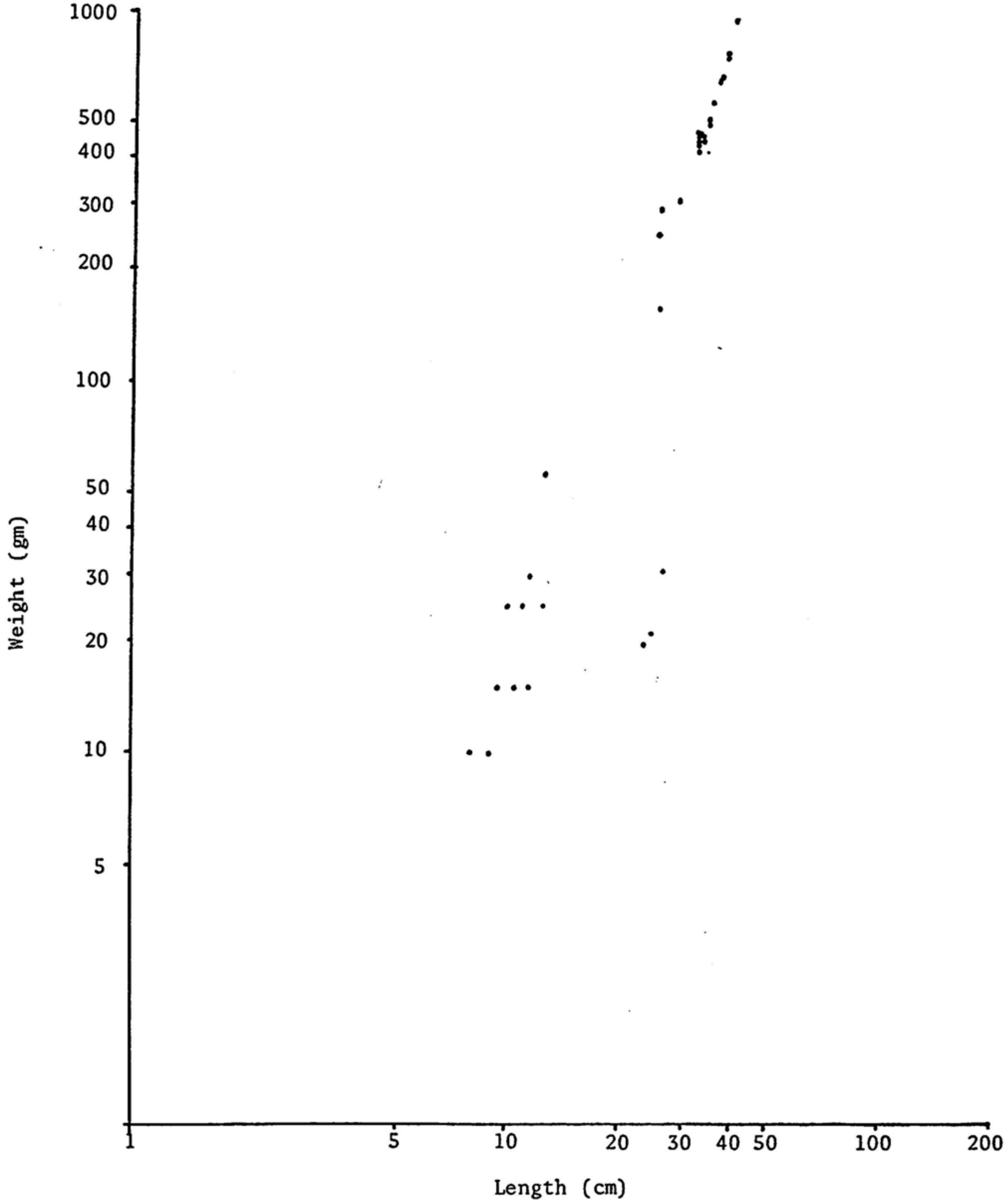


FIGURE 64 Striped Bass Weight-Length Regression

III. 3(iii)c. Atlantic Salmon

BACKGROUND

Sources: The story and somewhat tragic history of the Atlantic salmon is a complex one, entailing a voluminous literature. We have attempted here only to summarize some of this. The following sources were consulted and the reader is referred to these for more detailed information.

(1) Smith and W. M. Carter. International Atlantic Salmon Symposium (full references given in Section VI).
This volume presents the proceedings of an Interational symposium held at St. Andrew's in 1972 and includes papers on all aspects of salmon management, biology, and survival.

(2) Scott and Crossman, 1973. A general description of salmon form and life history.

(3) Anonymous, 1971. "Report on a study of the control of angling waters in New Brunswick." This report is concerned mainly with the question of leases, but provides an excellent general treatment of the economics of the sports fishery and a review of some biological aspects of Atlantic salmon management.

(4) Netboy, 1974. "The Salmon and their fight for survival". A popular treatment of this topic but with much detail concerning the history of exploitation and destruction of Atlantic salmon in New Brunswick.

(5) The International Atlantic Salmon Foundation Newsletters. "The I.A.S.F. is an international, non-governmental conservation agency which sponsors educational and research projects to assist restoration and management of Atlantic salmon". The newsletter provides up-to-date information on all aspects of salmon management. This organization sponsored the symposium of source 1 above. Its headquarters are in St. Andrew's, New Brunswick.

(6) Hooper; 1970, 1973, 1974. These reports provide statistics taken from returns of requests to licensed anglers. They include data for Kouchibouguac River but it is scanty. The 1974 report provides a good evaluation of statistics that can be obtained by questionaire to anglers.

(7) Ruggles and Turner, 1973. Describes changes in the grilse-to-large salmon ratio in the Miramichi River.

LIFE HISTORY

The Atlantic salmon is the prime example of an anadramous species. Adults migrate from the sea to the stream (or at least river system) of their birth to spawn and then die or return again to sea. Young salmon remain in fresh water for 2 or 3 years and then descend to sea to spend one or more years before returning to fresh water to spawn. The life cycle of Atlantic salmon is outlined below; predation and environmental hazards are outlined separately after the life cycle outline.

A major unknown in the life history of the salmon prior to 1959 was the site(s) of activity in the sea. J. M. Menzies in 1949 postulated that all salmon from North America and Europe have common feeding grounds in the North Atlantic.....in the late 50's, schools of salmon were found off of Greenland and tagging evidence showed these to come from both Europe and North America; all were fish which had spent one year or more at sea. Sites of grilse (spend only one year at sea) congregation in the sea , at least for the North American population, remain unknown.

FLUCTUATIONS IN ABUNDANCE

Rivers of the Maritimes are the last stronghold of Atlantic salmon on the eastern side of the Atlantic and the best salmon rivers are to be found in New Brunswick. The life history of salmon is a complex one, and each stage is associated with a different habitat. The salmon is subject to hazards of one sort or another at almost every stage of this cycle (Salmon outline II). The most critical periods or areas are (i) migration above the head of the tide and spawning, and (ii) predation of salmon at sea by man. Declines in salmon population and their elimination from many areas during the first 60 years of this century were associated largely with man-induced disruption of upstream migration and of spawning grounds. These disruptions have continued to the present but in recent years have been over-shadowed by drastic declines associated with the discovery and subsequent exploitation of salmon at their feeding grounds in the northwest Atlantic (the "West Greenland Fishery") and intensive fishing for salmon off of Newfoundland ("Newfoundland drift net fishery") and in inshore waters (e.g. New Brunswick drift net and trap fisheries) during their migrations.

LIFE HISTORY

Stage/Activity	Comments
Egg Depositing	- October-November in fresh water streams from just above head of tide to extreme headwaters. Male and female pair off over gravel beds; male excavates depression, eggs deposited, fertilized, covered. Spawning when temperatures drop to 5.6 - 4.4° C. - Gravel oxygen not less than 7 ppm; water velocity greater than 100 cm/sec
↓ Hatching	- April to mid-May when water temperature just beginning to rise
↓ Emerge as "Alevins" or	- May or June. Alevins carry yolk sac; about 15 mm long. Yolk sac may be used up before emerging.
"Fry" or "Fingerlings"	- Remain near spawning area; optimum growth at 15.5-18.5° C to 5-8 cm long
↓ "Parr"	- Autumn fry move to parr habitats in pools and deeper riffles of streams. - Parr stage distinguished by 8-12 dark vertical bars - Young parr feed on insect larvae; older parr on insects and alevins/fry of subsequent years, also on sucker fry - In Miramichi, most parrs spend 3 years (2-4) in this stage - Optimum temperature 15-19° C
↓ "Smolt"*	- Parr after 2-4 years lose parr markings, assume silvery coating. 12-18 cm long; downstream movement
↓ Drift to Sea*	- Spring/early summer. Temperature influences time of migration. Congregate at head of estuary, then "disappear". Some evidence for a full run (seaward) of smolt. - Migrations cease when water temperature exceeds 10° C
↓ N.W. Atlantic Feeding Grounds	- Sea salmon silvery on sides and belly; back, shades of green, brown, blue; x-shaped black spots numerous above lateral line; pectoral and caudal fins blackish - feed on fish, euphausids - may spend 1-4 years at sea
↓ Return as "Grilse"	- Grilse after 1 year at sea. Deeply forked tail 45-65 cm; 1.3-3 kg weight. Mostly males. - do not feed
or "Salmon"	- Salmon after 2 or more years at sea; 2 year old (sea) fish 2.5-9 kg (6-15 lbs) - Two spawning runs: June, September-October (Miramichi). High temperatures and lack of freshets between these times apparently inhibit upstream run. Do not feed during run.
↓ Prepare to Spawn	- bronze-purple coloration acquired; male develops hooked jaw
↓ Spawn	- as above
die / "Kelts"*	- thin, darkly colored spawned fish, "Black Salmon"
↓ "Mended* Kelts"	- regains silvery appearance — Kelt survival about 10% → fall or next spring return to sea (to N.W. Atlantic Feeding Grounds) - Kelts may return following fall spawning or the following spring

SALMON OUTLINE II

Atlantic Salmon - Predation, Hazards and Survival

Stage/Activity/Survival	Predators	Other Hazards
Eggs under gravel (600-800 eggs/lb. body weight of female) ↓		Freshets log drives pollution
25% of eggs survive to Fingerlings ↓ 5-10% of Fingerlings survive first summer ↓ Parr Habit ↓	Birds (Mergansers, herons, Kingfishers, gulls) Fish (trout perch, eels, chub)	Disease Pollutants: insecticides (toxic) urban (O_2 effects) mine wastes (toxic) pulp & paper (O_2 effects) Forestry: steam damage changes in cover siltation, etc.
Smolt Habit (about 35 smolt go seaward for every 5000 eggs laid) ↓		
Sea ↓	Seals, sharks, tuna, porpoise, conger eel West Greenland fishery	
Return journey ↓	Newfoundland Drift Net Fishery	
Rivers (1-5% of the 35 smolt return as grilse or salmon) ↓	New Brunswick Coastal Fisheries	
Head of tide ↓	Trap nets, gill nets Anglers, poachers	Obstacles to migration: road building dams forestry
Spawning sites		Disruption of spawning sites: forestry agriculture

Apart from fluctuations in abundance associated with fishing pressure discussed below, salmon populations undergo natural, cyclical changes in abundance. The basis of these fluctuations are not well understood. Huntsman (1931) distinguished the following cycle fluctuations in abundance:

(i) a depression in abundance on the average every 9.6 years
(ii) 48 year periodicity in general course of abundance and scarcity
(iii) 3 year periodicity for the Miramichi system

The 3 year periodicity appears to be accounted for by the initial (unexplained) establishment of a dominant year class; parr produced by the dominant year class apparently suppress survival of parr produced in subsequent years until the parr move out to sea at 3 years of age. Females take six generations from spawning to spawning, re-enforcing this phenomenom.

Canadian commercial catches of salmon increased greatly during the early '60's reaching a maximum of 1,787,000 lbs. in 1967 for Nova Scotia and New Brunswick. Thereafter, they declined to 754,000 lbs. in 1969 and 342,000 lbs. in 1971. This decline appeared to be associated with greatly increased catches in the West Greenland fishery which increased more or less regularly from 133,000 lbs. in 1960 to about 5 1/2 million lbs. in 1971. Tagging evidence supported the contention that substantial numbers of Canadian-born fish were being taken in the Greenland fishery. Apparently associated with the increases, both the Canadian territorial water commercial fisheries and the West Greenland fisheries catches by sportsmen in Canadian rivers have decreased more or less regularly from 1963 to 1971. For example, Hooper gives catch per hour statistics showing a decline from about 0.4/hr. in 1963 to 0.075/hr. in 1971 for late bright salmon and grilse (September 1 - September 30) on the main southwest Miramichi River.

Besides changes in total numbers of salmon entering Canadian rivers, age composition of the stocks changed also. Prior to 1963, the grilse and large salmon entered the Miramichi system in approximately equal numbers, but after 1963 and to 1971, the proportion of large salmon dropped to 13%. This was apparently associated with greater exploitation of large salmon at sea then of grilse. Ruggles and Terner remarked, "This change in composition has reduced the reproductive capacity of the stock. The major effect of this reduced reproductive capacity has been a rapid decline in fall-run stocks of grilse and large salmon".

In 1972 following considerable international and national concern for the survival of this species, bans were placed on commercial salmon fishing by the New Brunswick drift net fishery (floating nets in the St. John and Miramichi estuaries). New Brunswick inshore fisheries (nets attached to shore), and the Newfoundland drift net fishery (floating nets off Port aux Basque). In the same year, Denmark, a main exploiter of the Greenland fishery, negotiated a bilateral agreement endorsed by ICNAF with the U. S. providing a gradual phaseout of offshore fishing around Greenland over a period of 5 years. The inshore Greenland fishery, which also takes substantial numbers of fish of Canadian origin, remains however.

There bans have had some effect. The June-July, 1975 Newsletter of the International Atlantic Salmon Foundation quotes data showing an increase in spawner counts on the Restigouche River from 830 in 1972 to 2314 in 1974. However, it is remarked that there is a long way to go before nets should be allowed back.....estimates for the number of salmon the Restigouche could support go as high as 250,000.

MANAGEMENT

While these results are encouraging, concern has been expressed that intense poaching activities on New Brunswick River may largely negate the benefits of controls on the commercial fisheries. Further, it has been stressed that the numbers of rivers able to support salmon populations continues to decline, and there should be no complacency with respect to home water (stream) management. An outline of general management principles is given below.

I. Management of fish stocks by:
   (i) control of fishery
   (ii) addition of fish

II. Management of environment
   (i) Resisting or reversing man-made destructive influences
   (ii) Improving the natural state

II (i) and (ii) include, for example, clearing obstructions, bulldozing of channels, and construction of fishways to allow fish to reach spawning grounds; and movement of spawning grounds by, for example, addition of gravel to supplement spawning areas, water level control, planting of appropriate trees to provide shade or shelter, or removing of trees and establishing shrub vegetation to increase bank stability.

Each salmon system is unique, and proper management of the environment requires prior limnological and engineering surveys to establish the exact management scheme. Such surveys were beyond the scope of the current study. The limnological studies carried out by CWS during the summer of 1975 will presumably provide an initial assessment in these regards.

ANGLING/RUN SEASONS IN NEW BRUNSWICK

The angling seasons for New Brunswick Rivers as outlined by Hooper are:

(i) Kelt angling season, usually commencing around April 15 and terminating about May 10 when the fish are no longer availabe. By regulation, the season is to May 20. Only previous year spawners that overwinter are exploited.

(ii) Bright salmon seasons: two large upstream migrations and runs usually occur, an early run commencing in early to mid-June and peaking in July and a late run in September and continuing to spawning time near the end of October.

Some pertinent statistics from Hooper reports:

- Catch per rod-day for large salmon (over 5 lbs.) decreased from 0.09 in 1969 to 0.07 in 1971 but increased in 1972 to 0.16.
- The Northumberland Strait Drainage Angling effort in 1970 amounted to 6.05% of total provincial effort. Of this drainage the Kouchibouguac River accounts for 23.47%, and for 1.42% of the provincial effort. The Kouchibouguacis River (cited as Kouchibouguac River, presumably in error, p. 24) accounts for 6.78% of the drainage and 0.41% of provincial effort. Of 16 subdrainages for the province with highest angling effort, Kouchibouguac River ranked 15th. Estimated angler days for the entire Northumberland Strait drainage in 1970 were 61,529.
- Sport fishery highlights summarized in the 1974 report are given below, ver batim. (see pp. 9, 10, 11 - Hooper, 1974)

SPORT FISHERY HIGHLIGHTS, 1969-1973 (Hooper, 1974)

1969: (1) Non-resident license sales decreased (2.3%) for the first time since 1960. Resident sales increased very slightly.

(2) Kelt catches (fish killed only) were poor, the result of unusually low adult salmon escapement in 1968.

(3) Catches of early bright fish were favorable but few late bright fish were angled for the second consecutive year.

(4) The Nepisiguit, Petitcodiac and Coverdale rivers produced lower catches of bright fish compared with previous years.

(5) Excellent catches of salmon were obtained from the Big Salmon, St. John, Nashwaak and Tobique rivers, perhaps the result of commercial netting restrictions in St. John Harbour and Bay of Fundy.

1970: (1) 845 fewer non-resident licenses were sold in 1970 than 1969, partially the result of past poor angling success during the late bright seasons, particularly on Miramichi rivers. The 1970 February flood may also have produced discouraging pre-season angling reports.

(2) Catches of bright fish were 15% below 1969 catches. Large salmon angled decreased 25% for Miramichi and 10% for Restigouche rivers during the early bright season.

(3) Anglers during the late bright season again had poor success; field officers reported more "dark" (July) fish were caught than "bright" (September) fish.

(4) Very low catches were reported from the Sevogle, Napisiguit and Coverdale rivers. Good angling catches continued on the Tobique River.

(5) The Nashwaak River received the Province's third highest angling pressure for Atlantic salmon in 1970; the Nashwaak ranked fifth in 1969; large salmon accounted for a large portion of Nashwaak River catches; there is some speculation the good angling has resulted from (1) St. John River oriented salmon are being diverted to the Nashwaak as a result of the Mactaquac Dam and (2) the removal of the Marysville Dam in 1950 which finally resulted in Substantial returning adult populations.

1971: (1) Resident and non-resident license sales and angling effort decreased; resident license sales decreased 48% as a result of the cancellation of resident trout licenses in 1971; non-resident license sales decreased 20% as a result of poor late season angling in Miramichi rivers since 1968 and end of season curtailment (two weeks) for all Miramichi rivers.

(2) Kelt season kills were especially disappointing being 54% lower than in 1970.

(3) Catches of early bright fish were 30% less than in 1970; the large salmon harvest declined substantially for the third consecutive year, the most important declines occurring on the Miramichi and Restigouche rivers.

(4) Anglers caught very few fish during the late bright season the scarcity of large salmon was especially apparent on Miramichi rivers.

1971: (5) Grilse and large salmon compositions during the early and late bright seasons remained similar to those of 1967 and 1970, indicating little overall effect from the commercial fisheries restrictions; however, the estimated additional spawning escapement saved from angling exploitation, extrapolated from weekly Fisheries harvest tables, may have been 750 grilse and 153 large salmon.

(6) New Brunswick angling leases expired March, 1971, resulting in 16 lease cancellations; the result was 242 new river miles, which were made available for public or controlled public angling in 1972. Most of these waters were on the Miramichi or Restigouche drainages.

1972: (1) Commercial fisheries for Atlantic salmon in New Brunswick were banned by the Canada Fisheries Service; restrictions were also implemented on certain Newfoundland, Quebec and Nova Scotia commercial salmon fisheries. New Brunswick's late bright season (Sept. 1 to Oct. 15) on Miramichi rivers was further restricted (shortened) from two to six weeks depending on river. The province-wide bag limit was also restricted from 4 fish to 2 fish per angler per day.

(2) License sales and angling effort increased 19% and 22% respectively, in 1972 over 1971. Residents accounted for the increases.

(3) Miramichi rivers, especially the main Southwest Miramichi, were primarily responsible for the large increase (24%) in angling effort over 1971 although appreciable effort increases also occurred on the Restigouche (17%) and St. John (19%) rivers.

(4) Kelt season catch and effort declined for the fourth consecutive year.

(5) The bright season angling catch was approximately twice the 1971 catch for the Miramichi, St. John and Restigouche drainages; the catch of large salmon increased five-fold over the previous year for the Miramichi and Restigouche rivers (Figures 29 and 30); anglers reported a three-fold increase of large salmon for St. John rivers.

(6) Grilse catches during the bright seasons increased very slightly indicating that if the Province's commercial fisheries had not been banned, 1972 would have been a very poor angling catch year.

1973: (1) Similar commercial and sport fisheries seasons and bag limit restrictions were implemented as in 1972.

(2) License sales increased 16% over 1972; resident sales increased 16% and non-resident sales increased 18%.

(3) Angling effort increased 12% in 1973 over 1972 for New Brunswick rivers; the important increases were in bright season angling: 1. Restigouche (37% increase); 2. St. John (33% increase) and 3. kelt season angling only, the main Southwest Miramichi.

(4) Kelt season catches more than doubledover the previous year; the large salmon component increased spawning escapement in 1972.

1973: (5) Bright season catches decreased 22% in 1973 from 1972; the decrease was the result of poor catches on Miramichi rivers which had only a 2% increase in bright season effort. Bright season catches increased 7% and 13%, respectively, on Restigouche and St. John rivers, the result of large angling effort increases.

DATA AND COMMENTS

Sixteen salmon smoult were taken in eel traps on June 9 and 10. A single bright salmon was caught in a 5½" net on June 10. Smoults were 12.5 - 15 cm length. The salmon was 76 cm long. Data on these are given in Appendix C.

As discussed above we were surprised not to take more bright salmon through the summer. Two principal spawning runs occur in the Miramichi, one in June and one in the fall. High temperature and lack of freshets inhibit runs between these times. The unusually dry 1975 season may thus have been a factor in the general absence of salmon in our catches.

Until we have more information on the salmon and the results of the limnological survey in hand little can be said concerning the current status of the salmon population. All indications are that the Park population is a limited one and in accordance with the general concern for this species shall be protected and as possible its production enhanced. The eel trap fishery needs to be examined critically in this regard.

III. 3(iii) d. Brook Trout (<u>Salvelinus fontinalis</u>)

BACKGROUND (Sources: Leim and Scott, 1966; Scott and Crossman, 1973; White, 1940, 1942)

The brook trout is in general, "a fresh water form that may go to sea when stream conditions such as rising temperatures become unfavorable" (Leim and Scott, 1966).

LIFE HISTORY

Stage/Activity	Comments
Spawning	- late September, October, November
	- gravelly shallows with strong spring water flow favored
	- eggs deposited in nest
Hatching	- incubation time depends on temperature, oxygen; about 100 days at 5° C, 50 days at 10° C; upper lethal temperature, 11.7° C
	- larvae remain in bed until yolk is absorbed; emerge April and May; about 3.8 cm length
Parr	- eat insect larvae, insects, small snails
	- fish-eating birds are main predators
Sea Run Initially at 2-3 yrs	- April and May; also reported in October and early January
	- order of 12-35% go to sea
	- once in estuary, eat elvers, crustaceans, small fish (mummichogs, others)
	- smaller fish of run resemble salmon smolts (2 and 3 years old)
Sea Life	- confined to shore waters and estuaries
	- crustaceans, fish, sandworms, etc.
	- average sea life about 2 months
Return to Streams	- April, June-July, November (Ellersley, P.E.I.)
	- differ in appearance from fresh water trout; more slender but thicker through the body; dorsal surface dark greenish-blue, sides silvery, belly pearly-white
	- not all are in breeding condition
	- feed sparingly

DATA AND COMMENTS

Data for individual fish are given in Appendix C. These include data for three trout taken in November. Lengths of trout are given by month in Figure 65 and a weight-length plot is given in Figure 66.

Two small trout, 15 and 20 cm in length were taken in an eel trap on June 6. Others were taken in gill nets set up the Kouchibouguac River near the Park boundary, and one was taken near the mouth of this river between June 13 and July 31, the largest individual being 1.1 kg. Stomach contents of three trout taken in November consisted mainly of silversides.

The occurrence of trout in the marine sector of the Park in June and July but not in August is consistent with literature reports.

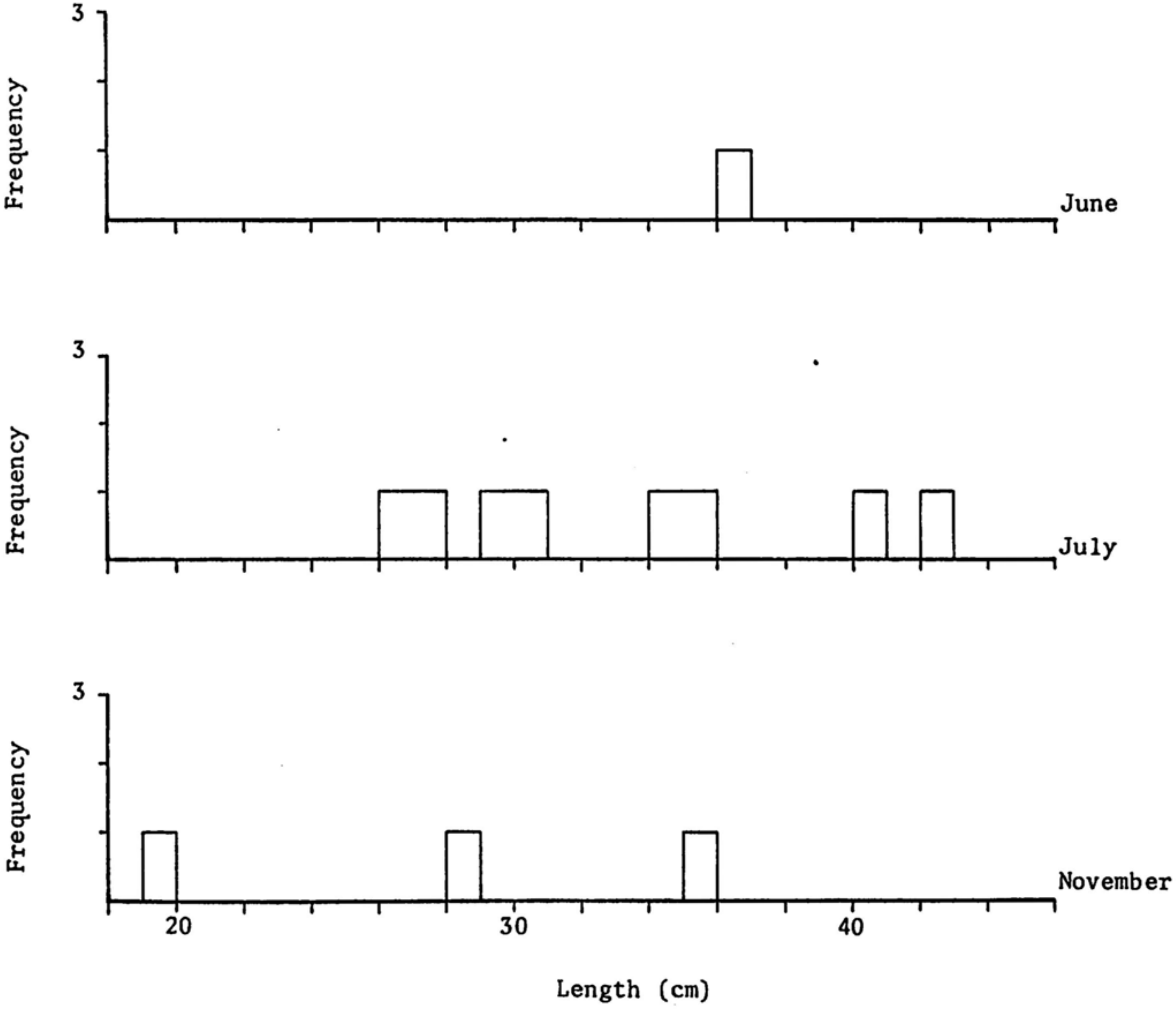


FIGURE 65 Brook Trout Frequency-Length Distribution, 1975

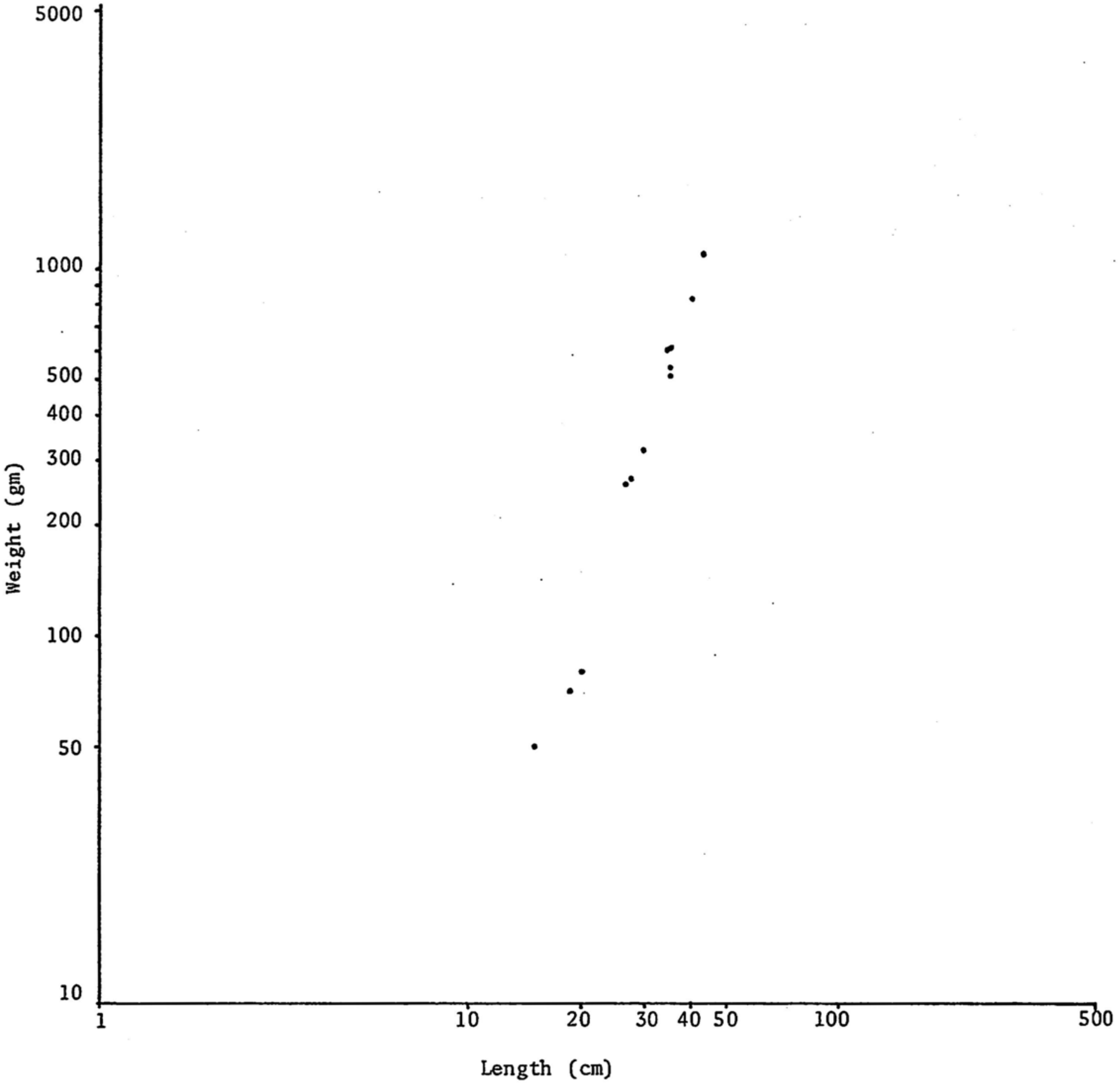


FIGURE 66 Brook Trout Weight-Length Regression

III. 3(iii) e. American Smelt (<u>Osmerus mordax</u>)

BACKGROUND (Sources: McKenzie, 1958; Scott and Crossman, 1973; Leim and Scott, 1966)

Smelt fishing is an important fishery in New Brunswick. Mr. J. Kelly tells us that about 32,000 are taken out of the Kouchibouguac Lagoon each winter; these taken through the ice by box nets. This fish is anadramous, living in the sea and entering fresh water to spawn but is also capable of spending its entire life in fresh water.

LIFE HISTORY

Stage/Activity	Comments
Spawning	- brooks and streams above head of tide or below head of tide (particularly if obstacles) - April to June - eggs sink, adhesive, stick to rocks, vegetation...may cover bottom - spawning may last 3 weeks,
high post spawning; mortality in some populations	
Hatching	- after 2-3 weeks - 5 mm length when hatched
Fry carried to brackish water	- fry eat copepods, other plankton
5 cm length by August ocean close inshore by sand and gravel beaches	
Sea life	- schooling, pelagic , mid-water in coastal areas; eat crustaceans, marine worms, small fish - predators include cod, salmon, seals, birds
Return to spawn	- maturity of 2-3 years old (12-20 cm length); most commercial catch in this category; some larger - Growth rate, Miramichi; Age 1 -- --; 2 135 139 mm; 3 152 160; 4 169 183; 5 183 206 - Spawning runs do not occur until water temperature rises to 8.9° C; does not continue above 18.3° C

DATA AND COMMENTS

Smelt were caught in early June in the eel traps. Two were caught in the fish trap between June 17 and 23. Data for individual fish are given in Appendix C. The length frequency distribution is given in Figure 67 and the weight-length regression in Figure 68. Other data are given as described in the general data section above.

These fish represent post-spawners returning to sea. The size range is similar to that observed for smelt in the Miramichi. Stomach contents of two smelt taken in nets (June 10) consisted of sandlances.

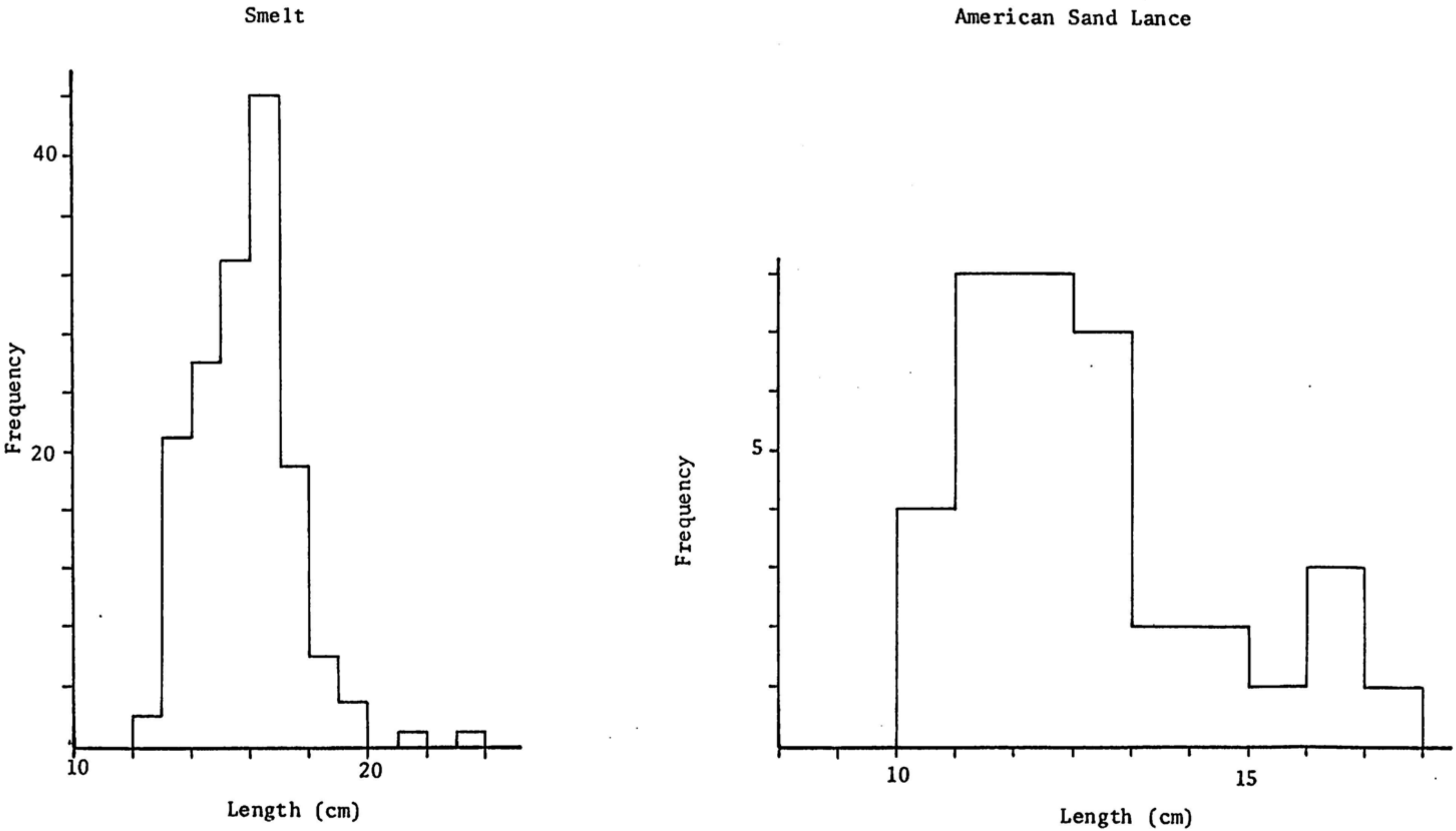


FIGURE 67 Smelt and American Sand Lance Frequency-Length Distribution - June, 1975

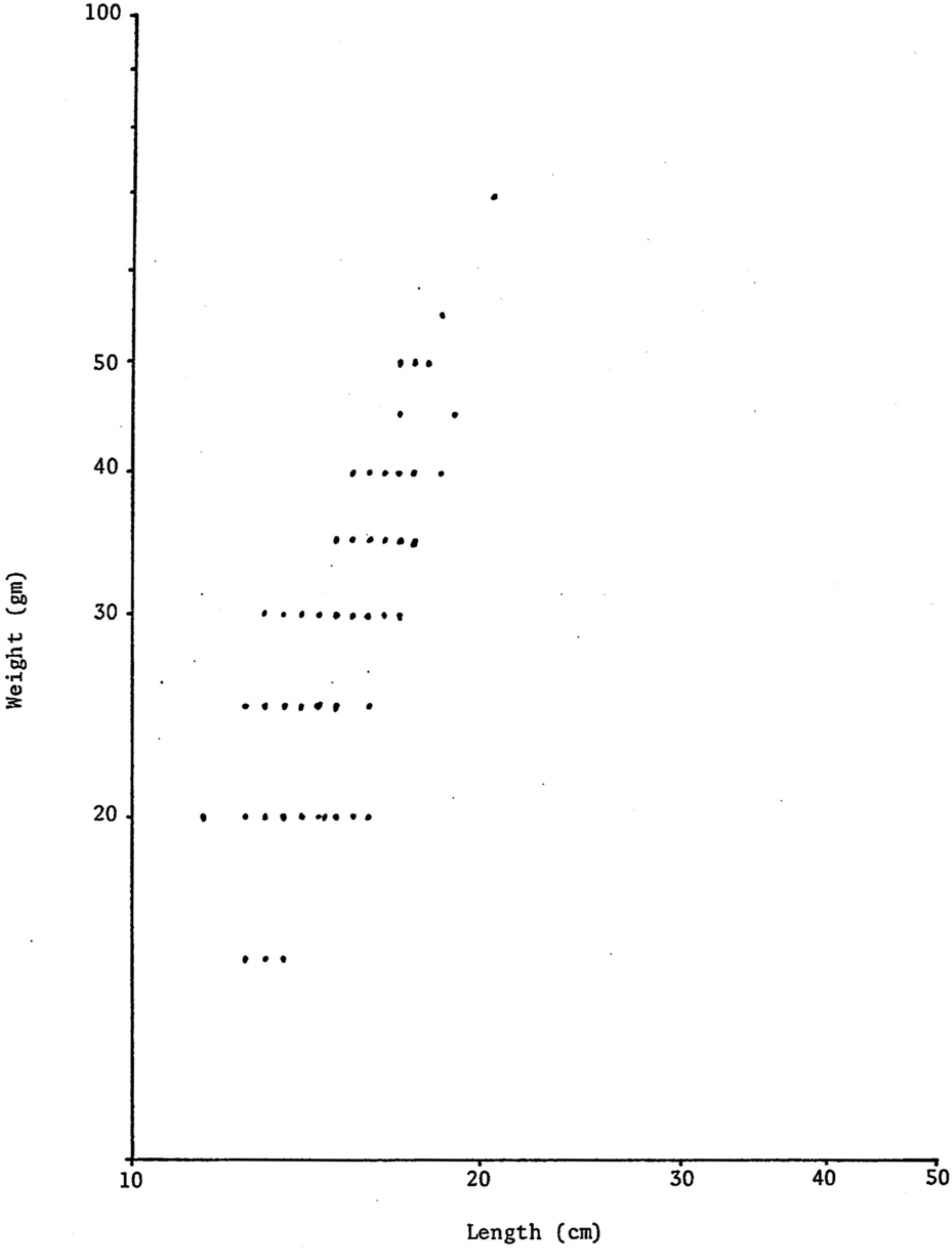


FIGURE 68 Smelts Weight-Length Regression

III . 3 (iii) f. Tomcod (Microgadus tomcod)

BACKGROUND (Sources: Leim and Scott, 1966; Scott and Crossman, 1973; Mc-Kenzie, 1959)

Tomcod are taken both commercially (largely for animal food) and as a sport fish (winter fishing through the ice) in various parts of eastern Canada. One half to one million pounds are taken annually in the Miramichi system.

LIFE HISTORY

Stage/Activity	Comments
Spawning and eggs	- mid-winter (December, January) usually beneath the ice - may spawn in salt water but apparently prefer to move into estuaries and rivers - spawn over sandy, gravel bottoms - eggs adhesive - return run of post spawners peak in January
Hatching	- 22-50 days incubation 4.4° C to 0° C
Move down river	- are said to remain through the first summer in waters where they hatch; by June about 50 mm length
Coastal waters	- No data on growth rates available; maximum size about 38 cm, 570 g - feed on annelids, crustaceans, small fishes including smelt and bass
Spawning run	- winter

DATA AND COMMENTS

A length-frequency histogram for tomcod caught in June is given in Figure 69. Weight-length data are plotted in Figure 70. Individual fish data are given in Appendix C. Other data are given as described in the general data section above.

Large numbers of tomcod were taken from the eel traps on June 6 and 10. It appears from the length-frequency data (Figure 69) that these probably included mainly 1, 2 and 3 year old fish. A few caught in the same length range were taken on July 8 in seines, and on July 28 one individual 3.7 cm in length was taken in a seine; this fish would be from the current year corhort (0+). Tomcod were taken in November travelling upstream. These were in the "mature" stage. Stomach contents of tomcod included sandshrimp, silversides, sticklebacks, mummichogs, amphipods and benthic annelids.

It appears that the cod largely move out of the estuary by July as no significant numbers were taken later. Occurrence of large numbers in early June was somewhat surprising, as the return run in the Miramichi is reported to occur in January (spawning in December and January).

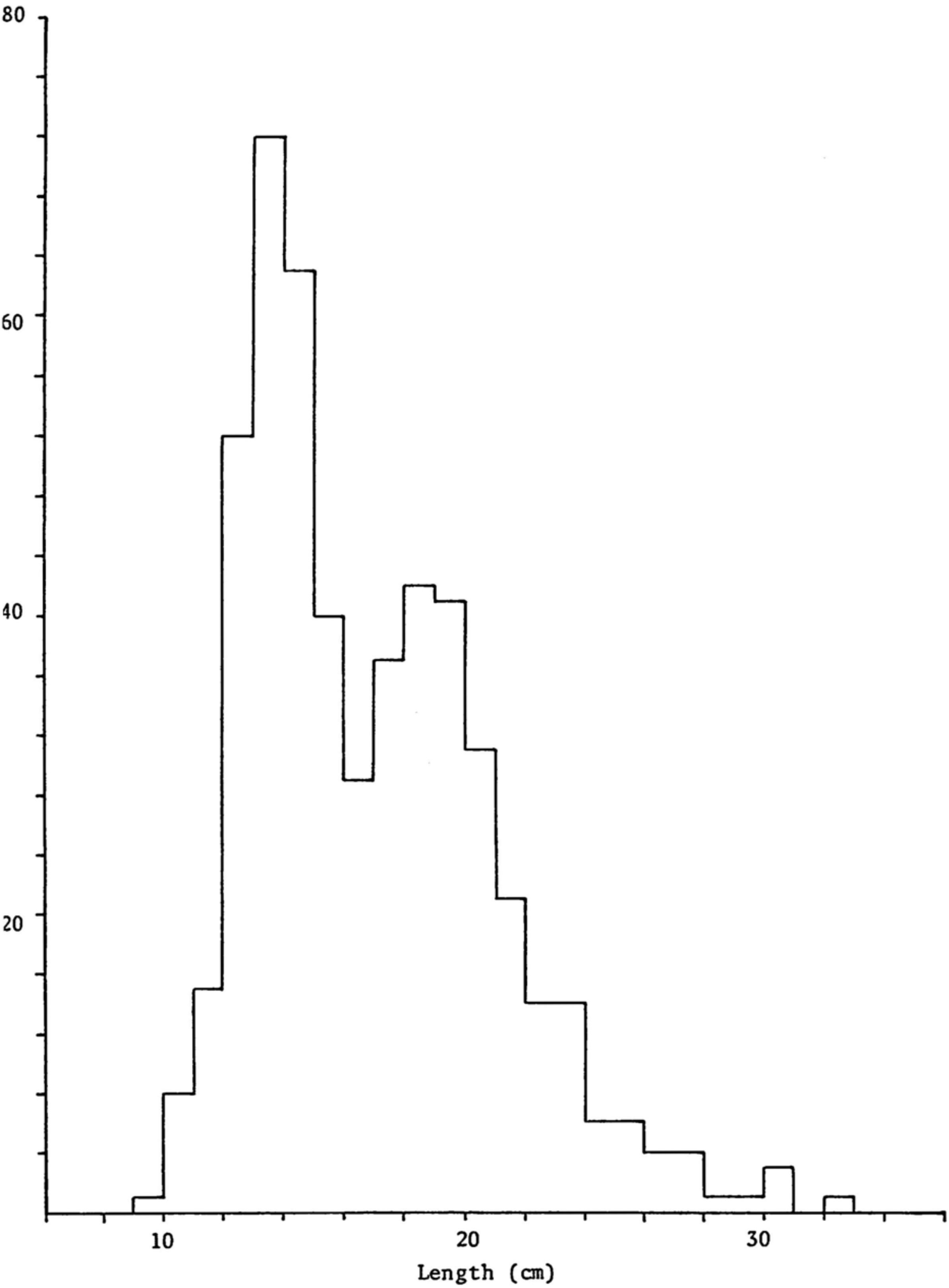


FIGURE 69 Tomcod Frequency-Length Distribution - June, 1975

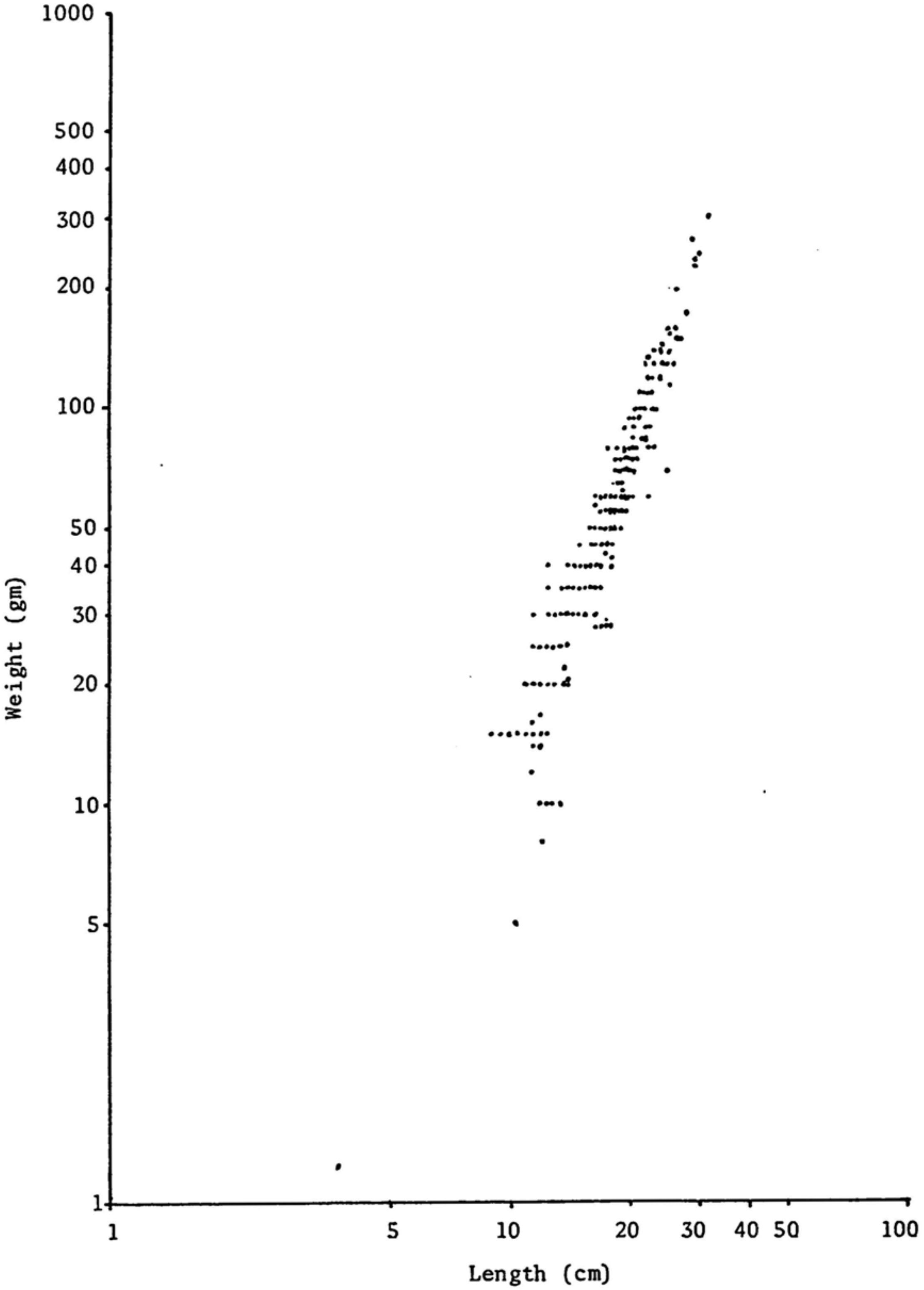


FIGURE 70 Tomcod Weight-Length Regression

III 3(iii)g. Smooth Flounder (Liopsetta putnami)

BACKGROUND (Sources: Leim and Scott, 1966)

The smooth flounder is apparently not taken commercially because of its restricted distribution and small size. It is "confined to shallow estuaries and coastal areas, usually in warmer and somewhat brackish waters". It spawns late winter and early spring - little else is known concerning it breeding habits. It feeds on crustaceans, small molluscs, worms.

DATA AND COMMENTS

Data for individual fish are given in Appendix C, length-frequency data in Figure 71, and weight-length data in Figure 72. Other data are given as described in the general data section above.

Large numbers of smooth flounder were taken in eel traps and in the fish trap. As well they were observed visually through the summer throughout the lagoon, especially in the channels, but also in the *Zostera* beds, mud and sand bottoms (observed at 28 point stations).

The length-frequency distribution shows distinct modes, and suggests that nine age groups were present (ages 2-9). A growth rate of about 3 cm/yr is indicated.

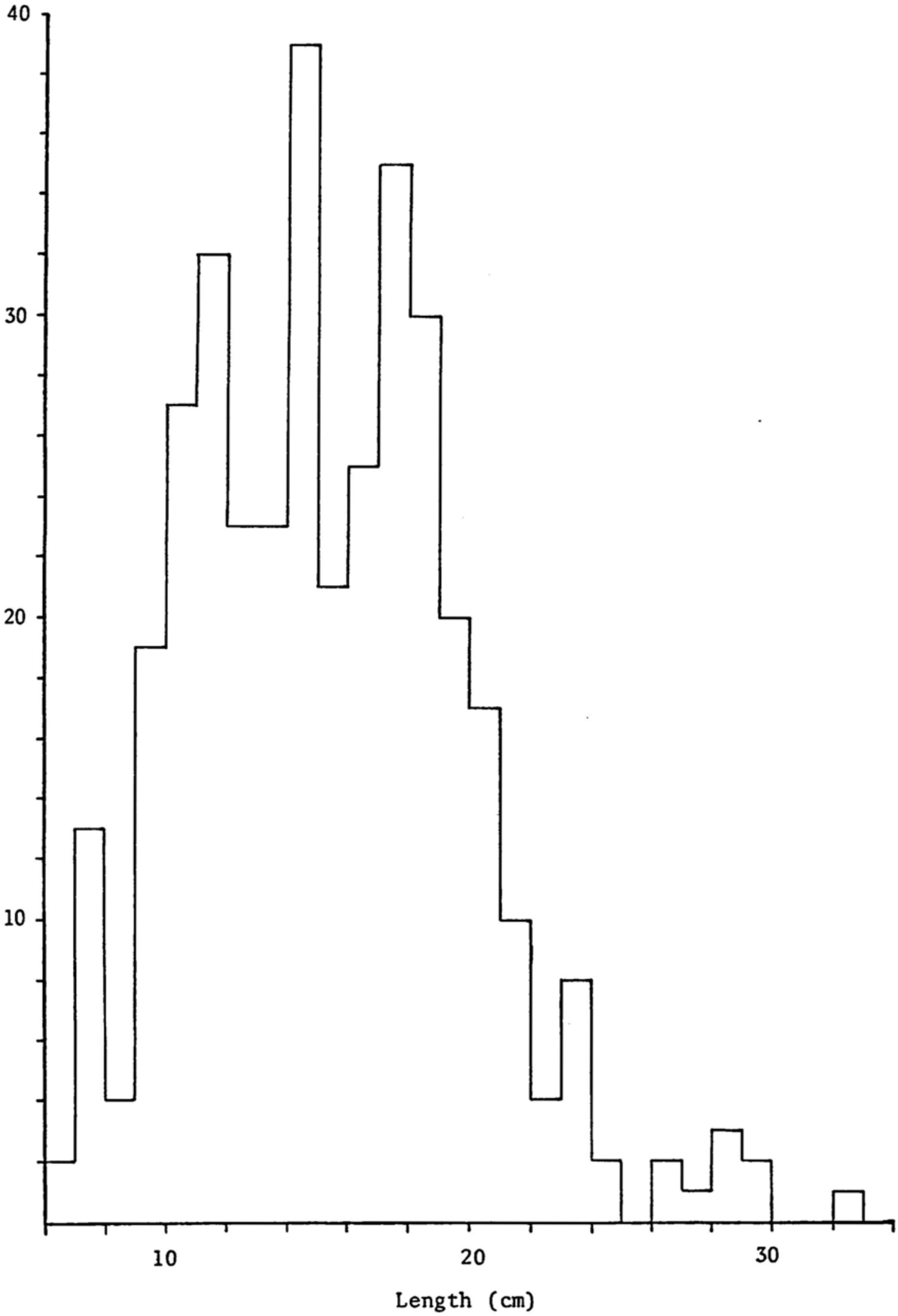


FIGURE 71 Smooth Flounder Frequency-Length Distribution - June, 1975

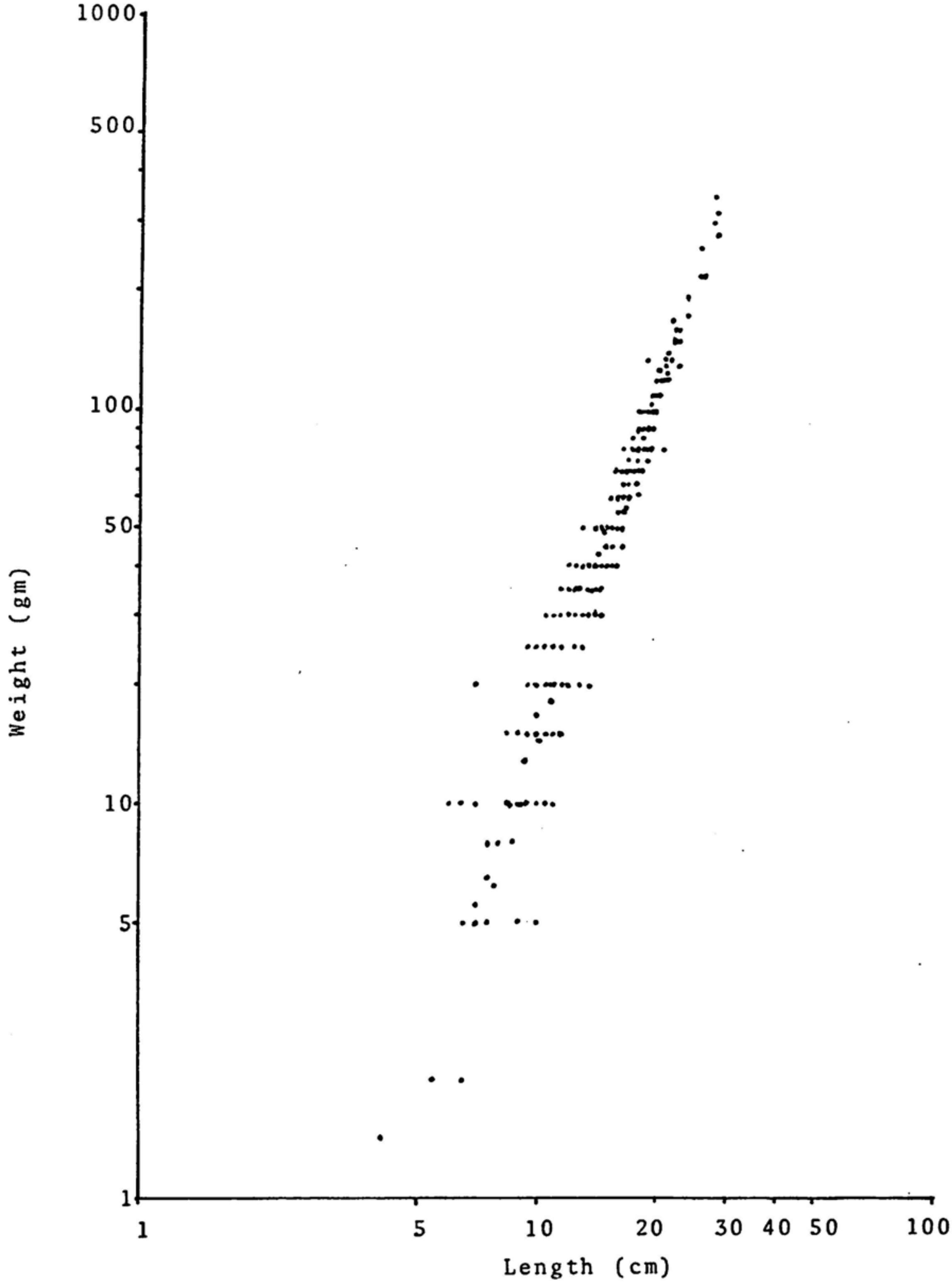


FIGURE 72 Smooth Flounder Weight-Length Regression

III. 3(iii) h. American Eel (Anguilla rostrata)

BACKGROUND (Sources: LeBlanc, 1973; Leim and Scott, 1966; Scott and Crossman, 1973; Eales, 1968)

This is the only catadramous species occurring in this region, living much of its life in fresh water (or within the estuarine system) and returning to sea to breed. The eels are long-lived and undertake remarkable migrations. There are several distinct stages in the life history, outlined on the next page. Yellow and silver eels are fished commercially in Canada, specifically in the Park waters in traps set after the ice leaves and maintained then until about mid-June. Eels are sought principally for export markets.

LeBlanc (1973) reported observing elvers just below the dam on the Kouchibouguac River in the second week in August. No other observations are available on eels in the Park region.

The yellow eels (immature) are residents in fresh water or estuaries. These are non-migratory and undergo transition to "silver eels" at the time of their maturation. The silver eels migrate seaward in the fall, sometimes accompanied by yellow eels; it is not known if the latter leave for the sea. A small spring downstream of yellow eels has been observed in some areas. Eels eat juvenile salmon and may compete for food items. However, the extent of predation on a competition with salmon has not been precisely ascertained.

In Canada, yellow and silver eels are caught commercially, but not "elvers" although the latter are popular in Europe. Eels are caught in the Kouchibouguac and Kougibouguacis Rivers in hoop nets (Figure 73). Because of the great masses of suspended macrophytes occurring in the water in June, the nets are lifted; elsewhere they may be left in for the period April through October, silver eels being caught later in the season. Spearing through the ice is a method of catching eels in some areas. There are claims that hoop net fisheries have significant effects on salmon stocks (Eales, 1968).

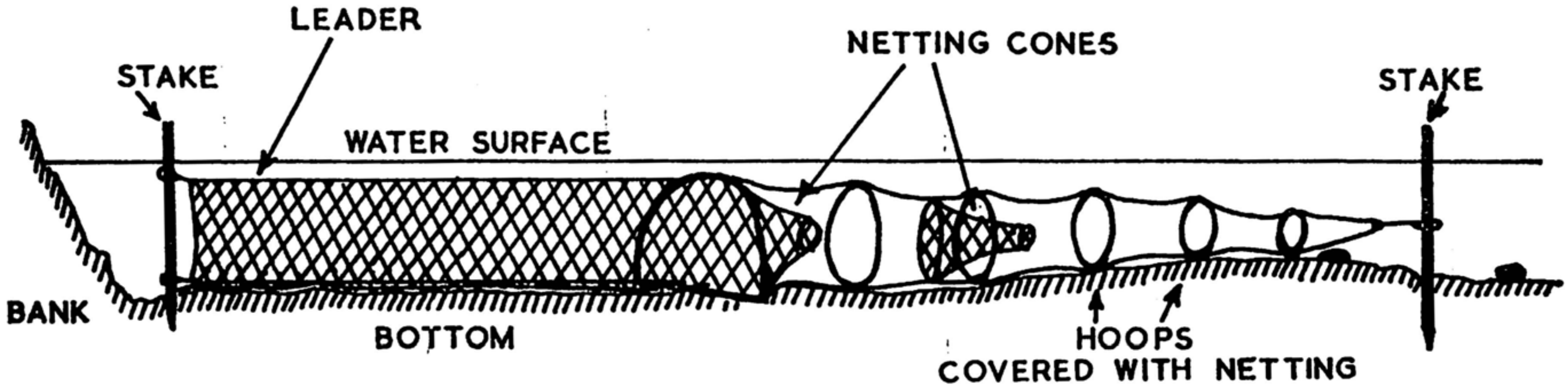


FIGURE 73 A Fyke Net and Method of Setting it (from Eales, 1968)

LIFE HISTORY

Stage/Activity	Comments
Migrate to sea ("Silver eels")	- Autumn
↓	- length (time) of journey unknown
Sargasso Sea spawning grounds	- Spawn early spring
↓ → adults die	
leptocephalus larval stage	
↓	
Reaches american shores in 1 year; metamorphosis	- metamorphosis when 60-65 mm; during winter on approaching or in inshore waters (April)
↓	
"Glass Elver"	- transparent; May and June migrate upstream
↓	
Pigmentation develops "Elver" By time reaches streams and rivers, changes habit from pelagic to bottom	- dark, almost non-transparent - 65-90 mm; occur in great numbers - 6-8 cm length when entering fresh water
↓	
Adult phase in fresh water , or estuary Yellowish-greenish color, "Yellow Eels"	- Not well-known. Move into muddy, silty bottoms of lakes. Cariverous predators of young salmon, insects, larvae, snails, earth worms, larval lamprey; in brackish waters, eat any small fishes or invertebrates available; feed at night - how long this phase lasts uncertain; 5-20 years possibly. All large eels are females; males less than 45-60 cm. Females to 122 cm and 16 lbs. - Eels presumed to be 9-11 years old are 61 to 71 cm length
↓	
Migrating instinct lose appetite, body takes on metallic sheen, pectoral fin becomes black and pointed = "Silver Eels"	- flesh is very firm, rich in fat; prepared for return journey Appear in autumn in lower estuary - In winter the eels lie in a torpid state in the mud
↓	
To Sea	

DATA AND COMMENTS

In Figure 74, size data are given for eels taken from hoop nets in June. Data for individual eels are given in Appendix C. These eels are yellow eels, possibly caught during the minor spring migration of yellow eels. Alternatively, they represent eels normally staying in the lower part of the estuary year round. Eels were observed in eelgrass beds of the lagoon throughout the summer.

In Tables 34 and 35, other fish caught in eel traps during June are indicated; they include almost all species found in Park estuarine waters. We have yet to sample these traps during April and May, but it seems probable that large numbers of salmon smolt, bass, and trout are caught during these months.

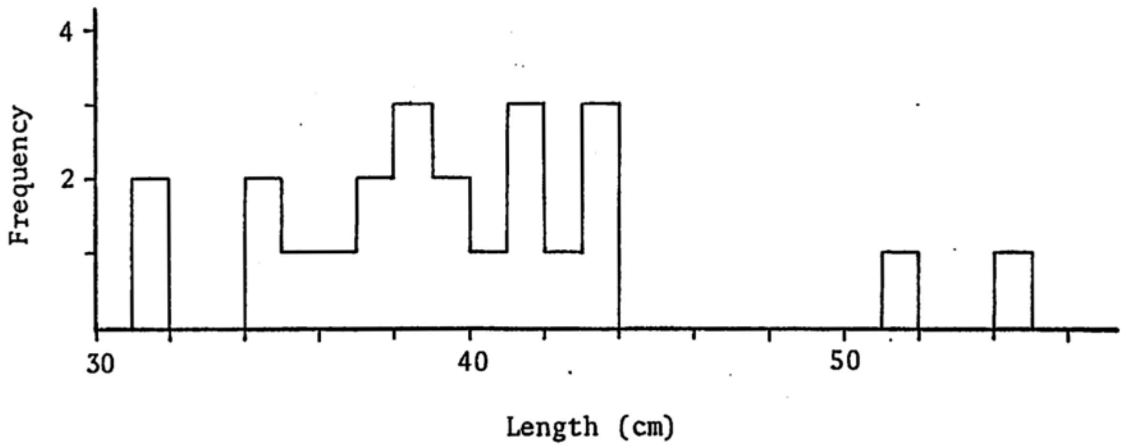


FIGURE 74 American Eel Frequency-Length Distribution

June, 1975

III. 3(iii)i White Sucker

BACKGROUND, DATA AND COMMENTS

This is a freshwater fish which apparently wanders occasionally into brackish waters. McKenzie reports the white sucker being caught in box and bag nets in the Miramichi in May and June and in smelt nets off the larger tributaries in the winter.

White suckers were caught at positions 16,17 and 20 (Figure 60). Data for individual fish are given in Appendix C, length-frequency data in Figure 75, and weight-length data in Figure 76.

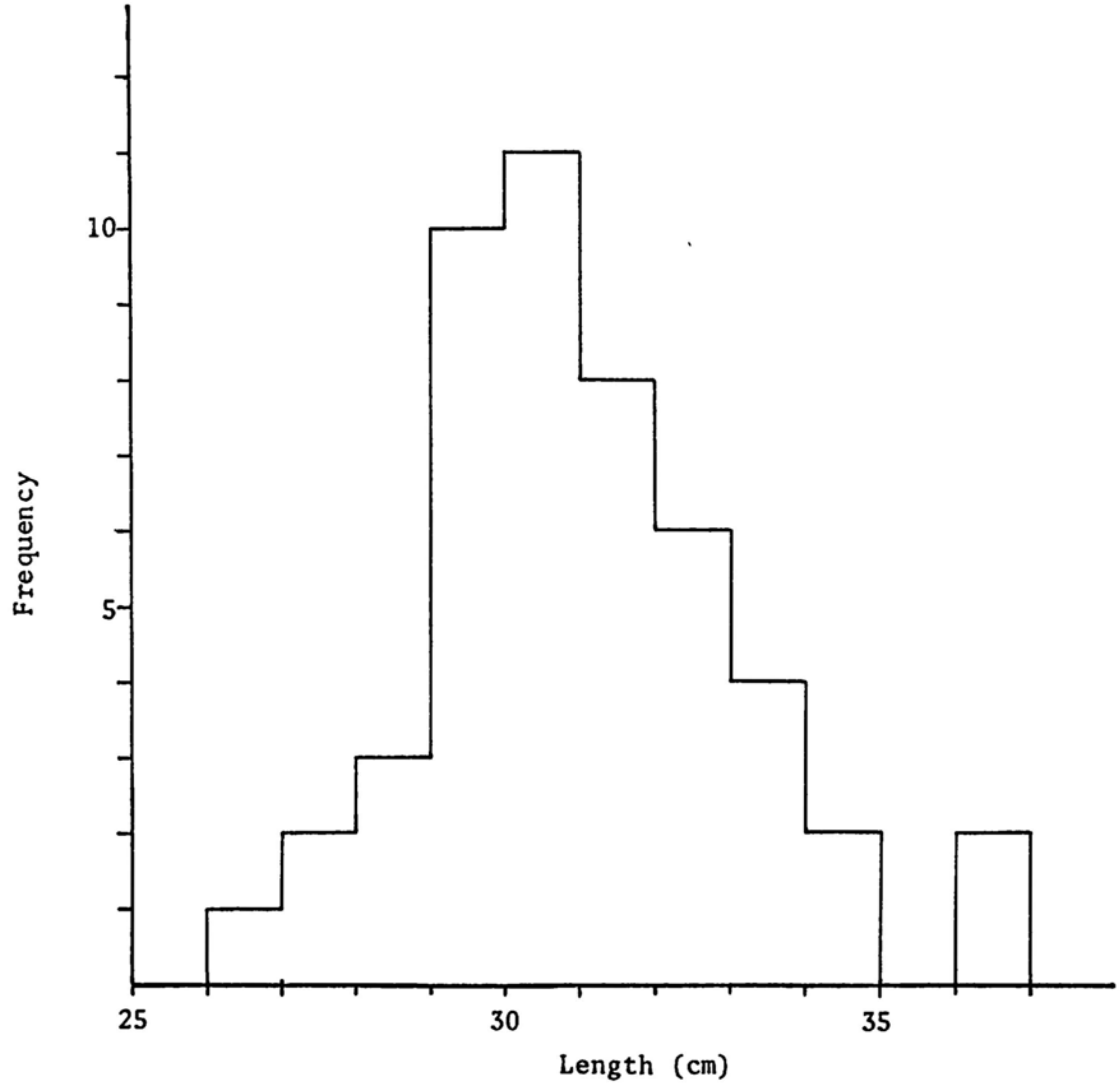


FIGURE 75 White Sucker Frequency-Length Distribution - July, 1975

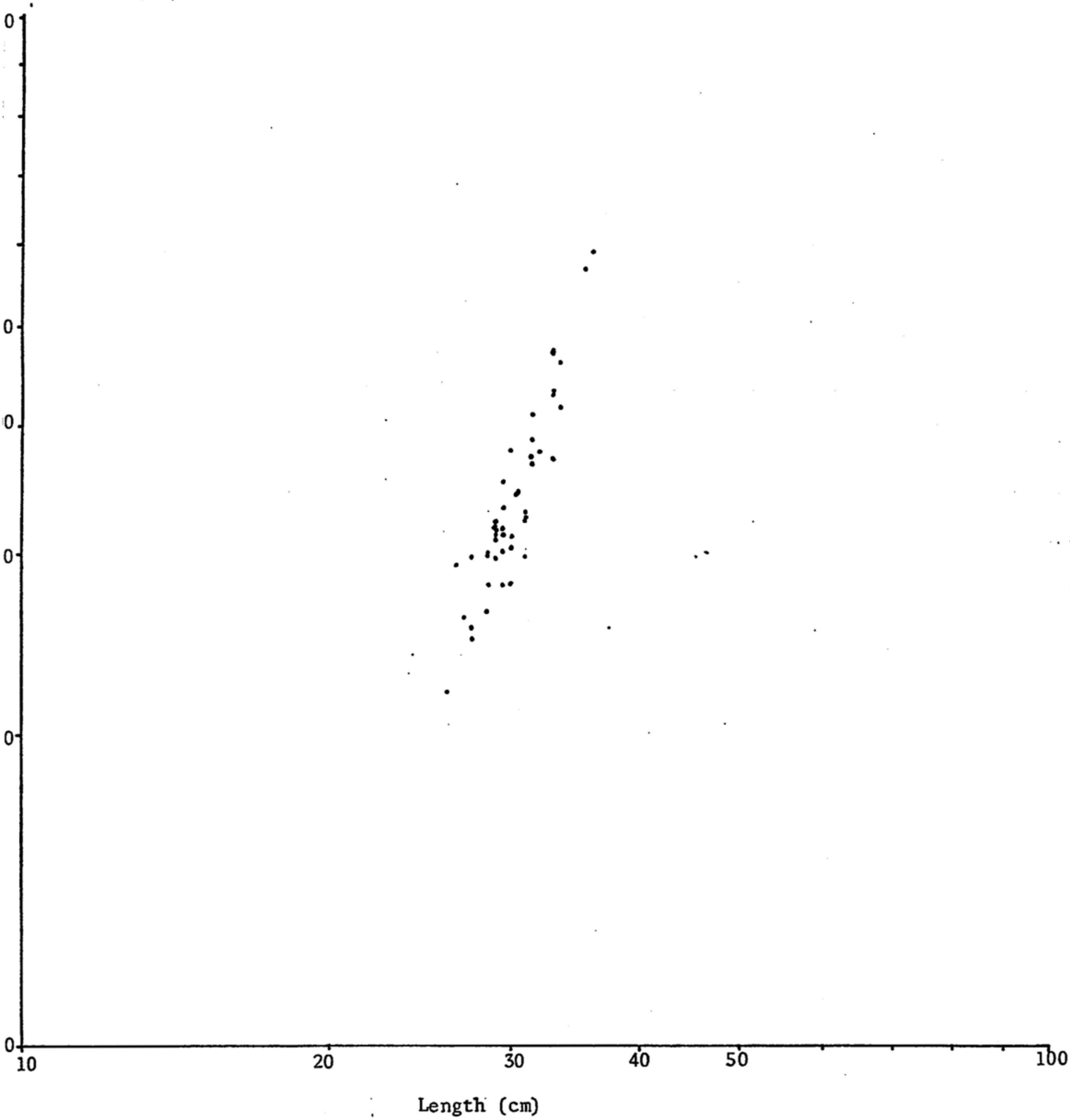


FIGURE 76 Sucker Weight-Length Regression

IV. SUMMARY

Tides

Tides at Logiecroft were of the mixed, semi-diurnal type similar to Rustico. Time of high water of the major mode lagged behind Rustico by varying periods, usually between one and two hours. The magnitude of the major mode also varied in relation to the Rustico tides, varying between 0.39 and 0.97 times the Rustico magnitude. Current observations at the narrows between the two lagoons suggests the southern lagoon flushes faster than the northern lagoon.

Bathymetry

The lagoons are characterized as being generally shallow (less than 1 m depth) except in channels which in the lagoons are mostly between 2 and 3 m depth. The "mud flats" adjacent to the dunes have an average depth of about 30 cm (referred to lowest low water observed in July, 1975).

Salinity, Temperature and Currents

The degree of salinity stratification in the three major rivers increased in the order Black River - Kouchibouguacis River - Kouchibouguac River; the Black River had a salinity structure tending toward the "partially mixed estuary" type, while the Kouchibouguacis structure had features characteristic of the "salt wedge" circulation type. Differences in the degrees of stratification are probably related to differences in river discharge, this being greatest (per unit cross-sectional area) for the Kouchibouguac River.

The degree of salinity stratification decreases down the rivers and the channels towards the sea; this must be accompanied by increased mass flow past any point of land as the sea is approached.

Within the lagoon, away from the channels, there is little if any stratification; salinities in the lagoonal area were generally in the range 20-30 ‰ during the summer.

Within the Kouchibouguac estuarine system, almost the full range of estuarine circulation patterns is present, from vertically homogeneous in the lagoonal waters to the salt wedge type in the Kouchibouguac River. The exact structures within the river changes with the tide, and seasonally. During the summer of 1965, minimum surface water salinities in the rivers (within the Park) increased from less than 3 ‰ in June and early July and early

July to 11.5 ‰ in late August.

Temperature profiles were complementary to the salinity profiles, with high temperatures in the lower salinity waters; thermoclines and heloclines, when they were distinct occurred between 2 and 6 ft. (0.6 and 1.8 m). Surface water temperatures increased from a mean of about 7 1/2° C on June 10 to a maximum average of about 24.5° C on August 6, then declined to about 20° C on August 29.

Currents were generally strong and regularly reversing with the tide in the rivers and channels, while in the broad lagoonal expanse areas from the channels they were weak and less regular. Currents recorded from river-channel areas reached values as high as 1.25 m/sec; in the lagoonal expanses they were generally between 5 and 25 cm/sec.

Sediments

Within the channels, soft "sandy muds" predominate; these are generally stabilized by a surface mat, possibly diatomaceous in nature. In areas of channels subject to strong currents, highly compacted "gravelly sands" occur, and in the region of the passages through the sand dunes, the compacted gravelly sands are overlain by transitory well-suited coarse sands.

"Sandy muds" predominate in the broad lagoonal expanses of the northern lagoon, and "gravelly sands" in the southern lagoon. It is suggested that this difference is associated with the recent recolonization (within the last 15 years) of the lagoonal expanses by eelgrass, and the greater fresh water input and associated sediment load going into the northern lagoon. On this basis, it is predicted that the sediments of the southern lagoon will become increasingly "muddy". This has important biological implications.

The Major Biofacies

Five major "biofacies" which are discretely distributed were defined. These are (1) Ruppia-mud, (2) Ruppia-Zostera-mud, (3) Zostera, (4) Channels, and (5) Beaches. The Ruppia-mud biofacies occurs towards the heads of the rivers (within the Park). The Zostera biofacies occurs over the broad lagoonal expanses, excluding the channels and extending up the rivers in a wedge shape; between the Ruppia-mud and Zostera biofacies, the zone of overlap of Ruppia and Zostera is delineated as the Ruppia-Zostera-mud biofacies.

The upstream limits of Zostera distribution (and the corresponding downstream limit of the Ruppia-mud biofacies) is believed to occur at a point where salinities go below 4-5 ‰ for prolonged periods.

The Zostera biofacies covers more than 90% of the estuarine system. Three subdivisions of this biofacies were defined: Zostera-mud, Zostera-sand and Bare sand; these occur in a patchwork type distribution within the Zostera biofacies. The beach biofacies includes the sandy intertidal beaches. These are areas of high clam production.

Infauna, Epifauna and Small Fish

There were some important differences between the various biofacies or their subdivisions with respect to the associated fauna, notably:

1. Observed (from stomach contents) major prey species (sand shrimp, silversides, sand lances) occurred mainly in the Zostera-sand and bare sand biofacies, or were species which leave the dense Zostera stands at hight for more open areas. The implication is that the predators (tomcod, trout, bass, smelt) do not feed in the dense eelgrass stand. It is suggested that the physical structure of these stands and the large diurnal fluctuations in oxygen within the stands to make them inhospitable to the predator species. Because Zostera and associated fine sediment accumulation are still increasing, it is suggested that the possible feeding areas for these predators will decrease in the future.
2. Crabs and mussels occurred in greatest numbers in channel biofacies. These species do not do well in Zostera biofacies because of space limitation (crabs) and smothering by fine sediments (mussels).
3. Clams were generally abundant only in the beach biofacies.

Some species were widely distributed and commonly abundant in the shallow submerged biofacies, notably Littorina littorea (edible periwinkle), Mytilus edulis (mussel), Macoma balthica (infaunal bivalve), Nereis virens and Glycera dibranchiata (polychaete worms), and various gastropods. Several crustaceans were observed only in the Zostera biofacies, although they may leave this at night. The predatory (on bivalves) species, Lunatia heros (moon snail) and the star fish, Asterias vulgaris, were most abundant in channels. The region of Little Gulley - the "Marine sandy zone" of the channel biofacies - is a unique area with high concentrations of mussels, crabs, and lobsters.

The Algal Flora

Ten species of brown and red "seaweeds" excluding P. subtilissima were encountered in the lagoon. Overall, Fucus distichus is the most common of these species. None make up a major portion of the plant biomass in the lagoons. The discovery of Gracilaria foliifera in the lagoonal waters is the first record for this species in New Brunswick. The red and brown algae exhibited some interesting distribution of patterns; G. foliifera, for example was common in the southern part of the southern lagoon, but not elsewhere, while Ahnfeltia plicata was common in the northern lagoon, but was not found in the southern lagoon. Many of the red and brown algal species were commonly unattached, lying motionless between the blades of Zostera. With two exceptions, however, they all appeared to be normal inhabitants of the lagoon (i.e. not drifting from the sea).

Polysiphonia subtilissima (red algae) was a common epiphyte on eelgrass, and may contribute substantially to primary production. This was the only red algal species penetrating the estuarine sectors of the rivers.

Some green algal species made up a substantial portion of the plant biomass. Enteromorpha intestinalis occurred in large quantities in the rivers and Chaetomorpha linum, in the lagoon.

No substantial quantities of Irish Moss, Chondrus crispus were found in the lagoon.

The Submerged Angiosperms

The most important biological feature of the estuarine system as a whole is the occurrence of submerged angiosperms throughout the system, except in channels. Except in the upper, less saline reaches of the rivers where Ruppia maritima occurs, eelgrass (Zostera marina) predominates. This plant increases greatly in biomass during the month of June; in mid-July anthesis occurred and by the end of July, seeds were found in the water column. During its initial growth in June it seems to be easily eroded and masses of fresh eelgrass, and also Enteromorpha which increases greatly in biomass during the same period, were observed in the water column. These drifting masses catch in nets, making fishing very difficult during June and July. Eelgrass began regrowing in this system about 15 years ago, presumably following its near absence there since the general decimation of Zostera in the '30's.

Eelgrass stands over most of the northern lagoon were judged to be mature; i.e., fully developed, while it appears that eelgrass may still increase in abundance in the southern lagoon. It is suggested that while the eelgrass forms a major food base for the system, it is "counterproductive" for many desirable species because of adverse physical, chemical and sedimentary conditions associated with the eelgrass stands.

Nutrients and Oxygen

Lagoon and river mouth waters sampled during the daytime between July 17 and August 28 were generally supersaturated with oxygen, reflecting the high primary production associated with macrophytes. It appears that in dense eelgrass stands, oxygen levels at night may fall below critical values for desirable fish species.

Concentrations of inorganic nitrogen (NO_3^-, NO_2^-, NH_4^+) and phosphate were generally low. Nitrate was undetectable in most samples. Phosphate concentrations were generally above the level considered limiting for marine plant growth. A low N:P ratio suggests nitrogen was the limiting nutrient for plant growth. Roots of *Zostera marina* exhibited nitrogen-fixing activity, and it is suggested that the high productivity of *Zostera* in this system is associated with uptake of nitrogen and phosporus from the sediments.

Irish Moss

We could find no basis for the claims of local fishermen that harvestable quantities of Irish Moss occur in the lagoon waters.

Clams

Population dynamics of the beach clam populations were examined, and rates of growth and mortality estimated for exploited and unexploited populations. It appears that the clam population as a whole is intensively exploited. Quantitative estimates of total yields and catch per unit effort were made for different rotation harvest schemes. A three year rotation harvest appears optimal. According to our calculation, it would result in a doubling of yield for the Park as a whole, and an increase in catch per unit effort by a factor of 5.

Mussels

While mussels are widely distributed and generally abundant in the Park waters, mussel "beds" are not extensive. Further, there are few with many mussels of length greater that 50 mm, the size generally harvested. The mussels are loosely attached in these beds, and could be easily harvested. Recovery of intensively exploited beds might be very slow or might not occur.

Periwinkles

Common periwinkles are present in high numbers in the lagoonal system, but are generally small (less than 15 mm height).

Oysters

Although it is evident that oyster beds were once reasonably extensive in the Park waters, notably in the Logiecroft area, only a few beds are now to be found. The decrease may have been associated with Melpeque disease, or with renewed eelgrass growth or both. Whatever the cause, it is evident that conditions will become progressively less favorable for establishment of oyster beds in the future, because of increasing eelgrass growth and associated accumulation of fine sediments.

Lobster

Substantial numbers of lobster were found only in the Little Gulley region. Low numbers were taken in traps set in channels within the Park. This limited distribution is related to the limited availability of suitably stable bottom for burrowing.

Crabs

Crabs of exploitable sizes occur within the lagoon; only in channels are they present in any abundance. We are uncertain how or when the stock is recruited (as larvae or small crabs from outside of the lagoon). The crabs move rapidly towards bait, and it suggested that a much simpler method of fishing that the use of traps could be utilized.

Fish

Fishing was conducted through the summer (June 6 - August 28) using gill nets (1 1/2" - 6 1/2" mesh). Catches in eel traps were also examined. The fishing is an ongoing program, and more information is required for most species. The following is a summary of conclusions or results from the summer fishing.

Salmon - smolt were taken from traps in June. Only one salmon was caught, this on June 9. This individual was bright. Absense of salmon later in the summer may have been related to the unusually dry summer and consequent lack of appropriate signals for salmon outside to move into the rivers.

Gaspereau - Gaspereau were taken in abundance during their spawning run in June.

Striped Bass - Small bass, presumably 1 and 2 years of age were caught in eel traps in early June. Occasional bass were taken through the summer; all were small, less than 34 cm in length. Stomach contents consisted mainly of sand shrimp, sand lances and silversides, all fauna characteristic of bare sand and *Zostera*-sand biofacies.

Brook Trout - Small trout were caught in eel traps in early June. Occasional trout were taken up until July 31, the largest individual was 1.1 kg in weight.

Smelt - Post spawning smelt were taken in traps and nets between June 5 and June 23. Stomach contents included sand lances.

Tomcod - Large numbers of tomcod were taken in eel traps in early June. These appeared to include mainly 1, 2, or 3 year old fish. Occasional individuals were taken after this up to July 28. We were surprised to observe large numbers in January in the Miramichi.

Smooth Flounder - Large numbers of smooth flounder were taken in traps in early June and they were observed in lagoonal waters throughout the summer, both in channels and in eel-grass beds. Size-frequency distributions suggest 9 age groups were present and indicate a growth rate of about 3 cm/annum.

Eels - Yellow eels were caught in large numbers in eel traps in early June. This may represent a minor spring migration of yellow eels towards the lagoon. Eels were observed in eel-grass beds throughout the summer.

White Sucker - Suckers were caught in the Kouchibouguac River near the Park boundary in July. This area is within the zone of marine influence.

General Comments - In general, the seasonal occurrence of the various species was as expected. We did not catch shad, white perch, winter flounder, mackerel or capelin which have previously been reported in Park waters.

The occurrence of significant numbers of small trout, bass and salmon in eel traps points to the need to examine this fishing further for its possible influence on other species.

Other Species of Possible Exploitable Value

Gracilaria foliifera is an "agarophyte". It is not presently commercially exploited in Canadian waters. The southern part of the Kouchibouguacis Lagoon appears to be a favorable environment for this species and this area might at some time be suitable for cultivation of this species.

Moon snails are mentioned by Caddy et al (1974) under the category "miscellaneous unexploited species". They are present in the Park waters in fairly large numbers and might be utilized by tourists.

Seeds of Zostera marina were utilized at one time by California industries to make flour (Felger and Moser, 1973). Such a use might appeal to tourists.

V. DISCUSSION: AN OVERVIEW

We have provided up to this point in the report detailed information concerning individually identifiable processes or objects, integrating the information best we could along the way. In this section, we present our view of the system as a whole, in the context general management considerations.

There are no comparable studies to this one on the sort of system that exists in the marine sector of Kouchibouguac Park. While some of its properties might have been predicted *a priori*, the impression we have of the system after one season's intensive field work is far different from that we had anticipated. Viewing the lagoons from the boardwalk at Kelly's Beach, one gets the impression of broad expanses of lagoon teeming with life. One only has to look down beside the boardwalk to see schools of silversides and occasional and bass; clumps of Zostera are viewed round and about, and clams are taken in seemingly unendless quantities from the nearby beach.

This situation does not prevail throughout the lagoons however. The shallows of the Kelly's Beach area are unusual in being a region of moderate currents - these resulting from tide induced differences. in water levels between the lagoons, and spillovers through this narrow neck. The bottom is sandy with only scattered eelgrass, thus allowing free movement of fish, which congregate around the boardwalk to avoid the glare of the mid-day sun. The constant current brings with it a continual supply of small invertebrates, and maintains oxygen at favorable levels. The clam population of the beach area, as it turns out is one of the most productive ones, at least potentially, the density of small clams ranking 6th of 38 areas examined. This in turn is associated with a favorable substratum and consistent currents bringing food and young to settle.

Such conditions are unusual. Over broad expanses of the lagoons, more so in the northern lagoon then in the southern, currents are almost non-existent. Thickets of eelgrass growth extend to the surface damping the slight water motion that exists. Fine sediments fall out of suspension and when they are stirred up, smother invertebrates or cause them to cease feeding. Even though some mussels and clams may occur there, their growth rates are low. The high density of the eelgrass turions prevents free movement of larger fish and of burrowing activities by crabs. Because the thickets extend to the water surface, the fish do not have access from above. Dead leaves accumulate on the sediments consuming oxygen and stimulating sulfate reduction and production of sulfide below. During the daytime, oxygen is produced in abundance, at least in the upper levels of the canopy, but at night falls to levels critical for many "desirable" species. The large expanses of dense eelgrass stands are in one sense comparable to the aquatic weeds associated with lake eutrophication.

Thus, for many of the "desirable" (harvestable) species, e.g. clams, mussels, crabs and the larger predatory fish, these areas are inhospitable, In the winter when ice cover further restricts gas exchange with the atmosphere and the macrophyte production of the previous season consumes the oxygen present, probably leading to widespread and continuous low oxygen conditions and perhaps anaerobesis and sulfide in the water column.

This does not mean, however, that the eelgrass beds do not in some way support desirable species. Crustaceans and worms move out of the eelgrass beds at night, en masse, into the more open areas or descend into channels. For these species (e.g. Nereis, Mysis, Gemmarus, Idotea) the eelgrass beds are a protective habitat during the day, but at night when they move away, they are subject to predation. Further, a constant stream of detritus and its associated organisms from the eelgrass beds provides food for filter-feeding organisms in the more open areas. The important point is that the desirable species occur outside of the dense eelgrass stands and that these open areas are of relatively restricted extent. Accordingly, the species which occupy the open areas are not on the whole abundant in the Park waters, at least not in comparison to the total area of the lagoons. These species include the mussels, oysters, the quahaug (hard shelled clam), crabs and lobsters. Perhaps potential seasonal visitors; e.g., winter flounder and mackerel, should also be included in this category.

The channels through the lagoon are particularly vital areas, because they are eelgrass free. Currents maintain favorable oxygen conditions and bring continuous supplies of suspended particles for the filter feeders. Surrounded by eelgrass beds they must be sites of intense activity at night and it is here that much of the feeding activity of the nekton must take place[1] It is only in the channels that high concentrations of mussels, crabs, lobsters and flounder occur. An important consequence of this is that because the only major populations do occur here they might be quickly fished out. This is particularly so of the mussels and lobster. The mussel beds are loosely attached and are easily removed . If a bed was completely removed, it might be a long time (if at all) before conditions would be suitable for re-establishment of the mussel bed. Further, in the channel mussel beds the population structure indicated that recruitment is not continuous - older mussels seem to prevent settlement of young and growth is slow. Thus non-complete, but intensive harvesting could not be sustained. Lobsters are abundant only in the Little Gully region, and the area could be rapidly fished out. Crabs and flounder do occur in the eelgrass stands and these might form a reservoir to replace those taken from channels where they are most efficiently harvested.

The extent to which the larger fishes are affected by the eelgrass situation is somewhat uncertain. The salmon do not normally feed extensively in the estuarine sector in any case, and their numbers are dependent more on the stream conditions above the head of the tide. might also be considered in the same category although juveniles may spend limited time in the lower part of the estuary. For these species, the broad expanse of the lagoons is of little consequence one way or the other. It is important to realize in this respect that the rivers of the Park are not major rivers and that while these fish may be locally abundant, it is unlikely that their populations would sustain intensive commercial fishing.

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1. It should be mentioned also that two seals, presumably harbour seals, were observed in channels during July, 1975. These may feed extensively on the benthos.

Other migratory species - trout, striped bass, smelt and tomcod do normally feed in the lower estuary at some time. Smelt, which generally leave the estuary before the maximum biomass of Zostera is reached, may not be adversely affected by the Zostera, in fact conditions then may be ideal in the spring when Zostera is just beginning to grow. Tomcod occurring in the estuary in the spring may also find feeding conditions favorable. However spawning areas for the tomcod (over sandy or gravelly bottoms, under the ice in winter) in the Park are probably relatively restricted.

Foraging sites for trout and striped bass are undoubtedly restricted by the dense eelgrass growth. Thus we found species characteristic of the open sandy areas or of sandy areas interspearsed with Zostera stands in their stomachs, but not the mummichog which is most abundant in the eelgrass beds (it is a major prey species elsewhere). If, as we have predicted, eelgrass growth increases further in the southern lagoon, the feeding areas for these species will become more restricted

A few species are abundant in the eelgrass stands, and large populations do occur in the Park. These include periwinkles and eels and mussels. The mussels are generally small however, are irregularly distributed and could not be easily harvested without mass upheaval of the Zostera beds. The same applies for periwinkles. Certainly there need be no restriction on harvesting of the periwinkles providing non-destructive methods are used. The eelgrass beds are a prime site for eels and this species is certainly abundant in the Park system as a whole. As mentioned above crabs are common in the eelgrass beds and while they might not be easily harvested there, they might form an important reservoir to restock populations exploited from the channels.

The prime habitat of soft-shelled clams occurs above the level of eelgrass growth, thus they are relatively unaffected by the eelgrass, and are correspondingly abundant in proportion to the occurrence of suitable beaches. However, the areas of highest abundance seem to be in beaches adjacent to sandy sublittoral sediments. Thus some decrease in general abundance might be expected in the future in the southern lagoon if as we have suggested, eelgrass and muddy bottoms become more widespread there.

Aside from their importance as feeding grounds and habitats, the channels through the lagoon constitute vital "canals" or roadways through the lagoonal system. For the majority of species there are no alternate pathways to the spawning grounds. Boat traffic also is limited to the channels. In a generally shallow system in particular it is in the channels that key sedimentary and water exchange processes occur. The channels may be viewed as the heart of the estuarine system, biologically and physically. The lagoonal channels are few, narrow and short. Together with the region at the head of the tide, so for the anadramous fishes, the channels must be given the status *Areas of Particular Concern* within the Park, and afforded appropriate protection. For this reason on its own, intensive fishing activities in the channels must be avoided.

On the whole, it is our impression that the Kouchibouguac estuarine system is a rather delicate one, with high production of only a few species with the possible exception of clams and smelt. Intensive fishing of other species is likely to have some effects beyond that on the desired species itself. The spring months, for example, are a period of multiple species activity, and fishing for one species will almost certainly take others as well. Intensive fishing activity in the lagoon channels by any methods involving dragging devices or even constant setting and removal of heavy traps may cause extensive disruption of the soft, feebly stabilized sediments. Such disruptions might lead to extensive erosion and smothering of mussel populations as well as causing upheaval of crab habitats. Species within the eelgrass canopies are dispersed and not easily collected by non-destructive means. Even traversing these areas in a power boat causes some upheaval and redistribution of sediments which, if conducted on a large scale, might have widespread adverse effects. No species at the moment appears to be in danger from overfishing. However, by appropriate management, yields of a number of species might be substantially increased. Further limited commercial fishing of some species could be done without adverse effects.

We do not mean to give the impression, as we may have done, that this system is one suffocated by an aquatic weed problem and "eutrophication" in its ugliest sense. The growth of eelgrass as we observe it in this type of system is a natural phenomenon simply interrupted for a brief period in recent history by some sort of natural catastrophic event. The changes that have occurred with regrowth of eelgrass are mainly quantitative ones rather than the qualitative ones, and even though they may have led to somewhat lower production of desirable species than might be the case in the absence of eelgrass, there is no question of attempting to reverse this natural phenomenon. The system remains rich in its diversity and highly productive of some species. In the end, the greatest value of the system lies in its near pristine state. With appropriate care, this need not be altered greatly by harvesting of its resources.

Regulations for exploitation of biological resources vary from simple to detailed according to the information on the resource available and the exploitation pressure. At the simplest level, the only regulation concerns closed seasons. These are considered in relation to seasonal activities of the species concerned. Specifying fishing gear, mesh sizes and specific areas for fishing requires more information on the species concerned. Limiting numbers taken require (or should be based on) some information of the population structure and abundance. In only a few fisheries is sufficient information available to objectively set limits for the total catch; the seal population is an example. Gathering of such information is a formidable task as is also the monitoring of catches and although desirable, it is quite obviously impossible to obtain such information for every species that is subject to intensive harvesting.

A practical alternative to this, and more sophisticated than "simple" regulations, is suggested by our studies on the clam population. For this intensively exploited population, only one regulation exists (other than banning fishing in polluted areas) - that being a minimum size limit. This is certainly inadequate, both from the biological point of view and from the point of view of envorcing the regulations. Given detailed knowledge of the population dynamics, appropriate maximum "sustainable yields" could be calculated. However, implementation of regulations to ensure that such yields are not exceeded presents practical problems. The alternative suggested by our very simple calculations is implementation of ROTATION HARVEST schemes.

For three year rotation harvests, we calculated yield for the system as a whole would double. Further, catch per unit effort would go up by a factor of 5 - certainly a benefit to the exploiters. Thus it would be expected to catch twice the previous number of clams with 1/5 of the previous effort. This system also has the biological advantage of ensuring existence of large stocks to maintain adequate recruitment and has the practical advantage that it is easy to enforce. A three year rotation harvest appears optimal for this species which becomes of harvestable size at 3 to 4 years of age. By analogy, it can be reasonably guessed that for other invertebrate species, a rotation harvest at intervals corresponding to the age at which the species becomes harvestable would likewise be optimal.

Could a rotation harvest scheme be utilized for anadramous fish populations? For invertebrates with pelagic larval stages, recruitment seems to be determined by factors other than the size of the reproductive stock or population fecundity, at least within fairly wide limits. Further, one population may be recruited largely from larvae produced by other populations. For anadramous fish populations, however, population fecundity does have a major influence on recruitment - if a fish is not in the stream to lay eggs, none will develop there. Further for those species with strong homing tendencies, local populations are entirely dependent on their own population for recruitment. A rotation harvest scheme applied to such a population might be expected to have even greater benefits than for marine invertebrates because recruitment would be enhanced. Further, by taking into consideration the interval between birth and return to the stream, competition between young year classes (parr for example), etc., it may be possible to increase yields substantially with relatively short interharvest intervals or with longer harvest intervals and thereby allow a good fraction of the streams to be fished at any one time.

Rotation harvest schemes do not seem to be in common use, perhaps because of the local nature of fisheries - although banning fishing in some areas for a period because of overexploitation is in principal the same idea. For a relatively small system such as the Park, in which it is not of great inconvenience to fishermen to restrict fishing to a few locales, it would seem to be practical. For species for which it is uncertain to what extent they are exploited, and for which more time is required to obtain the appropriate information, rotation harvests would provide a sensible alternative to either banning fishing, or simply continuing the *status quo*. Where a number of species are involved, the interval for the rotation harvest could be a compromise or mean between the intervals appropriate for the various individual species. Further, since any interval (except for an annual interval) below the optimum harvest interval would have some beneficial effect, the interval selected could be biased somewhat by considerations of how many different areas can be practically delineated.

In the recommendations, we have attempted to present possible alterantives with respect to management of resources. It is realized that the most desirable management schemes may be the most expensive and difficult to carry out. To say that some commercial fishing of a resource could be conducted does not mean we recommend that it be done - this is a matter of Parks policy. We have attempted to accommodate, however, within the recommendations, the multiple demands on this system and the need for frugality in these times.

Other recommendations or management schemes might be conceived. If the main body of our report provides the basis for this, then it has achieved its primary aim - to provide a broad scientific basis for management considerations.

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VII. APPENDICES

APPENDIX A SEDIMENT SAMPLE ANALYSES

Sample Number	Reference Number	Figure Number	Field Description
1	P-3	48	Vert. Dist. Level. 3 26-7-1975 (core)
2	20	29	Core No. 6 19-8-1975
3	KB	44	Core No. 12 20-8-1975
4	9	44	Core Clam 1 27-8-1975
5	T-1	44	Core No. 1 T. I 21-8-1975
6	37	44	Core Clam 1 15-8-1975
7	43	29	Core No. 4 23-7-1975
8	52	29	Core No. 1 13-8-1975
9	P-7	48	Vert. Dist. Level 7 26-7-1975
10	53	29	Core No. 1 P.S. 8-8-1975
11	56	29	Core No. 1 P.S. 18-8-1975
12	C-2	11	No. 43 (outside of the bag)
13	5	29	Core No. 2 P.S. 7-8-1975
14	29	29	Core No. 1 11-8-1975
15	C-1	11	No. 46 (outside of the bag)
16	23	29	Core sample, Point Stn. 1 16-7-1975
17	41	29	Core No. 4 P.S. 8-8-1975
18	11	29	Core No. 3 19-8-1975
19	28	29	Core No. 9 18-7-1975
20	C-3	11	No. 57 (outside of the bag)

GRAIN SIZE ANALYSIS

Initial weight:

Final weight:

Working number: 1

Sample number: Vert. Dist. Level 3
26-7-75 Core

Analyst: A.E.A. Date: February, 1976

Map No.: P-3

FINE FRACTION

Treatment:

Peptiser: Batch: Wt. per 20 ml:

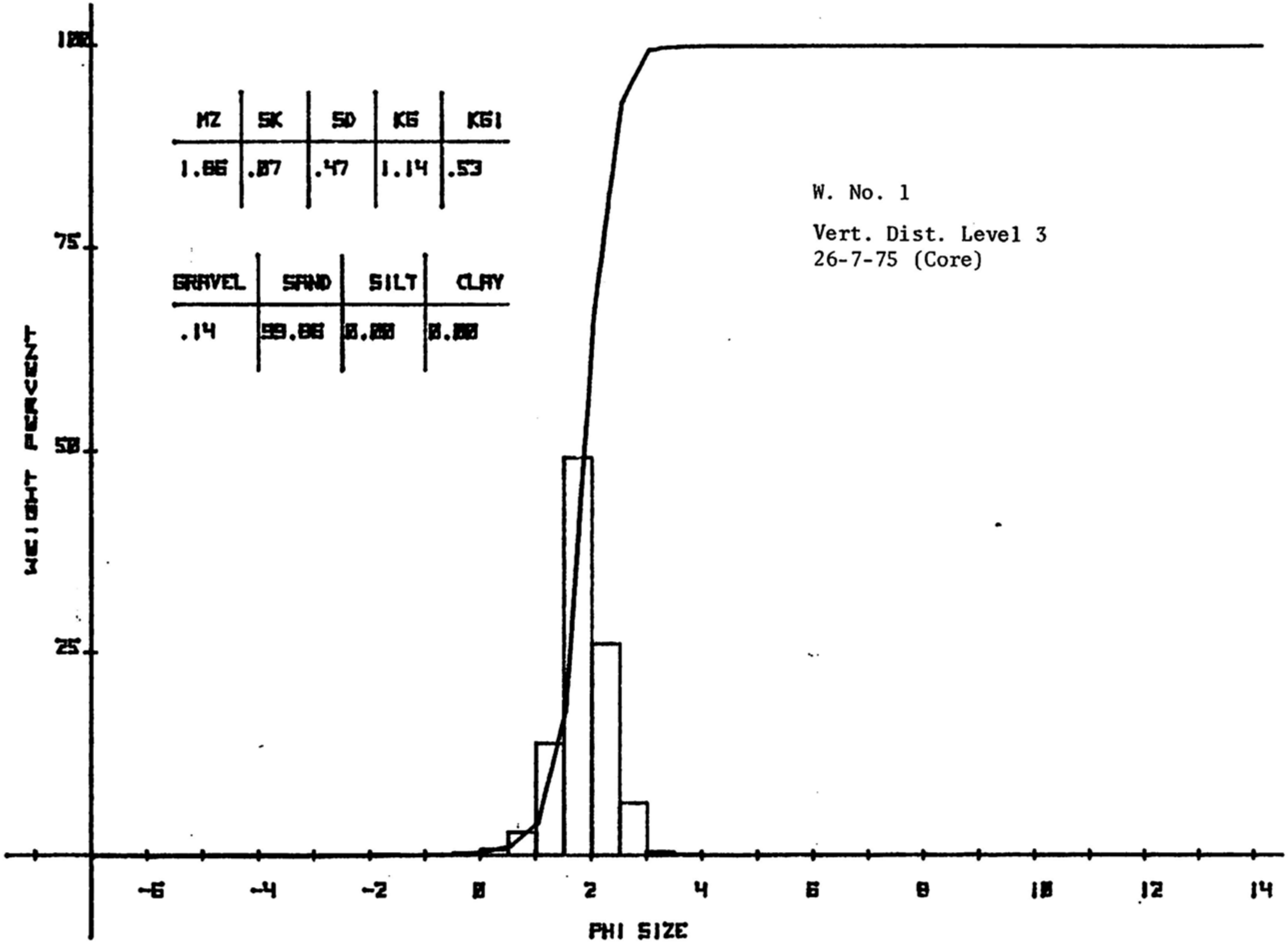
Size	Dish	Dish Wt.	Dish Sed.	Sed. Wt.	less Calgon	x 50	%	Notes

SAND FRACTION

Sieve Analysis No.

146.3757 gm.

Size	Dish	Dish Wt.	Dish & Sed.	Sed. Wt.	Cum. Wt.	%	Description
-1 1/2				0.1545			25% shell & organics
-1ø				0.0545			approx. 50% shell & organics
-1/2				0.1140			25% shell & organics
0ø				0.3690			10% shell & organics
1/2				1.0125			5% shell & organics
1ø				4.1490			
1 1/2				20.1975			
2ø				71.9100			
2 1/2				38.1278			
3ø				9.4120			
3 1/2				0.5870			
4ø				0.1679			
pair				0.2590			


MZ | SK | SD | KG | KGI
1.86 | .07 | .47 | 1.14 | .53
GRAVEL | SAND | SILT | CLAY
.14 | 99.86 | 0.00 | 0.00
W. No. 1
Vert. Dist. Level 3
26-7-75 (Core)
WEIGHT PERCENT
100
75
50
25
-6
-4
-2
0
2
4
6
8
10
12
14
PHI SIZE

GRAIN SIZE ANALYSIS

Initial weight:

Final weight:

Working number: 2

Sample number: Core No. 6 19-8-75

Analyst: A.E.A Date: February, 1976

Map No.: 20

FINE FRACTION

Treatment:

Peptiser: Batch: Wt. per 20 ml:

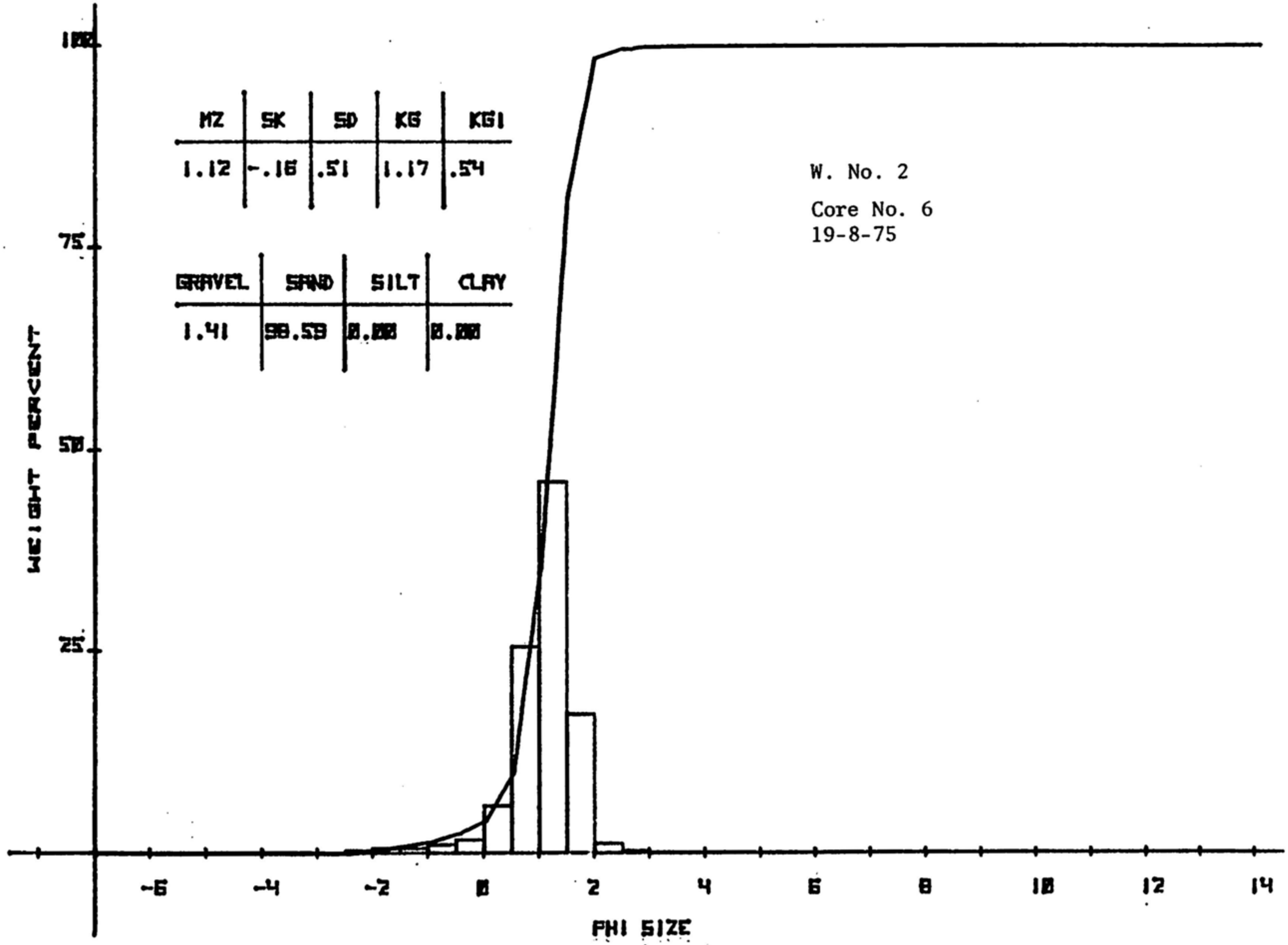
Size	Dish	Dish Wt.	Dish Sed.	Sed. Wt.	less Calgon	x 50	%	Notes

SAND FRACTION

Sieve Analysis No.

155.759 gm.

Size	Dish	Dish Wt.	Dish & Sed.	Sed. Wt.	Cum. Wt.	%	Description
-2ϕ				0.4670			25% shell
-1 1/2				0.8425			approx. 5% shell
-1ϕ				0.8785			approx. 7% shell
-1/2				1.5805			approx. 3% shell
0ϕ				2.5100			
1/2				9.0280			
1ϕ				39.6465			
1 1/2				71.6027			
2ϕ				26.6850			
2 1/2				1.8226			
3ϕ				0.4257			
3 1/2				0.1230			
4ϕ				0.0370			
pair				0.1100			



MZ | SK | SD | KG | KG1
1.12 | -.16 | .51 | 1.17 | .54
GRAVEL | SAND | SILT | CLAY
1.41 | 98.59 | 0.00 | 0.00
W. No. 2
Core No. 6
19-8-75
WEIGHT PERCENT
100
75
50
25
-6
-4
-2
0
2
4
6
8
10
12
14
PHI SIZE

GRAIN SIZE ANALYSIS

Initial weight:

Final weight:

Working number: 3

Sample number: Core No. 13 K.B. 20-8-75

Analyst: A.E.A. Date: February, 1976

Map No.: K.B.

FINE FRACTION

Treatment:

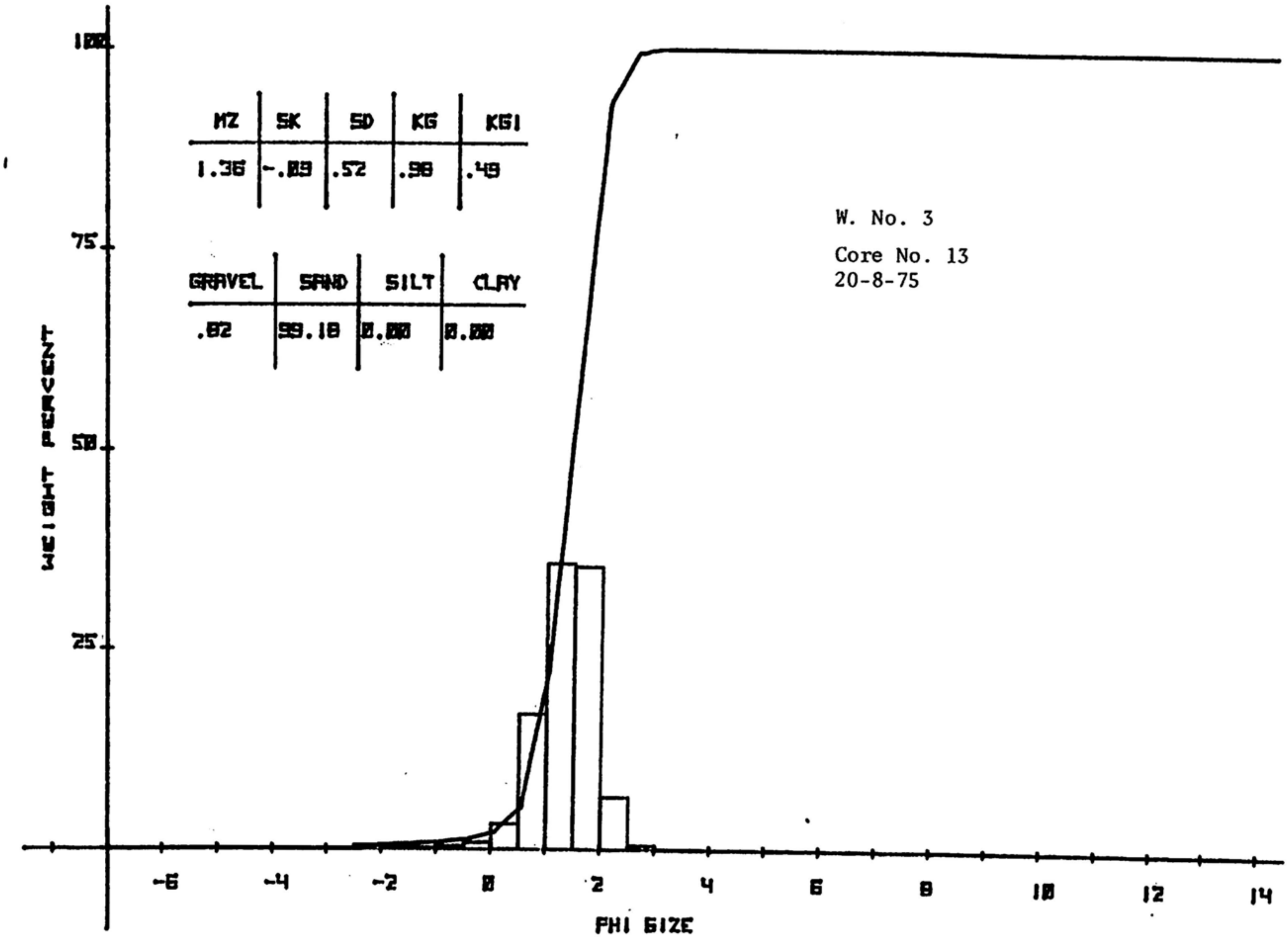
Peptiser: Batch: Wt. per 20 ml:

Size	Dish	Dish Wt.	Dish Sed.	Sed. Wt.	less Calgon	x 50	%	Notes

SAND FRACTION Sieve Analysis No.

147.4447 gm.

Size	Dish	Dish Wt.	Dish & Sed.	Sed. Wt.	Cum. Wt.	%	Description
-2ϕ				0.6700			
-1 1/2				0.2490			
-1ϕ				0.2875			
-1/2				0.5385			10% shell
0ϕ				1.1945			
1/2				4.6345			
1ϕ				24.7660			
1 1/2				52.4953			
2ϕ				51.8990			
2 1/2				9.5570			
3ϕ				0.7000			
3 1/2				0.0500			
4ϕ				0.0479			
pair				0.3555			


MZ SK SD KG KG1
1.36 -.03 .52 .98 .49
GRAVEL SAND SILT CLAY
.82 99.18 0.00 0.00
W. No. 3
Core No. 13
20-8-75
WEIGHT PERCENT
100
75
50
25
-6 -4 -2 0 2 4 6 8 10 12 14
PHI SIZE

GRAIN SIZE ANALYSIS

Initial weight:

Final weight:

Working number: 4

Sample number: Clam - 1 Core 27-8-75

Analyst: A.E.A. Date: February, 1976

Map No.:

FINE FRACTION

Treatment:

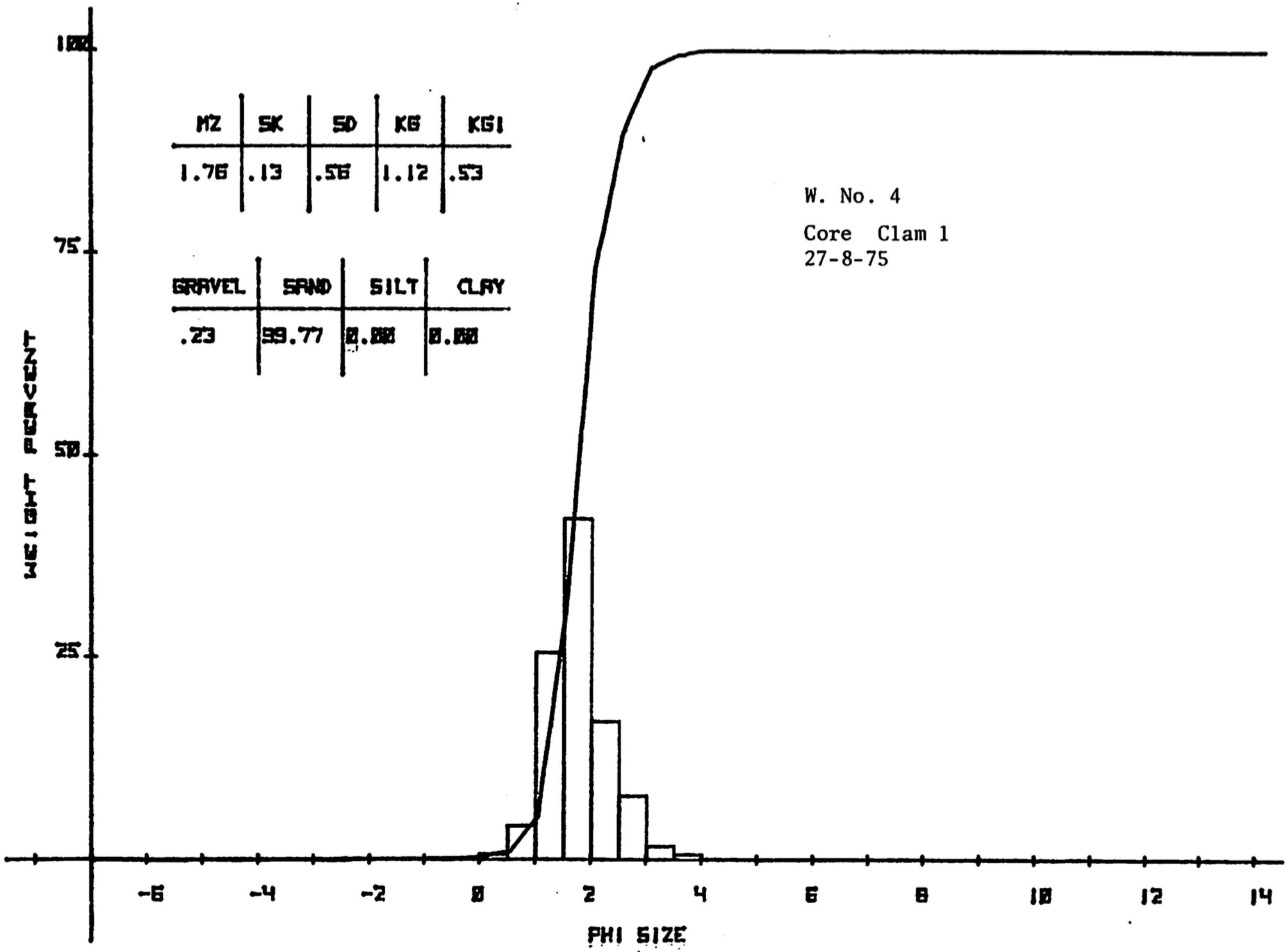
Peptiser: Batch: Wt. per 20 ml:

Size	Dish	Dish Wt.	Dish Sed.	Sed. Wt.	less Calgon	x 50	%	Notes

SAND FRACTION Sieve Analysis No.

171.8084 gm.

Size	Dish	Dish Wt.	Dish & Sed.	Sed. Wt.	Cum. Wt.	%	Description
-2ϕ				0.2190			
-1 1/2				0.0750			
-1ϕ				0.0965			
-1/2				0.0791			
0ϕ				0.2490			
1/2				1.0890			
1ϕ				7.0385			
1 1/2				43.1975			
2ϕ				71.2370			
2 1/2				28.8165			
3ϕ				13.3010			
3 1/2				2.7790			
4ϕ				0.9513			
pair				2.6800			


MZ SK SD KG KG1
1.76 .13 .56 1.12 .53
GRAVEL SAND SILT CLAY
.23 99.77 0.00 0.00
W. No. 4
Core Clam 1
27-8-75
WEIGHT PERCENT
100
75
50
25
-6 -4 -2 0 2 4 6 8 10 12 14
PHI SIZE

GRAIN SIZE ANALYSIS

Initial weight:

Final weight:

Working number: 5

Sample number: Core No. 1 TI

Analyst: A.E.A. Date: February, 1976

Map No.: T.I

FINE FRACTION

Treatment:

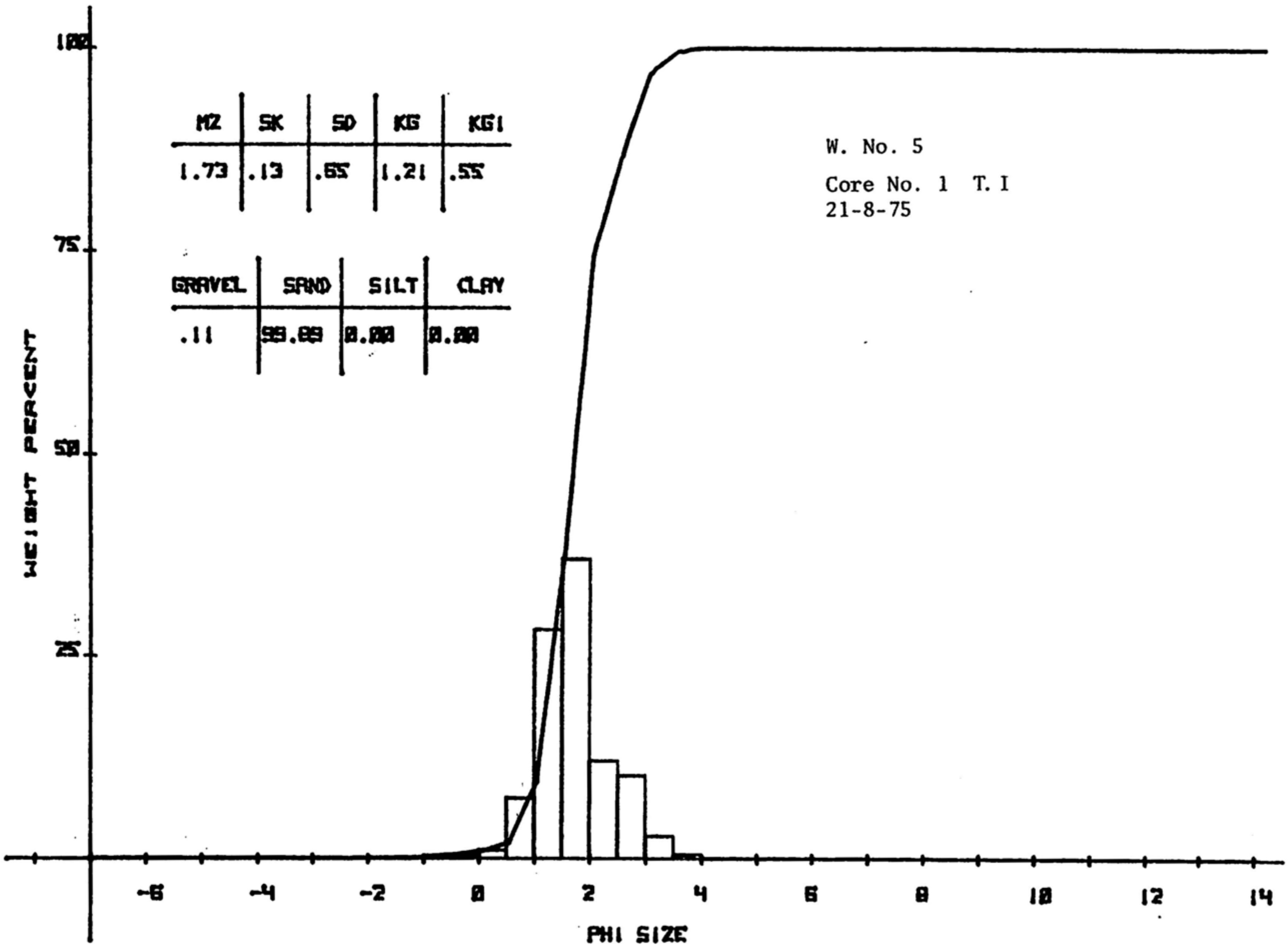
Peptiser: Batch: Wt. per 20 ml:

Size	Dish	Dish Wt.	Dish Sed.	Sed. Wt.	less Calgon	x 50	%	Notes

SAND FRACTION Sieve Analysis No.

153.5337 gm.

Size	Dish	Dish Wt.	Dish & Sed.	Sed. Wt.	Cum. Wt.	%	Description
-1 1/2				0.0085			a shell fragment
-1ø				0.1630			75% shell and shell fragments
-1/2				0.4652			80% shell and shell fragments
0				0.5982			40% shell and shell fragments
1/2				1.5370			10% shell and shell fragments
1ø				11.3920			approx. 5% shell and fragments
1 1/2				43.1160			
2ø				56.4628			
2 1/2				18.4010			
3ø				15.6035			
3 1/2				4.2090			
4ø				0.7035			
pair				0.8740			


MZ | SK | SD | KG | KG1
1.73 | .13 | .65 | 1.21 | .55
GRAVEL | SAND | SILT | CLAY
.11 | 99.89 | 0.00 | 0.00
W. No. 5
Core No. 1 T. I
21-8-75
WEIGHT PERCENT
100
75
50
25
-6
-4
-2
0
2
4
6
8
10
12
14
PHI SIZE

GRAIN SIZE ANALYSIS

Initial weight:

Final weight:

Working number: 6

Sample number: Clam - 1 Core 15-8-75

Analyst: A.E.A Date: February, 1976

Map No.:

FINE FRACTION

Treatment:

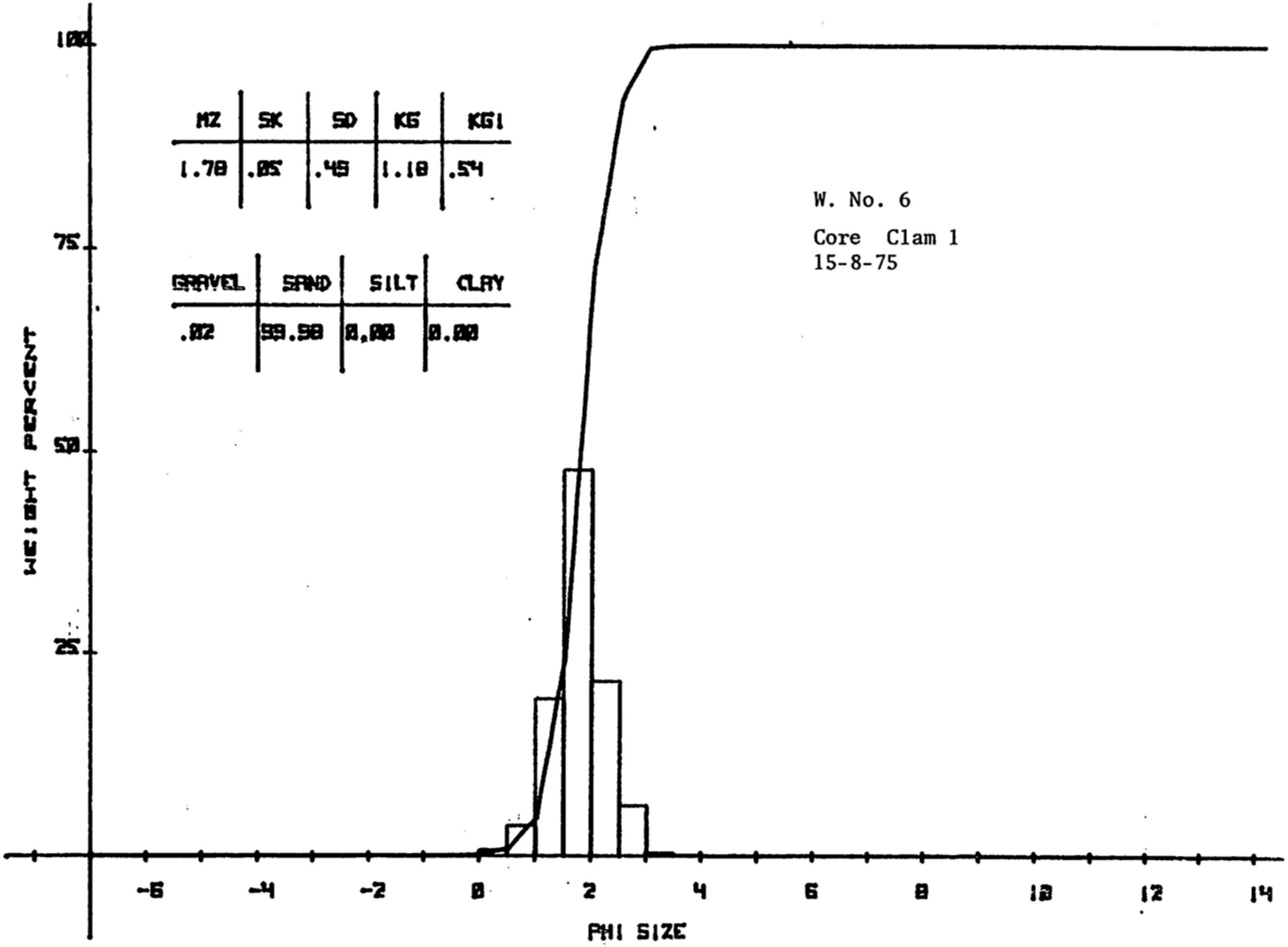
Peptiser: Batch: Wt. per 20 ml:

Size	Dish	Dish Wt.	Dish Sed.	Sed. Wt.	less Calgon	x 50	%	Notes

SAND FRACTION Sieve Analysis No.

144.5861 gm.

Size	Dish	Dish Wt.	Dish & Sed.	Sed. Wt.	Cum. Wt.	%	Description
-1ϕ				0.0315			
-1/2				0.0574			
0ϕ				0.1340			
1/2				1.0250			
1ϕ				5.4275			
1 1/2				28.0125			
2ϕ				68.9545			
2 1/2				31.1533			
3ϕ				9.0370			
3 1/2				0.5045			
4ϕ				0.0870			
pair				0.2825			


MZ SK SD KG KG1
1.78 .05 .45 1.18 .54
GRAVEL SAND SILT CLAY
.02 99.98 0.00 0.00
W. No. 6
Core Clam 1
15-8-75
100
75
50
25
WEIGHT PERCENT
-6 -4 -2 0 2 4 6 8 10 12 14
PHI SIZE

GRAIN SIZE ANALYSIS

Initial weight:

Final weight:

Working number: 7

Sample number: Core No. 4 23-7-75

Analyst: A.E.A. Date: February, 1976

Map No.: 43

FINE FRACTION

Treatment:

Peptiser: Batch: Wt. per 20 ml:

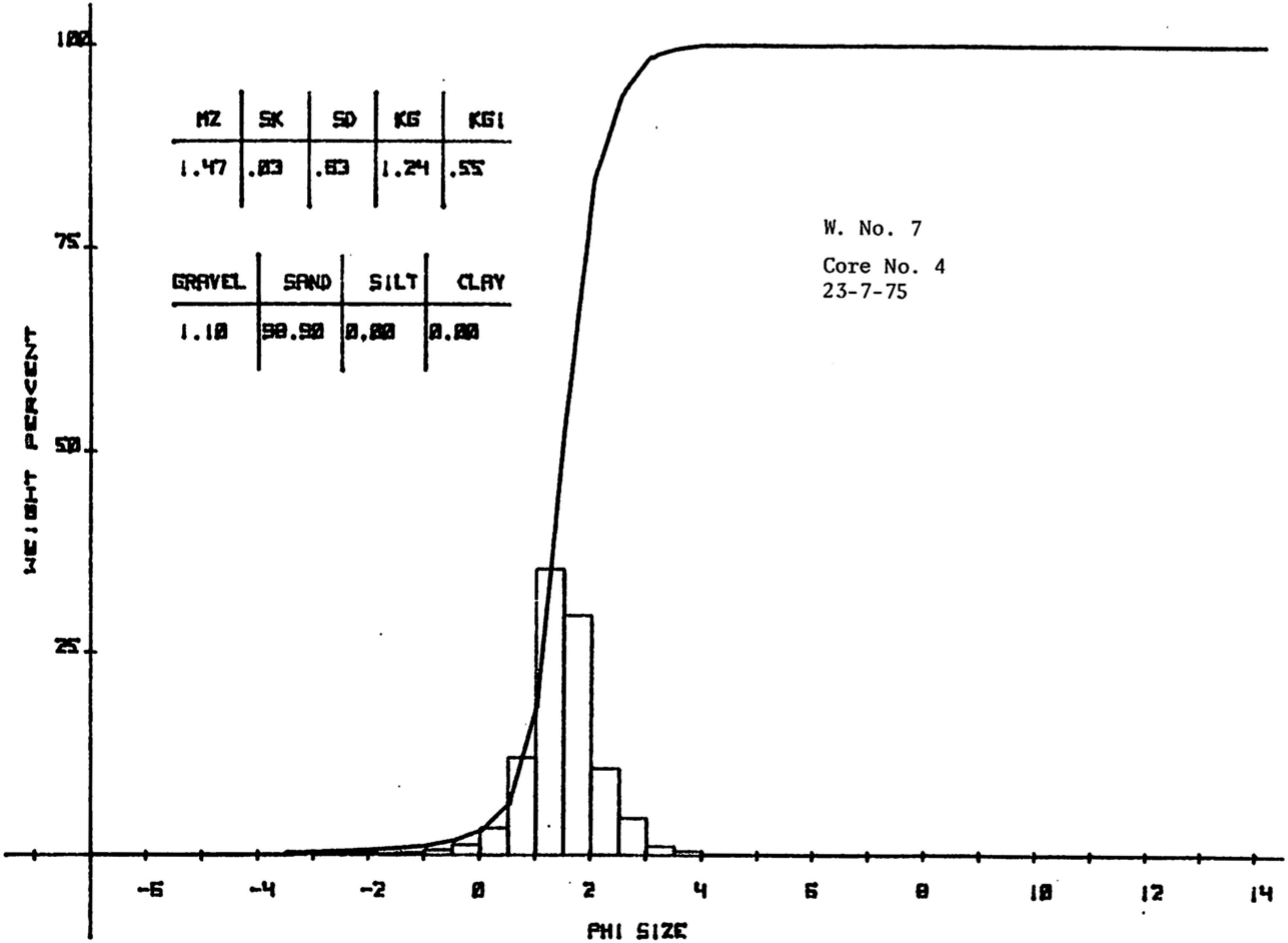
Size	Dish	Dish Wt.	Dish Sed.	Sed. Wt.	less Calgon	x 50	%	Notes

SAND FRACTION

Sieve Analysis No.

139.9975 gm.

Size	Dish	Dish Wt.	Dish & Sed.	Sed. Wt.	Cum. Wt.	%	Description
-3ø				0.4710			a big gastropod
-2 1/2				0.1783			
-2ø				0.1880			another gastropod
-1 1/2				0.2717			
-1ø				0.4140			25% organics, 15% shell
-1/2				0.8485			10% organics(mostly diatoms)
0				1.6960			20% organics(mostly diatoms)
1/2				4.5235			10% shell & organics
1ø				16.6045			
1 1/2				48.8680			
2ø				40.9325			
2 1/2				14.7260			
3ø				6.3145			
3 1/2				1.5260			
4ø				0.6865			
pair				1.7485			



W. No. 7

Core No. 4
23-7-75

GRAIN SIZE ANALYSIS

Initial weight:

Final weight:

Working number: 8

Sample number: Core No. 1 P.S. 13-8-75

Analyst: A.E.A. Date: February, 1976

Map No.: 52

FINE FRACTION

Treatment:

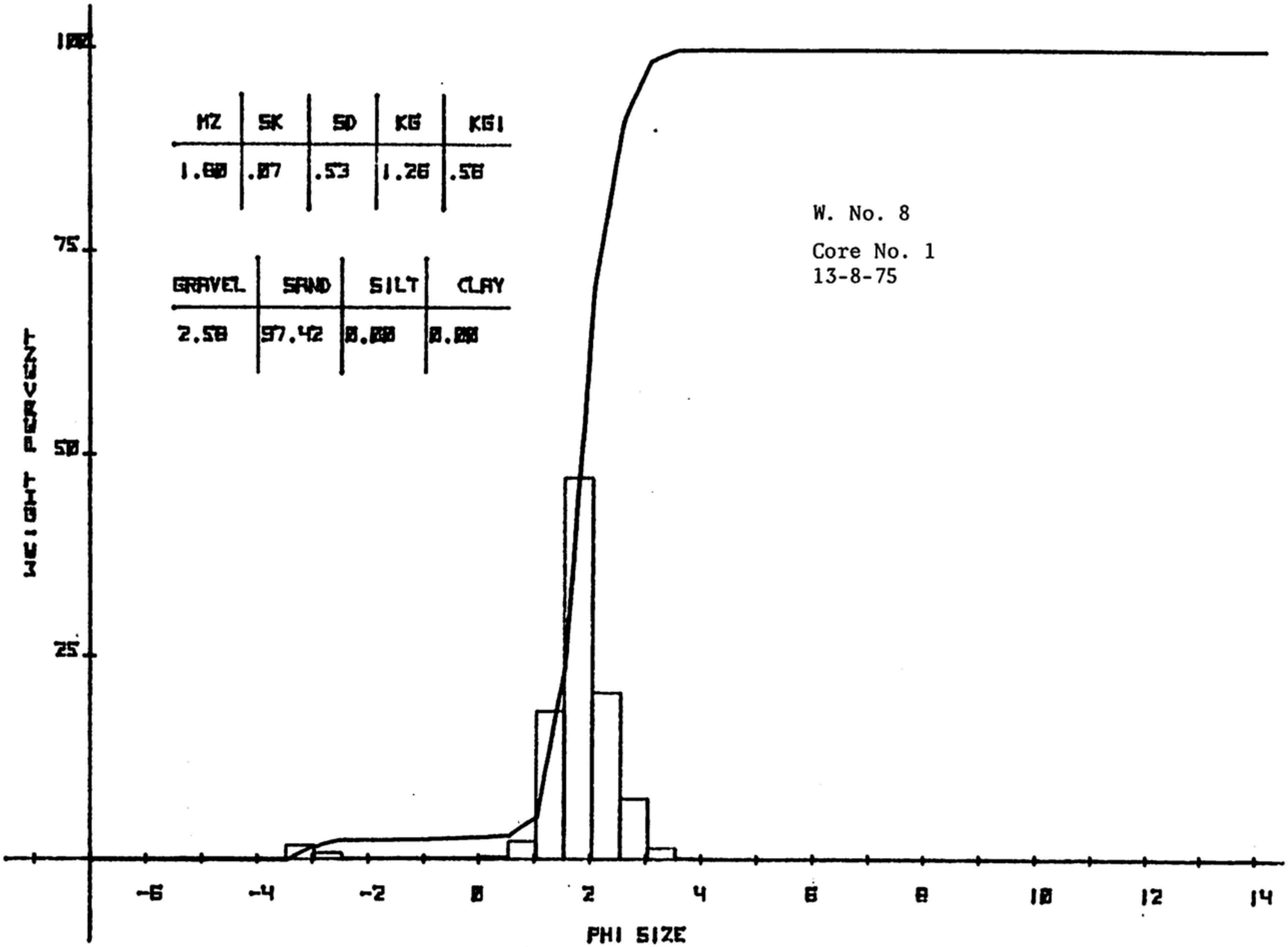
Peptiser: Batch: Wt. per 20 ml:

Size	Dish	Dish Wt.	Dish Sed.	Sed. Wt.	less Calgon	x 50	%	Notes

SAND FRACTION Sieve Analysis No.

84.7737 gm.

Size	Dish	Dish Wt.	Dish & Sed.	Sed. Wt.	Cum. Wt.	%	Description
-3ϕ				1.3875	1.3875	1.65	2 gastropods (shell)
-2 1/2				0.6200	2.0000	2.38	2 small gastropods
-1 1/2				0.0500	2.0600	2.45	
-1ϕ				0.0642	2.1200	2.52	20% shell
-1/2				0.0975	2.1600	2.57	30% shell & 30% organics
0ϕ				0.0880	2.2500	2.68	30% shell & 30% organics
1/2				0.1850	2.4300	2.89	25% shell & organics
1ϕ				1.8205	4.2500	5.05	25% shell & organics
1 1/2				15.0170	19.2700	22.9	10% organics
2ϕ				28.7760	58.0000	69.0	
2 1/2				16.9075	74.3500	88.4	
3ϕ				6.1750	80.5200	95.7	
3 1/2				1.1055	81.6000	97.0	
4ϕ				0.6710	82.3000	97.9	
pair				1.8090	84.10	100	


MZ
SK
SD
KG
KGI
1.80
.07
.53
1.26
.58
GRAVEL
SAND
SILT
CLAY
2.58
97.42
0.00
0.00
W. No. 8
Core No. 1
13-8-75
100
75
50
25
WEIGHT PERCENT
-6
-4
-2
0
2
4
6
8
10
12
14
PHI SIZE

GRAIN SIZE ANALYSIS

Initial weight:

Final weight:

Working number: 9

Sample number: Vert. Dist. Level 7
26-7-75 Core

Analyst: A.E.A. Date: February, 1976

Map No.: P-7

FINE FRACTION

Treatment:

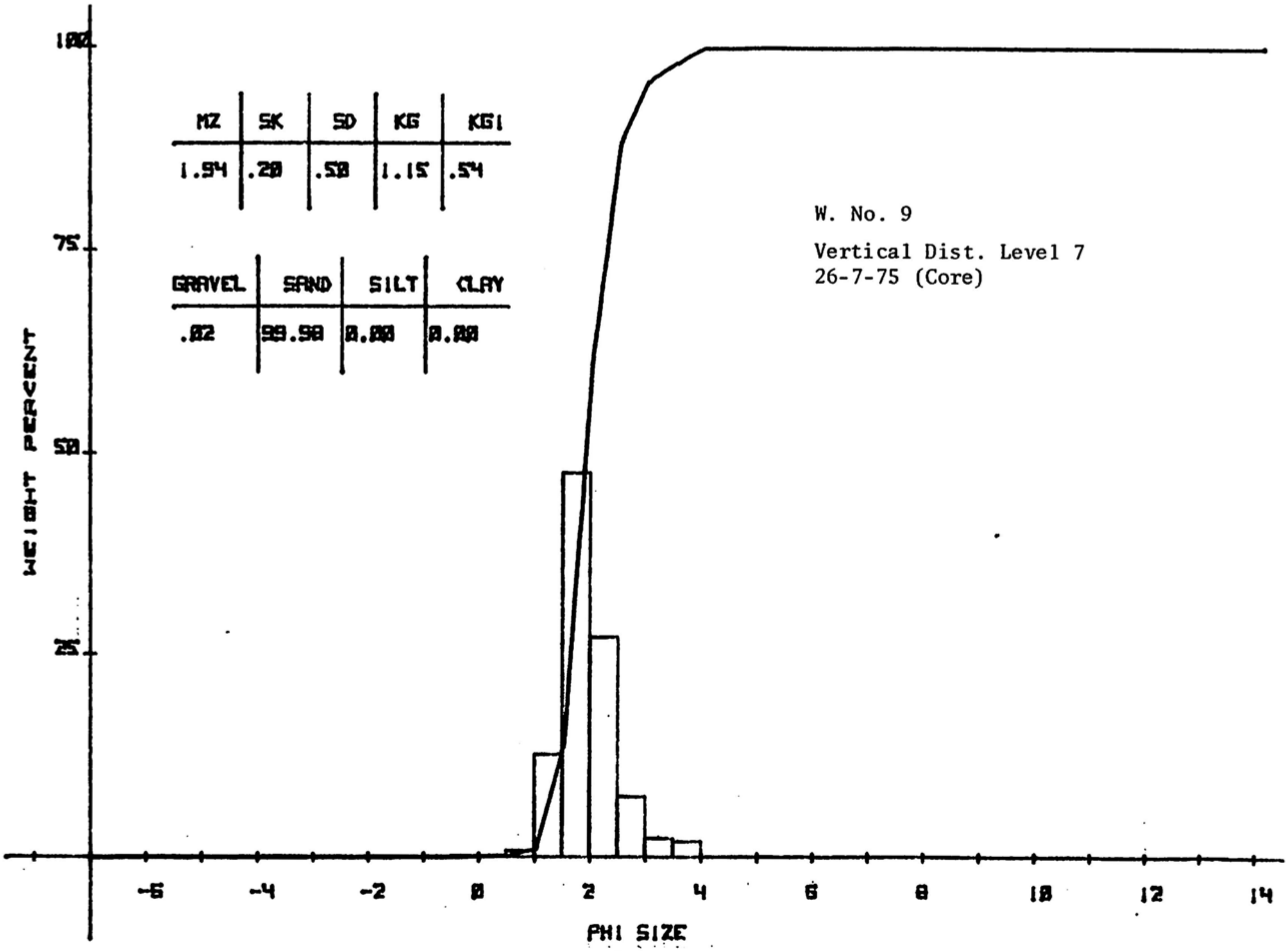
Peptiser: Batch: Wt. per 20 ml:

Size	Dish	Dish Wt.	Dish Sed.	Sed. Wt.	less Calgon	x 50	%	Notes

SAND FRACTION Sieve Analysis No.

118.3525 gm.

Size	Dish	Dish Wt.	Dish & Sed.	Sed. Wt.	Cum. Wt.	%	Description
-1 1/2				0.0245			one shell
1/2				0.0440			all organics
0ϕ				0.0890			90% organics
1/2				0.1455			80% organics
1ϕ				0.8475			40% organics (mostly plants and diatoms)
1 1/2				14.4620			10% organics (plants)
2ϕ				54.2345			5% organics
2 1/2				30.9305			
3ϕ				8.5515			
3 1/2				2.6250			
4ϕ				2.2090			
pair				4.1785			



W. No. 9

Vertical Dist. Level 7
26-7-75 (Core)

GRAIN SIZE ANALYSIS

Initial weight:

Final weight:

Working number: 10

Sample number: Core No. 1 P.S. 8-8-75

Analyst: A.E.A. Date: February, 1976

Map No.: 53

FINE FRACTION

Treatment:

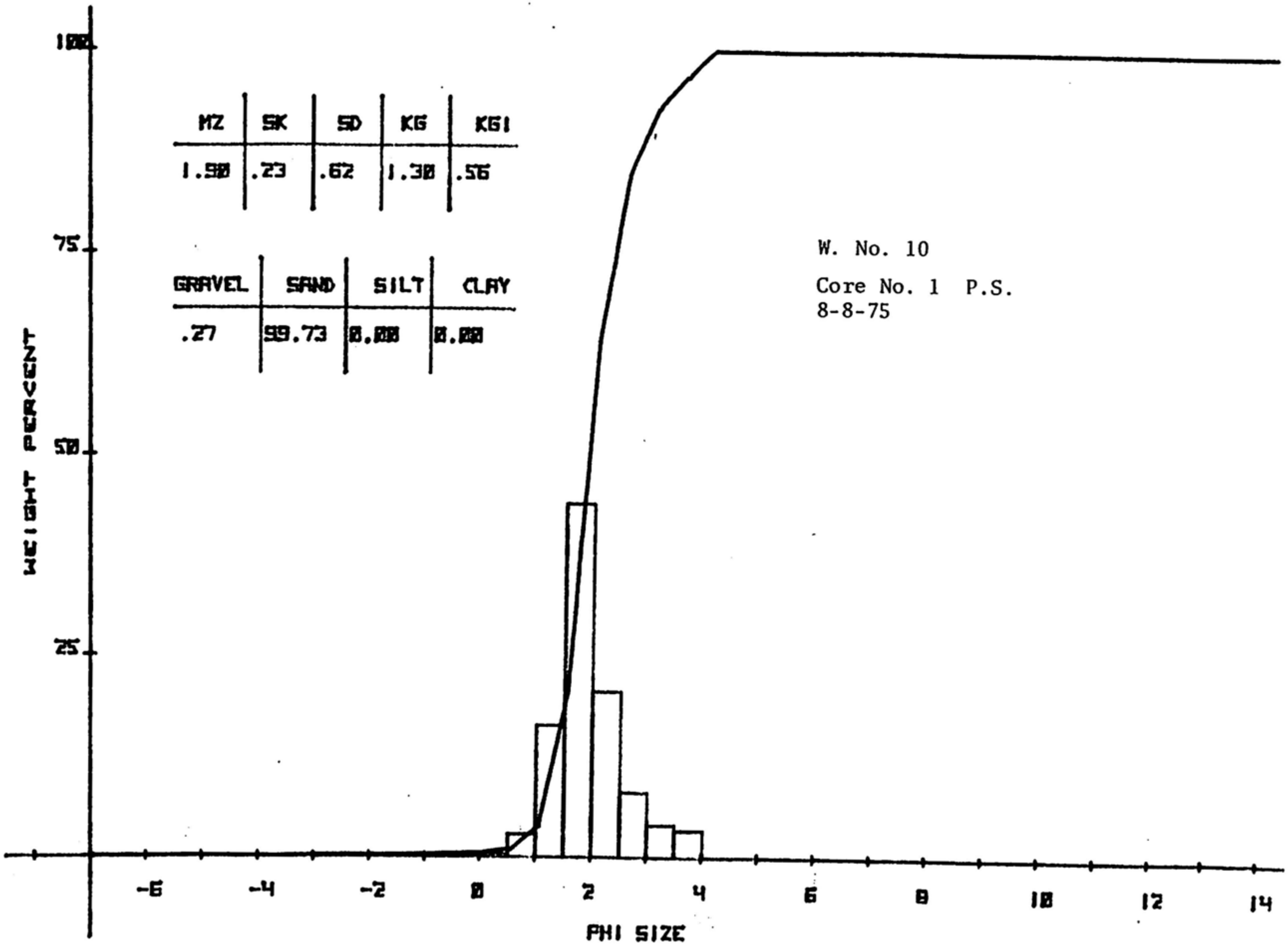
Peptiser: Batch: Wt. per 20 ml:

Size	Dish	Dish Wt.	Dish Sed.	Sed. Wt.	less Calgon	x 50	%	Notes

SAND FRACTION Sieve Analysis No.

118.4005 gm.

Size	Dish	Dish Wt.	Dish & Sed.	Sed. Wt.	Cum. Wt.	%	Description
-3ϕ				0.1390			one big shell
-1 1/2				0.0800			all shell fragments
-1ϕ				0.0790			all shell fragments
-1/2				0.1070			30% organics, 70% shell
0				0.1450			30% organics, 30% shell
1/2				0.4335			20% shell & organics
1ϕ				3.1870			10% shell & organics
1 1/2				18.3115			5% organics
2ϕ				49.0312			approx. 2% organics
2 1/2				22.9595			
3ϕ				9.0113			
3 1/2				4.4845			
4ϕ				3.7220			
pair				6.7100			


MZ
SK
SD
KG
KG1
1.90
.23
.62
1.30
.56
GRAVEL
SAND
SILT
CLAY
.27
99.73
0.00
0.00
WEIGHT PERCENT
100
75
50
25
-6
-4
-2
0
2
4
6
8
10
12
14
PHI SIZE
W. No. 10
Core No. 1 P.S.
8-8-75

GRAIN SIZE ANALYSIS

Initial weight:

Final weight:

Working number: 11

Sample number: Core P.S. 1 18-8-75

Analyst: A.E.A. Date: February, 1976

Map No.: 56

FINE FRACTION

Treatment:

Peptiser: Batch: Wt. per 20 ml:

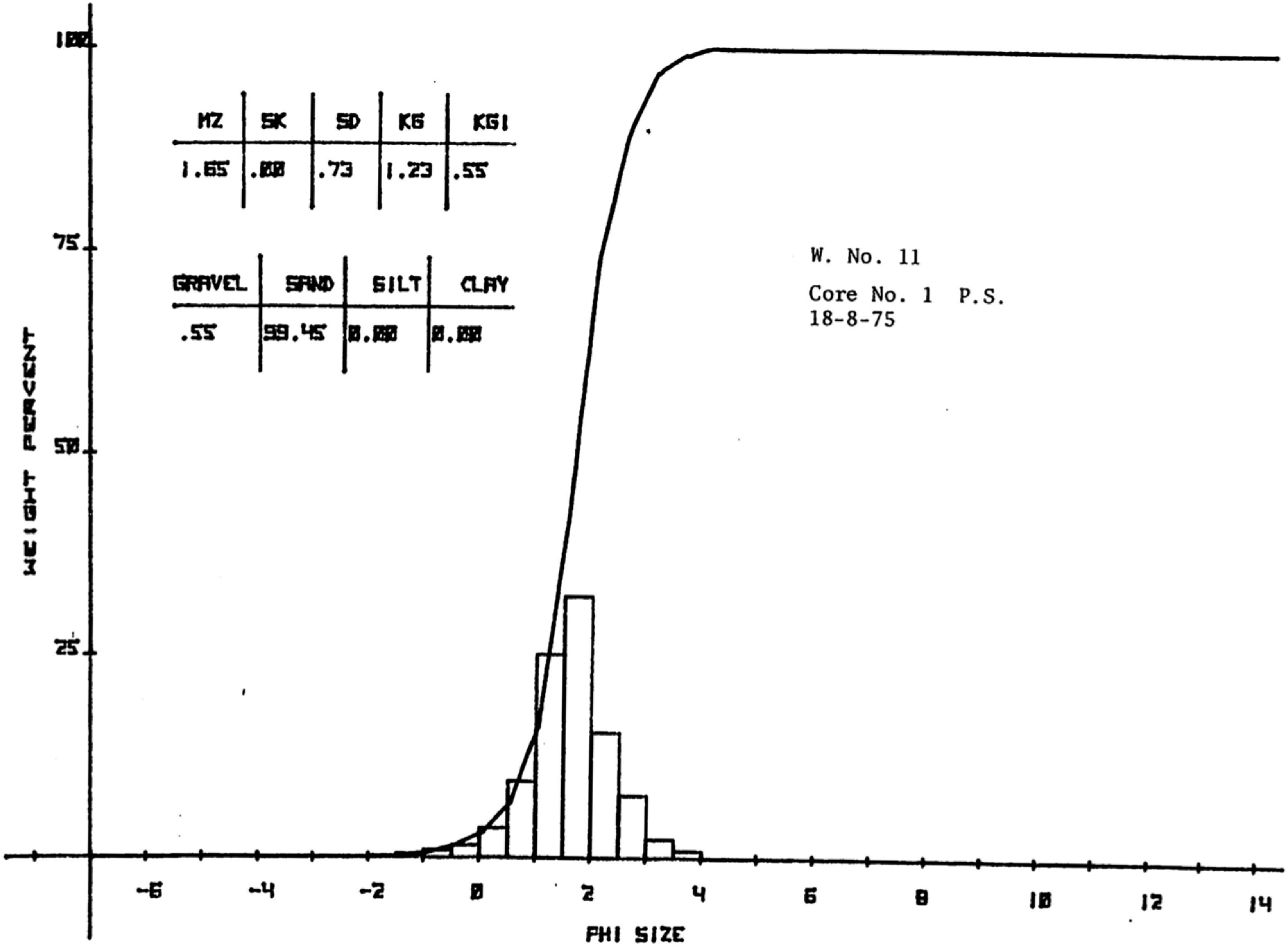
Size	Dish	Dish Wt.	Dish Sed.	Sed. Wt.	less Calgon	x 50	%	Notes

SAND FRACTION

107.5882 gm.

Sieve Analysis No.

Size	Dish	Dish Wt.	Dish & Sed.	Sed. Wt.	Cum. Wt.	%	Description
-1 1/2				0.1425			some wood & organics
-1ϕ				0.4413			10% wood
-1/2				0.9850			approx. 5% wood
0ϕ				1.6370			approx. 5% wood
1/2				3.8993			approx. 3% wood
1ϕ				10.0566			
1 1/2				26.7170			
2ϕ				34.3185			
2 1/2				16.4785			
3ϕ				8.1850			
3 1/2				2.4310			
4ϕ				0.9515			
pair				1.3450			



MZ SK SD KG KG1
1.65 .00 .73 1.23 .55
GRAVEL SAND SILT CLAY
.55 99.45 0.00 0.00
W. No. 11
Core No. 1 P.S.
18-8-75
WEIGHT PERCENT
100
75
50
25
-6
-4
-2
0
2
4
6
8
10
12
14
PHI SIZE

GRAIN SIZE ANALYSIS

Initial weight:
Final weight:

Working number: 12
Sample number: 43
Analyst: A.E.A. Date: February, 1976
Map No.: C-2

FINE FRACTION

Treatment: 20 ml H_2O_2 → centrifuged
Peptiser: 50 ml Calgon Batch: #12 0.0120 mg.
Wt. per 20 ml:

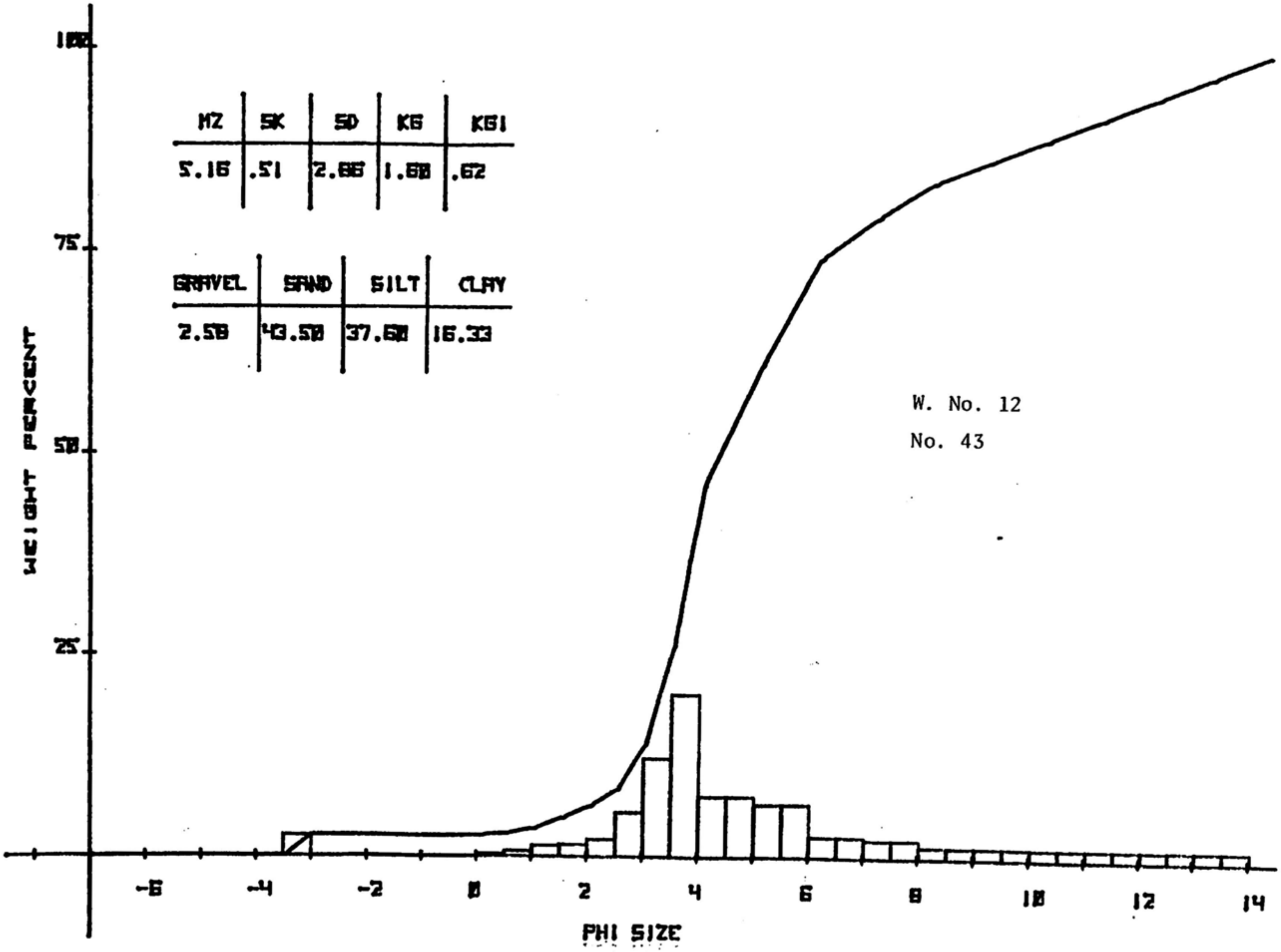
Size	Dish	Dish Wt.	Dish Sed.	Sed. Wt.	less Calgon	x 50	%	Notes
4ϕ	1	1.3970	1.5697			8.035		pair added
5ϕ	2	1.3999	1.5329			6.050		2.557
6ϕ	3	1.3961	1.4960			4.395		2.227
7ϕ	4	1.4007	1.4833			3.530		0.865
8ϕ	5	1.4077	1.4746			2.780		0.750
9ϕ	63	1.3377	1.3914			2.085		0.695

SAND FRACTION

Sieve Analysis No.

> 63 8.9867 gm.

Size	Dish	Dish Wt.	Dish & Sed.	Sed. Wt.	Cum. Wt.	%	Description
-3ϕ				0.4385			one shell
-0ϕ				0.0015			few shell fragments
1/2				0.0385			40% shell, 60% organics (diatoms)
1ϕ				0.1030			30% shell, some woods & organics
1 1/2				0.2265			5% shell, some woods & organics
2ϕ				0.2525			5% mica, some shell fragments and organics
2 1/2				0.3570			5% mica and organics
3ϕ				0.9367			5% mica and organics
3 1/2				2.0685			
4ϕ				3.4190			
pair				1.1450			



MZ | SK | SD | KG | KG1
5.16 | .51 | 2.66 | 1.60 | .62
GRAVEL | SAND | SILT | CLAY
2.50 | 43.50 | 37.60 | 16.33
W. No. 12
No. 43
100
75
50
25
WEIGHT PERCENT
-6
-4
-2
0
2
4
6
8
10
12
14
PHI SIZE

GRAIN SIZE ANALYSIS

Initial weight:

Final weight:

Working number: 13

Sample number: Core No. 2 P.S. 7-8-75

Analyst: A.E.A. Date: February, 1976

Map No.: 5

FINE FRACTION

Treatment: 20 ml H_2O_2 → centrifuged
50 ml calgon

Peptiser: Batch: #12
0.0120 mg.

Wt. per 20 ml:

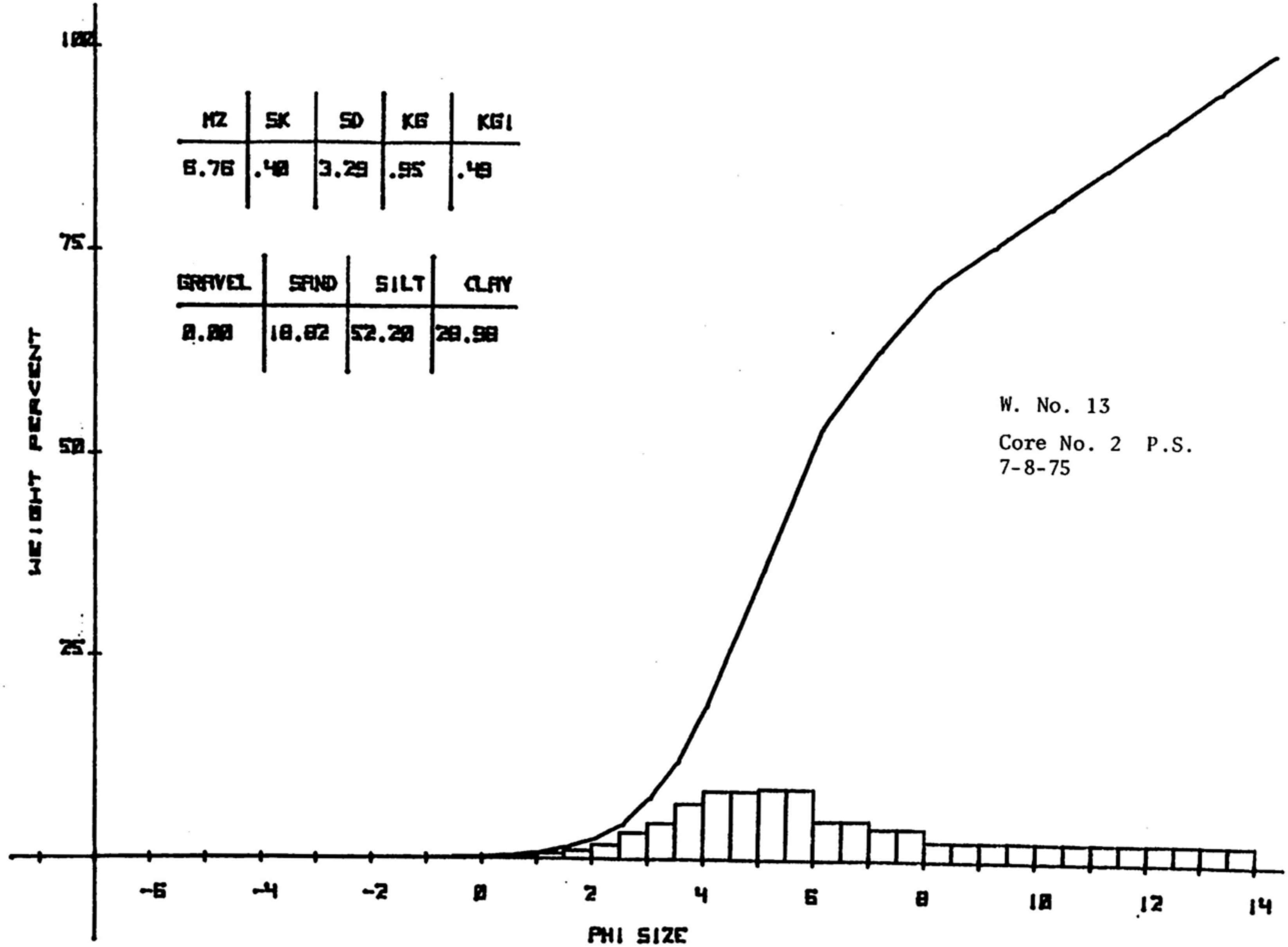
Size	Dish	Dish Wt.	Dish Sed.	Sed. Wt.	less Calgon	x 50	%	Notes
4ϕ	7	1.4047	1.6434			11.335		pair added
5ϕ	8	1.4017	1.5973			9.180		2.511
6ϕ	9	1.3995	1.5500			6.925		2.611
7ϕ	10	1.4016	1.5231			5.475		1.450
8ϕ	11	1.4013	1.4993			4.300		1.175
9ϕ	62	1.3438	1.4170			3.060		1.240

SAND FRACTION

> 63 3.5049 gm.

Sieve Analysis No.

Size	Dish	Dish Wt.	Dish & Sed.	Sed. Wt.	Cum. Wt.	%	Description
0ϕ				0.0275			95% organics
1/2				0.0250			85% organics
1ϕ				0.0500			40% organics
1 1/2				0.1015			30% organics
2ϕ				0.1535			10% organics, 2% shell fragments
2 1/2				0.2639			approx. 2% shell fragments
3ϕ				0.4880			
3 1/2				0.6630			
4ϕ				1.0205			
pair				0.7120			


MZ SK SD KG KG1
6.76 .40 3.29 .95 .49
GRAVEL SAND SILT CLAY
0.00 18.82 52.20 28.98
100
75
50
25
WEIGHT PERCENT
-6 -4 -2 0 2 4 6 8 10 12 14
PHI SIZE
W. No. 13
Core No. 2 P.S.
7-8-75

GRAIN SIZE ANALYSIS

Initial weight:
Final weight:

Working number: 14
Sample number: Core No. 1 11-8-75
Analyst: A.E.A. Date: February, 1976
Map No.: 29

FINE FRACTION

Treatment: 20ml H_2O_2 → Centrifuged
50ml Calgon
Peptiser: Batch: #12 Wt. per 20 ml:
0.0120 mg.

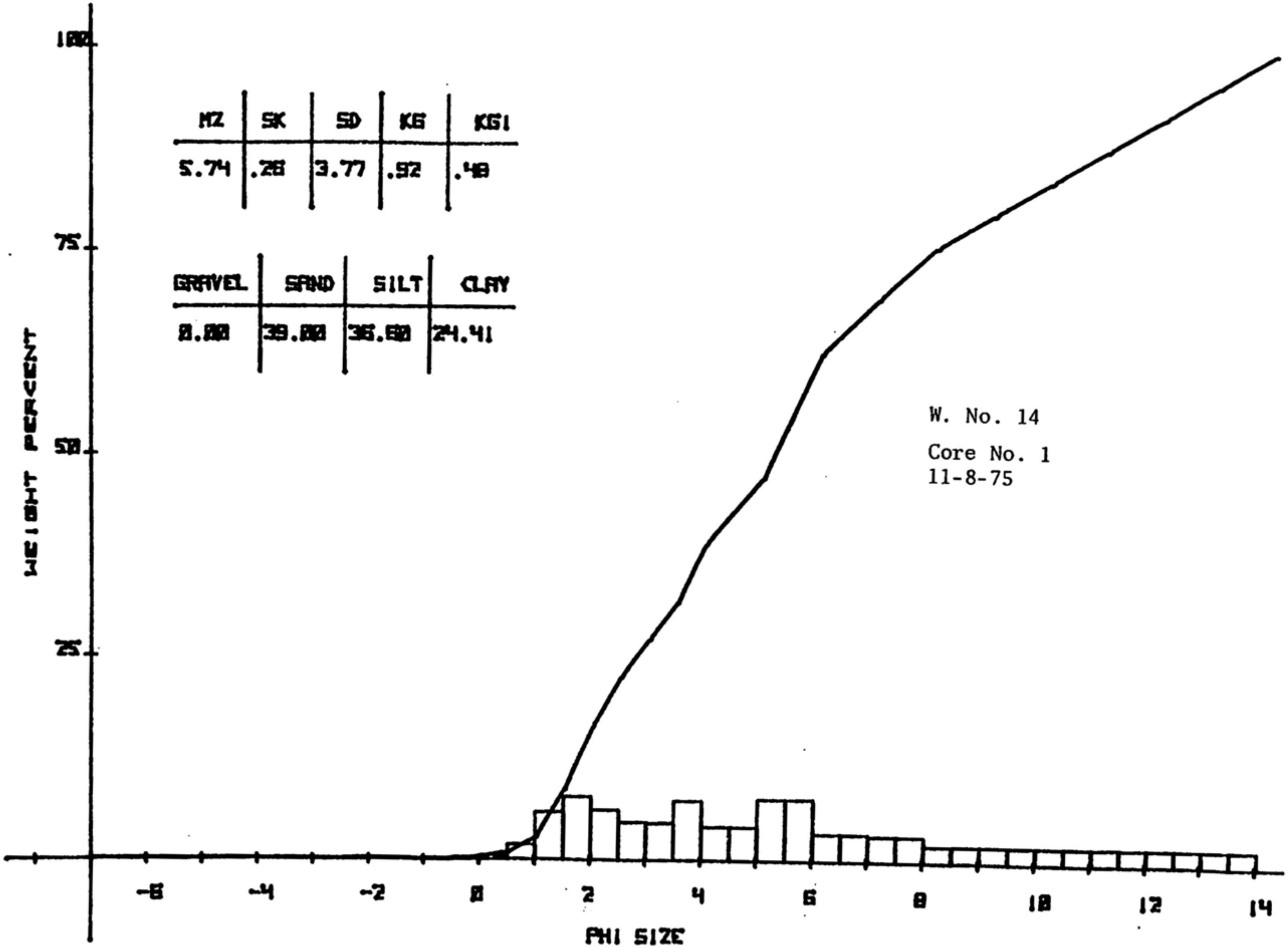
Size	Dish	Dish Wt.	Dish Sed.	Sed. Wt.	less Calgon	x 50	%	Notes
4ϕ	13	1.3949	1.6834			13.825		pair added
5ϕ	14	1.3977	1.6797			12.500		2.0802
6ϕ	15	1.3947	1.5950			9.415		3.8402
7ϕ	16	1.3975	1.5639			7.720		1.6950
8ϕ	17	1.3987	1.5334			6.135		1.5850
9ϕ	61	1.3482	1.4562			4.800		1.3350

SAND FRACTION

Sieve Analysis No.

> 63 11.3130 gm.

Size	Dish	Dish Wt.	Dish & Sed.	Sed. Wt.	Cum. Wt.	%	Description
0ϕ				0.0650			40% organics & some woods
1/2ϕ				0.1275			15% organics
1ϕ				0.4720			15% organics
1 1/2ϕ				1.4755			approx. 5% organics
2ϕ				1.9440			
2 1/2				1.5490			
3ϕ				1.1755			
3 1/2				1.1482			
4ϕ				1.8460			
pair				1.5103			


MZ
SK
SD
KG
KG1
5.74
.28
3.77
.92
.48
GRAVEL
SAND
SILT
CLAY
0.00
39.00
36.60
24.41
100
75
50
25
WEIGHT PERCENT
-6
-4
-2
0
2
4
6
8
10
12
14
PHI SIZE
W. No. 14
Core No. 1
11-8-75

GRAIN SIZE ANALYSIS

Initial weight:

Final weight:

Working number: 15

Sample number: 46

Analyst: A.E.A. Date: February, 1976

Map No.: C-1

FINE FRACTION

Treatment: 20 ml H_2O_2 Centrifuged
50 ml calgon

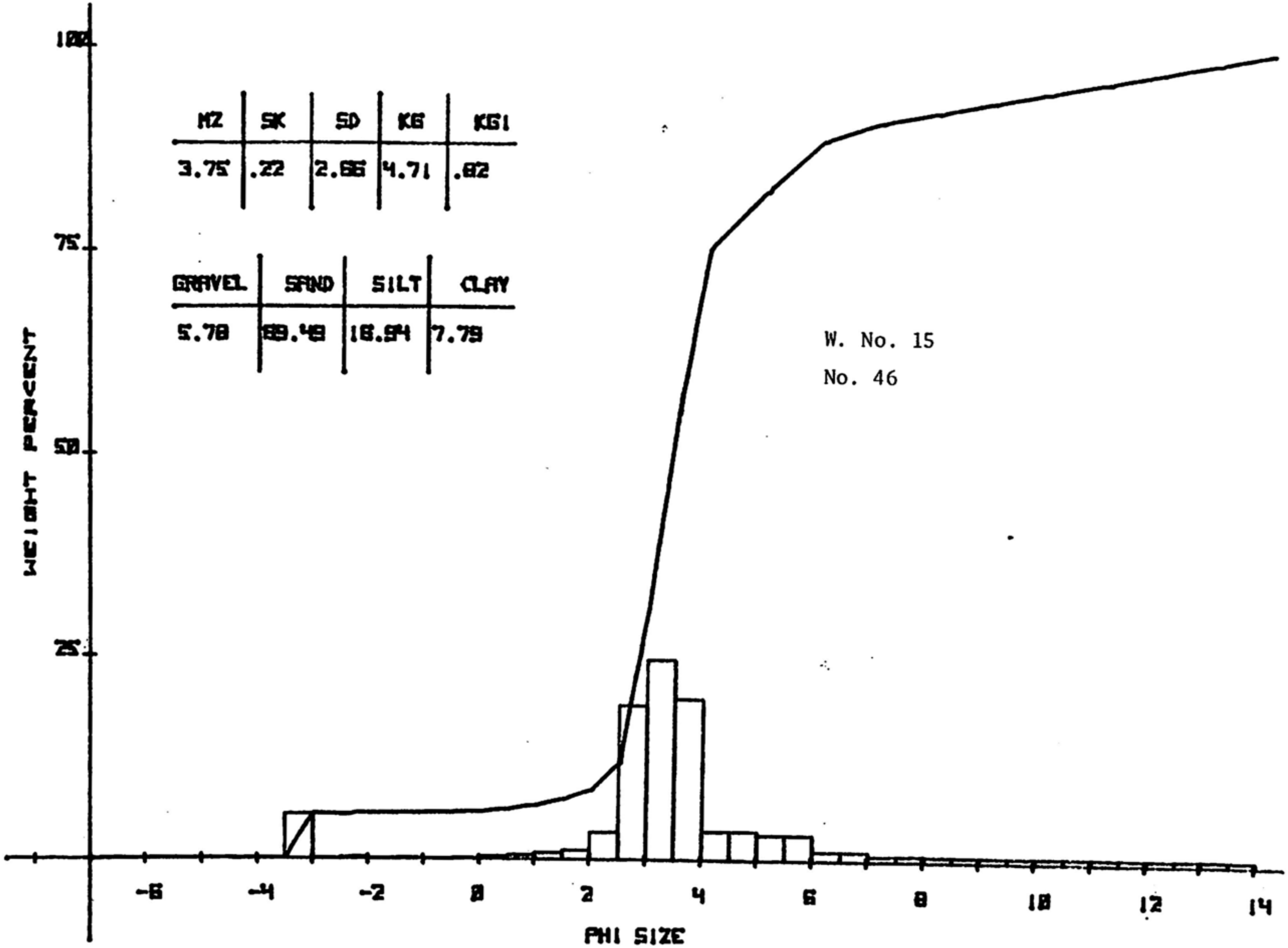
Peptiser: Batch: #12 Wt. per 20 ml:
0.0120 mg

Size	Dish	Dish Wt.	Dish Sed.	Sed. Wt.	less Calgon	x 50	%	Notes
4ϕ	19	1.3982	1.5838			8.680		pair added
5ϕ	20	1.4039	1.5527			6.840		3.349
6ϕ	21	1.3888	1.5188			5.400		2.949
7ϕ	22	1.3948	1.4932			4.320		1.080
8ϕ	23	1.3953	1.4810			3.685		0.635
9ϕ	60	1.3453	1.4153			2.900		0.785

SAND FRACTION Sieve Analysis No.

63 29.2592 gm.

Size	Dish	Dish Wt.	Dish & Sed.	Sed. Wt.	Cum. Wt.	%	Description
-3ϕ				2.6065			one rock fragment
-2ϕ				0.0863			one shell
-1ϕ				0.0415			
0ϕ				0.0320			80% organics, 10% shell
1/2				0.1485			80% organics, 10% shell
1ϕ				0.2317			70% organics, 10% shell
1 1/2				0.3625			60% organics
2ϕ				0.5245			50% organics
2 1/2				1.5845			25% organics
3ϕ				8.9882			10% organics
3 1/2				11.6350			
4ϕ				3.0180			
pair							


MZ | SK | SD | KG | KG1
3.75 | .22 | 2.66 | 4.71 | .82
GRAVEL | SAND | SILT | CLAY
5.78 | 69.49 | 16.94 | 7.79
W. No. 15
No. 46
100
75
50
25
WEIGHT PERCENT
-6
-4
-2
0
2
4
6
8
10
12
14
PHI SIZE

GRAIN SIZE ANALYSIS

Initial weight:

Final weight:

Working number: 16

Sample number: Core sample Point Stn. 1 16-7-75

Analyst: A.E.A. Date: February, 1976

Map No.: 23

FINE FRACTION

Treatment: 20 ml H_2O_2 → centrifuged
50 ml calgon

Peptiser: Batch: #12 Wt. per 20 ml:
0.0120 mg.

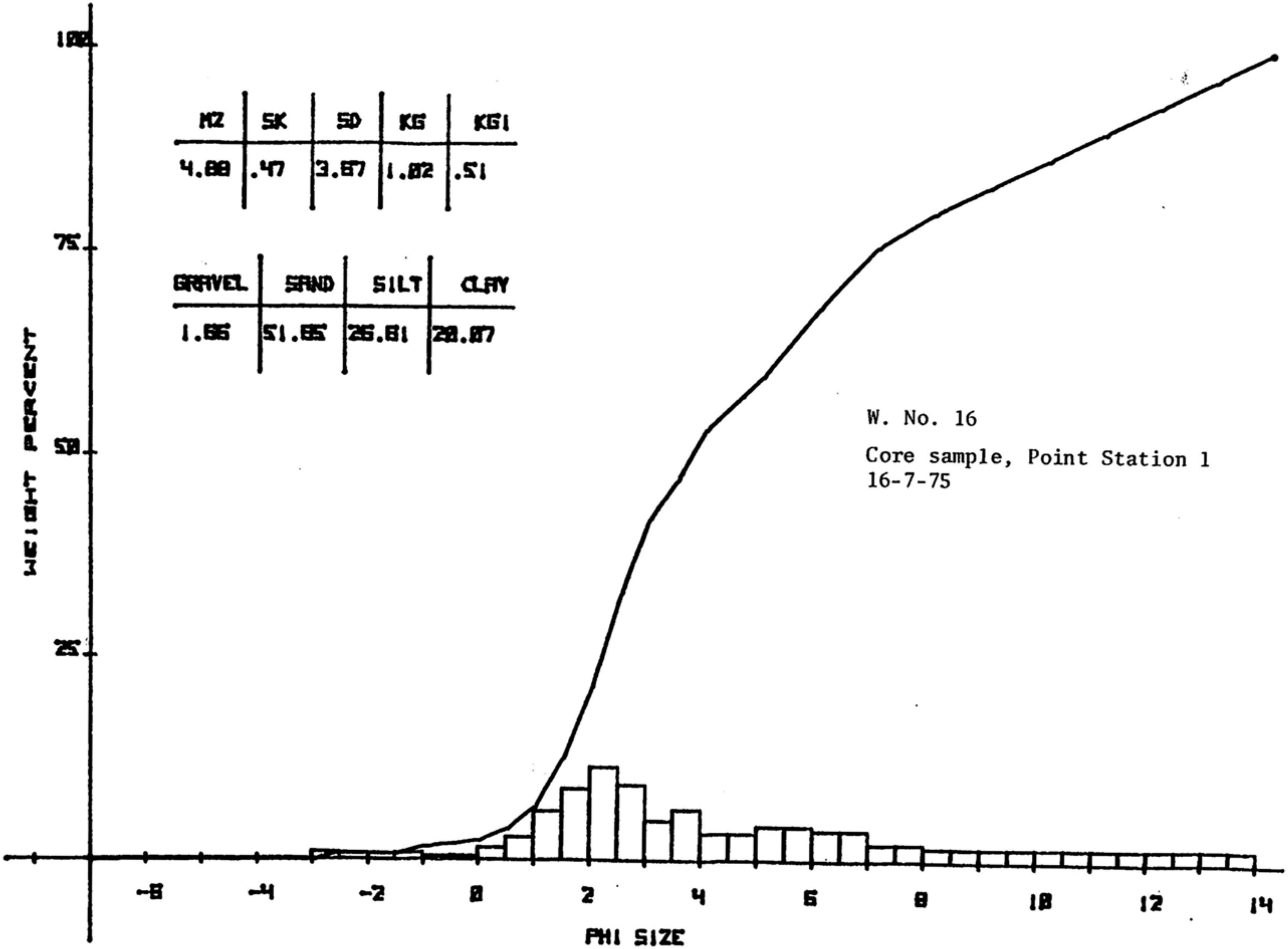
Size	Dish	Dish Wt.	Dish Sed.	Sed. Wt.	less Calgon	x 50	%	Notes
4ø	25	1.4010	1.6474			11.720		pair added
5ø	26	1.4000	1.6231			10.555		1.8650
6ø	27	1.3996	1.5893			8.885		2.3698
7ø	28	1.3400	1.4880			6.800		2.0850
8ø	29	1.3400	1.4648			5.640		1.1600
9ø	59	1.3449	1.4361			3.960		1.6800

SAND FRACTION

Sieve Analysis No.

> 63 16.7223 gm.

Size	Dish	Dish Wt.	Dish & Sed.	Sed. Wt.	Cum. Wt.	%	Description
-2 1/2				0.2390	0.2390		shell
-1				0.2285	0.4680		40% shell, 40% wood
-1/2				0.1020	0.5700		20% shell, 40% wood
0				0.1175	0.6870		10% shell, 20% wood
1/2				0.4065	1.0900		30% shell, 40% wood
1				0.7753	1.8700		10% shell, 20% organics
1 1/2				1.6935	3.5600		approx. 40% shell & organics
2ø				2.4590	6.0100		approx. 40% shell & organics
2 1/2				3.2220	9.2300		approx. 40% shell & organics
3ø				2.6055	11.8000		20% shell & organics
3 1/2				1.3745	13.2000		20% shell & organics
4ø				1.7615	15.0000		40% organics, mostly diatoms
pair				1.7375	16.7000		


MZ | SK | SD | KG | KG1
4.00 | .47 | 3.67 | 1.02 | .51
GRAVEL | SAND | SILT | CLAY
1.06 | 51.05 | 26.01 | 20.87
WEIGHT PERCENT
100
75
50
25
-8
-4
-2
0
2
4
6
8
10
12
14
PHI SIZE
W. No. 16
Core sample, Point Station 1
16-7-75

GRAIN SIZE ANALYSIS

Initial weight:

Final weight:

Working number: 17

Sample number: Core No. 4 P.S. 8-8-75

Analyst: A.E.A. Date: February, 1976

Map No.: 41

FINE FRACTION

Treatment: 20 ml H_2O_2 → Centrifuged
50 ml calgon

Peptiser: Batch: #12 Wt. per 20 ml:
0.0120 mg.

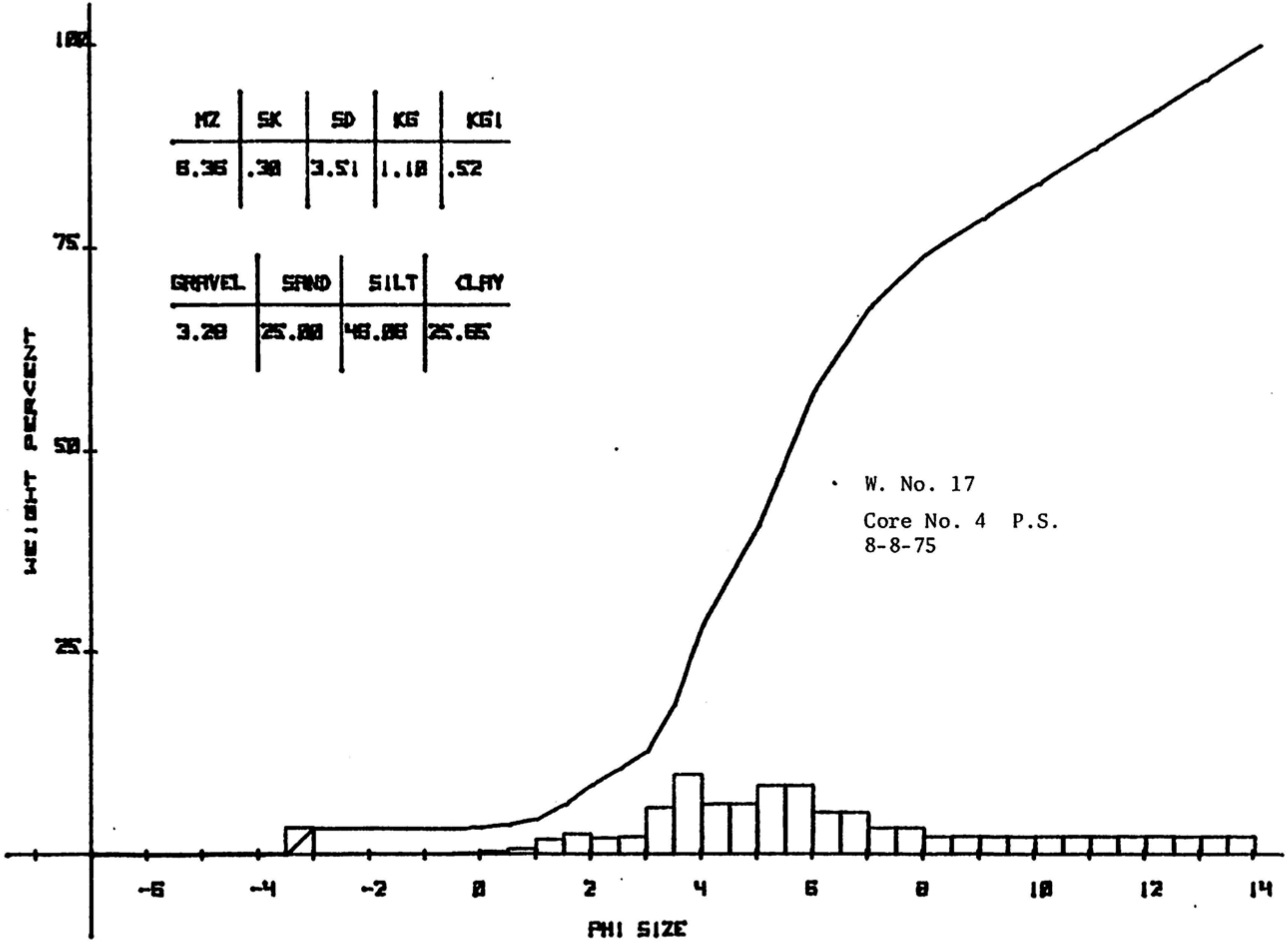
Size	Dish	Dish Wt.	Dish Sed.	Sed. Wt.	less Calgon	x 50	%	Notes
4ϕ	31	1.3330	1.6333			14.415		pair added
5ϕ	32	1.3319	1.5932			12.465		2.7723
6ϕ	33	1.3308	1.5327			9.495		3.7923
7ϕ	34	1.3309	1.4869			7.200		2.2950
8ϕ	35	1.3335	1.4604			5.745		1.4550
9ϕ	58	1.3421	1.4395			4.270		1.4750

SAND FRACTION

Sieve Analysis No.

> 63 7.9783 gm.

Size	Dish	Dish Wt.	Dish & Sed.	Sed. Wt.	Cum. Wt.	%	Description
-3ϕ				0.7350			one shell
0ϕ				0.0325			85% organics (mostly diatoms)
1/2				0.0665			50% organics
1ϕ				0.1390			50% organics
1 1/2				0.4015			10% organics, 3% shell fragments
2ϕ				0.5525			5% organics, 5% shell fragments
2 1/2				0.4440			10% shell, 5% organics
3ϕ				0.4800			5% shell, 2% organics
3 1/2				1.2853			2% organics
4ϕ				2.1975			
pair				1.6445			



MZ SK SD KG KG1
6.36 .30 3.51 1.10 .52
GRAVEL SAND SILT CLAY
3.20 25.00 46.06 25.65
WEIGHT PERCENT
100
75
50
25
-6 -4 -2 0 2 4 6 8 10 12 14
PHI SIZE
W. No. 17
Core No. 4 P.S.
8-8-75

GRAIN SIZE ANALYSIS

Initial weight:

Final weight:

Working number: 18

Sample number: Core No. 3 19-8-75

Analyst: A.E.A. Date: February, 1976

Map No.: 77

FINE FRACTION

Treatment: 20 ml H_2O_2 → Centrifuged
50 ml calgon

Peptiser: Batch: #12 0.0120 mg. Wt. per 20 ml:

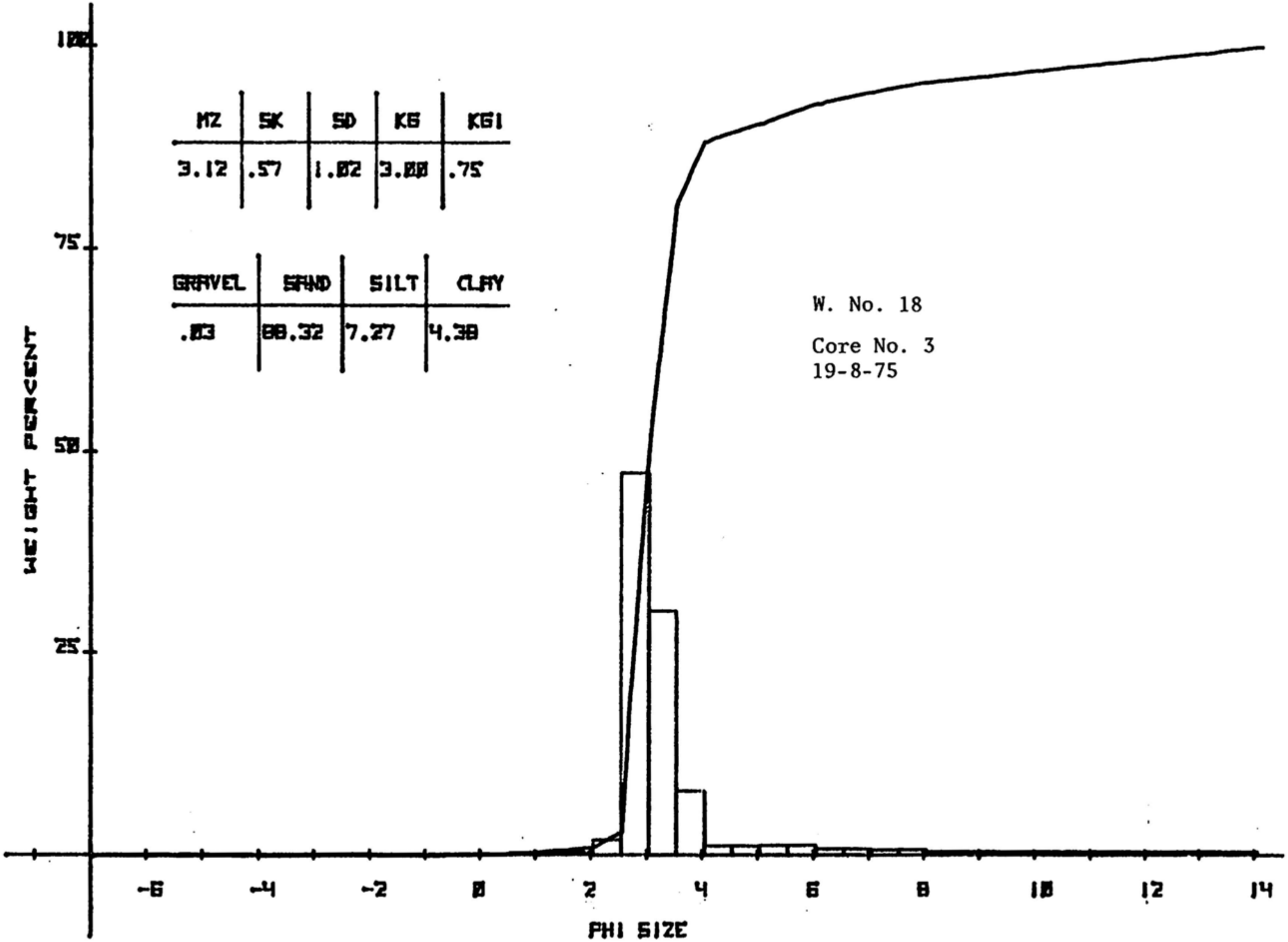
Size	Dish	Dish Wt.	Dish Sed.	Sed. Wt.	less Calgon	x 50	%	Notes
4ϕ	37	1.3415	1.4390			4.275		pair added
5ϕ	38	1.3442	1.4294			3.655		0.9336
6ϕ	39	1.3420	1.4131			2.955		1.0136
7ϕ	40	1.3411	1.3999			2.340		0.6150
8ϕ	41	1.3377	1.3866			1.845		0.5000
9ϕ	57	1.3380	1.3788			1.440		0.4050

SAND FRACTION

Sieve Analysis No.

> 63 37.1249 gm.

Size	Dish	Dish Wt.	Dish & Sed.	Sed. Wt.	Cum. Wt.	%	Description
-1				0.0110			all shell & organics
-1/2				0.0125			all shell & organics
0				0.0200			40% shell, 60% organics
1/2				0.0355			30% shell, some woods & organics
1ϕ				0.0982			some woods & organics (mostly diatoms)
1 1/2				0.1068			some woods & organics (mostly diatoms)
2ϕ				0.1390			approx. 5% mica, woods, & organics
2 1/2				0.7870			approx. 5% mica organics
3ϕ				19.9505			
3 1/2				12.7045			
4ϕ				3.3410			
pair				0.6272			


MZ
SK
SD
KG
KG1
3.12
.57
1.02
3.00
.75
GRAVEL
SAND
SILT
CLAY
.03
88.32
7.27
4.38
100
75
50
25
WEIGHT PERCENT
-6
-4
-2
0
2
4
6
8
10
12
14
PHI SIZE
W. No. 18
Core No. 3
19-8-75

GRAIN SIZE ANALYSIS

Initial weight:

Final weight:

Working number: 19

Sample number: Core No. 3 18-7-75

Analyst: A.E.A. Date: February, 1976

Map No.: 28

FINE FRACTION

Treatment: 20 ml H_2O_2 → Centrifuged

Peptiser: 50 ml calgon Batch: #12 Wt. per 20 ml: 0.0120 mg.

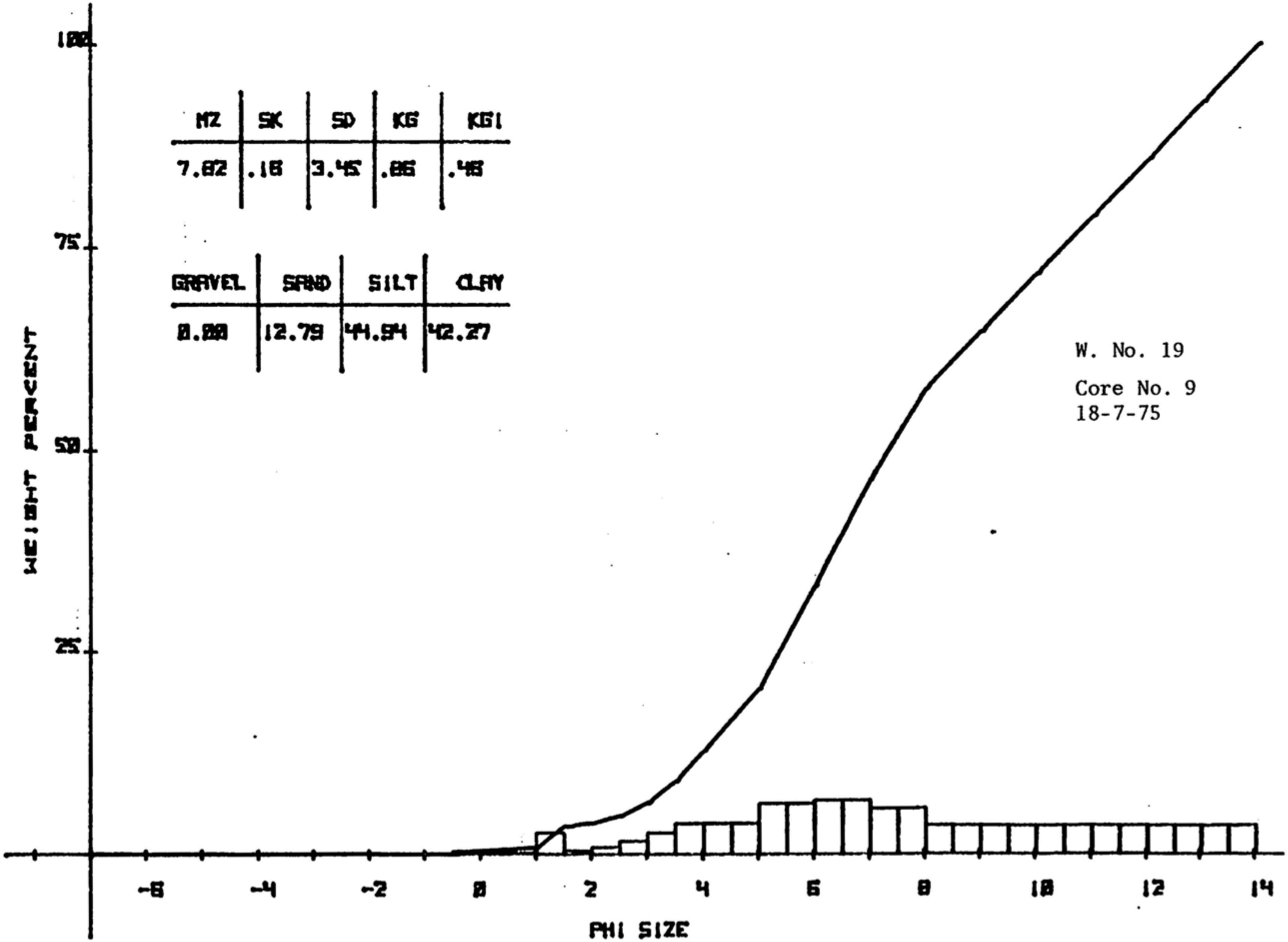
Size	Dish	Dish Wt.	Dish Sed.	Sed. Wt.	less Calgon	x 50	%	Notes
4ϕ	43	1.3366	1.6021			12.675		pair added
5ϕ	44	1.3388	1.5837			11.645		1.1297
6ϕ	45	1.3323	1.5420			9.885		1.8597
7ϕ	46	1.3350	1.5052			7.910		1.9750
8ϕ	47	1.3350	1.4718			6.240		1.6700
9ϕ	56	1.3405	1.4408			4.415		1.8250

SAND FRACTION

> 63 1.7334 gm.

Sieve Analysis No.

Size	Dish	Dish Wt.	Dish & Sed.	Sed. Wt.	Cum. Wt.	%	Description
0ϕ				0.0578			some wood & organics
1/2				0.0245			85% wood & organics
1ϕ				0.0290			85% wood & organics
1 1/2				0.0393			50% wood & organics
2ϕ				0.0609			50% wood & organics
2 1/2				0.1320			
3ϕ				0.2390			
3 1/2				0.3900			
4ϕ				0.5615			
pair				0.1994			


MZ | SK | SD | KG | KGI
7.82 | .18 | 3.45 | .86 | .48
GRAVEL | SAND | SILT | CLAY
0.00 | 12.79 | 44.94 | 42.27
100
75
50
25
WEIGHT PERCENT
-6
-4
-2
0
2
4
6
8
10
12
14
PHI SIZE
W. No. 19
Core No. 9
18-7-75

GRAIN SIZE ANALYSIS

Initial weight:

Final weight:

Working number: 20

Sample number: 57

Analyst: A.E.A. Date: February, 1976

Map No.: C-3

FINE FRACTION

Treatment: 20 ml H_2O_2 → Centrifuged
50 ml calgon

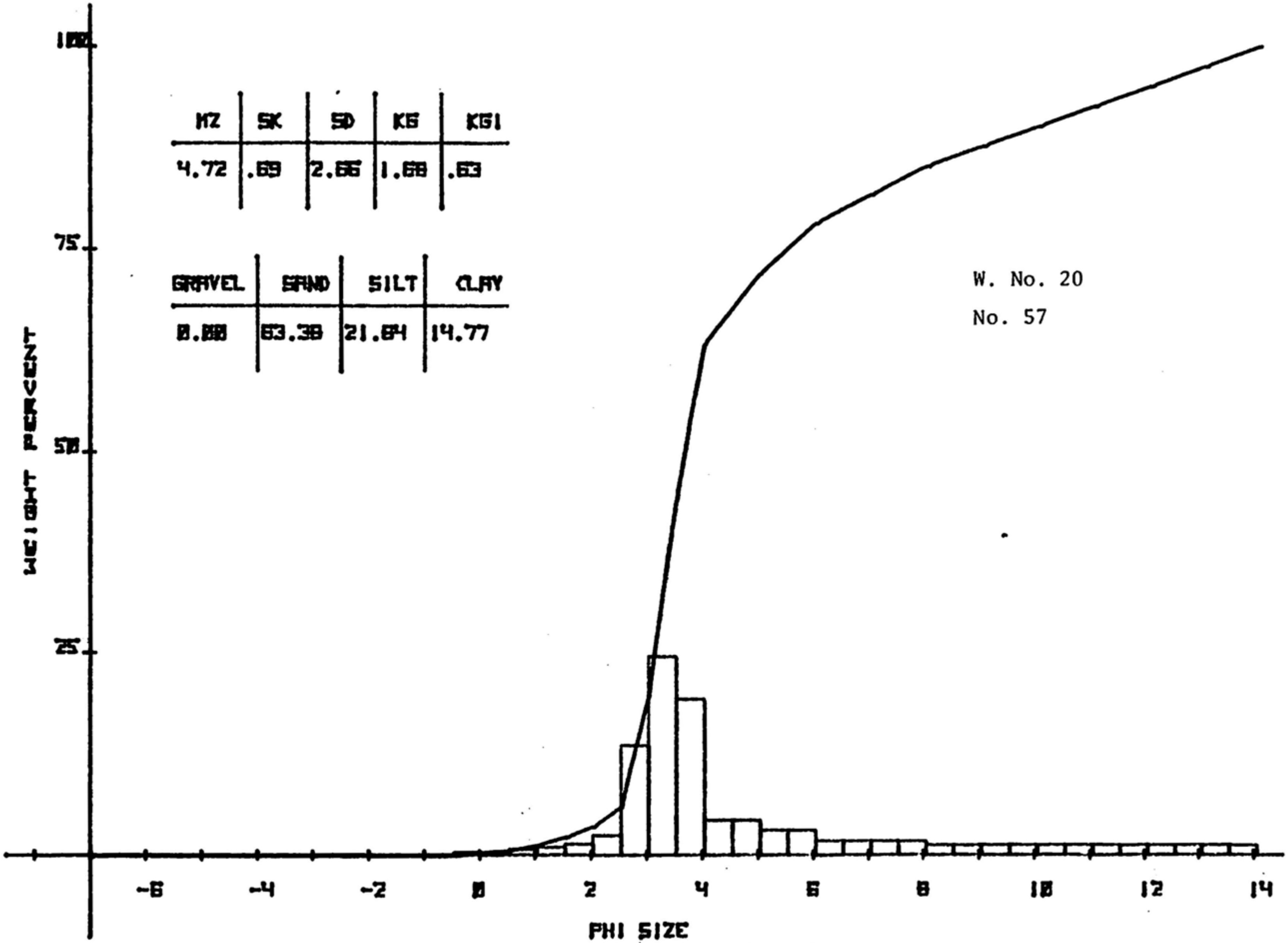
Peptiser: Batch: #12 Wt. per 20 ml:
0.0120 mg.

Size	Dish	Dish Wt.	Dish Sed.	Sed. Wt.	less Calgon	x 50	%	Notes
4ϕ	49	1.3432	1.5452			9.350		pair added
5ϕ	50	1.3472	1.5080			7.440		2.4838
6ϕ	51	1.3439	1.4807			6.240		1.7738
7ϕ	52	1.3416	1.4582			5.230		1.0100
8ϕ	53	1.3395	1.4362			4.235		0.9950
9ϕ	54	1.3407	1.4170			3.215		1.0200

SAND FRACTION Sieve Analysis No.

> 63 19.3183 gm.

Size	Dish	Dish Wt.	Dish & Sed.	Sed. Wt.	Cum. Wt.	%	Description
0ϕ				0.0958			all organics, few mica
1/2				0.0720			some woods, mostly organics
1ϕ				0.1990			some woods, organics, few mica
1 1/2				0.2755			approx. 5% mica, all organics
2ϕ				0.3885			approx. 5% mica & few shell fragments
2 1/2				0.7035			approx. 7% mica & organics
3ϕ				3.8765			
3 1/2				7.0290			
4ϕ				5.5310			
pair				1.1475			


MZ | SK | SD | KG | KGI
4.72 | .69 | 2.66 | 1.68 | .63
GRAVEL | SAND | SILT | CLAY
0.00 | 63.38 | 21.84 | 14.77
W. No. 20
No. 57
100
75
50
25
WEIGHT PERCENT
-6
-4
-2
0
2
4
6
8
10
12
14
PHI SIZE

Rock Crab Data

Sample Number	Carapace Length(cm)	Weight (gm)	Date of Capture	Location of Capture	Method of Capture	Sex
1	8.090	81.6	16/7/75	1	LT	M
2	8.940	128.1	16/7/75	1	LT	M
3	9.465	151.2	16/7/75	1	LT	M
4	8.720	122.8	16/7/75	1	LT	M
5	10.215	187.4	16/7/75	1	LT	M
6	8.695	115.0	16/7/75	1	LT	M
7	9.830	128.5	16/7/75	1	LT	M
8	9.725	161.2	16/7/75	1	LT	M
9	7.715	80.3	16/7/75	1	LT	M
10	8.225	112.6	16/7/75	1	LT	M
11	7.935	99.3	16/7/75	1	LT	M
12	7.000	72.2	16/7/75	1	LT	M
13	8.660	131.8	16/7/75	1	LT	M
14	10.145	203.8	16/7/75	1	LT	M
15	8.115	100.5	16/7/75	1	LT	M
16	8.295	104.5	16/7/75	1	LT	M
17	7.290	82.5	16/7/75	1	LT	M
18	8.550	124.2	16/7/75	1	LT	M
19	8.580	122.8	16/7/75	1	LT	M
20	8.740	129.2	16/7/75	1	LT	M
21	8.250	111.9	16/7/75	1	LT	M
22	9.225	151.4	16/7/75	1	LT	M
23	8.515	107.7	16/7/75	1	LT	M
24	7.605	84.0	16/7/75	1	LT	M
25	7.710	99.5	16/7/75	1	LT	M
26	8.150	106.3	16/7/75	1	LT	M
27	9.435	169.7	16/7/75	1	LT	M
28	8.725	134.8	16/7/75	1	LT	M
29	8.210	115.4	16/7/75	1	LT	M
30	8.125	106.7	16/7/75	1	LT	M
31	7.740	95.5	16/7/75	1	LT	M
32	7.755	84.2	16/7/75	1	LT	F
33	8.065	112.7	16/7/75	1	LT	M
34	9.135	116.1	16/7/75	1	LT	M
35	8.110	100.7	16/7/75	1	LT	M
36	8.295	109.9	16/7/75	1	LT	M
37	8.725	134.2	16/7/75	1	LT	M
38	7.720	85.2	16/7/75	1	LT	M
39	8.395	118.4	16/7/75	1	LT	M
40	7.980	99.3	16/7/75	1	LT	M
41	7.415	73.4	16/7/75	1	LT	M
42	8.835	128.7	16/7/75	1	LT	M
43	6.990	68.8	16/7/75	1	LT	M
44	4.615	19.4	16/7/75	1	LT	M
45	8.700	129.4	16/7/75	1	LT	M
46	8.510	104.5	16/7/75	1	LT	M
47	5.070	16.2	20/7/75	2	LT	F
48	5.495	31.0	20/7/75	2	LT	F
49	6.050	33.7	20/7/75	2	LT	F
50	7.555	78.3	25/7/75	3	LT	M
51	10.50		1/8/75	4	LT	M
52	10.04		1/8/75	4	LT	M
53	9.10		1/8/75	4	LT	M

Sample Number	Carapace Length(cm)	Weight (gm)	Date of Capture	Location of Capture	Method of Capture	Sex
54	11.45		1/8/75	4	LT	M
55	9.33		1/8/75	4	LT	F
56	8.64		1/8/75	4	LT	F
57	9.58		1/8/75	4	LT	M
58	7.45		1/8/75	4	LT	M
59	10.34		1/8/75	4	LT	M
60	9.26		1/8/75	4	LT	M
61	7.76		1/8/75	4	LT	M
62	9.02		1/8/75	4	LT	M
63	8.18		1/8/75	5	LT	M
64	8.32		1/8/75	5	LT	M
65	8.07		1/8/75	5	LT	M
66	8.39		1/8/75	5	LT	M
67	6.98		1/8/75	5	LT	M
68	6.12		1/8/75	5	LT	M
69	5.93		1/8/75	5	LT	F
70	8.163	73.45	7/8/75	7	LT	M
71	8.470	90.69	7/8/75	7	LT	M
72	9.090	120.19	7/8/75	7	LT	M
73	7.525	70.05	7/8/75	7	LT	M
74	8.190	80.51	7/8/75	6	LT	M
75	10.470	212.5	8/8/75	8/9	LT	M
76	7.920	80.4	8/8/75	8/9	LT	M
77	9.855	181.2	8/8/75	8/9	LT	M
78	6.335	31.4	8/8/75	8/9	LT	F
79	7.625	76.5	8/8/75	8/9	LT	F
80	8.880	124.9	8/8/75	8/9	LT	M
81	8.470	106.4	8/8/75	8/9	LT	F
82	7.855	86.3	8/8/75	8/9	LT	M
83	5.220	23.1	8/8/75	8/9	LT	F
84	6.910	53.3	8/8/75	8/9	LT	F
85	7.995	95.3	8/8/75	8/9	LT	M
86	6.430	49.8	8/8/75	8/9	LT	F
87	7.390	69.7	8/8/75	8/9	LT	M
88	8.210	98.5	8/8/75	8/9	LT	M
89	6.225	42.5	8/8/75	8/9	LT	F
90	6.485	47.1	8/8/75	8/9	LT	F
91	5.700	32.4	8/8/75	8/9	LT	F
92	5.395	30.1	8/8/75	8/9	LT	F
93	6.085	40.5	8/8/75	8/9	LT	F
94	9.72	171.9	13/8/75	10	LT	M
95	7.09	65.9	13/8/75	10	LT	M
96	8.46	102.1	13/8/75	10	LT	M
97	8.51	117.3	13/8/75	10	LT	M
98	6.86	58.3	13/8/75	10	LT	M
99	8.42	101.1	13/8/75	10	LT	M
100	7.81	89.6	13/8/75	10	LT	M
101	6.94	62.6	13/8/75	10	LT	M
102	8.50	110.7	13/8/75	10	LT	M
103	8.50	112.5	13/8/75	10	LT	M
104	9.15	136.6	13/8/75	10	LT	M
105	8.88	118.2	13/8/75	10	LT	M
106	9.47	153.9	13/8/75	10	LT	M
107	8.31	114.7	13/8/75	11	LT	M
108	10.81	206.1	13/8/75	11	LT	M

Sample Number	Carapace Length(cm)	Weight (gm)	Date of Capture	Location of Capture	Method of Capture	Sex
109	10.62	211.5	13/8/75	11	LT	M
110	9.02	119.3	13/8/75	11	LT	M
111	7.45	72.3	13/8/75	11	LT	M
112	10.90	161.1	13/8/75	11	LT	M
113	9.78	176.3	13/8/75	11	LT	M
114	9.18	144.6	13/8/75	11	LT	M
115	8.54	121.3	13/8/75	11	LT	M
116	9.86	177.8	13/8/75	11	LT	M
117	8.90	133.4	13/8/75	11	LT	M
118	9.04	133.0	13/8/75	11	LT	M
119	7.88	92.7	13/8/75	11	LT	M
120	7.88	86.4	13/8/75	11	LT	M
121	7.66	86.2	13/8/75	11	LT	M
122	8.46	123.2	13/8/75	11	LT	M
123	7.75	69.7	14/8/75	12	LT	M
124	8.65	111.9	14/8/75	13	LT	M
125	9.34	100.37	14/8/75	13	LT	M
126	10.07	131.3	14/8/75	13	LT	M
127	8.26	92.5	14/8/75	13	LT	M
128	7.99	83.1	14/8/75	13	LT	M
129	7.20	54.1	14/8/75	13	LT	M
130	7.44	64.4	14/8/75	13	LT	M
131	6.40	49.4	14/8/75	13	LT	M
132	8.96	125.2	14/8/75	13	LT	M
133	7.06	54.0	14/8/75	13	LT	M
134	6.87	54.3	14/8/75	13	LT	M
135	7.38	79.6	14/8/75	13	LT	M
136	8.25	88.6	14/8/75	13	LT	M
137	7.98	77.1	14/8/75	13	LT	M
138	7.74	78.9	14/8/75	13	LT	M
139	8.24	85.9	14/8/75	13	LT	M
140	7.56	76.4	14/8/75	13	LT	M
141	7.90	74.7	14/8/75	13	LT	M
142	7.44	75.9	14/8/75	13	LT	M
143	8.40	103.9	14/8/75	13	LT	M
144	7.48	75.4	14/8/75	13	LT	M
145	8.94	101.9	19/8/75	14/15	LT	M
146	9.07	143.5	19/8/75	14/15	LT	M
147	7.76	88.7	19/8/75	14/15	LT	M
148	10.21	200.8	19/8/75	14/15	LT	M
149	7.93	99.1	19/8/75	14/15	LT	M
150	8.16	111.3	19/8/75	14/15	LT	M
151	8.28	111.0	19/8/75	14/15	LT	M
152	8.34	103.2	19/8/75	14/15	LT	F
153	8.46	128.0	19/8/75	14/15	LT	M
154	7.89	92.4	19/8/75	14/15	LT	F
155	8.30	108.2	19/8/75	14/15	LT	M
156	8.03	106.8	19/8/75	14/15	LT	M
157	8.45	115.4	19/8/75	14/15	LT	M
158	7.77	92.2	19/8/75	14/15	LT	M
159	8.63	110.8	19/8/75	14/15	LT	M
160	9.86	154.0	19/8/75	14/15	LT	M
161	7.80	86.9	19/8/75	14/15	LT	M
162	7.60	81.2	19/8/75	14/15	LT	M
163	7.50	83.2	19/8/75	14/15	LT	M

Sample Number	Carapace Length(cm)	Weight (gm)	Date of Capture	Location of Capture	Method of Capture	Sex
164	7.22	68.6	19/8/75	14/15	LT	M
165	7.59	78.6	19/8/75	14/15	LT	F
166	7.64	88.6	19/8/75	14/15	LT	M
167	7.42	80.3	19/8/75	14/15	LT	M
168	7.20	78.5	19/8/75	14/15	LT	M
169	7.26	66.3	19/8/75	14/15	LT	M
170	7.28	79.7	19/8/75	14/15	LT	M
171	8.54	120.4	19/8/75	14/15	LT	M
172	6.89	65.8	19/8/75	14/15	LT	M
173	7.20	73.5	19/8/75	14/15	LT	M
174	8.64	119.2	19/8/75	14/15	DR	M
175	6.66	46.1	19/8/75	14/15	DR	F
176	5.46	28.3	19/8/75	14/15	DR	M
177	5.22	28.9	19/8/75	14/15	DR	F
178	9.55		19/8/75	14/15	DR	M
179	7.6		19/8/75	14/15	DR	M
180	7.7		19/8/75	14/15	DR	M
181	9.0		19/8/75	14/15	DR	M
182	7.3		19/8/75	14/15	DR	M
183	7.7		19/8/75	14/15	DR	M
184	9.8		19/8/75	14/15	DR	M
185	10.3		19/8/75	14/15	DR	M
186	7.8		19/8/75	14/15	DR	M
187	7.9		19/8/75	14/15	DR	M
188	7.0		19/8/75	14/15	DR	M
189	6.3		19/8/75	14/15	DR	M
190	3.4		19/8/75	14/15	DR	M
191	10.8		19/8/75	14/15	DR	M
192	5.5		19/8/75	14/15	DR	F
193	6.8		19/8/75	14/15	DR	M
194	4.5		19/8/75	14/15	DR	F
195	9.8		19/8/75	14/15	DR	M
196	7.2		19/8/75	14/15	DR	M
197	4.8		19/8/75	14/15	DR	F
198	4.5		19/8/75	14/15	DR	F
199	4.5		19/8/75	14/15	DR	M
200	3.5		19/8/75	14/15	DR	F
201	5.1		19/8/75	14/15	DR	F
202	3.8		19/8/75	14/15	DR	M
203	10.87	204.2	28/8/75	16	LT	M
204	10.50	180.0	28/8/75	16	LT	M
205	10.58	200.2	28/8/75	16	LT	M
206	10.19	155.9	28/8/75	16	LT	M
207	9.84	146.1	28/8/75	16	LT	M
208	10.60	178.4	28/8/75	16	LT	M
209	10.32	153.2	28/8/75	16	LT	M
210	10.53	186.3	28/8/75	16	LT	M
211	11.88	258.1	28/8/75	16	LT	M
212	11.31	223.3	28/8/75	16	LT	M
213	11.76	245.7	28/8/75	16	LT	M
214	10.72	163.0	28/8/75	16	LT	M
215	11.36	212.2	28/8/75	16	LT	M
216	10.63	170.4	28/8/75	16	LT	M
217	11.17	218.4	28/8/75	16	LT	M
218	8.21	104.0	28/8/75	16	LT	M

Lobster Data

Sample Number	Carapace Length (cm)	Weight (gm)	Date of Capture	Location of Capture	Method of Capture	Sex
1	7.0	227.4	1/8/75	5	LT[1]	M
2	7.0	252.5	1/8/75	5	LT	M
3	6.740	190.84	7/8/75	7	LT	F
4	6.195	140.57	7/8/75	7	LT	F
5	4.740	90.45	7/8/75	7	LT	F
6	6.05	151.6	19/8/75	14	LT	M
7	6.96	267.0	19/8/75	14	LT	M
8	3.63	38.7	19/8/75	LG[2]	DR[3]	M
9	3.98	52.6	↓	↓	↓	M
10	5.04	94.2	↓	↓	↓	F
11	6.05	160.2	↓	↓	↓	M
12	6.64	213.3	↓	↓	↓	F
13	5.09	116.1	↓	↓	↓	F
14	4.86	104.2	↓	↓	↓	M
15	5.87	129.2	↓	↓	↓	F
16	6.31	188.7	↓	↓	↓	M
17	3.55	35.4	↓	↓	↓	M
18	5.24	131.4	↓	↓	↓	F
19	6.56	163.9	↓	↓	↓	M
20	3.76	32.5	↓	↓	↓	F
21	6.37	220.8	↓	↓	↓	M
22	6.34	179.4	↓	↓	↓	F
23	5.62	144.6	↓	↓	↓	F
24	3.44	36.8	↓	↓	↓	M
25	3.7	45.1	↓	↓	↓	M
26	8.32	325.6	↓	↓	↓	M
27	6.91	166.1	↓	↓	↓	M
28	5.72	146.8	↓	↓	↓	F

[1] Lobster trap
[2] Little Gulley
[3] Diver

APPENDIX C FISH DATA

Legend: Method of Capture

GN xx Gill net

↑ Moving upstream

↓ Moving downstream

FT Fish Trap
ET Eel Trap
LT Lobster Trap
DR Diver
M Male
F Female

Stomach Contents Description

		Amount:	
ss	sand shrimp	e	- empty
sl	sand lance	1/8	- 1/8 filled
s	silverside	1/4	- 1/4 filled
d	decapods	1/2	- 1/2 filled
c	crustaceans	3/4	- 3/4 filled
mu	mummichog	f	- full
		?	- unknown amount

Color of "mush" (plankton or digested material):

gr	grey	b	brown
w	white	bl	black
g	green	y	yellow
		m	mixed

Gonad - weight in grams

Age - x otolith or scales collected

GASPEREAU

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
01	27.2		6/6	1	GN	F	3-4	e		
02	26.8		6/6	1	GN	F	3-4	e		
03	24.8		6/6	1	GN					
04	25.6		6/6	1	GN					
05	25.6		6/6	1	GN					
06	30.6		6/6	1	GN	F	3-4	e		
07	28.5		6/6	1	GN	F	3-4	e		
08	24.5		6/6	1	GN	M	4	e		
09	28.5		6/6	1	GN	M	5	e		
10	28.8		6/6	1	GN	F	4-5	¼		
11	26.4		6/6	1	GN → 90% in 2½", 10% in 5½"	F	4	¼		
12	24.8		6/6	1	GN	M	4	¼		
13	27.8		6/6	1	GN	M	5	3		
14	28.4		6/6	1	GN	M	4	fg		
15	26.4		6/6	1	GN	F	4	e		
16	30.0		6/6	1	GN	F	4	fg		
17	26.0		6/6	1	GN	M	5	e		
18	25.0		6/6	1	GN	F	4	fg		
19	25.0		6/6	1	GN	M	5	e		
20	25.0		6/6	1	GN	F	4-5	e		
21	25.0		6/6	1	GN	F	4	f		
22	24.0		6/6	1	GN	F	4	e		
23	28.8	310.0	7/6	3	GN	F	4	e	55	x
24	28.0	300.0	7/6	3	GN	M	4	e	35	x
25	30.0	375.0	7/6	3	GN	M	4	e	65	x
26	28.6	290.0	7/6	3	GN	F	4	e	45	x
27	29.0	340.0	7/6	3	GN	F	4	e	60	x
28	29.0	310.0	7/6	3	GN	F	4	e	50	x
29	31.0	400.0	7/6	3	GN	F	4	e	100	x
30	28.6	330.0	7/6	3	GN	M	4	?g	40	x
31	31.0	415.0	7/6	3	GN → 3½"	F	4	?g	85	x
32	27.0	260.0	7/6	3	GN	M	5	e	30	x
33	28.0	300.0	7/6	3	GN	M	4	e	40	x
34	29.0	350.0	7/6	3	GN	F	4	e	80	x
35	30.5	440.0	7/6	3	GN	F	4	e	110	x
36	30.0	340.0	7/6	3	GN	F	4	e	60	x
37	30.0	370.0	7/6	3	GN	F	4	?g	80	x
38	30.0	380.0	7/6	3	GN	F	4	e	75	x
39	29.0	300.0	7/6	3	GN	M	4	e	40	x
40	27.0	270.0	7/6	3	GN	F	4	e	80	x

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
41	30.0	400.0	7/6	3	GN 3½	F	4			
42	31.0	400.0	7/6	3	GN 3½	F	4			
43	30.0	350.0	7/6	3	GN 3½	F	4			
44	28.0	320.0	7/6	2	GN 5½/2½/1½	F	4	e	45	x
45	27.0	260.0	7/6	2	GN 5½/2½/1½	M	4	fb	30	x
46	28.5	330.0	7/6	2	GN 5½/2½/1½	F	4	e	60	x
47	28.0	280.0	7/6	2	GN 5½/2½/1½	M	4	e	30	x
48	25.0	230.0	7/6	2	GN 5½/2½/1½	F	4	e	35	x
49	25.0	210.0	7/6	2	GN 5½/2½/1½	F	4	e	30	x
50	28.5	300.0	7/6	2	GN 5½/2½/1½	F	4	fb	40	x
51	28.0	260.0	7/6	2	GN 5½/2½/1½	M	4	e	30	x
52	28.5	330.0	7/6	2	GN 5½/2½/1½	F	4	e	65	x
53	25.0	240.0	7/6	2	GN 5½/2½/1½	F	4	fg	50	x
54	27.0	235.0	7/6	2	GN 5½/2½/1½	F	4	½g	40	x
55	28.0	270.0	7/6	2	GN5½/2½/1½	F	4	e	50	x
56	27.5	270.0	7/6	2	GN 5½/2½/1½	M	4	fg	35	x
57	28.5	320.0	7/6	2	GN 5½/2½/1½	F	4	e	50	x
58	30.0	355.0	7/6	2	GN 5½/2½/1½	F	4	fg	50	x
59	28.0	285.0	7/6	2	GN 5½/2½/1½	F	4	e	50	x
60	30.5	330.0	7/6	2	GN 5½/2½/1½	F	4	e	50	x
61	28.0	300.0	7/6	2	GN 5½/2½/1½	F	4	e	50	x
62	28.5	285.0	7/6	2	GN 5½/2½/1½	M	4	e	40	x
63	30.0	345.0	7/6	2	GN 5½/2½/1½	F	4	e	60	x
64	27.5	260.0	7/6	2	GN 5½/2½/1½	F	4	e	55	x
65	27.0	280.0	7/6	2	GN 5½/2½/1½	F	4	e	45	x
66	26.0	220.0	7/6	2	GN 5½/2½/1½	F	4	e	40	x
67	25.0	210.0	7/6	2	GN 5½/2½/1½	F	4	e	40	x
68	25.0	210.0	7/6	2	GN 5½/2½/1½	M	4	e	30	x
69	27.5	255.0	7/6	2	GN 5½/2½/1½	M	4	e	30	x
70	28.0	300.0	7/6	2	GN 5½/2½/1½	F	4	fe	55	x
71	28.0	335.0	7/6	2	GN 5½/2½/1½	F	4	fb	60	x
72	28.0	260.0	7/6	2	GN 5½/2½/1½	M	4			
73	25.0	185.0	10/6	4	GN 6½/3½	M	4	½	20	x
74	26.5	245.0	10/6	4	GN 6½/3½	M	4	fw	30	x
75	28.0	280.0	10/6	4	GN 6½/3½	F	4	fw	35	x
76	25.0	175.0	10/6	4	GN 6½/3½	M	4	e	10	x
77	24.5	170.0	10/6	4	GN 6½/3½	M	4	fg	15	x
78	27.0	255.0	10/6	4	GN 6½/3½	M	4	fg	25	x
79	24.5	170.0	10/6	4	GN 6½/3½	F	4	fwb	25	x
80	25.5	190.0	10/6	4	GN 6½/3½	M	4	¼w	25	x
81	28.0	260.0	10/6	4	GN 6½/3½	M	4	fw	40	x
82	27.0	255.0	10/6	2	GN 5½/2½/1½	F	4	e	40	x
83	29.5	310.0	10/6	2	GN 5½/2½/1½	F	4	e	60	x

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
84	29.0	315.0	10/6	2	GN 5½/2½/1½	F	4	e	55	x
85	29.0	310.0	10/6	2	GN 5½/2½/1½	F	4	fw	50	x
86	28.5	300.0	10/6	2	GN 5½/2½/1½	F	4	½w	50	x
87	29.0	350.0	10/6	2	GN 5½/2½/1½	F	4	e	50	x
88	28.5	310.0	10/6	2	GN 5½/2½/1½	M	4	fw	40	x
89	27.0	255.0	10/6	2	GN 5½/2½/1½	M	4	fg	30	x
90	29.5	340.0	10/6	2	GN 5½/2½/1½	F	4	fg	40	x
91	30.5	370.0	10/6	2	GN 5½/2½/1½	F	4	e	70	x
92	28.0	340.0	10/6	2	GN 5½/2½/1½	F	4	e	60	x
93	26.0	240.0	10/6	2	GN 5½/2½/1½	F	5	½w	70	x
94	28.5	320.0	10/6	2	GN 5½/2½/1½	F	4	fg	55	x
95	29.0	350.0	10/6	2	GN 5½/2½/1½	F	4	e	50	x
96	29.0	350.0	10/6	2	GN 5½/2½/1½	F	4	e	70	x
97	27.0	280.0	10/6	2	GN 5½/2½/1½	M	4	e	40	x
98	27.5	220.0	12/6	2	GN 3½	F	4	e	35	x
99	29.5	300.0	13/6	2	GN 6½/3½	F	4	e	55	x
100	28.5	270.0	13/6	2	GN 6½/3½	F	4	¼bl	50	x
101	25.6	220.0	13/6	2	GN 6½/3½	F	4	e	35	x
102			14/6		ET					
103			14/6		ET					
104			14/6		ET					
105			14/6		ET					
106			14/6		ET					
107			14/6		ET					
108			14/6		ET					
109			14/6		ET					
110			14/6		ET					
111			14/6		ET					
112			14/6		ET					
113			14/6		ET					
114			14/6		ET					
115			14/6		ET					
116			14/6		ET					
117	28.0		16/6		FT					
118	29.0	350.0	18/6	5	GN 3½ ↓	F	4	fb	55	x
119	28.5	315.0	18/6	5	GN 3½ ↓	F	4	e	60	x
120	25.0	170.0	20/6	7	GN 2½	F	4	?w	35	x
121	26.5	220.0	20/6	7	GN 2½	M	4	e	30	x
122	28.0	280.0	20/6	7	GN 2½	F	4	e	60	x
123	26.0	210.0	20/6	7	GN 2½	F	4	e	40	x
124	26.0	200.0	20/6	7	GN 2½	M	5	e	25	x
125	27.0	230.0	20/6	7	GN 2½	F	4	e	50	x
126	27.0	235.0	20/6	7	GN 2½	F	4	?w	40	x

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
127	27.5	240.0	20/6	7	GN 2½	F	4	¼w	50	x
128	25.0	150.0	20/6	7	GN 2½	F	4	e	50	x
129	27.5	200.0	20/6	7	GN 2½	M	4-5	¼w	25	x
130	27.0	250.0	20/6	7	GN 2½	F	4	e	60	x
131	26.5	200.0	20/6	7	GN 2½	M	4	½w	30	x
132			20/6	7	GN 2½	F				x
133	28.5	190.0	24/6	11	GN 2½/3½	M	4	½g	10	x
134	27.5	225.0	24/6	11	GN 2½/3½	M	4	e	30	x
135	29.5	210.0	24/6	11	GN 2½/3½	F	4	½g	15	x
136	30.0	275.0	24/6	11	GN 2½/3½	F	4	¼w	40	x
137	26.5	225.0	24/6	11	GN 3½/2½	F	4	¼w	50	x
138	25.0	200.0	24/6	11	GN 3½/2½	F	4	¼g	40	x
139	27.8	220.9	4/7	16	GN 34↑2↓/2½	M				
140	28.4	249.8	4/7	16	GN 34↑2↓/2½	F				
141	29.0	283.1	4/7	16	GN 34↑2↓/2½	M				
142	28.2	285.7	4/7	16	GN 34↑2↓/2½	F				
143	27.5	224.4	4/7	16	GN 34↑2↓/2½	M				
144	27.0	274.4	4/7	16	GN 34↑2↓/2½	F				
145	27.8	251.1	4/7	16	GN 34↑2↓/2½	M				
146	26.2	196.5	4/7	16	GN 34↑2↓/2½	F				
147	27.1	210.7	4/7	16	GN 34↑2↓/2½	M				
148	29.0	282.3	4/7	16	GN 34↑2↓/2½	F				
149	28.6	242.1	4/7	16	GN 34↑2↓/2½	F				
150	25.7	192.4	4/7	16	GN 34↑2↓/2½	M				
151	28.7	274.1	4/7	16	GN 34↑2↓/2½	F				
152	28.8	273.1	4/7	16	GN 34↑2↓/2½	F				
153	28.0	231.4	4/7	16	GN 34↑2↓/2½	M				
154	26.1	203.1	4/7	16	GN 34↑2↓/2½	M				
155	28.6	259.5	4/7	16	GN 34↑2↓/2½	F				
156	28.5	228.3	4/7	16	GN 34↑2↓/2½	F				
157	26.1	202.5	4/7	16	GN 34↑2↓/2½	F				
158	27.0	227.6	4/7	16	GN 34↑2↓/2½	M				
159	27.2	231.2	4/7	16	GN 34↑2↓/2½	F				
160	29.0	290.4	4/7	16	GN 34↑2↓/2½	M				
161	26.5	255.5	4/7	16	GN 34↑2↓/2½	F				
162	26.5	200.8	4/7	16	GN 34↑2↓/2½	M				
163	28.5	248.4	4/7	16	GN 34↑2↓/2½	M				
164	28.0	265.9	4/7	16	GN 34↑2↓/2½	M				
165	27.6	232.5	4/7	16	GN 34↑2↓/2½	F				
166	27.2	223.2	4/7	16	GN 34↑2↓/2½	M				
167	27.3	226.1	4/7	16	GN 34↑2↓/2½	F				
168	29.0	281.9	4/7	16	GN 34↑2↓/2½	M				
169	24.5	206.3	4/7	16	GN 34↑2↓/2½	F				
170	27.4	231.5	4/7	16	GN 34↑2↓/2½	M				

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
171	28.0	302.3	4/7	16	GN 34↑2↓/2½	F				
172	26.5	227.3	4/7	16	GN 34↑2↓/2½	M				
173	24.2	205.4	4/7	16	GN 34↑2↓/2½	F				
174	25.0	250.8	4/7	16	GN 34↑2↓/2½	F				
175	28.5	247.6	5/7	16	GN 2½	F	6	e	7.6	x
176	25.5	197.3	5/7	16	GN 2½	M	6	¼w	9.5	x
177	27.5	210.5	5/7	16	GN 2½	M	6	e	7.2	x
178	27.0	224.5	5/7	16	GN 2½	M	5	e	11.2	x
179	28.0	213.8	5/7	16	GN 2½	M	6	e	5.4	x
180	27.5	211.5	5/7	16	GN 2½	F	6	¼w	4.5	x
181	28.0	233.1	5/7	16	GN 2½	M	5	e	9.2	x
182	28.0	227.0	5/7	16	GN 2½	F	6	e	8.8	x
183	27.0	241.0	5/7	16	GN 2½	M	5	e	14.0	x
184	28.0	223.0	5/7	16	GN 2½	M	6	½g	6.6	x
185	26.5	196.0	5/7	16	GN 2½	M	5	e	10.0	x
186	27.0		7/7	16	GN 2½					
187	28.5		7/7	16	GN 2½					
188	26.5		7/7	16	GN 2½					
189	27.0		7/7	16	GN 2½					
190	29.0		7/7	16	GN 2½					
191	24.5	161.2	11/7	15	GN 2½	F	5	?w	19.3	x
192	26.0	234.5	11/7	15	GN 2½	F	4	fe	25.4	x
193	24.5	208.9	11/7	15	GN 2½	F	5	fy	21.3	x
194	28.5	248.7	17/7	17	GN 2½/3½					
195			17/7	19	GN 2½/3½					
196	28.5	315.7	31/7	20	GN 3½ ↑					x

<u>STRIPED BASS</u>

	Number	cm Length	gm Weight	Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
	01	10.0		5/6		ET					
	02	25.5	160.0	9/6		ET					
	03	9.5	15.0	9/6		ET					
	04	9.0	10.0	10/6		ET					
	05	11.5	15.0	10/6		ET					
	06	12.5	25.0	10/6		ET					
	07	8.5	10.0	10/6		ET					
	08	9.0	10.0	10/6		ET					
	09	9.5	15.0	10/6		ET					
	10	10.5	15.0	10/6		ET					
	11	10.0	25.0	10/6		ET					
	12	11.5	30.0	10/6		ET					
	13	11.0	25.0	10/6		ET					
	14	8.0	10.0	10/6		ET					
	15			14/6		ET					
	16			14/6		ET					
	17			14/6		ET					
	18	7.5		17/6		FT					
	19	28.4	316.6	4/7	16	GN 2½↑					
	20	33.0	466.5	7/8	21	GN 2½/3½↑					
Parasites:	21	32.0	426.8	7/8	23	GN 2½/3½↑					
Copepod	22	34.0	528.3	12/8	24	GN 2½/3½↑			f,ss		x
Copepod	23	33.5	469.5	12/8	24	GN 3½↑	F	2	¼w	1.5	x
	24	32.0	469.1	12/8	24	GN 3½↑	M	2	1/8w	3.5	x
	25	32.5	470.0	12/8	24	GN 3½↑			f,ss,sl		x
	26	32.0	482.0	12/8	24	GN 3½↑			f,ss,sl		x
Parasites:	27	32.0	445.5	12/8	24	GN 3½↑	M	2	e	2.1	x
Worms	28	32.0	446.4	28/8	24	GN 3½↑	?		f,d		x
	29	34.25	524.0	2/11	20	GN 3½↑	M	2	1/8,s		x
	30	12.5	57.0	2/11	20	GN 1½↑	?	1	e		x
	31	36.0	666.0	2/11	20		M	1	¼,gr		x
	32	23.5	198.0	2/11	20		?	1	e		x
	33	24.25	227.0	2/11	20 →	GN		1	e		x
	34	40.0	978.0	2/11	20	3½: 2↑	M	3	e		x
	35	36.5	680.0	2/11	20	2↓	M	3	¼,s		x
	36	26.5	312.0	2/11	20	2½: 2↓		1	e		x
						1?					
						3↑					

<u>STRIPED BASS</u> (cont.)

Number	Length	Weight	Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Age	Parasites
37	35.0	581.0	2/11	16 →	GN 3½: 2	F	2	¼, ss	x	x
38	38.0	765.0	2/11	16	2	F	1	¼, gr	X	X
39	25.5	298.0	2/11	16	2½: 2	?	1	e	x	x
40	25.0	255.0	2/11	16	1	?	1	1/8, s	x	x
					3					
41	38.0	794.0	2/11	16	GN 2½	?	2	f, gr	x	x

	Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
	01	20.0	80.0	10/6		ET					
	02	15.0	50.0	10/6		ET					
	03	35.5	620.0	13/6	2	GN 6½/3½					
	04	34.4	607.3	4/7	16	GN 2½ ↑					
	05	41.9	1100.0	4/7	16	GN 2½ ↑					
	06	26.5	258.0	4/7	16	GN 2½ ↑					
	07	35.0	513.5	5/7	16	GN 2½					
	08	29.5	320.6	5/7	16	GN 2½					
	09	25.5		7/7	16	GN 2½					
Parasites:	10	28.5		7/7	16	GN 2½					
2 Copepods	11	40.0	840.0	31/7	15	GN 3½	F	3-4	?y	12.8	
	12	35.0	539.0	2/11	20	GN 3½ ↓	F	2	f,9s		
	13	27.5	269.0	2/11	16	GN 2½ ↑	?	1	1/8,s		
	14	18.5	71.0	3/11	16	GN 1½ ↑	?	1	f,s		
					SMOLT SALMON						
	01	13.5	30.0	9/6		ET					
	02	14.5	40.0	9/6		ET					
	03	13.0	25.0	9/6		ET					
	04	15.5	40.0	9/6		ET					
	05	15.0	40.0	9/6		ET					
	06	15.0	40.0	9/6		ET					
	07	15.0	40.0	9/6		ET					
	08	13.5	30.0	9/6		ET					
	09	13.0	30.0	9/6		ET					
	10	12.5	30.0	9/6		ET					
	11	16.5	40.0	10/6		ET					
	12	13.5	20.0	10/6		ET					
	13	12.5	20.0	10/6		ET					
	14	13.5	25.0	10/6		ET					
	15	14.0	25.0	10/6		ET					
	16	13.5	30.0	10/6		ET					
Salmon	01	76.0	4.6 kg	10/6	2	GN 5½	F	3		30.0	x
Sculpin	01	5.5		9/6		ET 1/10					

SMELTS

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
01	16.0		5/6		ET					
02	14.2		5/6		ET					
03	13.0		5/6		ET					
04	15.0		5/6		ET					
05	11.7		5/6		ET					
06	13.2		5/6		ET					
07	23.4		6/6	1	GN 2½ ↑					
08	20.5	70.0	7/6	2	GN 1½					
09	13.5	20.0	9/6		ET					
10	17.0	40.0	9/6		ET					
11	16.0	30.0	9/6		ET					
12	15.5	30.0	9/6		ET					
13	16.0	30.0	9/6		ET					
14	13.0	30.0	9/6		ET					
15	13.5	30.0	9/6		ET					
16	15.5	30.0	9/6		ET					
17	15.5	30.0	9/6		ET					
18	14.5	30.0	9/6		ET					
19	14.5	30.0	9/6		ET					
20	14.5	30.0	9/6		ET					
21	15.5	30.0	9/6		ET					
22	18.0	50.0	10/6	4	GN 6½/3½	M		f,sand lance		x
23	18.5	55.0	10/6	4	GN 6½/3½	M		f,sand lance		x
24	14.5	25.0	10/6		ET					
25	14.5	30.0	10/6		ET					
26	14.5	20.0	10/6		ET					
27	15.5	30.0	10/6		ET					
28	15.5	30.0	10/6		ET					
29	13.0	20.0	10/6		ET					
30	14.0	20.0	10/6		ET					
31	18.5	40.0	10/6		ET					
32	14.5	20.0	10/6		ET					
33	15.5	30.0	10/6		ET					
34	14.5	25.0	10/6		ET					
35	13.5	20.0	10/6		ET					
36	15.5	30.0	10/6		ET					
37	15.5	35.0	10/6		ET					
38	16.5	35.0	10/6		ET					
39	14.5	25.0	10/6		ET					
40	13.0	20.0	10/6		ET					

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
41	13.5	20.0	10/6		ET					
42	17.0	45.0	10/6		ET					
43	16.5	30.0	10/6		ET					
44	17.5	35.0	10/6		ET					
45	17.0	35.0	10/6		ET					
46	15.0	30.0	10/6		ET					
47	15.5	30.0	10/6		ET					
48	14.0	30.0	10/6		ET					
49	13.0	25.0	10/6		ET					
50	15.0	30.0	10/6		ET					
51	13.5	15.0	10/6		ET					
52	15.0	30.0	10/6		ET					
53	15.5	30.0	10/6		ET					
54	15.0	30.0	10/6		ET					
55	17.0	40.0	10/6		ET					
56	14.0	20.0	10/6		ET					
57	15.0	30.0	10/6		ET					
58	16.0	30.0	10/6		ET					
59	13.5	25.0	10/6		ET					
60	16.5	35.0	10/6		ET					
61	13.5	20.0	10/6		ET					
62	17.0	35.0	10/6		ET					
63	13.0	20.0	10/6		ET					
64	15.5	30.0	10/6		ET					
65	16.5	30.0	10/6		ET					
66	14.7	20.0	10/6		ET					
67	16.0	20.0	10/6		ET					
68	13.5	20.0	10/6		ET					
69	15.0	25.0	10/6		ET					
70	16.0	25.0	10/6		ET					
71	14.5	25.0	10/6		ET					
72	13.0	15.0	10/6		ET					
73	14.5	25.0	10/6		ET					
74	12.5	15.0	10/6		ET					
75	14.0	20.0	10/6		ET					
76	13.5	20.0	10/6		ET					
77	13.0	20.0	10/6		ET					
78	16.0	35.0	10/6		ET					
79	13.5	20.0	10/6		ET					
80	16.0	30.0	10/6		ET					
81	15.0	20.0	10/6		ET					
82	16.0	30.0	10/6		ET					
83	17.0	50.0	10/6		ET					

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
84	16.0	30.0	10/6		ET					
85	16.0	30.0	10/6		ET					
86	16.0	30.0	10/6		ET					
87	13.0	20.0	10/6		ET					
88	15.5	30.0	10/6		ET					
89	13.0	20.0	10/6		ET					
90	13.0	20.0	10/6		ET					
91	12.5	20.0	10/6		ET					
92	16.0	30.0	10/6		ET					
93	13.0	20.0	10/6		ET					
94	12.5	20.0	10/6		ET					
95	14.0	30.0	10/6		ET					
96	16.0	30.0	10/6		ET					
97	14.0	30.0	10/6		ET					
98	15.0	35.0	10/6		ET					
99	16.5	30.0	10/6		ET					
100	17.0	30.0	10/6		ET					
101	15.5	35.0	10/6		ET					
102	15.0	30.0	10/6		ET					
103	15.5	30.0	10/6		ET					
104	16.0	30.0	10/6		ET					
105	14.5	25.0	10/6		ET					
106	15.5	30.0	10/6		ET					
107	15.5	20.0	10/6		ET					
108	14.5	30.0	10/6		ET					
109	16.0	30.0	10/6		ET					
110	17.0	30.0	10/6		ET					
111	15.5	20.0	10/6		ET					
112	14.0	20.0	10/6		ET					
113	15.0	30.0	10/6		ET					
114	15.0	30.0	10/6		ET					
115	14.0	20.0	10/6		ET					
116	16.5	40.0	10/6		ET					
117	16.0	35.0	10/6		ET					
118	16.5	40.0	10/6		ET					
119	17.5	50.0	10/6		ET					
120	12.5	20.0	10/6		ET					
121	12.5	20.0	10/6		ET					
122	17.5	40.0	10/6		ET					
123	16.5	35.0	10/6		ET					
124	15.0	25.0	10/6		ET					
125	12.5	25.0	10/6		ET					
126	16.5	20.0	10/6		ET					

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
127	15.5	35.0	10/6		ET					
128	14.5	25.0	10/6		ET					
129	15.0	25.0	10/6		ET					
130	14.0	25.0	10/6		ET					
131	15.0	30.0	10/6		ET					
132	17.0	50.0	10/6		ET					
133	15.5	35.0	10/6		ET					
134	16.0	40.0	10/6		ET					
135	13.5	25.0	10/6		ET					
136	15.5	25.0	10/6		ET					
137	11.5	20.0	10/6		ET					
138	16.0	25.0	10/6		ET					
139	17.5	40.0	10/6		ET					
140	13.5	25.0	10/6		ET					
141	14.0	30.0	10/6		ET					
142	13.5	20.0	10/6		ET					
143	13.5	30.0	10/6		ET					
144	17.5	50.0	10/6		ET					
145	15.5	40.0	10/6		ET					
146	15.5	30.0	10/6		ET					
147	19.0	45.0	10/6		ET					
148	14.5	30.0	10/6		ET					
149	16.5	35.0	10/6		ET					
150	13.0	25.0	10/6		ET					
151	16.0	35.0	10/6		ET					
152	13.5	25.0	10/6		ET					
153	12.5	25.0	10/6		ET					
154	16.0	25.0	10/6		ET					
155	15.0		17/6		FT					
156	15.0		23/6		FT					

TOMCODS

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
01	18.0		5/6		ET					
02	17.3		5/6		ET					
03	18.2		5/6		ET					
04	20.3		5/6		ET					
05	13.2		5/6		ET					
06	11.8		5/6		ET					
07	19.0		5/6		ET					
08	23.0		5/6		ET					
09	12.0		5/6		ET					
10	13.0		5/6		ET					
11	11.0		5/6		ET					
12	19.0		5/6		ET					
13	23.0		5/6		ET					
14	13.2		5/6		ET					
15	16.2		5/6		ET					
16	13.2		5/6		ET					
17	12.2		5/6		ET					
18	12.0		5/6		ET					
19	15.8		5/6		ET					
20	18.7		5/6		ET					
21	13.2		5/6		ET					
22	12.0		5/6		ET					
23	13.0		5/6		ET					
24	12.4		5/6		ET					
25	15.2		5/6		ET					
26	19.2		5/6		ET					
27	10.4		5/6		ET					
28	10.7		5/6		ET					
29	12.0		5/6		ET					
30	12.8		5/6		ET					
31	13.2		5/6		ET					
32	14.0		5/6		ET					
33	13.0		5/6		ET					
34	16.0		5/6		ET					
35	15.0		5/6		ET					
36	11.6		5/6		ET					
37	26.5	150.0	9/6		ET					
38	21.5	85.0	9/6		ET					
39	13.0	20.0	9/6		ET					
40	21.3	95.0	9/6		ET					

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
41	11.5	12.0	9/6		ET					
42	25.3	115.0	9/6		ET			e		x
43	22.4	80.0	9/6		ET			½w		x
44	19.5	55.0	9/6		ET			½w		x
45	14.0	20.0	9/6		ET			½w		x
46	13.8	20.0	9/6		ET			e		x
47	13.8	20.0	9/6		ET			f		x
48	12.0	15.0	9/6		ET			fb		x
49	10.4	05.0	9/6		ET			e		x
50	13.5	10.0	9/6		ET			fg		x
51	13.8	22.0	9/6		ET			f		x
52	12.8	10.0	9/6		ET			fm		x
53	17.0	40.0	9/6		ET			½g		x
54	12.2	08.0	9/6		ET			f		x
55	12.5	10.0	9/6		ET			e		x
56	11.5	14.0	9/6		ET			fg		x
57	12.0	14.0	9/6		ET			fg		x
58	12.0	10.0	9/6		ET			½g		x
59	18.0	42.0	9/6		ET			½g		x
*60	20.5	80.0	9/6		ET			fg		x
61	19.0	60.0	9/6		ET			fg		x
62	20.5	60.0	9/6		ET			fw		x
*63	22.5	110.0	9/6		ET			f		x
64	23.5	100.0	9/6		ET			¼w		x
65	20.5	80.0	9/6		ET			¼w		x
66	18.0	40.0	9/6		ET			½g		x
67	19.0	50.0	9/6		ET			½g		x
*68	16.5	40.0	9/6		ET			f		x
69	17.5	50.0	9/6		ET			¼w		x
70	20.5	70.0	9/6		ET			½w		x
*71	29.0	270.0	9/6		ET	M		f	40	x
72	14.0	25.0	9/6		ET			½w		x
73	15.5	35.0	9/6		ET			½g		x
74	18.0	50.0	9/6		ET			¼g		x
75	14.5	30.0	9/6		ET			½g		x
76	14.0	30.0	9/6		ET			¼g		x
77	16.0	40.0	9/6		ET			fg		x
78	13.0	20.0	9/6		ET			½g		x
79	14.0	30.0	9/6		ET			¼g		x
80	13.0	25.0	9/6		ET			e		x
81	12.5	20.0	9/6		ET			e		x
82	14.0	30.0	9/6		ET			¼w		x
83	13.5	20.0	9/6		ET			½g		x

*Stomach conts:
Amphipods
Nereis parts?
Sticklebacks
Sand shrimp

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
84	12.0	15.0	9/6		ET			½g		x
85	11.5	15.0	9/6		ET			f,bl		x
86	12.5	15.0	9/6		ET			½w		x
87	12.0	20.0	9/6		ET			e		x
88	13.0	20.0	9/6		ET			e		x
89	12.0	25.0	9/6		ET			¼w		x
90	12.0	25.0	9/6		ET			¼w		x
91	11.5	15.0	9/6		ET					
92	11.0	15.0	9/6		ET					
93	15.0	40.0	10/6		GN 6½/3½			f,ss		
94	15.0	30.0	10/6		ET					
95	27.0	150.0	10/6		ET					
96	23.0	80.0	10/6		ET					
97	17.5	50.0	10/6		ET					
98	21.5	90.0	10/6		ET					
99	18.5	60.0	10/6		ET					
100	22.5	120.0	10/6		ET					
101	20.0	90.0	10/6		ET					
102	18.0	50.0	10/6		ET					
103	17.0	40.0	10/6		ET					
104	17.0	50.0	10/6		ET					
105	18.5	55.0	10/6		ET					
106	16.5	45.0	10/6		ET					
107	17.0	45.0	10/6		ET					
108	19.0	75.0	10/6		ET					
109	19.5	60.0	10/6		ET					
110	22.0	80.0	10/6		ET					
111	16.0	45.0	10/6		ET					
112	15.0	45.0	10/6		ET					
113	13.0	35.0	10/6		ET					
114	12.5	20.0	10/6		ET					
115	12.0	20.0	10/6		ET					
116	20.0	80.0	10/6		ET					
117	20.0	60.0	10/6		ET					
118	20.0	70.0	10/6		ET					
119	25.0	70.0	10/6		ET					
120	22.0	85.0	10/6		ET					
121	18.0	60.0	10/6		ET					
122	14.0	25.0	10/6		ET					
123	24.0	130.0	10/6		ET					
124	24.0	140.0	10/6		ET			mu,8cm,10g		
125	23.0	140.0	10/6		ET					
126	22.0	135.0	10/6		ET					

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
127	23.0	120.0	10/6		ET					
128	22.0	90.0	10/6		ET					
129	16.0	40.0	10/6		ET					
130	18.0	50.0	10/6		ET					
131	19.0	70.0	10/6		ET					
132	21.0	75.0	10/6		ET					
133	20.0	40.0	10/6		ET					
134	18.5	60.0	10/6		ET					
135	19.0	50.0	10/6		ET					
136	18.0	50.0	10/6		ET					
137	17.5	50.0	10/6		ET					
138	15.5	30.0	10/6		ET					
139	17.0	40.0	10/6		ET					
140	20.0	60.0	10/6		ET					
141	12.0	15.0	10/6		ET					
142	15.0	40.0	10/6		ET					
143	18.0	40.0	10/6		ET					
144	12.0	20.0	10/6		ET					
145	13.0	20.0	10/6		ET					
146	12.0	20.0	10/6		ET					
147	30.0	250.0	10/6		ET					
148	25.5	155.0	10/6		ET					
149	23.0	130.0	10/6		ET					
150	23.0	130.0	10/6		ET					
151	20.5	75.0	10/6		ET					
152	26.0	130.0	10/6		ET					
153	20.5	85.0	10/6		ET					
154	21.5	100.0	10/6		ET					
155	25.5	140.0	10/6		ET					
156	20.5	80.0	10/6		ET					
157	16.5	50.0	10/6		ET					
158	17.0	50.0	10/6		ET					
159	20.5	75.0	10/6		ET					
160	19.0	65.0	10/6		ET					
161	19.0	60.0	10/6		ET					
162	21.0	75.0	10/6		ET					
163	19.5	70.0	10/6		ET					
164	16.5	50.0	10/6		ET					
165	16.5	50.0	10/6		ET					
166	19.5	60.0	10/6		ET					
167	14.0	30.0	10/6		ET					
168	15.0	35.0	10/6		ET					
169	17.5	45.0	10/6		ET					

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
170	15.5	40.0	10/6		ET					
171	15.0	40.0	10/6		ET					
172	12.5	25.0	10/6		ET					
173	13.0	25.0	10/6		ET					
174	15.0	35.0	10/6		ET					
175	16.0	35.0	10/6		ET					
176	15.5	30.0	10/6		ET					
177	16.5	35.0	10/6		ET					
178	22.5	90.0	10/6		ET					
179	20.0	95.0	10/6		ET					
180	19.5	70.0	10/6		ET					
181	21.0	80.0	10/6		ET					
182	28.0	175.0	10/6		ET					
183	20.5	80.0	10/6		ET					
184	25.0	130.0	10/6		ET					
185	20.5	70.0	10/6		ET					
186	17.0	40.0	10/6		ET					
187	20.5	80.0	10/6		ET					
188	22.5	90.0	10/6		ET					
189	16.0	40.0	10/6		ET					
190	26.0	155.0	10/6		ET					
191	18.0	50.0	10/6		ET					
192	18.0	50.0	10/6		ET					
193	20.0	60.0	10/6		ET					
194	18.0	50.0	10/6		ET					
195	23.0	100.0	10/6		ET					
196	19.0	65.0	10/6		ET					
197	17.5	50.0	10/6		ET					
198	16.5	50.0	10/6		ET					
199	16.0	50.0	10/6		ET					
200	19.5	90.0	10/6		ET					
201	15.5	35.0	10/6		ET					
202	16.5	50.0	10/6		ET					
203	13.5	30.0	10/6		ET					
204	18.5	60.0	10/6		ET					
205	15.0	30.0	10/6		ET					
206	16.5	35.0	10/6		ET					
207	15.0	40.0	10/6		ET					
208	15.0	25.0	10/6		ET					
209	14.0	25.0	10/6		ET					
210	17.0	40.0	10/6		ET					
211	17.0	50.0	10/6		ET					
212	14.0	30.0	10/6		ET					

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
213	12.0	20.0	10/6		ET					
214	26.5	160.0	10/6		ET					
215	19.5	75.0	10/6		ET					
216	19.0	55.0	10/6		ET					
217	24.0	120.0	10/6		ET					
218	29.5	230.0	10/6		ET					
219	24.0	120.0	10/6		ET					
220	14.0	30.0	10/6		ET					
221	19.0	55.0	10/6		ET					
222	18.0	50.0	10/6		ET					
223	18.5	55.0	10/6		ET					
224	17.0	45.0	10/6		ET					
225	18.0	50.0	10/6		ET					
226	15.5	40.0	10/6		ET					
227	20.0	70.0	10/6		ET					
228	20.5	70.0	10/6		ET					
229	11.5	15.0	10/6		ET					
230	13.0	30.0	10/6		ET					
231	12.0	20.0	10/6		ET					
232	18.0	45.0	10/6		ET					
233	14.5	30.0	10/6		ET					
234	13.0	30.0	10/6		ET					
235	12.5	30.0	10/6		ET					
236	13.0	30.0	10/6		ET					
237	16.5	45.0	10/6		ET					
238	14.0	30.0	10/6		ET					
239	13.0	30.0	10/6		ET					
240	15.0	35.0	10/6		ET					
241	12.5	25.0	10/6		ET					
242	15.5	40.0	10/6		ET					
243	15.0	40.0	10/6		ET					
244	17.5	60.0	10/6		ET					
245	16.0	45.0	10/6		ET					
246	17.5	50.0	10/6		ET					
247	15.0	35.0	10/6		ET					
248	15.0	35.0	10/6		ET					
249	12.5	30.0	10/6		ET					
250	14.0	30.0	10/6		ET					
251	16.0	50.0	10/6		ET					
252	13.0	30.0	10/6		ET					
253	14.5	30.0	10/6		ET					
254	18.5	55.0	10/6		ET					
255	14.0	35.0	10/6		ET					

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
256	15.0	35.0	10/6		ET					
257	14.5	40.0	10/6		ET					
258	16.5	50.0	10/6		ET					
259	16.5	50.0	10/6		ET					
260	13.0	30.0	10/6		ET					
261	13.0	30.0	10/6		ET					
262	11.5	25.0	10/6		ET					
263	12.0	20.0	10/6		ET					
264	18.5	60.0	10/6		ET					
265	13.5	25.0	10/6		ET					
266	15.0	35.0	10/6		ET					
267	11.5	20.0	10/6		ET					
268	12.5	20.0	10/6		ET					
269	12.0	20.0	10/6		ET					
270	16.0	40.0	10/6		ET					
271	12.5	20.0	10/6		ET					
272	11.0	20.0	10/6		ET					
273	13.0	30.0	10/6		ET					
274	14.0	35.0	10/6		ET					
275	9.5	15.0	10/6		ET					
276	13.5	30.0	10/6		ET					
277	18.0	60.0	10/6		ET					
278	13.5	30.0	10/6		ET					
279	13.0	30.0	10/6		ET					
280	13.5	30.0	10/6		ET					
281	13.0	30.0	10/6		ET					
282	12.0	20.0	10/6		ET					
283	18.5	55.0	10/6		ET					
284	14.0	35.0	10/6		ET					
285	13.5	25.0	10/6		ET					
286	13.0	25.0	10/6		ET					
287	11.5	20.0	10/6		ET					
288	13.0	30.0	10/6		ET					
289	12.5	20.0	10/6		ET					
290	14.0	30.0	10/6		ET					
291	13.0	30.0	10/6		ET					
292	14.5	35.0	10/6		ET					
293	12.5	35.0	10/6		ET					
294	13.0	30.0	10/6		ET					
295	11.5	25.0	10/6		ET					
296	15.0	40.0	10/6		ET					
297	15.0	40.0	10/6		ET					
298	13.5	20.0	10/6		ET					

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
299	11.5	30.0	10/6		ET					
300	13.0	30.0	10/6		ET					
301	13.0	30.0	10/6		ET					
302	16.5	50.0	10/6		ET					
303	17.5	50.0	10/6		ET					
304	16.5	50.0	10/6		ET					
305	14.0	40.0	10/6		ET					
306	12.5	40.0	10/6		ET					
307	15.0	40.0	10/6		ET					
308	13.5	30.0	10/6		ET					
309	17.0	50.0	10/6		ET					
310	14.0	35.0	10/6		ET					
311	12.5	25.0	10/6		ET					
312	14.5	30.0	10/6		ET					
313	14.0	20.0	10/6		ET					
314	17.0	35.0	10/6		ET					
315	14.5	40.0	10/6		ET					
316	14.5	30.0	10/6		ET					
317	13.0	20.0	10/6		ET					
318	13.0	25.0	10/6		ET					
319	14.0	30.0	10/6		ET					
320	11.0	15.0	10/6		ET					
321	13.5	25.0	10/6		ET					
322	12.0	15.0	10/6		ET					
323	12.0	20.0	10/6		ET					
324	13.0	25.0	10/6		ET					
325	19.0	50.0	10/6		ET					
326	12.5	25.0	10/6		ET					
327	14.5	35.0	10/6		ET					
328	14.0	30.0	10/6		ET					
329	11.5	20.0	10/6		ET					
330	10.5	15.0	10/6		ET					
331	12.0	20.0	10/6		ET					
332	12.0	20.0	10/6		ET					
333	17.0	40.0	10/6		ET					
334	12.5	30.0	10/6		ET					
335	12.5	25.0	10/6		ET					
336	10.0	15.0	10/6		ET					
337	11.0	20.0	10/6		ET					
338	12.0	20.0	10/6		ET					
339	16.0	40.0	10/6		ET					
340	14.0	30.0	10/6		ET					
341	11.0	15.0	10/6		ET					

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
342	11.5	20.0	10/6		ET					
343	13.0	20.0	10/6		ET					
344	9.0	15.0	10/6		ET					
345	12.0	20.0	10/6		ET					
346	12.5	25.0	10/6		ET					
347	15.5	35.0	10/6		ET					
348	11.5	20.0	10/6		ET					
349	11.5	20.0	10/6		ET					
350	13.0	20.0	10/6		ET					
351	10.5	15.0	10/6		ET					
352	10.5	15.0	10/6		ET					
353	13.0	30.0	10/6		ET					
354	12.0	20.0	10/6		ET					
355	12.0	20.0	10/6		ET					
356	9.5	15.0	10/6		ET					
357	26.5	200.0	10/6		ET					
358	29.5	240.0	10/6		ET					
359	20.5	95.0	10/6		ET					
360	20.5	90.0	10/6		ET					
361	13.5	35.0	10/6		ET					
362	18.5	70.0	10/6		ET					
363	23.0	110.0	10/6		ET					
364	17.0	55.0	10/6		ET					
365	24.0	120.0	10/6		ET					
366	19.0	70.0	10/6		ET					
367	17.5	60.0	10/6		ET					
368	19.5	90.0	10/6		ET					
369	18.5	75.0	10/6		ET					
370	18.5	85.0	10/6		ET					
371	19.5	85.0	10/6		ET					
372	22.0	130.0	10/6		ET					
373	18.5	65.0	10/6		ET					
374	22.5	110.0	10/6		ET					
375	22.5	60.0	10/6		ET					
376	18.5	60.0	10/6		ET					
377	17.5	60.0	10/6		ET					
378	20.5	90.0	10/6		ET					
379	17.5	60.0	10/6		ET					
380	17.5	80.0	10/6		ET					
381	20.0	70.0	10/6		ET					
382	19.5	80.0	10/6		ET					
383	18.5	80.0	10/6		ET					
384	19.0	70.0	10/6		ET					

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
385	17.0	60.0	10/6		ET					
386	32.0	310.0	10/6		ET					
387	17.5	50.0	10/6		ET					
388	18.0	50.0	10/6		ET					
389	22.0	110.0	10/6		ET					
390	19.0	75.0	10/6		ET					
391	21.5	110.0	10/6		ET					
392	19.5	70.0	10/6		ET					
393	12.5	30.0	10/6		ET					
394	18.0	55.0	10/6		ET					
395	14.0	30.0	10/6		ET					
396	18.0	55.0	10/6		ET					
397	24.5	160.0	10/6		ET					
398	15.5	40.0	10/6		ET					
399	14.0	30.0	10/6		ET					
400	22.0	100.0	10/6		ET					
401	15.0	45.0	10/6		ET					
402	12.5	30.0	10/6		ET					
403	15.5	40.0	10/6		ET					
404	16.5	60.0	10/6		ET					
405	14.0	35.0	10/6		ET					
406	17.5	55.0	10/6		ET					
407	18.0	55.0	10/6		ET					
408	14.0	35.0	10/6		ET					
409	21.0	100.0	10/6		ET					
410	20.0	75.0	10/6		ET					
411	19.5	80.0	10/6		ET					
412	20.0	60.0	10/6		ET					
413	18.0	50.0	10/6		ET					
414	19.0	60.0	10/6		ET					
415	21.5	100.0	10/6		ET					
416	19.5	70.0	10/6		ET					
417	13.0	30.0	10/6		ET					
418	18.0	50.0	10/6		ET					
419	20.0	80.0	10/6		ET					
420	19.0	60.0	10/6		ET					
421	15.5	40.0	10/6		ET					
422	14.0	40.0	10/6		ET					
423	16.5	45.0	10/6		ET					
424	13.0	30.0	10/6		ET					
425	24.5	145.0	10/6		ET					
426	15.5	40.0	10/6		ET					
427	16.5	40.0	10/6		ET					

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
428	16.0	40.0	10/6		ET					
429	14.5	35.0	10/6		ET					
430	15.0	40.0	10/6		ET					
431	16.0	40.0	10/6		ET					
432	18.5	60.0	10/6		ET					
433	13.5	30.0	10/6		ET					
434	14.0	30.0	10/6		ET					
435	20.5	85.0	10/6		ET					
436	16.5	50.0	10/6		ET					
437	19.0	75.0	10/6		ET					
438	15.0	30.0	10/6		ET					
439	13.0	30.0	10/6		ET					
440	19.0	50.0	10/6		ET					
441	18.0	60.0	10/6		ET					
442	18.0	60.0	10/6		ET					
443	17.0	55.0	10/6		ET					
444	19.0	60.0	10/6		ET					
445	13.0	30.0	10/6		ET					
446	19.5	80.0	10/6		ET					
447	18.5	50.0	10/6		ET					
448	14.0	30.0	10/6		ET					
449	12.5	20.0	10/6		ET					
450	11.5	20.0	10/6		ET					
451	18.5	60.0	10/6		ET					
452	17.5	50.0	10/6		ET					
453	20.0	60.0	10/6		ET					
454	19.0	55.0	10/6		ET					
455	13.5	30.0	10/6		ET					
456	16.5	45.0	10/6		ET					
457	14.5	30.0	10/6		ET					
458	15.0	35.0	10/6		ET					
459	13.0	30.0	10/6		ET					
460	13.5	30.0	10/6		ET					
461	14.0	25.0	10/6		ET					
462	15.5	35.0	10/6		ET					
463	13.0	25.0	10/6		ET					
464	13.5	30.0	10/6		ET					
465	12.5	25.0	10/6		ET					
466	12.5	15.0	10/6		ET					
467	12.0	15.0	10/6		ET					
468	11.0	20.0	10/6		ET					
469	12.5	25.0	10/6		ET					
470	15.0	35.0	10/6		ET					

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
170	16.5	60.0	10/6		ET					
171	21.0	80.0	10/6		ET					
172	17.0	60.0	10/6		ET					
173	13.5	30.0	10/6		ET					
174	13.5	30.0	10/6		ET					
175	10.5	15.0	10/6		ET					
176	13.5	35.0	10/6		ET					
177	10.5	15.0	10/6		ET					
178	9.5	10.0	10/6		ET					
179	13.5	30.0	10/6		ET					
180	16.0	50.0	10/6		ET					
181	15.0	40.0	10/6		ET					
182	13.0	30.0	10/6		ET					
183	16.5	50.0	10/6		ET					
184	12.0	30.0	10/6		ET					
185	17.0	60.0	10/6		ET					
186	13.0	30.0	10/6		ET					
187	10.5	20.0	10/6		ET					
188	10.0	15.0	10/6		ET					
189	14.0	35.0	10/6		ET					
190	15.0	50.0	10/6		ET					
191	16.0	55.0	10/6		ET					
192	12.5	25.0	10/6		ET					
193	7.5	5.0	10/6		ET					
194	17.0	65.0	10/6		ET					
195	10.0	15.0	10/6		ET					
196	7.0	5.0	10/6		ET					
197	10.0	10.0	10/6		ET					
198	18.0	70.0	10/6		ET					
199	15.0	45.0	10/6		ET					
200	16.5	50.0	10/6		ET					
201	15.0	50.0	10/6		ET					
202	10.0	15.0	10/6		ET					
203	11.0	20.0	10/6		ET					
204	13.5	30.0	10/6		ET					
205	10.0	20.0	10/6		ET					
206	9.5	10.0	10/6		ET					
207	12.5	30.0	10/6		ET					
208	10.0	15.0	10/6		ET					
209	11.0	20.0	10/6		ET					
210	10.0	15.0	10/6		ET					
211	9.5	10.0	10/6		ET					
212	14.0	40.0	10/6		ET					

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
127	16.0	40.0	10/6		ET					
128	17.5	70.0	10/6		ET					
129	13.0	30.0	10/6		ET					
130	9.5	10.0	10/6		ET					
131	13.5	35.0	10/6		ET					
132	14.5	40.0	10/6		ET					
133	14.5	40.0	10/6		ET					
134	11.5	20.0	10/6		ET					
135	12.0	20.0	10/6		ET					
136	14.5	40.0	10/6		ET					
137	16.5	50.0	10/6		ET					
138	14.5	35.0	10/6		ET					
139	21.5	120.0	10/6		ET					
140	15.5	40.0	10/6		ET					
141	13.5	30.0	10/6		ET					
142	16.5	55.0	10/6		ET					
143	9.0	5.0	10/6		ET					
144	11.5	20.0	10/6		ET					
145	10.0	15.0	10/6		ET					
146	12.0	20.0	10/6		ET					
147	8.5	10.0	10/6		ET					
148	6.5	5.0	10/6		ET					
149	16.0	50.0	10/6		ET					
150	17.0	65.0	10/6		ET					
151	16.5	60.0	10/6		ET					
152	16.0	60.0	10/6		ET					
153	13.5	30.0	10/6		ET					
154	16.5	50.0	10/6		ET					
155	16.0	50.0	10/6		ET					
156	11.0	10.0	10/6		ET					
157	14.0	30.0	10/6		ET					
158	7.0	5.0	10/6		ET					
159	19.5	100.0	10/6		ET					
160	9.5	10.0	10/6		ET					
161	9.5	15.0	10/6		ET					
162	15.0	40.0	10/6		ET					
163	10.0	10.0	10/6		ET					
164	16.5	45.0	10/6		ET					
165	28.5	280.0	10/6		ET					
166	11.0	20.0	10/6		ET					
167	17.5	75.0	10/6		ET					
168	17.5	70.0	10/6		ET					
169	18.0	80.0	10/6		ET					

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
84	17.0	60.0	10/6		ET					
85	15.5	50.0	10/6		ET					
86	18.0	70.0	10/6		ET					
87	24.0	195.0	10/6		ET					
88	15.5	50.0	10/6		ET					
89	19.5	80.0	10/6		ET					
90	14.0	30.0	10/6		ET					
91	13.5	40.0	10/6		ET					
92	19.0	80.0	10/6		ET					
93	15.0	40.0	10/6		ET					
94	11.5	20.0	10/6		ET					
95	20.5	110.0	10/6		ET					
96	24.0	175.0	10/6		ET					
97	16.5	60.0	10/6		ET					
98	26.5	220.0	10/6		ET					
99	18.5	90.0	10/6		ET					
100	28.5	320.0	10/6		ET					
101	20.0	110.0	10/6		ET					
102	18.0	62.0	10/6		ET					
103	20.0	110.0	10/6		ET					
104	19.5	90.0	10/6		ET					
105	19.0	75.0	10/6		ET					
106	20.0	110.0	10/6		ET					
107	16.5	60.0	10/6		ET					
108	15.5	45.0	10/6		ET					
109	13.5	30.0	10/6		ET					
110	19.5	90.0	10/6		ET					
111	14.5	30.0	10/6		ET					
112	11.5	20.0	10/6		ET					
113	15.5	50.0	10/6		ET					
114	23.0	130.0	10/6		ET					
115	19.0	90.0	10/6		ET					
116	16.0	60.0	10/6		ET					
117	18.0	100.0	10/6		ET					
118	17.0	60.0	10/6		ET					
119	19.0	100.0	10/6		ET					
120	18.0	80.0	10/6		ET					
121	13.0	30.0	10/6		ET					
122	13.5	30.0	10/6		ET					
123	22.5	150.0	10/6		ET					
124	11.5	15.0	10/6		ET					
125	10.0	5.0	10/6		ET					
126	19.5	80.0	10/6		ET					

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
41	18.0	80.0	9/6		ET					
42	17.0	70.0	9/6		ET					
43	15.0	50.0	9/6		ET					
44	16.0	60.0	9/6		ET					
45	14.0	50.0	9/6		ET					
46	16.0	50.0	9/6		ET					
47	16.5	65.0	9/6		ET					
48	14.0	40.0	9/6		ET					
49	16.0	60.0	9/6		ET					
50	10.5	25.0	9/6		ET					
51	8.5	10.0	9/6		ET					
52	13.0	40.0	9/6		ET					
53	13.0	40.0	9/6		ET					
54	11.5	30.0	9/6		ET					
55	9.0	15.0	9/6		ET					
56	21.4	125.0	10/6	2	GN 5½/2½/1½			e		x
57	23.0	150.0	10/6		ET					
58	22.5	150.0	10/6		ET					
59	21.0	120.0	10/6		ET					
60	21.0	120.0	10/6		ET					
61	23.0	170.0	10/6		ET					
62	15.0	40.0	10/6		ET					
63	19.0	90.0	10/6		ET					
64	14.5	35.0	10/6		ET					
65	18.0	90.0	10/6		ET					
66	14.0	40.0	10/6		ET					
67	17.0	60.0	10/6		ET					
68	12.5	30.0	10/6		ET					
69	12.5	35.0	10/6		ET					
70	11.0	20.0	10/6		ET					
71	17.0	70.0	10/6		ET					
72	18.0	80.0	10/6		ET					
73	18.5	80.0	10/6		ET					
74	18.5	100.0	10/6		ET					
75	14.0	35.0	10/6		ET					
76	21.5	140.0	10/6		ET					
77	14.0	30.0	10/6		ET					
78	17.5	70.0	10/6		ET					
79	18.0	80.0	10/6		ET					
80	13.0	25.0	10/6		ET					
81	19.0	90.0	10/6		ET					
82	18.5	70.0	10/6		ET					
83	26.0	220.0	10/6		ET					

SMOOTH FLOUNDER

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
01	10.0		5/6		ET					
02	14.8		5/6		ET					
03	11.0		5/6		ET					
04	9.8		5/6		ET					
05	9.0		5/6		ET					
06	32.0		6/6	1	↓GN 5½					
07	18.0	75.0	9/6		ET			e		
08	19.5	110.0	9/6		ET			½W		
09	17.0	65.0	9/6		ET			e		
10	16.0	60.0	9/6		ET					
11	14.0	50.0	9/6		ET					
12	28.0	300.0	9/6		ET					
13	23.0	160.0	9/6		ET					
14	22.5	150.0	9/6		ET					
15	22.5	160.0	9/6		ET					
16	17.0	75.0	9/6		ET					
17	14.5	50.0	9/6		ET					
18	17.5	85.0	9/6		ET					
19	16.5	60.0	9/6		ET					
20	18.0	90.0	9/6		ET					
21	13.5	40.0	9/6		ET					
22	10.5	30.0	9/6		ET					
23	14.5	50.0	9/6		ET					
24	14.0	50.0	9/6		ET					
25	12.0	30.0	9/6		ET					
26	8.5	10.0	9/6		ET					
27	11.0	25.0	9/6		ET					
28	12.5	25.0	9/6		ET					
29	11.0	30.0	9/6		ET					
30	20.0	120.0	9/6		ET					
31	28.0	350.0	9/6		ET					
32	20.5	120.0	9/6		ET					
33	19.0	100.0	9/6		ET					
34	19.5	100.0	9/6		ET					
35	18.0	90.0	9/6		ET					
36	18.0	80.0	9/6		ET					
37	18.0	80.0	9/6		ET					
38	19.5	100.0	9/6		ET					
39	18.5	80.0	9/6		ET					
40	18.5	80.0	9/6		ET					

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
471	11.0	20.0	10/6		ET					
472	11.0	20.0	10/6		ET					
473	12.0	25.0	10/6		ET					
474	17.5	50.0	10/6		ET					
475	18.0		10/6		ET					
476	12.5		10/6		ET					
477	11.5		10/6		ET					
478	10.5		10/6		ET					
479	12.0		10/6		ET					
480	14.5		10/6		ET					
481	12.5		10/6		ET					
482	11.0		10/6		ET					
483	10.0		10/6		ET					
484	12.5		10/6		ET					
485	9.5		10/6		ET					
486	22.0		15/6		FT					
487	14.0		15/6		FT					
488	20.0		16/6		FT					
489	13.5		16/6		FT					
490	15.0		16/6		FT					
491	15.0		16/6		FT					
492	25.0		17/6		FT					
493	10.0		17/6		FT					
494	15.5		19/6		FT					
495	16.5	40.0	24/6	11	GN 1½	M		3/4 A		x
496	14.0		25/6		FT					
497	12.0	16.7	8/7	2	BS					
498	19.3	60.5	8/7	2	BS					
499	14.0	20.8	8/7	2	BS					
500	11.5	16.0	8/7	2	BS					
501	3.7	0.2	28/7	3	BS					
502	16.5	57.0	2/11	20	GN 1½ ↑	M	4	e		x
503	17.5	28.0	2/11	20	GN 1½ ↑	M	4	F,1s,1ss		x
504	17.5	43.0	3/11	20	GN 1½ ↑	M	4	F,bl		x
505	18.0	28.0	3/11	20	GN 1½ ↑	M	4	½,ss		x
506	16.5	28.0	3/11	16	GN 1½ ↓	M	4	F,s		x
507	17.0	28.0	3/11	20	GN 1½ ↑	M	4	½,g		x
508			4/11	20	GN 1½ ↑					
509			4/11	20	GN 1½ ↑					

STICKLEBACKS - THREESPINE

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
01	6.0	2.2	2/7	1	BS					
02	5.8	2.0	2/7	1	BS					
03	5.3	1.8	2/7	1	BS					
04	5.8	2.2	2/7	1	BS					
05	4.6	1.2	2/7	1	BS					
06	5.9	2.1	2/7	1	BS					
07	4.8	1.2	2/7	1	BS					
08	5.4	1.8	2/7	1	BS					
09	5.2	1.8	2/7	1	BS					
10	5.1	1.2	2/7	1	BS					
11	5.3	1.6	2/7	1	BS					
12	5.2	1.9	2/7	1	BS					
13	5.7	1.9	2/7	1	BS					
14	5.5	2.4	2/7	1	BS					
15	4.8	1.5	2/7	1	BS					
16	4.6	0.7	2/7	1	BS					
17	4.8	1.3	2/7	1	BS					
18	5.7	2.0	2/7	1	BS					
19	5.4	1.7	2/7	1	BS					
20	4.6	1.0	2/7	1	BS					
21	5.0	1.5	2/7	1	BS					
22	5.0	1.4	2/7	1	BS					
23	5.0	1.7	2/7	1	BS					
24	5.2	1.5	2/7	1	BS					
25	5.4	1.3	2/7	1	BS					
26	5.2	1.4	2/7	1	BS					
27	4.9	1.1	2/7	1	BS					
28	5.1	1.7	2/7	1	BS					
29	4.2	0.9	2/7	1	BS					
30	5.7	2.0	2/7	1	BS					
31	5.3	1.6	2/7	1	BS					
32	5.1	1.1	2/7	1	BS					
33	5.5	1.4	2/7	1	BS					
34	5.1		2/7	1	BS					
35	6.0		2/7	1	BS					
36	5.6	2.5	8/7	2	BS	F				
37	5.2	1.9	8/7	2	BS					
38	5.9	2.7	8/7	2	BS					
39	5.7	2.2	8/7	2	BS					
40	5.5	2.6	8/7	2	BS					

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
41	5.4	2.0	8/7	2	BS					
42	4.8	1.4	8/7	2	BS					
43	6.2	3.5	8/7	2	BS					
44	5.2	2.0	8/7	2	BS					
45	5.6	2.3	8/7	2	BS					
46	5.9	2.4	8/7	2	BS					
47	5.5	2.3	8/7	2	BS					
48	5.1	1.9	8/7	2	BS					
49	5.4	2.1	8/7	2	BS					
50	5.0	1.5	8/7	2	BS					
51	5.1	2.0	8/7	2	BS					
52	5.0	1.6	8/7	2	BS					
53	5.6	2.8	8/7	2	BS					
54	4.0	2.4	8/7	2	BS					
55	5.6	2.2	8/7	2	BS					
56	5.3	2.2	8/7	2	BS					
57	5.2	1.8	8/7	2	BS					
58	5.0	1.6	8/7	2	BS					
59	5.2	1.8	8/7	2	BS					
60	4.6	1.8	8/7	2	BS					
61	4.6	1.4	8/7	2	BS					
62	5.5	1.6	8/7	2	BS					
63	5.2	1.8	8/7	2	BS					
64	6.1	2.9	8/7	2	BS					
65	5.1	1.9	8/7	2	BS					
66	4.9	1.6	8/7	2	BS					
67	5.3	2.4	8/7	2	BS					
68	4.7	1.6	8/7	2	BS					
69	5.2	1.8	8/7	2	BS					
70	5.1	1.7	8/7	2	BS					
71	5.2	2.0	8/7	2	BS					
72	5.6	2.7	8/7	2	BS					
73	5.4	2.2	8/7	2	BS					
74	5.9	2.8	8/7	2	BS					
75	5.1	1.7	8/7	2	BS					
76	5.6	2.2	8/7	2	BS					
77	5.4	2.2	8/7	2	BS					
78	5.0	1.5	8/7	2	BS					
79	4.7	1.4	8/7	2	BS					
80	5.5	2.0	8/7	2	BS					
81	5.0	1.5	8/7	2	BS					
82	5.3	1.7	8/7	2	BS					
83	4.6	1.7	8/7	2	BS					

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
84	5.7	2.6	8/7	2	BS					
85	5.5	7.0	8/7	2	BS					
86	4.7	1.7	8/7	2	BS					
87	5.2	2.0	8/7	2	BS					
88	5.1	1.8	8/7	2	BS					
89	5.4	2.0	8/7	2	BS					
90	4.6	1.4	8/7	2	BS					
91	4.9	1.7	8/7	2	BS					
92	4.7	1.5	8/7	2	BS					
93	4.8	1.3	8/7	2	BS					
94	5.1	1.6	8/7	2	BS					
95	7.1	3.8	8/7	2	BS	F				
96	4.8	1.2	8/7	2	BS					
97	5.3	1.5	8/7	2	BS					
98	5.4	1.7	8/7	2	BS					
99	5.6	1.6	8/7	2	BS	F				
100	5.3	1.5	8/7	2	BS	F				
101	4.0	1.0	8/7	2	BS					
102	4.2	1.3	8/7	2	BS					
103	5.1	1.3	8/7	2	BS					
104	5.2	1.6	8/7	2	BS					
105	4.5	0.9	8/7	2	BS					
106	4.4	0.9	8/7	2	BS					
107	5.0	1.3	8/7	2	BS					
108	4.0	1.0	8/7	2	BS					
109	5.3	0.9	28/7	3	BS					
110	6.0	2.0	28/7	1	BS	F		4	?w	
111	6.0	2.1	28/7	1	BS	F		4		

STICKLEBACKS - FOURSPINE

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
01	5.0	1.2	2/7	1	BS					
02	5.0	1.3	2/7	1	BS					
03	4.5	0.9	2/7	1	BS					
04	4.7	1.0	2/7	1	BS					
05	4.9	1.0	2/7	1	BS					
06	3.7	0.7	2/7	1	BS					
07	4.4	0.8	2/7	1	BS					
08	4.3	0.8	2/7	1	BS					
09	3.6	0.6	2/7	1	BS					
10	4.5	1.1	2/7	1	BS					
11	4.4	0.8	2/7	1	BS					
12	4.3	0.7	2/7	1	BS					
13	5.0	1.1	2/7	1	BS					
14	4.3	0.9	2/7	1	BS					
15	3.9	0.6	2/7	1	BS					
16	4.6	0.8	2/7	1	BS					
17	3.6	0.5	2/7	1	BS					
18	4.0	0.5	2/7	1	BS					
19	5.0	0.9	2/7	1	BS					
20	4.0	0.5	2/7	1	BS					
21	4.2	0.6	2/7	1	BS					
22	4.2	0.7	2/7	1	BS					
23	3.7	0.6	2/7	1	BS					
24	3.4	0.4	2/7	1	BS					
25	4.2		2/7	1	BS					
26	3.9		2/7	1	BS					
27	4.2	1.1	8/7	2	BS					
28	4.8	1.4	8/7	2	BS					
29	4.5	1.2	8/7	2	BS					
30	3.8	0.8	8/7	2	BS					
31	4.1	0.8	8/7	2	BS					
32	3.6	0.9	8/7	2	BS					
33	3.5	0.8	8/7	2	BS					
34	4.0	0.9	8/7	2	BS					
35	3.6	0.7	8/7	2	BS					
36	3.7	0.8	8/7	2	BS					
37	3.5	0.7	8/7	2	BS					
38	3.7	0.6	8/7	2	BS					
39	3.8	0.8	8/7	2	BS					
40	3.8	0.8	8/7	2	BS					
41	3.6	0.6	8/7	2	BS					

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
42	3.5	0.6	8/7	2	BS					
43	3.7	0.7	8/7	2	BS					
44	4.3	0.9	8/7	2	BS					
45	4.0	0.9	8/7	2	BS					
46	3.8	0.8	8/7	2	BS					
47	4.0	0.7	8/7	2	BS					
48	3.8	1.0	8/7	2	BS					
49	3.7	0.7	8/7	2	BS					
50	3.8	0.9	8/7	2	BS					
51	4.0	0.9	8/7	2	BS					
52	4.0	0.9	8/7	2	BS					
53	3.5	0.9	8/7	2	BS					
54	3.7	0.8	8/7	2	BS					
55	4.5	1.0	8/7	2	BS					
56	4.9	1.3	8/7	2	BS					
57	5.0	1.4	8/7	2	BS					
58	3.6	0.7	8/7	2	BS					
59	5.3	1.6	8/7	2	BS					
60	4.9	1.5	8/7	2	BS					
61	4.8	1.5	8/7	2	BS					
62	4.0	0.8	8/7	2	BS					
63	4.1	0.6	8/7	2	BS					
64	4.5	0.8	8/7	2	BS					
65	3.4	0.4	8/7	2	BS					
66	5.2	1.2	8/7	2	BS					
67	3.7	0.5	8/7	2	BS					
68	4.8	0.9	8/7	2	BS					
69	3.8	0.5	8/7	2	BS					
70	4.0	0.6	8/7	2	BS					
71	3.7	0.6	8/7	2	BS					
72	4.2	0.8	8/7	2	BS					
73	3.8	0.6	8/7	2	BS					
74	3.7	0.6	8/7	2	BS					
75	4.5	0.7	8/7	2	BS					
76	4.7	0.9	8/7	2	BS					
77	4.0	0.7	8/7	2	BS					
78	4.6	0.9	8/7	2	BS					
79	4.9	0.9	8/7	2	BS					
80	4.2	0.8	8/7	2	BS					
81	4.4	0.9	8/7	2	BS					
82	5.3	1.3	8/7	2	BS					
83	4.7	0.9	8/7	2	BS					
84	4.3	0.9	8/7	2	BS					
85	3.8	0.6	8/7	2	BS					

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
86	4.8	1.1	8/7	2	BS					
87	4.1	1.0	8/7	2	BS					
88	4.2	0.8	8/7	2	BS					
89	4.1	0.7	8/7	2	BS					
90	4.0	0.6	8/7	2	BS					
91	4.5	1.0	8/7	2	BS					
92	3.9	0.6	8/7	2	BS					
93	3.7	0.6	8/7	2	BS					
94	4.1	0.7	8/7	2	BS					
95	3.5	0.6	8/7	2	BS					
96	3.8	0.7	8/7	2	BS					
97	3.6	0.4	8/7	2	BS					
98	4.7	1.1	8/7	2	BS					
99	4.3	0.8	8/7	2	BS					
100	3.6	0.6	8/7	2	BS					
101	4.1	0.7	8/7	2	BS					
102	3.9	0.6	8/7	2	BS					
103	3.5	0.5	8/7	2	BS					
104	4.0	0.7	8/7	2	BS					
105	3.9	0.6	8/7	2	BS					
106	4.1	0.6	8/7	2	BS					
107	3.6	0.5	8/7	2	BS					
108	4.0	0.6	8/7	2	BS					
109	3.7	0.5	8/7	2	BS					
110	3.5	0.5	8/7	2	BS					
111	4.5	1.0	8/7	2	BS					
112	4.1	0.7	8/7	2	BS					
113	4.1	0.7	8/7	2	BS					
114	4.0	0.7	8/7	2	BS					
115	3.8	0.6	8/7	2	BS					
116	4.2	0.7	8/7	2	BS					
117	4.5	0.9	8/7	2	BS					
118	3.4	0.5	8/7	2	BS					
119	3.7	0.6	8/7	2	BS					
120	4.8	1.2	8/7	2	BS					
121	3.5	0.6	8/7	2	BS					
122	4.2	0.8	8/7	2	BS					
123	4.1	0.8	8/7	2	BS					
124	4.2	0.9	8/7	2	BS					
125	3.9	0.6	8/7	2	BS					
126	3.8	0.6	8/7	2	BS					
127	4.1	0.7	8/7	2	BS					

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
128	3.5	0.4	8/7	2	BS					
129	3.9	0.6	8/7	2	BS					
130	3.7	0.6	8/7	2	BS					
131	3.5	0.6	8/7	2	BS					
132	3.3	0.4	8/7	2	BS					
133	3.4	0.4	8/7	2	BS					
134	3.3	0.5	8/7	2	BS					
135	3.5	0.6	8/7	2	BS					
136	3.6	0.6	8/7	2	BS					
137	3.7	0.7	8/7	2	BS					
138	3.4	0.6	8/7	2	BS					
139	3.3	0.5	8/7	2	BS					
140	3.6	0.5	8/7	2	BS					
141	3.5	0.5	8/7	2	BS					
142	4.3	1.0	28/7	3	BS	F	4			
143	4.0	0.7	28/7	1	BS					
144	4.0	0.5	28/7	1	BS					
145	3.5	0.3	28/7	1	BS					

STICKLEBACKS - NINESPINE

01	6.4	1.5	2/7	1	BS
02	4.7	0.7	2/7	1	BS
03	5.0	0.7	2/7	1	BS
04	5.0	0.8	8/7	2	BS
05	5.5	1.5	8/7	2	BS

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
01	4.2	1.2	2/7	1	BS					
02	4.3	0.9	2/7	1	BS					
03	4.5	1.0	2/7	1	BS					
04	3.7	0.9	2/7	1	BS					
05	3.7	0.8	2/7	1	BS					
06	3.9	0.8	2/7	1	BS					
07	4.0	1.0	2/7	1	BS					
08	4.2	0.9	2/7	1	BS					
09	3.8	0.8	2/7	1	BS					
10	3.8	0.8	2/7	1	BS					
11	4.3	1.2	2/7	1	BS	F				
12	3.7	0.5	2/7	1	BS					
13	4.5	1.2	2/7	1	BS					
14	3.7	0.7	2/7	1	BS					
15	3.7	0.7	2/7	1	BS	F				
16	3.7	0.5	2/7	1	BS					
17	4.4	0.8	2/7	1	BS	F				
18	4.0	0.7	2/7	1	BS	F				
19	4.3	0.9	2/7	1	BS	F				
20	3.6	0.5	2/7	1	BS					
21	3.8	0.6	2/7	1	BS					
22	4.1	0.6	2/7	1	BS					
23	3.6	0.5	2/7	1	BS					
24	4.2	0.8	2/7	1	BS	F				
25	4.0	0.7	2/7	1	BS					
26	3.7	0.5	2/7	1	BS					
27	4.0	0.5	2/7	1	BS					
28	4.2	0.7	2/7	1	BS					
29	3.8	0.6	2/7	1	BS					
30	3.8	0.6	2/7	1	BS					
31	4.4		2/7	1	BS					
32	3.8	0.8	8/7	2	BS					
33	3.9	0.7	8/7	2	BS					
34	4.2	0.8	8/7	2	BS					
35	4.6	0.9	8/7	2	BS					
36	4.2	1.1	8/7	2	BS					
37	3.7	0.7	8/7	2	BS					
38	3.7	0.8	8/7	2	BS					
39	4.0	0.8	8/7	2	BS					
40	3.7	0.8	8/7	2	BS					
41	3.7	0.7	8/7	2	BS					
42	3.8	0.8	8/7	2	BS					
43	4.4	1.0	8/7	2	BS					

Number	cm Length	gm Weight	Date of Capture	Location of Capture	Method of Capture	Sex	Maturity	Stomach	Gonad	Age
44	3.8	0.8	8/7	2	BS					
45	3.8	0.9	8/7	2	BS					
46	3.5	0.8	8/7	2	BS					
47	4.2	0.9	8/7	2	BS					
48	4.7	1.1	8/7	2	BS					
49	3.9	0.5	8/7	2	BS					
50	3.8	0.5	8/7	2	BS					
51	4.4	0.9	8/7	2	BS					
52	4.0	0.6	8/7	2	BS					
53	3.7	0.6	8/7	2	BS					
54	4.7	0.6	8/7	2	BS					
55	4.4	1.0	8/7	2	BS					
56	3.7	0.6	8/7	2	BS					
57	3.6	0.5	8/7	2	BS					
58	3.9	0.6	8/7	2	BS					
59	3.7	0.6	8/7	2	BS					
60	3.5	0.7	8/7	2	BS					
61	3.7	0.7	8/7	2	BS					
62	4.1	0.6	8/7	2	BS					
63	3.8	0.4	8/7	2	BS					
64	3.7	0.8	8/7	2	BS					
65	3.8	0.8	8/7	2	BS					
66	3.8	0.8	8/7	2	BS					
67	3.3	0.6	8/7	2	BS					
68	3.8	0.7	8/7	2	BS					
69	4.0	0.8	8/7	2	BS					
70	3.5	0.4	28/7	1	BS					
71	3.7	0.5	28/7	1	BS					