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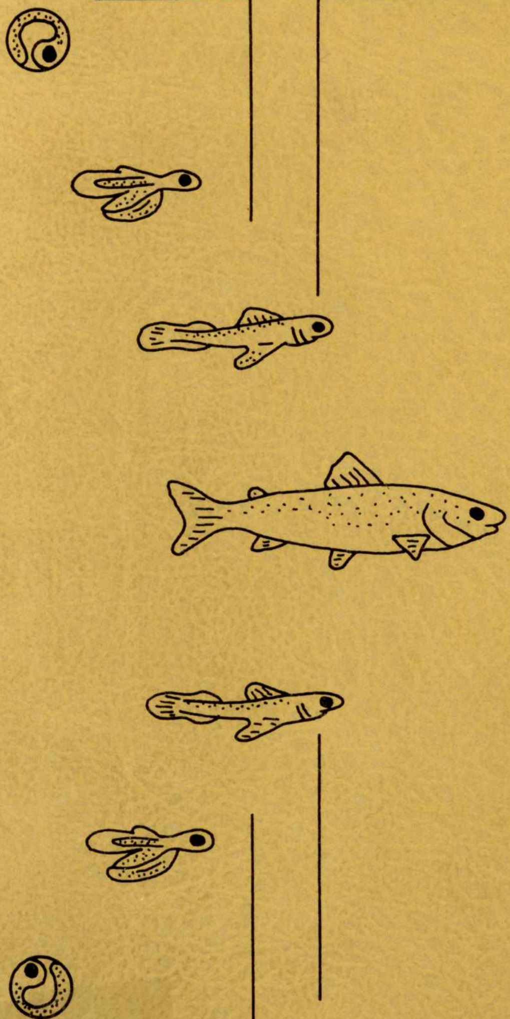

PROGRESS REPORT NO. 23

A SURVEY OF NINE LAKES
ON THE ISLAND OF NEWFOUNDLAND
1961

BY

W. D. SEABROOK

RESOURCE DEVELOPMENT BRANCH
NEWFOUNDLAND REGION
ST. JOHN'S

1962

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June, 1962

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INTRODUCTION

Responsibility for the management of the freshwater resources in the Province of Newfoundland came under the authority of the Federal Government in 1956 by agreement between the respective ministers. For several reasons only minor effort, to date, has been devoted to lake investigations.

During the summer of 1960 Drs.Scott and Crossman, Royal Ontario Museum, carried out a brief survey of the freshwater and estuarine fishes of the Island of Newfoundland. This survey, the results of which will appear in published form, was jointly sponsored by the Royal Ontario Museum and the Canada Department of Fisheries. This past year has been the first during which personnel have been available to devote full time to the study and ultimate management of these resident freshwater species.

The Island of Newfoundland has one of the largest, unexploited sports fishing resources in Eastern Canada. The local fishery is based mainly on the Eastern Brook Trout (*Salvelinus fontinalis*) followed closely by the Atlantic salmon. The salmon is undoubtedly the lure for the "out of province" sportsmen.

Two factors are responsible for the fact that this fishery is relatively unexploited. The distribution of the population in the larger urban centers and the remainder along the coast. Relatively few persons live in the interior of the Island. Road access to the interior is sparse and what roads that do exist are privately owned. The isolation of the Island has cut down on the tourist fishing pressure although in recent years this pressure has been on the increase.

The present near virgin state of these fish stocks is now a temporary affair. With the proposed increase in roads, these stocks will be open to increased exploitation. In Newfoundland the Department has an excellent opportunity to apply the principles of management to fish stocks before they have been subjected to intensive fishing.

Geology

The geology of a region has a great significance on the waters of that region. It controls the form of the drainage as well as the chemistry of the water. The geology of the Island does not lend itself to a productive watershed. There are two main types of rock on the Island, the granites and the sedimentaries which consist for the most part of Paleozic sandstones and sandstone derivatives. The only limestones in the Island lie in the St. George's formation on the West Coast. These are dolomitic limestones and are relatively insoluble.

The rocks have undergone extreme warping and considerable shearing has taken place. Several of the major lakes lie in depressions arising out of shear or fault action.

The Humber, Exploits, and Gander Rivers lie in these preglacial zones of weakness which have now been modified by glaciation.

Glaciation has been severe in Newfoundland. There were two glacial epicenters, one on the Avalon Peninsula and one to the northeast of Buchans. There is some difference of opinion whether or not the entire Island was glaciated. Some think that the northwestern tip was spared. This opinion is based upon the evidence of ancient plant types. Others feel that the entire Island was buried beneath the ice.

The center of the Island is a plateau ranging from 800 to 1,700 feet with hills (monadnocks) rising out of it. The area between these hills is post glacial drainage; lakes, (in various states of encroachment by bog plants), streams and bogs. The area is poorly drained due to the hard rock and low relief. Drainage on the lowland and slope areas is superior, due to the topography and easily eroded nature of the till.

Twenhofel (1947) claims that this region has more of these water features than any average area of Michigan, Wisconsin, or Minnesota. This highland region is drained to the north by three major river systems, the Exploits, Gander, and Terra Nova river systems. It is bounded on the west by the Long Range Mountains, and is drained to the south by numerous short rivers.

Major faulting in the Avalon Peninsula lies in a northeast-southwest direction as in the rest of the Island. It is suspected that Conception Bay, Trinity Bay, and St. Mary's Bay originated through faulting and that they are drowned valleys. At present there are no major rivers on the Avalon; it is speculated that submerged rivers in the above mentioned bays used the present rivers and streams as their tributaries and headwaters.

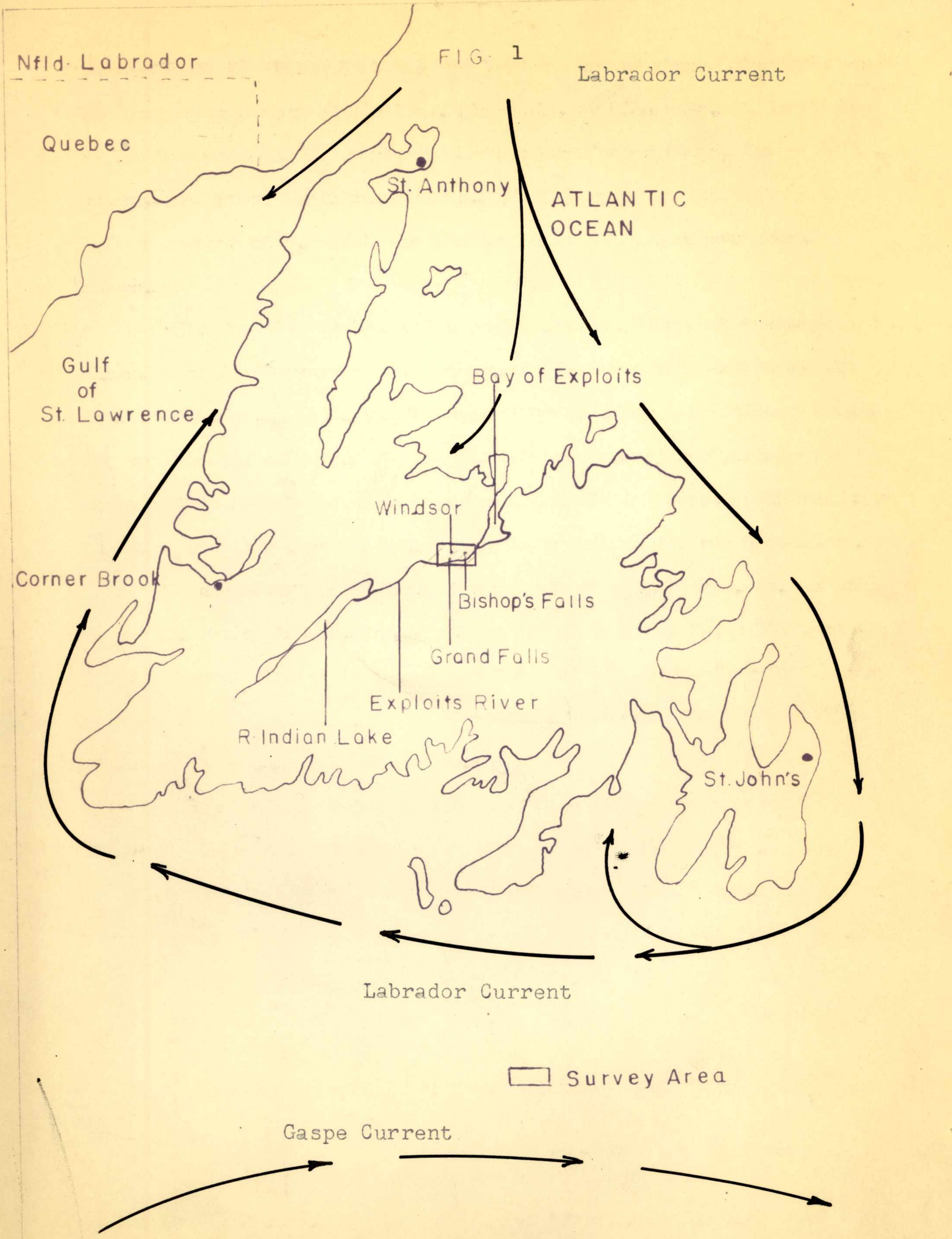
The center of Avalon is a plateau extending from Cape. St. Francis to Renews. This plateau, due to the resistant rock and low relief, contains many post glacial lakes. These lakes lie in depressions in the rock scooped out by glaciation. It is a region of barrens with the exception of the northern end which is wooded.

In the lowland to the southwest of Conception Bay numerous lakes lie in the valleys of old rivers now clogged by glacial debris. These old rivers and lake systems are oriented in zones of weakness. The lowland areas are covered by ground moraine from ten to one hundred feet thick. It is in this moraine that the lowland lakes lie.

Climate

The description of climate that follows has been taken mainly from Hare, 1952.

The sea is the dominating influence on the climate of the Island of Newfoundland (Fig. 1). The principle flow of water is the cold Labrador current moving south along the Labrador coast, east along the northeast



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DEPARTMENT OF FISHERIES, CANADA

Major Ocean Currents about Newfoundland

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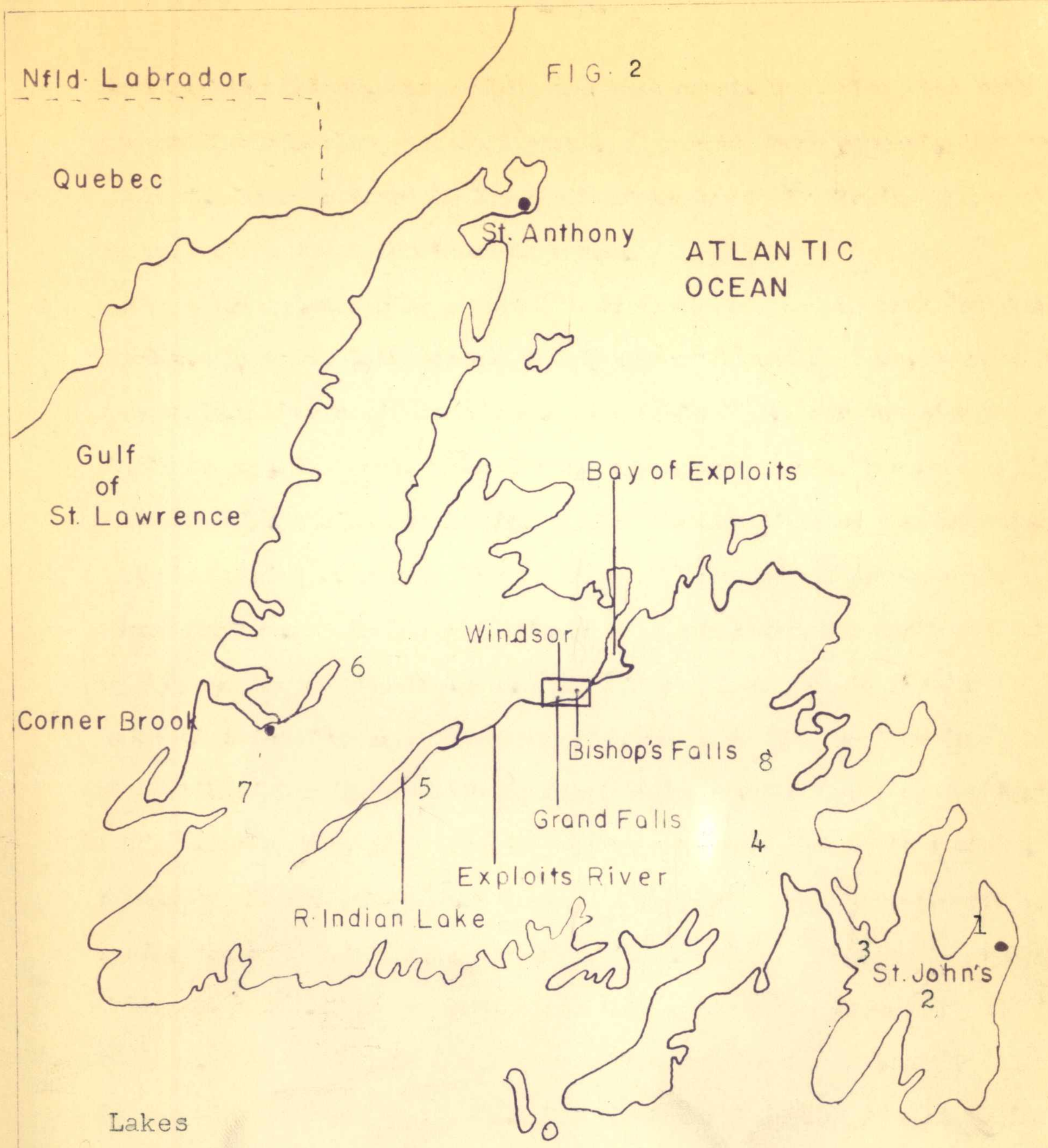
coast of the Island, south along the east coast, west along the south coast, and north again along the west coast. A second ocean current, the Gaspe current, flows eastward to the south of the westerly flowing Labrador current along the Island's south coast.

During the spring months this current brings down pack ice from the Arctic. By March this ice completely surrounds the western, northeastern, and eastern shores of the Island. The Gulf of St. Lawrence clears by April or May, the northeast and east coasts may remain blockaded until June or July. This pack ice has a significant effect on the temperature. The air passing over this ice may be cooled as much as over a continental land surface. This lowering of air temperature retards the onset of spring and the attendant thaws. The affect of the ice is particularly noted when ice free conditions prevail, and very mild weather is prevalent.

In winter the central plateau becomes much colder than the coasts. During January a monthly mean temperature for the plateau is 18-20°F. with a monthly minimum of -15°F. For a similar period on the Avalon or Burin Peninsulas a monthly mean approach of 25°F. and the monthly minimum rarely falls below 0°F. The summer coastal temperatures are lower than the inland regions. The northern regions become warmer than the southern regions of the province during the summer. The south coast is the coolest region of all due to the prevailing southwest winds passing over the cool Gaspe and Labrador currents. In the autumn the temperatures fall more rapidly in the north than the south, establishing a temperature gradient from north to south.

The thaw is defined as the period when the mean temperature is 32°F. or more. This thaw commences on the plateau about April 15. It is somewhat earlier on the Avalon and Burin Peninsulas, and becomes later as one moves west along the south coast and north along the west coast, reaching



Lakes

1. Hogan's Pond
2. Ocean Pond
3. Dildo Pond
4. Gambo Pond
5. Red Indian Lake
6. Deer Lake
7. George's Lake
8. Butt's Pond.

▭ Survey Area

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the Strait of Belle Isle about May 5, one month later than the Avalon Peninsula. Freeze-up follows the same pattern in reverse, it is earlier in the inland areas than along the coast (Buchans, November 15).

The whole Island has a well distributed and abundant rainfall. In the west, southwest, and in many of the hilly districts (including St. John's) rainfall exceeds 50 inches per year. Prevailing summer winds are southwesterlies. These warm, moist streams of air overrun the cool fronts of cyclones resulting in frequent and prolonged precipitation. Such frontal activity is more common over Newfoundland than any other area of eastern North America. The hilly nature of the coasts increases the precipitation as the fronts approach. The north coast of the Island is drier than the south coast.

Snowfall is heavy in most districts, it is heaviest in the hilly southwest of the Island. Corner Brook Lake receives 218 inches of snow annually, along the railway 100 to 125 inches of snow are received. Snow begins in mid to late November and is permanent by early December. Snow becomes rain by April.

MATERIALS AND METHODS

Lakes investigated during this survey (Fig. 2) were situated in various geographic areas of the province. Where possible, in connection with the major drainage systems. In the Avalon Peninsula Hogan's Pond is located on the highland plateau. Ocean Pond is associated with the Conception Bay lowland area of glacially clogged rivers mentioned in the introduction. Dildo Pond is situated in the lowland immediately to the south of Trinity Bay. In the central part of the Island Gambo Pond is situated in a lowland which extends from the head of Freshwater Bay. Red Indian Lake lies in the high plateau and is the major body of water associated with the Exploits River, it is a lake that lies in an old shear zone. Deer Lake, in the Humber River system, receives the major drainage from the west coast area north and west of the Long Range Mountains, it also lies in an old fault zone. George's Lake, on the Harry's River system, is the only good sized lake associated with the sole limestone deposits on the Island, the St. George's formation. Observations were carried out on Butt's Pond in conjunction with a study of landlocked Arctic Char, resident in this pond.

The survey party consisted of a biologist as party chief, and one summer student; casual help was hired when required. Every assistance was provided by the Protection Branch who supplied personnel to assist in the investigation of Gambo Pond, Deer Lake, and George's Lake on the west coast. Accommodation was in Department cabins, and in commercial establishments. For the survey of Butt's Pond a CNR boarding car was chartered, this proved most adequate.

Access to all lakes surveyed during 1961 season, with the exception of Butt's Pond, was by road. Transportation on land was by Jeep Station Wagon; this machine gave considerable trouble throughout the entire field season.

A sixteen foot moulded plywood boat, powered by an 18 h.p. motor, was used for this s tudy. A large boat such as this gave considerable stability while carrying out operations such as setting and retrieving gill nets. An 18 h.p. motor was found to be inadequate and a cruise in this boat usually resulted in the occupants getting quite wet.

Morphometric data were collected for each lake studied (Appendix 1), with the exception of Square Pond. The data from Red Indian Lake and Deer Lake are incomplete. Soundings were made using a 12 volt Bendix DR-19 echo sounding, depth recorder. As this model uses a crystal transducer, problems were encountered concerning its installation in a small boat. The transducer must be protected from all shocks such as bumping against the bottom when the boat is in shallow water or is being beached.

To overcome this problem the transducer was mounted in a well so that it could be raised into the boat when in shallow water. When lowered, the transducer came flush with the bottom of the boat. The recorder was mounted under the deck of the boat beside the steering gear (Fig. 3).

Lines were run across the body of water using prominent headlands and bays as benchmarks. The lines were then plotted on a map, the direction of the run was indicated. As long as a constant speed per line was maintained, equal relative distances on the map and on the recording represented equal absolute distances. Each recording was then subdivided into eight or sixteen units, the corresponding line on the map was divided in a like manner. Maps were plotted at 10 foot depth intervals with the exception of George's Lake which was plotted at 30 foot intervals. Each ten foot interval was located between two of these fixed points on the recorder tracing and plotted between the same two fixed points on the map. The maps resulting from this method are of suitable accuracy for biological investigations.

Netting was carried out on all lakes investigated, with the exception of Hogan's Pond. Time was a factor at this point and as this pond had been netted before, it was considered advantageous to overlook it this time. A standard gang of gill nets was used consisting of 1½", 2", 3", 4", 5", 5½" stretched mesh nets. The object of these nettings was to determine the species present rather than the quantities of fish in the water, for this reason it was felt that there would be no disadvantage in mixing nylon and cotton nets in the same gamg.

Nets were set at various depths and in a variety of locations in each of the lakes surveyed. A concentration of nets was set in zone of from 20 to 40 feet deep. This zone proved to be the most productive in

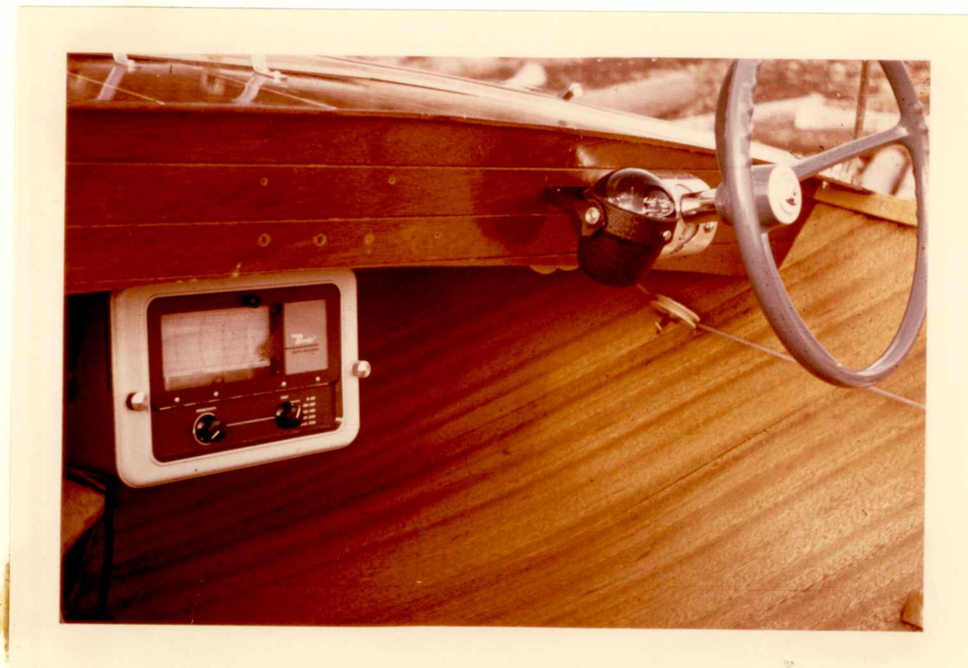


Fig. 3. Echo Sounding Depth Recorder
Used for Lake Investigations

most of the lakes fished. Specimens taken were weighed, measured for fork lengths, sexed, a scale sample taken, and preserved in 10 per cent formaldehyde.

Plankton samples were made using a small straining net consisting of a truncated canvas cone about 12 cm. high and No. 20 bolting cloth cone 30 cm. long. The sample was collected in a removable bucket. Hauls were made vertically using a 50 foot line. Preservation was in 25 per cent alcohol. This preservative was too strong as it caused rupturing of specimens.

Temperatures were taken at 2 foot intervals using a max-min thermometer. Later in the season an electronic thermometer, known as a thermistor, became available. The thermistor proved very useful and accurate.

Water samples were taken for determination of total dissolved solids and pH. These samples were taken at the surface. Analyses of total dissolved solids was carried out using a conductivity meter, T.D.S. was determined for 77°F. Determination of pH was by meter. Secchi disc recordings were carried out for water transparency, it is felt that these light measurements are of very little value due to the fact that light conditions varied so much from day to day. All the above limnological observations were taken at the same stations in each lake.

RESULTS AND DISCUSSION

Hogan's Pond

Geology and Geography

Hogan's Pond is located on the Avalon Plateau at an altitude of 475 feet. It is post-glacial lake lying in a hollow in an extensive area of ablation moraine. The bedrock of the area consists of paleozic sedimentaries (sandstones or sandstone derivatives) of the Conception formation.

To the north and east is a region of faulting, Hogan's Pond lies in a slight lowland between these regions. Hills rising to 700 feet lie to the south-east of the lake to the northeast and northwest and west hills rise to 550, 625, and 575 feet respectively. The area is well wooded with black spruce. The lake is surrounded with cottages, a limited amount of farming is carried out on the high land surrounding the lake and within the watershed. These farms and cottages undoubtedly add soluble material to the pond.

Drainage

There is no apparent inflow to the lake, other than intermittent streams which may exist at times of heavy run-off. It would appear, that in the past, Hogan's Pond and Mitchell's Pond were one body of water connected by a shallow narrows. This narrows has been spanned by a cause-way. A culvert is now the only communication between these two lakes.

The outflow from Hogan's is through Mitchell's Pond to Hugh's Pond and then through Beachy Cove Brook to the Atlantic Ocean, a distance of approximately three miles. This brook has a series of precipitous water falls which block the passage of anadromous fish to this system.

Morphometry

The lake is of irregular shape with its long axis lying in a north-south direction. There is a large bay on the eastern shore containing an island.

The pond has a mean length of .27 miles and a mean width of .22 miles. The area is 6.47×10^6 sq. ft. The maximum depth is 35 feet, with a mean depth of 16.3 feet. This deep point lies in the approximate center of the lake. The shoreline falls off gradually to a depth of 10 feet except on the northern shore where the drop is abrupt. From 10 feet the bottom falls off gradually to 35 feet. Very shallow water less than one foot in depth, broken in several places by emergent rocks lies between the island and the

Table 1. Volume of Hogan's Pond Under Various Depth Strata and Per Cent of Total Volume of the Lake

Depth in Feet	Volume Under Given Depth	Per Cent Total Volume
Surface	108.6×10^6	100%
20 ft.	20.5×10^6	19%

shore in the eastern bay, it is impossible to cross this reef with a boat.

The bottom varies from rock of about 8 inch diameter and boulders around the shore to deep mud in the region below 10 feet. This mud is interspersed with numerous large rocks, presumably glacial erratics, as the whole region is one of ablation moraine.

The index of shoreline development is 2.5. For details concerning the determination of this index refer to Appendix 2.

Ocean Pond

Geology and Geography

Ocean Pond lies in the lowland to the southwest of Conception Bay at an altitude of 250 feet. It is a region of old rivers, these rivers are now clogged with glacial debris and numerous lakes lie along their former courses. The lake lies in a region of Precambrian sedimentaries heavily overlain with ground moraine. The surrounding country is gently rolling with an elevation of not more than 100 feet. The lowlands between these hills contain numerous marshes and peat bogs.

At the northern end of the lake is the predominantly summer community of Ocean Pond situated on the Canadian National Railway line. Associated with this community is a small sawmill. This mill uses timber which is cut about the southern end of the lake and brought down in booms. At one time a small sawmill was operated at the southern end of the lake but in recent years this has been abandoned. The southern half of the lake is well wooded, the northern end has extensive areas of barrens.

Drainage

Ocean Pond is located in the headwaters of the Rocky River drainage approximately 19 miles from St. Mary's Bay. At the outflow of the pond a small wooden dam has been constructed, this raises the water level about one foot.

The waters flow from Ocean Pond to Round Pond West, through Long Pond, Gull Pond and a tributary of Rocky River to Rocky River and then to the sea. The outflow of Rocky River consists of two waterfalls several hundred yards apart. These waterfalls make the system inaccessible to anadromous fishes. A fishway was constructed around the lower obstruction, it was unsuccessful and has now fallen into disrepair.

The pond drains an area of 8.3 square miles, consisting of several small lakes and their drainages. The only permanent drainage on the western shore is through western Gull Pond, this system has a length of about 1¼ miles. To the north a small stream 1/2 a mile long flowing through the community of Ocean Pond drains two small lakes. Several tributaries, ranging up to a mile in length, run in on the northeast shore. All these tributary streams terminate in small lakes which appear to be supplied by intermittent streams and springs. The only drainage to the southern half of the lake consists of two intermittent streams. The country surrounding the southern half of the pond is flat and well wooded.

Morphometry

The lake is elongate in shape, lying in a northeast southwest direction. The shoreline is irregular with a development index of 4.36, the highest of any lake investigated. The lake is very shallow and contains 30 islands. It has a mean length of 3.2 miles and a mean width of .32 miles. The area is 35.3×10^6 sq. ft. The maximum depth is 32 feet, the mean depth is 14.9. The volume is 525.9×10^6 cu. ft.

Table 2. Volume of Ocean Pond Under Various Depth Strata and Per Cent of Total Volume of the Lake.

Depth in Feet	Volume Under Given Depth in Cubic Feet	Per Cent Total Volume
Surface	525.9×10^6	100%
20 ft.	8.0×10^6	1.5%

For the purpose of description, the lake can be divided into four sections corresponding to the four basins of the pond. The northern section is divided from the central section by a shallow narrows about $1\frac{3}{4}$ miles from the head of the lake. This section has a maximum depth of 22 feet. The bottom slopes gently to a depth of 20 feet except along the northern shore and the headlands where the drop is quite abrupt. Echo sounder tracings indicate the bottom is overlaid with a deep layer of mud up to 8 feet deep. Bottom dredgings confirm the presence of grey mud. Large boulders are covering the bottom, some reaching to the surface make boating treacherous. This northern section is separated from middle section by a shallow narrows at the point where the inflow West Gull Pond enters. The water in this narrows is about two feet deep except on the eastern shore where it is slightly deeper, at this point a boat may pass through.

The middle section contains the deepest water in the lake (32 feet). This section ends in a cul de sac at its southern end. The section is $1\frac{1}{4}$ miles long. The region contains many islands (10) and has a very irregular shoreline. The bottom slopes gently down to the maximum depth except off the islands where the drop off on the offshore side is abrupt. The bottom in this section is a black muck to a depth of approximately 6 feet. Boulders and reefs rise up through this muck reaching near the surface and making travel dangerous.

From the southeast corner of the central section a short channel leads into the eastern bay and at the entrance of this bay a narrow channel 1/3 mile long leads south to the southern section.

The eastern bay is very shallow with a length of 3/4 of a mile and a maximum depth of 12 feet in the northern half. The southern end at the entrance is very shallow, an outboard motor boat had to be poled through this region. This area is scattered with emergent rocks, the average depth is about 2 feet. The bay contains 3 islands.

The channel leading to the southern section has an even depth of 9 feet except in the southern end where it decreases to 4 feet. At the outlet of this channel into the southern section of the lake a deep "hole" of 28 feet is encountered. This section of the pond had large areas of very shallow water (less than 10 feet) and contains 6 islands. The length of this section is one mile, the maximum depth is 21 feet, the drop-off to this depth is very gradual. Bottom deposits are of black muck, echo sounder tracings indicate this mud extends to a depth of 5 feet. Numerous reefs and boulders project from the bottom and either break the surface or lie just below it, particularly in the southern part of the region. The southern section of the lake and the connecting channel are a particularly beautiful region.

Dildo Pond

Geology and Geography

Dildo Pond lies in a lowland 3/4 of a mile south of Trinity Bay at an altitude of 100 feet. The bedrock is Precambrian sedimentaries which are sandstones and sandstone derivatives covered with glacial till.

The surrounding country is of well rounded hills. To the northeast elevations rise gently to 450 feet in a distance of one mile. To the north the rise is to 250 feet in 1/4 mile. In the southeast the country rises gently to 250 feet in a distance of 2 miles, and southwest to 450 feet in 1.5 miles, to the west two hills rise to heights of 450 feet and 600 feet at distances of one mile and 1¾ miles respectively.

Provincial highway #4 skirts the western shore of the lake, allowing ready access, this road proceeds to the Trans Canada Highway, Whitbourne and Colinet. Stretching for a distance of 1½ miles along this road, on the western shore of the pond, is the town of Blaketown. At the southern tip of the lake is a small tourist establishment. A stream parallels the Whitbourne road for a distance of 2¼ miles; there are numerous mink ranches along this road. Mink ranching is an important industry in this area. Complaints were made to this writer concerning the large amounts of waste and debris which is allegedly thrown into this stream by these mink ranchers. Undoubtedly, the presence of the town, tourist camp and mink ranches add a certain amount of soluble materials to the waters of this pond. Extensive beds of *Equisetum sp.* grow in water about 3 feet deep at the outflow of this brook.

Drainage

The drainage area of Dildo Pond is 24.3 square miles, it is located primarily to the south and east of the pond. To the south the land lies in a broad valley extending to the south coast. In this valley lie the southward draining Colinet and Rocky Rivers. To the east the country is a flat plateau at 200 feet liberally scattered with lakes. The southern inflow extends from the southernmost tip of the lake for a distance of 4½ miles. The stream has one tributary flowing from Goose Pond, a substantial lake two miles to the east.

The eastern drainage flows into the southern half of the lake. The larger of these streams is 1¼ miles long and terminates in Strayaway Pond.

Fig. 4. Dildo Brook Waterfall

Fig. 5. Dildo Brook Dam

This stream also receives intermittent drainage from four other small lakes. The smaller of the two streams lies 1/2 mile to the north of the first and is 3/4 mile long. There is no drainage from the west or from the north.

Outflow from the lake is through Dildo Brook, 3/4 mile in length, running from the northwest corner of Dildo Pond to South Dildo on Dildo Arm of Trinity Bay. Between the lake and the ocean is a waterfall (Fig. 4) impassable to anadromous fishes, and a dam (Fig. 5) also impassable to anadromous fish. This dam supplies water for a local fish plant.

Morphometry

The lake is elongate in shape and lies in a north-south direction. It has a shoreline development index of 2.07 which would indicate a very regular shoreline. It is moderately deep and contains two islands located in the southern end. Dildo Pond has a mean length of 2.5 miles and a mean width of .42 miles, with an area of ~~4.21~~ 42.1 x 10^6 square feet. The maximum depth is 70 feet, the mean depth is 32.7 feet. The volume is 1376.7 x 10^6 cubic feet.

Table 3. Volume of Dildo Pond Under Various Depth Strata and Per Cent of Total Volume of the Lake

Depth in Feet	Volume Under Given Depth in Cubic Feet	Per Cent Total Volume
Surface	1376.7 x 10^6	100%
20	583.3 x 10^6	42%
40	250.6 x 10^6	11%
60	16.9 x 10^6	1%

The bottom is very regular. The deepest point, 70 feet, is located in the northern end of the pond. The section of the lake containing the islands is shallow, reaching a maximum depth of 30 feet. A causeway spans the narrow bay at the south end of the lake. The ten foot contour approaches this causeway. Beyond this point the lake is very shallow, 8 feet, with a sandy bottom.

The drop-off from shore along the southern and eastern shores is quite gradual, with numerous rocks lying just below the surface. Along the northern and eastern shores the drop-off is more precipitous. This drop-off corresponds with the topography of surrounding country, the northern and western shores are hilly while the southern and eastern shores are more or less level.

Bottom samples taken at the north and south ends of the lake indicate that the bottom is covered with black mud, the echo sounder tracings do not show this mud, it is therefore supposed not to be a thick layer. In shallow water on the eastern shore rocks and boulders,from 6 inches up, were most common. Bottom materials on the western beaches and shallow water areas consisted of gravel and till.

Gambo Pond

Introduction

Gambo Pond consists of two distinct bodies of water joined by a narrows about 1/2 mile in length. In this report the drainage and morphometry will be considered separately under the headings of Gambo Pond South and Gambo Pond North. An attempt will be made to define these waters as two separate lakes. Geology and Geography will be discussed under the present topic heading, for it is felt that the same forces effected the formation of both lakes.

Geology and Geography

The ponds lie in a northeast-southwest valley which appears to be an extension of Freshwater Bay, an arm of Bonavista Bay. The relief from Gambo Lake to the sea is extremely low and is made up of lacustrine and glacial deposits. These deposits consist of extensive sand flats in the tidal zone of Gambo River, and great numbers of glacial erratics along the entire river. The lakes are at an altitude less than 50 feet and probably less than 25 feet. The lake basins are well below sea level. The valley in which these ponds lie appears to have been developed in two ways, by the combined action of Riverhead and Triton Brooks and by glaciation. The valley is deep with the range of hills along the northern side rising to 500 feet and along the southern shore to 400 feet and occasionally to 500 feet. The va lleys of Riverhead and Triton Brooks are also steep walled. The hills of Riverhead Brook rise to 400 feet within 1/4 - 1/2 mile of the brook and the hills of Triton Brook rise 500 - 700 feet with 3/4 mile to one mile of the brook. The lake basin appears to be a continuation of these valleys.

The valley appears to have been modified by glaciation. It shows the typical U shape, particularly near the entrance of Riverhead Brook where the valley is somewhat confined. The shores of both lakes are littered with boulders too large to be accounted for by lacustrine action. The outflow of Gambo River and the "narrows" both appear to be end moraines. It is postulated that a glacier moved down the pre-glacial valley pushing up an end moraine at what is now Gambo River and Freshwater Bay. The glacier then appears to have retreated beyond what is now the "narrows" and readvanced up to this point, leaving an end moraine as its snout. Outwash waters from this glacier dumped large quantities of silt in what is now Gambo Pond North, causing it to become considerably shallower than Gambo Pond South.

The northern half of the lake (Gambo Pond North) lies in an area of gneisses. The northeastern end of this pond lies in the acidic intrusive (granites). The drainage area is of granitic rocks, with the exception of a small area of Ordovician and Silurian sediments on the Mint Brook system.

The southern half of the lake (Gambo Pond South) lies primarily in an area of Ordovician sedimentaries (sandstones and sandstone derivatives), with a small area of the eastern shore lying in the granite. Riverhead and Triton Brooks lie primarily in these sedimentary rocks with a small per cent of their headwaters in the granite rocks. There is very little drainage from the granites. The eastern division between the drainage of Gambo Pond North and Gambo Pond South is closely associated with the division between the granites and the Ordovician sedimentaries. The main drainage of Gambo Pond South is from the Ordovician sedimentaries.

Gambo Pond North

Drainage

There are three major flows to the lake - Parsons Brook, Mint Brook, and the drainage through the narrows from Gambo Lake South. The total drainage area is 205 square miles.

Mint Brook drains the land to the north of the lake and has a length of 27 miles, picking up several tributaries along its course. It has two major ponds - Masons Pond, two miles, and North Pond, 12.5 miles from Gambo Lake. There are several small brooks feeding North Pond.

Parsons Brook drains into the southeastern corner of Gambo Pond North. It has an overall length of 13 miles, it has numerous tributaries and small ponds along its length./ The "narrows" consist of a shallow, narrow channel about 1/2 mile in length, it has a depth of less than four feet and its course is obstructed by many boulders lying above or just below the surface. There is a flow of water from Gambo Pond South to Gambo Pond North. The shores of the narrows are littered with logs as the Anglo Newfoundland Development Company drives logs through this passage. There are two short intermittent streams running into the north side of the Pond from the height of land which is a swampy plateau lying one mile inland at an altitude of 550 feet. On the southern shore there are two intermittent streams draining a swamp 1½ miles inland at an altitude of 500 feet, and one very short intermittent stream about 1/4 mile in length entering the lake near the narrows.

The outflow from the pond to the sea is by the Gambo River. This is a wide, shallow river with a boulder and silt bottom, flowing through a low region of what appears to be glacial moraine. The distance to the sea is approximately one mile. Extensive sand flats cover the tidal zone of this river.

Morphometry

This is a long narrow lake lying in a northeast-southwest direction. It has a regular shoreline with a shoreline development index of 2.68. The pond has a mean length of 6.5 miles and a mean width of .4 miles. The area is 3.93 square miles. The maximum depth is 46 feet, located at the center of the pond off what is known locally as Half Way Point. The mean depth is 21.5 feet, and the volume is 2356.4×10^6 cubic feet.

Table 4. Volume of Gambo Pond North Under Various Depth Strata and Per Cent of Total Volume of the Lake

Depth in Feet	Volume Under Given Depth in Cubic Feet	Per Cent Total Volume
Surface	2356.4×10^6	100%
20	546.9×10^6	23%
40	11.9×10^6	0.5%

The bottom of the lake is very regular. The drop to the maximum depth of 46 feet is gradual off the southern shore and quite abrupt along the northern shore, particularly at the middle section. The southern end of the lake is shallow. Depth recorder tracings indicate that the bottom is covered with mud to a considerable depth. The shoreline consists of large boulders, rocks, and rubble. At the outflow of Parsons Brook a

Fig. 6. Log Covered Beach,
Gambo Pond, July, 1961.

considerable outwash fan of sand has been built up.

Logging

Gambo Pond North suffers from the effects of poorly executed log driving practiced by the Anglo Newfoundland Development Company. A large catch boom has been installed at the outflow of the narrows to receive logs driven either loose or in boom from Triton Brook, at the southern end of Gambo Pond South. A catch boom has also been installed at the mouth of Mint Brook. Logs are driven down the pond by the prevailing southwesterly winds. These logs are driven in this manner to a loading operation at the northern end of this pond, from whence they are transported by rail to the mills.

Under suitable wind conditions the catch boom at the "narrows" is opened and the logs are allowed to drift, unboomed, to the northern end of the pond. When logs are being driven in this manner, it is impossible to use a small boat on the lake. This method of driving results in large numbers of logs being driven on to the shore. At places the beach is so littered with logs that it is impossible to launch a boat from a trailer (fig. 6).

When the logs come to rest at the northern end of the lake, they completely block the shore, so that using a boat is impossible. This happened several times during this party's work on the pond. Complaints were made to a local officer of the A.N.D. Company, the logs were boomed and towed away.

Another problem resulting from such operations is the blockage of the narrows by logs when the wind changes during one of these "free drives". The party was delayed four days when Gambo Pond North became inaccessible due to logs choking the narrows.

The Gambo Lakes are a popular sports fishing area. Poor logging practices cut down on the accessability of the waters to the sportsmen, as well as making their use dangerous.

Gambo Pond South

Drainage

There are two major tributaries flowing into Gambo Pond South, these are Riverhead Brook, located at the extreme southwestern end of the pond, and Triton Brook, on the southern shore about two miles east of Riverhead Brook. The total drainage area is 200 square miles. The larger of these tributaries is Triton Brook, having an overall length of 23 miles. It has one major tributary, Rocky Brook. The rest of the river is supplied by short intermittent streams and two short permanent streams. At a distance of 15 miles from the pond Triton Brook divides into two branches, one 8 miles in length and the other 5 miles long. Considerable logging is carried out on this Brook. As it has a poorly developed tributary network and does not arise from a lake as a reservoir, it is subject to extreme variations in flow. There are extensive sand deposits at its mouth where a small delta has been formed.

Riverhead Brook has an overall length of 13 miles at the Pond. The Brook lies in a very steep valley, however approximately 4 miles upstream the valley walls become less steep allowing the development of feeder tributaries. A marsh lies at the outflow of Riverhead Brook. There are three short streams flowing from the height of land into the north shore of the lake, the longest has a length of approximately 3¼ miles. There is one stream 3½ miles long arising from several small ponds flowing into the southern shore.

The outflow is through the narrows into Gambo Pond North.

Morphometry

This body of water has the form of a slight crescent lying in slightly northeast southwest direction. The shoreline is regular, with a shoreline development of 2.6. It consists of boulders, rock, rubble, and logs. The mean length is 4.7 miles, the mean width is .6 miles, and the area is 4.73 square miles. The Pond has a maximum depth of 140 feet, a mean depth of 65.4 feet, and a volume of 8626.3×10^6 cubic feet. The bottom consists of gravel and rock where sampled. The echo sounder gave no indication of a mud bottom.

Table 5. Volume of Gambo Pond South Under Various Depth Strata and Per Cent of Total Volume of the Lake

Depth in Feet	Volume Under Given Depth in Cubic Feet	Per Cent Total Volume
Surface	8626.3×10^6	100%
20	6249.6×10^6	72%
40	3769.9×10^6	44%
60	1963.5×10^6	23%
80	946.4×10^6	11%
100	286.6×10^6	3%

The deepest region of the pond (140 feet) is located about 1½ miles east of the mouth of Riverhead Brook. The lake becomes progressively shallower as we approach the narrows. The drop-off on both the northern and southern shores is very abrupt in the southwestern and middle portions of the lake. The drop-off is less abrupt in the eastern half of the lake.

Red Indian Lake

Geology and Geography

Red Indian Lake is the reservior of the Exploits River, the largest river on the Island of Newfoundland. The lake lies in a northeast-southwest direction at an altitude of 500 feet. It has a regular shoreline. The lake and river both lie in an old geological zone of weakness. The region has been considerably modified by glaciation. Red Indian Lake and the Exploits River are preglacial in origin.

The country surrounding the lake consists of rolling hills rising to an altitude of 1,450 feet within five miles of the northwestern shore of the lake. The lake shore is well wooded. However, within a mile of the shore, forest becomes scattered and stunted, and bogs and barrens predominate. This bog and barren topography is typical of the high central plateau. It is scattered with numerous small lakes having only intermittent or bog connections with each other. The northeastern shore is well wooded with spruce and fir, an area of birch as the dominant species is located in the area between the Exploits River and Mary March's Brook. The forest in this region is interspersed with bogs, these bogs are not as extensive as those to the northwest of the lake. The topography in this region is quite flat, the land rises to an elevation of 750 feet within five miles of the lake shore. The height of land in this region is Hungry Hill, a monadnock 1,299 feet high about $5\frac{1}{4}$ miles southeast of the lake.

The central section of the lake might be considered as the region from the outflow of Victoria River on the southern shore to Harbour Round, and on the northern shore from Buchans Brook to a point opposite Harbour Round. Along the northern shore the land rises steeply to a height of 900 feet about 1/3 mile from the shore, from this level isolated hills rise to 1,576 feet. The country is well wooded along this shore of the lake. As one proceeds inland, trees become stunted and sparse, and barren conditions prevail. The topography of the southern shore in the region from Victoria River to Harbour Round is less severe than the northern shore. The land rises to an elevation of 800 feet with 3/4 mile from shore. The height of land in this area is 1,250 feet, southeast of Harbour Round. As the shoreline approaches Harbour Round it becomes steeper, terminating in Harbour Round Head with a near vertical drop of 300 feet. The country is well wooded with mixed black spruce and balsam fir, this forest is broken by numerous bogs and lakes.

The southern section of the lake is considered as the area from Harbour Round and a point on the northern shore opposite from this harbour to Lloyd's River. The principal feature on the northern shore is Shanadithit Bay, extending northeast in a broad valley of low relief. The area to the northeast of the bay slopes gently to an altitude of 700 feet in a distance of one mile. The relief becomes increasingly steep progressing south to Lloyd's River. Lloyd's River enters the lake through a canyon with walls of 200 feet. This area is well wooded for a distance of six miles from shore, except on the highland along Lloyd's River, which is barren. The southern shore from Harbour Round to Lloyd's River rises to an altitude of 1,250 feet approximately 2½ miles from the shoreline. This slope becomes increasingly steep as Lloyd's River is approached. The height of land in this region (1,500 feet) is the northeast extremity of the Annieopsquotch Mountains which parrellel the course of Lloyd's River to the south. The land in this region is well wooded with black spruce and balsam fir. It is classed as productive forest by the Newfoundland Commission on Forestry, 1955. The general appearance of the southern half of the lake is of very hilly country; this is due to the small deep valleys cut by tributary streams. It is not a tectonic feature.

The lake lies mainly in a region of Ordovician volcanic rocks. At the northern end a group of undefined Ordovician sedimentaries outcrop. On the southwest shore there is a small outcrop of either Pennsylvanian or Mississippian sediments, these sediments underlie the lake in this region. Drainages to the west of the lake lie in a region of granites with small outcrops of diorites and gabbros. The only exception to this is Buchans Brook which lies entirely within the Ordovician volcanics. To the north and west of the lake the rock is primarily the Ordovician volcanics of the same formation in which Red Indian Lake lies. The northern drainage limit for this system is defined by the boundary between these volcanics and the Ordovician sedimentaries of the Exploits Valley lowland.

To the south Lloyd's River and Lloyd's Lake lie in a region of mixed granites, Devonian sedimentaries, volcanics and intrusive basic anorthosite. Victoria River drains Victoria Lake into Red Indian Lake. It lies in the Ordovician volcanics and draws its tributaries primarily from this fromation. Some, however, flow through small regions of diorite, quartz diorite and gabbro. Victoria Lake drains an area of gabbros, volcanics, granites, and paragneisses.

There are three towns associated with Red Indian Lake: Buchans, a mining town operated by the American Smelting and Refining Company, with a population of approximately 2,000; Millertown on the northeastern shore, associated primarily with the Anglo-Newfoundland Development Company; Buchans Junction, a small village at the junction of the Millertown and Buchans roads on Mary March's Brook.

Drainage

Red Indian Lake drains an area of 2,200 square miles, principally to the south, southeast and northwest of the lake. There are two main drainages from the south - Victoria River and Lloyd's River. Victoria River, forty miles long, arises in Victoria Lake southeast of Red Indian Lake. Victoria Lake drains the region southeast of Red Indian Lake and the Annieopsquotch Mountains. A considerable amount of logging takes place through this river. Logs are collected in a catch boom at the mouth. The river empties into Red Indian Lake on the north eastern shore over a series of low water falls. No free floating logs are encountered in the lake.

Lloyd's River arises twelve miles from the southern tip of Red Indian Lake in Lloyd's Lake. Observations of this river were made during a flight in the American Smelting and Refining Company aircraft, and during a short exploration at the northern end of the river. The river is straight, bordered by steep hills ranging up to an altitude of 1,050 feet along both sides. It has several small islands and gravel bars. From the air it appears to be quite shallow, with areas of riffles and quiet pools. The bottom appeared to be clean gravel. There are no natural or artificial obstructions and no logging takes place on this river. It would appear to offer large areas of excellent spawning and nursery conditions for Atlantic salmon and trout. Lloyd's Lake drains a large area to the south. The drainage of Victoria and Lloyd's Lake are separated by the Annieopsquotch Mountains. To the west of Lloyd's Lake the drainage is west to the Gulf of St. Lawrence.

To the west of Red Indian Lake the principal drainages are through Shanandithit Brook, Buchans Brook, and Star River. These are 22, 6 and 21 miles in length respectively.

The drainage to the north is through Mary March's Brook (20 miles) and its principal tributary Glodes Brook (10 miles). There are several short brooks entering the eastern shore of the lake draining the area between the lake and Victoria River.

The outflow from Red Indian Lake is through the Exploits River. A large storage control dam has been constructed at the outflow. This dam backs up approximately 28 feet of water and causes an annual fluctuation of 19 feet in the lake's water level. This dam is 632 feet in length, it has four main sluice gates 15 feet wide, seven emergency gates 10 feet wide, and 26 log chutes. A channel 1,100 feet wide and about 1/4 mile long leads from the lake to the dam.

Morphometry

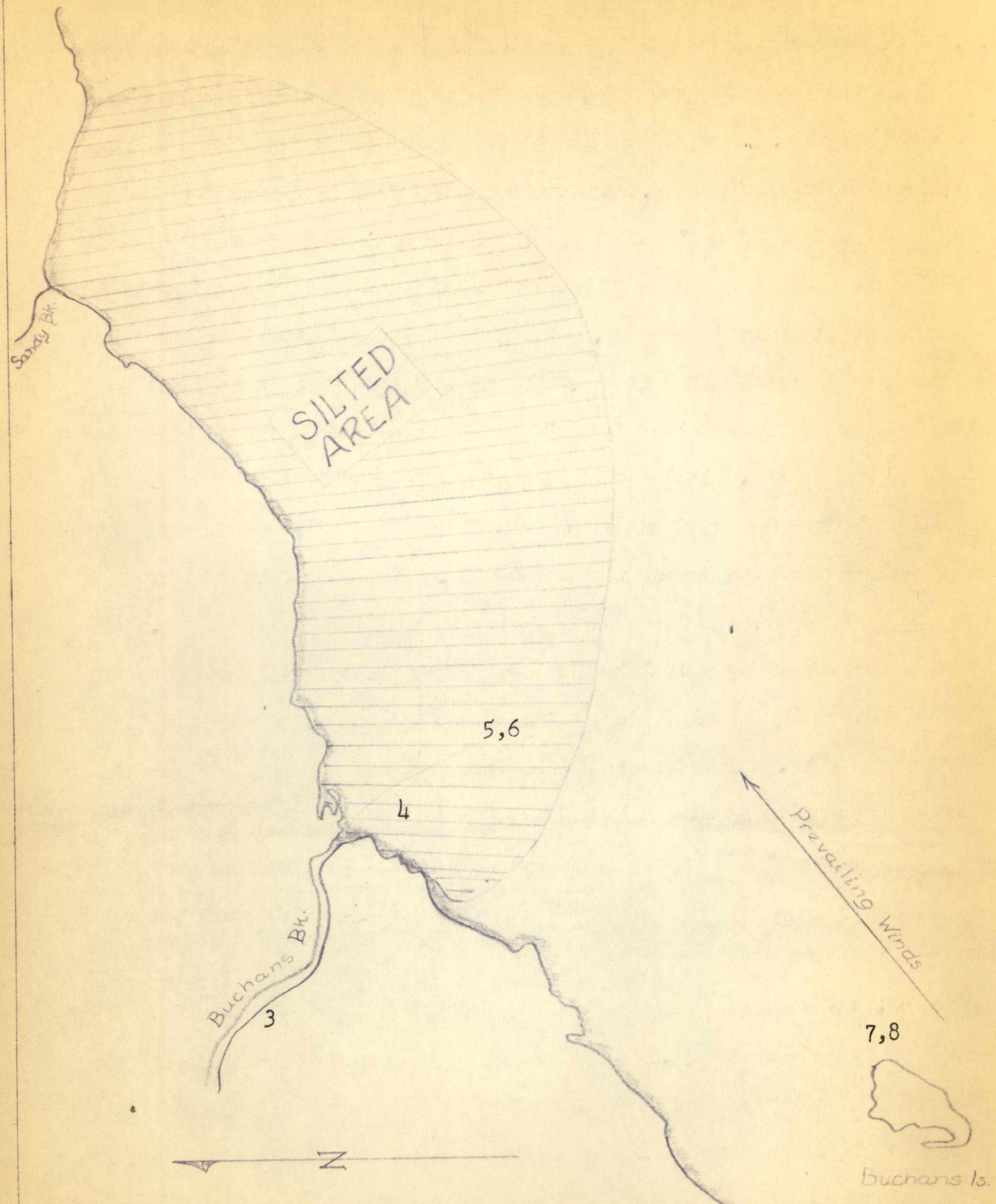
Red Indian Lake is a long narrow lake lying in a northeast, southwest direction. It has a mean length of 20.1 miles, a mean width of 1.9 miles, and an area of 70.3 square miles. The index of shoreline development is 3.42.

Soundings from the lake are incomplete due to poor weather conditions encountered, and the limited range of the depth recorder (300 ft.). Several soundings were taken using a lead, the deepest point located to date is 466 feet located 200 yards off Harbour Round Head. It is expected that future soundings will locate deeper water. Soundings carried out to date in the region from Buchans to the Exploits River indicate a moderate slope to a depth of 35 - 60 feet, followed by a rapid drop to a depth greater than 300 feet on the western shore. The eastern shore has a rapid drop to a depth of greater than 300 feet. A limited number of soundings were carried out at the southern end of the lake in the vicinity of Lloyd's River. The water in this region is relatively shallow, from Lloyd's River to a point approximately four miles north on the lake soundings indicated a depth of less than 300 feet. Soundings were not carried out beyond this point.

Observations carried out during a flight over the northern end of the lake from Millertown to Mary March's Brook indicated that the lake in this area is quite shallow, with a sand and gravel bottom. The entire lake is surrounded with sand and gravel beaches with the exception of the area near Harbour Round Head where the shore consists of cliffs dropping directly into the lake.

Pollution

The American Smelting and Refining Company operates a lead, copper, and zinc mine and concentrating mill at Buchans, 3½ miles west of Red Indian Lake. Tailings and mill effluent, as well as townsite (population 2,000) sewage, are emptied into Buchans Brook. Buchans Brook has a course of 4.6 miles to Red Indian Lake. When the mill is in operation a large silt suspension is present in Red Indian Lake. During the period of the writer's visit, the prevailing winds were southwest. Under these



DRAWN: W.D.S	DEPARTMENT OF FISHERIES, CANADA	DATE: 21/6/62
CHECK:	Silting, Red Indian Lake and Sample Locations, 1961.	SCALE: 1.25" = 1 Mile
APPROVED:		DWG. No.

REQ. 14-9513

conditions this stain covered an area from Buchans Brook to the east past Sandy River, a distance of 4½ miles long and several hundred yards wide. According to local residents, the extent and direction of this discoloured area depends on prevailing winds (Fig. 7).

Discussions were held with the manager, mill superintendent, and town manager concerning the operation of the mine and concentrating mill, and the disposal of town sewage. All concerned were most co-operative.

Tailings amount to 260,884 short dry tons per year. No analysis had been carried out by the Company on these tailings, an analysis of the ore was available (Table 6).

Table 6. Composition of Ore Mined by ASARCO at Buchans, Newfoundland

Constituent	Per Cent of Ore
$BaSO_4$	45.9
SiO_2	23.8
Al_2O_3	5.1
CaO	1.8
Copper	.09
Lead	.42
Zinc	1.23
Iron	3.5
Gold	.010 oz./ton.
Silver	.87 oz./ton.

The ore is concentrated by means of flotation. It is considered by the Company that reagents used for this purpose (Table 7) are not disposed of in the tailings. A customs rebate is received on them when the concentrated ore is shipped out of the country. It is assumed that these reagents are retained on the ore. The Company claims the pH of the tailings is 10.5 and pH of water used is 7.0.

Table 7. Flotation Chemicals Used by ASARCO At Buchans, Nfld.

Chemical or Reagent	Lbs. per Ton of Ore
Sulphur	1.2
Sodium Cyanido	.2
Zinc Sulphate	1.6
Reagent 301 (Butylalcohol, Carbon, Bisulphide, Sodium Hydroxide)	1.3
Thiocarbanalid	.06
Hydrated Lime	1.76
Dowfroth	.014
Crycellic Acid	.044
Copper Sulphate	.91
Isoprapyl Zanthate	.17
Sodium Bichromate	.76

There are no settling basins, the effluent is pumped directly from the mill into a ditch, tributary to Buchans Brook. The mill is closed on Sundays, there are 306 milling days in an average year (1960).

Townsite sewage is also emptied into Buchans Brook, It is carried by one 12-inch sewer and empties into the brook about four miles from the lake. The town manager informed the author that this sewer is 1/3 full at the peak hour (5:00 p.m.). There is no treatment of sewage. Water for the mill and municipal use is drawn from Buchans Lake located one mile north of the town, and the source of Buchans Brook. Water requirements for the mill are 1,500,000 gallons per day, for the townsite 250,000 gallons per day.

Some water samples were analyzed by the Industrial Waters Section, Department of Mines and Technical Surveys, Ottawa. Samples were collected on August 21, 1961, at the following Locations (Fig. 7):

Location No.	Location
1.	Mill tailings shoot #1.
2.	Mill tailings shoot #2.
3.	Buchans Brook, one mile from Red Indian Lake.
4.	Red Indian Lake, 200 yards off Buchans Brook.
5.	Red Indian Lake, 3/4 mile off Buchans Brook at surface.
6.	Red Indian Lake, 3/4 mile off Buchans Brook at 30 feet depth.
7.	Red Indian Lake, Buchans Island at surface.
8.	Red Indian Lake, Buchans Island at 30 feet depth.
9.	Exploits River, 3 miles below Badger Brook.
10.	Exploits River, below Exploits Dam.

Detailed results of analysis of these samples is given in Appendix 3. This analysis was not concerned with chemicals and reagents used for flotation purposes.

Mines and Technical Surveys reports that water samples taken at the effluent pipes are high in sulphates and highly mineralized containing copper, zinc, manganese, and lead, and a high ratio of pottasium to sodium, some of the metals are suspended or in a colloidal state. In Buchans Brook there is a decrease in pH and mineralization, there is still suspended matter and a significant pickup of metals has occurred. Zinc has risen to over 5 ppm and lead and iron have also increased. There are still indications of metals in suspension and as colloids. Further dillution occurs when these waters mix with Red Indian Lake. Proceeding across the lake, concentrations of all metals are very low, usually within the range of experimental error. Zinc remains at 0.3 ppm; there is evidence of colloidal zinc.

There is some indication that contaminated waters sink, sample 5 (3/4 mile off Buchans Brook) at the surface shows lower concentrations than sample 6 taken at the same location but at a depth of 30 feet. The water at the outlet of the Exploits River is typical of the surface waters of Newfoundland. The tailings effluents have high $KMnO_4$ values indicating the presence of organic matter or reducing substances. Waters other than the tailings effluents have a "fairly low and relatively constant" value.

Mines and Technical Surveys conclude that, under conditions existing at the time, contamination by heavy metals from the mine tailings has almost disappeared 3/4 mile out in the lake. It must be borne in mind that the samples were collected six hours after the mill reopened following a two day holiday. During this holiday no tailings were discharged. At the time of sampling, the turbid area in the lake covered a very small area, not more than 100 yards wide and one mile long. Local residents informed the author that under northeasterly winds the turbid area extends as far as Buchans Island.

Bottom samples were taken off Buchans Brook. Very fine sediments were stratified - a blue layer on top, a brown layer in the middle, and a gray layer on the bottom. When the material is exposed to the air it sets to a consistency of concrete. No analysis of this material was carried out.

The analysis carried out by the Department of Mines and Technical Surveys, Mines Branch, has the following precision:

Copper	±	0.02 ppm.
Zinc	±	0.03 ppm.
Lead	±	0.02 ppm.

It would appear that some pollution occurs in Red Indian Lake with regard to zinc. Under conditions of full operation, the silt covers large areas in the lake and would have a deleterious effect on fish in the area affected. The sampling programme carried out at Buchans was very brief and it would be advisable to carry out more extensive observations and analysis in the future.

Deer Lake

Geology and Geography

Deer Lake is located on the West Coast of the Island of Newfoundland. It is located nineteen miles from the sea on the Humber River. The Humber River is preglacial in origin, lying in an old zone of structural weakness. The lake lies in a northeast-southwest direction and has a regular shoreline. It lies at an altitude of seventeen feet.

The southern end of the lake is bounded by steep hills rising to a height of 1,450 feet within two miles of the southwestern shore and to a height of 1,550 feet within one mile of the southeastern shore. In the central section of the lake the hills are not as steep as in the southern section, particularly on the western shore where the land rises to 1,100 feet in a distance of three miles. The rise from the immediate shoreline is quite gradual. The eastern shore in this region,particularly near South Brook and Pasadena, is quite flat, rising only 250 feet in the first mile and a quarter. As one proceeds north, the hills come closer to the shore until at Little Harbour the land rises 1,000 feet in three-quarters of a mile. The northern end of the lake is low lying country with a very gentle slope rising to 250 feet in 3¼ miles, this is particularly true of the northwestern shore and the northern end of the lake. The northeastern shore has a more abrupt shoreline rising to 900 feet in one mile.

There are several small communities on the eastern shore of Deer Lake. South Brook, Pasadena, Midland, Little Harbour and Lake Siding. The town of Deer Lake (population 3,000) is located at the northern end of the lake. The village of Nicholsville is situated one-half mile from the lake on its main tributary, the Upper Humber River. The Trans Canada Highway follows the eastern shore of the lake.

Deer Lake lies predominately in a bed of Mississippian sediments (sandstones and sandstone derivatives). The southern end lies in a region of gneisses of undetermined age. There is a bed of Precambrian sediments outcropping on the southwest shore. The Upper Humber watershed drains a large area of gneisses in its upper half, the lower half lies in the Mississippian sediments of the Deer Lake and Humber formations. The Grand Lake drainage drains mainly the granites lying to the east of the lake.

The southwestern drainage from this lake lies in the gneiss and the northwestern in the Mississippian sediments of the Humber formation. The eastern drainage from Deer Lake lies in this same bed of gneiss.

Considerable driving takes place on Deer Lake. Logs are driven down the Upper Humber River and boomed at the mouth where it enters Deer Lake. The logs are then taken in booms down the Lake to a large holding boom at the southern end. Logging on this lake appears to be a well executed operation, however, after periods of wind large numbers of free drifting logs are encountered. It would appear that during periods of favourable winds (N to NE) the booms at the Upper Humber are opened and the logs set free to drift down the lake. This operation makes the lake treacherous for small boat operators. It must also add extra hazard to aircraft operating out of South Brook.

Drainage

Deer Lake drains an area of 2,650 square miles to the north and east of the lake. The drainage is from two separate sources, the Upper Humber River with an inflow (measured at Junction Brook) of 3,070 cfs., and from Grand Lake, the largest lake on the Island, through the Deer Lake powerhouse with a flow of 5,070 cfs.

The Upper Humber system drains the land to the north and northwest of the lake. It has a length of approximately 80 miles and drains an area of 800 square miles. Grand Lake drains the land to the east, northeast and southwast of Deer Lake, an area of 1,850 square miles. To the east this drainage meets the Red Indian Lake drainage. There are no major rivers flowing into this lake, however there are numerous brooks, 5 to 25 miles long, flowing into the eastern shore. Drainage is somewhat less from the west of this lake. Grand Lake originally flowed into the Upper Humber system through Junction Brook. In 1925 Bowaters Newfoundland Company dammed Junction Brook at Grand Lake and diverted the waters through the Humber Canal to the then newly constructed Deer Lake powerhouse. This is the largest powerhouse in Newfoundland, with a capacity of 156,000 horsepower.

There are several other tributaries flowing into Deer Lake. On the western shore there is North Brook, and its main tributary Coal Brook, as well as six other short brooks less than five miles in length. On the eastern shore there are five small brooks, the longest of which is South Brook, eight miles long.

The outflow is by the Humber River to the Humber Arm of Bay of Islands, a distance of eleven miles.

Morphometry

Deer Lake has a regular shoreline of boulders, rubble, sand and gravel. The index of shoreline development is 2.5. There are sand and gravel beaches particularly on the eastern shore in the vicinity of South Brook. The lake has a mean length of 11 miles and a mean width of 1.4 miles, The area is 22 square miles. Maximum depth is 310 feet, the mean depth is 145 feet and the volume is $95,001 \times 10^6$ cubic feet. This volumetric data was obtained from soundings taken during a brief survey in 1958.

Unfortunately the depth recorder was inoperative during our survey of this lake and complete soundings could not be obtained. Bottom samples indicated that the bottom is brown mud with considerable bark material in it. Heavy weather on this lake disturbs large amounts of bark fiber. This was noticed adhering to gill nets after strong winds.

George's Lake

Geology and Geography

George's Lake is located on the West Coast of the Island about fifteen miles south of the town of Corner Brook. It lies at an altitude of 487 feet. The surrounding country consists of rounded hills rising to altitudes between 750 and 1,000 feet within one-half mile of the lake. In the southern section these hills drop quite abruptly into the lake.

The area to the northwest of the lake has, in the past, been logged. At present, however, no logging is carried out and all that remains of the operation are the railway tressels and boom piers in the north west bay. The country surrounding the lake is well wooded with black spruce and balsam fir.

The Canadian National Railway main line skirts the western shore of the lake. Two small communities are located on this line, George's Lake and Spruce Brook. There are several summer cottages at the north eastern end of the lake. The Trans Canada Highway skirts the shore of a bay located on the eastern shore which will be referred to as Eastern Bay.

George's Lake lies in a bed of Ordovician sedimentaries of the Humber Arm formation. These are sandstones and sandstone derivatives. Spruce Brook, flowing from the west of the lake, drains Ordovician sediments of the St. George's formation. This formation is the only limestone on the island. According to Mr. H. Lilly of the Department of Geology, Memorial University of Newfoundland, these are very hard dolomitic limestones and not very soluble. He says that kettles boiled for long periods using these waters never become coated with slaked lime, which is so common in hard water regions. It is possible that the headwaters of Pinchgut Brook also lie in a small region of St. George's sediments lying northeast of the lake. A fault runs across the northern end of the lake in a northeast-southwest direction. This undoubtedly accounts for the very deep water in this region (288 feet).

Drainage

George's Lake lies on the Harry's River system. It is fed by several small streams, the largest of which are Spruce Brook flowing from the west, and Pinchgut Brook flowing from the east. These are eight and twelve miles long respectively. On the western shore there are two other short brooks both less than five miles in length. A brook seven miles long flows into the northern tip of the pond. On the eastern shore there are three short brooks (excluding Pinchgut). These are each less than three miles long.

The outflow is through Harry's River to St. George's Bay, a distance of 23 miles.

Morphometry

George's Lake has a somewhat irregular shape. The shoreline is quite regular, having an index of development of 2.21. It lies in a northeast-southwest direction. There are three bays at the northern end, a bay on the western shore, and also directly across on the eastern shore. There is a long narrow bay at the northwest corner of the lake. There are two islands, one at the entrance of the western bay and one at the entrance of the eastern Bay.

The lake has a mean length of 3.1 miles and a mean width of .9 miles. The area is 6.27 square miles. The maximum depth is 296 feet, the mean depth is 138.2 feet, and the volume is 23,171.2 x 10^6 cubic feet. Volumes under the various depths are included in Table 8.

Table 8. Volume of George's Lake Under Various Depth Strata and Per Cent of Total Volume of the Lake.

Depth in Feet	Volume Under Given Depth in Cubic Feet	Per Cent Total Volume
Surface	$23,171.2 \times 10^6$	100
30	$18,339.6 \times 10^6$	79
60	$12,794.2 \times 10^6$	55
90	$9,042.8 \times 10^6$	39
180	$1,974.6 \times 10^6$	9
270	88.3×10^6	.4

The lake is very deep and the drop-off from shore is rapid. This is evidenced by the fact that 79 per cent of the lake is below a depth of 30 feet. A deep channel lies in the approximate center of the lake and runs for about one-half the length of the lake (-288 feet). The only shallow water is to be found in the western and northern bays, with a maximum depth of 60 and 30 feet respectively. An extensive outwash fan of sand has built up off the entrance of Spruce Brook. The drop-off the edge of this fan is very abrupt. There is an area of shallow water between the island and the mainland at the entrance to the eastern bay.

Butt's Pond

Geology and Geography

Butt's Pond is set in a depression among low hills. The highest being 681 feet and lying 3½ miles west of the lake. The pond lies at an altitude of approximately 150 feet. The land to the north, east, and south of the lake consists of low hills rising to 250 feet. The surrounding country is well wooded with black spruce; birch has grown in where the spruce has been cut over.

The lake lies in an outcrop of gneisses. With the exception of these gneisses the entire Middle Brook drainage, of which Butt's Pond is a part, lies in granitic rocks.

Drainage

Butt's Pond is located 2.4 miles from tidehead on Middle Brook. Middle Brook has an east to west drainage flowing into Freshwater Bay, an arm of Bonavista Bay. Middle Brook has an overall length of 30.3 miles and a drainage area of approximately 115 square miles. Butt's Pond is the first of five major lakes on the Middle Brook drainage (Table 9).

Table 9. Major Lakes in Middle Brook Drainage, Distance from Tidehead, and Distance Between Lakes.

Lake	Distance from Tidehead (miles)	Distance Between Lakes (miles)
Butt's Pond	2.4	-
Square Pond	5.8	.5
1st. Burnt Pond	11.6	1.3
2nd. Burnt Pond	19.4	3.9
Rodney Pond	24.8	2.4

Morphometry

The pond may be broken into four regions on the basis of its shape. The Main Body, Northern, Southeastern, and Southwestern Arms. The Northern Arm points due north, the other two arms lie at angles of approximately 120 degrees to it.

Butt's Pond has a mean length of 0.9 miles, and a mean width of 0.6 miles. The area is approximately 50.1×10^6 square feet (1.8 square miles), the volume is $1,830 \times 10^6$ cubic feet. The volumes under the various depth strata are included in Table 10. The maximum depth is 25 meters, the average depth is 11.6 meters. The maximum depth occurs in an isolated deep pocket in the southern end of the main body of the lake. There is another deep pocket of 23 meters in the central region of the main body of the lake. The lake drops rapidly to a depth of five meters with the exception of the Northern and Southwestern Arms where the drop is not so pronounced. In the Southwestern Arm the maximum depth is two meters. The inflow into

Table 10. Volume of Butt's Pond Under Various Depth Strata and Per Cent of Total Volume of the Lake.

Depth Meters	Volume Under Given Depth (Cu.Ft.)	Per Cent Total Volume	Depth in Feet
Surface	1830×10^6	100.00	Surface
5	110.0×10^6	6.00	16.6
10	38.6×10^6	2.10	33.2
15	17.4×10^6	.94	49.8
20	4.2×10^6	.23	66.4
25		.00	83.0

Butt's Pond enters at the base of this arm. The Southeastern Arm is moderately deep (maximum depth 20 meters); the outflow from the lake is at the head of this arm. The Northern Arm has a maximum depth of five meters. There are extensive areas of shallow water (under five meters deep) on the eastern shore of the main body of the lake. Large numbers of mature Arctic Char were located in a shallow bay in this region.

There is a small lake approximately 100 yards to the west of the Northern Arm, it is in communication with Butt's Pond by a small brook. This brook has laid down an extensive fan of sand at its outflow. This lake was not sampled although many small char were taken at its outflow.

The bottom of the main lake in the areas sampled varies from rubble and gravel in the shallows to black muck as in Table 11.

Table 11. Bottom Materials in Areas Sampled, Butt's Pond

Depth in Meters	Bottom Type
1	Rubble and gravel
4	Rubble
8	Sand and small rubble
15	Sand and small rubble
25	Black muck

The index of shore development is 2.7 (Appendix 4). The shoreline consists of rubble to boulder sized materials. There are two areas of sand flats, one at the outflow of the stream on the western shore of the Northern Arm, and one at the head of a small bay on the eastern shore. There is an area of mud and detritus at the mouth of the Southwestern Arm.

Temperature

Thermal stratification of lakes under summer conditions is the accepted rule. This stratification is brought about by the warming of surface waters, as a result of this warming a decrease in density takes place. This decrease in density of warm surface waters causes them to float upon cooler, denser sub-surface waters. Wind action is now unable to mix these surface waters due to thermal resistance. This phenomenon results in the formation of three temperature zones. The epilimnion consist of warm surface waters, the temperature is relatively constant through the depth of the epilimnion. The thermocline is the zone in which a rapid decrease in temperature takes place through a narrow zone of depth. Birge (1904) defines the thermocline as the zone where the fall in temperature with increasing depth from the surface is at least 1°C. per meter (0.548°F. per foot). The hypolimnion is the zone lying below the thermocline in which the water maintains a relatively constant temperature to the bottom. Under ideal conditions the temperature of hypolimnion approaches 4°C. (39.2°F.).

Reference to Figures 8 to 13 will indicate that this thermal stratification is evident in only two of the lakes investigated - Ocean Pond and Gambo Pond North. In these two waters this stratification may only be a temporary affair. It will be noted that the difference in temperature between the surface and the bottom is very small (maximum difference 12°F.). In particular the bottom temperatures are very high, the minimum recorded was 51°F. in George's Lake, the average bottom temperature was 58.7°F. This very small temperature difference between surface and bottom, and high

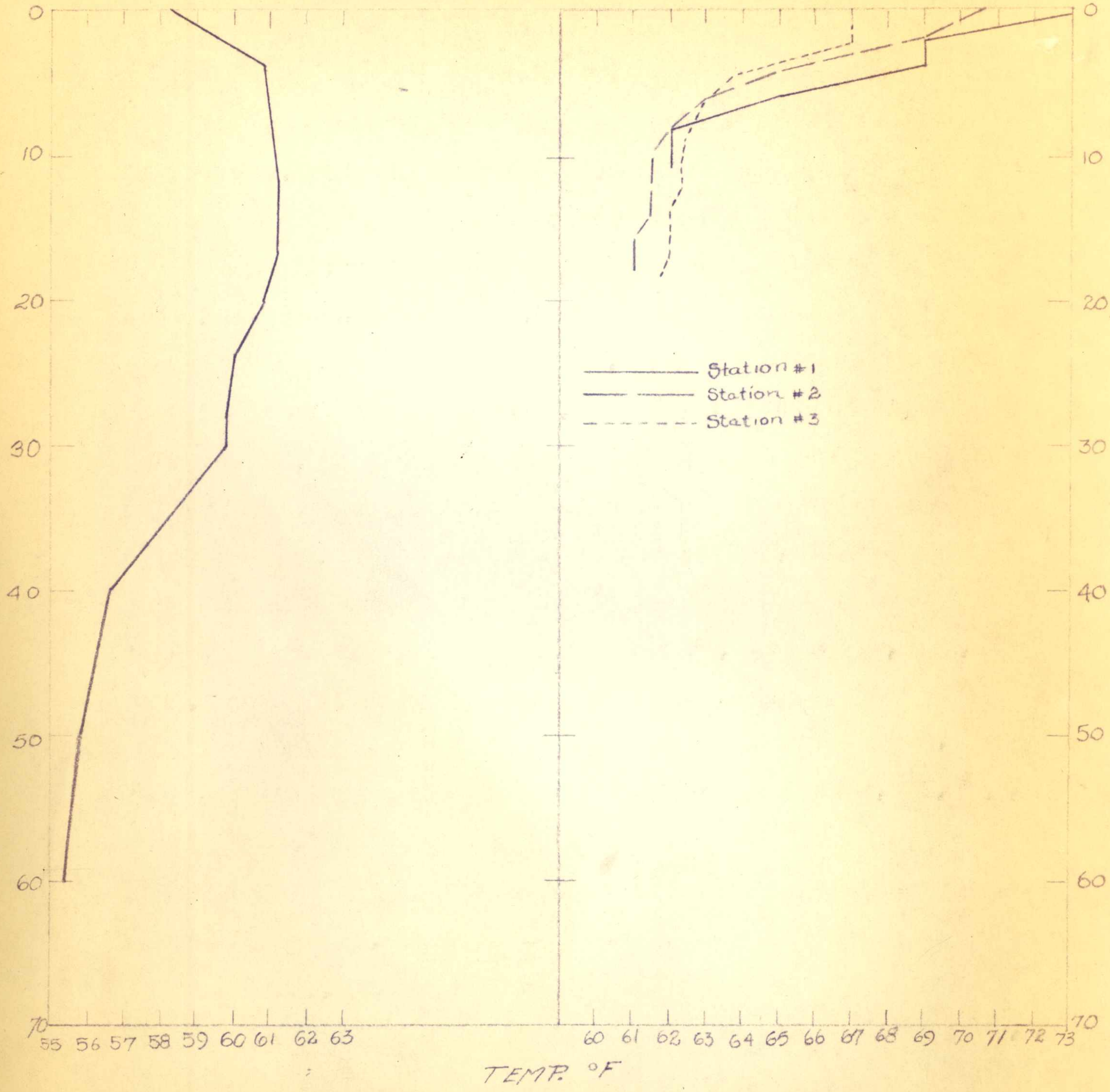


Fig. 8 Temperature Dildo Pond

June 27, 1961

Fig. 9 Temperature Ocean Pond

June 21, 1961.

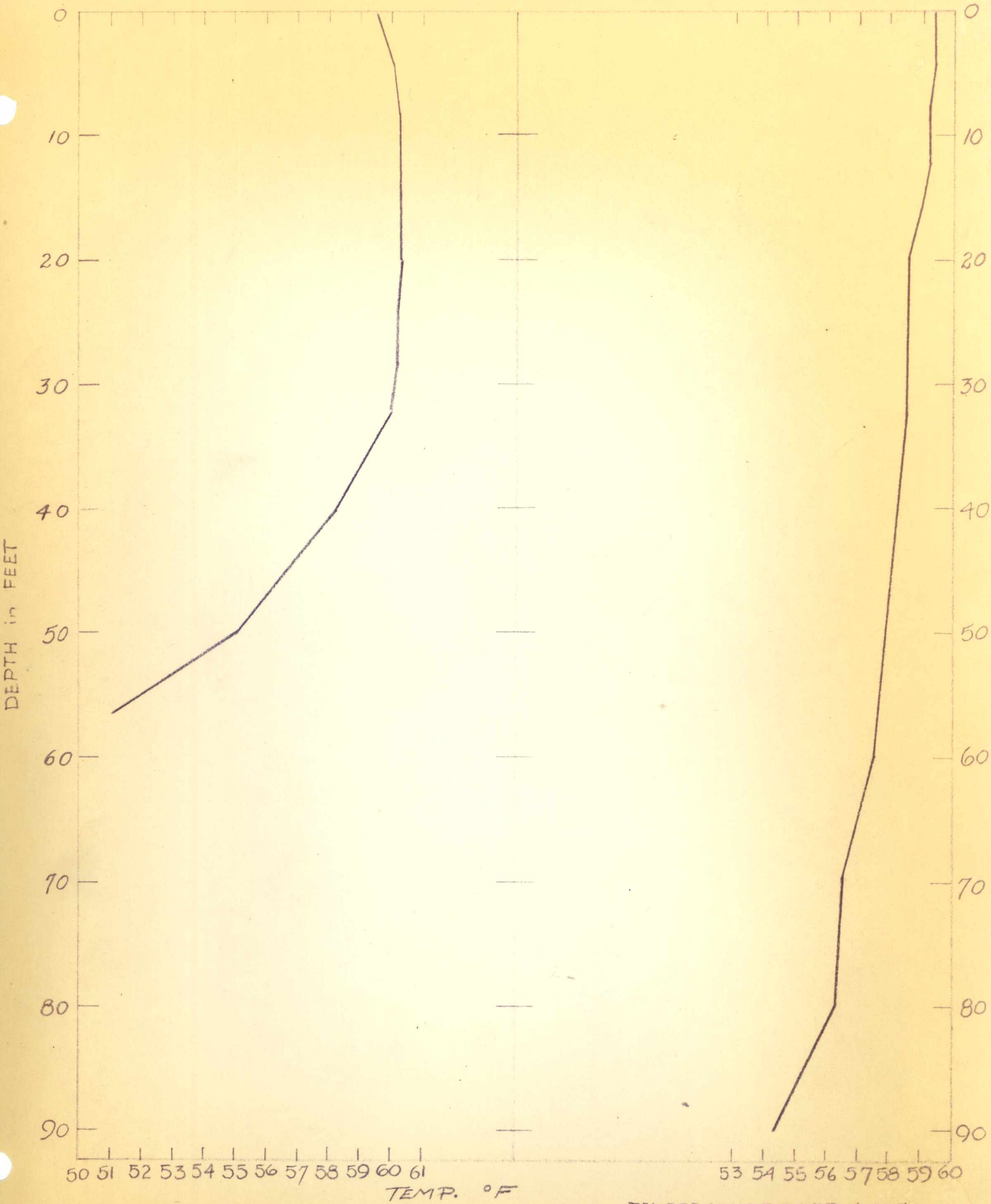


Fig 10 TEMPERATURE GEORGES LAKE
15 SEPT. 1961

Fig 11 . TEMPERATURE DEER LAKE
15 SEPT. 1961

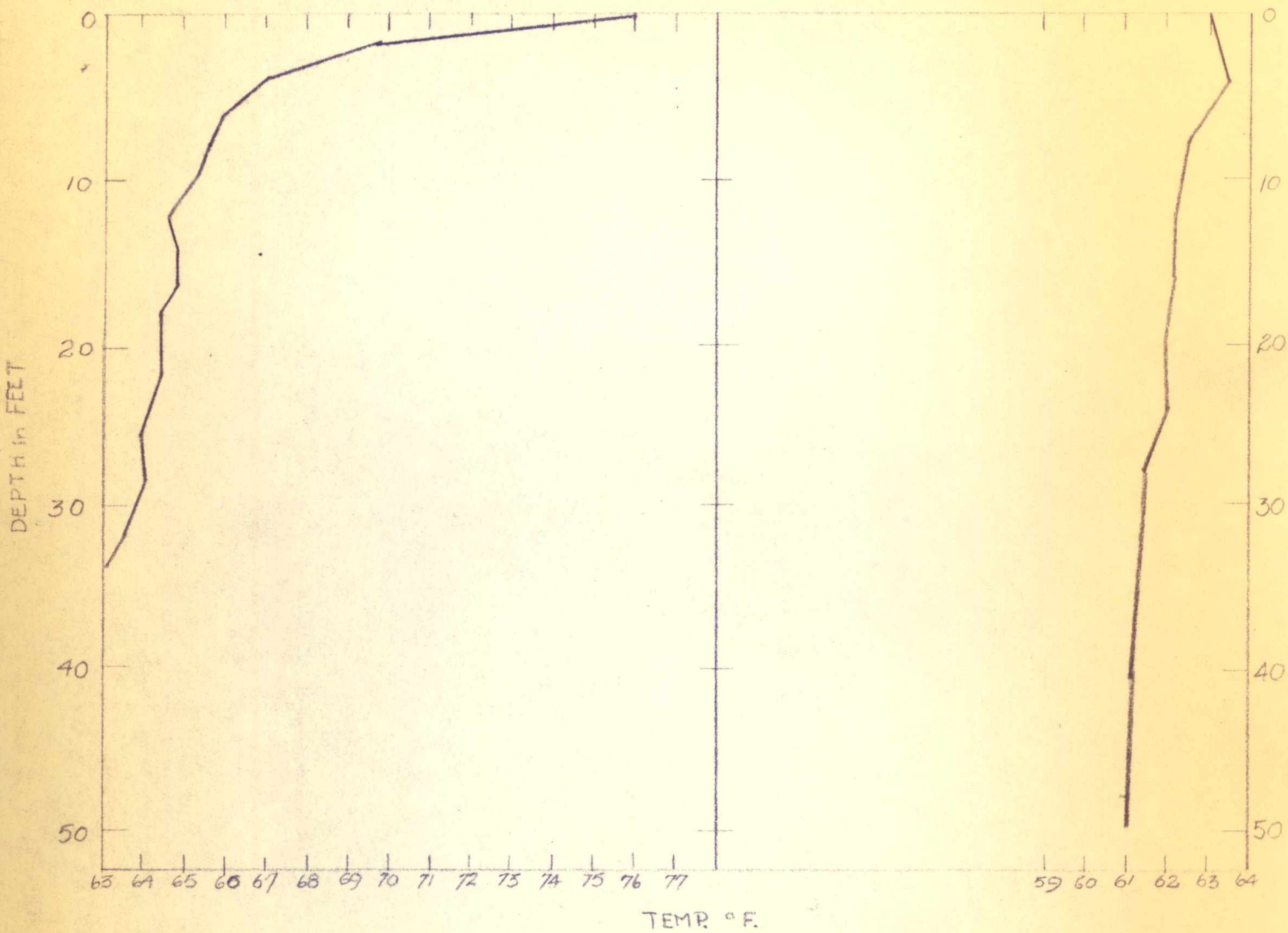


Fig. 12 Temperature Gambo Pond North

8 July 1961

Fig. 13 Temperature Gambo Pond South

13 July 1961

bottom temperature is not conducive to thermal stratification. There is not a great enough contrast between the surface waters and the bottom waters to set up a thermal resistance to the continuous circulation of surface and bottom waters (overturn). Under the action of prevailing summer winds, the lakes investigated appeared to be in a continuous state of overturn. These conditions will constantly replace the bottom waters and summer stagnation should not take place.

Climatic conditions peculiar to the Island of Newfoundland are undoubtedly responsible for the unusual conditions arising in the lakes. Spring weather is cool, there is no sharp transition between cool early spring weather and hot late spring and early summer weather. The summers are cool. Wind velocities are high and relatively constant, few days are wind free. In addition to these climatic factors the lakes are oriented with their long axis in a northeast-southwest direction, which is the direction of the prevailing spring and summer winds.

Table 12 indicates that during summer of 1961 temperatures were above normal for St. John's and Gander, although April and May were slightly below normal. Winds were well below normal for St. John's, at Gander winds were slightly above normal for April, May and June, and below normal for July, August and September. Rainfall was well below normal at both locations. These climatic conditions would favour stratification, if such were to exist.

Table 12. Temperature, Winds, and Precipitation for April-September, 1961, as Contrasted to Ten Year Average for St. John's and Gander, Nfld.

Month	Temperature of		Wind in Miles		Precipitation in inches	
	1961	Normal	1961	Normal	1961	Normal
ST. JOHNS						
April	31.6	34.5	10759	11349	4.74	4.77
May	40.7	42.2	10945	10899	3.61	3.88
June	55.1	50.1	9691	10166	1.45	3.72
July	59.6	59.7	9443	10097	1.60	3.49
August	61.0	60.0	9808	10595	1.57	4.00
September	55.3	53.8	10240	10619	2.01	4.71
GANDER						
April	33.2	33.7	11694	10139	3.51	2.73
May	44.9	43.8	11755	9742	1.78	2.43
June	57.3	52.8	10569	9264	1.77	3.04
July	61.6	62.3	7322	8407	.82	3.20
August	63.4	61.0	7815	8622	2.06	3.78
September	55.6	54.0	8474	9557	2.46	3.35

Total Dissolved Solids (T.D.S.)

The importance of total dissolved solids (T.D.S.) to the standing crop of plankton and bottom fauna was established by Northcote and Larkin (1956). They point out that a high T.D.S. will increase the possibility of necessary carbonates, bicarbonates, and trace elements being present. T.D.S. values from the lakes investigated in 1961 are very low. Table 13 indicates a range of 19.6 ppm to 86.0 ppm. These values are in line with what might be expected from a region of hard rocks such as this. Values of 77.5 ppm and 75.0 ppm from George's Lake would indicate some small influence from the dolomitic limestones of the St. George's formation. These limestones are very hard and would appear to be only slightly soluble. High values for Red Indian Lake at Star River may be due to the intermediate and basic rocks in which this drainage lies.

Table 13. pH and Total Dissolved Solids for Lakes Investigated During 1961 Field Season

Date	Location	pH	Temp. °F.	Specific Conductance Micromhos	Converted to 77°F.	T.D.S. (ppm.)
June 25/61	Ocean Pond	6.65	77	34	34.0	31.6
July 4	Dildo Pond	6.9	76	30	30.4	29.1
July 7	Gambo Pond	6.6	76	24	24.3	24.5
Aug. 1	Red Indian Lake (1)	6.5	76	27	27.3	26.7
Aug. 2	Red Indian Lake (2)	6.5	76	108	109.4	86.0
Aug. 15	George's Lake (1)	6.5	74	90	93.5	75.0
Aug. 15	George's Lake (2)	7.55	73	92	96.8	77.5
Sept. 15	Deer Lake	6.7	74	37	38.4	34.6
Oct. 28	Butt's Pond	6.7	75	17	17.6	19.6
Nov. 3	Square Pond	6.95	75	17	17.6	19.6
Apr. 21/62	Hogans Pond	6.3	71	41	42.0	37.3

pH values for all waters, with the exception of George's Lake (2) was below 7. The George's Lake (2) sample was taken at the mouth of Spruce Brook. The higher value here, 7.5, was probably because this river drains the limestones of the St. George's formation. Acid water conditions generally encountered are due in part to the numerous bogs which drain into these lakes and to the acidic rocks on which the drainages lie.

Fishes

Table 14 records the species of fish taken from the various lakes investigated during 1961. Netting was carried out at all depths, however, the twenty to forty foot range was concentrated upon as this seemed to be the most productibe of fish.

A sample of Microgadus tomcod taken from Deer Lake confirms the record of Jeffers (1932) of Microgadus in freshwater in Newfoundland. Three tomcods were netted at a depth of 50 feet just off South Brook. This location is approximately fifteen miles from salt water.

A population of very large smelt (Osmerus mordax) were taken from Deer Lake. The largest of these smelt was 27 cms. ($10\frac{3}{4}$ inches). Preliminary scale readings indicate that these smelt are non-migratory.

Table 14. Species of Fish Taken in Lake Investigations, 1961

Lake	Salmo salar	Salmo trutta	Salvelinus fontinalis	Salvelinus alpinus	Osmerus mordax	Coregonus clupeaformis	Microgadus tomcod	Anguilla rostrata	No. Net Sets
Hogans Pond						4			3
Ocean Pond	114		3						4
Dildo Pond	7	8							5
Gambo Pond (S)	4		3	3					2
Gambo Pond (N)	70		7						5
Red Indian Lake 1/	82		53						4
Georges Lake			4	3				1	3
Deer Lake	25		1	19	36		4		3
Butts Pond 2/	84	1	47	135	21				7
Square Pond	49		31	1					6

1/ One lb. landlocked salmon have parr marks visible, some smolts with red ventral fins. Largest landlocked salmon taken $8\frac{1}{2}$ lbs.

2/ Arctic Char range from several ounces to $7\frac{1}{2}$ lbs. In all other lakes Arctic Char taken were less than 1/2 lb. All brook trout were sea run.

The Eastern Brook Trout (Salvelinus fontinalis) was most common, being netted from 8 of the 10 lakes investigated, this was followed closely by the landlocked salmon or ounaniche (Salmo salar). The Arctic char (Salvelinus alpinus) was found to be more widely distributed than was previously known. Species of sticklebacks were observed in warm quiet areas in most ponds and lakes investigated. The brown trout (Salmo trutta) was originally introduced to the Avalon Peninsula, particularly the St. John's region, in 1886. It is interesting to note that this fish has now apparently moved into central Newfoundland as indicated by the Butt's Pond sample. The whitefish (Coregonus clupeaformis) was introduced at the same time (1886) and has apparently not moved out of the ponds into which it was originally introduced. The rainbow trout (Salmo gairdneri) was planted extensively throughout the Avalon Peninsula at the same time, it appears to have not adapted except in a few ponds to the east and northeast of St. John's.

Fish which are native to the Island of Newfoundland are either anadromous or catadromous, or have anadromous varieties, One might speculate on the cause of such an occurance. Newfoundland was completely covered by ice during the last glaciation, all preglacial fish life was undoubtedly exterminated. Those fish, which were adapted to live only in fresh water, could not re-invade the Island. It was left, therefore, for fish who had retained the anadromous or catadromous habit to re-invade the island waters.

Salmon and chars from all waters investigated were heavily parasitized with Cestodes in the stomach and pyloric caecae and with Acanthocephalans in the intestines.

CONCLUSION

The lakes of the Island of Newfoundland are oligotrophic. Numerous shallow ponds exist, however, the total dissolved solids content of the waters is very low. Using T.D.S. as an indicator of productivity, these lakes would appear to have a low productivity and as such are oligotrophic.

The apparent lack of temperature stratification in these ponds will have an effect on the movement of fish through the waters. It will allow cold water fish to approach the surface particularly during dull weather and the hours of sunset, sunrise and darkness. This will account for the success of fly fishing and shallow water spinning in these ponds.

A great need in our waters is for a forage fish. A rapid growing, plankton feeding species to be used as prey by the present salmonoid populations. Investigations should be carried out on the productivity of our waters to determine their suitability for such a species. Deep water fish are also conspicuously absent. Qualitative and quantitative investigations of bottom fauna would determine the suitability of our lakes to support bottom feeding fish. The only bottom feeder on the Island at present is the whitefish (*Coregonus clupeaformis*) in Hogan's Pond.

We are particularly fortunate in both the size and kind of our freshwater fish stocks at present. There is no competitor for the salmonoid fishes presently resident in our lakes. Every effort should be made to prevent the introduction of unwanted species to the Island, particularly those bait species so widely used on the mainland (e.g. chub minnows) which can successfully compete with our resident trout. As tourist fishing pressure increases, so will the chance of such an accidental introduction.

SUMMARY

1. Investigations were carried out on nine lakes on the Island of Newfoundland during 1961.

2. Sounding, netting, and water sampling was carried out on all lakes investigated.

3. Maps constructed from sounding data are of an accuracy suitable for biological investigations.

4. Lakes situated on the high central plateau lie in shallow depressions scooped out by glacial action.

5. Deep lakes such as Gambo Pond South and Red Indian Lake, Deer Lake and St. George's Lake lie in preglacial river valleys or fault zones modified by glaciation.

6. Thermal stratification is not common in the lakes investigated due to cool climate and constant wind.

7. Total dissolved solids are very low. The island is composed almost entirely of resistant rock. This would indicate low productivity. The lakes investigated are oligotrophic.

8. pH values are all below 7 with an exception on George's Lake. All lakes drain bogs and lie over acidic rocks resulting in acid waters.

9. Atlantic Salmon, Eastern Brook Trout, Arctic Char, Brown Trout, Smelts, Tomcods, Whitefish and Eels were netted.

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MORPHOMETRIC DATA FROM LAKES INVESTIGATED 1961

Lake	Mean Length (miles)	Mean Width (miles)	Area X10⁶ sq. ft.	Maximum Depth feet	Mean Depth feet	Volume X10⁶ cu. ft.	Index Shoreline Development
Hogan's Pond	.27	.22	6.47	35	16	108.6	2.5
Ocean Pond	3.2	.32	35.5	32	15	525.9	4.36
Dildo Pond	2.5	.42	4.21	70	32	1376.7	2.07
Gambo Nortn	6.5	.40	108.4	46	22	2356.4	2.68
Gambo South	4.7	.60	130.6	140	65	8626.3	2.6
Red Indian	20.1	1.9	1954.3	466*			3.2
Deer	11.0	1.4	611.6	310	145	95001.0	2.5
George's	3.1	.9	176.4	296	138	23171.2	2.2
Butts Pond	.9	.6	50.1	83		1830	2.7

* Maximum depth sounded to date.

APPENDIX 2

Determination of Shoreline Development and Volume.

Shoreline Development $\dfrac{S}{\sqrt{A\pi}}$ S - perimeter
A - area
π - 3.142

Volume - Mean Depth x Area

Mean Depth - Maximum depth x .467 (Newman, 1959).

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

MINES BRANCH
MINERAL PROCESSING DIVISION

INDUSTRIAL WATERS SECTION
40 Lydia Street, Ottawa, Ont.

ANALYSIS OF WATER SAMPLE(S)

(In parts per million)

Location	Near Buchans, Newfoundland		
Source of Water	Mine Tailings Shoot #1	Mine Tailings Shoot #2	Buchan's Brook
Sampling point	At outlet pipe	At outlet pipe	From middle of Brook below outlet from mine
Reference	V.R. Taylor, Dept. of Fisheries		
Laboratory number	5969	5970	5964
Date of sampling	Aug. 21/61	Aug. 21/61	Aug. 21/61
Storage period (days)	51:53	51:53	51:53
Temp. at sampling (°C)	18.9	18.9	18
Temp.at Testing (°C)	23.6	23.8	22.2
Appearance, odour, etc.	Heavy ppte	Heavy ppte	Heavy black ppte
Oxygen consumed ($KMnO_4$)	10.	35.	2.6

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ANALYSIS OF WATER SAMPLE(S)

(In parts per million)

pH		7.7	7.7	6.7
Alkalinity as $CaCO_3$	(-Phenolphthalein	0.0	0.0	0.0
	(-Total	12.0	11.4	20.7
Conductance, micromhos at 25°C		537.	512.	105
Hardness as $CaCO_3$	(Total	213	197	39.1
	(Non-carbonate	201	186	18.4
Sodium	(Na)	16.0	16.3	1.7
Potassium	(K)	10.0	8.5	0.5
Iron (Fe)	Total	0.01	Trace	0.54
	Dissolved	-		Trace (filt. sample)
Manganese (Mn)	Total	-	-	0.30
	Dissolved	0.33	0.38	0.21
Copper (Cu)	T & D	0.25 : 0.09	0.23 : 0.09	0.06:0.03
Zinc (Zn)	T & D	0.18 : 0.16	0.20 : 0.15	5.6 :5.3
Lead (Pb)	T & D	0.53 : 0.36	0.48 : 0.40	0.64:0.40

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ANALYSIS OF WATER SAMPLE(S)

(In parts per million)

Carbonate	(CO_3)	0.0	0.0	0.0
Bicarbonate	(HCO_3)	14.6	13.9	25.2
Sulphate	(SO_4)	154.	151.	23.7
Chloride	(Cl)	72	56	2.0
Nitrate	(NO_3)	-	-	0.0
Silica	(SiO_2)	2.5	2.4	3.6

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ANALYSIS OF WATER SAMPLE(S)

(In parts per million)

Location	Near Buchans, Newfoundland		
Source of water	Red Indian Lake	Red Indian Lake	
Sampling point	200 yds. from mouth of Buchan's Brook	3/4 mile from mouth of Buchan's Brook at surface	3/4 mile from mouth of Buchan's Brook at 30 ft. depth
Reference	V. R. Taylor, Dept. of Fisheries		
Laboratory number	5962	5963	5965
Date of sampling	Aug. 21/61	Aug. 21/61	Aug. 21/61
Storage period (days)	51:53	51:53	51:53
Temp. at sampling (°C)	18.9	16.	16.4
Temp. at testing (°C)	23.7	23.7	21.9
Oxygen consumed ($KMnO_4$)	3.8	4.8	4.6

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

MINES BRANCH
MINERAL PROCESSING DIVISION

INDUSTRIAL WATERS SECTION
40 Lydia Street, Ottawa, Ont.

ANALYSIS OF WATER SAMPLE(S)

(In parts per million)

pH		6.7	6.3	6.6
Turbidity (Units)		3	0	3
Alkalinity as $CaCO_3$	(-Phenolphthalein	0.0	0.0	0.0
	(-Total	9.4	4.1	5.2
Conductance, michomhos at 25°C		62.9	28.6	32.1
Hardness as $CaCO_3$	(Total	22.4	9.7	10.8
	(Non-carbonate	13.0	5.6	5.6
Sodium (Na)		2.2	1.3	1.4
Potassium (K)		0.3	0.2	0.2
Iron (Fe)	Total	0.17	0.10	0.30
	Dissolved	0.06	Trace	0.05
Manganese (Mn)	Total	-	-	-
	Dissolved	0.11	0.05	0.04
Copper (Cu)	T & D	0.02:0.02	0.03:0.03	0.07:0.05
Zinc (Zn)	T & D	0.59:0.51	0.32:0.27	0.36:0.36
Lead (Pb)	T & D	0.07 -	0.11: -	0.02: -

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

MINES BRANCH
MINERAL PROCESSING DIVISION

INDUSTRIAL WATERS SECTION
40 Lydia Street, Ottawa, Ont.

ANALYSIS OF WATER SAMPLE(S)

(In parts per million)

Carbonate	(CO_3)	0.0	0.0	0.0
Bicarbonate	(HCO_3)	11.5	5.0	6.3
Sulphate	(SO_4)	11.7	3.7	4.0
Chloride	(Cl)	2.7	2.5	2.5
Nitrate	(NO_3)	Trace	0.0	Trace
Silica	(SiO_2)	3.9	2.1	2.0

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

MINES BRANCH
MINERAL PROCESSING DIVISION

INDUSTRIAL WATERS SECTION
40 Lydia Street, Ottawa, Ont.

ANALYSIS OF WATER SAMPLE(S)

(In parts per million)

Location	Near Buchans, Newfoundland			
Source of water	Red Indian Lake off Buchan's Island		Exploits River	
Sampling point	At surface	At 30 ft. depth	Below dam at Red Indian Lake	4 miles below Badger Brook
Reference	V. R. Taylor, Dept. of Fisheries			
Laboratory number	5961	5966	5967	5968
Date of sampling	Aug. 21/61	Aug. 21/61	Aug. 19/61	Aug. 21/61
Storage period (days)	51:53	51:53	53:55	51:53
Temp. at sampling (°C)	-	15.5	17.	20.5
Temp. at testing (°C)	23.7	23.4	23.4	23.4
Oxygen consumed ($KMnO_4$)	5.4	4.4	4.4	4.8

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

MINES BRANCH
MINERAL PROCESSING DIVISION

INDUSTRIAL WATERS SECTION
40 Lydia Street, Ottawa, Ont.

ANALYSIS OF WATER SAMPLE(S)

(In parts per million)

pH		6.4	6.2	6.4	6.4
Turbidity (Units)		0	0	0	0
Alkalinity as $CaCO_3$	(-Phenolphthalein	0.0	0.0	0.0	0.0
	(-Total	5.0	4.4	4.5	4.6
Conductance, micromhos at 25°C		30.8	28.0	26.7	27.1
Hardness as $CaCO_3$	(Total	9.7	9.0	8.6	9.3
	(Non-carbonate	4.7	4.6	4.1	4.7
Sodium (Na)		1.6	1.4	1.5	1.5
Potassium (K)		0.4	0.2	0.7	0.2
Iron (Fe)	Total	0.06	0.06	0.05	0.08
	Dissolved	Trace	Trace	0.0	Trace
Manganese (Mn)	Total	-	-	-	-
	Dissolved	0.03	0.02	0.02	0.02
Copper (Cu)	T & D	0.02:0.02	0.05:0.05	Trace:0.0	0.01:0.0
Zinc (Zn)	T & D	0.28:0.26	0.27:0.27	0.16:0.15	0.13:0.13
Lead (Pb)	T	0.0: -	Trace: -	0.0: -	0.01: -

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

MINES BRANCH
MINERAL PROCESSING DIVISION

INDUSTRIAL WATERS SECTION
40 Lydia Street, Ottawa, Ont.

ANALYSIS OF WATER SAMPLE(S)

(In parts per million)

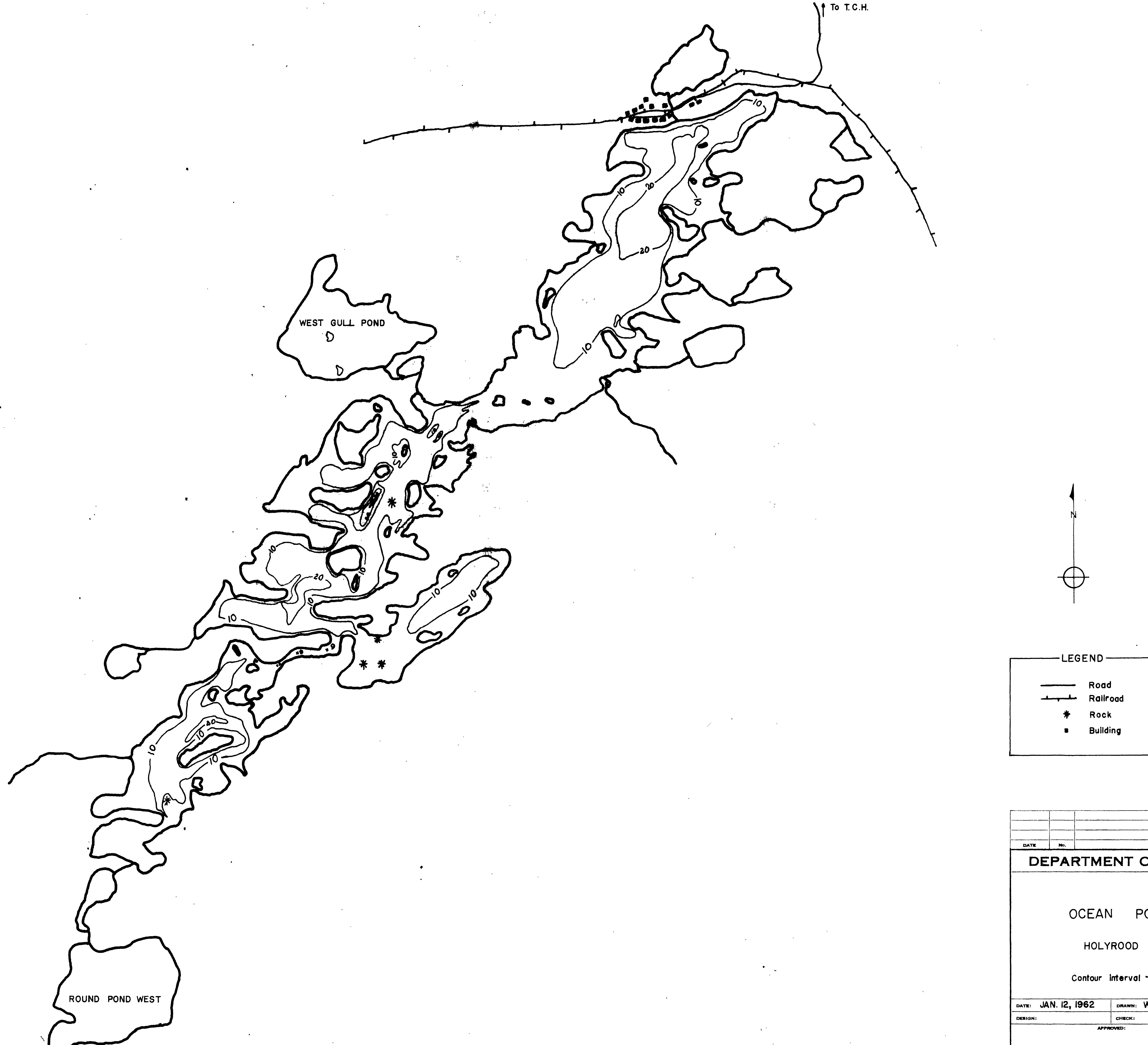
Carbonate	(CO_3)	0.0	0.0	0.0	0,0
Bicarbonate	(HCO_3)	6.1	5.4	5.5	5.3
Sulphate	(SO_4)	3.9	4.2	3.3	3.9
Chloride	(Cl)	2.8	2.3	2.3	2.4
Nitrate	(NO_3)	Trace	0.0	0.0	0.0
Silica	(SiO_2)	2.0	2.0	1.7	1.4

Thorburn Road
To Thorburn Road
To Thorburn Road
MITCHELLS POND NORTH
T.N
28° 18'
M.N.
LEGEND
Building
Rock
Road - provincial
Road - private
10
20
30
X35
Old Broad Cove Road
To Thorburn Road
DATE
No.
REVISION
BY
DEPARTMENT OF FISHERIES, CANADA
HOGAN'S POND
ST. JOHN'S
Contour interval - 10 feet
DATE: JAN. 11. 1962
DRAWN: W. D. S.
SCALE: 1" = 396'
DESIGN:
CHECK:
APPROVED:
DWG. No. N-D-91


Thorburn Road
To Thorburn Road
To Thorburn Road
MITCHELLS POND NORTH
T.N
M.N.
26° 16'
LEGEND
Building
Rock
Road - provincial
Road - private
10
20
30
35
To Thorburn Road
Old Broad Cove Road
DATE
No.
REVISION
BY
DEPARTMENT OF FISHERIES, CANADA
HOGAN'S POND
ST. JOHN'S
Contour interval – 10 feet
DATE: JAN. 11. 1962
DRAWN: W. D. S.
SCALE: 1" = 396'
DESIGN:
CHECK:
APPROVED:
DWG. No. N-D-91

Req. 7433


To T.C.H.
WEST GULL POND
ROUND POND WEST
10
20
40
N
LEGEND
Road
Railroad
Rock
Building
DATE
No.
REVISION
BY
DEPARTMENT OF FISHERIES, CANADA
OCEAN POND
HOLYROOD
Contour interval — 10 feet
DATE: JAN. 12, 1962
DRAWN: W.D.S.
DESIGN:
CHECK:
SCALE: 5" = 1 mile
APPROVED:
DWG. No. N-D-92



DATE	No.	REVISION	BY

DEPARTMENT OF FISHERIES, CANADA

OCEAN POND

HOLYROOD

Contour Interval — 10 feet

DATE: JAN. 12, 1962 DRAWN: W.D.S. SCALE: 5" = 1 mile
DESIGN: CHECK:
APPROVED: DWG. No. N-D-92

DATE	No.	REVISION	BY

DEPARTMENT OF FISHERIES, CANADA

DILDO POND

ARGENTIA

Contour interval — 10 feet

DATE: Jan. 15/62	DRAWN: W.D.S.	SCALE: 1.75" 4 ~~125~~" = ~~5 1/2~~ miles
DESIGN:	CHECK:	
APPROVED:		DWG. No. N-D- 93

DEPARTMENT OF FISHERIES, CANADA

DILDO POND

ARGENTIA

Contour interval — 10 feet

DATE: Jan. 15/62	DRAWN: W.D.S.
DESIGN:	CHECK:
APPROVED:	
SCALE: 1-15" 4 [illegible] = [illegible] miles	DWG. No. N-D- 93

DATE	No.	REVISION	BY

DEPARTMENT OF FISHERIES, CANADA

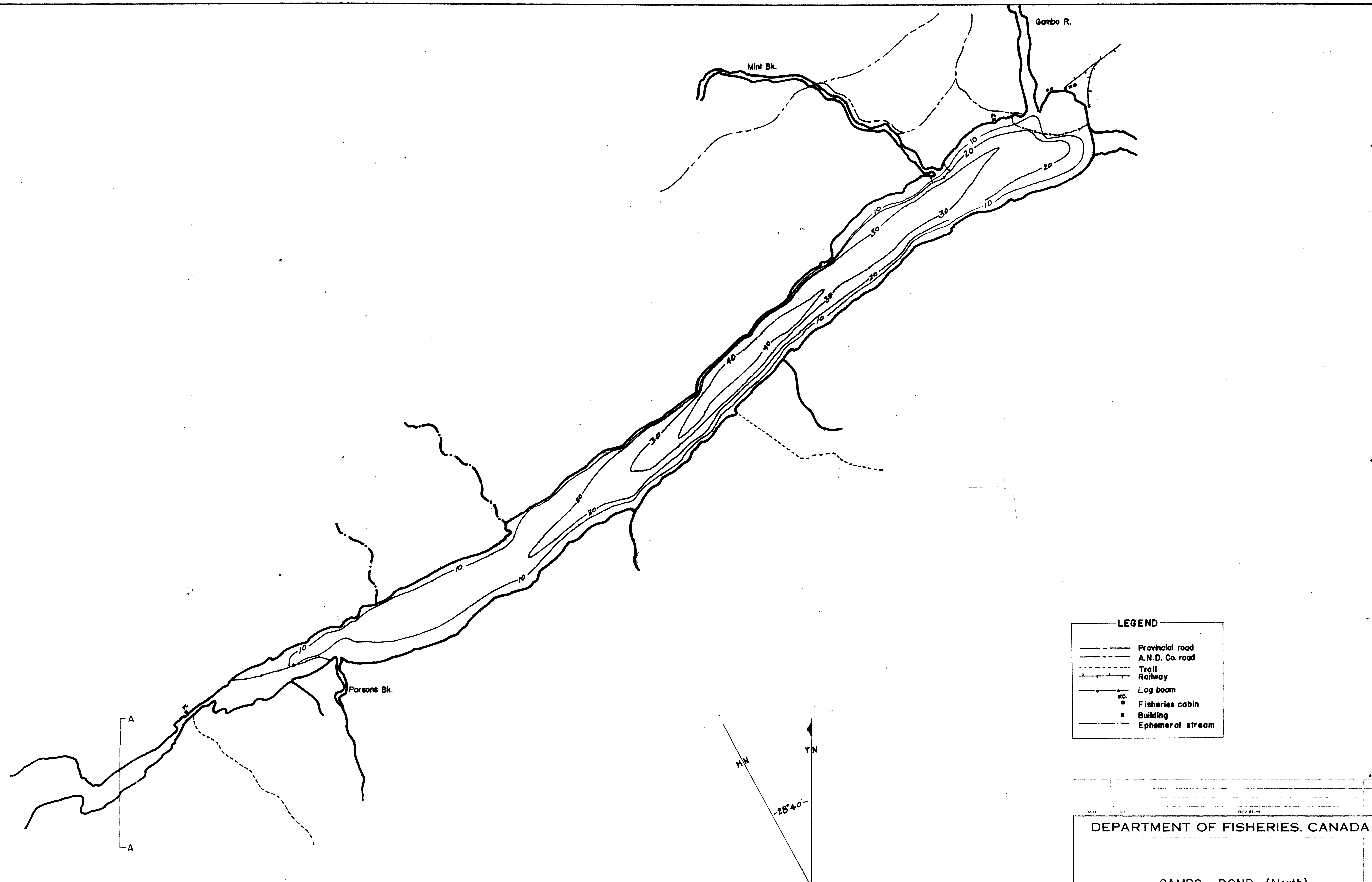
GAMBO POND (North)

GLOVERTOWN

Contour interval — 10 feet

DATE: Jan 16/62	DRAWN: W.D.S.	SCALE: 2.5" = 1 mile
DESIGN:	CHECK:	
APPROVED:		DWG. No. N-D-94

Req. 7433



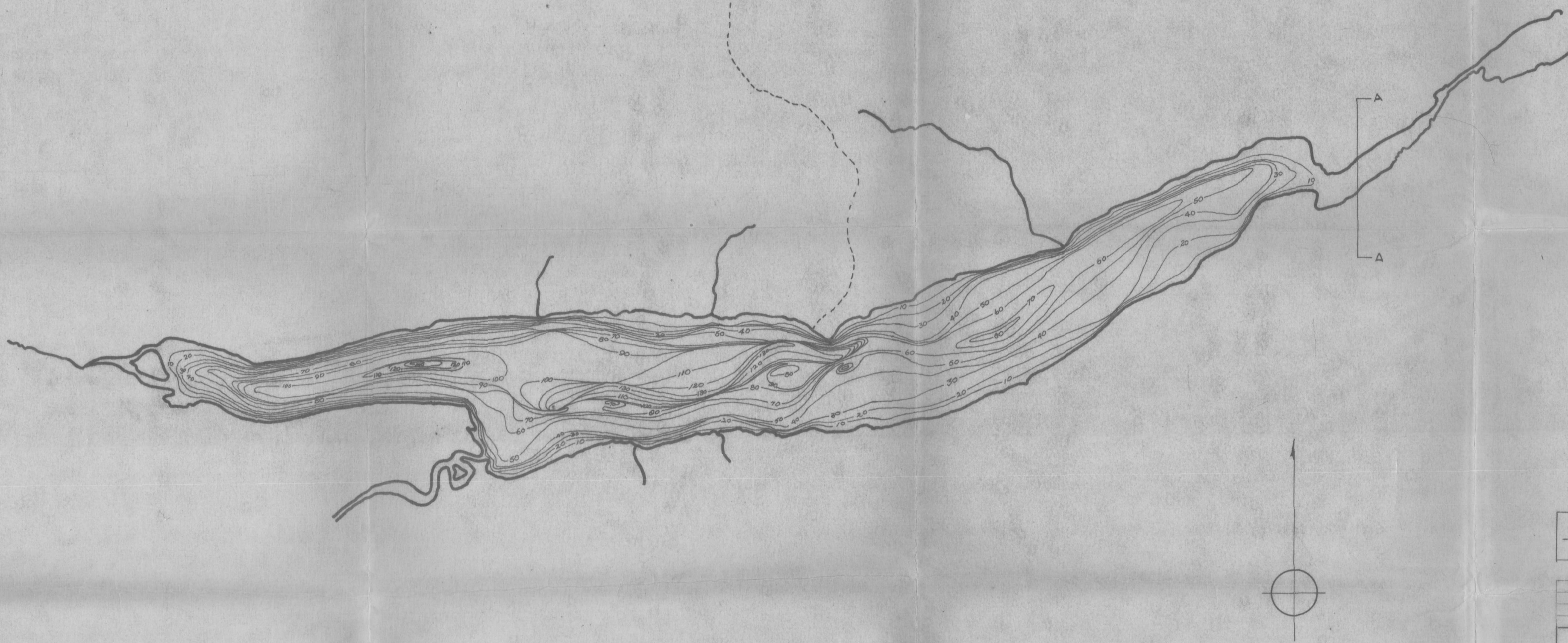
DEPARTMENT OF FISHERIES, CANADA

GAMBO POND (North)

GLOVERTOWN

Contour interval — 10 feet

DATE: Jan 16/62	DRAWN: W.D.S.	SCALE: 2.5" = 1 mile	
DESIGN:	CHECK:		
	APPROVED:	DWG. No. N-D-94	



LEGEND

-------- Trail

DATE	No.	REVISION	BY

DEPARTMENT OF FISHERIES, CANADA

GAMBO POND (South)

GLOVERTOWN

Contour interval — 10 feet

DATE: Jan. 17/ 62	DRAWN: W.D.S.	SCALE: 2.5" = 1mile
DESIGN:	CHECK:	
APPROVED:		DWG. No. N-D- 95

LEGEND

---------- Trail

DATE	No.	REVISION	BY

DEPARTMENT OF FISHERIES, CANADA

GAMBO POND (South)

GLOVERTOWN

Contour interval — 10 feet

DATE: Jan. 17/62	DRAWN: W.D.S.	SCALE: 2.5" = 1 mile
DESIGN:	CHECK:	
APPROVED:		DWG. No. N-D-95


TCH
TCH
LEGEND
Railroad
Road
Building
Rock
N
M N
DEPARTMENT OF FISHERIES, CANADA
GEORGE'S LAKE
HARRYS RIVER
Contour interval — 30'
DATE: Feb. 8/62
DRAWN: W.D.S.
SCALE: 5" = 1mile
DWG. NO. N-D-100


LEGEND
Railroad
Road
Building
Rock
TCH
TCH
M N
DATE
No.
REVISION
BY
DEPARTMENT OF FISHERIES, CANADA
GEORGE'S LAKE
HARRYS RIVER
Contour interval — 30'
DATE: Feb. 8/62
DRAWN: W.D.S.
SCALE: 5" = 1mile
DESIGN:
CHECK:
APPROVED:
DWG. No. N-D-100