Digitized by the Internet Archive
in 2011 with funding from
University of Toronto

LIBRARY

R. A. RYDER, W. B. SCOTT
AND E. J. CROSSMAN

ROYAL ONTARIO MUSEUM
UNIVERSITY OF TORONTO

*Fishes of Northern Ontario,
North of the Albany River*

ROYAL ONTARIO MUSEUM - UNIVERSITY OF TORONTO

ROYAL ONTARIO MUSEUM LIBRARIES

3 1761 05013 6696

ROM

Contribution No. 60

LIFE SCIENCES

ROYAL ONTARIO MUSEUM

UNIVERSITY OF TORONTO

R. A. RYDER

W. B. SCOTT AND

E. J. CROSSMAN

*Fishes of Northern Ontario,
North of the Albany River*

R. A. RYDER is a member of the Research Branch, Ontario Department of Lands & Forests.

W. B. SCOTT AND E. J. CROSSMAN are Curator and Associate Curator respectively of the Department of Ichthyology & Herpetology, Royal Ontario Museum, University of Toronto.

Akimiski Island, lying 14 miles to the east of Attawapiskat, is under the jurisdiction of the Northwest Territories. It has been included in this study because we are unaware of any previously published accounts of its fishes.

This paper is Contribution No. 64-9 of the Ontario Department of Lands and Forests, Research Branch, Maple, Ontario.

PRICE: 75 cents per copy

© The Governors of the University of Toronto, 1964

PRINTED AT THE UNIVERSITY OF TORONTO PRESS

INTRODUCTION

Fish collections made in the Patricia Portion of the Kenora District in northern Ontario since 1955 have included many species not previously recorded from the region, and vastly increased the known range of other species already documented by Dymond and Scott (1941), and Radforth (1944). With the gradual accumulation of these records, it seemed desirable at this point to fill in the gaps in the published distribution of fishes for northern Ontario and bring together all previously published records with those which have accumulated since 1944. The works of Melvill, Lower and Comeau (1915), while providing an interesting account of the fisheries in and around Hudson and James Bays in 1914, contain nomenclatural difficulties with some fish species. Furthermore, it was not always made clear in their surveys when fish were actually collected or when the survey participants were told by the residents that certain species occurred. Consequently, their distribution records are omitted from this study.

The majority of the new distributional records were collected in conjunction with the Patricia Inventory Project, a fisheries inventory jointly financed by the Ontario Department of Lands and Forests and the Indian Affairs Branch of the Department of Citizenship and Immigration of Canada. The Patricia Inventory was initiated in 1959 and is still in progress. The Department of Lands and Forests was responsible for the field work on this project and emphasized the assessment of the quantitative and qualitative aspects of the region's fisheries resources with an economic potential.

Additional distributional records also were obtained by the Department of Lands and Forests from the Pacific Salmon Project which was instituted in 1954 to test the feasibility of the introduction of two species of *Oncorhynchus* into the Hudson and James Bay watersheds. Field parties collected fish during the summers of 1957 and 1958 at various sites on the Hudson and James Bay coasts and tributary waters while attempting to determine the success of the Pacific salmon introductions. All specimens collected on the Patricia Inventory and Pacific Salmon projects were preserved in 10% formalin and forwarded to the Royal Ontario Museum, where they were subsequently identified by one or more of the three co-authors of this paper.

Data from Dymond and Scott (1941) were augmented, to complete the distributional record of fishes for the Patricia Portion of Ontario. Some of the records which were included in Radforth (1944), but which were not supported by specimens, were omitted. A few additional records have been added to this account from creel census or commercial fisheries data collected by the Ontario Department of Lands and Forests. This was particularly true in the case of the lake trout, *Salvelinus namaycush* (Walbaum) which was taken in seine samples only on rare occasions, and for which no doubt of existence occurs. Additional distributional records for the lake sturgeon, *Acipenser fulvescens* Rafinesque, the lake whitefish, *Coregonus clupeaformis* (Mitchill), the brook trout, *Salvelinus fontinalis* (Mitchill) and the burbot, *Lota lota* (Linnaeus) were also included on this basis.

Figure 1—Map of northern Ontario showing 25 sites in the Patricia Portion and Akimiski Island, N.W.T., where fish collections were made. Numbers in parentheses after the collection site names refer to the collection site numbers in the annotated lists and on Table 1. Major drainage basins in the Hudson Bay watershed are delineated with broken lines. The three watershed diversions are marked at the locations of the actual diversion channels. The dotted line separates the two principal physiographic regions; the Precambrian Shield (west) and the Hudson Bay lowlands (east).

DESCRIPTION OF REGIONS

The Patricia Portion of the Kenora District, for the purposes of this paper, includes that part of Ontario north of and including the Albany River from its estuary on James Bay to its headwaters, Lake St. Joseph, thence along the 51°N latitudinal line westward to Manitoba (Figure 1). The western limit of this region is formed by the Manitoba-Ontario boundary. Hudson Bay and James Bay form the northern and eastern boundaries. These boun-

daries enclose an area of approximately 135,000 square miles, or about one-third the area of the whole Province.

Included in the fish records for the Patricia Portion of Ontario were collections made from intermittent streams, tidal pools, and coastal waters on the west end of Akimiski Island. Akimiski Island lies 14 miles to the east of the Attawapiskat River estuary, in the judicial District of Keewatin, Northwest Territories.

The Patricia Portion consists of two principal physiographic regions; namely, the Precambrian Shield and the Hudson Bay Lowlands with an areal ratio of 8:7 respectively (Figure 1). The Precambrian Shield provides a great diversity of aquatic habitat. Most of the lakes in this region are moderately deep to deep, range in area from extremely small to 238 square miles (Big Trout Lake), and contain a more complex species composition than do the Hudson Bay lowland lakes. The greater elevations and hardrock substrates found on the Precambrian Shield provide for steeper stream gradients and more complicated watershed systems. The Precambrian Shield region consists of many vegetation types and geological and glacial patterns which are beyond the scope of this paper.

The Hudson Bay lowlands follow the shorelines of Hudson and James Bays, and are characterized by black spruce (*Picea mariana*) and tamarack (*Larix laricina*) muskegs, relatively few large shallow lakes, and simple river systems. Most of the smaller lakes in this formerly submerged region are shallow bog lakes containing only a few cyprinids, cottids and gastrosteids. Sutton and Hawley lakes (Figure 1) form an anomalous situation for this region as they are both relatively deep. Perhaps these two lakes should not be considered as true Hudson Bay lowland lakes as they lie across a local metamorphic intrusion.

More detail pertaining to the geology, meteorology and vegetation of the Precambrian Shield and the Hudson Bay lowlands is documented by Coleman (1922); Coombs (1954); Hills (1960); Hustich (1957); Rowe (1959) and Thornthwaite (1948).

METHODS OF COLLECTION

Most of the collections for the present study were taken in seines of $\frac{1}{4}$ inch mesh, 4 feet deep and 10 or 25 feet in length. Additional collections were made in experimental nylon gill nets of graded mesh sizes from $1\frac{1}{2}$ inches (stretched measure) to 5 inches at $\frac{1}{2}$ inch intervals. Gill nets ranged from 50 feet to 400 feet in length for each mesh size and measured 5 feet in depth. As the fish faunal surveys of the Pacific Salmon Project and Patricia Inventory were incidental to the major projects, they will be evaluated only from the qualitative aspect of providing additional distributional records, and the quantitative aspects will not be considered except as they demonstrate a relative abundance of species in the more intensively sampled lakes.

Twenty-five collection sites were established, including those surveys carried out by the Royal Ontario Museum between 1938–1942. Several to many stations representing different ecotypes were sampled at each collection site. While the degree of intensity of the sampling was not the same at

each collection site, the following sites (Figure 1) were sampled intensively: Attawapiskat Lake, Attawapiskat River, Big Trout Lake, Bug River, Deer Lake, Finger Lake, Hawley Lake, Lake St. Joseph, North Caribou Lake, Sandy Lake, Severn River, Sutton Lake and Wunnummin Lake. The remainder of the collection sites were sampled less intensively or only sporadically, and the degree of completeness of the collections should be judged accordingly.

The lakes which were more intensively sampled had collections from various ecological niches. The coastal streams were sampled from the intertidal zone to a maximum of about 15 miles upstream.

WATERSHED DIVERSIONS

Two artificial diversions (Figure 1) of the Albany River watershed have diverted waters formerly entering James Bay at Fort Albany into the Great Lakes-St. Lawrence watershed via Lake Superior. These two diversions are commonly referred to as the Long Lake and Ogoki diversions and were established in order to obtain a larger flow of water for pulpwood drives and hydro power on the Aguasabon and Nipigon Rivers. A third diversion of the Albany River watershed diverts water from Lake St. Joseph, at the headwaters of the Albany River, into Lac Seul which drains into the Nelson River watershed and eventually Hudson Bay. This diversion was constructed primarily for the generation of hydro power.

Any changes in fish fauna resulting from these diversions would have to occur in the Lake Superior and Nelson River watersheds, as physical barriers (dams) prevent the passage of fishes in the reverse direction. In the Ogoki Diversion, only those waters upstream from Mojikit Lake on the Ogoki River watershed could contribute species new to the Lake Superior watershed. The lower portion of the Ogoki River, from Mojikit Lake to its effluence into the Albany River, has been blocked off by a dam, thus preventing passage of fishes from the Albany River to Lake Superior.

The Long Lake Diversion system is much simpler. The only major change here was in diverting the waters of Long Lake into Lake Superior instead of their normal route to the Albany River. Fishes formerly occurring in Long Lake now have access to Lake Superior via the diversion channel from Long Lake to the Aguasabon River and thence downstream to Lake Superior.

Passage of fishes from the Albany River watershed to the Nelson River watershed would include only those species present in Lake St. Joseph at the time of the diversion. The faunal exchange would of necessity be unidirectional, from Lake St. Joseph to Lac Seul, because of physical barriers preventing access of fishes to Lake St. Joseph from Lac Seul. It is unlikely that passage of fish from the Albany River watershed to the Nelson River watershed would enrich the fauna of the latter watershed, except perhaps locally. All fish species recorded from the Albany River watershed (Table 1) are known to occur in the Nelson River watershed (Hinks, 1943; Keleher and Kooyman, 1957).

It is conceivable, however, that at least two species of fishes endemic to the Albany River could enrich the fauna of Lake Superior, although both species occur in other of the Great Lakes. The threespine stickleback, *Gasterosteus aculeatus* Linnaeus, and *Percina shumardi* (Girard), the river darter, are both absent from Lake Superior although the former species occurs in Lake Ontario, and the latter species in southern Lake Michigan and western Lake Erie (Hubbs and Lagler, 1958). Neither of these species has been reported from Lake Superior to date, even though the Longlac Diversion has been operating since 1938 and the Ogoki Diversion since 1943.

The fallfish, *Semotilus corporalis* (Mitchill), has been reported on at least two occasions from the Moose River watershed in the Hudson Bay drainage (Melvill, *et al.*, 1915; Dymond, 1947). Allin (1951) suggested that a specimen taken from Cedar Creek (Lake Superior drainage) gained access by way of either the Longlac or Ogoki Diversions, or perhaps both. This would imply that *S. corporalis* is present in the Albany River watershed, although our distribution data do not support this thesis. The fallfish is a primary division species (as defined by Darlington, 1957) and presumably is not equipped physiologically to be able to make its way from the mouth of the Moose River to the mouth of the Albany River, through the estuarial waters of James Bay.

Three other primary division species found in the Hudson Bay watershed would not have access to the Albany River (unless already present) and hence could not gain access to Lake Superior at the time of the diversion construction. The mooneye, *Hiodon tergisus* Le Sueur, has been recorded from the Nelson and Moose River (doubtful record) watersheds (Hinks 1943; Dymond, 1937), but has not been found in the major intervening watersheds of Ontario; the Severn, Winisk, Attawapiskat and Albany drainage systems (Table 1). The goldeye, *Hiodon alosoides* (Rafinesque) has been recorded from the Nelson (Hinks, 1943), Severn (present study) and Moose (Dymond and Hart, 1927) watersheds, but not the Albany. Another primary division species, the freshwater drum, *Aplodinotus grunniens* Rafinesque, was recorded from the lower reaches of the Nelson drainage (Scott and Kooyman, 1952), and the Moose River watershed (Dymond and Hart, 1927), but is lacking in the Albany and other major intervening watersheds.

Besides the three-spined stickleback and the river darter, which already occur in the Albany watershed, only one other species not presently found in Lake Superior is likely to have access via one of the two diversions from the Albany. This fish is a peripheral division species (Darlington, 1957), and consequently is physiologically adapted for travel through the estuarial waters of Hudson and James Bays. The arctic char, *Salvelinus alpinus* (Linnaeus) has been recorded from the Severn and Winisk River watersheds in Ontario (Ryder, 1961; present study) and possibly extends its range even further southward, at least in the estuarial waters of Hudson and James Bays. However, in order for the arctic char to gain access to Lake Superior, it would have to have occurred either in Long Lake or Mojikit Lake and tributary waters at the time of impoundment and diver-

sion. This eventuality is very unlikely as Long Lake is about 325 water miles, and Mojikit Lake 375 water miles from the mouth of the Albany River. The arctic char does not normally penetrate waters this far inland on the West Coast of Hudson Bay (See Figure 3 of McPhail, 1961).

In summary, only the three-spined stickleback and the river darter are likely to gain access to Lake Superior from the Albany River watershed by way of diversions. Neither species was found by Harkness and Hart (1927) in Long Lake. It is unlikely that the three-spined stickleback occurs in either Long Lake or Mojikit Lake and tributaries as it is usually closely associated with the marine environment (Radforth, 1944). The river darter possibly occurs at both these sites, but could easily be overlooked because of difficulties experienced in collecting this species.

ANNOTATED LIST OF SPECIES¹

Acipenser fulvescens Rafinesque

The lake sturgeon ranges widely in North America (Harkness and Dymond, 1961), and appears to be distributed generally throughout the Patricia region. It is especially abundant in the larger river systems and some of the medium to large shallow lakes where commercial fisheries exist. This species is not readily caught with ordinary seines and gill nets, and this possibly explains why it was not observed at some collection sites. It is likely that the lake sturgeon is actually absent from the Sutton River watershed, including Hawley and Sutton Lakes, as well as the Goose Creek watershed. Small lake sturgeon were captured in the intertidal region of the Attawapiskat River, although none were taken in the marine environment proper.

Collection Sites² (15) 2, 3, 4, 6, 9, 11, 12, 13, 15, 16, 17, 18, 19, 20, 25.

Oncorhynchus gorbuscha (Walbaum)

A total of 513,000 pink salmon eyed-eggs and sac fry was introduced into Goose Creek, approximately 12 miles east of Fort Severn, in January 1956. Additional fingerling plantings (224,112) took place in the spring of 1956. A total of 496 fingerlings was taken in fyke nets the following June during their downstream migration to Hudson Bay. To the best of our knowledge, no adult pink salmon were ever captured in Hudson Bay or its tributary waters.

Oncorhynchus keta (Walbaum)

A total of 425,000 chum salmon eyed eggs was planted in the Winisk River and its tributary, the Mishamattawa, in January of 1955. An additional planting of 449,450 fingerlings was introduced into the upper reaches of the Attawapiskat River in June of the same year. Despite the fact that field parties were maintained on the Winisk and Attawapiskat Rivers during the summers of 1957 and 1958 in an attempt to locate possible spawning runs of chum salmon, no adults were ever captured.

¹See Table 1 for tabular arrangement of species by collection site and watershed.

²Location of collection sites shown in Figure 1.

Salvelinus alpinus (Linnaeus)

The arctic char was first recorded for Ontario waters in 1960 when a large specimen was taken six miles upstream from the effluence of the Severn River into Hudson Bay (Ryder, 1961). The present paper will serve to document the capture of two more specimens both taken by gill nets in the Winisk River, one in 1961, the other in 1962. The former specimen is now in the Royal Ontario Museum (Cat. No. 22110). These records extend the published range of the arctic char another 112 miles southeastward. It is likely that the arctic char makes only sporadic appearances in the rivers tributary to Hudson Bay at this latitude as no known spawning runs exist. The discovery of arctic char even farther south on the west coast of Hudson and James Bays is a distinct possibility, but requires much more intensive sampling at various times of the year.

Collection Sites (2) 4, 6.

Salvelinus fontinalis (Mitchill)

The distribution of brook trout in the Patricias is tied in with the marine withdrawal of Hudson and James Bays. It is possible that reinvasion of the area by the brook trout occurred through the marine environment, resulting in the present distribution which includes all the major streams and deeper lakes of the Hudson Bay lowlands as well as smaller lakes and suitable streams on adjacent portions of the Precambrian Shield. The brook trout occurs upstream on the Severn and its tributary the Fawn, as far as Big Trout Lake, and in the Winisk River as far as its effluence at Winisk Lake. This species was not found in the environs of Attawapiskat Lake although it occurs in the lower reaches of the Attawapiskat River. The brook trout ascends the Albany River at least to the Fort Hope-Miminiska region. Brook trout also occur in Ney and Echoing Lakes where the Hayes River watershed enters Ontario southward from Manitoba. The Nelson River drainage of the Patricias does not contain brook trout although they are common in the lower reaches of the Nelson in Manitoba. It is likely that Lake Winnipeg, because of warm, turbid waters and a great variety of competitive species, serves as an ecological barrier preventing brook trout from entering the Nelson River watershed of Ontario.

Collection Sites (8) 2, 3, 4, 5, 6, 7, 8, 9.

Salvelinus namaycush (Walbaum)

The lake trout is absent from the Hudson Bay lowlands except for the Sutton-Hawley Lake region, which provides the only deep lakes of the area. It is generally distributed throughout the Precambrian Shield portion of the Patricias where the habitat is favourable. The lake trout is one of the major species entering the commercial fishery of the region where it commands the highest prices. Lake trout are able to survive in some mesotrophic lakes at this latitude and are occasionally taken in the Sutton River. Only alternate year spawning occurs in some of the Patricia lakes, possibly because of the relative infertility of the waters and the shorter growing seasons.

Collection Sites (6) 7, 8, 9, 14, 23, 25.

Coregonus artedii LeSueur

The lake herring is generally distributed throughout the larger lakes of the area. A dwarf form occurring in Big Trout Lake appears to be properly assigned to the *artedii* group. Anadromous lake herring occur in many of the larger coastal streams and ascend these rivers to spawn in September. These runs are also recorded by Dymond (1933) for the west coast of Hudson and James Bays. Insufficient sampling from the estuarial waters of Hudson and James Bays proper leaves some doubt as to whether this species is ever very far from the influence of density currents from its spawning stream. In any event, because of the relatively low salinity of Hudson and James Bays, they are not to be considered as a true marine habitat in the waters adjacent to Ontario.

The lake herring is at present, economically unimportant in the Patricias. *Coregonus* (*Leucichthys*) *tullibee* (Richardson), formerly recorded by Dymond and Scott (1941), is now considered to be synonymous with *C. artedii* LeSueur.

Collection Sites (14) 2, 3, 5, 7, 8, 9, 11, 12, 14, 17, 19, 20, 24, 25.

Unidentified coregonids (*Leucichthys*) were taken from three northern Ontario lakes. These specimens were left unidentified as to species as they did not fit the characteristics outlined by Koelz (1929) for Great Lakes coregonids. As with those species tentatively identified, positive identification will depend on the completion of systematic work on the genus in this region.

Collection Sites (3) 13, 17, 18.

Coregonus clupeaformis (Mitchill)

The lake whitefish is common in all the medium to large lakes of the area, and seems to thrive equally well in shallow or deep lakes at this latitude. This species provides the greatest tonnage of any species entering the commercial fishery in the Patricias although the price per pound is low for most lakes because of heavy *Triaenophorus crassus* infestations. Anadromous spawning runs occur on some of the larger coastal streams, beginning in late August and combining with the lake herring spawning runs in September. As with the lake herring, there is some doubt as to whether the lake whitefish remains in a marine environment for any length of time or rather stays within the influence of major tributaries which retain their identity far out into Hudson and James Bays.

Collection Sites (21) 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 23, 24, 25.

Coregonus clupeaformis × *C. artedii*

Four specimens of this hybrid combination were taken in the lower reaches of the Attawapiskat River in 1957. As noted previously, the anadromous spawning runs of *C. artedii* and *C. clupeaformis* overlap in this river. The majority of the fish apparently spawn immediately below the first major rapids. It is likely that this hybrid occurs in other areas of the Patricias

where the two parent species occur and the spawning seasons coincide or overlap.

Collection Sites (1) 2.

Coregonus nigripinnis (Gill)

The blackfin cisco was recorded from Attawapiskat Lake by Dymond and Scott (1941) and by the present study from the same lake as well as Deer Lake. Until a comprehensive taxonomic study on the coregonids of the northern inland lakes has been completed, the identifications of *C. nigripinnis* and *C. zenithicus* are tentative. It is possible that *C. nigripinnis* is merely a deep-water form of *C. artedii*.

Collection Sites (2) 12, 25.

Coregonus zenithicus (Jordan and Evermann)

Two collection sites were tentatively established for the short jawcisco. As with the previous species, systematic work is required prior to final classification.

Collection Sites (2) 9, 12.

Prosopium cylindraceum (Pallas)

The apparently sporadic distribution of the round whitefish may be explained in part by the lack of intensive sampling in some lakes, as this species does not appear to be abundant anywhere in the Patricias or indeed, throughout its entire range. Its occurrence in the upper reaches of the Severn and Albany Rivers (Big Trout Lake and Lake St. Joseph), and apparent absence towards the mouths of these same two rivers, suggest unfavorable habitat in the latter situations. However, far more intensive sampling is required to establish adequately the range of this species in the Patricias, before explanations for its distributional pattern are dependable.

Collection Sites (4) 4, 9, 10, 13.

Mallotus villosus (Müller)

The capelin occurs commonly in Hudson and James Bays and occasionally becomes stranded in tidal pools. The one specimen included in this study was taken in a tidal pool on Akimiski Island, Northwest Territories. It is likely that the capelin might be found in tidal pools anywhere on the lowlands of Hudson and James Bays in the Patricias.

Collection Sites (1) 1.

Esox lucius Linnaeus

The northern pike is one of the most widely distributed species in the Patricia Portion of Ontario. It does not frequent saline waters and is thus a primary species as defined by Darlington (1957); consequently, the northern pike is separated from Akimiski Island by an ecological barrier, that is, about 14 miles of saline waters in James Bay. For this reason it may also be absent from many of the short, simple river systems, arising

on the Hudson Bay lowlands and emptying directly into Hudson or James Bays. The northern pike is making an increasingly important contribution to the commercial fisheries production in the region.

Collection Sites (22) 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 23, 24, 25.

Hiodon alosoides (Rafinesque)

The goldeye is common to a small number of lakes in the Sandy-Finger Lake region next to the Manitoba boundary. Their association with the sauger, *Stizostedion canadense* (Smith), and turbid waters is apparent. Both the goldeye and the sauger reach their peak abundance in the Sandy Finger Lake region of the Patricias. Mean values for turbidity in Finger and Sandy Lakes are 21.1 and 16.1 turbidity units respectively. Most of the Patricia lakes have turbidity values less than 2.0 turbidity units.

The goldeye is absent from other Patricia lakes and does not occur elsewhere in northern Ontario except in Lake Abitibi (35.0 turbidity units) on the Quebec boundary, and local populations in tributaries of Lake Winnipeg reaching into Ontario. The reason for their absence in seemingly ecologically suitable sites in northwestern Ontario, to which the goldeye has access, is not clearly understood.

Collection Sites (2) 19, 20.

Catostomus catostomus (Forster)

The longnose sucker seems to be generally distributed throughout the Patricias, at least in the larger lakes and rivers.

Collection Sites (15) 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 19, 20, 25.

Catostomus commersoni (Lacépède)

The white sucker is the most widely distributed species in northern Ontario. Apparently it is found in all types of situations with the exception of small bog lakes on the Hudson Bay lowlands which probably freeze solid during the winter.

Collection Sites (23) 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25.

Catostomus spp.

While the two species of *Catostomus* are widely distributed in the Patricias their relative abundance in any particular situation varies greatly. The long nose sucker apparently is absent from Lake St. Joseph, and in other moderately warm, shallow lakes such as Favourable, Finger, Sandy and Northwind. The white sucker is abundant in all of these waters. The long nose sucker probably reaches its peak abundance in Big Trout Lake where it outnumbers the white suckers throughout most of the lake, with the exception of the littoral zone. Only one specimen of longnose sucker was captured in Deer Lake, an exceptionally deep lake which forms an early sharp thermocline, and retains it throughout the summer months. Most of the other Patricia lakes studied were well mixed during the summer season and where a thermocline was formed, it was generally of short or inter-

mittent duration. The favoured habitat of the longnose sucker seems to be the deeper, oligotrophic lakes lacking strong thermal stratification (Big Trout), and larger rivers, while the white sucker inhabits chiefly the littoral zones, in these situations and in the thermally stratified lakes with stable thermoclines. It is possible that the two species of *Catostomus* are sympatric. A species might compete best with a sympatric form in situations where the habitat is optimal for the former. While the longnose sucker is more generally found in the deeper lakes, depth itself is not likely to be a factor governing distribution of the species, except as depth affects temperature levels and oxygen concentrations.

Moxostoma macrolepidotum (LeSueur)

The northern redhorse is generally distributed throughout the larger lakes and river systems of northern Ontario, but does not appear to be abundant in any situation. It is absent from the deeper lakes, such as Big Trout, Deer, Sutton and Hawley, which have mean depths of 52, 71, 95 and 67 feet respectively.

Collection Sites (13) 2, 3, 6, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20.

Chrosomus eos Cope

The northern redbelly dace was recorded only from Goose Creek. As most of the collections originated from larger lakes and streams, it is likely that this species is much more widely distributed in favourable habitat situations than the collections would indicate. It probably occurs in bog situations throughout the Patricias.

Collection Sites (1) 5.

Chrosomus neogaeus (Cope)

Although the finescale dace was actually collected at only three collection sites, it probably occurs in suitable habitat situations throughout the Patricias, as suggested by Dymond and Scott (1941).

Collection Sites (3) 2, 5, 6.

Hybopsis plumbea (Agassiz)

The lake chub is widely distributed throughout northern Ontario lakes and larger streams. It is difficult to explain its apparent absence in Lake St. Joseph and in the Winisk River watershed which includes Wunnummin Lake. Night collecting, which is usually the most successful for this species, might reveal the presence of the lake chub at collection sites where it has not yet been recorded. In any event, it is probably more widely distributed than the number of collection sites from which it was taken would suggest.

Collection Sites (12) 2, 3, 6, 7, 8, 9, 10, 12, 14, 19, 20, 25.

Notropis atherinoides Rafinesque

The emerald shiner occurs generally in all the larger lakes on the Precambrian Shield portion of the Patricias, reaching a peak in abundance in the turbid waters of Sandy and Finger Lakes.

Collection Sites (10) 9, 11, 12, 13, 14, 16, 18, 19, 20, 25.

Figure 2—Map of the Patricia Portion of Ontario and Akimiski Island (N.W.T.) showing the collection sites (numbers) and *Notropis* species (symbols) collected at each site. Northward distribution of the genus *Notropis* in Ontario is apparently restricted south of the 60° July isotherm.

Notropis heterolepis Eigenmann and Eigenmann

Dymond and Scott (1941) reported the blacknose shiner as fairly common in weedy bays of Lake Attawapiskat. Later collections revealed that this species occurs in lakes in the upper reaches of all four major drainage systems (Severn, Winisk, Attawapiskat and Albany), but was not common in any of them.

Collection Sites (4) 10, 11, 12, 13.

Notropis hudsonius (Clinton)

The spottail shiner is the most widely distributed species of *Notropis* in the Patricia area, and generally the most common at any particular collection site.

Collection Sites (15) 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 23, 25.

Notropis volucellus (Cope)

The mimic shiner was taken at four collection sites and did not appear to be common in any of them.

Collection Sites (4) 12, 13, 19, 21.

Notropis spp.

It is interesting to note that the genus *Notropis* is apparently absent from the Hudson Bay lowlands, although it appears to be widely distributed in the larger lakes situated on the Precambrian Shield. None of the four species of *Notropis* was collected from the lower reaches of the four major watersheds, namely, the Severn, Winisk, Attawapiskat and Albany, nor were they taken from Hawley and Sutton Lakes, or Goose Creek, all situated on the Hudson Bay lowlands. While the lake habitat on the Hudson Bay lowlands is considerably different from those lakes at a similar latitude on the Precambrian Shield, the habitats provided by the larger rivers originating on the Precambrian Shield and flowing on to the lowlands are not obviously different in adjacent regions. The lower portions of the Severn, Winisk, Attawapiskat and Albany Rivers all appear to be environmentally suitable, for example, for *Notropis atherinoides*, and indeed, *N. atherinoides* has easy access to each of these sites from the middle regions or headwaters of these same rivers. The fact that this species has not yet established populations in the lower portions of these rivers suggests a physiological incompatibility with the climate.

The use of the 65° July isotherm to predict the maximum northward extent of certain fish species has been successfully used in Ontario by Radforth (1944) and in Manitoba by Keleher (1956). In the present work a line approximating the 60° July isotherm apparently establishes the maximum extent of four species of *Notropis* in Ontario (Figure 2). It should be noted that no *Notropis* spp. were collected at any of the eight collection sites situated on the Hudson Bay lowlands. One or more representatives of this genus were collected at 15 out of 17 inland collection sites, however. As most North American cyprinids are all primary species as defined by Darlington (1957), it seems likely that dispersal of the genus *Notropis* in the Patricias was of necessity through fresh waters inland and not by way of the estuarial waters of Hudson and James Bays.

Pimephales promelas Rafinesque

The fathead minnow was captured in small boggy streams near the lower reaches of the Severn and Attawapiskat Rivers. Dymond and Scott (1941) suggest that this species is taken in association with *Chrosomus neogaeus* in boggy favourable habits.

Collection Sites (2) 3, 6.

Rhinichthys cataractae (Valenciennes)

The longnose dace is generally distributed throughout the Patricias in the larger lakes and streams.

Collection Sites (11) 2, 3, 5, 6, 7, 9, 10, 11, 12, 14, 22.

Table 1—Distribution of fishes by collection site and major watershed in the Patricia Portio

Collection sites	<i>Acipenser fulvescens</i>	<i>Oncorhynchus gorbusha</i>	<i>Oncorhynchus keta</i>	<i>Salvelinus alpinus</i>	<i>Salvelinus fontinalis</i>	<i>Salvelinus namaycush</i>	<i>Coregonus artedii</i>	<i>Coregonus clupeaformis</i>	<i>Coregonus nigripinnis</i>	<i>Coregonus zenithicus</i>	<i>Coregonus artedii</i> <i>X C. clupeaformis</i>	<i>Prosopium cylindraceum</i>	<i>Mallotus villosus</i>	<i>Esox lucius</i>	<i>Hiodon alosoides</i>	<i>Catostomus catostomus</i>	<i>Catostomus commersoni</i>	<i>Moxostoma macrolepidotum</i>	<i>Chrosomus eos</i>	<i>Chrosomus neogaeus</i>	<i>Hybopsis plumbea</i>	<i>Natropis</i>
Akimiski Island (1)													X									
Albany River (2)	X				X		X	X						X		X	X	X		X	X	
Attawapiskat Lake (12)	X						X	X	X	X				X		X	X	X			X	X
Attawapiskat River (3)	X		E		X		X	X			X			X		X	X	X			X	
Big Trout Lake (9)	X				X	X	X	X		X		X		X		X	X				X	X
Bug River (10)												X		X		X	X				X	
Deer Lake (25)	X					X	X	X	X					X		X	X				X	X
Favourable Lake (24)							X	X						X			X					X
Finger Lake (20)	X						X	X						X	X	X	X	X			X	X
Goose Creek (5)		E			X		X	X						X		X	X		X	X		
Hawley Lake (7)					X	X	X	X						X		X	X				X	
Lake St. Joseph (13)	X							X				X		X			X	X				X
Magiss Lake (15)	X						X	X						X			X	X				
Nikip Lake (16)	X							X						X			X	X				X
North Caribou Lake (14)						X	X	X						X		X	X	X			X	X
Northwind Lake (21)																	X					
Petownikip Lake (18)	X							X						X			X	X				X
Sakwasso Lake (17)	X						X	X						X			X	X				
Sandy Lake (19)	X						X	X						X	X	X	X	X			X	X
Setling Net Lake (22)																	X					
Severn River (6)	X			X	X			X						X		X	X	X		X	X	
South Trout Lake (23)						X		X						X			X					
Sutton Lake (8)					X	X	X	X						X		X	X				X	
Winisk River (4)	X		E	X	X			X				X	2	X		X						
Wunnummin Lake (11)	X						X	X						X		X	X	X				X
Watersheds																						
ALBANY	X				X	X*	X	X	X*			X		X		X	X	X		X	X	X
ATTAWAPISKAT	X		E		X		X	X	X	X	X			X		X	X	X			X	X
WINISK	X		E		X		X	X				X		X		X	X	X				X
SEVERN	X				X	X	X	X	X	X		X		X	X	X	X	X		X	X	X
SUTTON					X	X	X	X						X		X	X				X	
GOOSE		E			X		X	X						X		X	X		X	X		

Additional records from Long Lake (Harkness and Hart, 1927) shown by asterisks, are included here to make the known distribution of fishes by watershed complete.

Semotilus margarita (Cope)

The pearl dace was not common at any of the three sites at which it was collected. As in the case of *Chrosomus* spp. and *Pimephales promelas*, the pearl dace is probably widely distributed throughout the area in suitable habitats. Radforth (1944) suggests a relationship between the distribution of this species and the 65° July isotherm. The three Patricia collection sites for *S. margarita* were Goose Creek (50° July isotherm), Hawley Lake (50°–55° July isotherm), and Big Trout Lake (near the 60° July isotherm). A collection site for this species in Manitoba (Keleher, 1956) was situated at approximately the 55° July isotherm. It is apparent then, that the 65° July isotherm does not relate to the distribution of *S. margarita*. At the time of Radforth's observation, very few fish collections had been made in the Patricia Portion of Ontario.

Collection Sites (3) 5, 7, 9.

Lota lota (Linnaeus)

The burbot is widely distributed in the larger lakes and river systems of the Patricias. One notable exception is the Hawley-Sutton Lake watershed, to which apparently the burbot has not gained access. This species is generally associated with lake trout and longnose suckers in the deeper portions of the lacustrine habitat in thermally stratified lakes. In colder lakes such as Big Trout, the distribution within the lake is more general.

Collection Sites (16) 2, 3, 4, 6, 9, 11, 12, 13, 14, 19, 20, 21, 22, 23, 24, 25.

Percopsis omiscomaycus (Walbaum)

The trout-perch can be found in all the larger lakes and rivers of the Patricias. It has never gained access, however, to the Hawley-Sutton Lake watershed. Trout-perch are often a conspicuous part of the fauna during night collections (Hubbs and Lagler, 1958), and were possibly missed at some collection sites where night collections were not made.

Collection Sites (17) 2, 3, 6, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 23, 25.

Ambloplites rupestris (Rafinesque)

Only one specimen of rock bass was taken in Lake St. Joseph, the headwaters of the Albany River. This is the northernmost record in Ontario for this species although they reach a higher latitude in Lake Winnipeg, Manitoba. Rock bass are also found in small numbers in Lac Seul, about 35 miles southwest of Lake St. Joseph. It is not known how the rock bass reached the headwaters of the Albany River as the water connection between Lac Seul and Lake St. Joseph is impassable to fishes from the former to the latter lake. It is possible that at some time in the past there was a connection between the upper reaches of the Nelson River drainage and the headwaters of the Albany River, through the agency of stream piracy, or perhaps by glacial action.

The discontinuous distribution of the rock bass in the northern part of its range (it is missing in all the watersheds between the Nelson and the

Figure 3—Map of the Patricia Portion of Ontario and Akimiski Island (N.W.T.) showing the collection sites (Numbers) and distribution of four percoid species (symbols). Northward distribution of these four percids is apparently limited by the 60° July isotherm.

Moose with the above-noted exception), suggests a connection between the two extinct Pleistocene lakes, Lake Agassiz (Nelson drainage) and Lake Barlow-Ojibway (Moose drainage). The distribution of the freshwater drum and the goldeye, which are absent from the intervening drainages between the Nelson and the Moose and the Severn and the Moose respectively, supports this hypothesis.

Collection Site (1) 13.

Etheostoma exile (Girard)

The Iowa darter appears to have a discontinuous range in northern Ontario. It was taken from only Deer and Attawapiskat Lakes (Figure 3) in the Patricias and was rare in both these locations.

Collection Sites (2) 12, 25.

Etheostoma nigrum Rafinesque

The Johnny darter is the commonest darter in the Patricias. It is found in the littoral zones of all the medium to large lakes and in the larger rivers. Collection Sites (14) 2, 3, 6, 7, 9, 10, 11, 12, 13, 14, 19, 20, 23, 25.

Perca flavescens (Mitchill)

The yellow perch is common in most of the Precambrian Shield lakes of the Patricias. The Attawapiskat River marks the limits of its northward dispersal in the Hudson Bay lowlands and only one specimen was taken here in two summers of rather intensive collecting. It is absent entirely from the Hawley-Sutton Lake watershed, and missing from the lower reaches (Hudson Bay lowlands portion) of the Winisk and Severn Rivers.

The yellow perch is small and stunted in most Patricia lakes although it reaches a fair size in the Sandy-Finger Lake Region. This region is relatively warm compared to that on the same latitude lying to the east of Sandy Lake. Furthermore, Sandy and Finger Lakes are extremely shallow, and warm up more rapidly than most of the Patricia Lakes. The climate in this region then, is not so adverse for the yellow perch as in regions lying to the north and east.

The distribution of the yellow perch and three other percids (as well as the genus *Notropis*) was related to the 60° July isotherm (Figure 3). None of these species was taken north of the 60° July isotherm with the exception of one yellow perch specimen which was captured at the mouth of the Attawapiskat River after two summers of intensive collecting. This specimen was no doubt, a stray from the headwaters of the Attawapiskat River, where the yellow perch is common (Dymond and Scott, 1941).

Collection Sites (17) 3, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 23, 24, 25.

Percina caprodes (Rafinesque)

The logperch was absent from some lakes which were intensively sampled, despite the fact that it seems to have a moderately wide distribution in the Patricias. Most notable of these were Deer, Hawley, Sutton, and North Caribou. This species was quite common in some situations.

Collection Sites (9) 3, 6, 9, 10, 11, 12, 13, 17, 20.

Percina shumardi (Girard)

Only four of 25 collection sites produced the river darter (Figure 3), and two of these (Sandy and Finger Lakes) are contiguous waters. Dymond and Scott (1941), noted that this species was fairly common in the Drinking Marten River near Attawapiskat Lake. *P. shumardi* entered later collections only occasionally. Underhill (1957) places the arrival of the river darter as Post-Lake Duluth in Minnesota, based on its presence in the Red River basin (Hudson Bay drainage) and its absence in the Lake Superior basin.

Collection Sites (4) 12, 13, 19, 20.

Stizostedion canadense (Smith)

The sauger does not occur in lakes or lower reaches of the major rivers on the Hudson Bay lowlands. It is also absent from deep, clear lakes such as Big Trout and Deer. The sauger reaches its greatest abundance in the shallow, turbid waters of Sandy and Finger lakes. Its northward distribution appears to be related to the 60° July isotherm (Figure 3).

Collection Sites (11) 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 22.

Stizostedion vitreum (Mitchill)

The walleye is almost universally distributed in the medium to large lakes of the Patricias and the larger river systems. It is completely absent from the Sutton River watershed however, and other smaller watersheds originating on the Hudson Bay Lowlands. It occurs downstream almost to the estuaries of the Severn, Winisk, Attawapiskat and Albany Rivers, although it is usually more abundant above the intertidal zones in these rivers, especially from the first rapids above the intertidal zone. Walleyes taken near the mouths of the Winisk and Severn Rivers were in poor condition. Walleyes are occasionally taken in the summer in the process of resorbing their eggs, an indication perhaps of a less than favorable habitat. In Big Trout Lake the walleye is restricted to the extremely shallow west end, and the Bug River tributary. They are taken only rarely around the islands in the open, limnetic zone of the lake. Probably both cold temperatures and deep waters in the limnetic zone provide adverse conditions for the walleye at this latitude.

The walleye is absent from Echoing and Ney Lakes (Figure 1), near the headwaters of the Hayes River, a fact that might explain the extent of inland penetration by the brook trout to these lakes.

Collection Sites (19) 2, 3, 4, 6, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 23, 24, 25.

Stizostedion spp.

There is probably considerable interspecific competition between the walleye and the sauger, and they may be considered as sympatric species. The sauger reaches its greatest abundance in turbid waters and is, perhaps, better able to compete with the walleye under these conditions. Doan (1941) noted that turbid waters possibly facilitate survival of sauger spawn. In any event, the affinity demonstrated by saugers for turbid waters is well documented.

Cottus bairdi Girard

The mottled sculpin is distributed generally throughout the Patricias although it appears to be absent from the Sutton River watershed. As cottids are generally difficult species to collect, they may be even more widely distributed than indicated by their occurrence in the collections. Systematic work on this species and *C. cognatus* Richardson, is required to clearly separate the two species in the Patricia area.

Collection Sites (13) 3, 7, 9, 10, 11, 12, 13, 14, 15, 17, 19, 20, 25.

Cottus cognatus Richardson

The slimy sculpin is moderately common in the Patricia region. It is apparently absent from many of the shallow lakes and also some deep lakes. As with the preceeding species, it may be present in some lakes and not observed because of inadequate collection techniques. It occurs in many of the larger streams flowing into Hudson and James Bays.

Collection Sites (11) 2, 3, 5, 6, 9, 10, 11, 12, 17, 19, 22.

Cottus ricei (Nelson)

The spoonhead sculpin was taken in the marine waters of James Bay off Akimiski Island, and in island tidal pools. It was found in these locations in association with *Gasterosteus aculeatus*, *Pungitius pungitius* and *Myoxocephalus quadricornis* (Linnaeus). As with *C. bairdi* and *C. cognatus*, *C. ricei* is probably more common than the collections would indicate. Inland, fresh water collections of *C. ricei* were made in the lower reaches of the Severn and Attawapiskat Rivers, and in Sandy and Deer Lakes. The spoonhead sculpin was not abundant in any of these latter situations.

Collection Sites (5) 1, 3, 6, 19, 25.

Myoxocephalus quadricornis (Linnaeus)

The fourhorn sculpin was collected at five points along the Hudson and James Bay coasts in the tributary streams and tidal pools. This species occurred in the tidal pools of Akimiski Island and James Bay proper. Upstream migrations of large individuals occurred in the lower reaches of the Severn, Winisk and Attawapiskat Rivers in September. If this species (often referred to as *M. thompsoni* in fresh waters) occurs elsewhere in the Patricias and occupies a profundal niche as it does in the Great Lakes, it probably would not be collected except by bottom trawling and this was not attempted.

Collection Sites (5) 1, 3, 4, 5, 6.

Eucalia inconstans (Kirtland)

The brook stickleback was taken at only five collection sites. This species thrives however in boggy situations and is possibly widely distributed in the area.

Collection Sites (5) 2, 3, 6, 11, 14.

Gasterosteus aculeatus Linnaeus

The distribution of the threespine stickleback is limited to the coastal waters of Hudson and James Bays, the tidal pools of the coast, and the lower reaches of the influent streams. It penetrates inland at least as far as Sutton Lake, a distance by water of about 85 miles from Hudson Bay. This species was also captured in the tidal pools, intermittent streams and the James Bay coastal waters of Akimiski Island, in association with *Pungitius pungitius* (Linnaeus).

Collection Sites (5) 1, 2, 3, 7, 8.

Pungitius pungitius (Linnaeus)

The ninespine stickleback is the most widely distributed gasterosteid in the Patricias. It is exceeded in numbers only by the threespine stickleback in estuarial waters, tidal pools and on the Hudson Bay lowlands where the ninespine stickleback is also common. The latter species occurs also in the coastal waters, tidal pools and intermittent streams of Akimiski Island. The ninespine stickleback is a major forage fish in many of the larger inland lakes where it reaches its peak abundance.

Walters (1955) postulates two glacial refugia for *P. pungitius*, the Bering refugium and the Mississippi refugium. Recent work on the morphology of *P. pungitius* (McPhail, 1963), supports this theory. Dispersal of the ninespine stickleback apparently occurred through marine waters, and the form occurring on the Hudson Bay lowlands, the tidal pools and estuaries in Hudson and James Bays originated from the Bering refugium according to McPhail (1963). The inland form of *P. pungitius* dispersed from the Mississippi refugium throughout the extinct Pleistocene lakes (Lake Agassiz and Lake Barlow-Ojibway) or through headwater captures reached the Precambrian Shield portion of the Patricias.

Collection Sites (14) 1, 2, 3, 6, 7, 8, 9, 10, 11, 12, 14, 19, 20 25.

Cyclopterus lumpus Linnaeus

The first lumpfish from Ontario waters, and possibly the first from freshwater, was captured in the Winisk River by Alpheus Gull while lifting gill nets on July 15, 1964. This specimen was a mature male, measuring 127 mm. (standard length) and 161 mm. total length. It was captured in fresh water, 2 miles downstream from the townsite of Weenusk (figure 1), an unusual habitat for this marine species. The lumpfish normally occupies rocky bottom of full sea water where it attaches itself to stones by means of its modified pelvic fins which assume the form of a sucker-like disc. Often it floats among masses of aquatic vegetation. This freshwater locality, virtually devoid of large stones or aquatic vegetation, seems to provide atypical ecological conditions for an adult lumpfish.

The specimen was kindly donated to the Royal Ontario Museum (Accession No. 971) by Mr. H. G. Lumsden who also provided the information pertaining to its capture.

DISCUSSION

The present work increases the total species recorded for the Patricia Portion of Ontario from 33 (Dymond and Scott 1941) to 43, plus 1 hybrid and 2 exotics. The ranges of many of these species are extended considerably from those previously published.

The Patricias provide a rigorous climate for most fishes, and many species reach their northern limit of distribution within this region. The Patricias lie between the 50° and 65° July isotherms (Thomas, 1953), and a small portion of the Hudson Bay coastline, between Weenusk and Cape Henrietta Maria, at the junction of Hudson and James Bays, lies north of the 50° July isotherm and has a subarctic climate.

The salinity concentrations in Hudson and James Bays are not of the same magnitude as those in the Atlantic Ocean, and rather than having a true marine habitat, Hudson and James Bays should more properly be likened to a giant estuary. Movements of freshwater fishes about the open waters of Hudson and James Bays are little known, and on the basis of our present knowledge, it appears that most species remain within the individual river estuaries or move along the shoreline in the littoral region of the bays. Two brook trout tagged in the Sutton River by the Ontario Department of Lands and Forests, were later recovered in the Winisk River, a minimal distance of 55 miles travelled through Hudson Bay. Even in this case it is not known if the tagged trout ever left the estuarial influences of either the Sutton or Winisk Rivers for any length of time. Peripheral species, as defined by Darlington (1957), possibly travel freely about the littoral

Figure 4—Map of northern Ontario showing major watershed systems and their points of origin. Regions of past submergence (marine or freshwater) are delineated by broken lines. (From Geological Association of Canada, 1958. In part)

region of the bays in the summer season, but almost certainly remain within the influences of the river estuaries or their density currents, to avoid the severe winter temperatures in Hudson and James Bays as recorded by Hachey (1954). Besides the brook trout, other peripheral species that might occur both in Hudson and James Bays and their tributary streams in the Patricias are: lake sturgeon, arctic char, lake herring, lake whitefish, round whitefish, burbot, mottled sculpin, slimy sculpin, spoonhead sculpin, fourhorn sculpin, threespine stickleback and ninespine stickleback.

Eleven species of fish reach their northern distribution limits for Ontario in the Patricias. Mean air temperatures as expressed by isotherms are more important in describing northern limits of distribution than are lines of latitude. In Canada, most July isotherms reach their lowest latitude in Ontario. Consequently, fish species do not normally reach their highest latitude of distribution in that province. Besides the eight species of fishes previously described, limited by temperature in their northward distribution (Figures 2 and 3), the goldeye, fathead minnow, and rock bass also appear to reach their threshold of survival in the Patricias possibly because of low mean temperatures.

While there are certain objections to the use of isotherms in interpreting the distribution of fishes (Underhill, 1957), they provide nevertheless, the best general basis for explaining the maximum penetration of species reaching their northernmost range in Ontario. Until the actual physiological limitations of a species are known, the mean July isotherm furnishes a convenient index for a complex of limiting factors.

Darlington (1957) redefined Myers (1938) classification of fishes according to their ability to tolerate salt water. Briefly this classification is: (1) primary division species—fishes strictly confined to fresh water; (2) secondary division species—fishes having a little salt tolerance but living in fresh water; (3) peripheral division species—fishes occurring in fresh water but having much salt tolerance. Knowing Darlington's classification, as well as the present distribution of fishes, enables one to postulate on the origin of different fish species and their mode of dispersal.

Of the peripheral division fishes, the following species probably radiated both through the low salinity waters of Hudson and James Bays, as well as through the extinct Pleistocene Lakes (Lake Agassiz and Lake Barlow-Ojibway): lake sturgeon, lake herring, lake whitefish, round whitefish, burbot, all the cottids (with the possible exception of the deepwater sculpin), and the ninespine stickleback (McPhail, 1963). Unfortunately, the northern boundaries of extinct Lakes Agassiz and Barlow-Ojibway (Figure 4) are not yet clearly defined in the Patricias, and more detailed information on dispersal through these former large bodies of water would be highly speculative. Other species of peripheral division fishes apparently were restricted primarily to a marine dispersal pattern in the Patricias, occurring for the most part in Hudson and James Bays, or in tributaries readily accessible to the marine environment. These species depending on marine dispersal routes are: arctic char, brook trout, and threespine stickleback. Two other species belonging to peripheral division families (fivespine stickleback and lake trout), have no affinity for saline waters, and were

likely dispersed through the extinct Pleistocene lakes, although the latter species has been known to enter the sea (Rounsefell, 1958).

No secondary division fishes are found in the Patricias. The following primary division fishes dispersed through extinct Pleistocene lakes from their various glacial refugia: northern pike, goldeye, all the catostomids and cyprinids, trout-perch, rock bass and all the percids. More accurate delineation of the boundaries of the Extinct Pleistocene lakes, and a determination of which Pleistocene lakes were contemporaneous with one another, would help in explaining the apparent discontinuous distribution in northern Ontario and Manitoba, of such species as the goldeye, rock bass, river darter and freshwater drum.

The limited amount of sampling on Akimiski Island produced only four peripheral division species and one marine species (capelin) of fishes. The four peripheral division species, (threespine stickleback, ninespine stickleback, spoonhead sculpin, and fourhorn sculpin), were captured in intermittent freshwater streams, saltwater tidal pools, and James Bay proper around Akimiski Island, with the exception of the fourhorn sculpin which was not taken in the freshwater habitat on the island. The capture of only peripheral and marine species on Akimiski Island suggest a marine rather than deltic or glacial origin for this island.

The four major river systems of the Patricias, the Severn, Winisk, Attawapiskat and Albany, were all sampled at both their headwaters on the Precambrian Shield and at their mouths on Hudson and James Bays. The Severn and Attawapiskat Rivers were rather intensively sampled, particularly in their lower reaches. Assuming equal intensity of sampling for the four major watersheds, we might expect to collect more species from the Severn and Albany River systems, both of which have at least part of their headwaters situated on extinct glacial lake beds (Figure 4). The Winisk and Attawapiskat River systems appear to miss the extinct Pleistocene lake beds and consequently, were not as accessible to as many fish species. More species were collected from the Severn (37) and Albany (34) drainages than from the Attawapiskat (33) and Winisk (26) (Table 1), despite the fact that the Attawapiskat system was possibly the most intensively fished. When contrasting the two intensively fished drainages, (Severn and Attawapiskat, the former with accessibility to extinct Pleistocene lakes), a difference of four species is shown (Table 1). The Albany (extinct Pleistocene lake accessibility) can be similarly contrasted with the Winisk drainage basin, both these systems being less intensively fished. A difference of eight species exists between the Winisk drainage (26 species) and the Albany drainage (34 species) although at least part of this difference is due to the lack of concentrated fishing effort in the Winisk drainage. Consequently, it appears that the watersheds which had access to the extinct Pleistocene lakes (Figure 4) have a more complex species composition than those which were unaccessible. The likelihood of this speculation depends on more intensive sampling at the mouths of the Winisk and Albany Rivers and the intermediate sections of all the watersheds between their headwaters and mouths. Most species of fishes not yet recorded from the mouth of the Winisk River, but expected to occur there, are small

species. More intensive seining is indicated then, in this area. Accurate delineation of the extinct Pleistocene lakes would also enable dispersal routes to be plotted more definitely. Aside from the differences in species composition due to the previous existence of Pleistocene lakes, we should expect the four major watersheds to have a large number of species in

Table 2—Number of species (in parentheses) found in each of the four major watersheds, and number of species common to any two watersheds.

	<i>Albany</i>	<i>Attawapiskat</i>	<i>Winisk</i>	<i>Severn</i>
Albany	(34)	30	24	31
Attawapiskat	30	(33)	24	32
Winisk	24	24	(26)	25
Severn	31	32	25	(37)
Mean No. Species—32.5				
Mean No. Species in Common to 4 Watersheds—27.7				

common. The four watersheds had a mean number of species of 32.5 (Table 2), and a mean number of species in common between watersheds of 27.7. Hence, there appear to be no great differences in the species composition of the major watersheds.

The Sutton River and Goose Creek watersheds are both short and simple, arising out of the Hudson Bay lowlands (Figure 4), and flowing more or less straight to Hudson Bay. Both streams appear to have a depauperate fish fauna (14 and 12 species respectively). The Sutton watershed was intensively sampled; in Goose Creek very little seining was accomplished although gill nets were fished frequently. Many species, almost universally distributed elsewhere in the Patricias, were apparently absent from these two watersheds. The lake sturgeon, redhorse sucker, lake emerald shiner, spottail shiner, burbot, trout-perch, yellow perch, logperch, sauger, and walleye in particular were common species elsewhere in the Patricias, but were not collected in these watersheds.

While there have been many fishery investigations in the Patricias in the last ten years, only relatively few selected sites have been sampled intensively. The vastness of the area and its inaccessibility, preclude the possibility of intensive faunal sampling in the near future. The sites presently sampled with a fair degree of intensity are, however, scattered among all the major watersheds of the region, and probably represent the distribution patterns in the remainder of the Patricias.

ACKNOWLEDGEMENTS

The success of this study was dependent to a large extent on the collections made by student biologists employed on the Patricia Inventory Studies by the Ontario Department of Lands and Forests for the period from 1959 to 1962. Supplementary collections from the Pacific Salmon Project (1955-1958) were provided by the same agency. We are extremely grateful to the innumerable residents of the Patricia Portion of Ontario who assisted in our work or contributed additions to the collections.

The following people critically appraised the manuscript making many valuable suggestions in the process: Dr. W. E. Swinton, Director of the Royal Ontario Museum, Dr. J. R. Dymond, Dr. D. P. Fowler, R. Hepburn and K. H. Loftus, all of the Ontario Department of Lands and Forests.

Mr. G. C. Armstrong of the same organization provided data on the introduction of the Pacific salmon species into the Hudson Bay watershed.

Peter Buerschaper and Kenneth Zurosky of the Royal Ontario Museum prepared the field collections for later identification in the laboratory.

REFERENCES

- ALLIN, A. E. 1951
The fallfish, *Semotilus corporalis*, from Lake Superior drainage of Western Ontario. *Copeia*, No. 4: 300-301.
- COLEMAN, A. P. 1922
Glacial and post-glacial lakes in Ontario. *Publ. Ont. Fish. Res. Lab.*, No. 10: 1-76.
- COOMBS, DONALD B. 1954
The physiographic subdivisions of the Hudson Bay Lowlands south of 60 degrees north. *Geogr. Bull.* No. 6: 1-16.
- DARLINGTON, PHILIP J. JR. 1957
Zoogeography: The geographical distribution of animals. John Wiley and Sons, Inc., New York.
- DOAN, KENNETH H. 1941
Relation of sauger catch to turbidity in Lake Erie. *Ohio Jour. Sci.*, 41(6): 449-452.
- DYMOND, J. R. 1933
Biological and oceanographic conditions in Hudson Bay. 8. The Coregonine fishes of Hudson and James Bays. *Contr. Canad. Biol. and Fish.*, 8(1): 1-12.
- 1937
New records of Ontario fishes. *Copeia*, No. 1. p. 59.
- 1947
A list of the freshwater fishes of Canada east of the Rocky Mountains. *Roy. Ont. Mus. Zool., Misc. Publ.* No. 1. 36 pp.
- AND JOHN L. HART. 1927
The fishes of Lake Abitibi (Ontario) and adjacent waters. *Publ. Ont. Fish. Res. Lab.*, No. 28: 1-19.
- AND W. B. SCOTT. 1941
Fishes of Patricia Portion of the Kenora District, Ontario. *Copeia*, No. 4: 243-245.
- HACHEY, H. B. 1954
The hydrography of Hudson Bay. *Proc. Roy. Soc. Canada*, 48, Ser. III: 19-23.
- HARKNESS, WILLIAM J. K. AND JOHN L. HART. 1927
The fishes of Long Lake, Ontario. *Publ. Ont. Fish. Res. Lab.*, No. 29: 23-31.
- AND J. R. DYMOND. 1961
The lake sturgeon. *Ont. Dept. Lands and Forests.* 121 pp.
- HILLS, G. A. 1960
Regional site research. *Forest. Chron.*, 36(4): 401-423.
- HINKS, DAVID. 1943
The fishes of Manitoba. *Dept. Mines and Nat. Res., Man.* 102 pp.
- HUBBS, CARL L. AND KARL F. LAGLER. 1958
Fishes of the Great Lakes Region. *Cranbrook Inst. Sci., Bull.* No. 26. 213 pp.
- HUSTICH, ILMARI. 1957
On the phytogeography of the subarctic Hudson Bay lowland. *Acta. Geographica*, 16(1): 1-48.
- KELEHER, J. J. 1956
The northern limits of distribution in Manitoba for cyprinid fishes. *Canadian Jour. Zool.*, 34: 263-266.

- AND B. KOOYMAN. 1957
Supplement to Hinks' "The fishes of Manitoba." Dept. Mines and Nat. Res., Manitoba, pp. 104-117.
- KOELZ, WALTER. 1929
Coregonid fishes of the Great Lakes. U.S. Bur. Fish. Doc., No. 1048: 297-643.
- MCPHAIL, J. D. 1961
A systematic study of the *Salvelinus alpinus* complex in North America. Jour. Fish. Res. Bd. Canada, 18(5): 793-816.
- 1963
Geographic variation in North American ninespine sticklebacks, *Pungitius pungitius*. Jour. Fish. Res. Bd. Canada, 20(1): 27-44.
- MELVILL, C. D., A. R. M. LOWER AND NAP. A. COMEAU. 1915
Reports on fisheries investigations in Hudson and James Bays and tributary waters. Dept. Naval Serv. App. Ann. Rept., 1914: 1-85.
- MYERS, G. S. 1938
Fresh-water fishes and West Indian zoogeography. Smithsonian Rept., 1937. pp. 339-364.
- RADFORTH, ISOBEL. 1944
Some considerations of the distribution of fishes in Ontario. Contr. Roy. Ont. Mus. Zool., No. 25. 116 pp.
- ROUNSEFELL, GEORGE A. 1958
Anadromy in North American Salmonidae. U.S. Fish and Wildl. Serv., Fish. Bull. 131: 171-185.
- ROWE, J. S. 1959
Forest regions of Canada. Dept. North. Affairs and Nat. Res., Bull. 123: 1-71.
- RYDER, R. A. 1961
First Ontario record of the arctic char, *Salvelinus alpinus*. Copeia, No. 3: 359-360.
- SCOTT, W. B. AND B. KOOYMAN. 1952
A northern record for *Aplodinotus grunniens*. Canadian Field-Nat., 66(3): 89.
- THOMAS, MORLEY K. 1953
Climatological Atlas of Canada. Nat. Res. Council Canada, Publ. No. 3151. 255 pp.
- THORNTHWAITE, C. W. 1948
An approach toward a rational classification of climate. Geogr. Rev., 38: 55-94.
- UNDERHILL, JAMES C. 1957
The distribution of Minnesota minnows and darters in relation to Pleistocene glaciation. Minnesota Mus. Nat. Hist., Occ. Pap. No. 7. 4 pp.
- WALTERS, V. 1955
Fishes of western arctic America and eastern arctic Siberia. Bull. Am. Mus. Nat. Hist., 106(5): 255-368.

LIBRARY
ROYAL ONTARIO MUSEUM