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The Survey of the Fishes of the McCormick Forest

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A SURVEY OF THE FISHES OF THE McCORMICK FOREST

BY

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ABSTRACT

The four drainage systems of the Cyrus H. McCormick Experimental Forest were surveyed from May, 1975, to October, 1975 with minnow traps, gill nets, fyke nets, hook and line, a back pack electrofishing unit, and an electrofishing boat to determine the distribution and relative abundance of fish. Bog ponds and shallow warm water lakes with bog characteristics are the predominant habitats. Over 2,500 fish were collected, approximately 1,600 of which were preserved and entered in the Northern Michigan University Museum of Zoology. Twenty nine species were collected, which included a range extension for the silvery minnow (Hybognathus nuchalis) and possibly one of the first inland lake occurrences for the longnose sucker (Catostomus catostomus) within the Lake Michigan drainage. Typical bog species like the northern redbelly dace (Phoxinus eos), finescale dace (Phoxinus neogaeus), pearl dace (Semotilus margarits), fathead minnow (Pimephales promelas), and the brook stickleback (Culaea inconstans), or species which are adaptable to a variety of habitat, such as the creek chub (Semotilus atromaculatus) or the yellow perch (Perca flavescens), were distributed throughout the McCormick Forest. The redbelly dace, creek chub, brook stickleback, the Iowa darter (Etheostoma exile), were found in each drainage. Game species, such as brook trout (Salvelinus fontinalis), largemouth bass (Micropterus salmoides), smallmouth bass (Micropterus dolomieu), and northern pike (Esox lucius), were present but were not collected in large numbers. Ten families and twenty five species were collected from the Peshekee drainage which is a part of the Lake Michigan watershed (the Yellow Dog, Huron, and Dead Rivers drain to Lake Superior);

three of the families, the Esocidae, Gadidae, and the Umbridae, were found only in the Peshekee drainage. In addition, four of the five centrarchids in the McCormick Forest were found only in the Peshekee drainage. Ten of the 12 cyprinids found in the McCormick Forest were collected from the Yellow Dog drainage including the longnose dace, the only species exclusive to the drainage. The Huron and Dead River drainages included 10 and 9 species respectively with cyprinids predominating.

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I especially would like to thank Duane King, Richard Berg, and my brother Kenneth Raisanen for their herculean efforts in assisting Dr. Werner and myself with a next to impossible task, that of hauling by hand, Northern Michigan University's electrofishing boat over difficult terrain to Lower Baraga Lake. Mark McQune deserves my thanks for his assistance and some of the photographs that appear in this thesis.

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INTRODUCTION

The Cyrus H. McCormick Experimental Forest is located 11.2 km north of Lake Michigamme and 20.9 km south of Lake Superior in the northwestern part of Marquette and the eastern part of Baraga Counties in the Upper Peninsula of Michigan. Within this 6,932 hectare area are 28 lakes and the headwaters for four major drainage systems (Fig. 1): the Dead River and the Huron River drain the southeastern and northwestern portions of the tract respectively, and flow into Lake Superior to the north; the Yellow Dog River drains the northeast and central portions of the Forest and flows into Lake Independence which in turn flows into Lake Superior via the Iron River; the Peshekee River drains the western sections of the Forest and flows into Lake Michigamme to the south. Lake Michigamme in turn drains via the Michigamme River into the Menominee River and eventually into Lake Michigan.

When the McCormick Forest was willed to the United States Department of Agriculture (USDA) in 1968 by the late Gordon McCormick, several studies were undertaken to inventory the vertebrate fauna of the area (Robinson 1973, 1975, Werner 1973, 1975). These studies on amphibians, birds, mammals, and reptiles provided base line data for future observations and research. As a continuation of this undertaking, a survey of the fishes of the McCormick Forest was initiated in the spring of 1975. The objectives of the survey were to determine the species present, their distribution, and their relative abundance among the four drainage systems.

Detailed studies on the distribution of fishes in the Great Lakes Region are incomplete. This is particularly true of the Upper

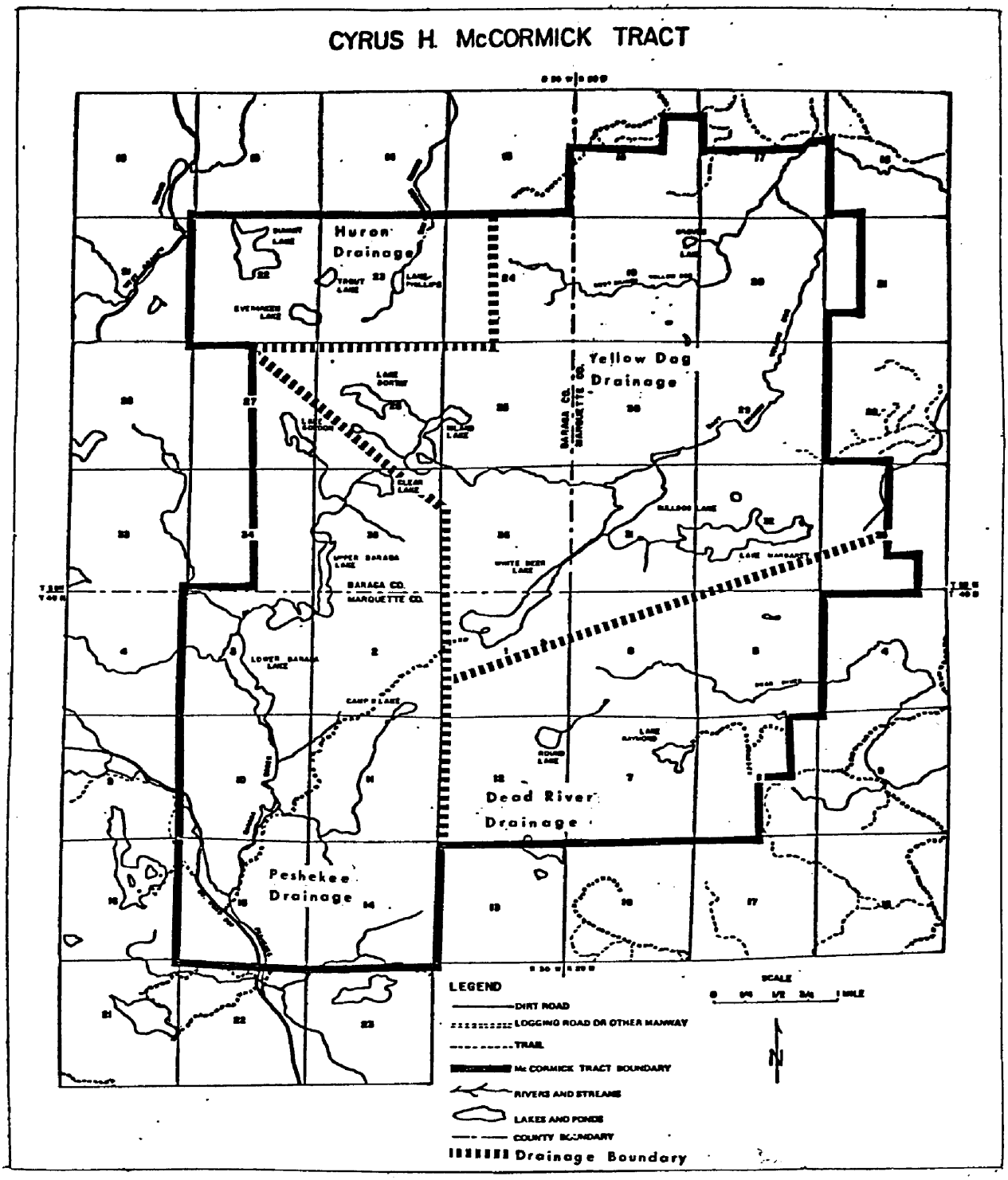

Figure 1. Map of the Cyrus H. McCormick Forest with drainage boundaries indicated.

Peninsula of Michigan and the McCormick Forest. The earliest recorded fish collections from the Lake Superior region were specimens taken from Lake Superior around 1850 (Agassiz 1850). Dr. H. J. Slack made the first recorded inland collections in 1867, when he collected common shiners (Notropis cornutus) and lake chubs (Couesius plumbeus) from the Montreal River in Keweenaw County. In 1901, Morgan Hebard collected blackshin shiners (Notropis heterodon) and golden shiners (Notemigonus crysoleucas) in the Pequaming area (possibly from Lake Superior), north of L'Anse, Michigan in Baraga County. Fowler's 1918 review of Cope's Partial Catalogue of the Cold-blooded Vertebrata of Michigan included references to the fish collected by Slack and Hebard. Adams (1906) published an account of the fish found during an ecological survey of the Porcupine Mountains located in the western end of the Upper Peninsula. The published accounts of the Shiras Expedition to Whitefish Point in Chippewa County and a survey of several lakes in Houghton County added to the early distributional knowledge of Upper Peninsula fishes (Hankinson 1916a, 1916b).

It was not until 1929 that written accounts of fish collected near the McCormick Forest were first published. That year, three publications appeared concerning the vertebrates of the Huron Mountains, a large private land holding approximately 13 km north of the McCormick Forest (Christy 1929, Hubbs 1929, Koelz 1929). This information was later compiled and updated by Manville (1948).

Upper Michigan's most extensive fish collection was made during the period from 1920 to 1938 by John N. Lowe, a former department head at Northern Michigan University. Lowe's collection includes specimens from all Upper Peninsula counties but Gogebic County at the western

end of the Upper Peninsula. Although Lowe made collections in waters that have their beginnings in the McCormick Forest, he did not make any collections within the Forest itself. Lowe's nearest collection to the McCormick Forest was in 1937 when he sampled Crooked Lake 8 km to the southwest. He also sampled Lake Michigamme in 1923, 11 km to the south, Lake Independence in 1926, 21 km to the northeast, and from 1923 to 1926, various sections of the Dead River, the closest being 27 km to the southeast (Taylor 1954).

From an examination of the McCormick property files at the Forest Service District Headquarters in Kenton, Michigan, and through personal communication with Kenneth Nowell, a former employee of the McCormick family, it has been determined that records concerning fish plants and related information were kept by the former owners. Despite assiduous effort, these records have not been located and may remain unavailable to the scientific community. During the McCormick family's period of ownership (early 1900's - 1968) several lakes were apparently stocked with fish before 1940. Largemouth bass (Micropterus salmoides) were stocked in White Deer Lake and Island Lake and trout (species unknown) were stocked in Lake Margaret and Summit Lake (personal communication with Kenneth Nowell).

In 1969 an investigation of the fish fauna was undertaken by Dwayne Campbell, a Forest Service Fisheries Biologist. Due to the remoteness of the Forest and a manpower shortage, the survey was limited. The fish populations in three lakes were sampled briefly by the hook and line method and gill nets. Several additional lakes were sampled by hook and line only. Campbell also analyzed the water quality in Lake Margaret, Summit Lake, White Deer Lake, and Lower Baraga Lake.

The influence of man's past activities in the McCormick Forest has not been extensive. Prior to the McCormick Forest's designation as an experimental forest, the land had been used for limited commercial and recreational purposes. The effects of logging during the 1880s and 1990s and cutting by the McCormick family's are remotely evident in some portions of the Forest by the presence of old stumps, the overgrown ruts of logging trails and most notably several dams. A dam was built on the Bulldog Lake outlet to ensure an adequate supply of water for floating logs downstream. This dam was later replaced by a concrete structure during the 1950s. The water levels in White Deer Lake and Bulldog Lake are still maintained by this structure. Dams have also been constructed at the outlets from Lower Baraga Lake and Clear Lake. The dates of construction are not known, but currently neither dam has much effect on the water levels in either lake.

Persistent rumors of lunker bass and trout plus the lure of an untouched wilderness kindled public interest when the McCormick land became a part of the National Forest system in 1968. Jerry Chiappetta (1970), a Michigan sports writer, reflected this interest in an article in the nationally circulated magazine, "Field and Stream". "What we found was a beautiful, unspoiled, unlittered, untrompled, and virtually unexplored wilderness with some pretty exciting and untopped fishing". For the present, public recreation in the McCormick Forest has been limited to hiking, fishing, or related activities that can be done on a day use basis only. These regulations plus the McCormick Forest's remoteness and inaccessability, have kept man's recent impact to a minimum.

METHOD AND MATERIALS

A variety of boating equipment was in use during the study. A 16 foot Forest Service boat and motor was used on the more accessible lakes, i.e. White Deer and Bulldog. A 17 foot and a 15 foot canoe plus a small lightweight aluminum john boat were used on remote lakes. The john boat (Fig. 2), although smaller than the canoes, provided more stability and room for setting nets or hauling bulky items like large minnow traps.

During the study, an electrofishing boat or boom shocker was also used in sampling the more accessible lakes (Fig. 3). The boat is similar in design to those of the Michigan Department of Natural Resources (DNR) and utilizes a variable rate DNR control panel, model 180-5. Power is supplied by a 230 volt 3500 watt 180 Hz 3-phase alternating current Homelite generator. Though potentially capable of 10 amps of alternating current the unit was limited to one or 2 amps by the low conductivity of the water. The electrofishing boat requires a crew of two or three men. One man monitors the control panel, operates the generator, controls the lighting, and maneuvers the boat using an outboard motor. The remainder of the crew, standing at the bow, nets the fish immobilized by the electric current. Operated in shallow water (one to 3 meters) at night, the electrofishing boat proved very effective.

Two types of minnow traps were used during the survey; a commercially available bait trap approximately 40 cm long and 19 cm in diameter, and a home made version of similar design 0.7 m long and 22 to 30 cm in diameter (Fig. 2). Both types were constructed of 0.3 to 0.6 cm mesh hardware cloth or similar material. The hole in the funnel of the

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Figure 2. Ten foot aluminum john boat with one large minnow trap and several small minnow traps (assembled or disassembled and stacked).

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Figure 3. Electrofishing boat with the electrodes in the water.

small traps was 1.9 to 2.5 cm in diameter and 2.5 to 7.6 cm in diameter for the larger traps. The small minnow traps could be disassembled and stacked one inside the other for easier transportation. The larger traps did not have this feature and were not used extensively in remote areas. Minnow traps were set in the shallows of larger lakes and ponds and occasionally in creeks or streams (Fig. 4). An attempt was made to place traps in all types of available habitat, especially in areas with suitable cover or locations where fish were seen. The traps were baited with white bread.

Fyke nets made of 1.9 cm heavy nylon mesh with a 58 cm diameter hoop and a 4.8 m lead were also used (Figs. 5 & 6). Fyke nets are most effective when fished in shallow water (Everhart 1953). In the McCormick lakes, these nets were set perpendicular to the shore in water deep enough to cover the net, usually 1.5 m and occasionally up to 3 m.

Gill nets were used in all but one of the lakes sampled, and until mid June two mesh sizes, 6.3 cm and 10.1 cm stretch measure, were in use. Both nets were 36.5 m long, multifilament nylon designed to be fished on the bottom. Gill nets were set perpendicular from shore with water depth ranging from 0.6 m at the shallow end to as much as 6 m on the lakeward end (Fig. 7). Offshore sets in the deeper sections of the larger lakes were also tried. Use of the 10.1 cm mesh was discontinued in mid June. Until that time only four fish had been taken by the 10.1 cm mesh while the 6.3 cm mesh, fished during the same period, had taken approximately twenty five times as many fish.

Another sampling device used was the backpack electrofishing unit (backpack shocker), which is one of the models currently used by the DNR (model BPW-1) (Fig. 8). The unit operates on a 12 volt 4 amp

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Figure 4. Small minnow trap set near shore in Lake Gordon. Brown stained water is typical of lakes in bog regions and in the McCormick Forest.

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Figure 5. Fyke nets used in the lakes of the McCormick Forest.

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Figure 6. Setting a fyke net in Island Lake.

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Figure 7. Typical gill net set, in this instance from the shore of Lake Gordon.

M. McCune

Figure 8. Electrofishing with the backpack shocker in the Island Lake outlet.

rechargeable battery. The battery's current is transformed into a pulsed 100 Hz square wave direct current with a 10 percent duty cycle and an output of 162.5 volts at two amps or 325 volts at one amp. Used mainly in rivers and small streams, this unit was very effective considering the generally low conductivity of the soft water in the McCormick Forest.

Fishing with plugs and casting equipment, i.e. the hook and line method, is not an efficient utilization of time but it was used to indicate the presence of large predatory species.

On several occasions fry were captured in the shallows of lakes using a small hand net. This also proved to be a time consuming method of collecting specimens and because of their small size, fry could not always be identified.

Because of the remoteness of the McCormick Forest and the inaccessibility of most of it's lakes and rivers, approximately half of the time in the field was spent traveling to and from the Forest or hauling equipment to and from sampling locations. A gravel road, terminating at White Deer Lake, provided the only driveable access route for bringing equipment into the interior of the Forest. Occasionally, well used foot trails allowed the use of a wheeled litter for hauling equipment (Fig. 9). The electrofishing boat was disassembled and hauled to Lower Baraga Lake by this means. Aside from White Deer, Bulldog, and Lower Baraga Lakes, equipment had to be hand carried or paddled to each sampling location.

For sampling purposes the McCormick Forest was divided into four areas based on the four drainage systems. Each drainage system was

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Figure 9. John boat strapped to the wheeled litter for hauling to the next sampling location. Photo taken at Lower Barage Lake.

given a sufficient portion of the field time, based on the number of sampling locations and their remoteness, to ensure adequate coverage. Approximately 4 weeks were spent sampling the Yellow Dog River drainage, 4 weeks on the Peshekee, and 2 weeks on the Huron and Dead River drainages. The major lakes in each drainage were sampled extensively with passive techniques (nets and traps). Because passive methods are selective toward certain species, less selective active methods (electrofishing) and supporting methods (hook and line) were used to supplement or test the efficiency of the passive collecting methods. Camp 11 Lake, Lake Phillips, and ponds less than 1.6 hectares in size not connected to a stream or tributary, were not sampled. Sections of the major rivers and streams in each drainage were sampled with the backpack shocker. If a physical barrier, i.e., a dam or waterfall was present, the stream was sampled above and below the barrier.

A rigid collecting schedule was not followed because quantative data other than relative abundance was not gathered. Nets or traps should be checked on a daily basis to minimize escape and provide high quality specimens for preservation. During this study, more than half of the nets and traps were checked 24 hours after setting, but on the average, the collecting time was 48 hours. Gill nets or fyke nets were never set for a period longer than 6 days without being checked. This limit was exceeded once with minnow traps when they were unable to be checked for 15 days due to the remoteness of the area. The effort in unit hours (Tables 1 and 2) for each type of gear is the combined time throughout the study for that particular equipment at each site. The effort for both active and passive gear does not include the time spent preparing to fish or setting equipment, it only includes the time that

Table 1 A summary of the total collecting time in hours expended for each lake and method used.[1]

Location	Minnow traps	Fyke net	Gill net	Backpack electro-fishing unit	Electrofishing boat	Hook and line	Dip net
Bulldog and White Deer	3752	48	96	1	3	1	0.5
Margaret	1680	96	72				
Island	528	88	70			1	
Dortay	1944	288	288				
Gordon	624	96	96				
Clear	864	144	144				0.5
Groves	66			1		0.5	
Lower Baraga	6072	480	48	0.5	2.5	2	
Upper Baraga	1920	192	48				
Summit	1224	96	168				
Trout	288	24	24				
Evergreen	2160	144	144				
Round	2160	96	96	1			
Raymond	2160	144	144				

[1]Collecting time is the combined time expended throughout the study for each piece of equipment at each site.

Table 2 Total collecting time in hours for each stream and method used.[1]

Location	Backpack electro-fishing unit	Minnow traps
Island Lake outlet	3	3240[2]
Clear Lake outlet	1	
Groves Lake outlet	1	
West Branch Yellow Dog River below falls	2	
West Branch Yellow Dog River above falls	1.5	
Camp 11 Creek	1	
Peshekee River	2	
Little West Branch Huron River	1	
Summit Lake outlet	1	
Dead River headwaters	2	
East Branch Yellow Dog River below falls	1.5	
East Branch Yellow Dog River above falls	0.5	
Upper Baraga Lake inlet (drainage from Lake Gordon and Clear Lake)	1	
Unnamed creek Peshekee drainage (T49N, R30W, Sec. 2)	0.5	

[1]Collecting time is the combined time throughout the study for that particular equipment at each site.

[2]This figure is derived from nine minnow traps which were not checked for 15 days due to the inaccessability of the location.

the equipment was in use.

Collected specimens were killed in the field with 10 percent formalin and later transferred to specimen jars with fresh 10 percent formalin in the laboratory. When collecting specimens which involved hiking to remote areas, formaldehyde was carried in concentrated form and diluted in the field in a light-weight plastic container. After killing, the specimens were transferred to plastic bags containing formalin soaked cotton for transport to the laboratory. The quality of specimens handled in this manner was very good if the specimens were killed immediately and remained in the killing solution for at least 0.5 hours or longer. A second transfer to fresh 10 percent formalin was made in the laboratory before specimens were placed in a permanent preservative of dilute (6.6 percent) formalin with a teaspoonful of borax added per quart to prevent shrinkage, the hardening of soft parts, and the softening of bony tissues. Specimens were identified to species using Hubbs (1958), Scott (1973), and Trautmen (1957). The specimens collected were entered into the Northern Michigan University Museum of Zoology except for several specimens sent to the University of Michigan Museum and the surplus specimens which were released alive at the collecting site.

The Four Drainage Systems, a Physical Description and Account of Sampling Techniques.

The Yellow Dog Drainage

The headwaters of the Yellow Dog River originate in the McCormick Forest. Within the Yellow Dog drainage there are six lakes, White Deer, Bulldog, Margaret, Island, Dortay, and Groves Lake (Fig. 1). The East Branch of the Yellow Dog is dominated by the interconnecting

waters (Fig. 10) of White Deer Lake and Bulldog Lake which have a combined surface area of 81.7 hectares (Forest Service report, Table 3). White Deer Lake is about 4.6 m deep while Bulldog Lake is probably about 9 m deep (Table 3). Depth estimates by Campbell (Table 4), and the estimates made during this study are primarily the result of observations made when setting or lifting gill nets and a few soundings. Both White Deer Lake and Bulldog Lake have a predominantly sand, gravel, and rock bottom. However, there are also detritus deposits in the shallows and throughout much of the northeast end of White Deer Lake and in the channel to Bulldog Lake. In Bulldog Lake, detritus deposits occur near the channel to White Deer Lake and in the area of the drainage from Island Lake. The combined flow from Lake Dortay and Island Lake plus the drainage from Lake Margaret comprise the main water sources for Bulldog Lake. White Deer Lake's main water sources are the small spring fed creeks that flow from the surrounding hillsides. Without the dam on the outlet from Bulldog Lake the water level in both lakes would probably be 1 to 2 m lower. (Fig. 11). The shoreline for both lakes is a mixture of bog habitat and hardwood-conifer forest with occasional rock outcroppings and a few very small sand or gravel beaches.

More time was spent collecting specimens from White Deer Lake than most of the other lakes due to its accessibility and the fact that the sampling techniques were initially tested there. All of the sampling methods employed during the study were used on White Deer Lake with a total collecting time of 3901.5 hours. Percentage wise, minnow traps were utilized more than any other type of gear (Table 1). Because White Deer Lake and Bulldog Lake are interconnected, the hours spent sampling both lakes, most of which occurred in White Deer Lake, were combined.

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Figure 10. Channel interconnecting Bulldog Lake and White Deer Lake.

Table 3 Physical characteristics of the lakes of the McCormick Forest.

Lake	Surface Area in Hectares[1]	Estimated Depth in Meters[2]	Shoreline in Meters[1]	Predominant Bottom Type
Bulldog	43.3	9.1	4023	Sand & Gravel
Clear	8.4	9.1	1402	Sand & Rock
Dortay	9.7	4.6	1810	Gravel & Detritus
Evergreen	6.8	6.1	1005	Sand & Detritus
Gordon	9.7	6.1	1728	Gravel & Rock
Groves	1.6	2.8		Sand & Detritus
Island	21.4	7.6	3840	Sand & Gravel
Lower Baraga	26.7	9.1	3200	Sand & Gravel
Margaret	49.4	9.1	5455	Sand & Rock
Raymond	9.7	6.1	1207	Rock & Detritus
Summit	24.7	9.1	2895	Sand & Gravel
Trout	4.5	6.1	722	Gravel
Upper Baraga	29.9	9.1	5242	Sand & Gravel
White Deer	28.4	4.6	4023	Sand & Gravel

[1]Forest Service Report (no date available).

[2]Depth estimated when setting or lifting gill nets, few actual soundings were made.

Table 4 A summary of physical characteristics of selected lakes in the McCormick Forest as reported by Campbell (1969).

Lake	Depth[1]	pH	Color[2]	Total hardness	Sampling method
Bulldog	2.4-3				
Evergreen	3				Hook and line
Lower Baraga	9.2	6.9	65	12 ppm	Gill net plus hook and line
Upper Baraga	9.2				
Margaret	7.9[3]	6.5	39	5 ppm	Hook and line
Summit	5.8[3]	7.1	23	20 ppm	Gill net plus hook and line
Trout	6.1				Hook and line
White Deer	4.6	6.8	40	12 ppm	Gill net plus hook and line

[1]Estimated depth in meters.

[2]Units on the Platinum-Cobalt scale.

[3]Maximum measured depth in meters.

Lake Margaret, whose surface area is 49.4 hectares is the largest lake in the McCormick Forest (Table 3). The shoreline around Lake Margaret is a mixture of bog habitat, hardwood-conifer forest, and rock outcrops. The lake is approximately 9 m deep and has a sand, gravel, and rock bottom. However, some detritus was encountered when setting gill nets near the outlet at the west end of the lake. Minnow traps, gill nets, and fyke nets were fished for a total of 1,848 hours (Table 1) with minnow traps being the most effective. No fish were collected from Lake Margaret with gill nets.

Island Lake, at 21.4 hectares has less than half the surface area of Lake Margaret. A depth of 7.6 was recorded when setting a gill net between the island and the point of land to the north (Fig. 1). Island Lake has extensive shallow areas that are less than 2 m deep. The shoreline is mostly bog habitat and hardwood-conifer forest. However, there are also some rock outcrops and gravel beach that is exposed during low water levels. The lake bottom is primarily gravel and rock with a little detritus. The main water sources for Island Lake are seepage from springs, a small unnamed pond to the west of Island Lake, and the outflow from Lake Dortay (Fig. 1). A total of 868 hours were spent sampling Island Lake with minnow traps, gill nets, and fyke nets (Table 1). Fish were taken by all of the passive gear with minnow traps and fyke nets being the most effective.

Lake Dortay is relatively shallow throughout, not exceeding 4.6 m in depth, and it has a surface area of 9.7 hectares. The northwest one-quarter of the lake is less than 1 m deep and has a detritus bottom with a bog shoreline. The remainder of the lake has a gravel and rock bottom with beaches of the same material backed by a hardwood-

conifer forest. Gill nets and fyke nets were fished extensively over both types of bottom with little success. A total of 2,520 hours were spent collecting in Lake Dortay (Table 1).

Groves Lake, the smallest lake sampled during the study, is the only lake drained by the West Branch of the Yellow Dog River. It has a surface area of 1.6 hectares and is probably less than 3 m deep although the depth was not verified by soundings or setting nets. There are no beaches and the lake is surrounded by bog habitat and hardwood-conifer forest. A total of 67.5 hours were spent sampling Groves Lake with minnow traps, the backpack shocker, and hook and line. One hour was also spent sampling the outlet and drainage from Groves Lake but no fish were collected or observed (Table 2).

A total of 8.5 hours were spent collecting specimens in the rivers of the Yellow Dog drainage with the backpack shocker (Table 2). Data was not kept on the length of each section of stream sampled but normally a minimum of 30 m was covered in an hour of collecting with the backpack shocker.

There are over 11.2 km of stream in the Yellow Dog drainage. The most significant in size are the drainages from Lake Margaret, Island Lake, and the East and West Branches of the Yellow Dog River. The drainage from Lake Margaret is a small stream that flows year round and was sampled only at the mouth where it flows into Bulldog Lake. The drainage from Island Lake is a larger stream that alternates sections of flowing well-aerated water with sluggish water held back by beaver (Castor canadensis) dams. This stream was sampled with minnow traps as well as the backpack shocker (Table 2). The East and West Branchs of the Yellow Dog River merge about 0.4 km before the river leaves the McCormick Forest.

The East Branch drains White Deer, Bulldog, Island, Dortay, and Lake Margaret and has a steady flow of water unless the dam on the outlet of Bulldog Lake is closed to raise the water levels in White Deer Lake and Bulldog Lake. The first 2.4 km of stream below the dam meanders sluggishly through a large open marsh with numerous beaver dams. Below the marsh, the river drops 67 m in a series of water falls and rapids over a distance of 0.64 km. Below the falls the terrain levels off and the river flows at a more moderate rate as it merges with the West Branch and then exits the McCormick Forest. Sampling above and below the falls was done with the backpack shocker (Table 2). The West Branch of the Yellow Dog River originates in the northern sections of the McCormick Forest in an area recently occupied by large beaver dams and receives water further downstream from Groves Lake (Fig. 1). Like the East Branch below the falls, the entire West Branch is a well-shaded moderately smaller and less impressive than the East Branch falls (Fig. 12). The backpack shocker was used above and below the West Branch falls of the Yellow Dog River for a total of 3.5 hours.

The Peshekee Drainage

The Peshekee River drainage system includes Upper Baraga Lake, Lower Baraga Lake, Clear Lake, Camp 11 Lake, and Lake Gordon. Upper Baraga, including the Middle Baraga Lake on some maps, and Lower Baraga Lake are the fourth and fifth largest lakes in the McCormick Forest with 29.9 and 26.7 hectares respectively (Table 3). Both lakes are about 9 m deep with a sand, gravel, and rock bottom. Lower Baraga has an extensive shallow area near the Baraga Creek outlet, while much of the north end and the smaller subbasin at the south end of Upper Baraga Lake are shallows 1 to 2 m deep. The main water sources for the Baraga Lakes are

the creeks that drain the land to the west of the McCormick Forest and the drainage from Lake Gordon and Clear Lake. The shoreline around Lower Baraga Lake has some rock outcrops and bog habitat but is primarily sand, gravel, or silt and detritus beach backed by a hardwood-conifer forest. At high water levels the shoreline vegetation often commences at the water's edge. The Upper Baraga shoreline is primarily hardwood-conifer forest to the waters edge with some rock outcrops and bog habitat.

Lake Gordon has a surface area of 9.7 hectares and a depth of 6.1 m was recorded in both subbasins in the lake when setting gill nets. The bottom is primarily gravel and rock. There are also some deposits of detritus in the shallows of the northwest half of the lake and bedrock ledges at the southeast end. Both of these locations were sampled with fyke nets, gill nets, and minnow traps (Table 1). The main water source for this lake is spring seepage and the shoreline is hardwood-conifer forest with some underlying bog habitat.

Clear Lake has a surface area of 8.4 hectares and a depth of about 6 m was recorded while setting gill nets. The sand, gravel, and rock bottom, spring seepage water supply, and the hardwood-conifer forest shoreline are typical of many of the lakes in the McCormick Forest. However, the water in Clear Lake was not stained the typical brown color, rather it was colorless.

In all, a total of 5.5 hours of sampling with the backpack shocker was done in the approximately 9 km of stream in the Peshekee River drainage system which does not originate in the McCormick Forest. The main branch of the Peshekee River originates 14 to 16 km west of the McCormick Forest and cuts through the southwest corner of the Forest

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Figure 12. Electrofishing the falls on the West Branch of the Yellow Dog River.

the creeks that drain the land to the west of the McCormick Forest and the drainage from Lake Gordon and Clear Lake. The shoreline around Lower Baraga Lake has some rock outcrops and bog habitat but is primarily sand, gravel, or silt and detritus beach backed by a hardwood-conifer forest. At high water levels the shoreline vegetation often commences at the water's edge. The Upper Baraga shoreline is primarily hardwood-conifer forest to the waters edge with some rock outcrops and bog habitat.

Lake Gordon has a surface area of 9.7 hectares and a depth of 6.1 m was recorded in both subbasins in the lake when setting gill nets. The bottom is primarily gravel and rock. There are also some deposits of detritus in the shallows of the northwest half of the lake and bedrock ledges at the southeast end. Both of these locations were sampled with fyke nets, gill nets, and minnow traps (Table 1). The main water source for this lake is spring seepage and the shoreline is hardwood-conifer forest with some underlying bog habitat.

Clear Lake has a surface area of 8.4 hectares and a depth of about 6 m was recorded while setting gill nets. The sand, gravel, and rock bottom, spring seepage water supply, and the hardwood-conifer forest shoreline are typical of many of the lakes in the McCormick Forest. However, the water in Clear Lake was not stained the typical brown color, rather it was colorless.

In all, a total of 5.5 hours of sampling with the backpack shocker was done in the approximately 9 km of stream in the Peshekee River drainage system which does not originate in the McCormick Forest. The main branch of the Peshekee River originates 14 to 16 km west of the McCormick Forest and cuts through the southwest corner of the Forest

as a large moderately-flowing stream with numerous rapids and riffles (Fig. 13). This section of the Peshekee River, which flows adjacent to County Road 607, and receives the drainage from Lake Gordon, Clear Lake, Upper Baraga Lake, and Lower Baraga Lake, was sampled twice with the backpack shocker (Table 2). Baraga Creek is a moderately sized stream that is swollen and flowing rapidly in the spring but becomes quite sluggish as the spring runoff lessens. Baraga Creek per se was not sampled, but the drainage from Camp 11 Lake and the small unnamed creek that originates in section 2 (Fig. 1), both of which flow into Baraga Creek, were (Table 2). The drainage from Camp 11 Lake has enough spring seepage to maintain a slight flow all year but the unnamed creek stops flowing completely during the summer. The drainages from Lake Gordon and Clear Lake combine to form a small moderately flowing stream with several beaver dams. This stream was sampled near Upper Baraga Lake with the backpack shocker (Table 2).

The Dead River Drainage.

There are only two lakes, Round Lake and Lake Raymond, in the Dead River drainage system that are within the McCormick Forest. Round Lake has a surface area of 7.3 hectares and is less than 3 m deep (Table 3). A portion of the east end of the lake has a sand bottom but the rest of the lake bottom is covered by detritus. The lake itself is encircled by bog mat. Lake Raymond is larger, 9.7 hectares, and deeper, up to 6.1 m. It's bottom is chiefly gravel and rock but the shallows and bay areas are often covered by detritus. Lake Raymond's shoreline is a mixture of bog habitat, hardwood-conifer forest, and rock outcroppings. Gill nets, fyke nets, and minnow traps were used in both lakes.

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Figure 13. The Peshekee River; looking north from the bridge at the entrance to the McCormick Forest.

(Table 1), but only minnow traps were effective. All of the fish collected in Round Lake or Lake Raymond were taken with minnow traps or the backpack shocker which was used in Round Lake but not in Lake Raymond. Both lakes are connected to the Dead River via intermittently flowing streams or seepage. The western headwaters of the Dead River drainage system which were sampled with the backpack shocker, originate in the McCormick Forest as a small slow-moving stream with numerous beaver dams.

The Huron Drainage.

There are four lakes in the Huron River drainage, Summit Lake and Trout Lake which drain into the Little West Branch of the Huron River, and Evergreen Lake and Lake Phillips which drain into the Little East Branch of the Huron River. Summit Lake is the largest lake with a surface area of 24.7 hectares and an approximate depth of 9 m (Table 3). The shoreline around Summit Lake is an abrupt transition from hardwood-conifer forest to water (Figure 14). The lake bottom is sand and rock with little detritus. Like Clear Lake in the Peshekee drainage, the water in Summit Lake is colorless. The water Summit Lake receives comes from Trout Lake and the springs that flow from the surrounding hills. A total of 1,448 hours were spent sampling Summit Lake with gill nets, fyke nets, and minnow traps (Table 1), all of which proved effective. Trout Lake was the second smallest lake sampled during the study (Table 3). It has a surface area of 4.5 hectares and is about 6 m deep. The bottom is chiefly gravel and detritus. The vegetation around the lake consisted of conifers with a bog habitat underlay. The drainage from Trout Lake flows intermittently into Summit Lake. A total

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Figure 14. Summit Lake shoreline.

of 336 hours were spent sampling Trout Lake with gill nets, fyke nets, and minnow traps with approximately equal effectiveness. Evergreen Lake has a surface area of 6.8 hectares and a depth of 6.1 m. The bottom is composed mostly of sand which is exposed at the east end of the lake and covered with detritus in the remaining sections. The shoreline vegetation is like that which surrounds Trout Lake with conifers and bog habitat predominating. The drainage from Evergreen Lake to Lake Phillips flows intermittently. This drainage and Lake Phillips were not sampled. The traps and nets used to sample Evergreen Lake were checked after being set for 6 days with a combined time of 2,448 hours.

There are no streams of any significant size in the Huron River drainage that lie within the McCormick Forest. The Little West Branch of the Huron River has its headwaters about 1.6 km west of the McCormick Forest but receives the outflow from Summit Lake. Although they lie outside the Forest, both the Summit Lake drainage and the Little West Branch of the Huron River were sampled with the backpack shocker (Table 2).

RESULTS

Field work began in May, 1975, and continued thru October, 1975. During this time 47 days were spent in the field, 40 of which were one day trips while the remainder included two or three day overnight trips while the remainder included two or three day overnight trips. Two additional days were spent in the field in May, 1976, to collect specimens from Round Lake.

Species Account

About 2,500 fish were taken in 69 collections throughout the McCormick Forest (Tables 5-8). Over 1,600 of these were retained for preservation, the remainder were released. Altogether, 29 species from 10 families and 21 genera were collected. The following in taxonomic order, is a brief account of the species collected in the McCormick Forest (Table 9). The terms abundant, common, and rare, used to describe the relative abundance of a species have the following connotation; abundant, easily collected in large numbers; common, collected often but not in large numbers; rare, seldom collected. Factors which might influence the apparent relative abundance of a species are presented in the discussion section of this work.

Catostomidae - the sucker family

Longnose Sucker (Catostomus catostomus)

The longnose sucker is rare in the McCormick Forest. One specimen, a male in post-breeding condition was taken in mid-June from Clear Lake in the Peshekee drainage (Table 5). This fish was collected along with 14 white suckers in a gill net. The white suckers had

Table 5 A summary of species found in the Peshekee River drainage system with the total number collected on the left and the number preserved on the right.

Family Species	Gordon Lake	Clear Lake plus the Clear Lake outlet	Upper Baraga Lake inlet	Upper Baraga Lake	Lower Baraga Lake	Peshekee River	Camp 11 Lake outlet	Unnamed creek T50N R30W Sec. 2
Catostomidae								
Catostomus catostomus		1/1						
Catostomus commersoni	55/6	16/1			6/0	2/2		
Centrarchidae								
Ambloplites rupestris				2/2	19/19			
Lepomis cyanellus	5/5							
Lepomis gibbosus	6/6							
Micropterus dolomieui					4/2	1/1		
Micropterus salmoides			2/2	4/3	3/3			
Cottidae								
Cottus bairdi			1/1			7/7	4/4	
Cyprinidae								
Notemigonus crysoleucas					5/5			
Notropis cornutus					2/2	6/6		
Phoxinus eos		2/2						10/10
Phoxinus neogaeus								1/1
Pimephales notatus		5/5				1/1		
Pimephales promelas		14/14						
Rhinichthys atratulus						41/41	5/5	
Semotilus atromaculatus	1/1	9/9	3/0			9/9	7/7	
Esocidae								
Esox lucius					5/1	1/1		

Table 5 continued

Family Species	Gordon Lake	Clear Lake plus the Clear Lake outlet	Upper Baraga Lake inlet	Upper Baraga Lake	Lower Baraga Lake	Peshekee River	Camp 11 Lake outlet	Unnamed creek T50N R30W Sec. 2
Gadidae								
Lota lota				1/1		1/1	1/1	
Gasterosteidae								
Culaea inconstans								1/1
Percidae								
Etheostoma exile		3/3						
Perca flavescens	40/9	3/3		6/6	40/39			
Percina caprodes						7/7		
Salmonidae								
Salmo trutta						1/1		
Salvelinus fontinalis			1/1					
Umbridae								
Umbra limi						1/1		

Table 6 A summary of species found in the Yellow Dog River drainage system with the total number collected on the left and the number preserved on the right.

Family Species	Bulldog and White Deer Lake	Margaret Lake	Island Lake	Island Lake outlet	Dortay Lake	West Branch Yellow Dog River below falls	West Branch Yellow Dog River above falls	East Branch Yellow Dog River below falls	Groves Lake
Catostomidae									
Catostomus commersoni							2/2		
Centrarchidae									
Micropterus salmoides	8/5		1/1						
Cottidae									
Cottus bairdi	3/3		1/1	3/0					
Cyprinidae									
Notemigonus crysoleucas	378/61	76/7	1/1	6/6					
Notropis heterolepis	10/10				1/1				
Phoxinus eos	1/1	3/3	2/2	32/32	20/20				
Phoxinus neogaeus	6/6	2/2		13/13	2/2				
Pimephales notatus	38/38		4/3						
Pimephales promelas		225/82							3/3
Rhinichthys atratulus						5/5			

Table 6 continued

Family Species	Bulldog and White Deer Lake	Margaret Lake	Island Lake	Island Lake outlet	Dortay Lake	West Branch Yellow Dog River below falls	West Branch Yellow Dog River above falls	East Branch Yellow Dog River below falls	Groves Lake
Rhinichthys cataractae						4/4			
Semotilus atromaculatus	14/11			13/13				2/2	
Semotilus margarita	10/2	1/1		52/51					
Gasterosteidae									
Culaea inconstans	2/2		6/6	2/2					12/12
Percidae									
Etheostoma exile	66/56	2/2	17/7		7/7				
Perca flavescens	116/44	74/8	40/22	30/30	9/9				
Salmonidae									
Salvelinus fontinalis						6/6	5/5	5/1	

Table 7 A summary of species found in the Huron River drainage system with the total number collected on the left and the number preserved on the right.

Family Species	Summit Lake	Trout Lake	Evergreen Lake	Summit Lake outlet	Little West Branch of the Huron River
Catostomidae					
Catostomus commersoni	13/7	1/1			
Cyprinidae					
Notropis heterolepis			1/1		
Phoxinus eos			50/50		
Rhinichthys atratulus	3/1			9/9	9/9
Semotilus atromaculatus	49/31			5/5	9/9
Semotilus margarita	20/16	2/2	60/60		
Gasterosteidae					
Culaea inconstans			10/10		
Percidae					
Etheostoma exile			1/1	2/2	
Perca flavescens	28/9	6/6			
Salmonidae					
Salvelinus fontinalis					2/2

Table 8 A summary of species found in the Dead River drainage system with the total number collected on the left and the number preserved on the right.

Family	Species	Round Lake	Raymond Lake	Dead River
Cyprinidae				
	Hybognathus nuchalis	3/3		
	Notropis heterolepis	2/0		
	Phoxinus eos	55/55	21/21	4/4
	Phoxinus neogaeus	1/1		
	Pimephales promelas	240/240		
	Semotilus atromaculatus			2/2
	Semotilus margarita	60/60	90/90	
Gasterosteidae				
	Culaea inconstans	2/2		2/2
Percidae				
	Etheostoma exile	4/1		

Table 9 Relative abundance per drainage system of the species occurring in the McCormick Forest.

Family	Species	Yellow Dog River Drainage System	Peshekee River Drainage System	Huron River Drainage System	Dead River Drainage System
		Status[1]			
Catostomidae					
	Catostomus catostomus		R		
	Catostomus commersoni	C	A	A	
Centrarchidae					
	Ambloplites rupestris		C		
	Lepomis cyanellus		C		
	Lepomis gibbosus		C		
	Micropterus dolomieui		R		
	Micropterus salmoides	C	C		
Cottidae					
	Cottus bairdi	C	C		
Cyprinidae					
	Hybognathus nuchalis				R
	Notemigonus crysoleucas	A	C		
	Notropis cornutus		R		
	Notropis heterolepis	C		R	R
	Phoxinus eos	A	A	A	A
	Phoxinus neogaeus	A	A		A
	Pimephales notatus	C	R		
	Pimephales promelas	A	C		A
	Rhinichthys atratulus	A	A	C	
	Rhinichthys cataractae	R			
	Semotilus atromaculatus	A	A	A	C
	Semotilus margarita	A		A	A
Esocidae					
	Esox lucius		A		

Table 9 continued

Family / Species	Yellow Dog River Drainage System	Peshekee River Drainage System	Huron River Drainage System	Dead River Drainage System
		Status[1]		
Gadidae				
Lota lota		R		
Gasterosteidae				
Culaea inconstans	C	C	C	C
Percidae				
Etheostoma exile	A	R	R	C
Perca flavescens	A	A	C	
Percina caprodes		C		
Salmonidae				
Salmo trutta		R		
Salvelinus fontinalis	C	R	R	
Umbridae				
Umbra lima		R		

[1] A Abundant, easily collected in large numbers.

C Common, collected often but not in great numbers.

R Rare, seldom collected.

apparently moved to inshore waters about 3 m deep for spawning. Longnose suckers were not collected in the other drainages in the McCormick Forest.

White Sucker (Catostomus commersoni)

The white sucker is common to abundant in the McCormick Forest (Table 9). This sucker was taken often in the Peshekee and Huron drainages with gill nets and fyke nets, but was not found in the Dead River drainage or above the falls on the East or West Branches of the Yellow Dog River (Tables 5-8). In the Peshekee drainage the greatest number collected came from Lake Gordon and Clear Lake when these lakes were sampled in mid-June and the suckers were spawning. White suckers were also observed in the Clear Lake outlet about 30 m downstream from the Lake in June. These fish were about 25 cm long and could have entered the stream to spawn. White suckers were also collected in Lower Baraga Lake and the Peshekee River in late July and August. In the Huron drainage, white suckers were collected in Summit and Trout Lakes (Table 7). In the Yellow Dog drainage white suckers were collected below the falls in the East Branch of the Yellow Dog River during October (Table 6).

Centrarchidae - the sunfish family

Rock Bass (Ambloplites rupestris)

The rock bass was common in the Baraga Lakes but was not collected or observed in any other location or drainage (Table 9). Most of the rock bass caught were small fish, less than 15 cm in total length, taken with minnow traps. However, one large specimen, 30 cm in total length, was collected in a fyke net. Several centrarchid nests,

presumably made by rock bass, were observed in shallow water (1 m deep) near the Lower Baraga Lake outlet in mid-July. The surface water temperature at that time was 24°C.

Green Sunfish (Lepomis cyanellus)

Green sunfish were found exclusively in Lake Gordon of the Peshekee drainage (Table 5). They were common in Lake Gordon and were readily caught along with pumpkinseed sunfish in fyke nets set in water 1 to 2 m deep. Spawning nests, which could have been made by green sunfish, were observed often in water about 1 m deep near the shore at the southeast end of the lake. The nests were small, about 0.3 m in diameter, but it could not be determined if they were made by green sunfish or by pumpkinseed.

Pumpkinseed (Lepomis gibbosus)

Pumpkinseeds were found exclusively in Lake Gordon (Table 5). They were common in the lake and were readily caught along with green sunfish in fyke nets set in water 1 to 2 m deep. The spawning nests mentioned in the account of the green sunfish could have been excavated by pumpkinseeds which spawn at the same time and in a similar manner. The surface water temperature (taken about 12 cm below the water surface) was about 16°C when the nests were observed.

Smallmouth Bass (Micropterus dolomieui)

One adult smallmouth bass, 48 cm total length, and two young of the year were taken from Lower Baraga Lake late in July (Table 5). One additional fry was collected in the Peshekee River. Although considered common in the Baraga Lakes of the Peshekee drainage smallmouth bass were not found in the other drainage systems of the McCormick

Forest nor the rest of the Peshekee drainage.

Largemouth Bass (Micropterus salmoides)

Largemouth bass were common throughout much of the McCormick Forest (Table 9). Specimens were collected and observed in White Deer Lake, Bulldog Lake, and Island Lake of the Yellow Dog drainage (Table 6). In the Peshekee drainage largemouth bass were collected in the Baraga Lakes and observed in Lake Gordon and Clear Lake (Table 5). A single largemouth bass was observed on a nest in Clear Lake when that lake was sampled in June and the water temperature 0.6 m below the surface was about 15°C. Largemouth bass were not found in the Huron or Dead River drainages.

Cottidae - the sculpin family

Mottled Sculpin (Cottus bairdi)

Mottled sculpins were abundant in flowing waters of the Peshekee drainage (Table 5). They were less abundant in the quiet waters of the Peshekee drainage and in the Yellow Dog drainage where they were found in White Deer, Bulldog, Island Lake, and the Island Lake drainage (Table 6). Sculpins were not collected below the falls on either branch of the Yellow Dog River, nor were they found in the Huron or Dead River drainages.

Cyprinidae - the minnow family

Silvery Minnow (Hybognathus nuchalis)

This species is rare in the McCormick Forest and has never been reported as occurring in Michigan before this study. One silvery minnow was collected from Round Lake in the Dead River drainage in

September, 1975 (Table 8). Two additional specimens were collected from the shallows of Round Lake in May, 1976. This species was not collected in the other drainages of the McCormick Forest. The status of this species is being further investigated.

Golden Shiner (Notemigonus crysoleucas)

Golden shiners were abundant in the Yellow Dog drainage (Table 6). More golden shiners were caught in White Deer Lake than any other species from a single location and golden shiners were the second most numerous species collected in the Forest. Golden Shiners were less numerous, but still abundant in Lake Margaret, few were collected from Island Lake and none were found in Lake Dortay. In the Peshekee drainage, golden shiners were common in the Baraga Lakes. Few specimens were collected from the Baraga Lakes but schools of golden shiners were observed (Table 5). This species was not collected or observed in the remaining lakes of the Peshekee drainage and it was not found in the Huron or Dead River drainages.

Common Shiner (Notropis cornutus)

Common shiners were rare in the McCormick Forest (Table 9). Two adults were collected from Lower Baraga Lake with the electrofishing boat and young of the year were taken from the Peshekee River in August, 1975 (Table 5). This species was not collected in the remaining lakes of the Peshekee drainage or from the rest of the McCormick Forest.

Blacknose Shiner (Notropis heterolepis)

The blacknose shiner is common in the McCormick Forest although it was collected in small numbers. This species was collected from

scattered locations in all drainages but the Peshekee (Tables 5-8).

Northern Redbelly Dace (Phoxinus eos)

The northern redbelly dace is one of four species that were found in all four drainage systems (Tables 5-8). This minnow is abundant in the McCormick Forest and was usually taken in large numbers from suitable habitat. Only one other species, the creek chub, was found in a greater number of locations. Female redbelly dace collected from the unnamed creek in section 2 (Fig. 1) in May contained small underdeveloped eggs while those collected from the Island Lake drainage in mid-June and from Groves Lake in mid-August seemed ready to spawn.

Finescale Dace (Phoxinus neogaeus)

This species was always collected in association with the northern redbelly dace but was not as widely distributed (Tables 5-8). Common to abundant in the McCormick Forest (Table 9), finescale dace were found in all but the Huron River drainage.

Bluntnose Minnow (Pimephales notatus)

Bluntnose minnows were also common in the McCormick Forest. The greatest number collected during the study came from White Deer Lake in the Yellow Dog drainage. A few specimens were also collected from Island Lake (Table 6). Males collected from White Deer Lake and Island Lake were in breeding condition as evidenced by well developed breeding tubercles on the snout. In the Peshekee drainage, bluntnose minnows were taken from two widely separated locations, the Peshekee River and Clear Lake (Table 6). Bluntnose minnows were not collected from the other drainages.

Fathead Minnow (Pimephales promelas)

Fathead minnows were collected in greater numbers than any other species and were considered abundant in the McCormick Forest (Table 9). In the Yellow Dog drainage, fatheads were the most numerous species collected from Lake Margaret. A few specimens were also taken from Groves Lake (Table 6). The fathead minnows collected from both lakes were in breeding condition. The males had well-developed breeding tubercles on the snout and an equally well-developed spongy pad on the back from behind the head to the base of the dorsal fin. Fathead minnows were also the most numerous fish collected in the Dead River drainage where they were found in Round Lake (Table 8). In the Peshekee drainage fathead minnows were collected in small numbers from Clear Lake and the Clear Lake outlet (Table 5). This species was not found in the Huron River drainage. The specimens collected from Clear Lake and Groves Lake seem considerably smaller than those collected from Lake Margaret. Mature males collected from Clear Lake and Groves Lake were about 45-60 mm long while the Lake Margaret specimens were about 75-90 mm long. There was also variation as to the length of the lateral line. Those from Lake Margaret had a lateral line that was almost complete while those from Clear or Groves Lake had a lateral line that ended below the dorsal fin.

Blacknose Dace (Rhinichthys atratulus)

Blacknose dace are considered common in the McCormick Forest (Table 9). Locally abundant populations were found in the Peshekee River and the outlet from Camp 11 Lake in the Peshekee drainage (Table 5). In the Yellow Dog drainage, blacknose dace were found below the falls on the East and West Branches (Table 6). In the Huron drainage, black-

nose dace were collected from Summit Lake and from the Summit Lake outlet just outside the McCormick Forest (Table 7). This species was not found in the Dead River drainage.

Longnose Dace (Rhinichthys cataractae)

Longnose dace were common below the falls on the West Branch of the Yellow Dog River but were not found in any other location in the Forest (Table 6).

Creek Chub (Semotilus atromaculatus)

Creek chubs are abundant throughout the Forest (Table 9). This species was found in each drainage and was collected in more locations than any other fish. In the Peshekee and Dead River drainages, creek chubs were found in flowing waters (Table 5). In the Huron drainage creek chubs were abundant in Summit Lake and common in the Summit Lake outlet and the Little West Branch of the Huron River (Table 7). In the Yellow Dog drainage, creek chubs were collected in White Deer, Bulldog, Island Lake, and the Island Lake outlet, and were collected above and below the falls on the East Branch of the Yellow Dog River (Table 5).

Pearl Dace (Semotilus margarita)

Pearl dace were not found in the Peshekee drainage but were abundant in the other drainages systems. A considerable number of pearl dace were collected from the lakes of the Dead River and Huron drainages (Tables 7 & 8). This species was also present in the lakes of the Yellow Dog drainage but the greatest number of specimens came from the Island Lake outlet (Table 6).

Esocidae - the pike family

Northern Pike (Esox lucius)

Northern pike, which were abundant in the Baraga Lakes, were not found in the rest of the Peshekee drainage with the exception of one specimen collected in the Peshekee River (Table 5). Northern pike were not collected or observed in the other drainages in the McCormick Forest.

Gadidae - the cod family

Burbot (Lota lota)

Burbot were collected only in the Peshekee drainage (Table 5). Three specimens, 15 to 30 cm in total length were collected, one each from Upper Baraga Lake, the Camp 11 Lake outlet, and the Peshekee River.

Gasterosteidae - the stickleback family

Brook Stickleback (Culaea inconstans)

Brook stickleback were one of the four species collected in each drainage system (Tables 5-8), and are considered common in the McCormick Forest (Table 9). The greatest number collected came from Groves Lake in the Yellow Dog drainage and Evergreen Lake in the Huron drainage.

Percidae - the perch family

Iowa Darter (Etheostoma exile)

Common in the McCormick Forest, Iowa darters were also found in each drainage system (Tables 5-8). The greatest number of Iowa darters were collected from White Deer Lake and Island Lake of the

Yellow Dog drainage. Iowa darters were not limited to these two lakes but were found in all but Groves Lake of the Yellow Dog drainage (Table 6). In the Dead River drainage Iowa darters were found in Round Lake (Table 8). In the Peshekee drainage this darter was found in the outlet from Clear Lake and in the Huron drainage they were collected just outside the McCormick boundary in the Summit Lake outlet (Tables 6 & 7).

Yellow Perch (Perca flavescens)

Yellow perch were the third most commonly collected fish in the McCormick Forest and were abundant in the Yellow Dog and Peshekee drainages (Tables 5 & 6). Perch were collected in all of the lakes sampled in these two drainages except Groves Lake. In the Huron drainage, perch were found in Summit Lake and Trout Lake. Yellow perch were not found in the Dead River drainage.

Logperch (Percina caprodes)

Logperch are rare in the McCormick Forest as a whole (Table 9). However, it was common in the only location from which it was collected, the Peshekee River (Table 5).

Salmonidae - the trout family

Brown Trout (Salmo trutta)

Brown trout are rare in the McCormick Forest. Only one specimen was taken from the Peshekee River and none were observed or caught in any other location (Table 5).

Brook Trout (Salvelinus fontinalis)

Brook trout range from abundant to rare in the McCormick Forest (Table 9). In the Yellow Dog drainage, brook trout were abundant below the falls on the East Branch of the Yellow Dog River and as abundant above and below the falls on the West Branch of the Yellow Dog but they were not found in the remainder of the drainage (Table 6). A single isolated population was found in the connecting waters between Upper Baraga Lake and Lake Gordon (Table 5). Brook trout were not found in the Dead River drainage and they were not collected within the Forest's boundaries in the Huron drainage. However, brook trout were collected from the Little West Branch of the Huron River just outside of the McCormick Forest (Table 7).

Umbridae - the mudminnow family

Central Mudminnow (Umbra limi)

A single mudminnow was collected from the Peshekee River of the Peshekee drainage system (Table 6). This species was not collected from any other location and is considered rare in the McCormick Forest.

DISCUSSION

The lakes of the McCormick Forest are typical of those in the western part of the Upper Peninsula of Michigan. The topography of the region and the dissolved substances in the water are strongly influenced by the bedrock exposed during the glaciation of an old mountain system. The bedrock in the McCormick Forest is composed mostly of granite, gneiss, and slate, rocks poor in dissolvable nutrients. The glacial drift tends to be acidic (Forest service soils report) and the soils that have formed have been strongly influenced by poor drainage and a history of conifer forests. Consequently the lakes formed in the McCormick Forest are acidic, soft, and relatively unproductive. These properties and the dark stained brown water, which is caused by an accumulation of leached humic material from the soil, are characteristic of bogs and lakes in bog regions (Ruttner 1968). Clear Lake is the only clear water lake in the McCormick Forest. Because the humic matter responsible for the brown coloration, flocculates in the presence of dissolved salts, particularly calcium, clear water lakes are usually alkaline lakes. Campbell found that Summit Lake was slightly basic and did have a higher total alkalinity then the brown water lakes that he tested (Table 4). Alkaline lakes are usually quite productive but the total alkalinity in Summit Lake and presumably Clear Lake, is so low that it is doubtful that there is much difference in the productivity of Summit Lake or the brown water lakes of the McCormick Forest.

Typical bog waters have a substrate that is composed exclusively of organic matter, (detritus). The breakdown of this material through decomposition or aerobic metabolism can cause an oxygen deficient con-

dition or in extreme situations, the total depletion of the dissolved oxygen in the water. In small shallow bog pools this can occur at any time of the year. In lakes with detritus accumulations, oxygen deficiency (winterkill), is likely to occur during the winter when atmospheric oxygen and sunlight is unable to reach the water due to a covering of ice and snow. Lakes that are susceptible to winterkill are usually inhabited by warm water species better able to tolerate low oxygen concentrations (Hubbs 1958). The following lakes in the McCormick Forest, Round, Groves, Camp 11, Dortay, Evergreen, Phillips and possibly White Deer Lake, have accumulated enough detritus that winterkill is likely during severe winters with heavy accumulations of snow. The remainder of the lakes in the McCormick Forest have predominantly rock, gravel, and sand bottoms with little detritus. The possibility of winterkill in these lakes should be slight.

Hubbs (1958) also classified lakes as warm or cold water lakes on the basis of their ability to support trout. Although a bottom temperature reading of 16.6°C taken in July in Lower Baraga Lake and 12.2°C from the bottom of Summit Lake in August are within the tolerance limits for brook trout, no trout were taken in these or any other lakes in the McCormick Forest. Cold water lakes that become ice covered in winter stratify thermally during the summer and have hypolimnetic temperatures near 4°C. The bottom temperatures recorded in Summit Lake and Lower Baraga indicate that stratification had not occurred. Few lakes less than 6.0 m deep stratify (Hubbs 1958), and it is doubtful that many lakes in the McCormick Forest stratify strongly.

All of the lakes in the McCormick Forest would be classified as shallow water lakes. Campbell concluded that water as deep as 9.1 m

might be found in the Baraga Lakes. The maximum depth recorded by Campbell was 7.9 m in Lake Margaret (Table 1). The soundings and observations made during this study (Table 2) confirm Campbell's conclusions. It is unlikely that any of the lakes in the McCormick Forest are deeper than 9.1 m and most are less than 7.6 m deep. Shallow water lakes that do not stratify during the summer are also prone to winterkill like those lakes with heavy detritus accumulations.

The effectiveness or validity of any sampling done with passive sampling equipment, i.e. nets or traps, depends on the movement of the species to be collected. A species' susceptibility to capture can be affected by seasonal migration, spawning activity, diurnal movement, habitat preferences, activity patterns, or responses to temperature and other environmental factors. When sampling lasts for more than a few days most of these factors must be taken into account. Active sampling equipment, such as the backpack shocker or the electrofishing boat, is more effective than passive gear because it is not limited as much by the activities of the fish. Rather the limitations are more mechanical in nature. For instance, when electrofishing, the conductivity of the water, its turbidity and depth, the type of electric current being used (A.C. or D.C.), or the size of the fish can affect efficiency (McCrimmon 1963, Weber 1973). To counter the deficiencies of specific collecting gear a variety of sampling methods or equipment can be used (Waters 1960). In the McCormick Forest passive sampling equipment, consisting of two different sized minnow traps, two gill net sizes, and a single fyke net design, was used to sample the remote lakes inaccessible with the more effective electrofishing boat.

To provide an indication of the effectiveness of the passive equipment, White Deer Lake and interconnecting Bulldog Lake were sampled extensively with all of the passive and active collecting equipment used during the study (Table 1). Except for the electrofishing boat, which was not used on White Deer or Bulldog Lake until September, 1975, all of the sampling was completed on both lakes by the end of May, 1975.

In White Deer Lake and Bulldog Lake two species, the pearl dace and the blacknose shiner, were collected with the electrofishing boat and were not collected by any of the passive fishing equipment (Table 10). However, both of these species were collected in other locations with minnow traps (Table 6). Four of the species collected with minnow traps, the northern redbelly dace, finescale dace, brook stickleback, and the mottled sculpin, were not collected by the electrofishing boat. The reader should not be mislead and assume that the electrofishing boat was not as effective. The passive sampling equipment was highly successful in White Deer Lake and Bulldog Lake for two reasons. First, the normal habitat for the first three species mentioned above is shallow, weedy water that is easily sampled with minnow traps but not the electrofishing boat, the sculpin is also difficult to collect with the electrofishing boat because it is a bottom dwelling species that usually remains on the bottom when stunned. However, these species would probably have been collected by the electrofishing boat if an effort equal to that expended with the passive gear had been exerted with the electrofishing boat. Second, all of the fish collected in White Deer Lake and Bulldog Lake, with the exception of the Centrarchids, spawn in the spring. When these lakes were sampled in May, 1975, spawning had just been completed by the early spawning species such as

Table 10 A comparison between active and passive collecting methods on White Deer Lake and Bulldog Lake.[1]

Species	Minnow traps	Gill nets	Fyke nets	Electrofishing boat	Backpack shocker	Hand dip net	Hook and line
Micropterus salmoides		X		X			X
Cottus bairdi	X				X		
Notemigonus crysoleucas	X			X		X	
Phoxinus eos	X						
Phoxinus neogaeus	X						
Pimephales notatus	X			X	X		
Semotilus atromaculatus	X			X	X		
Semotilus margarita				X			
Culaea inconstans	X						
Etheostoma exile	X			X			
Perca flavescens	X		X	X	X		X

[1] X indicates collection of species.

the yellow perch and the stickleback while the minnows and darters were just beginning, or were actively spawning. Because all of these species spawn in shallow water and are quite active at this time of the year they were easily caught in minnow traps or fyke nets.

Lower Baraga Lake was sampled extensively with minnow traps, fyke nets, and the electrofishing boat, during August, 1975. In Lower Baraga Lake the eight species found in the lake were collected with the electrofishing boat. Four of these, the largemouth bass, smallmouth bass, golden shiner, and common shiner, were not collected from Lower Baraga Lake with passive equipment (Table 11). Of the four, the smallmouth bass and the common shiner were collected from other locations in the Peshekee drainage (Table 5), but with the backpack shocker, an active collecting method, while the golden shiner was found only in Lower Baraga Lake. Only the largemouth bass was collected by passive means in the Peshekee drainage, and then only from Upper Baraga Lake with minnow traps. When Lower Baraga Lake was sampled in August, 1975, the fish collected had completed spawning and the water temperature was quite warm at 25.5°C. Consequently most of the species had moved to deeper cooler water where minnow traps and fyke nets are not as effective. Another possible explanation for the poor results with passive gear in Lower Baraga Lake, especially as far as the minnows are concerned, is that the small species and their populations are not as numerous as in White Deer Lake or Bulldog Lake and therefore less likely to be collected. This is a likely possibility for the number of fish collected in Lower Baraga Lake with the electrofishing boat was also less than the number collected for White Deer Lake or Bulldog Lake. The presence of four piscivorous species, the northern pike, largemouth bass, small-

Table 11 A comparison between active and passive collecting methods on Lower Baraga Lake.[1]

Species	Minnow Traps	Gill Nets	Fyke Nets	Electrofishing Boat	Back Pack Shocker	Hook and Line
Catostomus commersoni		X	X	X		X
Ambloplites rupestris	X		X	X		
Micropterus dolomiei				X		
Micropterus salmoides				X		X
Notemigonus crysoleucas				X		
Notropis cornutus				X		
Esox lucius	X		X	X		X
Perca flavescens	X		X	X	X	

[1] X indicates collection of the species.

bass, and burbot, in the Peshekee drainage could account for this. The lack of extensive shallow weedy habitat for spawning may also be responsible for the apparently small minnow populations in Lower Baraga Lake. The largemouth bass and smallmouth bass which were not collected by passive gear in Lower Baraga Lake are difficult to collect in nets or traps because of their territorial habits inactivity, and preference for cover during the summer (Crossman 1973).

When considering the effectiveness of the various sampling methods as indicated by the above comparisons, it would have to be concluded that some species are present in various lakes but were not collected. Approximately 60 percent of the species collected by Lowe in Marquette and Baraga Counties were found in the McCormick Forest. Considering the lack of habitat diversity in the McCormick Forest the sampling efficiency for the McCormick Forest as a whole was probably very good, perhaps 80 to 100 percent of the species present were collected.

Drainage Comparisons

Peshekee Drainage

Of the four drainages in the McCormick Forest the Peshekee drainage had the greatest variety of fish representing 10 families, 20 genera, and 25 species (Table 5). Three of the families, the pike (Esocidae), the cod (Gadidae), and the mudminnows (Umbridae) were only found in the Peshekee drainage and had one representative species each, the northern pike, burbot, and the central mudminnow respectively. Also found only in the Peshekee drainage were the rock bass, green sunfish, pumpkinseed, and smallmouth bass from the Centrarchidae; the longnose sucker from the Catostomidae; the brown trout from the Salmonidae; the common shiner from the Cyprinidae, and the logperch from the Percidae;

however these families were not exclusive to the Peshekee drainage. There were only four species, the silvery minnow, blacknose shiner, longnose dace, and pearl dace, all from the minnow family, that were not found in the Peshekee drainage. The species collected most often in the Peshekee drainage were the yellow perch and the white sucker. Very few minnows were collected except in Clear Lake and the Pehsekee River. The abundance of species in the Peshekee drainage is undoubtedly due to the size of the river and its southerly connections via Lake Michigamme and the Menominee River to Lake Michigan and past Great Lakes drainage via the Mississippi River which afforded entry to the Great Lakes from the Northwest and the upper Mississippi Valley (Hubbs 1958, Darlington 1957, p. 67). The species found in the river itself did not greatly increase the count since only one fish, the logperch, was found exclusively in the Peshekee River. Rather the variety of habitat afforted by the river, continuous flow, plus the relative lack of physical barriers, have provided a variety of fish with easy access to the McCormick Forest. The species that utilize or tolerate large rivers such as the northern pike, burbot, white sucker, smallmouth bass, rock bass, pumpkinseed, and some of the minnows probably entered the McCormick Forest via the present river. The remaining species in the Peshekee drainage including many of the minnows, the Iowa darter, yellow perch, or perhaps some of those already mentioned, conceivably followed the retreating glaciers, establishing themselves via presently non-existant streams (Darlington 1957 p. 586). Inevitably some, like the brook trout, and possibly the longnose sucker were left in isolated areas where they were able to survive. Not included above are the species introduced by man, the brown trout, perhaps the green sunfish, and possibly the

largemouth bass which could have established themselves in the Peshekee drainage after being introduced in some part of the Michigamme River or Menominee River drainages.

Yellow Dog Drainage

The Yellow Dog drainage had the second highest number of representative species and families in the McCormick Forest (17 species from 7 families). There were no families exclusive to the Yellow Dog drainage and only one species, the longnose dace, was not found in any other drainage. More cyprinids both in numbers and species diversity were collected in the Yellow Dog drainage than from any other drainage (Table 6). Although this may have been the result of sampling in the spring when the fish are spawning and collecting is easier, or it may also be due to the lack of predatory fish or competition from species such as the sunfish or suckers, and a variety of favorable habitat. Until recently when the largemouth bass was introduced into White Deer Lake and Island Lake, the only piscivorous species were the yellow perch and large creek chubs. Golden shiners, fathead minnows, and yellow perch were collected in the greatest numbers while the redbelly dace was collected from the most locations, which was indicative of the abundance of its preferred habitat, shallow clear water bog ponds and pools.

In a paper on the distribution of minnows and darters in Minnesota, Underhill (1957) listed specific minnows and darters that were considered as early arrivers after the recession of the glaciers. All of the minnows and the Iowa darter collected in the Yellow Dog drainage (Table 6) are included in that list. It would seem that species which are now established in the Yellow Dog drainage did so shortly after or as the glacier was receding from the area and before the falls

on the East and West Branches of the Yellow Dog River became an important physical barrier to upstream movement. It is also possible that the lakes in the McCormick Forest presently drained via the East Branch of the Yellow Dog River were at one time a part of the Dead River drainage. Theoretically the drainage followed the course presently occupied by Mulligan Creek which drains the low area less than 1 km to the east of the East Branch of the Yellow Dog River. There is some distributional evidence for this assumption in Lowe's records and in the collections made in the Yellow Dog and Dead River drainages in the McCormick Forest. Eight species, the pearl dace, fathead minnow, northern redbelly dace, finscale dace, blacknose shiner, creek chub, Iowa darter, and brook stickleback, were collected by Lowe in the Dead River outside the McCormick Forest but were not found by him in Lake Independence which receives water from the Yellow Dog River (Taylor 1954) (Table 12). In the McCormick Forest all eight of these species were collected in the Dead River drainage and the lakes drained by the East Branch of the Yellow Dog. Although not found in the Dead River drainage within the McCormick Forest, the golden shiner, which is very abundant in the lakes drained by the East Branch of the Yellow Dog River, was also collected by Lowe in the Dead River and not in Lake Independence.

The above assumed connection of the lakes presently drained by the East Branch of the Yellow Dog River, to the Dead River, could not have existed long because several species, the blacknose dace, longnose dace, and white sucker, found in the Dead River (Taylor 1954) and below the falls in the Yellow Dog River, are not found above the falls in the McCormick Forest. However the lack of suitable habitat could also be responsible for the failure of the longnose dace or the blacknose dace

Table 12. Comparison of the species collected during the present study from the lakes drained by the East Branch of the Yellow Dog River and the Dead River drainage with the species collected by Lowe from the Dead River and Lake Independence.

	Present Study			Lowe's Collection
	Lakes drained by the East Branch of the Yellow Dog River	Dead River	Dead River	Lake Independence
Cottus bairdi	X		X	X
Notemigonus crysoleucas	X		X	
Notropis heterolepis	X	X	X	
Phoxinus eos	X	X	X	
Phoxinus neogaeus	X	X		
Pimephales notatus	X			
Pimephales promelas	X	X	X	
Semotilus atromaculatus	X	X	X	
Semotilus margarita	X	X	X	
Culaea inconstans	X	X	X	
Etheostoma exile	X	X	X	

to become established above the falls on the East Branch of the Yellow Dog River, for both species prefer swiftly flowing water and this type of habitat is not abundant above the falls. The white sucker might have at one time occupied the lakes drained by the East Branch of the Yellow Dog River and died off, or was prevented from moving into the lakes by physical barriers like the falls. The latter seems more plausible because the lakes in the Yellow Dog drainage are physically similar to those in the McCormick Forest where white suckers are present.

The centrarchids, with the exception of the largemouth bass which was introduced, are notable for their absence from the lakes of the Yellow Dog drainage in the McCormick Forest. Apparently ecological barriers (probably stream habitat) or physical impediments (falls or rapids) existed that prevented sunfish from reaching the McCormick Forest through the Dead River drainage if that was the original drainage pattern. A similar situation exists today in the Yellow Dog River for sunfish have not moved upstream to the McCormick Forest from Lake Independence.

The presence of the yellow perch in all of the lakes drained by the East Branch of the Yellow Dog River implies that this species was in the process of establishing itself in the area before the white sucker, longnose dace, and blacknose dace arrived, that is, as the glacier was receding.

Huron Drainage

In the Huron River drainage 10 species and 9 genera and five families were collected (Table 7). However, one species, the brook trout was collected outside the McCormick Forest in the Little West Branch of the Huron River about 0.8 km west of Summit Lake. The Cyprinids

were the most common family in the drainage with five species. The most numerous and widely distributed fish were the pearl dace and the creek chub. In addition to Cyprinids, Summit Lake and Trout Lake were also occupied by yellow perch and white suckers. Evergreen Lake contained three Cyprinids, the pearl dace, northern redbelly dace, and the blacknose shiner, a Casterosteidae, the brook stickleback, and a single Percidae, the Iowa Darter. As indicated, the Iowa darter and the minnows are considered early arrivers following the recession of the glaciers (Underhill 1957). The absence of the yellow perch and the white sucker from Evergreen Lake and presumably Lake Phillips which was not sampled, could be due to the small intermittantly flowing outlet to Lake Phillips and the Little East Branch of the Huron River. However, the connection from Summit Lake to Trout Lake is seemingly as poor, yet yellow perch and white suckers are established in Trout Lake. Presumably the connection to Lake Evergreen was better developed at one time as was the connection to Trout Lake. Lack of suitable spawning habitat (detritus free sand or gravel), could account for the failure of white suckers to become established in Evergreen Lake but the absence of yellow perch which can produce in similar lakes, would be hard to explain if yellow perch had access to the lake.

Dead River Drainage

There were nine species and seven genera from three families collected in the Dead River drainage (Table 8), less than other drainages in the Forest. The bulk of the species and the greatest number of fish belong to the minnow family. The brook stickleback, and the Iowa darter were the only species collected in the Dead River drainage that were not

from the minnow family. The most unusual or unexpected species collected during the study, the silvery minnow, came from Round Lake in the Dead River drainage. How this species became established in Round Lake is a mystery for the silvery minnow (if that in fact is what it is) has never been collected in Michigan. The eastern subspecies, the eastern silvery minnow, occurs in the eastern portion of the Lake Ontario drainage while the western silvery minnow avoids the Great Lakes altogether. Confirmation of the species is being made at the University of Michigan Museum.

Round Lake is well suited for species such as the silvery minnow or northern redbelly dace which prefer small shallow bog ponds or pools. Other species which might have found their way into Round Lake have failed to establish themselves, probably due to a lack of spawning habitat and winterkill.

Apparently the outlet from Lake Raymond has never been well developed or downstream barriers were present which prevented common species such as the yellow perch from becoming established in the lake.

Discussion of Species Distribution in The McCormick Forest

The following in taxonomic order is a brief account of the distribution, habitat preferences, previous collections, and general notes relating to the relative abundance of the species occurring in the McCormick Forest. Although some of the species found in the McCormick Forest are distributed world wide in the northern regions, like the northern pike or the yellow perch, or have been introduced to other continents like the largemouth bass, only a generalization of the North American range will be given for it is sufficient for the purpose

of this discussion. Data on the distribution and abundance of species in the Upper Peninsula are from Taylor's (1954) review of the Lowe fish collections in the Upper Peninsula. References to Lowe's collections refer to collections made by him outside the McCormick Forest in drainage systems that have headwaters in the Forest. Descriptions of species habitat preferences are brief excerpts or accounts taken from the material in Crossman (1973) or Hubbs (1958).

Catostomidae - the sucker family

Longnose Sucker (Catostomus catostomus)

The McCormick Forest lies well within the southern limit of the range of the longnose sucker which occurs throughout Canada and generally in the northern states of the United States. The longnose sucker prefers cool clear lakes and streams but is restricted to cool lake bottoms in the southern portions of its range (Crossman 1973). In the Upper Peninsula of Michigan Lowe collected this species from lakes in the Lake Superior drainage in Houghton, Keweenaw, and Marquette Counties (Taylor 1954). Hubbs (1958) considered the longnose sucker as occurring inland only in the lakes with drainage to Lake Superior. In the McCormick Forest the longnose sucker was collected from Clear Lake in the Peshekee drainage which is part of the Lake Michigan drainage. The presence of the longnose sucker in Clear Lake and not in the other lakes of the Peshekee drainage could be accounted for by the habitat preference of the species. Further soundings and temperature readings near the bottom of Clear Lake might reveal a deeper colder lake than is now expected. The longnose sucker population might be larger than that indicated by the collection of a single specimen (Table 5). Longnose suckers spawn

before white suckers and possibly can not be collected in large numbers with spawning white suckers as was the case in Clear Lake.

White Sucker (Catostomus commersoni)

The white sucker is distributed over much of North America and is one of the most common and uniformly distributed species in the Upper Peninsula (Taylor 1954). Lowe collected it outside the McCormick Forest in all but the Huron River drainage. White suckers are usually found in shallow warmer water lakes and small to large rivers. The young of the white sucker have been reported in association with blacknose shiners, yellow perch, and stickleback while the adults have been collected with cold water Coregonids, northern pike, longnose suckers, yellow perch, walleye (Stizostedion vitreum), and burbot (Grossman 1973). Of these fish only the walleye and the Coregonids were not found in the McCormick Forest, and the blacknose shiner was not collected from lakes with white suckers. White suckers normally spawn in gravel bottom streams but will also spawn in lakes which is the case in Summit, Trout, Gordon, Clear, and the Baraga Lakes. Lack of suitable spawning habitat could account for the white suckers absence from Evergreen Lake and Round Lake but would not account for the absence of white suckers in all of the lakes in the Yellow Dog drainage and Lake Raymond in the Dead River drainage. Apparently physical barriers or past ecological barriers like small creeks have prevented the establishment of white suckers in those lakes.

Centrarchidae - the sunfish family

Rock Bass (Ambloplites rupestris)

The rock bass in Michigan is near the northern limit of the

species' range which extends from southern Canada to Louisiana and the Gulf states. Rock bass are native to the Upper Peninsula and are found in moderate numbers in all counties. They prefer shallow rocky habitat in lakes and are often found in slow moving warm water in large rivers, often in association with the pumpkinseed and smallmouth bass. The restriction of rock bass to Upper and Lower Baraga Lakes when suitable habitat and associated species like the pumpkinseed can be found in Lake Gordon could be due to the rock bass's avoidance of small streams with moderate to rapidly flowing water like the drainages from Clear Lake and Lake Gordon. The absence of rock bass in the other drainage systems in the McCormick Forest is to be expected for physical barriers like falls or rapids and unsuitable habitat like that in beaver dams is present downstream.

Green Sunfish (Lepomis cyanellus)

The Upper Peninsula of Michigan is at the northern edge of the range of the green sunfish. Hubbs (1958) considered green sunfish rare in the Upper Peninuula. Lowe collected green sunfish from a few scattered locations in the Upper Peninsula and from only one location in Marquette County. Taylor (1954) concluded that the green sunfish had been introduced in the areas sampled by Lowe, most of which were in the Lake Michigan drainage. This may well be the case for the green sunfish collected in Lake Gordon since this species was not found in any other location in the McCormick Forest and had not been reported from the Michigamme River or the Menominee River which connect the Peshekee River to Lake Michigan.

Pumpkinseed (Lepomis gibbosus)

The pumpkinseed sunfish is considered native to Michigan and is present in all counties of the Upper Peninsula (Taylor 1954). In the McCormick Forest pumpkinseed were found only in Lake Gordon with the green sunfish. However, unlike the green sunfish, pumpkinseed are found outside the McCormick Forest in the Dead River and in the Beaufort River which drains into Lake Michigamme (Taylor 1954). The absence of the pumpkinseed in the rest of the McCormick Forest is probably due to the same physical and ecological barriers that have prevented further movement by the green sunfish and the rock bass.

Smallmouth Bass (Micropterus dolomieui)

Smallmouth bass are native to the Great Lakes region and have also been planted extensively over the Upper Peninsula (Taylor 1954). Lowe made collections of this species in several locations in Marquette and Baraga Counties including Lake Michigamme and Lake Independence (Taylor 1954). Smallmouth bass prefer large cool clear lakes and rivers with rocky or sandy bottoms. Several lakes in the McCormick Forest, particularly Summit Lake and Lake Margaret, would be well suited for smallmouth bass but the species was found only in the Peshekee River and Lower Baraga Lake. No physical barriers exist between the Baraga Lakes but smallmouth bass were not collected in Upper Baraga Lake. In the other drainage systems, ecological and physical barriers have prevented this species from reaching the McCormick Forest.

Largemouth Bass (Micropterus salmoides)

Some authors place the northern limit of the largemouth bass in the lower Great Lakes (Crossman 1973) while others have suggested

that the species might have been originally native in the Upper Peninsula (Taylor 1954). In either case the largemouth bass has been extensively introduced by man and can now be found in all counties of the Upper Peninsula. In the McCormick Forest largemouth bass were planted in White Deer Lake and Island Lake in the Yellow Dog drainage. Largemouth bass prefer small, shallow, weedy warm water lakes and may have entered the Peshekee drainage naturally or they could have been introduced. The presence of a small population of largemouth bass in Clear Lake as opposed to the relatively large populations in the Baraga Lakes and Lake Gordon suggests that this species may have just recently established themselves in Clear Lake. Physical and ecological barriers have prevented the spread of largemouth bass in the rest of the lakes of the McCormick Forest.

Cottidae - the sculpin family

Mottled Sculpin (Cottus bairdi)

Mottled sculpins are found throughout the Great Lakes region and in much of Canada to the north of the Great Lakes. Lowe collected this species from many locations in the Upper Peninsula including Lake Michigamme, Lake Independence, and the Dead River. Mottled sculpins prefer cool streams but do well in any cool water with a rocky bottom. There is suitable habitat in each drainage system for the mottled sculpin but none were found in the Huron River or Dead River drainages. Low susceptibility to nets and traps could account for their apparent absence from the Huron and Dead River drainages. Mottled sculpins are bottom dwellers that spend much of their time in hiding. Although present in many locations only three sculpins were collected with passive sampling

equipment. Mottled sculpins are often found with brook trout and both species were collected from the Upper Baraga Lake inlet.

Cyprinidae - the minnow family

Silvery Minnow (Hybognathus nuchalis)

Generally the range of the silvery minnow is to the east, south, and west of the Great Lakes extending as far west as Alberta and south to Louisiana but avoiding the Great Lakes entirely except for the region around Lake Ontario. If the identification of this species is confirmed, the specimens collected from Round Lake in the McCormick Forest will be the first found in Michigan. Silvery minnows usually inhabit quiet, weedy inshore waters of large lakes and rivers (Crossman 1973). Spawning takes place over the bottom ooze in quiet water 5 to 15 cm deep near newly sprouted grasses (Crossman 1973). Spawning conditions should be ideal for the silvery minnow in Round Lake. Spawning reportedly takes place at temperatures of 13.0 to 20.5°C. The two specimens collected in May, 1976 were captured with minnow traps set adjacent to the bog mat in water about 0.3 deep when the water temperature was 14.4°C. The bottom ooze apparently constitutes the main food source of the silvery minnow (Crossman 1973). The specimens captured in Round Lake were held in an aquarium for approximately 3 weeks before being preserved and during that time they ignored oatmeal, earthworm pieces, or live food (Daphnia), but fed often on the detritus on the bottom of the aquarium. The presence of silvery minnows in Round Lake is difficult to explain at this time.

Golden Shiner (Notemigonus crysoleucas)

The range of the golden shiner extends from southern Canada

south to Texas and eastward to the Atlantic coast in Canada and the United States. The species is found throughout most of the Great Lakes region and is moderately common in the Upper Peninsula. Lowe collected golden shiners in Lake Michigamme and the Dead River drainage in Marquette County. In the McCormick Forest golden shiners were abundant and well distributed in the Yellow Dog drainage but less so in the Peshekee drainage. Golden shiners prefer clear, weedy, quiet waters with extensive shallow areas (Crossman 1973). This probably accounts for their abundance in the Yellow Dog drainage, particularly White Deer Lake which has a large amount of this habitat type. The small creeks and rivers which drain the Huron and Dead River drainages are not the preferred habitat for golden shiners and are probably responsible for the failure of this species to become established in those drainages.

Common Shiner (Notropis cornutus)

The range of the common shiner extends in a band across the middle of North America from Kansas and the Dakotas to the East coast. It is widely distributed in the Upper Peninsula and was collected by Lowe in Lake Michigamme and the Dead River outside of the McCormick Forest (Taylor 1954). Normally a stream resident, this species is commonly found near the shore in clear water lakes. In the McCormick Forest the common shiner was found in the Peshekee River and in Lower Baraga Lake. The lack of extensive stretches of gravel bottom streams probably limit the distribution and numbers of this species in the McCormick Forest.

Blacknose Shiner (Notropis heterolepis)

The approximate range of the blacknose shiner extends across

much of middle southern Canada through the Great Lakes to upper New England and south from the Great Lakes to Missouri and Tennessee. This species is distributed throughout the Upper Peninsula in moderate numbers and was collected by Lowe in the Dead River (Taylor 1954). The species prefers clear, quiet, weedy waters and seems to be found over a variety of bottom types from sand and gravel to detritus. Despite the fact that the blacknose shiner is a common and widespread species, little is known about its habits. Blacknose shiners are thought to spawn over sand bottoms (Crossman 1973). If this is so, the populations in the McCormick Forest will remain small because of the scarcity of this bottom type. Blacknose shiners are declining or have been eliminated from parts of their former range because of intolerance towards turbidity (Crossman 1973). This is particularly true of the industrial or agriculturally developed areas along the periphery of its range. The presence of this species in the McCormick Forest is a good indicator of the present condition of the waters and the Forest's history of minimal exploitation by man.

Northern Redbelly Dace (Phoxinus eos)

The general range of the northern redbelly dace extends from western Canada through the Great Lakes to the New England coast. In the Upper Peninsula the northern redbelly dace is a common species that has been recorded in all counties (Taylor 1954). Lowe's collections of the redbelly dace include specimens from Lake Michigamme and the Dead River. Northern redbelly dace prefer small quiet bog waters of all types with detritus or silt bottoms. This type of habitat abounds in the McCormick Forest and the species is well distributed in the Forest. The species

is typically associated with mudminnows, stickleback, finescale dace, and brook trout. The finescale dace and the northern redbelly dace which occupy the same habitat often produce fertile hybrids that are intermediate between both species in size of mouth and pigmentation (Taylor 1954). One hybrid was collected from Lake Dortay during this study.

Finescale Dace (Phoxinus neogaeus)

The range of the finescale dace which occurs in western Canada and eastward to the Atlantic coast is similar to that of the northern redbelly dace. The distribution of the finescale dace in the Upper Peninsula is spotty but it occurs in all counties (Taylor 1954). The finescale dace prefers cool bog lakes and ponds (Crossman 1973) and is often found in association with the redbelly dace, stickleback, and pearl dace. In the McCormick Forest the preferred habitat is apparently common but the finescale dace was not collected in as many locations as the northern redbelly dace.

Bluntnose Minnow (Pimephales notatus)

The range of the bluntnose minnow covers most of middle North America from southern Canada south to the Gulf states. In the Upper Peninsula bluntnose minnows have been recorded from all but Ontonagon county, and were collected by Lowe from Lake Michigamme (Taylor 1954). The bluntnose minnow seems to prefer clear lakes and ponds with a shallow sand and gravel bottom. This type of habitat is present in each drainage in the McCormick Forest but the bluntnose minnow was only found in the Yellow Dog and Peshekee drainages. The spawning habits of the bluntnose minnow and the fathead minnow are similar in that both species

construct and defend nests under rocks, sticks, or any object with a relatively flat underside. Both species are present in the McCormick Forest but only occur together in one location, Clear Lake.

Fathead Minnow (Pimephales promelas)

The range of the fathead minnow covers much of central North America from Mexico to Canada. In the Upper Peninsula fathead minnows have been recorded in all counties and were considered by Taylor (1954) to be common locally. Lowe's collection included fathead minnows from the Dead River. The occurrence of the fathead minnow in the McCormick Forest is spotty. Interestingly, fathead minnows were very common in Lake Margaret but were not found in White Deer Lake or Bulldog Lake into which Lake Margaret drains. It seems unlikely that fathead fry would never be washed downstream into Bulldog Lake and not survive there. The fathead minnow is found in a variety of habitats but seems to prefer still pond or stream waters with a soft bottom. This type of habitat is common in White Deer Lake yet the fathead was not found there.

Blacknose Dace (Rhinichthys atratulas)

The range of the blacknose dace covers much of the northeast one-quarter of the United States and the adjacent southern edge of Canada. In the Upper Peninsula the blacknose dace has been recorded in all counties and was collected by Lowe in the Dead River (Taylor 1954). The preferred habitat for the blacknose dace are small swiftly flowing clear streams (Crossman 1973). In the McCormick Forest this species is found in the Peshekee River and the creek draining Camp 11 Lake but has not moved further upstream in the Peshekee drainage. The blacknose dace spawn in swiftly flowing water and apparently the still waters of

the Baraga Lakes are an ecological barrier to the species. In the Yellow Dog drainage blacknose dace are present below the falls. The East Branch falls are obviously a physical barrier but the falls on the West Branch of the Yellow Dog River might be ascended. The habitat in the Dead River drainage and most of the Huron drainage is unsuitable for blacknose dace. One specimen was collected in Summit Lake but was probably a stray from the Summit Lake outlet.

Longnose Dace (Rhinichthys cataractae)

The longnose dace has a very extensive range in North America. It can be found from coast to coast in the northern states and much of Canada with extensions northward to the Yukon territories and southward to Mexico (Crossman 1973). In the Upper Peninsula the longnose dace is common in all counties and was collected by Lowe in the Dead River. In the McCormick Forest, the longnose dace was found only below the falls on the Yellow Dog River. The habitat in the Dead River drainage is not suitable for the longnose dace within the McCormick Forest and the falls have probably prevented the species from moving upstream in the Yellow Dog drainage. The habitat above the falls on the West Branch of the Yellow Dog River and in the Peshekee River is suitable for longnose dace. The longnose dace and blacknose dace were considered early arrivers in Minnesota rivers after the last glacial ice retreated (Underhill 1957) and both species are present below the falls in the Yellow Dog River. The blacknose dace is also present in the Peshekee River. Conceivably both species should have become established in the Peshekee River and above the falls on West Branch of the Yellow Dog River. The habitat above the falls on the East Branch of the Yellow Dog is marginal and the longnose dace might have occupied the area but died out. During

spawning longnose dace scatter their eggs in fast water and hybrids with other stream spawners like the pearl dace often result though none were found in the McCormick Forest. Longnose dace and blacknose dace which seemingly occupy the same habitat do not produce hybrids in the wild. Differences in spawning habits (Howell 1976) account for the lack of natural hybrids.

Creek Chub (Semotilus atromaculatus)

The general range of the creek chub covers much of central North America from Montana south to Texas and east to the Atlantic coast. Crossman (1973) considered the creek chub to be one of the most common stream minnows in eastern North America. In the Upper Peninsula the creek chub is extremely common in all counties (Taylor 1954). Lowe collected this species from many locations including the Dead River. The creek chub prefers small, clear streams but also occurs in the inshore waters of small lakes. In the McCormick Forest, the creek chub is very common and was collected in numerous streams and lakes. The presence of the creek chub in all four of the drainage systems in the McCormick Forest is probably due to the abundance of preferred habitat. The creek chub is often associated with the common shiner. Gravel is the spawning substrate for both species and hybridization often occurs. Lowe collected such a cross in the Dead River but none were found in the McCormick Forest.

Pearl Dace (Semotilus margarita)

The pearl dace is found throughout the lower provinces of Canada and in the north central states through the Great Lakes to New England (Crossman 1973). In the Upper Peninsula the pearl dace is

"absent from Keweenaw County and from much of the rest of the Keweenaw Peninsula" (Taylor 1954). Lowe collected pearl dace in the Dead River about 27 km southeast of the McCormick Forest. This species is normally found in bog lakes and ponds, typical habitat in the McCormick Forest. Associated with the pearl dace are the other bog species, the northern redbelly dace, finescale dace, brook stickleback, and the fathead minnows. Although extensively distributed and common, little is known about the biology of the pearl dace. Spawning observations in Michigan indicate that pearl dace spawn in clear water 24 to 60 cm deep on sand or gravel bottoms in weak or moderate current (Crossman 1973). Observations in the McCormick Forest indicate that pearl dace may also spawn in lakes. Lake Raymond and Evergreen Lake both had large populations of pearl dace but did not have inlets or outlets that were suitable for spawning. Further investigation during the spring spawning season would be necessary to confirm this hypothesis.

Esocidae - the pike family

Northern Pike (Esox lucius)

The range of the northern pike covers much of the north half of North America. The northern pike is common throughout the Upper Peninsula and was collected by Lowe in Lake Michigamme, the Dead River, and Lake Independence (Taylor 1954). This species prefers clear, warm, weedy lakes or slow moving rivers but can also be found in a wide range of habitat. In the McCormick Forest pike were found in the Upper and Lower Baraga Lakes and the Peshekee River but were not found in the other lakes with suitable habitat. The absence of preferred habitat connecting Clear Lake and Lake Gordon to the Baraga Lakes has apparently

limited the upstream movement in the Peshekee drainage. A similar situation probably exists in the other drainage systems as well since northern pike occur downstream but have not moved upstream to the McCormick Forest.

Gadidae - the cod family

Burbot (*Lota lota*)

The range of the burbot covers nearly all of the north half of North America. In the Upper Peninsula burbot are widely distributed but were seldom collected by Lowe. Taylor (1954) surmised that the burbot is more common than it's collections would indicate. Burbot have been collected in Lake Independence and the Menominee River by Lowe and nearer the McCormick Forest in the Michigamme drainage system (by the author). Burbot are found in a variety of habitat but are usually found in deep lakes or large cool rivers. Young of the year burbot are often found in tributary streams or shallow inshore waters (Crossman 1973) and were collected from both habitats in the McCormick Forest. Adults move inshore to spawn under the ice and at certain times to feed at night but seem to be limited to deep water during the warmest months. Burbot spawn over a sand or gravel bottom and could probably reproduce in Clear Lake or Lake Gordon. None were collected in these lakes but burbot are difficult to collect with passive gear, except when spawning, and could have been missed. Apparently physical barriers such as falls or ecological barriers such as small rivers have prevented the upstream movement of burbot into the McCormick Forest in the other drainage systems.

Gasterosteidae - the stickleback family

Brook Stickleback (Culaea inconstans)

The brook stickleback occurs widely in the central portion of the north half of North America (Crossman 1973). In the Upper Peninsula the brook stickleback is widely distributed and was collected by Lowe from many locations including the Dead River (Taylor 1954). Brook stickleback prefer clear, cool, densely vegetated water in small streams, spring fed pools, or similar habitat in swampy lake margins. In the McCormick Forest this type of habitat is very common and sticklebacks were frequently found with the fathead minnow, northern redbelly dace, finescale dace, and pearl dace.

Percidae - the perch family

Iowa Darter (Etheostoma exile)

The range of the Iowa darter covers much of the north half of North America and is similar to the range of the brook stickleback (Crossman 1973). In the Upper Peninsula Iowa darters are fairly common and were collected by Lowe from the Dead River and Lake Michigamme (Taylor 1954). This species prefers clear lakes or slowly moving streams with rooted aquatic vegetation and a sand or detritus bottom. Preferred spawning habitat is shallow water under overhanging banks where the eggs are laid on roots or fibrous material (Crossman 1973). In the McCormick Forest habitat suitable for Iowa darters is abundant and the species is found in each drainage system in varying numbers. Like most of the minnows in the McCormick Forest the Iowa darter is one of the first species to establish populations after the glaciers had retreated.

Yellow Perch (Perca flavescens)

The range of the yellow perch includes much of the north half of North America. In the Upper Peninsula, Taylor (1954), considered the yellow perch "typical of the lakes in the region". Lowe collected perch in many locations including Lake Michigamme, Lake Independence, and the Dead River. Yellow perch can adapt to a variety of warm or cold water lakes or slow moving rivers but prefer clear moderately vegetated lakes (Crossman 1973). Perch numbers decrease with increases in turbidity or decreased vegetation. Due to the shallow nature of White Deer Lake, aquatic vegetation is more abundant and the yellow perch population is seemingly higher there than in most of the other lakes in the McCormick Forest.

Logperch (Percina caprodes)

The range of the logperch covers the eastern half of North America from Hudson Bay to the Gulf of Mexico. In the Upper Peninsula the logperch is widely distributed and has been recorded from most counties. Lowe's collection includes logperch from Lake Independence (Taylor 1954). The logperch prefers sand, gravel, or rock bottom lakes or large rivers. The logperch was only found in the Peshekee River but its habit of staying in deeper offshore water in lakes (Crossman 1973) could have accounted for our not finding it in the Baraga Lakes. The falls on the Yellow Dog River would probably prevent upstream movement into the interior of the McCormick Forest if logperch did migrate from Lake Independence, however none were collected below the falls.

Salmonidae - the trout family

Brown Trout (Salmo trutta)

The brown trout is not native to North America but was introduced from Europe in the lake 1800s. Taylor considered it's distribution spotty in 1954. Lowe's collection included brown trout from a few locations. Lowe did collect this species from Barnhart Creek, a tributary of the Dead River about 15 km southeast of the McCormick Forest. Today the brown trout is found in many locations throughout the Upper Peninsula and the Great Lakes region. The occurrence of the brown trout in the Peshekee River is the result of periodic stocking by the Michigan Department of Natural Resources. It is not known if the introduced brown trout are successfully reproducing in the Peshekee River.

Brook Trout (Salvelinus fontinalis)

The original range of the brook trout was the northeastern part of North America including the Great Lakes region. This species has been introduced world wide and throughout it's original range. Lowe collected brook trout from many locations in the Dead River drainage system outside the McCormick Forest (Taylor 1954). Brook trout prefer clear, cool, well oxygenated streams and lakes and will seek cooler temperatures when the water warms. In the McCormick Forest brook trout were found in the stream that flows from Lake Gordon and Clear Lake into Upper Baraga Lake. Brook trout are also reported to occur in the Camp 11 Lake drainage (personal communication with Kenneth Nowell) but none were collected in the lower sections of that stream. These small populations are probably all that remain in the Peshekee drainage from cooler times. In the Yellow Dog River, brook trout were found above and below the falls

on the West Branch and below the falls only, in the East Branch of the Yellow Dog. The East Branch falls are an impassible physical barrier but brook trout can probably ascend the West Branch falls which are smaller. Attempts have apparently been made to introduce brook trout into Lake Margaret and Summit Lake but were not successful. The Island Lake drainage might be suitable for brook trout but none are present today.

Umbridae - the mudminnow family

Central mudminnow (Umbra limi)

The range of the central mudminnow is restricted to central North America with the Great Lakes and southern Canada near the northern limit. In the Upper Peninsula the mudminnow is found in all counties and is considered common (Taylor 1954). The mudminnow prefers heavily vegetated ponds or the pools of small creeks with a layer of organic material on the bottom, but are often found in cooler water with the mottled sculpin and the brook trout. The single specimen collected in the McCormick Forest came from the Peshekee River which is representative of the latter habitat. Suitable habitat is available for the mudminnow in each drainage system in the McCormick Forest but its secretive nature and preferred habitat make it difficult to collect.

Species Possibly Present in the McCormick Forest.

The following species which were collected by Lowe in Marquette and/or Baraga Counties might be present in the McCormick Forest; the walleye, brown bullhead (Ictalurus nebulosus), bluegill (Lepomis macrochirus), black bullhead (Ictalurus melas), rainbow trout (Salmo gairdneri),

brassy minnow (Hybognathus hankinsoni), mimic shiner (Notropis volucellus), blackchin shiner (Notropis heterodon), and the johnny darter (Etheostoma nigrum). All are native to the Upper Peninsula with the exception of the rainbow trout which has been widely introduced and has been planted in the Peshekee River by the Michigan Department of Natural Resources (DNR fish planting report). The walleye and the bullheads were collected by Lowe in the Michigamme drainage system. The walleye is common in Lake Michigamme and could easily become established in the McCormick Forest via the Peshekee River. The black bullhead (possibly misidentified - brown bullheads) was collected from Crooked Lake and the brown bullhead from the Beaufort River (Spurr River on some maps), 8.5 and 12.5 km respectively, to the southwest of the McCormick Forest. However, bullheads prefer slow-moving warm waters with soft bottoms and are unlikely to reach the McCormick Forest if they are not already there. The brassy minnow, which occurs in creeks and bog waters (Crossman 1973), was collected by Lowe in the Dead River and could occur in the McCormick Forest. The mimic shiner and the johnny darter were collected from Lake Independence by Lowe, however physical barriers, like falls, have probably kept these fish from reaching the McCormick Forest. The blackchin shiner is not a common species in the Upper Peninsula but it was collected often in the Menominee River drainage in Menominee County by Lowe, though it is doubtful that this species has moved upstream as far as the McCormick Forest.

The lamprey (Petromyzontidae)

Several species of lamprey (Petromyzontidae) were also collected by Lowe and could occur in the McCormick Forest, however none were collected.

Further additions to the fish fauna of the McCormick Forest will probably be via the Peshekee River for several reasons. First the Menominee River drainage has a great diversity of species that could successfully establish themselves in the McCormick Forest, including several redhorse (Moxostoma sp.), the hognose sucker (Hypentelium nigricans), rosyface shiner (Notropis rubellus), blackshin shiner, and several darters (Ethostoma sp.) (Taylor 1954). The variety of habitat afforded by the Menominee River drainage and man's activities would also be an aid in the upstream dispursion of species.

LITERATURE CITED

Adams, C.L. 1906. Fish in Porcupine Mountains. In: An ecological survey in Northern Michigan, a report of the St. Board of Geol. Surv. in Mich. for 1905. Wynkoop Hallenbeck Crawford Co. State Printers, Lansing. p. 638.

Agassiz, Louis. 1850. Lake Superior. reprint 1975. by Robert E. Krieger Publishing Co., Huntington, N.Y. 428 p.

Chiappetta, Jerry. 1970. McCormick Tract new Michigan wilderness. Field and Stream. 75 (May, 1970): p. 77.

Christy, Bayard H. 1929. The book of Huron Mountain. Big Bay, Michigan. 216 p.

Crossman, E.J. and W.B. Scott. 1973. Freshwater fishes of Canada. Fisheries Res. Bd. of Canada, Ottawa Bull. 184. 966 p.

Darlington, Philip J., Jr. 1957. Zoogeography. John Wiley & Sons, Inc. New York. 675 p.

Everhart, W. Harry and George A. Rounsefell. 1953. Fishery Science its methods and application. John Wiley & Sons, Inc. New York. 288 p.

Fowler, Henery W. 1918. A review of the fishes described in Cope's Partial catalogue of the cold-blooded vertebrata of Michigan Occas. Pap. Mus. Zool. Univ. of Mich. 60. 51 p.

Hankinson, Thomas L. 1916a. Observations of the fished of Houghton County, Michigan. Misc. Pap. of the Zool. of Mich. Michigan Geol. & Biol. Surv. 20. Biol. Ser. 4:13-24.

_____ 1916b. Results of the Shiras Expedition to Whitefish Point, Michigan. Misc. Pap. of the Zool. of Mich. Michigan Geol. & Biol. Surv. 20, Biol. Ser. 4:109-170.

Hubbs, Carl L. 1929. The fishes. In: The book of Huron Mountain. Huron Mtn. Club, Big Bay, Mich. p. 153-164.

Hubbs, Carl L. and Karl F. Lagler. 1958. Fishes of the Great Lakes Region. 2nd ed., 3rd reprint 1970. The Univ. of Mich. Press. Ann Arbor. 213 p.

Koelz, Walter. 1929. Leucichthys hubbsi a new cisco, from Ives Lake, Marquette County Michigan. Occas. Pap. Mus. Zool. Univ. of Mich. 204.

McCrimmon, H. R. and A. H. Berst. 1963. A portable A.C. D.C. backpack fish shocker designed for operation in Ontario streams. Prog. Fish Cult. 25 (3):159-162.

Manville, Richard H. 1948. The vertebrate fauna of the Huron Mountains, Michigan. The Amer. Midl. Nat. 39(3):615-640.

Ruttner, Franz. 1968. Fundamentals of limnology. Transl. D.G. Frey and F.E.J. Fry. 3rd ed. Univ. of Toronto Press. 295 p.

Robinson, W. L. 1973. McCormick Forest wildlike: here today and here tomorrow? Naturalist 24(1):12-20.

Robinson, W. L. 1975. Birds and Mammals Vertebrate animal populations of the McCormick Forest. U.S. Dept. Agr. Forest Service Research Pap. NC-118. North Central Forest Experiment Station, St. Paul.

Taylor, William Ralph. Records of fishes in the John N. Lowe collection from the Upper Peninsula of Michigan. Misc. Pub. Mus. Zool. Univ. of Mich. 87.

Trautmen, Milton B. 1957. The fishes of Ohio. The Ohio St. Univ. Press, Waverly Press, Inc. Baltimore. 683 p.

Underhill, J. C. 1957. The distribution of Minnesota minnows and darters. Occas. Pap. Minn. Mus. Natur. Hist. 7. 41 p.

Waters, Thomas F. 1960. The development of population estimate procedures in small trout lakes. Trans. Am. Fi. Soc. 89:287-294.

Weber, Cornelius I. ed. 1973. Fish. Biological field and laboratory methods for measuring the quality of surface waters and effluents. Environmental Monitoring Series. Office of Research and Development U.S. Environmental Protection Agency, Cincinnati, Ohio. (p. 1-10).

Werner, J. Kirwin. 1973. The reptiles and amphibians of the McCormick Forest. Naturalist 24(1):21-27.

Werner, J. Kirwin. 1975. Amphibians and reptiles. Vertebrate animal populations of the McCormick Forest. U.S. Dept. Agr. Forest Service Research Pop. NC-118. North Central Forest Experiment Station, St. Paul. p. 18-25.

APPENDIX 1.

Figures of the fishes of the McCormick Forest.

Longnose Sucker
Catostomus catostomus
about 0.14 x natural aize

Fathead Minnow
Pimephales promelas
about 0.4 x natural size

White Sucker
Catostomus commersoni
about 0.5 x natural size

Bluntnose Minnow
Pimephales notatus
about natural size

Longnose Dace
Rhinichthys cataractae
about 0.5 x natural size

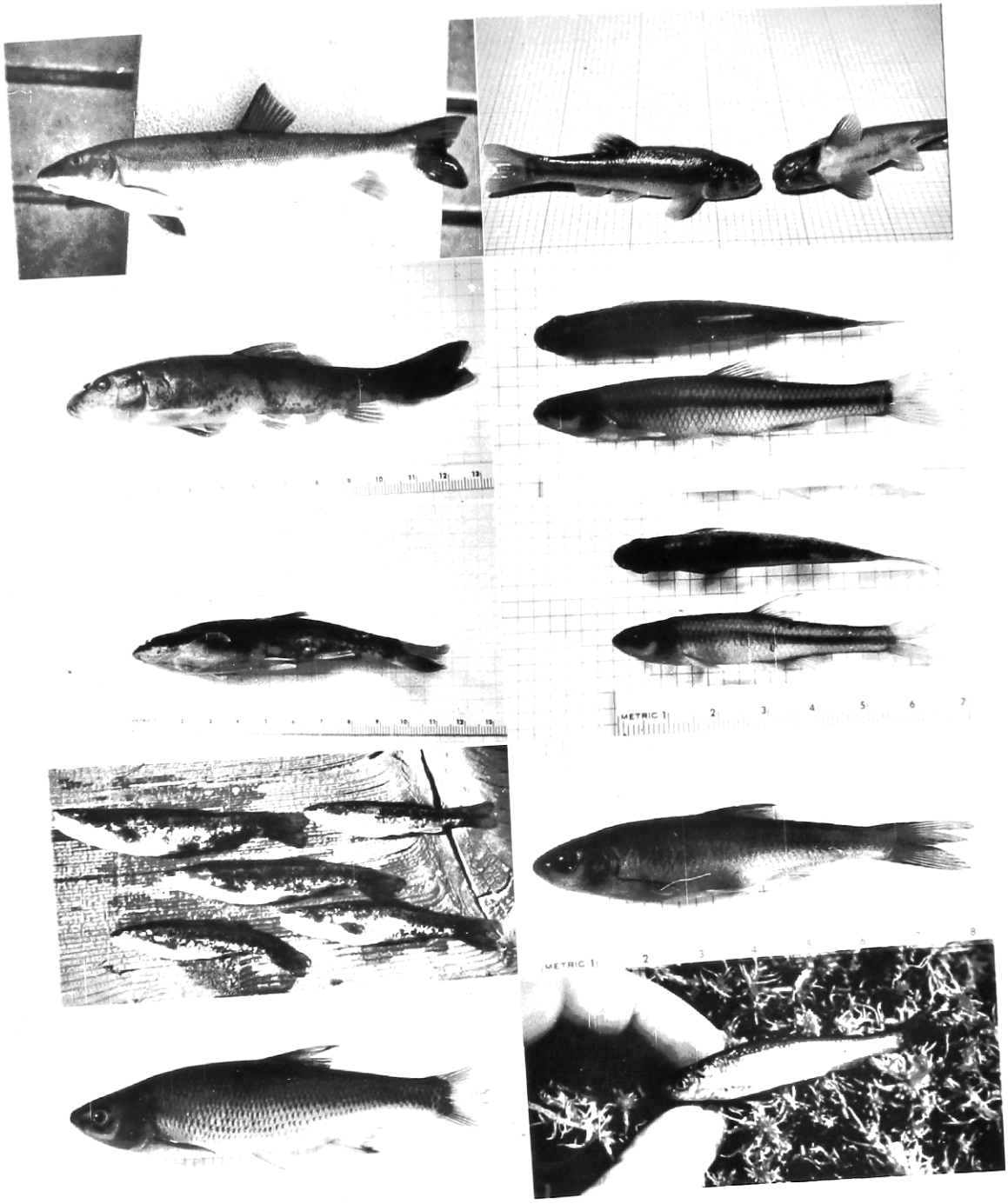
Blacknose Shiner
Notropis heterolepis
about 0.8 x natural size

Blacknose Dace
Rhinichthys atratulus
about 0.5 x natural size

Common Shiner
Notropis cornutus
about 0.9 x natural size

Golden Shiner
Notemigonus crysoleucas
about 0.5 x natural size

Silvery Minnow
Hybognathus nuchalis
about 0.7 x natural size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Northern Redbelly Dace
Phoxinus eos
about natural size

Brook Stickleback
Culaea inconstans
about 0.7 x natural size

Finescale Dace
Phoxinus neogaeus
about 0.7 x natural size

Mottled Sculpin
Cottus bairdi
about 0.6 x natural size

Creek Chub
Semotilus atromaculatus
about 0.5 x natural size

Yellow Perch
Perca flavescens
about 0.4 x natural size

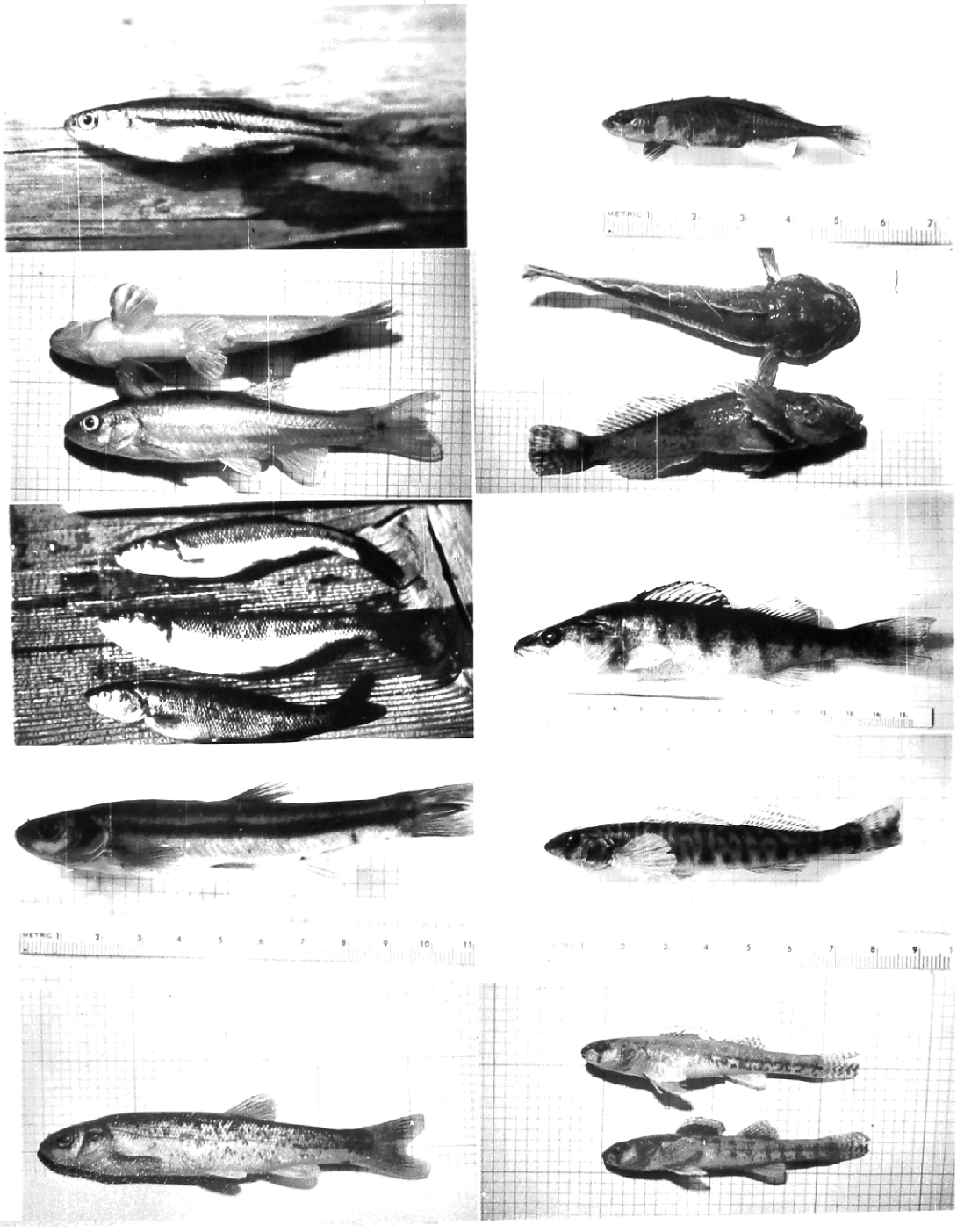
Pearl Dace
Semotilus margarita
about 0.6 x natural size

Logperch
Percina caprodes
about 0.7 x natural size

Pearl Dace
Semotilus margarita
alternate color phase
about 0.5 x natural size

Iowa Darter
Etheostoma exile

about 0.7 x natural size



Northern Pike
Esox lucius
about 0.4 x natural size

Largemouth Bass
Micropterus salmoides
about 0.9 x natural size

Burbot
Lota lota
about 0.2 x natural size

Pumpkinseed
Lepomis gibbosus
about 0.4 x natural size

Central Mudminnow
Umbra limi
about 0.6 x natural size

Green Sunfish
Lepomis cyanellus
about 0.4 x natural size

Rock Bass
Ambloplites rupestris
about 0.5 x natural size

Brown Trout
Salmo trutta
about 0.4 x natural size

Smallmouth Bass
Micropterus dolomieui
about 0.1 x natural size

Brook Trout
Salvelinus fontinalis
about 0.6 x natural size