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INSTITUTE FOR FISHERIES RESEARCH

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A FISHERIES SURVEY OF SPRUCE AND PETTICOAT LAKES,

BARAGA COUNTY

by

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Introduction

Spruce and Petticoat Lakes are located in Spurr Township, in the southeast portion of Baraga County, in the western part of the Upper Peninsula of Michigan. Each lake covers a portion of Section 33, T. 48 N., R. 31 W. In addition, the waters of Petticoat Lake lie within Sections 28, 29, and 32 of the same Town and Range, and Spruce Lake, while extending well into Section 34 of that Town protrudes southward into Section 3 of T. 47 N., (R. 31 W.). Both lakes are near the western headwaters of the Spruce River, which in turn enters the Michigamme River just below Lake Michigamme. The lakes are part of a group of lakes which lie within a rather small radius. Others in the group are Heart, Fence and Beaufort Lakes. Petticoat and Spruce Lakes are situated about 4 miles southwest of the Village of Michigamme. Highway U.S.-41 and the Duluth, South Shore and Atlantic Railroad pass about 2 miles north of the waters. Petticoat Lake is reached by a dirt side road turning south from U.S.-41 near Three Lakes, 5 miles west of the Village of Michigamme. The dirt road heading southwest from Michigamme and terminating at Fence Lake skirts the west shoreline of Spruce Lake.

The map of Petticoat Lake was made by an Institute for Fisheries Research lake survey party* on July 13, 1937, and that of Spruce Lake was made by the same party on August 13, 1937. A regular chemical and biological survey was made by this survey party on Petticoat Lake July 13 to 16, and Spruce Lake August 10 to 13, 1937.

Spruce and Petticoat Lakes are quite distant from population centers and have never been of outstanding recreational, or other, importance. Much of the surrounding area has been logged in the past, and the shores of one or both of the lakes may have been used as logging camp sites. In spite of the presence of dirt logging roads, the lakes are still relatively inaccessible, except during dry weather. There were no cottages, boat liveries or resorts on the lakes at the time of the survey, and their recreational use was limited to light fishing.

Little is known of the past history of the fishing in Spruce and Petticoat Lakes. Apparently most of the better catches in the past were northern pike. No outstanding catches have been reported from either lake. Spruce Lake was considered fair for pike, while fishing in Petticoat Lake was quite poor, at the time of the survey.

Consistent with present trends toward increasing public participation in outdoor recreation, it may be expected that Spruce and Petticoat Lakes will be of increasing importance as public fishing waters in the future, particularly if the quality of the fishing improves, and the degree of inaccessibility of the waters is reduced.

Physical Characters of Spruce and Petticoat Lakes

Spruce and Petticoat Lakes are relatively small lakes, irregular in shape and of shallow depth. They appear to have had a similar geologic

* Members of the survey party included: Franklin Bond, leader; John Greenbank, Wm. Beckman, and Floyd Ames, assistants.

origin. Probably the melting of large ice blocks left by the retreating glacier resulted in the formation of both basins.

The immediate shores of the lakes, although in large part densely wooded, are brushy or rocky at some places, while still other portions of the shoreline are skirted by marsh areas. The surrounding country is densely wooded with largely second-growth timber. It is rolling and has essentially sandy soils.

Both Spruce and Petticoat Lakes are in the Spruce River drainage, the latter water lying at the extreme northwest end of the drainage and emptying into the former. The drainage of Petticoat Lake, (which has no permanent inlets) includes little more than one square mile. A single small outlet leaves the southern extremity of the lake, joins the outlet of Heart Lake, meanders in an easterly direction for one mile, and finally enters the central western end of Spruce Lake. The latter water has a drainage of about 9 square miles, which includes 3 lakes (Petticoat, Heart and one other unnamed lake). Its drainage is bounded on the south by that of the Fence River and on the west and north by that of the eastern headwaters of the Sturgeon River. The single outlet of Spruce Lake, the Spruce River, flows in a southeasterly direction, entering the Michigamme River below Lake Michigamme. The lake outlet is crossed by a dam, now broken, which has no effect on water levels or fish movements.

The surface area of Petticoat Lake is 73.5 acres and that of Spruce Lake is 63.2. The former water has a maximum depth of 27 feet, while the latter, although having a basin the principal part of which is only slightly over 15 feet in depth, has a depression in the southeast end of the lake which reaches a depth of 36 feet. The two depressions of

Spruce Lake are almost completely isolated from each other, being connected by a narrow channel of water less than 5 feet deep.

Spruce and Petticoat Lakes, as has been mentioned, are irregular in outline. The former water has a shoreline of 2.4 miles, and a shoreline development of 2.14. (This means that the lake has 114 per cent (2.14 times) more shoreline than a perfectly circular lake of the same area would have). Petticoat Lake has an even 2 miles of shoreline and a shoreline development of 1.71. Other factors being equal, lakes with a high shoreline development (which is indicative of many bays and coves providing food, shelter, and spawning facilities for many fish species) are ordinarily more productive than lakes which have a more regular shoreline.

About twenty per cent of the basins of both Spruce and Petticoat Lakes are less than 15 feet in depth. Most of the area covered by less than 10 feet of water has sandy soil, while the deeper areas have substrata consisting largely of pulpy peat. Exceptions occur in both lakes. Considerable fibrous peat is present along some sections of the shoreline of Spruce Lake, particularly along the west side. In Petticoat Lake, the pulpy peat bottom soil extends all the way to the shore, on the west side of the lake. Both lakes have limited amounts of gravel bottom near some parts of the shore.

The water in Spruce and Petticoat Lakes is brown in color, that of the latter being less highly colored. Transparency of the water at the time of the survey was less than average for lakes of the physical and chemical nature of these waters. A Secchi disk (white metal disk about 6 inches in diameter), when lowered into the water, disappeared from view at a depth of $1\frac{1}{2}$ feet in Spruce Lake and $5\frac{1}{2}$ feet in Petticoat Lake.

Degree of clearness of the water is an important factor in determining the depth to which aquatic plants will grow in a given water, since none of the higher plants are able to survive in the continued absence of light. The color of the water apparently has some effect on the color of some species of fish (e.g., bass) caught in Spruce and Petticoat Lakes. Smallmouth bass collected by the survey party had a reddish-brown hue. It is not probable that such coloration of the skin would imply an impairment of the quality of the flesh for food.

Temperature and Chemical Characters of
Spruce and Petticoat Lakes

As a part of the survey conducted at Spruce and Petticoat Lakes, various physical and chemical data concerning the lake water itself were collected. Temperature of the water at various depths was observed, and information concerning the nature and amounts of dissolved gases, minerals and salts in the water was obtained. Such data are very important in assisting to determine the degree of suitability of a lake to the various fish species.

A summary of the temperature and chemical data collected during the survey is shown in Table I.

Table I
 Summary of Temperature and Chemical Conditions
 in Spruce and Petticoat Lakes

Lake	Spruce		Petticoat
Station	1	2	1
Location	Southeast depression	Center of South Bay	Center of Lake
Date	8/13/37	8/13/37	7/13/37
Air temperature, °F.	75	77	76
Surface temperature, °F.	74	75	79
Bottom temperature, °F.	42	62	55
Maximum depth, feet	32	17	27
Thermocline			
Location	0-20	5-15	5-18
Temperature			
Top of	74	73	78
Bottom of	46	63	58
Oxygen (p.p.m.)			
Surface	6.2	6.2	5.8
Bottom	0.0	0.1	0.5
Carbon dioxide (p.p.m.)			
Surface	2.0	1.5	1.5
Bottom	33.0	16.0	13.5
Methyl Orange Alkalinity (p.p.m.)			
Surface	13	12	13
Bottom	80	35	33
pH			
Surface	6.0	6.0	6.0
Bottom	6.0	5.8	5.8

The table indicates that at the time of the survey, water temperatures varied from 42° to 75°F. in Spruce Lake and from 55° to 79°F. in Petticoat Lake. Both lakes showed the presence of a thermocline (zone of rapid change in temperature, i.e., 1°C. or more per meter of depth). This stratum was not as clearly defined in these lakes as is commonly the case, however, and the southeast depression of Spruce Lake was unusual in that there was present no well defined epilimnion (area of warm, circulating water above the thermocline). Ordinarily, a thermocline does not begin at the surface, or even at a depth as little as 5 feet (particularly during mid-August, the time of the Spruce Lake survey). Oxygen analyses made at the lakes showed that in Spruce Lake there is insufficient oxygen at depths as little as 10 feet to support fish life. In the southeast depression, the figure is probably closer to 5 feet, while in Petticoat Lake it is 12 feet. In other words, the productive volume of the lakes is limited to a narrow stratum near the surface, below which fish are unable to survive. In most Michigan lakes, this oxygen-containing zone is considerably wider.

Some carbon dioxide was found at all depths in both Spruce and Petticoat Lakes, but this gas does not occur in sufficient amounts to require special consideration in the management of the fisheries there.

Methyl Orange Alkalinity tests (designed to show the amounts of certain minerals and salts in the water) showed the water in both Spruce and Petticoat Lakes to be quite soft. As given in the table, the dissolved mineral and salt content in Spruce Lake ranged from 12 to 80 parts per million, while that in Petticoat Lake ranged from 13 to 33 parts per million. Moderately hard waters are generally more productive than are soft waters, due to the requirements of certain plants and organisms. From 100 to 200 parts per million are ordinarily found in the more productive lakes.

Spruce and Petticoat Lakes are quite acid. Both waters at the time of the survey had a pH (hydrogen ion concentration) ranging from 5.8 to 6.0 (7.0 is neutral). Ordinarily, moderately alkaline waters are more productive than acid waters, particularly when warm-water species of fish are concerned.

No pollution was found to be present in either Spruce or Petticoat Lakes. None would be expected in view of the waters' far removal from sources of industrial or domestic wastes.

Biological Characters of Spruce and Petticoat Lakes

Rather extensive data were collected in connection with the surveys of Spruce and Petticoat Lakes, to determine their biological attributes. Representatives of the various species of vegetation in the lakes were collected and identified, and the abundance of plankton and bottom foods was roughly determined. A representative collection of the available sizes and species of fish present in the lake was made in order to study growth rate, condition, parasitism, etc.

Almost all of the vegetation found in Spruce and Petticoat Lakes was located above the 5-foot contour line. The former water has a fair amount of vegetation, while in the latter lake, aquatic vegetation is extremely scarce, being limited to only a few representatives of 3 species. The species of vegetation found in the lakes and their estimated abundance is shown in Table II.

Table II
Vegetation Found in Spruce and
Petticoat Lakes*

Species	Abundance	
	Spruce	Petticoat
Cattail (<u>Typha latifolia</u>)	Sparse	Common
Bur reed (<u>Sparganium americanum</u>)	Abundant	...
Yellow water lily (<u>Nuphar advena</u>)	Abundant	Common
Bulrush (<u>Scirpus sp.</u>)	Sparse	...
Wapato (<u>Sagittaria latifolia</u>)	Rare	...
Bladderwort (<u>Utricularia vulgaris var. americana</u>)	Sparse	Sparse
Spike rush (<u>Eleocharis palustris</u>)	Sparse	...
Leafy pondweed (<u>Potamogeton epihydrus</u>)	Common	...
Water moss (<u>Fontinalis nova angliae</u>)	Common	...

* Identifications by C. O. Grassl, Department of Botany, University of Michigan.

As has been mentioned, and as is evident from an inspection of the table, vegetation is very restricted in amount in Petticoat Lake. The presence of large quantities of deadheads, logs, branches, trash, etc. in the lake to some degree compensates for the lack of vegetation in providing shelter for fish and substrata for aquatic organisms.

Plankton was found to be fairly abundant in amount in Petticoat Lake and of somewhat less abundance in Spruce Lake at the time of the survey. Individual samples taken at a single period of the summer do not provide sufficient data upon which to base an estimate of plankton abundance throughout the year.

As might be expected in lakes with the limited basic fertility of Spruce and Petticoat Lakes, invertebrate bottom foods were found to be very scarce. One sample in Petticoat Lake produced no organisms at all, while another yielded only one phantom midge and 7 other midge larvae. Samples taken in Spruce Lake yielded results which were little better, with one barren sample occurring and another producing 18 phantom midge and one other midge larva. No other organisms were reported from the lake. A study of the vegetation along the lake shores

might have shown the presence of a few other invertebrates. The bottom foods are probably inadequate to meet the needs of more than a very limited fish population.

The fish species collected in Spruce and Petticoat Lakes, together with an estimate of their abundance (based on the frequency of their occurrence in survey collections and on other reports), and a summary of stocking during the 4 years preceding the survey, are shown in Table III.

Table III
Fish Collected in Spruce and Petticoat Lakes,
Their Abundance and Artificial Stocking

Species	Spruce Lake		Petticoat Lake	
	Abundance	Stocking	Abundance	Stocking
GAME FISH				
Northern pike	Common	...	Common	...
Walleyed pike	...	...	1932 and 1935 reported	Since '37 200,000
Perch	Absent ?	2,400	Common	2,200
Pumpkinseed	Common	...	Common	...
Largemouth bass	Rare	300	Rare	300
Smallmouth bass	Rare	700	Common	300
Bluegills	Absent ?	4,000	Absent ?	9,000
FORAGE FISH				
Blunt-nosed minnow	Rare	...	Very common	...
Golden shiner	...	...	Common	...
COARSE FISH				
Common sucker	Common	...	Abundant	...
Black bullhead	Common	...	...	...
Brown bullhead	Sparse	...	...	...

The smallmouth bass was not collected in Spruce Lake and the largemouth bass did not occur in survey collections from Petticoat Lake. The records are based on creel census records taken by Conservation officers at the lakes. The bass may have been misidentified. Walleyes occurred only twice in creel census records taken at Petticoat Lake, once in 1932 and once in 1935. There are no reports of bluegills for either lake in spite of repeated stockings, and perch have not been reported from Spruce Lake. This is of interest due to the frequently

exhibited uncanny ability of perch to become established in lakes when once introduced. The planted fish were apparently wiped out by the northern pike before a brood stock could be developed.

The results of the studies of growth rates of fish in Spruce and Petticoat Lakes are shown in Table IV. Scales from only northern pike were available from Spruce Lake, while a few perch and a number of smallmouth bass were collected from Petticoat Lake, in addition to northern pike. The fish from Petticoat Lake, having been collected in mid-July, are about half-way through the summer of growth indicated in the table, while Spruce Lake fish (collected in mid-August) have almost completed the summer's growth. The table includes a record of the number of specimens upon which the averages are based. Some age groups are too poorly represented to give reliable averages, due to the known natural fluctuation in size within the age groups.

Table IV
Growth Rate of Fishes of Spruce
and Petticoat Lakes‡

Species and Summer of growth	Petticoat Lake			Spruce Lake		
	Number of specimens	Average length, inches	Average weight, ounces	Number of specimens	Average length, inches	Average weight, ounces
Northern pike						
2	...	...	...	1	14 5/8	10.2
3	2	18 7/8	26.4	9	17 3/8	17.7
4	3	21 7/8	36.7	...	...	...
5	...	...	...	1	24 1/4	51.9
Perch						
5	8	6	1.4	...	...	...
6	1	6 1/8	1.5	...	...	...
Smallmouth bass						
3	1	9 3/8	6.1	...	...	...
4	4	9 3/8	6.0	...	...	...
5	6	11 1/4	10.1	...	...	...
6	3	14 1/4	22.7	...	...	...

‡ Age determinations by W. C. Beckman.

Northern pike in Petticoat and Spruce Lakes are growing at a rate equal to average for the State of Michigan (reaching legal size (14 inches) during their second summer) and are in good condition, having a better than average weight for their size. A perch in Michigan growing at an average rate reaches legal size (6 inches) during its second summer of growth. As seen in the table, perch are stunted in growth in Petticoat Lake, since keeper size is not reached before the 5th summer. This slow growth may be at least partially due to the sparsity of food in the lake, or to the overabundance of the perch. Smallmouth bass are growing at a less than average rate for the State as a whole since, on the average, a smallmouth bass in Michigan reaches keeper size (10 inches) during the third summer of life. Growth in Petticoat Lake is about equal to the average for lakes of the Upper Peninsula, however. The fish are not in the best of condition, but are uniformly lean (light for their length) when compared to the average for the State.

Spawning facilities in Spruce and Petticoat Lakes appear to be adequate for all of the species now present there. Northern pike have been maintaining themselves by natural propagation, and there is a great deal of sandy shoal present, with some gravel, to furnish spawning areas for the Centrarchid species. Perch would doubtless be able to spawn in Petticoat Lake in spite of the sparsity of vegetation, since brush, trash, etc., serves their needs about equally well. Walleyes would not be expected to reproduce in Petticoat Lake. In view of the small size of the lake, and the fact that northern pike are already present, the stocking of walleyes in the lake in the past (probably for the first time about 1930; again in 1937) has not been a logical management procedure for the water, and should be discontinued.

* Based on tables of average lengths and weights of game fish for the State of Michigan, prepared by Dr. W. C. Beckman of the Institute Staff.

Management Suggestions

Both Petticoat and Spruce Lakes are in the "all others" classification of lakes. This appears to be the proper classification for Petticoat Lake. Creel census reports collected by Conservation officers during the past 10 years at Petticoat Lake reveal that 98 hours of fishing has yielded 35 smallmouth bass, 30 northern pike, 4 largemouth bass, 2 perch and 2 walleyes. Smallmouth bass appeared more often than northern pike in the 1937 survey collections. Considering the short growing season and the low productivity of the lake, the species is providing fairly good fishing.

In Spruce Lake, on the other hand, the northern pike has a position of unquestioned dominance in the fish population. Judging by the few available creel census records for the water, 6 out of every 7 fish taken by anglers are northern pike. Sixty-five hours of fishing of which the Department of Conservation has a record, between 1930 and 1940, yielded 24 northern pike, one smallmouth bass, and 3 largemouth bass. Largemouth bass were rare at the time of the 1937 survey, and smallmouth bass were unreported. In view of the dominant position of northern pike in Spruce Lake, it is recommended that its classification be changed to that of a pike lake, in order to permit the usually more productive early season pike fishing which is not possible under its present classification.

All stocking in Spruce and Petticoat Lakes should be discontinued, with one possible exception. Since smallmouth bass have been constantly planted in the past in Petticoat Lake, the extent of their natural reproduction cannot readily be ascertained. If future investigation reveals that the smallmouth is not maintaining its numbers, additional stocking may be required from time to time. There are several gravel-bottomed

shoals in the lake where this species should spawn naturally. Bluegills, which have been stocked in both lakes, would not be expected to do well. Neither lake is suitable for walleyes. Stocking of perch in Spruce Lake might have points in its favor, in view of the sparsity of forage fish upon which northern pike can feed. However, the northern pike are maintaining fairly good numbers and are in good condition. Perch in Petticoat Lake are in poor condition and are showing poor growth. The similarity of conditions (physical, chemical and biological) in the two lakes makes it difficult to predict that the species would do much better in Spruce Lake. Consequently the stocking of perch in Spruce Lake is not recommended.

Kingfishers were the only fish predators seen by the survey party on both Spruce and Petticoat Lakes. Under conditions present at the lakes, bird or mammal predators which might occur would not do significant damage to the fishery there. No control measures are recommended.

No parasites were found in northern pike taken from Spruce Lake, and parasitism of other species there was also not observed. In Petticoat Lake, however, both the black spot parasite (Neascus) and the yellow grub (Clinostomum) were found to occur in smallmouth bass and perch, with the former parasite occurring also in northern pike taken from the lake. The skin, fins, and portions of the musculature of the latter species were infected. A few tapeworms were found in the intestine. Quite a heavy infestation of black spots occurred in the skin and fins of perch and smallmouth and a few yellow grubs were found in the musculature of both species. A few tapeworms appeared in the intestine and pyloric caecae of some bass examined, and a few cysts of Neascus were found in the livers of several perch. None of the parasites found in the lakes are harmful to man, and do not appear to hinder the growth and development of fish. Control measures are not practicable, and are not here recommended.

The cover for fish found in Spruce and Petticoat Lakes is probably adequate to support the limited fish populations which the low productivity and the extremely limited productive volumes of the lakes will permit. The sparsity of vegetation in Petticoat Lake is partially compensated for by the presence of large numbers of deadheads, branches, etc., as has been previously mentioned. No improvements seem necessary.

No advantage to either Spruce or Petticoat Lakes would be expected to accrue by a change in present water levels.

Spawning facilities appear to be adequate for all species which it would be desirable to perpetuate in the lakes concerned, and no improvements seem required.

It is not logical to expect that either Spruce or Petticoat Lakes will ever produce a large enough fish population to creditably withstand continued heavy fishing pressures.

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