No. 61 January, 1962

ONTARIO

RESOURCE MANAGEMENT REPORT

(Formerly Fish and Wildlife Management Report)

PROVINCE OF ONTARIO

DEPARTMENT OF LANDS AND FORESTS

Fish and Wildlife Branch

(These Reports are for Intra-Departmental Information
and Not for Publication)

Hon. J. W. Spooner
Minister

F. A. MacDougall
Deputy Minister

RESOURCE MANAGEMENT REPORT

(Formerly Fish and Wildlife Management Report)

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REPORTS ON THE ALGONQUIN NATIONAL PARK OF ONTARIO FOR THE YEAR 1893 -- CHIEF RANGER THOMSON'S REPORT *

Sessional Papers No. 22, Printed by
order of the Legislative Assembly,
Toronto, 1894.

Abstract

In this very early account of Algonquin Park, Chief Ranger Peter Thomson tells of building a headquarters at Canoe Lake and the establishment of 15 shelter-lodges in various parts of the park for the accommodation of rangers. He remarks on the abundance of moose, deer, bears, muskrats and other wildlife.

The Honorable A. S. Hardy,
Commissioner of Crown Lands, Toronto.

SIR,--I beg to submit the following report in connection with The Algonquin National Park of Ontario, from its inception up to the end of 1893.

On being appointed Chief Ranger of the Park, 21st July last, I received instructions from yourself to proceed thither in company with Mr. James Dickson, O.L.S., and to begin at once the erection of a house for headquarters and a number of small shelter-lodges in various portions of the Park for the accommodation of the rangers while on duty. Having made arrangements for the purchase of such provisions, tools, etc., as would be required, I left for the Park on the 23rd of July. I was joined at Orillia by Mr. Dickson, and on reaching Huntsville we found the supplies from Toronto, together with four canoes and three tents, which Mr. Dickson had previously procured and forwarded from Peterborough. Messrs. Stephen Waters of Huntsville, William Geall of Port Sydney, and Timothy O'Leary of Uptergrove, reported for duty here, having been appointed as under-rangers for the season on trial. The party was completed by the engaging of Robert Dinsmore of Huntsville and William Morgan of Port Sydney, as carpenters and builders, and Samuel Barr of Fenelon Falls as assistant.

After packing our outfit we proceeded from Huntsville to Dwight. On arriving at the latter place we transported our effects by wagon to Oxtongue lake, seven miles distant, and thence continued our journey in canoes up the Muskoka river to Canoe lake, in the township of Peck, which we reached on the 2nd of August, making no less than fifteen portages en route. At a point on the north side of Canoe lake we determined to build our headquarters, the lot chosen being the south half of 19 in the second concession of Peck.

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* We are able to reproduce this early report on Algonquin Park through the courtesy of the Legislative Library, Toronto.

REPORTS ON [illegible]

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through the coun[illegible]

After setting the men to clear the place, get out the timber, etc., Mr. Dickson and myself accompanied by one of the rangers, set out on a trip of inspection for the purpose of locating sites for the shelter-lodges and of obtaining an idea of the connections of the various water systems of the Park. We returned after a week's absence, having gone as far as Great Opeongo lake on the east and Cedar lake on the north, and touching on most of the lakes lying between. Shortly afterwards Mr. Dickson returned to Toronto.

The house at headquarters was finished about the latter part of August. It is a substantial, hewed-log building, 21 by 28 feet, with hewed timber floor and "scoop" roof. We selected this site for headquarters because of its accessibility to Canoe lake and the chain of waters of which this lake forms a part, its nearness to the proposed line of railway from Arnprior to Parry Sound, and also because of the fine grove of balsam, spruce and a few pine trees which stood upon it. During the absence of myself and staff in October, the employes of Messrs. Gilmour & Co., who own the pine timber in this part of Peck, built a lumber camp (doubtless through some misunderstanding) immediately alongside and within ten or twelve feet of our headquarters. They also entered the grove and took out the pine, at the same time cutting down a great number of other trees, and marring the beauty of the place, which I had hoped to preserve.

During the course of the summer and fall we erected, in addition to headquarters, fifteen shelter-lodges, on previously selected sites throughout the Park. Following are the situations of same:

(1) Cache lake, north side of Madawaska river, lot 5, con. 6, Canisbay.
(2) North side of lake of Two Rivers, south-east corner lot 30, con. 8, Canisbay.
(3) West side of south bay of Great Opeongo lake, township of Sproule, half a mile west of mouth of Mud creek.
(4) Southernmost point of south-east bay of Great Opeongo lake, township of Preston.
(5) South side of head of McDougal lake at entrance of Opeongo river, township of Preston.
(6) North end of Burnt lake at mouth of Petawawa river, lot 27, con. 1, Osler.
(7) North side of Great Opeongo lake, lot 22, con. 7, Bower.
(8) North side of Little Nipissing branch of Petawawa, lot 30, con. 10, Lister.
(9) East end of Cedar lake, near mouth of Petawawa river, lot 13, con. 7, Deacon.
(10) Foot of Horsehoe lake, township of Boyd, immediately adjoining north boundary of Lister.
(11) South side of Cauchon lake, lot 34, con. 6, Pentland.
(12) Head of Mink lake, lot 22, con. 7, Pentland.
(13) North side of Kioshkoqui lake, near head of Amable du Fond river.
(14) Grass bay, White Trout lake, lot 13, con. 13, McLaughlin.
(15) East side of Island lake, lot 16, con. 16, McLaughlin.

These shelter-lodges or huts are erected at such points as will be convenient for the purpose of preventing the entrance of poachers and trespassers into the Park, and will command the passage from one chain of waters to another, as well as other lakes or waters within a radius of half a day's journey. They vary in distance from one another from seven to ten miles, the limit being a day's journey on snowshoes in winter. The lodges are of a uniform size of 14 by 16 feet, and are made of unhewed logs and covered with hand-made shingles. There is no sawn lumber used in their construction. Each has a door and a window of four panes of glass, and inside are a small table and sleeping berths for four men. A small sheet-iron stove, made specially for the purpose, will be placed in each. The outlay for labor, which is almost the only item of cost of these lodges, was perhaps from $20 to $25 apiece. In erecting them, as well as the larger house at Canoe lake, we not only had to find our raw material in the forest, but we were obliged to haul the logs by hand, frequently for considerable distances. As will be seen, the lodges built so far are mainly in the southern, central and eastern portions of the Park. In order to provide a chain of communication to and from all parts of the Park, and to permit of an efficient patrol being kept up summer and winter, a number of additional lodges will be required in the northern and western sections.

It was necessary to spend considerable time and trouble in cutting trails and clearing portages along the lines of water communication from one shelter-lodge to another. In all we cut out upwards of 25 miles of portages and trails, and cleared many stretches of river and creek beds from floating timber, brush and other obstructions, in order to secure free passage for our canoes.

I may say that I have found a tendency on the part of the public in general, and more particularly of men who have been in the habit of hunting and trapping in the territory now included in the Park, to acquiesce in the new state of things. I came in contact with a number of trappers who were removing their traps from the Park, and who appeared to have given up any idea of further trapping there. While regretting the loss of their trapping grounds, they acknowledged that the fur-bearing animals were gradually becoming more scarce, and recognized that the preservation of game and fur animals within the Park would eventually be to their benefit, as the animals would increase in number and could be taken in their proper season outside the Park limits. We found a trapper's camping ground on the north side of Horseshoe and Mink lakes and seized several traps and a few beaver skins. The man himself could not be found. This is the only violation of the law which came under my notice. During the hunting season deer were several times pursued up to within a short distance of the Park, but so far as I know, the chase did not extend into it.

I received from the Department notices printed on linen, warning hunters, trappers and others, against trespassing in the Park. I had these nailed up at conspicuous places in the Park, and also at points in the neighborhood where they would be seen and read.

With regard to game, both moose and deer are plentiful, particularly in the northern and western townships of the Park, notwithstanding the reckless slaughter of late years. In my opinion, there are as many moose as deer, and in the township of Butt, just outside the west boundary, the moose are very numerous. Signs of beaver are seen in various places, but the families appear to be small. In very many localities where these animals have evidently existed in large numbers in times past, there is now no indication of their presence. They are, however, I am convinced, still sufficiently numerous to replenish the Park, if properly protected for a few years. Mink, otter, fisher and martin are plentiful, and muskrat abound. There are many bears and wolves. The former do little or no damage, but the wolves are very destructive to deer. The bonus of $10 per head for killing wolves does not seem to have had much effect in reducing their numbers, either here or in the surrounding country. Foxes are numerous, and prey upon the partridges. The latter are abundant, and wild ducks are often seen on some of the lakes. There are many shallow, soft bottomed lakes that seem suitable for the growth of wild rice, the favorite food of ducks, which does not at present appear to occur in the Park. The experiment of procuring some wild rice and sowing it in such places would be attended with very little cost.

Following your instructions, I have taken steps to obtain a quantity of white pine seed, in order that some experiments in forestry may be attempted.

The water in the rivers and lakes in the Park was last year unusually low. The snowfall this winter has so far been heavy, and up to 31st December, according to measurements made by myself, amounted to 55 inches.

Messrs. Gilmour & Co., whose headquarters are at the foot of South Tea lake, are carrying on extensive lumbering operations in Peck township. They have built a dam at the lower end of this lake, and have raised the water four feet. I understand that it is their intention to construct a dam at the foot of Joe lake as well. Lumbering is also being conducted in the Park by Messrs. Barnet & Co., Whitney & Co., Fraser & Co., and others; and I am pleased to say that from all these firms and their employes I have experienced the best of treatment, and a general desire has been shown to co-operate with myself and staff in furthering the objects for which the Park was established.

I have the honor to be, Sir,
Your obedient servant,

PETER THOMSON,

Chief Ranger.

Canoe Lake,
Algonquin National Park of Ontario,
3rd January, 1894.

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THE DISTRIBUTION OF PORCUPINE <u>Erethizon</u> <u>dorsatum</u> IN EXTREME NORTHWESTERN ONTARIO

by
D. W. Simkin
District Biologist, Sioux Lookout

Abstract

Data gathered at trappers' meetings in 1959 and 1960 from 285 trappers from Patricia West and Patricia Central enabled the writer to work out the present range of the porcupine in extreme northwestern Ontario. This information is presented on three maps of the region.

Accurate data on the distribution of many mammalian species inhabiting the large sparsely populated areas of northwestern Ontario are greatly lacking. In this respect the porcupine was no exception to the rule. This report is the first of a proposed series, the purpose of which is to illustrate the distribution of species whose range has never been clearly defined in the area in question.

During the trapper meetings held in the early summer of 1959 and 1960, 285 of the trappers interviewed in Patricia West and Patricia Central were questioned as to the status of porcupine on their trap-lines.

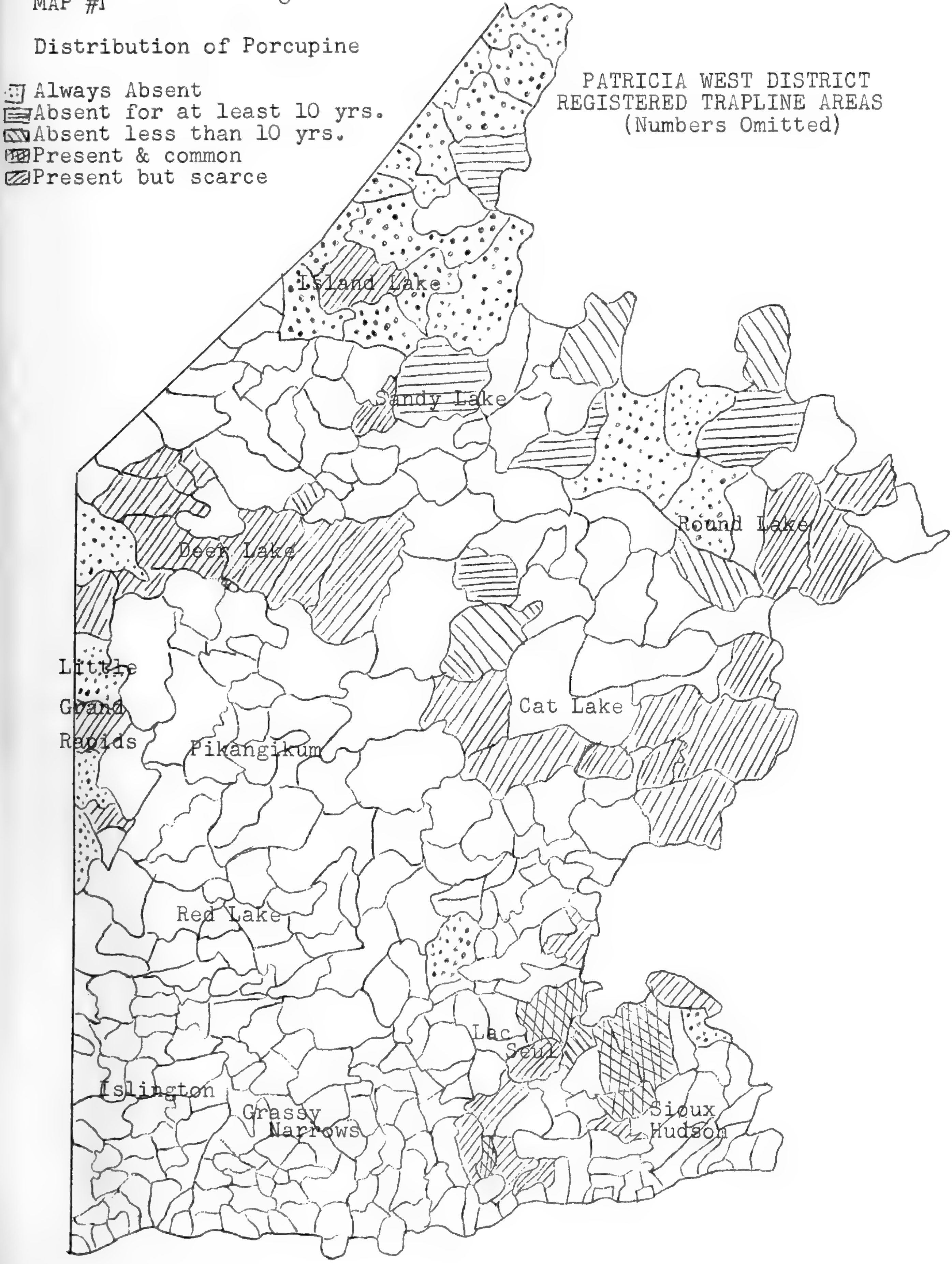
All of the trap-lines for which we have information concerning the status of this species are shown on maps 1 and 2. Upon examination of these maps it is readily apparent that there are many conspicuous gaps still in the data. I feel, however, that enough information is now available to draw a reasonably accurate distribution map for the species. Map 3.

As shown in maps 1 and 2 there are several areas within the zone shown on map 3 as being inhabited which are reported as having always been devoid of this species. Very few species are continuous in their distribution over areas as large as the one here discussed. The purpose of map 3 is to show the general status over large areas.

It should be stated here that even in the present and relatively common area the species is very scarce in comparison with southern Ontario densities.

MAP #I

Distribution of Porcupine



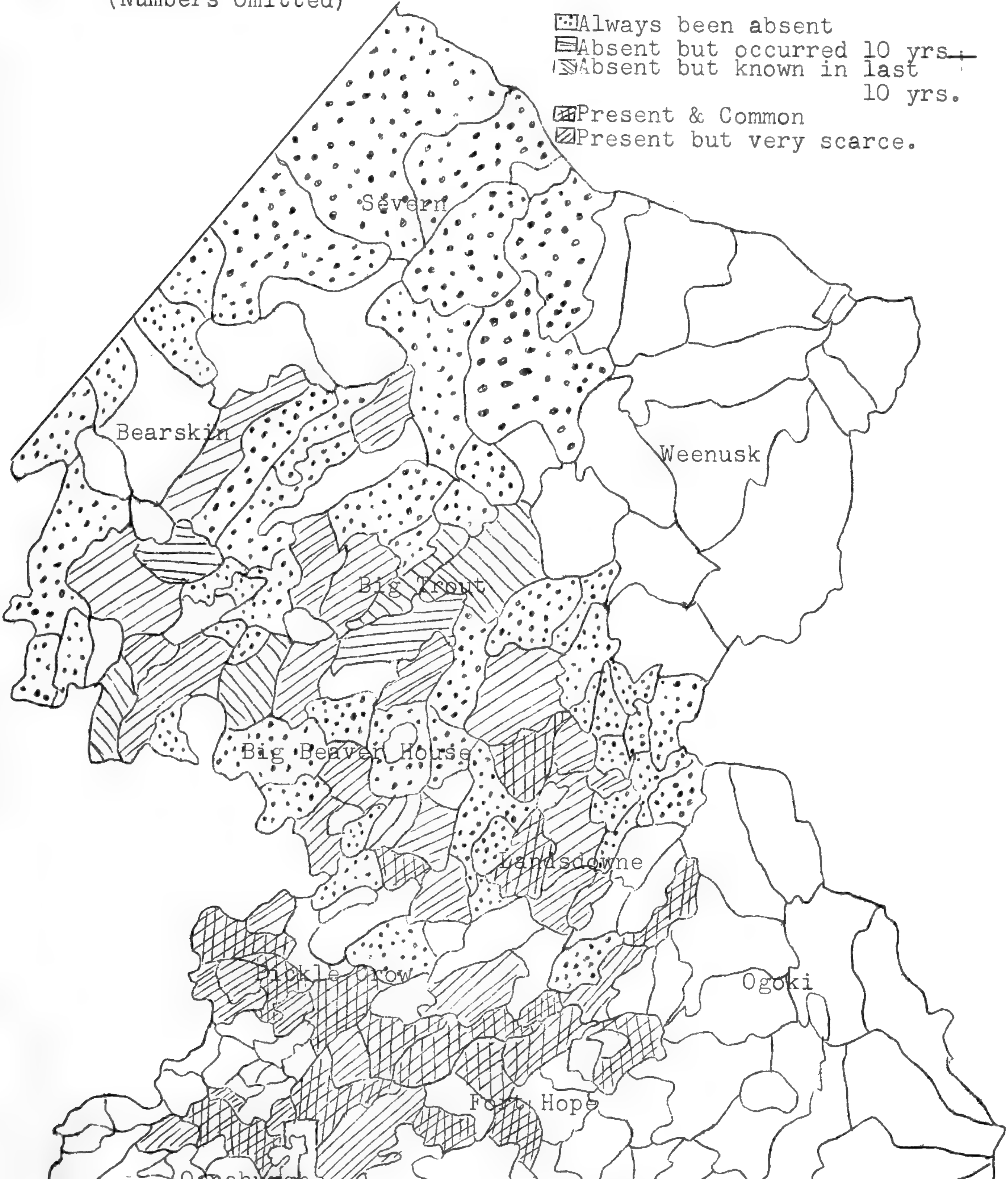
- ▤ Always Absent
- ▤ Absent for at least 10 yrs.
- ▧ Absent less than 10 yrs.
- ▦ Present & common
- ▨ Present but scarce

PATRICIA WEST DISTRICT
REGISTERED TRAPLINE AREAS
(Numbers Omitted)

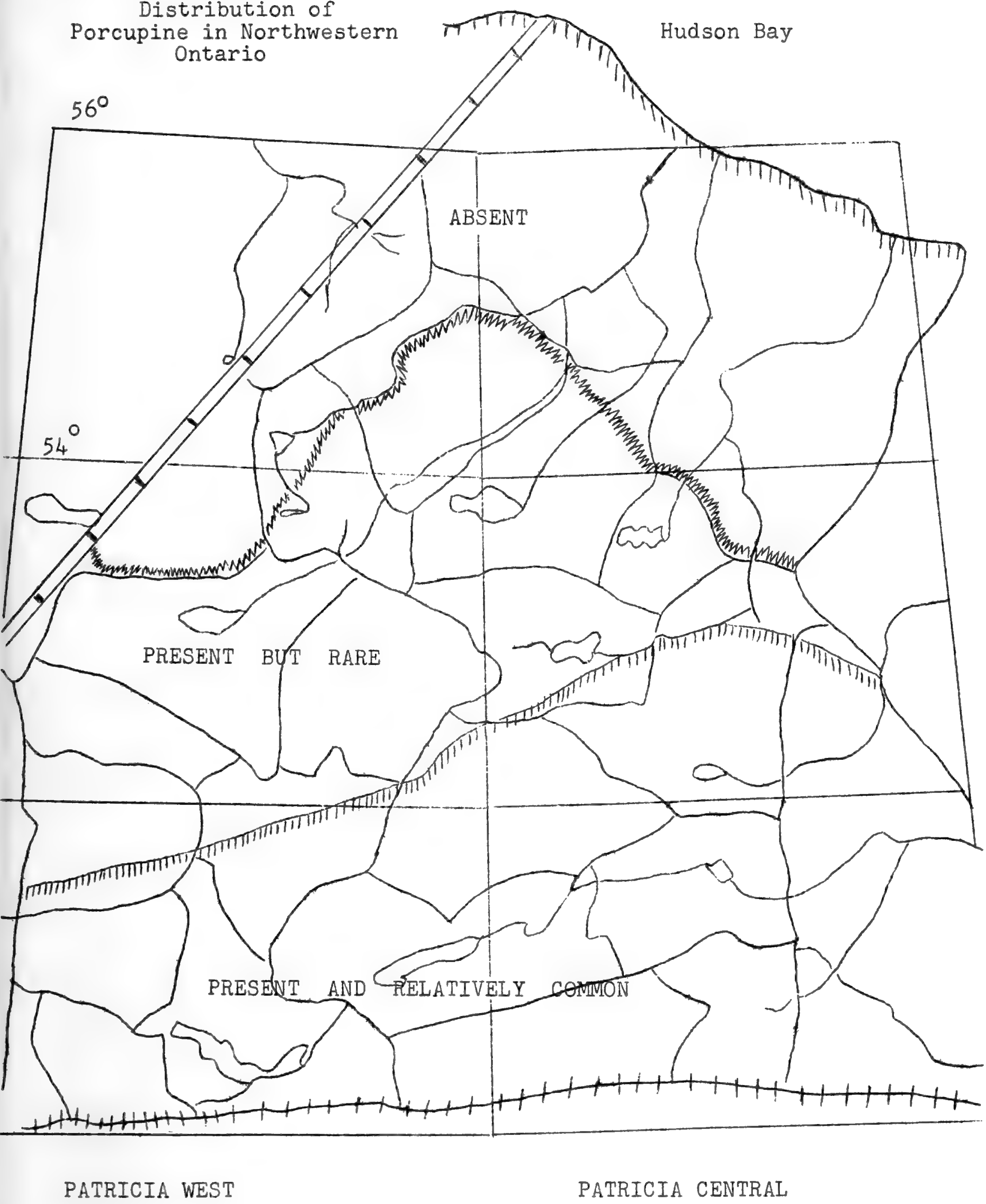
MAP #2

PATRICIA CENTRAL DISTRICT
REGISTERED TRAPLINE AREAS
(Numbers Omitted)

Distribution of Porcupine



MAP #3
Distribution of
Porcupine in Northwestern
Ontario



SPRING RUFFED GROUSE STRIP COUNTS LAKE HURON DISTRICT 1961

by
R. E. Mason
District Biologist

Abstract

In order to obtain an annual index to breeding and pre-season ruffed grouse populations, strip counts were begun in Lake Huron District in 1960. The population indices are derived from the King method strip count data collected during the spring and fall of 1960 and spring 1961. The data are analysed using covariance and regression analyses applied to the King method, and by the use of the King method directly. No significant differences could be demonstrated between the total spring population of 1960 and 1961, although a decline in grouse populations on poorer quality habitat during the same period is evidenced by the data. An increase of 75% between the spring and fall populations of 1960 was significant.

Contributing Personnel: R. R. Bellinger, H. W. Clark, H. J. Gingrich, G. R. Harris, M. Marr, R. T. Ellah, W. H. Flynn, R. A. Guenther, E. L. Johnston, G. C. Matthews.

Introduction:

After preliminary evaluation of the technique in 1959, strip counts were initiated in this district in 1960 to provide an annual index to breeding and pre-season ruffed grouse populations. The value of strip counts run on plots not pre-determined as to size is that variability in observations, as related to cover types, is presumably accounted for by the varying strip width.

However the resulting variation in plot size and the inclusion of plots on which no observations are made, makes the analysis of the information difficult. This difficulty has resulted in four proposals for the analysis on strip count information; King's ruffed grouse methods, Hayne's subpopulation method, Webb's varying hare method, and Kelker's Belt Method. (2) & (3). King's ruffed grouse method, which uses twice the mean flushing distance as the average strip width, has been found to introduce less variation than the other techniques, while retaining the advantage of allowing for some habitat variation. (see Spring Strip Counts, Lake Huron District 1960.)

For the 1960 spring data, confidence limits were calculated for the mean flushing distance, and this figure applied to the sum of strip lengths for the district. The inclusion of additional census periods permits an analysis of covariance technique to be applied to test for differences between census periods. In this report, the information has been analysed both ways for comparison.

Procedure

Strips are run through pre-chosen grouse habitat. Selection of areas was made by the conservation officer. By employing selected areas, a reduction in sampling variation was attempted. Using a compass, the strip is run, usually through a concession, in as straight a line as is practical. Observations are recorded, along with the angle of observation, and the distance from the observer at the time of the observation to a point along the strip estimated to be at a right angle to the point where the observation was made. This allows for the calculation of flushing distances without necessitating that the observer deviate from the line of travel.

Analysis of Data

Flushing distances are calculated from the data using the cosine of the angle of observation. Using the King method, the average flushing distance is doubled to produce the average strip width. The average strip width is then multiplied by the total length of strips to give the area sampled. Confidence limits expressed for the average flushing distance can be applied to the area sampled to produce an interval estimate of the grouse population, assuming flushing distances to be the source of experimental error.

Using the covariance analysis, the area sampled is calculated as before, only separately for each strip. Sampled areas for strips on which no observations were made were arrived at by using the average flushing distance for all strips completed by the observer who had recorded the zero strip. A single observer was used to eliminate the possibility of differential habitat selection between observers. Sampled areas are recorded in acres. Covariance analysis proceeds using the relation between sampled areas and number of observations.

Observations

Table 1. Ruffed Grouse Observations

Year	Grouse Observed	Strip Length	Flushing Distance	Area Sampled King	Area Sampled Covariance
1960 Spring	20	23.5	48.9	278.6	263.8
1960 Fall	129	55.8	75.6	1022.7	1057.6
1961 Spring	48	51.1	52.5	650.4	595.4

Table 2. Observations Other than Grouse

Species	Spring 1960	Fall 1960	Spring 1961
Cottontail	?	9	8
Snowshoe Hare	8	11	19
European Hare	3	10	1
Pheasant	4	3	
Red Squirrels		1	2
Black Squirrels			8
Red Fox	1		
Porcupine	1	1	
Woodcock	1	2	
Snipe	1		
Chipmunk			1
Woodchuck		1	
Deer		2	2
Waterfowl		1	3

Table 3. Grouse Per 100 Acre Estimates

Year	King Method	Covariance Method	
		Unadjusted	Adjusted
1960 Spring	7.18	7.58	7.71
1960 Fall	12.60	12.20	13.35
1961 Spring	7.38	8.06	7.35

Discussion

The mean numbers of grouse seen during each census period were tested for significant differences using an analysis of covariance. This analysis corrects the mean number of grouse,y, for the variability which can be accounted for by the varying plot size x, expressed in acres. The covariance analysis is presented in table 4.

Table 4. Covariance Analysis

Source of Variation	d.f.	$\sum x^2$	$\sum xy$	$\sum y^2$
Total	120	30567.1934	1519.6596	634.2645
Period	2	812.1226	169.3260	40.1995
Error	118	29755.0708	1350.3336	594.0650

From regression	d.f.	$\sum dy.\ x^2$	mean sq.	F
Common	119	558.714		
Error	117	432.786	4.5537	
Difference	2	25.928	12.9640	2.847

The tabulatar value of F at 0.10 level of confidence is 2.35. It has been proposed that 0.20 confidence levels are sufficient for most wildlife inventory purposes; hence the evidence indicates that the difference between at least one pair of means in the fourth column of table three is significant.

The mean differences which would appear to be of interest are the difference between the spring census periods of the two years, and the difference between the spring and fall population of the same year. The mean squares for the adjusted mean differences were calculated, and confidence limits set using the 0.20 level of t. The inclusion of zero by the confidence limits indicates non significance.

Spring 1960 - spring 1961 = 0.0553 ± 0.7987

Spring 1960 - fall 1960 = -0.8948 ± 0.7770

No difference can be demonstrated between the 1960 and 1961 breeding populations of ruffed grouse. The difference between spring and fall 1960 grouse population is significant, at the 0.20 level of confidence. However, from the degree of variation encountered in these three census periods, it would appear that changes in the population would have to be in the order of 60-65% before the change could be demonstrated even at this relatively low level of confidence. It would be desirable therefore to reduce the sampling error through a more stringent selection of habitat.

In order to evaluate the variation associated with habitat types, the regression of observations against plot size was plotted for each of the three census periods. The regressions, contained by their 0.20 confidence limits, are plotted in figures one, two, and three. If the habitat selected by all officers was homogeneous, or if grouse approached a random distribution in differing habitat types, each regression curve would describe a line of constant proportionality between the axes. That is, a plot of 100 acres would contain ten times as many grouse as a plot of 10 acres in size. Figure two is the only regression which approaches this condition.

If the selected habitat was homogeneous, then plot sizes would tend to be the same. That is, the grouse would tend to flush at the same distance on all strips. The data on flushing distances reveal that this was not so, although more consistency is apparent for strips completed by the same officer than for the whole district. The assumption is then made than grouse tend to be more randomly distributed in the fall than in the spring, within the areas selected by officers as "grouse habitat".

According to Dorney (1), spring ruffed grouse habitat selected is toward denser cover. This is evidenced by figures one and three. In both cases the density of grouse per unit area decreases with increasing plot size. The basis of the strip count technique is that plot size is a function of cover density. An examination of figures one and three, therefore, provides an estimate of changes in the grouse population not evident in the covariance analysis.

Under the covariance analysis, the mean plot size for all census periods used in the calculation of the adjusted grouse per plot means for each census period was 15.84 acres. For figures one and three, the difference at this plot size is obviously not significant, since the 0.20 intervals of both regressions overlap at this point. For plot sizes approaching 50 acres in size however, these regressions approach significance. Interval estimates of the regression values for several plot sizes are given in table five. Again, overlapping intervals indicate non-significance. Figure two data are not included since they were significantly different at the adjusted level of 15.84 acres.

Table 5. 0.20 Interval Estimates, Spring 1960 and 1961: Presented as Grouse/100 Acres.

Plot Size Acres	Spring 1960	Spring 1961
10	13.2 - 6.8	12.2 - 7.9
30	7.2 - 4.5	4.8 - 2.7
50	6.5 - 3.5	3.5 - 1.4
70	6.3 - 3.0	3.0 - 0.9
90	6.2 - 2.8	2.7 - 0.5
100	6.1 - 2.6	2.6 - 0.4

Although table four reveals no significant over all change between the 1960 and 1961 spring populations of grouse, table five indicates a possible decline in grouse numbers in the poorer quality habitat. Interval estimates of $\hat{Y}$ corrected to four places of decimals, while not containing zero for mean differences, very closely approach zero. Considering the low confidence level used (0.20), the possible decline should be accepted with caution. The regression analysis may however be capable of detecting somewhat smaller changes in the grouse population than the more inclusive covariance analysis.

Summary and Conclusions

Population indices for ruffed grouse are derived from King method strip count data collected during three census periods, spring and fall 1960, and spring 1961. The data are analysed using covariance and regression analyses applied to the King method, and by the use of the King method directly. No significant differences could be demonstrated between the total spring populations of 1960 and 1961, although a decline in grouse populations on poorer quality habitat during the same period is evidenced by the data. An increase of 73% between the spring and fall populations of 1960 was significant.

References

(1) Dorney, Robert S., 1959, Relationship of Ruffed Grouse to Forest Cover Types in Wisconsin, Wisc. Cons. Dept. Tech. Bull. No. 18.

(2) Hayne, Don W., 1949, An Examination of the Strip Census Method of Estimating Animal Populations, Journ. Wildl. Mgt., 13(2).

(3) Robinette, W. Leslie, et al., 1954, Methods for Censusing Winter-lost Deer, Trans. 19th N. Am. Wildl. Conf.

FIGURE 1

Spring 1960 Strip Counts

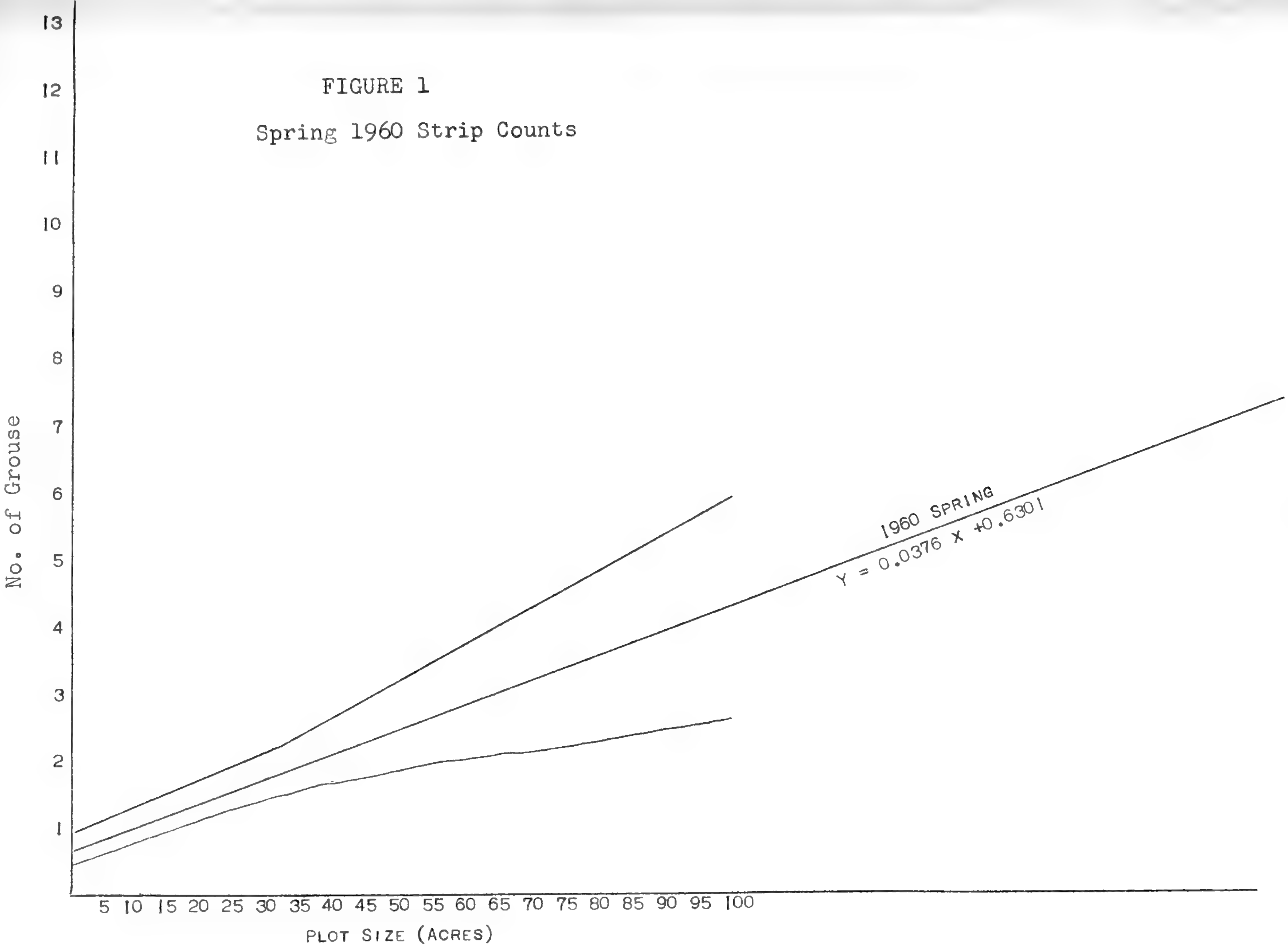


FIGURE 2
Fall 1960 Strip Counts

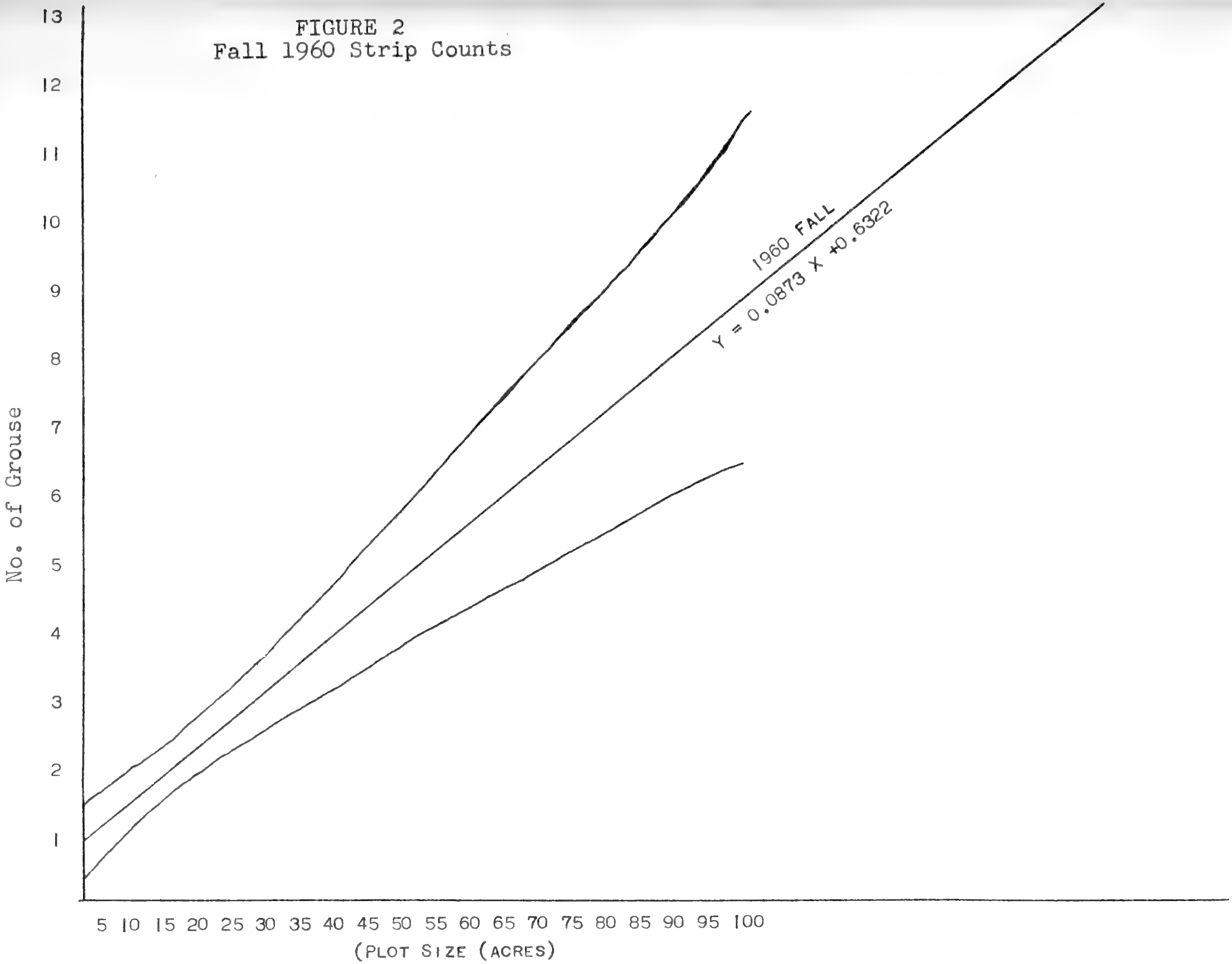
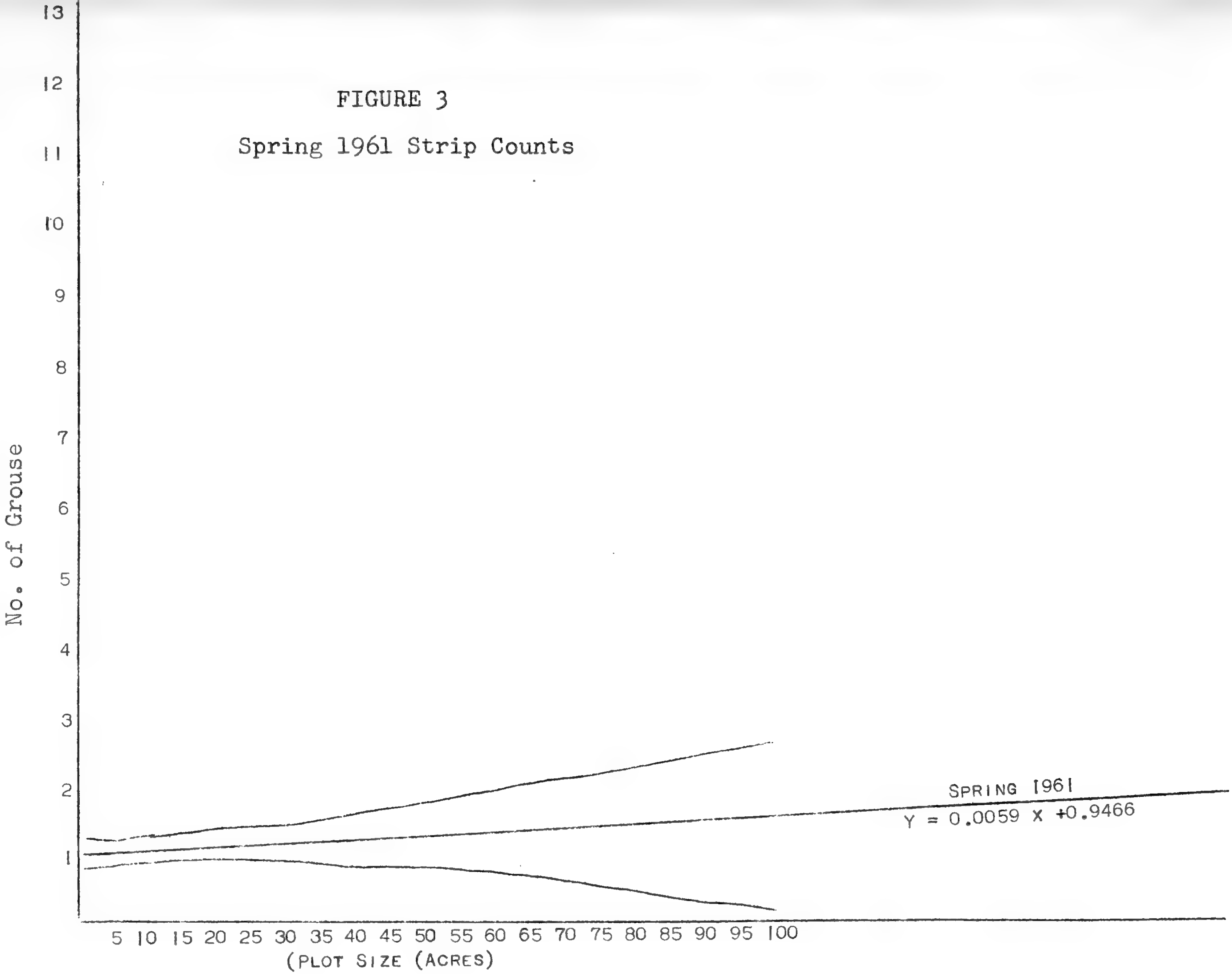


FIGURE 3

Spring 1961 Strip Counts



SUDBURY COMMERCIAL BAIT-FISH INDUSTRY IN 1959

by
D. A. Mulligan
Conservation Officer, Sudbury District

Abstract

An evaluation is made of the availability and utilization of the Sudbury Commercial Bait-Fish Industry in 1959. A standard report form and letter were issued with each licence sold to bait fish dealers in order to gather information on this phase of the fishing industry. In 1959, 145 licences were issued in the district. This report covers the returns of 35.9% of Sudbury's licensed live bait dealers, approximately 613,000 minnows and 171,000 worms. Peak sales were found to occur during mid-summer with a lower peak in January. With the provision of two assumptions, the gross income from the sales of minnows in 1959 was calculated to be $85,506.50, while gross income from the sales of worms was $11,904.50. Gross income from the combined sales was calculated to be $97,411.00.

Introduction

To assure the proper management of a natural resource it is necessary to attempt an evaluation of its availability and utilization. One of the newer resources to be exploited in recent years is the minnow and small coarse fish population. This phase of the fishing industry has developed geometrically with the coincidental increase of sports fishermen in Ontario.

Methods used

It was felt, here in Sudbury, that some attempt should be made to evaluate the extent of this resource and its use. A form letter (Exhibit 1) and a report form (Exhibit 2) were, therefore, prepared and issued to the licensee with his licence. The 1959 returns, although far from complete, are encouraging and it is anticipated that with additional public relations work, we will soon be in a position to set the parameters of this industry and evaluate its financial importance as a fish and wildlife resource. Information made available through the use of this medium includes:

1. The type and number of gear used in collecting the minnows.
2. Size and number of holding tanks or ponds.
3. Type of equipment used in transportation.
4. Whether aeration was used or not.

5. Source of minnows, i.e. name of stream, lake or pond.
6. Whether artificial propagation was attempted.
7. Relative annual abundance of resource.
8. Species and quantity sold by month.

Survey results

This report covers 52 bait dealer returns (35.9% of the district's total licence sale) and includes data on the sale of approximately 613,000 minnows and small coarse fish and 171,000 worms.

Table 1 shows the temporal distribution of sales by species. Figure 1 shows the temporal distribution of total sales and the temporal distribution of the two major species (common shiner and creek chub) from table 2. Fewer shiners were sold during 1959 when compared to chub, but when viewed as a per cent of individual species sales, the June, July and August sales of shiner topped the same period sales of chub.

Table 2 records the temporal distribution of the two major species as a per cent of total individual species sales and as a per cent of total minnow sales. Per cent temporal distribution of total species sales is also recorded in this table. Figure 2 represents the temporal distribution of the two major species expressed as a per cent of total sales.

Suckers and golden shiners were recorded as the chief species sold and reported under the column, "other species of minnows". Worm sales paralleled the sale of chubs with moderate January sales dipping to a low in April, but rising sharply through May to July, before once again dipping to a low in November.

With regards to the type of gear used -- the 52 licenses reporting indicated that 18 seines, 6 dip nests and 26 trap nets were used to harvest the minnows. Five licensees used a combination of seines and traps, while three used a combination of seines and dip nets. One hundred and forty-five licenses were issued in Sudbury in 1959 covering 24 dip nets, 38 seines and 253 traps. Holding tanks varied in size from a maximum of 7 ft. x 10 ft. x 3 ft. to 45 gallon barrels. The latter were most frequently used. Maximum pond size was reported as three-quarters of an acre. Vessels used in the transportation of the minnows ranged from barrels, to pails, tubs and bottles. Five licensees reported the use of aeration during transportation and a same number attempted artificial propagation of minnows.

Forty per cent of the licensees reported minnows scarce in 1959, thirty-five per cent abundant and the balance of twenty per cent failed to indicate one way or the other. Those that indicated a scarcity were almost unanimous in stating the time of scarcity -- late summer to early fall.

Other information was volunteered by the licensees -- gross income from sales, selling price of minnows, mortality, and cause of mortality. The selling price of minnows varied from seventy-five cents per dozen during May through September to fifty cents per dozen during the balance of the year. Likewise, the selling price of worms varied from three cents each to two and one half cents each. The chief cause of mortality appears to have been fungusing.

Discussion and Conclusion

To place a monetary value on this phase of the fishing industry, we are going to make two assumptions which we feel are quite within reason. First, we are going to assume that the 1959 returns are representative of the industry in Sudbury District. The sample we have for this year represents licensees that did not use their licenses, those that sold in large volume and those that only made a token attempt to realize an income from this resource. Secondly, we will assume that the average selling price (from January to December) of minnows is five cents each and the average selling price of worms is two and one half cents each.

Using the second assumption first, plus the recorded sales of the fifty-two licensees, we arrive at a gross income from minnow sales of: 613,296 x .05 equals $30,664.80; from worm sales of 170,786 x .025 equals $4,269.65. The gross income from the combined sales of the 52 licensees is then $34,934.45 or an average gross income of 652.58.

Applying the first assumption, we calculate the gross income from the sale of minnows in Sudbury District to be:

$$\frac{613,296}{52} \times 145 \times .05 = \underline{\$\ 85,506.50}$$

613,296	Reported sale of minnows by 52 licensees;
52	Number of licensees reporting;
145	Total number of bait dealer licenses issued in Sudbury during 1959.
.05	Average selling price of minnows.

Similarly, the calculated gross income from worm sales is $11,904.50. Total calculated gross income in Sudbury during 1959 is then: $ 85,506.50 plus $ 11,904.50 or $ 97,411.00.

One of the apparent failings of such a method of survey might be discussed here. Perhaps the most outstanding bias is the species identification by the licensees. The common white sucker obviously is one of the more important bait species here in Sudbury, yet reported sales are relatively low. This may be due to one of two reasons, viz: inability of the licensee to recognize different species or suppression of the true sales value of this species, by the licensee, due to the bad publicity the sucker has had as a

competitor of game fishes. It is well known that some of our larger dealers are artificially propagating the sucker, yet total sales reports are not at all comparable to those of the chub or shiner. To overcome this bias, vials or bottles containing alcohol could be distributed to the dealers with instructions to submit samples of the species that they offer for sale or a conservation officer could sample their tanks or ponds at intervals and interview the licensee with regards to sales volume of each species collected.

Examination of Table 2 and Figures 1 and 2 suggests an interesting variation in species availability. Creek chub show a moderately strong sales record from January through April, while the common shiner sales are relatively weak. During the May to September period the shiner closely parallels the chub in sales, exceeding chub sales during the month of July. This concentrated sales period for shiners might suggest that the availability of this species in ponds and streams might change with the season.

Summary

1. A standard report form and letter were issued with each licence sold to a bait fish dealer in an effort to gather information on this phase of the fishing industry.

2. This report covers the returns of 35.9% of Sudbury's licensed live bait dealers - approximately 613,000 minnows and 171,000 worms.

3. Peak sales were found to occur during mid-summer, with a lower peak in January.

4. 145 licenses were issued in Sudbury in 1959.

5. With the provision of two assumptions, the gross income from the sales of minnows in Sudbury during 1959 was calculated to be $85,506.50, while gross income from the sales of worms was $11,904.50. Gross income from the combined sales was calculated to be $97,411.00.

6. There is a suggestion of a seasonal variation in relative availability of the two major bait species.

TABLE 1

THE TEMPORAL DISTRIBUTION OF SALES BY SPECIES

MONTH	COMMON SHINER QUANTITY SOLD	CREEK CHUB QUANTITY SOLD	BLUNTNOSE MINNOW QUANTITY SOLD	FATHEAD MINNOW QUANTITY SOLD	OTHER SPECIES QUANTITY SOLD	WORMS QUANTITY SOLD
January	612	17,142	432	1,140	4,032	23,358
February	474	9,438	150	492	3,108	13,662
March	348	7,224	324	168	2,182	10,246
April	120	1,248	-	360	600	2,328
May	16,240	37,922	1,530	360	8,420	64,472
June	48,465	65,290	1,056	240	10,091	125,142
July	69,063	65,242	1,596	360	12,900	158,695
August	36,728	37,220	1,440	-	11,918	87,306
September	12,361	18,754	600	-	7,044	38,759
October	1,400	3,044	120	-	2,088	6,652
November	228	288	-	120	360	996
December	-	780	-	-	900	1,680
No Date	80,000	-	-	-	-	-
TOTAL	266,039	273,126	7,248	3,240	63,643	170,786

TABLE 2

	COMMON SHINER PER CENT OF SHINER SALES	CREEK CHUB PER CENT OF CHUB SALES	ALL SPECIES PER CENT OF TOTAL SALES	COMMON SHINER PER CENT OF TOTAL SALES	CREEK CHUB PER CENT OF TOTAL SALES
January	.3	6.3	4.4	.1	2.8
February	.3	3.4	2.6	.1	1.5
March	.2	2.6	1.5	.1	1.2
April	.1	.5	.4	.1	.2
May	8.7	13.9	12.1	2.6	6.2
June	26.1	24.2	23.5	7.9	10.6
July	37.1	24.2	29.8	11.1	10.6
August	19.7	13.6	16.3	5.9	6.1
September	6.6	6.5	7.3	2.0	3.1
October	.8	1.1	1.3	.2	.5
November	.1	.1	.2	.1	.1
December	-	.2	.3	-	.1

FIGURE 1 TEMPORAL DISTRIBUTION OF MAJOR SPECIES AS PER CENT OF THEIR TOTAL INDIVIDUAL SALES AND OF ALL SPECIES OF TOTAL SALES

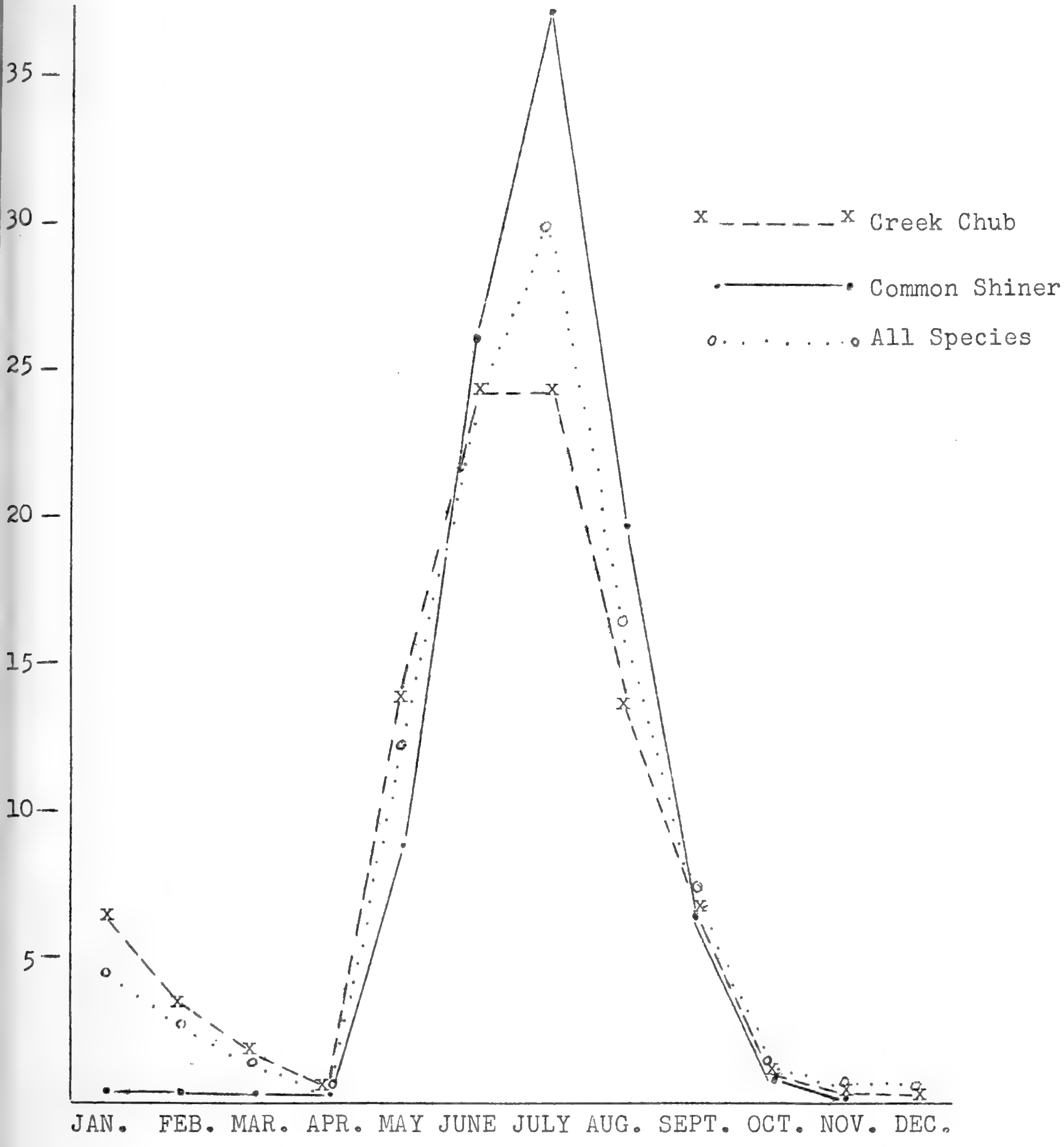
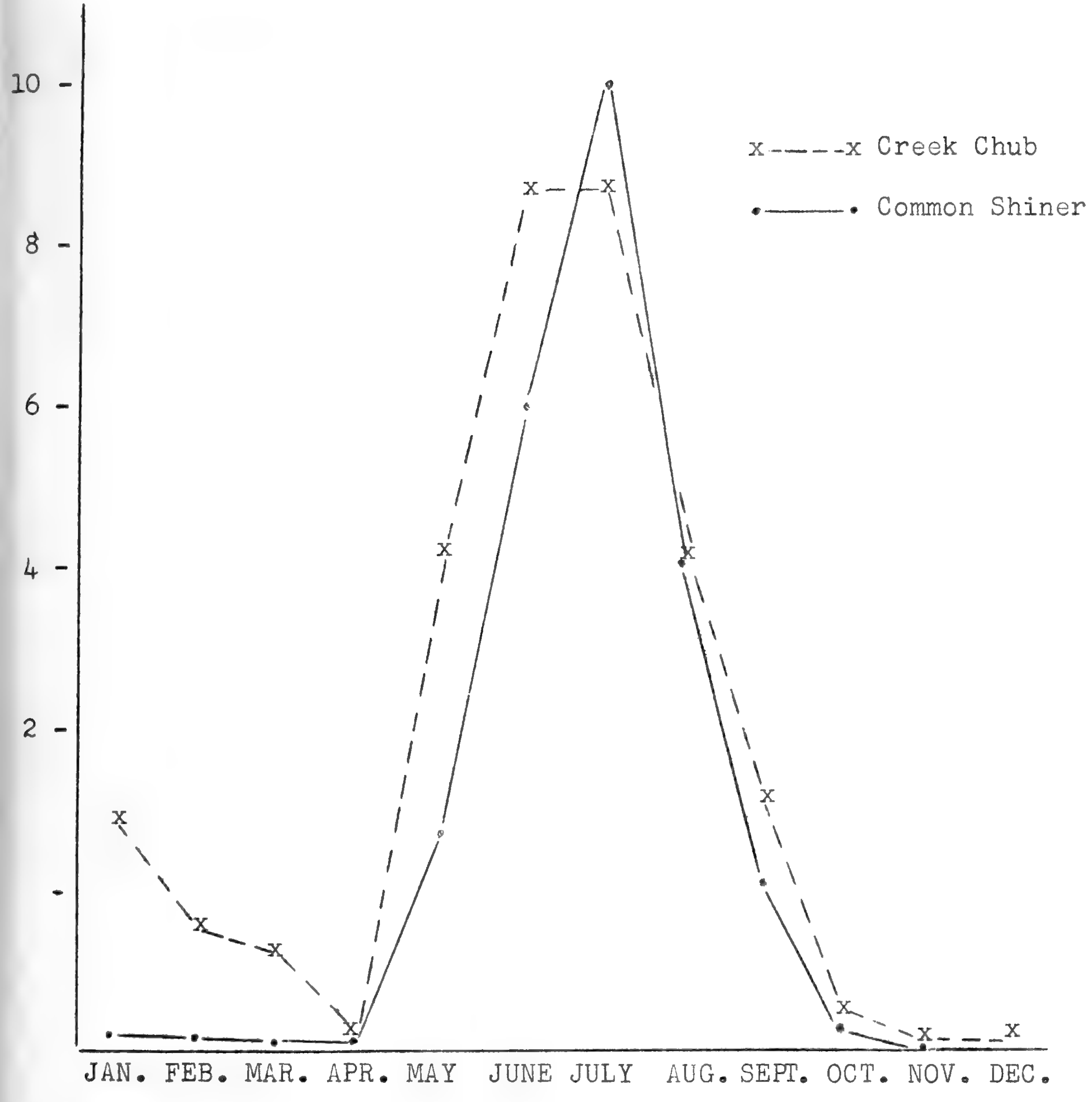


FIGURE 2



TEMPORAL DISTRIBUTION OF MAJOR

SPECIES AS PER CENT OF TOTAL SALES

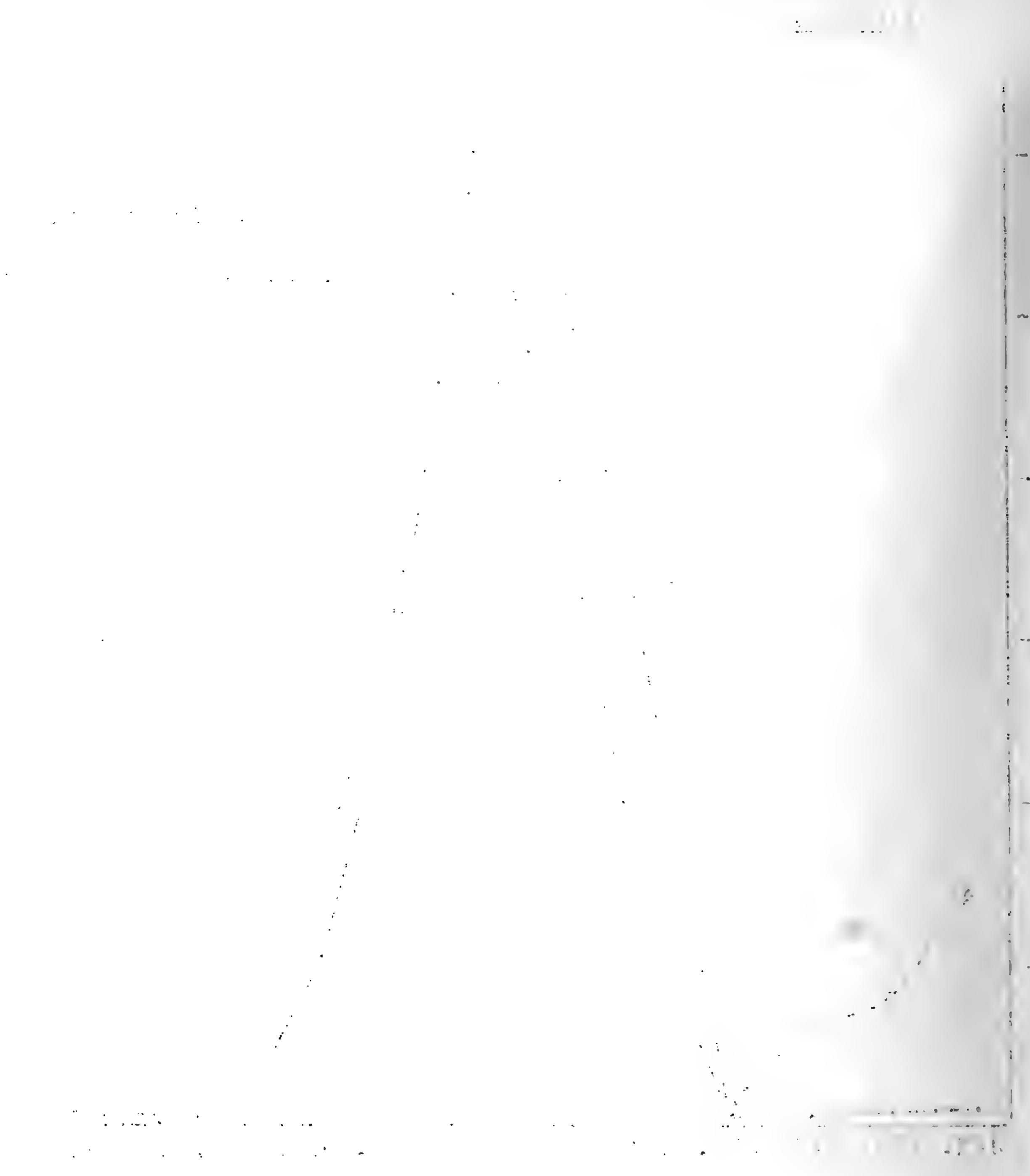


EXHIBIT 1

Fish and Wildlife Division

WHEN REPLYING KINDLY QUOTE
THIS FILE NUMBER

ONTARIO

DEPARTMENT OF LANDS AND FORESTS

SUDBURY, Ontario.

Dear Sir or Madam:

The number of people making application for minnow seine licences, trap licences, minnow dip net licences and bait-dealer's licences is increasing every year.

In recommending or refusing to approve these applications it is necessary that we know something about the size and value of the annual minnow harvest from our local waters.

Further, we may be justified in paying much more attention to this industry than the mere sale and control of licences. Artificial propagation of minnows to supply the demand during periods of scarcity may well be the answer to this annual problem in which we may be able to help.

It is unfortunate that we have very little information on record regarding your industry. If we are to manage it intelligently we must know roughly what the annual take of minnows amounts to and what this means in dollars and cents to the economy of the district.

We respectfully solicit your full co-operation in keeping a monthly record of the minnows you sell. At the end of December next this form should be submitted either to your local Conservation Officer or to the Department of Lands and Forests, 172 Elm St. W., Sudbury.

The information you submit will be kept strictly confidential and will not be used for any purpose but to benefit your business.

FAILURE TO MAINTAIN AND SUBMIT THE REQUESTED RETURN MAY MEAN SUSPENSION AND/OR CANCELLATION OF YOUR LICENCE.

Yours very truly,

For: G. A. Hamilton,
District Forester.

CFB/RM.

ANNUAL LIVE BAIT REPORT

EXHIBIT 2

To: Conservation Officer ____________________ For Year Ending December 31st, 19___

Licence No. ____________ Name (Print)________________ Address________________

Type of Fishing Gear Used: Check v, Seine, Dip Net, Trap	Size and No. of Holding Tanks or Ponds	Equipment Used in Transportation	Aeration Used Yes_____No___
Location of Grounds Where Minnows Taken	Did you Propagate Minnows or Other Bait? Yes___ No___ Did you find Minnows Scarce this year? _____ If so, When?____		

	Lake Shiner	Chubs	Bluntnosed Minnow	Fathead Minnow	Other Species of Minnows	Worms
MONTH	Quantity Sold	Quantity Sold	Quantity Sold	Quantity Sold	Quantity Sold	Quantity Sold
January						
February						
March						
April						
May						
June						
July						
August						
September						
October						
November						
December						

Above Return Correct to Best of My Knowledge Print Name________________ Date:________

(The information on this Form is confidential and used only for the benefit of the Bait Fish Industry)

THIS REPORT IS REQUIRED WITHIN 15 DAYS OF THE END OF THE YEAR REPORTED OR JANUARY 15TH

A PRELIMINARY REPORT ON THE WHITE LAKE FISHERY

by
M. L. Milton
District Biologist
White River District

Abstract

The purpose of this study was to determine over a prolonged period of time the effect of intense angling pressure on a lake hitherto unexploited. In order that conditions might be studied as they existed in the natural state, a biological survey was initiated in White Lake in White River District during the spring of 1961. This included depth soundings, test nettings, a pickerel tagging study and the taking of scale samples. A second phase of the programme was to establish a creel census technique. Tables and graphs showing angling success results by month over the summer period are presented.

Introduction

White Lake is situated in the White River Forestry District, twenty-three miles west of the town of White River, and thirty-five miles east of the town of Marathon. A bridge on the Trans-Canada Highway (Hwy. 17), crosses the lake, thereby providing excellent accessibility.

White Lake itself is twelve miles in length, five miles across at its widest point and supports excellent populations of Yellow Pickerel (Stizostedion vitreum), Northern Pike (Esox lucius) and Whitefish (Coregonus clupeaformis).

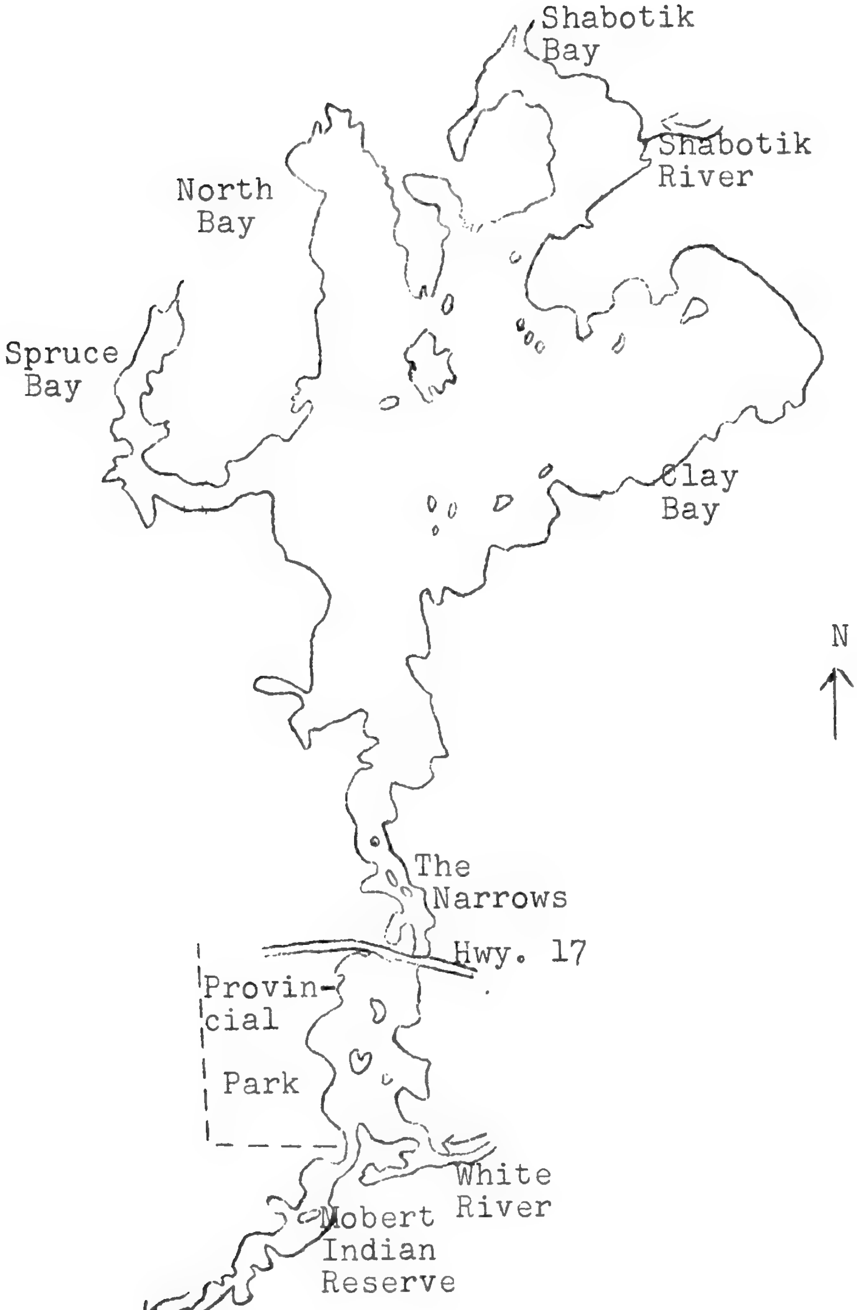
Previous to the opening of the highway, the lake was subjected to only slight angling pressure. However, the completion of the Great Circle Route in the fall of 1960 coupled with volumes of tourist literature has initiated a great influx of anglers to the area.

White Lake, being one of the largest and most accessible lakes along the route has naturally been subjected to a sharp upswing in angling pressure; thus affording an almost unique opportunity to study the effects of suddenly intensified angling pressure on a lake.

In order to properly study the effects of angling pressure, it is hoped that this programme may be continued over a number of years so that a trend in angling success may be established. In this way, the need, or lack of need, for the introduction of management practices should become apparent.

Figure 1:

WHITE LAKE



Before such a programme could be initiated it was necessary to conduct at least a partial biological survey of the lake in order that conditions may be studied as they existed in the natural state. For this reason this paper will be divided into two parts; the first dealing with the biological survey and the second with the creel census survey.

Part 1 - Biological Survey

Neither time nor money would allow for the complete biological survey of White Lake during the first season. It was felt however, that certain phases should be investigated as quickly as possible in order to establish certain pertinent facts.

A pickerel tagging project was initiated in the spring of 1961 before the beginning of the angling season. The purpose of this project was to tag a known number of pickerel, the returns from which, when compared with the total number of pickerel caught during the season, would give a very rough estimation of the pickerel population in the lake. This, if continued for several years, could conceivably establish a trend in the population size.

The lake was completely sounded in order that locations for test nettings might be found. As well, it is intended that a contour map of the lake will be made up as an aid to anglers.

Test nettings were carried out in order that growth rates and population proportions may be established. It may be possible to carry out similar nettings in several years using the same location to find whether or not growth rates and population proportions are remaining unchanged.

The remaining phases, necessary to complete the biological survey will be carried out during the remainder of the study as time permits.

Methods

(a) Tagging

Tagging was done in May during the pickerel spawning run at the mouths of the Shabotik and White Rivers (see map). Gill nets were used to secure the fish and although die-off was rather high, 519 pickerel were successfully tagged and released.

Both dart and oval type tags were used in an effort to see which would prove the most successful. The fifth and sixth spines on the dorsal fin were clipped on all tagged fish in order that tag losses might be ascertained. Besides the taking of scale samples, the length, weight and location of release of all fish was recorded.

(b) Sounding

The whole lake was sounded by echo sounder during the months of June and July, as time permitted.

(c) Test Netting

Six test-nettings were done in the lake using standard Department of Lands and Forests gill net gangs. An effort was made, making use of the information obtained while sounding, to place the nets such that all depths would be sampled.

Nets were set at sundown and picked up at sunrise the following morning, to avoid as much as possible, entanglement with anglers' lines.

Results

(a) Tagging

Table 1 shows calculations used to arrive at a very rough estimation of the pickerel population. This should in no way be interpreted as an accurate estimate.

When calculating population size, the number of pickerel caught rather than the number of pickerel retained was used since it was felt that anyone catching a small tagged fish would probably keep it, if only out of curiosity. Cooperation among anglers with regard to returning tags was found to be good.

It was found that the dart type tags are far superior to oval tags, particularly considering their ease of application.

Table 1:

No. of Fish Tagged and Released	519
No. of Tags Returned	75

Total No. of Pickerel caught (census estimate) - 35,077. (table 4)

X = Pickerel population in lake.

$$\frac{75}{519} = \frac{35,077}{X}$$

$$X = \frac{519 \times 35077}{75}$$

$$= 242,734.$$

(b) Sounding

Soundings showed that about sixty per cent of White Lake is less than 30 feet deep. There are however, fairly extensive deep water areas in the northern and north eastern parts of the lake, the greatest depth being 140 feet. Sounding results will be used to

prepare a contour map of the lake for distribution among anglers.

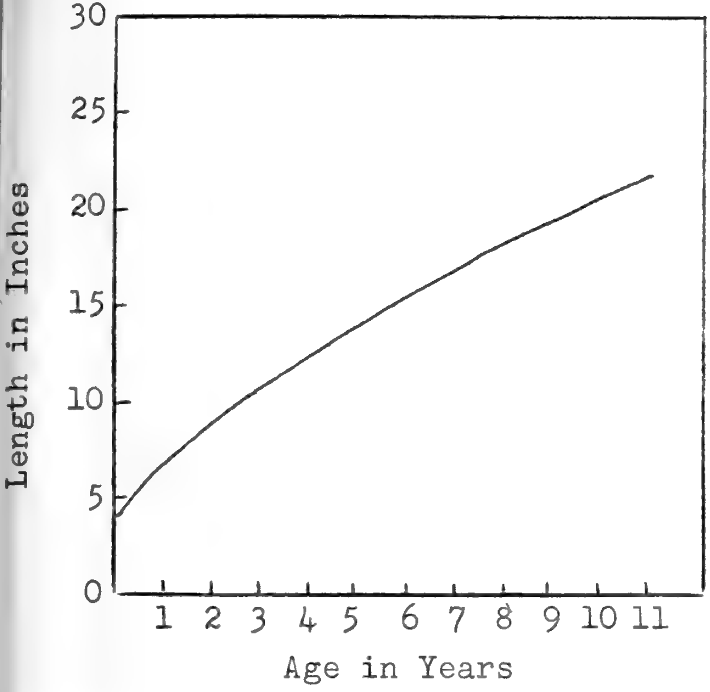
(c) Test Netting

Graphs 1 to 4 represent growth charts formulated from data collected during the six test nettings.

Graphs 5 and 6 represent length-weight charts, formulated to aid in the interpretation of creel census results.

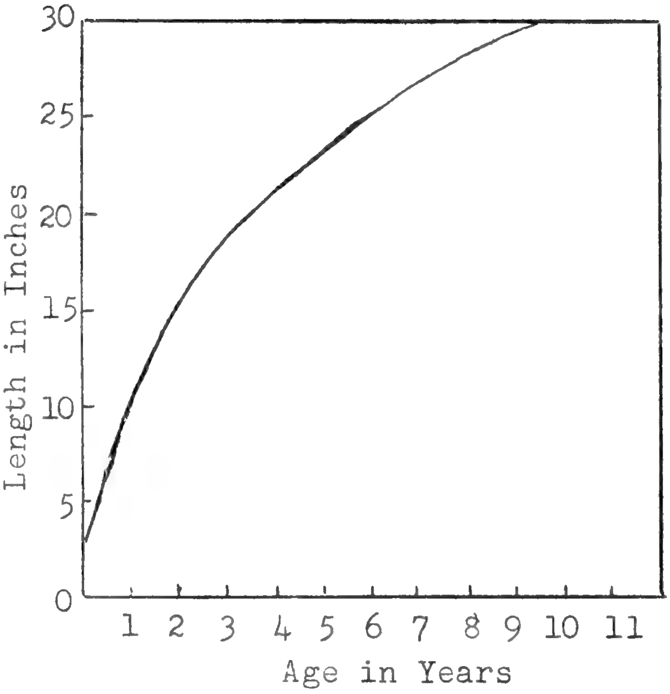
Graph 1:

Yellow Pickerel
Length versus Age



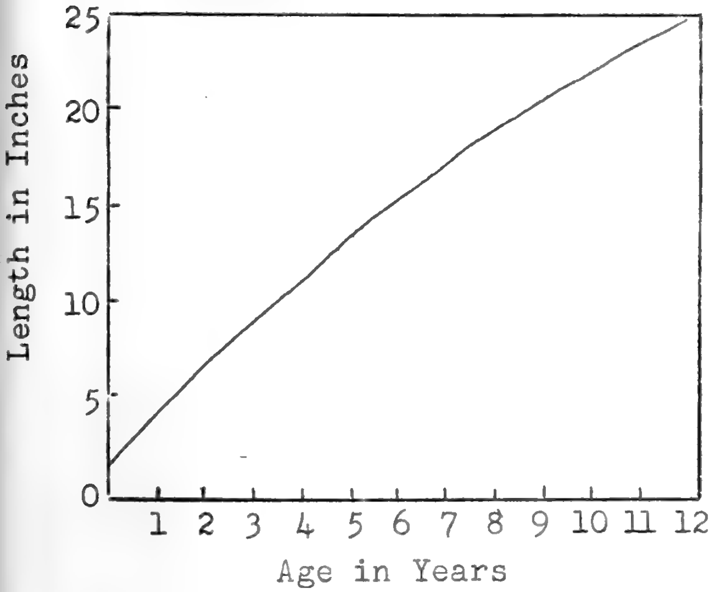
Graph 2:

Northern Pike
Length versus Age



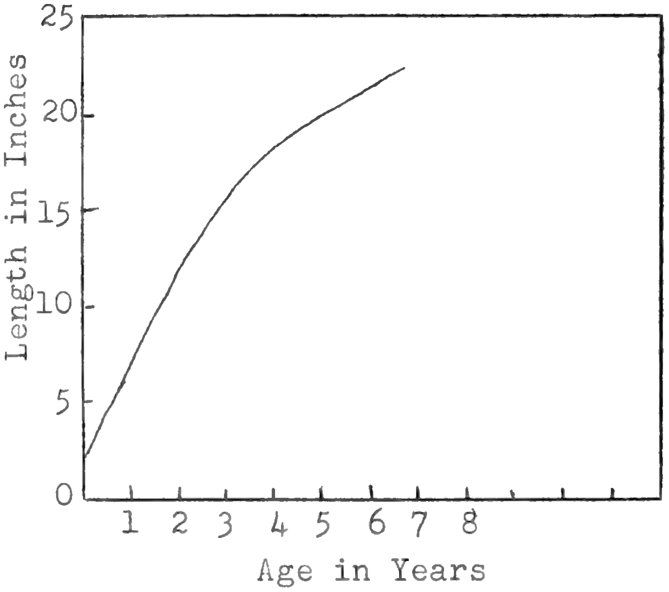
Graph 3

Lake Whitefish
Length versus Age

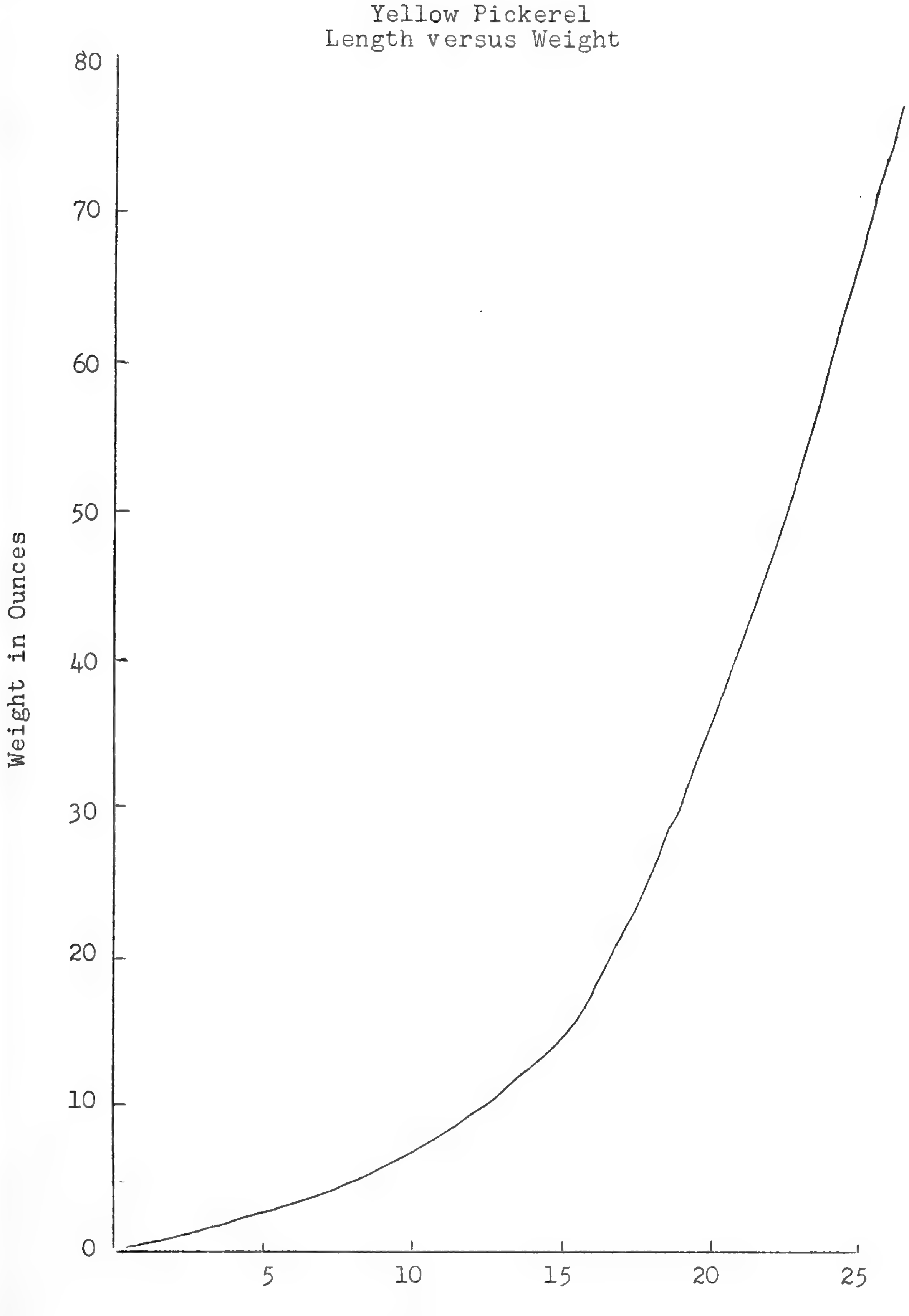


Graph 4:

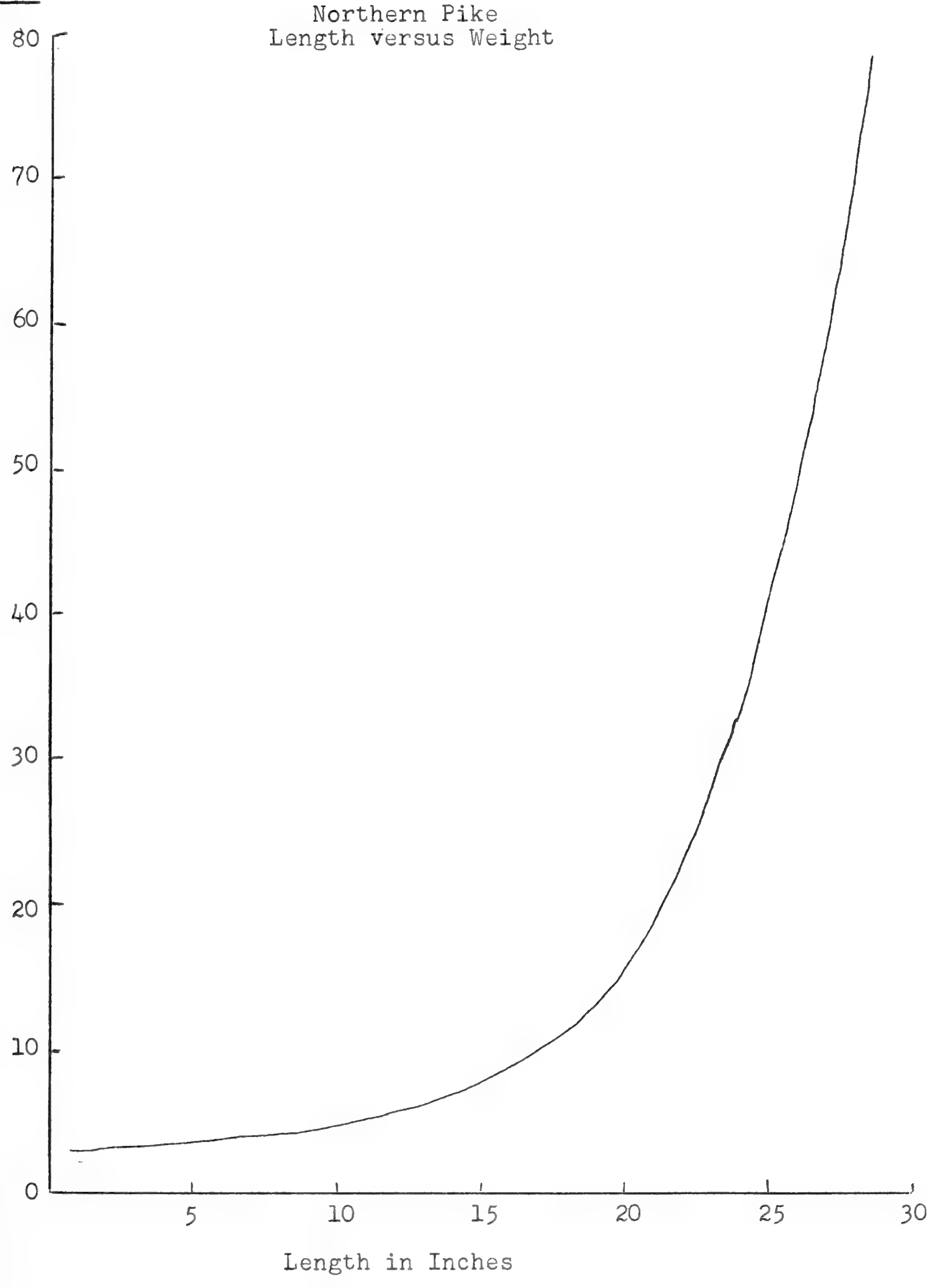
Common Sucker
Length versus Age



Graph 5:


Yellow Pickerel
Length versus Weight
Weight in Ounces
80
70
60
50
40
30
20
10
0
5
10
15
20
25
Length in Inches

Graph 6:


Northern Pike
Length versus Weight
Weight in Ounces
0
10
20
30
40
50
60
70
80
5
10
15
20
25
30
Length in Inches

Discussion of Results

(a) Tagging

The advisability of this phase of the programme is admittedly questionable. The use of gill nets and limited personnel accounts for a rather high die-off. Numerous problems were encountered during this project; cold weather and floating pulp logs constituting the major set-backs. The proximity of the angling season meant that many fish were caught on hook and line before proper dispersal could be accomplished. This undoubtedly places a heavy bias on the results.

If however, this project were continued during future years at exactly the same times and locations, presumably the same biases would be introduced. Thus since our intention was not to establish the size of the population but more specifically the yearly change in population size, perhaps the project is justifiable.

(b) Sounding

Sounding results showing extensive deep water areas, coupled with the presence of a thriving whitefish population indicate the presence of an environment suitable for the production of lake trout. Test nettings and interviews with local residents indicate that there is no native lake trout population.

(c) Test Nettings

Results indicate that all species in White Lake have a somewhat retarded growth rate as compared to the Ontario averages (Devitt, 1959). This is partially due no doubt, to the shorter growing season in northern parts of the province, but may also be attributable in part to competition among species.

Further test-netting at some future date may show a change in growth rate because of population changes induced by angling pressure.

Recommendations

(a) Tagging

It would seem wise to retain this phase of the programme, if only as a comparison with the population trends established by the creel census. In future years an effort will be made to utilize trap or hoop nets for the taking of pickerel.

(b) Sounding

Because of the evident absence of a lake trout population and presumably satisfactory environment, the introduction of a small breeding population of adult lake trout is recommended.

(c) Test Netting

It may be interesting after several years to undertake this phase of the programme again using identical locations, in order that possible changes in growth rates and population proportions may be studied.

Part 2 - Creel Census Survey

The prime requisite of this phase of the programme was to establish a census technique which, while not taxing personnel unduly, would provide sufficient accuracy to give a true picture of fishing success.

Methods

Because of the fluctuating nature of angling pressure in this area, the wisest approach was felt to be stratification by calendar months (Best and Boles, 1955). Otherwise, it was felt that a random selection of census days on a seasonal basis might well give overcoverage in months when angling pressure was low, and undercoverage when angling pressure was high.

The proximity of nearby towns, it was felt, might introduce differential angling pressure between week days and week-end days, particularly where a Canadian holiday was concerned. For this reason it was deemed advisable to treat week-ends and holidays separately from week days.

Census was carried out on all Canadian holidays, alternate week-end days; Saturday one week-end, Sunday the following week-end etc.; and thirty per cent of all week days, each month. The census period extended from the opening of pickerel season May 13th until the 20th of September, at which time all heavy angling pressure had ceased.

Since no table of random numbers was available, week day census days were chosen by numbering uniform sized pieces of paper with the week day dates of the particular month. They were then placed in a box and thirty per cent drawn for the sample.

Whenever possible, an aircraft boat count was carried out on census days, thus providing a total towards which to correct results in case all parties could not be directly contacted. Since the angling and forest fire seasons occur at roughly the same time of year however, it was often impossible to obtain an aircraft count of the boats on the lake. On these days an estimate of the number of parties was obtained by travelling the lake; usually in mid afternoon, in as short a time as possible, in order that no parties would be counted twice because of movement. This alternative seems to have proven quite satisfactory.

The location of the highway, with adjacent camping areas prompted most angling parties to set up camp near the highway and travel up the lake to fish each day.

On census days personnel tried to contact as many parties as possible at the camping area between dusk and dark. This was done in order that the full day's fishing results could be obtained. It was also felt to be more efficient than contact on the lake, since most camps were concentrated in a relatively small area.

Discussion of Methods

The camp concentration previously mentioned will undoubtedly continue since, while anglers had to camp in unorganized sites this past season, a Provincial Park situated on the lake shore (see map), is fast nearing completion and will probably be open for the 1962 angling season.

It is realized that these methods could undoubtedly be improved upon. It was necessary however, to reach a final plan as quickly as possible in order that the first year's data would not be rendered valueless for comparison with data collected in future years. Moreover, it is felt that as long as consistancy is maintained as completely as possible throughout the study, any shortcomings should remain constant and therefore not distort the overall picture to any great degree.

Results

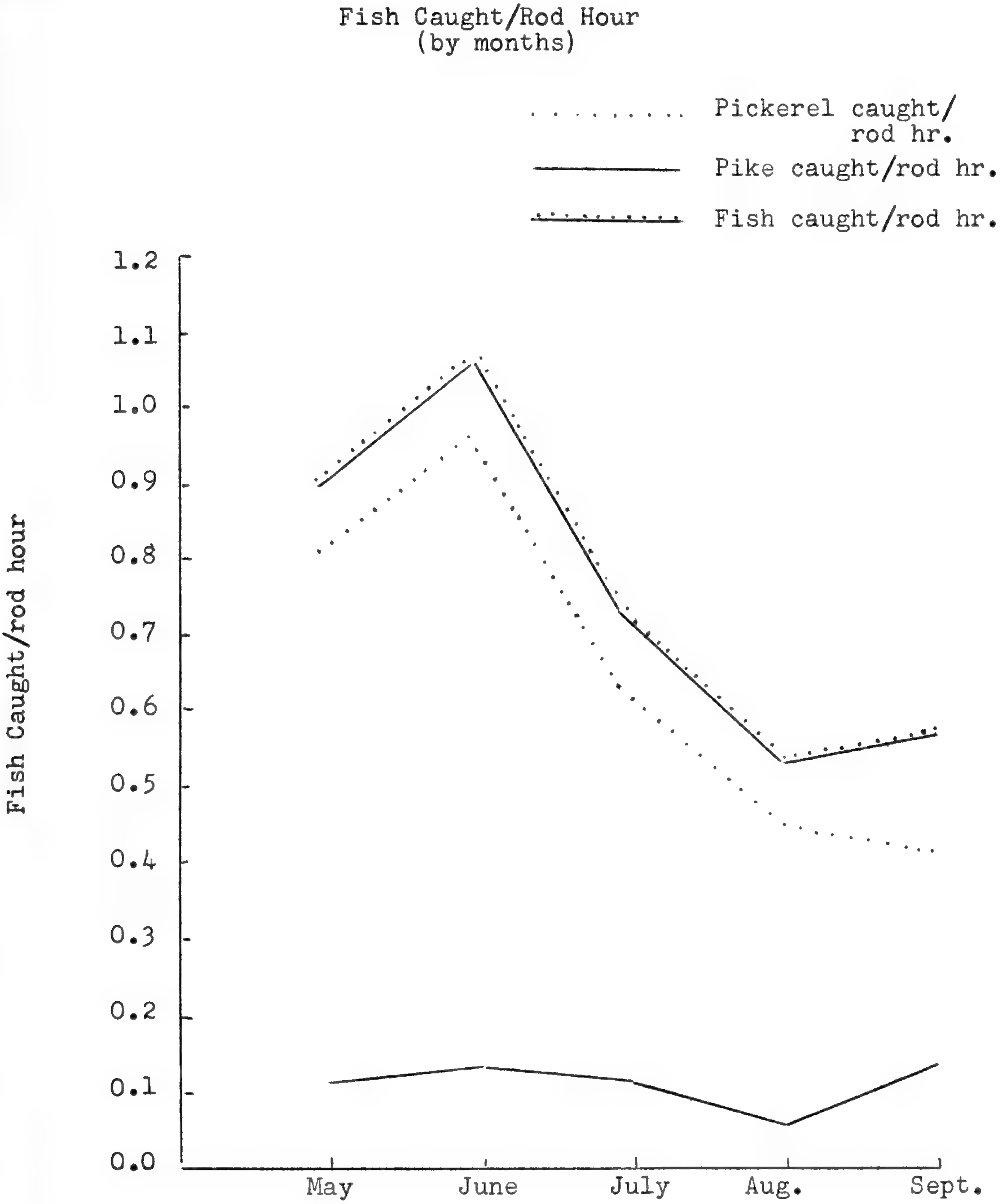
Table 2 shows the angling success results derived from actual information before any conversions of any kind were made.

Graphs 7 to 10 show the differential angling success on a monthly basis.

Table 2:

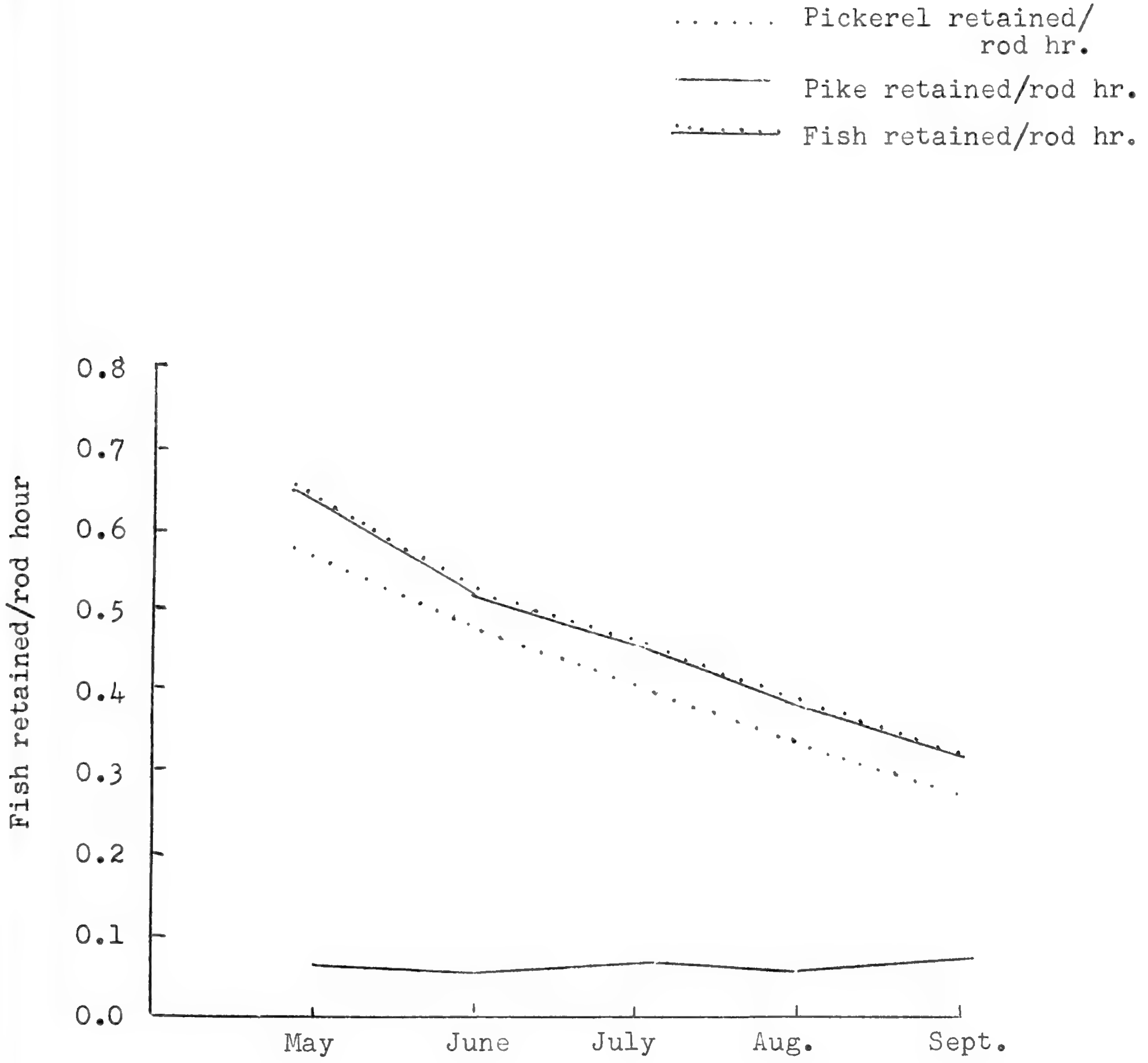
	MAY	JUNE	JULY	AUG.	SEPT.
Number Pickerel caught per rod hr.	0.80	0.94	0.62	0.46	0.40
" Pike caught per rod hr.	0.11	0.12	0.11	0.07	0.15
" Fish caught per rod hr.	0.90	1.06	0.73	0.53	0.55
" Pickerel retained per rod hr.	0.59	0.50	0.42	0.35	0.28
" Pike retained per rod hr.	0.06	0.05	0.06	0.04	0.07
" Fish retained per rod hr.	0.65	0.55	0.48	0.39	0.35
lbs. Pickerel retained per rod hr.	1.02	0.91	0.70	0.58	0.46
lbs. Pike retained per rod hr.	0.16	0.17	0.16	0.09	0.16
lbs. Fish retained per rod hr.	1.18	1.09	0.86	0.67	0.62
Av. Wt. in lbs. per Pickerel retained	1.74	1.83	1.68	1.68	1.67
Av. Wt. in lbs. per Pike retained	2.72	3.40	2.88	2.11	2.23
Av. Wt. in lbs. per Fish retained	1.83	1.97	1.82	1.73	1.79

Graph 7:


Fish Caught/Rod Hour
(by months)
Pickerel caught/rod hr.
Pike caught/rod hr.
Fish caught/rod hr.
Fish Caught/rod hour
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
May
June
July
Aug.
Sept.

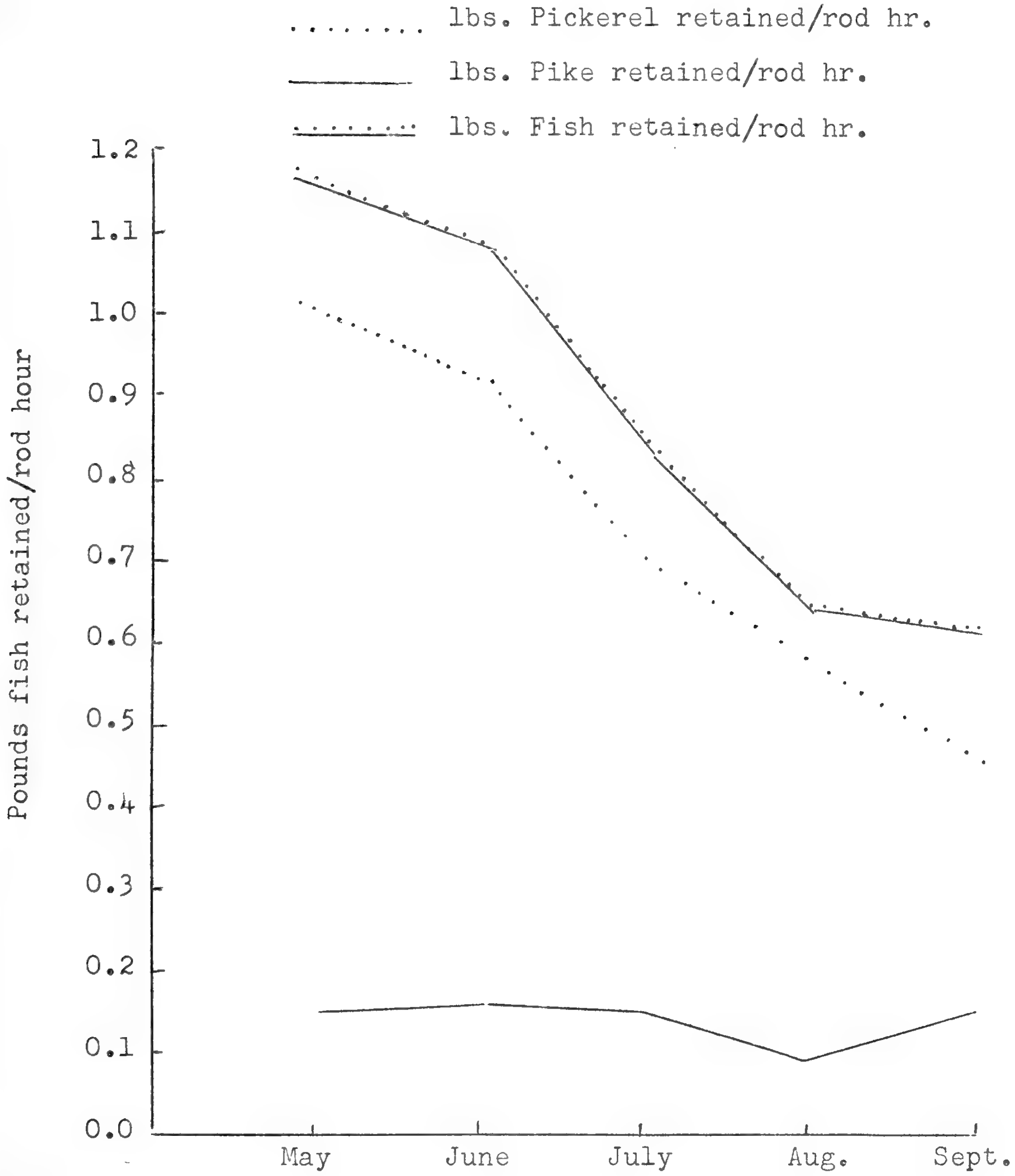
Graph 8:

Fish Retained/Rod Hour
(by months)

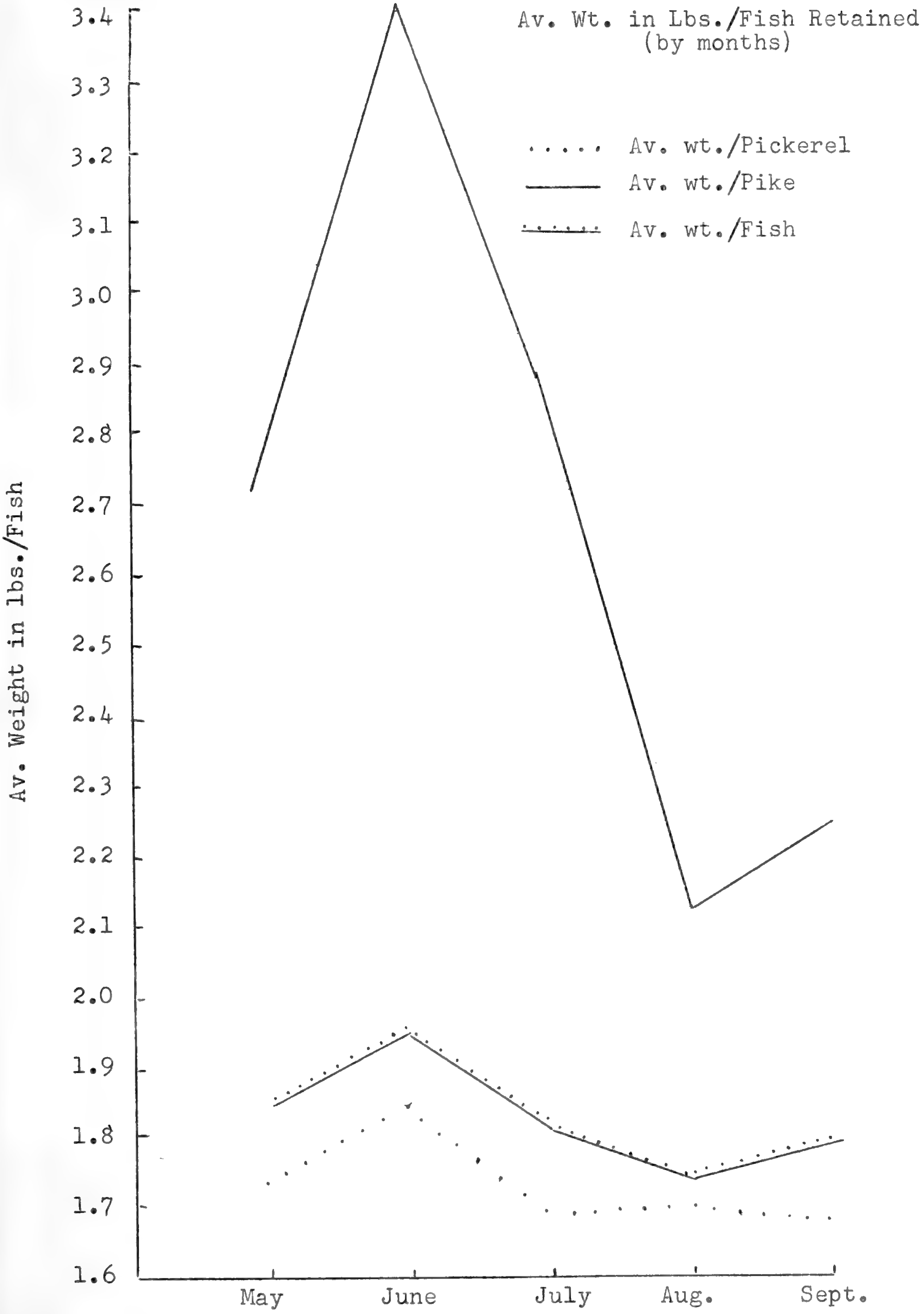


Graph 9:

Lbs. Fish Retained/Rod Hour
(by months)



Graph 10:


Av. Wt. in Lbs./Fish Retained
(by months)
..... Av. wt./Pickerel
——— Av. wt./Pike
Av. wt./Fish
Av. Weight in lbs./Fish
3.4
3.3
3.2
3.1
3.0
2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
May
June
July
Aug.
Sept.

In order to derive total angling success over the whole summer period, it was necessary that the data collected each month undergo several conversions.

If contact was not established with all parties on any census day, it was necessary that that day's results be multiplied by the appropriate factor to account for all parties observed on the lake. For example, if 30 boats were observed during that day's aircraft boat count but only 20 parties were interviewed that evening, then that day's data would be multiplied by 3/2.

It was further necessary to apply a conversion factor to the data collected on census days such that the results would be increased by the appropriate amount for coverage of the whole month. For example, if there were 1000 pickerel caught during 7 census week days in June, the results would be multiplied by 20/7 or 2.86, so that 20 week days, the actual number, were taken into account. This was also done for week-end days and holidays. These totals were then summed to give the monthly totals.

Table 3 shows the calculated angling success stratified on a monthly basis.

Table 4 shows the calculated angling success on a summer basis. This was derived by summing the monthly totals.

Table 3:

Month	Number of parties	Number of Anglers	Total Hours	Number Pickerel Caught	Number Pickerel Retained	Pounds Pickerel Retained	Number Pike Caught	Number Pike Retained	Pounds Pike Retained
MAY	427	1093	3753	3279	2261	3945	426	212	583
JUNE	1064	3124	13708	13129	6934	12802	1554	654	2152
JULY	1237	3937	16377	10461	6976	11646	1823	823	2603
AUGUST	1312	3617	14375	6262	4755	7817	1041	571	1217
SEPTEMBER	474	1236	5317	1946	1346	2217	788	385	867

Table 4:

Month	Number of parties	Number of Anglers	Total Hours	Number Pickerel Caught	Number Pickerel Retained	Pounds Pickerel Retained	Number Pike Caught	Number Pike Retained	Pounds Pike Retained
SUMMER TOTALS	4514	13007	53530	35077	22272	38427	5632	2645	7422

Discussion of Results

Since this programme is to be of comparative nature on an annual basis, very little can be said of the results to date.

Recommendations

Now that a reasonably practical method of survey has been instituted, it is recommended that this method be adhered to as closely as possible for the duration of the programme. Otherwise direct comparison from year to year will be impossible.

No final estimate as to the number of years for which this study should be carried on has yet been reached. A minimum of four years would seem desirable with the provision of continuation after that time should it be found that trends have not yet become clearly established.

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A REVIEW OF THE BIOLOGY AND MANAGEMENT OF PICKEREL

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Abstract

A survey was made of the important literature on the pickerel in order to review this species' biology and management. Information is provided on distribution, habits & habitat, food, reproduction, growth, ecology, parasites and disease, mortality, harvest data and management.

Species: *Stizostedion vitreum vitreum* (Mitchill)

Family: Percidae.

Order: Percomorphi.

Common names: Pickerel, yellow pickerel, yellow pikeperch, walleye, walleyed pike, and doré.

Introduction

Pickerel probably forms one of the most important inland fisheries in North America. It is sought after commercially and is highly prized as a sports fish. Practically the whole catch, both commercial and sport, is utilized as food (Niemuth, Churchill and Wirth, 1959). The paper attempts to summarize the important literature on pickerel to date. Papers not used in this summary are also included in references for the convenience of the reader. (Niemuth *et al* op. cit.) have provided the most recent review of the biology and management of pickerel. Since their review was sufficiently complete, it was difficult for the present writer to refrain from extracting passages completely intact from their paper.

Range

The range of the pickerel in North America extends from Labrador and New Brunswick on the east, thence south to Northern Alabama and the upper Mississippi Valley. On the west it extends into Nebraska and the Saskatchewan River Valley. The Pickerel range extends north into the Mackenzie River and Hudson Bay drainage systems (Niemuth *et al* op. cit.; and Mackay, 1958).

Pickerel are found throughout Ontario, particularly in the Great Lakes Basin. They are very abundant in Northern Ontario, the range having been extended through stocking (Mackay, 1958).

Habitat

Pickerel thrive in moderately fertile waters but occur in all types of lakes, providing the necessary spawning and feeding grounds are present. Spawning requires two to four feet of water with a gravel substrate, and a current or wave action to provide the necessary aeration for the eggs. Feeding takes place along bars and shoals, and among rocks along the edges of weed beds (Niemuth et al op. cit., and Carlander, Whitney, Speaker, Madden, 1960.).

An unusual spawning habitat has been observed in Wisconsin on the flooded marsh vegetation of the Wolf River Bottoms. Pickerel were found spawning in the tangled root masses of bog vegetation in Tumas Lake, Manitowoc County, (Niemuth et al op. cit.).

The habits of pickerel are such they never become abundant in weedy waters (Niemuth et al op. cit.). The above statement requires some clarification since many local Ontario waters contain extensive weed beds as well as considerable numbers of pickerel.

Habits

Pickerel live near or on the lake bottom. They are nocturnal in habit and depend largely on unwary or resting fish for food. During the daytime they retire to deep, dark water. During the evening, they migrate to the bars and shoals to feed among rocks or along the edges of the weed beds. They may be active during the daytime in turbid waters or during cloudy weather. During midsummer (July and early August) they remain in deep water where they continue to feed (Niemuth et al op. cit.). (In contrast to this last statement, pickerel in the Tweed District are known to come into shallow water at night to feed, even during July and August). Winter finds pickerel active and feeding, especially when the ice first forms and prior to the spring break-up (Niemuth et al op. cit.).

Food

There is virtually no information on the feeding habits of young pickerel in the wild. Young pickerel in rearing ponds feed on plankton and crustaceans at first. Later, they feed on insect larvae, particularly chironomids. When young pickerel reach three inches in length, they begin to feed on fish. At six inches, plankton becomes unimportant in their diet. Adult pickerel feed mainly on fish. Other animals, particularly aquatic insects, are also utilized. Pickerel are vigorous swimmers and are capable of overtaking such fish as the largemouth bass (Niemuth et al op. cit.).

Mating

Pickerel start out on their spawning migration with the first warm weather after the ice goes out when temperatures range from 38° to 44° F. Males are the first to seek the spawning grounds and linger on after the females have left. Spawning begins in

Wisconsin between mid-April and May first, the peak occurring when temperatures range from 48° to 50° F. The spawning season begins one to two weeks later in Northern Wisconsin than in Southern Wisconsin (Niemuth et al op. cit.). In Ontario, spawning begins in early April or May (Mackay, 1958). Hile's (1954) data indicate the older fish are the first to start on the spawning migration.

Prospective spawners lie off a ripple or bar in the daytime and come in to spawn at night. A female is accompanied by one or more males. Male and female sidle up to each other. Vents are tilted slightly, brought close together, and the sex products emitted. The unattended eggs are randomly deposited on the gravel substrate (Niemuth et al op. cit.).

Number of eggs

On the average, about 50,000 eggs are produced per female, although there is considerable variation depending upon the size of the fish and the locality concerned (Niemuth, Churchill and Wirth, 1959). The eggs hatch in 26 days when the water temperature is 40° F and seven days when the water temperature is 57° F (Niemuth et al op. cit.).

Age at Initial Breeding

In most populations males breed at two to three years of age and females at four to five years of age (Niemuth et al op. cit.). Rawson (1956) found that few individuals bred at five years in Lac La Ronge in Saskatchewan; most breeding started when fish were eight to ten years of age.

Growth

Generally, females grow faster and larger than males (Niemuth et al op. cit.) although Kennedy (1949) found the growth of females and males approximately the same in Lake Manitoba. Pickerel introduced into new lakes of suitable environment grow faster than elsewhere (Stroudt 1949; and Eddy and Carlander 1939). Wild young of the year may reach five to six inches in the fall and are usually over six inches by May first (Niemuth, Churchill and Wirth, 1959). Weights over ten pounds are rare, but individuals measuring three feet in length and weighing twenty-five pounds have been found (Niemuth et al op. cit.). (Niemuth et al op. cit.) present a table of length and age for pickerel from various places.

Longevity

Pickerel live about seven years in Wisconsin, but individuals eighteen to twenty years have been found (Niemuth et al op. cit.).

Mobility

The only known migration is the spawning run, which may be as much as a hundred miles. Pickerel have no clear-cut home range, but apparently drift around in their environment in response to food supplies (Niemuth _et al_ op. cit.). Mackay (1958) states they are active swimmers and may travel distances up to 175 miles.

General Ecology

Pickerel are important components of the predator-prey balances in lakes with extensive open water free of weeds. Often they are co-habitants of yellow perch (Niemuth _et al_ op. cit.) and are associated with fairly large populations of the latter (Smith and Krefting, 1953, and Maloney and Johnson, 1955). It is suggested the similarity in habitat preference of yearling perch and pickerel together with difference in growth rates and feeding habits may be important factors in this relationship (Maloney and Johnson, 1955). In large, cold lakes the role of pickerel is assumed by the lake trout (Niemuth _et al_ op. cit.).

Pickerel are competitors of both large and smallmouth bass. Where successful introductions of pickerel have been made in exclusively bass waters, a decline of the bass has followed (Niemuth _et al_ op. cit.). On the other hand, white bass appear to be successful competitors of pickerel. In Spirit Lake, Iowa, pickerel increased during periods of low white bass density and the reverse situation prevailed during periods of white bass dominance (Rose, 1955).

Pickerel are subject to the usual fish-eating bird and mammalian predators, but this form of predation is probably small due to their nocturnal habits, their preference for open, deep water areas, and the relative size of the adults. Young pickerel are probably more susceptible than adults to this form of predation (Niemuth _et al_ op. cit.).

Although pickerel are vigorous and successful competitors in their own rights, habitat changes due to man's activities can affect them. Increased water levels in the Wolf and Fox River lakes above Lake Winnebago in Wisconsin (Lakes Poygan, Winneconne, and Butte Des Morts) resulted in a decline of emergent and submergent aquatic vegetation. In the resulting open water a pickerel - white bass associes replaced the bass - perch and pickerel (Niemuth _et al_ op. cit.).

At low oxygen concentrations, pickerel often become victims of winter-kill in shallow lakes (Niemuth _et al_ op. cit.).

Parasites and Disease

Little is known of the disease problem in natural pickerel populations. Lymphocystis is common and contageous in nature but is not known to cause mortality. Unsightly external lumps develop but this does not affect the flavour of the flesh. Parasites found

consist of Cestoda, particularly Proteocephalus sp; Piscicola sp; fish leeches; Neacus, the black fluke; and Clinostomum, the yellow fluke. None of these parasites are known to infect man or to cause significant mortality in pickerel populations (Niemuth et al op. cit.).

Population Mortality and Productivity

Changes in the annual harvest of pickerel from year to year appear to be caused by the large fluctuations in the strength of year classes; these fluctuations being exaggerated in a population with high mortality rates. These fluctuations in year class strength can be traced to the survival of the young (Niemuth et al op. cit.) which is determined during the first summer (Maloney and Johnson, 1955).

The following is a table of pickerel yield from various bodies of water (data from Niemuth et al op. cit.).

TABLE I:

Location	Pounds Per Acre
Escanaba Lake, Wisconsin	20 - 40
High and Fishtrap Lakes, Wisconsin	10 - 20
Spirit Lake, Iowa	8 - 12
Lake Erie (Blue and yellow pickerel)	6.5 in 1956

Angling and natural mortalities reported are as follows: (data from Niemuth et al op. cit.)

TABLE II:

Location	Mortality	
	Angling	Natural
Escanaba Lake, Wisconsin	23%-40%	10%-15%
East Okoboji Lake, Iowa	32%	

Management

The large fluctuations in year class strength, which is traced to the survival of young, produces one of the greatest problems in pickerel management. Although knowledge of the actual mechanism regulating the survival of young pickerel is far from complete, it appears intra-and interspecific competition are involved. Research has not reached the point of forecasting the size of a year class or prescribing means of improving recruitment in poor years. Since pickerel are a "big water" fish, the creation of spawning grounds as a management measure is not easy (Niemuth et al op. cit.).

Artificial stocking has met with variable success. Stocking fry in new habitats often has resulted in good survival and very rapid growth, but results from stocking fry in habitats already containing pickerel have often been very poor (Eddie and Carlander 1939, Stroudt 1949, Carlander, Whitney, Speaker and Madden 1960). Carlander and associates (1960) have reviewed past results of fry stocking of pickerel in various lakes. Stocking of fry had a significant effect on pickerel populations in Clear Lake, which is in sharp contrast to earlier studies on pickerel fry stocking in Lakes Huron and Michigan (Hile, 1937), Lake of-the-Woods (Carlander, 1943), and in the Red Lakes in Minnesota (Smith and Krefting, 1953). The latter lakes are much larger and the rate of stocking in the latter was much less than in Clear Lake (Authors reviewed by Carlander et al op. cit.). In the larger lakes many of the pickerel spawn in streams tributary to them, whereas all pickerel in Clear Lake spawn in the lake itself (Carlander et al op. cit.). Although Carlander and his associates have shown that stocking can make a significant contribution to the population, they indicate more data are required to determine whether stocking can contribute to the annual harvest (Carlander et al op. cit.).

The trend in Management in Wisconsin has been to liberalize fishing regulations for pickerel. The ice fishing season has been lengthened, the season is opened earlier in the spring, and the thirteen inch size limit has been abolished. Year-round fishing has been permitted in several Wisconsin watersheds. The spawning runs on several watersheds have been exploited for many years without harm to the population, notably in the Lake Winnebago chain of waters including the Wolf River. Although regulations have been liberalized, they have not been completely removed. Sport fishermen have a bag limit of five and the season is closed during the spawning run in many waters. In Northern Green Bay, commercial fishermen have a minimum size limit of fifteen inches and a closed season during April and May (Niemuth et al op. cit.).

There is not much concern in Wisconsin of overfishing since angling mortality is modest and the pickerel is a moody, seasonal biter. Nevertheless, some caution is desirable since it takes three to four years for pickerel to reach a desirable size (Niemuth et al op. cit.). Although stocking may be recommended to boost an overfished population, it has yet to be demonstrated that stocking can influence the annual harvest Carlander et al op. cit.).

Little liberalization in pickerel management regulations has occurred in Ontario, however, size limits have been removed due to mutilation and mortality occurring when young pickerel are removed from the hook and returned to the water, and the growth variation occurring in different lakes. By 1958, management regulations depended mainly on possession limits and closed seasons (Mackay, 1958). Recently, the pickerel season in Southern Ontario has been extended into the winter months.

Techniques

Two techniques used in pickerel management are touched on in this section, one only briefly. Johnson (1953) describes a method for reducing mortality due to fin clipping operations which consists chiefly of retaining fish in holding tanks for twenty-four hours after the clipping operation and before releasing them.

Probably one of the more interesting techniques is the method used in rearing pickerel in natural rearing ponds. The method appears to be similar to that used for rearing fresh water fish in many parts of the world, particularly in Southern Asia (review by Hora, 1949). Any pond of one-quarter acre or larger will produce pickerel, provided crustacenas and fish are provided as forage in sufficient amounts and at the right time (Smith and Moyle 1943). The maximum water depth used in Minnesota ponds was five to six feet (Dobie, 1956). A mean production of 48 pounds per acre has been reached in Minnesota, but a maximum production of 234 pounds per acre has been realized (Niemuth et al op. cit.). Dobie (1956a) stresses the importance of organic material in the pond bottom in maintaining rearing success. Pickerel can be raised up to a size of three to six inches in length in fertilized or rich natural rearing ponds at a cost of about three cents each (Niemuth et al op. cit.)

The ponds used could be drained in order to manipulate the organic content of the pond bottom when necessary. The method of managing the ponds is described in detail by Dobie (1956 and 1956a) and Dobie and Moyle (1956), and consists of fertilizing the pond bottom with ordinary barnyard manure, filling the pond with water and stocking, applying three applications of sheep manure while the fish are in the ponds, watching the ponds for signs of starvation, harvesting the fish at the appropriate time, draining the ponds and planting rye in the pond bottom in cases where the organic content of the soil is low (Dobie, 1956a). Martin (1958) suggests the use of hay as fertilizer in place of sheep manure. The hay helps in the production of zooplankters which are fed upon by pickerel, and helps prevent the development of phytoplankton blooms which are poisonous to the fish (Dobie, 1956a and Martin, 1958). Recently, work in pond management for pickerel has been started in Southern Ontario (Roseborough, 1959).

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