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THE MICHIGAN CREEL CENSUS

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This discussion is intended to show, briefly, the several kinds of creel census now in operation in Michigan, the methods of taking the census, its extent, and the kind of information which may be obtained from the census alone or in conjunction with other studies. Because of the growing interest in creel census and the excellent opportunity to carry on such work with the CCC and with other agencies, it is possible that these studies may be further extended by other states or other organizations. In this discussion the difficulties and shortcomings of the methods, as well as the successes achieved, are mentioned for the benefit of those who may become actively interested in census work.

Methods of Taking Census

Michigan now has two distinct kinds of creel census in operation: the general census taken primarily by conservation officers, and the intensive census carried on by several of the relief organizations. The first represents a sampling of the fishing over the entire state; the second covers all or nearly all of the fishing on selected waters.

The census blank now used by both groups is shown in last year's Proceedings of the North American Wildlife Conference (page 338). These perforated sheets (4″ by 6″) are prepared in books of 100 each.

The general census is taken as a part of the regular work of the conservation officers, and the number of reports to be submitted by an individual officer, as well as the localities from which records are taken, are left to his discretion. The records taken by the officers include only the day's fishing to the time of the interview, not the full day's fishing as recorded in the intensive census. The officers prepare the records in connection with checking fishermen for violation of the fishing laws. The difficulty with this system consists primarily in obtaining a representative sample of the fishing. Some officers who enjoy this work submit many more records than do those who dislike it or who fail to understand its value. The census is probably given most attention when other duties are not pressing. During the hunting season, for example, time is not available for the work. There is probably a tendency, too, to get records where (and when) the fishing is concentrated. Curves of the various size groups suggest plainly that the lengths are generally estimated rather than measured. Since

the officers have many duties, it cannot be expected that they devote more than a limited amount of time and attention to the census work. The census data are determined for hatchery districts and for geographical districts, each consisting of a number of counties. Data for any one county may not be representative, but it is believed that figures for a number of counties taken collectively give a reasonably adequate picture of fishing conditions.

The general census was initiated in 1927, chiefly through the efforts of former Commissioner Harold Titus, and became extensive enough to be valuable in 1928. Since the census began, over 100,000 fishing records have been submitted representing about half a million hours of fishing. Data from these records have been compiled by the Institute for Fisheries Research.

The intensive census is taken by several agencies including the state ECW, the U. S. Park Service ECW, the U. S. Forest Service and several Resettlement Projects (U. S. Parks Service). It consists, primarily, of having crews of men patrol the lakes to contact the fisherman when the latter reaches shore. Each census-taker is responsible for a definite amount of shoreline. The method is discussed more fully in a paper by the writer presented at the 1935 meeting of the American Fisheries Society. With few exceptions, the intensive census has been taken only on lakes, although a further extension of the work on trout streams is contemplated.

Intensive winter census has now been taken on about 35 lakes and intensive summer census on about 30 lakes. On some lakes the records are now available for several seasons; the Fife Lake census is entering its fourth year. Data have not yet been compiled for most of the 1936 census.

Census-taking in winter is a relatively easy matter. Comparatively few people fish at that season and access to the lakes is usually limited to a few points along the shore. Fishing tends to be concentrated in certain spots on the lake and is limited to daylight hours. An eight-hour census (from about 9:00 a.m. to 5:00 p.m.) will usually cover all of the fishing. Men for the census work are more readily available in winter, since some of the other projects cannot be carried out at that season.

The intensive census-taking in summer presents a greater number of problems. The fishing day extends from about 5:00 a. m. to 10:00 or 11:00 p.m., necessitating the use of several shifts of census-takers. Lakes are generally accessible from most of the points along the shore, and fishing is much more extensive than in winter.

The summer census is generally taken from about daylight to about dark. A few of the late fishermen are not contacted, but records for

their fishing are usually submitted by those who operate the boat livery or by the fishermen themselves.

It has been found that the average CCC boy cannot "take" the census satisfactorily, but that, in almost every camp, a select group of men under reasonably close supervision can do the work in an entirely dependable and acceptable manner. It has become obvious that the common species of fish are not well known even to the more intelligent enrollees (and many or most of the fishermen) and training of the men is necessary if the species are to be correctly recorded.

It has been found, too, that the fisherman is entirely willing to give the information regarding his fishing if he need not write it. A law requiring that the fisherman report his catch is not necessary, but it is highly important that some competent census-taker record the information and examine the fish to determine the species and size.

There are several ways of checking on the dependability of the information. When placed in the various size groups, the curve for the sizes of any species of fish should be relatively smooth. If half-inches are decidedly less abundant than even inches, it is obvious that the measurements have not been taken correctly to the nearest half-inch. If data as recorded by one of the census-takers on the lake differs decidedly from information taken by the others, it casts some doubt on the reliability of the figures. The census-taker places his initials on each sheet and can be referred to when unusual lengths are indicated or if some of the data are missing on one or more of his sheets. The placing of the census-taker's initials on the sheets is especially desirable too because it encourages more careful work.

During the early stages of the census, it was considered desirable, occasionally, to discard the data for one or two lakes because one or more of the census-takers were obviously not recording the information correctly, but, with improved supervisory personnel, the taking of creel census by the several agencies (chiefly CCC) has been considered entirely satisfactory.

INFORMATION PROVIDED BY THE CENSUS

Listed below are some of the kinds of information which may be made available by the census, with brief summaries of the findings on a few of the Michigan lakes.

(1) *Total Annual Crops.* There are certain difficulties in indicating the total yield. It might be expressed in pounds per acre of shoal, pounds per acre of the lake as a whole, or pounds per cubic unit of water. If expressed in pounds per acre of shoal, certain fish using the open water (perch, pike, lake trout, walleyes, etc.) are not given full consideration. Many of the lakes have not been sounded

so the expression in pounds per cubic unit could not be used even if it were considered desirable. Production is now expressed in pounds per acre of water regardless of depth, extent of shoal, etc. The size of the fish is listed in length only and is converted into weight later by the use of length-weight tables. For most of the lakes, the weights of the fish have not yet been determined. The approximate number of fish caught per acre, and their average length, are shown below:

Lake	County	Approximate Area (Acres)	Year	Approximate No. Per Acre	Approximate Ave. Length (Inches)	Chief Species
Fife	Grand Traverse	800	1934	16	8½	Varied
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Hemlock	Cheboygan	6	1935	36 (8#)	8	All Brook Trout
Lost	Otsego	4½	1935	100.2 (30.2#)	9	All Brook Trout
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Big Portage	Jackson	480	1936	24	8½	Bluegills, Sunfish
Cedar	Washtenaw	56	1936	55	7½	Bluegills, Sunfish
Sugarloaf	Washtenaw	205	1936	27	8	Bluegills, Sunfish
Clear	Jackson	137	1936	71	8	Bluegills, Black Crappie

Total yield can be obtained only from the intensive census.

It is obvious that the yield from Michigan lakes varies greatly, depending to some extent on the intensity of fishing and to a very considerable degree on other factors.

(2) *Distribution of Species.* In some lakes or areas the catch is almost entirely one species; in other lakes or areas the catch is varied.

In the Waterloo area (in southern Michigan) two-thirds of the fish taken in the summer of 1935 were bluegills (intensive census); in the lower two tiers of counties in 1935 (general census), bluegills constituted 86 per cent of the lake fish caught (perch 5 per cent), and in the northern several tiers of counties in the Lower Peninsula, bluegills constituted only 6 per cent of the lake catch (perch 47 per cent). Perch gradually replace bluegills from the southern part of the Lower Peninsula to the northern end. Other species, too, show definite trends in abundance with changes in latitude.

The combination of species is also significant. Certain fish generally are associated with other species (as for example bluegills and large-mouthed bass), and a habitat containing one in abundance will probably also support the other. The evidence also suggests that regardless of stocking, the southern lakes will probably continue to be primarily "bluegill" lakes and the northern waters (in the Lower

Peninsula) primarily perch waters (both with exceptions, of course).

(3) *Interrelation of Species.* The census shows that as one species increases another declines. In Fife Lake (intensive census) for two seasons, the proportion of game fish to pan fish remained constant (about 12-13 per cent game fish), but within the two groups the species varied widely for the two years. An increase in the catch of one species is frequently accompanied by a decrease in the catch of another competing species.

(4) *Intensity of Fishing.* The census shows that fishing intensity varies widely, ranging from a very few fisherman-days per acre in some lakes to 84 fisherman-days per acre on a small trout lake.

Fishing tends to be concentrated in mid-summer (apparently not the best time of the summer to fish) and in northern Michigan probably varies as the number of tourists and resorters varies.

(5) *Catch Per Hour and Per Fisherman-day.* The total production is probably of most interest to the fisheries worker, but the catch per hour or catch per day's fishing is of prime interest to the angler. The per hour catch varies widely with different lakes, but seems to average about one fish per hour's fishing. In the Waterloo Project (summer of 1936), it varied from 0.4 in one lake to 3.3 in another. The average fisherman-day in summer is about 3 hours; in winter it is slightly longer. The average catch per fishing trip varies widely with different lakes.

The catch per hour is not necessarily an indication of the crop. A small lake in the Pigeon River State Forest produced only 0.4 trout per hour, but nevertheless yielded 30 pounds per acre.

(6) *Sex of the Angler.* Should women be required to buy licenses? The census gives some information on this question. On Fife Lake, in 1934, about a fourth of the anglers were women, in 1935 about a fifth were women. In the Waterloo area in southern Michigan (summer, 1936) 16 per cent were women. In 1935 (general census) in Michigan, women composed about 7 per cent of the lake fishermen and about 4½ per cent of the stream (trout) fishermen (6 per cent for lakes and streams combined). In Fife Lake, women caught more fish per hour than did the men; in lakes in the state as a whole, the catch by women and men was almost identical (1.7 fish per hour for women, 1.9 for men). On trout streams women averaged one fish per two hours; men about one fish per hour.

By comparison with data on the number of woman anglers in the intensive census, the figures for the general census seem too low. It is possible that the officers tended to avoid the woman anglers. The actual percentage of woman fishermen on lakes is probably somewhere between 10 per cent and 20 per cent.

(7) *Residence of Anglers.* In southern Michigan (general census, 1935), only 3-5 per cent of the stream fishermen were non-residents; in the upper end of the Lower Peninsula, 41 per cent were non-residents. Non-resident lake fishermen varied from 3 per cent in a part of southern Michigan to over 50 per cent in the western half of the Upper Peninsula. Winter fishing was almost entirely by residents except possibly in a few southern counties. About 35 per cent of the fishing in Fife Lake in 1935 was by non-residents. Half the fishing on this lake was by persons living 200 or more miles away. In the Waterloo area in southern Michigan, only 6 per cent were non-residents, and 93 per cent lived in 3 nearby counties.

Ohio, Indiana and Illinois contribute most of the "outside" anglers. Their catch on lakes is about equal (per hour) to the catch by residents. On streams non-residents excelled in 1935 (general census).

The tourist and resort industry is now considered second only to manufacturing in Michigan and fishing constitutes a chief attraction.

(8) *Empty Creels.* On Fife Lake in 1934 the chances of taking fish were 3 to 1; on the lakes in the Waterloo area (summer, 1936), the chances of taking fish were about 2 to 1. These figures varied decidedly with the season. In winter the chances of taking fish are much fewer than in summer.

(9) *Effectiveness of Methods and Baits.* Information on the effectiveness of various methods and baits is primarily of interest to the fishermen, but is also of value in determining suitable legislation, especially on heavily-fished waters. Data for the catch of various species on various kinds of bait and by the several methods (still-fishing, casting and trolling) are available for about 20,000 fishing records (intensive census), but are too numerous to be discussed here.

Certain baits are outstanding for the taking of certain species. The consistency with which these baits excel (in various lakes or in one lake for various seasons) suggests plainly that chances of taking these particular species are very much better when "the right bait" is used.

There is almost invariably a close correlation between the catch per hour, the size of the fish and the chances of taking fish. The method or bait taking many fish takes also small fish and most frequently takes fish; the opposite is true for baits or methods taking large fish.

(10) *Time of Day and Fishing.* Limited data show that fishing in general is best soon after daylight in the morning and the hour or two before dark in the evening. On Fife Lake, in 1934, a majority of the fishermen fished at the wrong time of day.

(11) *Weather and Fishing.* There seems to be a relatively close correlation between temperature and the catch. Fish characteristic

of warm waters (large-mouthed bass, bluegills, sunfish, etc.) seem to bite best when the weather (water) is warm; fish characteristic of cool waters (perch, pike and small-mouthed bass) seem to bite best when the weather is mild or cool. It is to be expected that fish are more active and feed more voraciously when the environment (including temperature) is most nearly ideal for the species and that ordinarily fishing for them is best at such times.

No close relationship has been found between fishing and the various kinds of meteorological data (other than temperature).

(12) *Determination of Stocking Needs.* The census assists in determining stocking needs. It shows the number of undersized fish taken, the intensity of fishing and the catch per hour of each species. It shows, too, over a period of years, whether or not a species is declining. The census also helps to show whether or not stocking is effective. Of many plants of wall-eyes in Fife Lake, apparently only one was effective, since the wall-eyes taken are of relatively uniform size and are of a larger size each year with no smaller fish in evidence.

Excellent trout fishing in 1935 on three lakes was due entirely or almost entirely to stocking.

The Institute is comparing a graph of the catch for each species for each hatchery district for an 8-year period; also a graph for the stocking during an 8-year period (starting 3 years earlier than the graph of the catch). If stocking is effective, the graphs should be similar. The study has not yet been completed.

A decline in the size of fish from year to year or from early summer to fall suggests over-fishing. On many of the lakes (intensive census) the average size declines in mid-summer, but increases again in late summer or fall. This trend is probably partially due to an increased percentage of inexperienced fishermen in mid-summer.

(13) *Bag Limits.* The census shows how many "limit" catches are made. On Fife Lake (1934) the limit catches represented less than 2 per cent of all fishing. On some Branch County lakes on certain days in winter (1935), fully half the fishermen caught their limit of 25 bluegills. The effectiveness of the legal bag and size limits may be tested by the census.

(14) *Sustained Yield.* The total poundage of fish which can be taken without impairing future angling can be determined only with difficulty because of constant changes in the fish population due to natural causes. If with current fishing intensity there is no decline in the annual catch, it may be determined, at least, that the amount taken each year is not excessive. If there is a gradual decline in the catch, the lake is probably over-fished. An attempt was made on Fife Lake to determine the total population as well as the yield by

coupling tagging and creel census. Only a few hundred fish were captured for tagging, however, so no determination of the total population could be made in this lake which yields over 10,000 fish annually. Further attempts will be made to tag a minimum of several thousand fish in Fife Lake.

In a lake in the Pigeon River State Forest which seemed suitable for trout, but which contained only minnows, 6,000 brook trout averaging 3¼ inches long were planted in the summer of 1933. An intensive creel census shows that this lake produced to the anglers a total of 199 fish (average length 10½ inches) in 1935.

Heavy winter-kill in several rich lakes in the Waterloo area in southern Michigan made possible a determination of the number of fish which had been present in the lakes. The two lakes which were studied (by G. P. Cooper) showed a presence of over 1,000 fish per acre (average size in one lake 6 inches, in the other lake 7 inches) exclusive of yearlings, minnows and obnoxious fish. Since lakes in the area are somewhat similar, it is probable that the other lakes contain at least 300 to 400 legal fish per acre. Census records show that 4 of the lakes produced only about 25 to 75 fish per acre in 1936. It seems that many more fish in these lakes die from natural causes than are removed by fishing. A doubling of the fishing intensity would probably not be injurious.

What constitutes a sustained yield in a lake is not known, but census data coupled with other studies will eventually indicate how large a crop may be expected from various types of waters without injury to subsequent fishing.

(15) *Movements of Fish.* By zoning Fife Lake and by noting where tagged fish were released and where they were recaptured, it was considered possible to note to what extent each species spreads through the lake. As indicated above, the study could not be made because too few fish were captured for tagging. A knowledge of fish movements within a lake is important, of course, in stocking and in lake improvement.

(16) *Growth of Fish.* The census may be used as an aid in determining rate of growth. Scale samples are collected by some of the census-takers to be used later for growth studies. It has been found, however, that only exceptionally dependable men should be used to collect the scales. Growth may be determined directly from the census where fish of an exotic species and of known length had been planted. In the small lake previously mentioned as producing 10½ inch brook trout, the fish showed a very exceptional growth. It is possible, of course, that only the larger fish in the planting survived and that the growth averaged less than 7¼ inches (average 3¼ when

planted, 10½ when caught) for the year the fish were in the lake.

(17) *Winter Fishing.* The census is especially valuable to obtain information on the relative catch of fish in summer and in winter. The question of the effect of winter fishing upon the fish population tends to be an important one wherever resort development is extensive and accurate information is needed to better weigh the arguments on both sides. The census has indicated (Hazzard and Eschmeyer, 1937) that: Relatively few lakes are heavily fished in winter; that in general the catch in winter is meager and that with a few exceptions, winter fishing is not harmful to summer fishing.

(18) *General Comments.* Further uses of the census probably will suggest themselves to the reader. It is evident that this inventory is of some value to almost every phase of fish management as well as of interest and value to the angler himself.

The census for a lake or stream obviously increases in value from year to year because it shows trends which cannot be determined from the census for a single season.

Valuable information can be obtained by encouraging clubs or individual fishermen to keep accurate and complete records of their fishing. In Michigan one club at least (The Kinne Creek Club) has kept a reasonably complete and accurate record of its fishing for over 50 years. These long period records show trends in the fishing which cannot be obtained by other practicable methods. Depending upon memory alone to compare current fishing with angling in the "good old days" is certainly far from reliable.

(19) *Terminology.* The term "creel census" does not express the full use of this survey, but because of long usage (since 1927 in Michigan) and because the term is not easily confused with other types of study, it is believed that the expression "creel census" is better suited than "fish yield study" or some expressions which have at times been used.

The term "fisherman-day" has been used to express the fishing of one fisherman for one day. To say that a lake was fished for 5,000 fisherman-days is obviously better than saying that it was fished by 5,000 fishermen if by "fisherman" we mean the fishing of one person for one day.

(20) *Compilation of Data.* The many compilations and correlations of the data are made for the Institute by the Department of Mathematics (Sorting and Tabulating Division) of the University of Michigan. The information is transferred to code cards which are turned over to the Mathematics Department for sorting and tabulat-

ing. This method has been found far superior to the laborious and time consuming compilation of the information with calculating machines.

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Information Provided By the Census

Listed below are some of the kinds of information which may be made available by the census, with brief summaries of the findings on a few of the Michigan lakes.

Total annual crop: There are certain difficulties in indicating the total yield. It might be expressed in pounds per acre of shoal, pounds per acre of the lake as a whole, or pounds per cubic unit of water. If expressed in pounds per acre of shoal, certain fish using the open water (perch, pike, lake trout, walleyes, etc.) are not given full consideration. Many of the lakes have not been sounded so the expression in pounds per cubic unit could not be used even if it were considered desirable. Production is now expressed in pounds per acre of water regardless of depth, extent of shoal, etc. The size of the fish is listed in length only and is converted into weight later by the use of length-weight tables. For most of the lakes, the weights of the fish have not yet been determined. The approximate number of fish caught per acre, and their average length, are shown below:

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Total yield can be obtained only from the intensive census.

It is obvious that the yield from Michigan lakes varies greatly, depending to some extent on the intensity of fishing and to a very considerable degree on other factors.

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The combination of species is also significant. Certain fish generally are associated with other species (as for example bluegills and large-mouthed bass), and a habitat containing one in abundance will probably also support the other. The evidence also suggests that regardless of stocking, the southern lakes will probably continue to be primarily "bluegill" lakes and the northern waters (in the Lower Peninsula) primarily perch waters (both with exceptions, of course).

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Intensity of Fishing: The census shows that fishing intensity varies widely, ranging from a very few fisherman-days per acre in some lakes to 84 fisherman-days per acre on a small trout lake.

Fishing tends to be concentrated in mid-summer (apparently not the best time of the summer to fish) and in northern Michigan probably varies as the number of tourists and resorters varies.

Catch Per Hour and Per Fisherman-day: The total production is probably of most interest to the fisheries worker, but the catch per hour or catch per day's fishing is of prime interest to the angler. The per hour catch varies widely with different lakes, but seems to average about one fish per hour's fishing. In the Waterloo Project (summer of 1936), it varied from 0.4 in one lake to 3.3 in another. The average fisherman-day in summer is about 3 hours; in winter it is slightly longer. The average catch per fishing trip varies widely with different lakes.

The catch per hour is not necessarily an indication of the crop. A small lake in the Pigeon River State Forest produced only 0.4 trout per hour, but nevertheless yielded 30 pounds per acre.

Sex of the Angler: Should women be required to buy licenses? The census gives some information on this question. On Fife Lake, in 1934, about a fourth of the anglers were women, in 1935 about a fifth were women. In the Waterloo area in southern Michigan (summer, 1936) 16% were women. In 1935 (general census) in Michigan, women composed about 7% of the lake fishermen and about 4½% of the stream (trout) fishermen (6% for lakes and streams combined). In Fife Lake, women caught more fish per hour than did the men; in lakes in the state as a whole, the catch by women and men was almost identical (1.7 fish per hour for women, 1.9 for men). On trout streams women averaged one fish per two hours; men about one fish per hour.

By comparison with data on the number of women anglers in the intensive census, the figures for the general census seem too low. It is possible that the officers tended to avoid the woman anglers. The actual percentage of woman fishermen on lakes is probably somewhere between 10% and 20%.

Residence of Anglers: In southern Michigan (general census, 1935), only 3.5% of the stream fishermen were non-residents; in the upper end of the Lower Peninsula, 41% were non-residents. Non-resident lake fishermen varied from 3% in a part of southern Michigan to over 50% in the western

half of the Upper Peninsula. Winter fishing was almost entirely by residents except possibly in a few southern counties. About 35% of the fishing in Fife Lake in 1935 was by non-residents. Half the fishing on this lake was by persons living 200 or more miles away. In the Waterloo area in southern Michigan, only 6% were non-residents, and 93% lived in 3 nearby counties.

Ohio, Indiana and Illinois contribute most of the "outside" anglers. Their catch on lakes is about equal (per hour) to the catch by residents. On streams non-residents excelled in 1935 (general census).

The tourist and resort industry is now considered second only to manufacturing in Michigan and fishing constitutes a chief attraction.

Empty Creels: On Fife Lake in 1934 the chances of taking fish were 3 to 1; on the lakes in the Waterloo area (summer, 1936) the chances of taking fish were about 2 to 1. These figures varied decidedly with the season. In winter the chances of taking fish are much fewer than in summer.

Effectiveness of Methods and Baits: Information on the effectiveness of various methods and baits is primarily of interest to the fishermen, but is also of value in determining suitable legislation, especially on heavily-fished waters. Data for the catch of various species on various kinds of bait and by the several methods (still-fishing, casting and trolling) are available for about 20,000 fishing records (intensive census), but are too numerous to be discussed here.

Certain baits are outstanding for the taking of certain species. The consistency with which those baits excel (in various lakes or in one lake for various seasons) suggests plainly that chances of taking these particular species are very much better when "the right bait" is used.

There is almost invariably a close correlation between the catch per hour, the size of the fish and the chances of taking fish. The method or bait taking many fish takes also small fish and most frequently takes fish; the opposite is true for baits or methods taking large fish.

Time of Day and Fishing: Limited data show that fishing in general is best soon after daylight in the morning and the hour or two before dark in the evening. On Fife Lake, in 1934, a majority of the fishermen fished at the wrong time of day.

Weather and Fishing: There seems to be a relatively close correlation between temperature and the catch. Fish characteristic of warm waters (large-mouthed bass, bluegills, sunfish, etc.) seem to bite best when the weather (water) is warm; fish characteristic of cool waters (perch, pike and small-mouthed bass) seem to bite best when the weather is mild or cool. It is to be expected that fish are more active and feed more voraciously when the environment (including temperature) is most nearly ideal for the species and that ordinarily fishing for them is best at such times.

No close relationship has been found between fishing and the various kinds of meteorological data (other than temperature).

Determination of Stocking Needs: The census assists in determining stocking needs. It shows the number of undersized fish taken, the intensity of fishing and the catch per hour of each species. It shows, too, over a period of years, whether or not a species is declining. The census also helps to show whether or not stocking is effective. Of many plants of walleyes in Fife Lake, apparently only one was effective, since the walleyes taken are of relatively uniform size and are of a larger size each year with no smaller fish in evidence.

Excellent trout fishing in 1935 on three lakes was due entirely or almost entirely to stocking.

The Institute is comparing a graph of the catch for each species for each hatchery district for an 8-year period; also a graph for the stocking during an 8-year period (starting 3 years earlier than the graph of the catch). If stocking is effective, the graphs should be similar. The study has not yet been completed.

A decline in the size of fish from year to year or from early summer to fall suggests over-fishing. On many of the lakes (intensive census) the average size declines in mid-summer, but increases again in late summer or fall. This trend is probably partially due to an increased percentage of inexperienced fishermen in mid-summer.

Bag Limits: The census shows how many "limit" catches are made. On Fife Lake (1934) the limit catches represented less than 2% of all fishing. On some Branch County lakes on certain days in winter (1935), fully half the fishermen caught their limit of 25 bluegills. The effectiveness of the legal bag and size limits may be tested by the census.

Sustained Yield: The total poundage of fish which can be taken without impairing future angling can be determined only with difficulty because of constant changes in the fish population due to natural causes. If with current fishing intensity there is no decline in the annual catch, it may be determined, at least, that the amount taken each year is not excessive. If there is a gradual decline in the catch, the lake is probably over-fished. An attempt was made on Fife Lake to determine the total population as well as the yield by coupling tagging and creel census. Only a few hundred fish were captured for tagging, however; so no determination of the total population could be made in this lake which yields over 10,000 fish annually. Further attempts will be made to tag a minimum of several thousand fish in Fife Lake.

In a lake in the Pigeon River State Forest which seemed suitable for trout, but which contained only minnows, 6,000 brook trout averaging 3½ inches long were planted in the summer of 1933. An intensive creel census shows that this lake produced to the anglers a total of 199 fish (average length 10⅛ inches) in 1935.

Heavy winter-kill in several rich lakes in the Waterloo area in southern Michigan made possible a determination of the number of fish which had

been present in the lakes. The two lakes which were studied (by G. P. Cooper) showed a presence of over 1,000 fish per acre (average size in one lake 6 inches, in the other lake 7 inches) exclusive of yearlings, minnows and obnoxious fish. Since lakes in the area are somewhat similar, it is probable that the other lakes contain at least 300 to 400 legal fish per acre. Census records show that 4 of the lakes produced only about 25 to 75 fish per acre in 1936. It seems that many more fish in these lakes die from natural causes than are removed by fishing. A doubling of the fishing intensity would probably not be injurious.

What constitutes a sustained yield in a lake is not known, but census data coupled with other studies will eventually indicate how large a crop may be expected from various types of waters without injury to subsequent fishing.

Movements of Fish: By zoning Fife Lake and by noting where tagged fish were released and where they were recaptured, it was considered possible to note to what extent each species spreads through the lake. As indicated above, the study could not be made because too few fish were captured for tagging. A knowledge of fish movements within a lake is important, of course, in stocking and in lake improvement.

Growth of Fish: The census may be used as an aid in determining rate of growth. Scale samples are collected by some of the census-takers to be used later for growth studies. It has been found, however, that only exceptionally dependable men should be used to collect the scales. Growth may be determined directly from the census where fish of an exotic species and of known length had been planted. In the small lake previously mentioned as producing 10½ inch brook trout, the fish showed a very exceptional growth. It is possible, of course, that only the larger fish in the planting survived and that the growth averaged less than 7¼ inches (ave. 3¼ when planted, 10½ when caught) for the year the fish were in the lake.

Winter Fishing: The census is especially valuable to obtain information on the relative catch of fish in summer and in winter. The question of the effect of winter fishing upon the fish population tends to be an important one wherever resort development is extensive and accurate information is needed to better weigh the arguments on both sides. The census has indicated (Hazzard and Eschmeyer, 1937) that: Relatively few lakes are heavily fished in winter; that in general the catch in winter is meager and that with a few exceptions, winter fishing is not harmful to summer fishing.

General Comments: Further uses of the census probably will suggest themselves to the reader. It is evident that this inventory is of some value to almost every phase of fish management as well as of interest and value to the angler himself.

The census for a lake or stream obviously increases in value from year to year because it shows trends which cannot be determined from the census for a single season.

Valuable information can be obtained by encouraging clubs or individual fishermen to keep accurate and complete records of their fishing. In Michigan one club at least (The Kimie Creek Club) has kept a reasonably complete and accurate record of its fishing for over 50 years. These long period records show trends in the fishing which cannot be obtained by other practicable methods. Depending upon memory alone to compare current fishing with angling in the "good old days" is certainly far from reliable.

Terminology: The term "creel census" does not express the full use of this survey, but because of long usage (since 1927 in Michigan) and because the term is not easily confused with other types of study, it is believed that the expression "creel census" is better suited than "fish yield study" or some expressions which have at times been used.

The term "fisherman-day" has been used to express the fishing of one fisherman for one day. To say that a lake was fished for 5,000 fisherman-days is obviously better than saying that it was fished by 5,000 fishermen if by

"fisherman" we mean the fishing of one person for one day.

Compilation of Data: The many compilations and correlations of the data are made for the Institute by the Department of Mathematics (Sorting and Tabulating Division) of the University of Michigan. The information is transferred to code cards which are turned over to the Mathematics Department for sorting and tabulating. This method has been found far superior to the laborious and time consuming compilation of the information with calculating machines.

Literature on the Michigan Creel Census

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