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INSTITUTE FOR FISHERIES RESEARCH
DIVISION OF FISHERIES
MICHIGAN DEPARTMENT OF CONSERVATION
COOPERATING WITH THE
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ANGLERS' CATCH OF RAINBOW TROUT IN LAKES DURING SPECIAL WINTER SEASON, JANUARY-FEBRUARY 1960

By Kenneth E. Christensen

and James R. Ryckman

Rainbow trout are being planted in several hundred Michigan lakes. Most of these lakes are "combination" lakes, with warm-water fish populations. All contain, in the summer (and thus, throughout the year), a zone of water cold enough and with oxygen enough to support a population of trout. Returns to anglers from many plantings in experimental lakes have varied from less than 10 percent to as much as 80 percent. Since these fish are planted to be caught, the greatest harvest, spread over a generous portion of the angling seasons, should be the goal.

Big Twin Lake, Kalkaska County, was opened experimentally to winter fishing for rainbow trout in the winter of 1952-53. This experiment was discontinued after the first year because few rainbows were caught. A second experiment permitting winter fishing for rainbow trout was initiated at Corey Lake, St. Joseph County, in 1957. The study on Corey Lake has demonstrated that winter anglers could harvest rainbow trout, with no undue effects on the harvest in the open-water seasons.

In 1959, the Director of the Conservation Department was empowered to designate lakes which would be open to taking of rainbow trout through the ice, by hook-and line, during the months of January, February and December. Under this authority, 202 lakes in Michigan were opened, effective January 1, 1960.

At Mr. Max Hunt's suggestion, an evaluation of the results on several lakes in Region II was initiated. The Institute cooperated with personnel in Region II (and, subsequently, Regions I and III) in establishing a creel census procedure and schedule designed to give reliable estimates of the rainbow trout harvest and angling pressure on selected lakes.

The creel census was conducted by personnel from the Fish, Field Administration, and Parks divisions of the Conservation Department. The schedule of census days (Figure 1) was established by reference to a table of random numbers, with four strata of time intervals: weekdays, A.M. and P.M.; and weekend days, A.M. and P.M. To obtain a miminum of four sets of counts in each stratum required that each lake should be censused at least 16 days during the two-month season. Means of modifying the schedule, to permit flexibility in assigning work periods, were suggested. Those taking the census were instructed to interview as many anglers as possible, since light fishing pressure would make it difficult to obtain sufficient data in the limited census time. Dr. Don W. Hayne gave advice in setting up the census schedule.

On February 4, K. E. Christensen met with Messrs. Max Hunt and Jack Hammond at Roscommon and reviewed the data for the month of January from three of the lakes in District 9. These data were used to forumlate a set of instructions for calculating the harvest of rainbow trout from the lakes being censused. Also, Christensen met with the District Fisheries Supervisors from Region II, and with Henry Vondett, District Fisheries Supervisor in Region III, at the Higgins Lake Training School on March 23 to review the records for lakes in Region II. Finally, all of the census records were rechecked and tabulated in the Ann Arbor office of the Institute by the authors.

Accompanying tables give summaries of census data on hours per fishing trip, trout per trip, total angling trips, total hours of fishing, estimated

Figure 1.--Sampling schedule of census effort for winter rainbow trout fishing, January and February, 1960.

Each census clerk checked on two lakes (A and B) on a systematic schedule.

Date	Day of week						
	Saturday	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
Jan. 1	..	..	..	..	..	..	..
2-8	Lake A(PM)	..	..	..	..	Lake A(AM)	..
	Lake B(AM)	..	..	..	..	Lake B(PM)	..
9-15	Lake A(AM)	..	..	..	..	Lake A(PM)	..
	Lake B(PM)	..	..	..	..	Lake B(AM)	..
16-22	..	Lake A(PM)	..	..	Lake A(AM)	..	..
	..	Lake B(AM)	..	..	Lake B(PM)	..	..
23-29	..	Lake A(AM)	..	..	..	..	Lake A(PM)
	..	Lake B(PM)	..	..	..	..	Lake B(AM)
Jan. 30-Feb. 5	Lake A(PM)	..	..	..	..	..	Lake A(AM)
	Lake B(AM)	..	..	..	..	..	Lake B(PM)
Feb. 6-12	Lake A(PM)	..	..	..	..	..	Lake A(PM)
	Lake B(AM)	..	..	..	..	..	Lake B(AM)
13-19	..	Lake A(AM)	..	..	..	Lake A(PM)	..
	..	Lake B(PM)	..	..	..	Lake B(AM)	..
20-26	..	Lake A(PM)	..	..	..	..	Lake A(AM)
	..	Lake B(AM)	..	..	..	..	Lake B(PM)
27-29	..	..	..	..	..	..	..

total catch of trout, and rainbow trout stocking records for 1958 and 1959, for the 72 censused lakes. Confidence limits for census data are expressed as plus or minus one standard error. Many of the estimates have 95 percent confidence limits (equal to two standard errors) of something less than plus or minus 30 percent.

The creel census on the 72 lakes concerned in the present study involved a considerable amount of effort on the part of more than 50 Conservation Department employees, including Conservation Officers, Fire Officers, Park Managers, hatchery employees, Lake and Stream Improvement personnel, and District Fisheries Supervisors.

The 72 lakes which were censused are listed in Tables 1 and 2 by Conservation Department Region and District and by county, but Tier, Range and Section are not given. Most of the lakes are so well known as trout lakes that there is little chance of confusion as to what lakes are involved. Following are the locations by Tier, Range and Section of those lakes (listed in the table) for which confusion might result from duplication of lake names in one county:

Johnson Lake, Marquette County	T. 45 N., R. 25 W., Sec. 27
Island Lake, Schoolcraft County	T. 43 N., R. 16 W., Sec. 14, 15
Silver Lake, Cheboygan County	T. 33 N., R. 3 W., Sec. 11, 12
Lake George, Ogemaw County	T. 21 N., R. 1, 2 E., Sec. 13, 18
Arnold Lake, Clare County	T. 19, 20 N., R. 4 W., Sec. 2, 35
Lake Sixteen, Allegan County	T. 2 N., R. 11 W., Sec. 16
Halfmoon Lake, Washtenaw County	T. 1 N., 1 S., R. 3, 4 E., Sec. 1, 6, 31
Square Lake, Oakland County	T. 2 N., R. 10 E., Sec. 6

Details of procedure in computing estimates from field census data are given in the appendix, following the tables.

Table 1.--Angling effort and rainbow trout catch indices, and estimates of angling trips, angling hours and rainbow trout harvest, from several lakes open to hook-and-line fishing through the ice, January and February, 1960

Region, district, lake, county	Hours per trip	Trout per trip	Estimate of angling trips	Total angling hours	Total catch of rainbow trout
Region I					
District 1					
Beatons, Gogebic	4.05±0.24	0.48±0.10	387±81	1567±315	186±54
Moon, Gogebic	4.32±0.44	0.26±0.08	152±62	658±259	40±20
Clear, Houghton	3.40±0.61	2.00±0.44	↓ 134	456	258
Crystal, Houghton	3.50±0.14	1.39±0.12	693±143	2426±492	963±217
Emily, Houghton	3.80±0.13	0.89±0.09	[1] ↓ 1698	3654	1612
District 2					
No census					
District 3					
Deer, Alger	1.97±0.21	0.00	114±39	225±73	...
Gooseneck, Delta	3.84±0.16	0.34±0.11	365±74	1402±277	124±48
Angeline, Marquette	2.55±0.08	0.81±0.11	818±88	2085±215	663±79
Johnson, Marquette	2.04±0.11	0.01±....	801±177	1635±350	8±18
Twin, Marquette	2.73±0.17	1.85±0.23	284±84	775±225	525±114
Witch, Marquette	2.22±0.12	0.10±0.06	309±71	687±154	31±23
District 4					
Grand Sable, Alger	3.70±0.10	0.00	258±33	954±118	0
Bass, Luce	2.68±0.14	0.17±0.31	356±73	954±190	61±30
N. Manistique, Luce	3.20±0.47	0.00	No counts made; no anglers present on 10 of the 17 census days.		
Dodge, Schoolcraft	2.70±0.25	0.49±0.14	287±56	775±136	141±49
Island, Schoolcraft	2.64±0.20	0.91±0.22	135±28	357±68	123±39
Region II					
District 5					
Louise, Charlevoix	2.82±0.10	1.60±0.14	1208±183	3408±506	1933±339
Walloon, Charlevoix					
West arm	4.68±0.31	0.00	219±42	1024±179	0
North arm	3.95±0.36	0.00	347±31	1371±17	0
Silver, Cheboygan	2.98±0.20	0.94±0.22	623±132	1800±111	586±184
Avalon, Montmorency	2.08±0.10	0.23±0.06	1475±361	3069±736	339±116
Big, Otsego	2.86±0.15	0.69±0.12	579±80	1655±211	400±90

Table 1, continued

Region, district, lake, county	Hours per trip	Trout per trip	Estimate of angling trips	Total angling hours	Total catch of rainbow trout
Region II, continued					
District 6					
Bear, Kalkaska	3.19±0.20	0.70±0.14	420±77	1340±231	294±80
Selkirk, Kalkaska	3.36±0.32	0.00	252±98	846±318	0
District 7					
Bright, Crawford	2.79±0.23	1.38±0.24	215±57	600±150	297±94
Glory, Crawford	2.42±0.53	1.56±0.61	268±91	648±215	418±151
George, Ogemaw	2.39±0.18	0.65±0.13	601±106	1437±230	391±106
Loon, Oscoda	2.51±0.16	0.66±0.13	1064±204	2670±440	702±190
Tea, Oscoda	3.09±0.20	0.13±0.05	788±139	2436±403	102±44
District 8					
Harper, Lake	2.49±0.10	1.38±0.10	1311±332	3264±814	1809±476
Paradise, Lake	2.90±0.10	1.58±0.20	665±237	1929±685	1051±133
Reed, Lake	2.79±0.22	0.74±0.14	231±75	645±204	171±65
Sand, Lake	2.84±0.17	1.13±0.14	567±122	1610±329	641±159
Brockway, Mecosta	2.97±0.17	0.02±0.01	646±104	1920±291	13±7
Hannah, Mecosta	2.70±0.10	0.28±0.07	932±141	2517±379	261±77
Halfmoon, Muskegon	2.33±0.10	0.37±0.07	1622±119	3780±863	600±456
Bills, Newaygo	2.72±0.10	0.39±0.10	1754±499	4770±1348	684±261
Ryerson, Newaygo	2.71±0.17	0.23±0.10	1207±503	3270±1367	278±167
Heitman, Oceana	2.25±0.07	0.05±0.02	960±217	2159±484	48±20
Pebawma, Oceana	2.14±0.14	0.00	247±50	529±103	0
Sunrise, Osceola	2.69±0.14	1.70±0.14	1260±229	3390±588	2142±428
District 9					
Arnold, Clare	3.34±0.07	0.02±0.01	903±107	3016±357	14±10
Windover, Clare	3.71±0.32	1.79±0.17	487±79	1805±253	872±277
Littlefield, Isabella	3.13±0.09	0.07±0.02	1468±139	4594±346	98±33
Region III					
District 10					
Sixteen, Allegan	1.94±0.01	0.42±0.01	722±217	1394±415	303±109
Deep, Barry	3.12±0.02	0.97±0.02	847±167	2642±508	821±194
Little Long, Barry	2.06±0.14	0.00	891±190	1836±371	0
Sugarbush, Barry	2.97±0.02	0.57±0.01	1593±276	4730±787	908±212
Hemlock, Cass	3.59±0.18	0.52±0.09	73±55	263±197	38±36

Table 1, continued

Region, district, lake, county	Hours per trip	Trout per trip	Estimate of angling trips	Total angling hours	Total catch of rainbow trout
Region III, District 10, continued					
Rupert, Kalamazoo	2.39±0.12	0.23±0.00 [2]	502±221	1200±529	116±59
Nevins, Montcalm	1.98±0.01	0.01±0.00 [2]	795±181	1575±350	7±7
Cedar, Van Buren	2.80±0.02	0.63±0.01	1251±224	3504±602	788±205
Huzzy, Van Buren	2.93±0.06	0.73±0.03	181±137	531±398	132±104
District 11					
Lee, Calhoun	2.77±0.26	0.04±0.04	823±211	2280±552	31±33
Sonoma, Calhoun	2.36±0.11	0.00	No estimates, angler count records lost		
Bird, Hillsdale	1.53±0.17	0.00	No estimates, angler count records lost		
Hemlock, Hillsdale	1.89±0.11	0.44±0.08	166±97	314±187	73±45
Lime, Jackson	1.93±0.14	0.00	No estimates, angler count records lost		
Swains, Jackson	2.46±0.14	0.00	No estimates, angler count records lost		
Appleton, Livingston	2.89±0.14	0.00	557±167	1609±475	0
Chemung, Livingston	3.09±0.20	0.01±0.01	1126±375	3480±1136	10±11
Halfmoon, Washtenaw	3.32±0.17	0.00	207±46	686±149	0
Pickeral, Washtenaw	2.72±0.57	0.09±0.04	450±148	1224±308	41±26
District 12					
Davison, Lapeer	3.43±0.18	0.00	954±166	3273±542	0
Davie, Lapeer	3.08±0.14	0.00	837±138	2596±412	0
Bridge, Oakland	No angling recorded during 16 census periods				
Cemetery, Oakland	No angling recorded during 16 census periods				
Crotche, Oakland	3.39±0.27	0.00	426±126	1449±414	0
Deer, Oakland	2.11±0.14	0.08±0.04	No estimates, insufficient data		
Oxbow, Oakland	3.18±0.19	0.51±0.14	823±159	2619±482	419±141
Schoolhouse, Oakland	2.17±0.24	0.00	236±55	515±105	0
Square, Oakland	2.36±0.13	0.00	735±139	1734±314	0
Sugden, Oakland	2.14±0.14	0.00	621±131	1305±260	0

[1] Ratio estimate obtained by direct proportion expansion of officers' records (8 of 36 weekend periods, 8 of 84 weekday periods, censused 100 percent).

[2] Standard error less than 0.01

Table 2.--Rainbow trout plantings and estimates of harvest and angler-trips for several lakes open to hook-and-line fishing through the ice, January-February, 1960

Region County Lake	Trout plantings 1958	 1959	Estimated total Catch of trout	 Angler trips
Region I				
Gogebic County				
Beatons	2,000	0	186	387
Moon	5,000	5,000	40	152
Houghton County				
Clear	3,000	3,000	258	134
Crystal	2,000	2,000	963	693
Emily	2,000	2,000	1,612	1,698
Alger County				
Deer	2,000	0	0	114
Delta County				
Gooseneck	2,000	2,000	124	365
Marquette County				
Angeline	2,000	2,000	663	818
Johnson	2,200	2,500	8	801
Twin	1,000	1,000	525	284
Witch	3,000	3,000	31	309
Alger County				
Grand Sable	3,000	2,000	0	258
Luce County				
Bass	2,000	2,514	61	356
N. Manistique	2,000	2,000	0	No estimate
Schoolcraft County				
Dodge	2,000	1,500	141	287
Island	2,000	1,500	123	135
Region II				
Charlevoix County				
Louise	6,000	5,000	1,933	1,208
Walloon	0	17,500	0	566

Table 2, continued

Region County Lake	Trout plantings 1958	 1959	Estimated total Catch of trout	 Angler trips
Region II, continued				
Cheboygan County				
Silver	6,000	6,000	586	623
Montmorency County				
Avalon	3,600	3,000	339	1,475
Otsego County				
Big	2,400	2,000	400	579
Kalkaska County				
Bear	7,200	6,000	294	420
Selkirk	1,500[1]	0	0	252
Crawford County				
Bright	720	600	297	215
Glory	720	600	418	268
Ogemaw County				
George	2,400	1,000	391	601
Oscoda County				
Loon	2,400	2,000	702	1,064
Tea	3,000	2,500	102	788
Lake County				
Harper	5,400	4,500	1,809	1,311
Paradise	2,400	2,000	1,051	665
Reed	2,400	2,000	171	231
Sand	3,030	2,525	641	567
Mecosta County				
Brockway	500	500	13	646
Hannah	1,500	1,500	261	932
Muskegon County				
Halfmoon	3,000	3,000[2]	600	1,622
Newaygo County				
Bills	5,000	5,000[2]	684	1,754
Ryerson	3,600	3,000	278	1,207
Oceana County				
Hartman	1,500	1,500	48	960
Pebawma	2,000	2,000	0	247

Table 2, continued

Region County Lake	Trout plantings 1958	 1959	Estimated total Catch of trout	 Angler trips
Region II, continued				
Osceola County				
Sunrise	4,200	3,500	2,142	1,260
Clare County				
Arnold	2,000	2,000	14	903
Windover	2,976	6,606	872	487
Isabella County				
Littlefield	6,000	5,000	98	1,468
Region III				
Allegan County				
Sixteen	1,000	1,000	303	722
Barry County				
Deep	0	3,000	821	847
Little Long	2,000	0	0	891
Sugarbush	2,000	2,000	908	1,593
Cass County				
Hemlock	1,000	1,000	38	73
Kalamazoo County				
Rupert	2,000	1,000	116	502
Montcalm County				
Nevins	0	2,000	7	795
Van Buren County				
Cedar	3,000	3,000	788	1,251
Huzzy	4,000	2,000	132	181
Calhoun County				
Lee	1,000	1,250	31	823
Sonoma	3,750	0	0	No estimate
Hillsdale County				
Bird	2,000	2,500	0	No estimate
Hemlock	0	3,750	73	166
Jackson County				
Lime	500	600	0	No estimate
Swains	3,500	4,375	0	No estimate

Table 2, concluded

Region County Lake	Trout plantings 1958	 1959	Estimated total Catch of trout	 Angler trips
Region III, continued				
Livingston County				
Appleton	0	750	0	557
Chemung	0	2,500	10	1,126
Washtenaw County				
Halfmoon	1,200	1,500	0	207
Pickerel	0	50	41	450
Lapeer County				
Davison	0	2,500	0	954
Davie	3,500	3,500	0	837
Oakland County				
Bridge	1,000	1,000	0	0
Cemetery	1,400	1,400	0	0
Crotche	1,500	2,000	0	426
Deer	3,000	3,000	No estimates	
Oxbow	0	6,000	419	823
Schoolhouse	900	900	0	236
Square	0	2,500	0	735
Sugden	1,600	3,000	0	621

1/ The most recent planting (1,500) in Selkirk Lake was in 1957; none planted in 1958 or 1959.

2/ Halfmoon Lake, Muskegon Co., planted 1/21/60; and Bills Lake, Newaygo Co., planted 1/19/60.

Appendix

1. Calculation of "hours-per-trip" and its standard error:

The hours of angling are totaled for all anglers interviewed, and divided by the number of anglers interviewed, to obtain the mean hours per trip. The variance ($s^2_{\bar{x}}$) of this mean is determined from:

$$s^2_{\bar{x}} = \frac{\Sigma X^2 - \frac{(\Sigma X)^2}{n}}{\frac{n-1}{n}}$$

Standard error of the mean, $(s_{\bar{x}}) = \sqrt{s^2_{\bar{x}}}$

Where X = individual record of hours-per-trip, and

n = number of angler trips

2. Calculation of "trout-per-trip" and its variance and standard error:

The trout caught by anglers who were interviewed are totaled and divided by the number of angler-trips to obtain the mean trout per trip. When two or more anglers in one party caught one or more trout, the trout are apportioned as equally as possible to all anglers without resorting to fractional trout. The variance and the standard error are determined by the same formulae as used in the hours-per-trip calculations, where X = number of trout caught on a particular trip, and n = total number of angler trips.

3. Calculation of estimate of total angling hours and its variance and standard error:

Data on angler counts from within each stratum each day (weekend A.M., weekend P.M., weekday A.M., and weekday P.M.) were averaged first. Then for these daily averages within strata, a mean and variance were found for each stratum. The two weekend strata had 18 weekend days and each contained five hours (A.M. or P.M.): thus an expansion factor of 5 times 18 = 90 was used to convert the hourly mean per stratum to the estimate of

total angling hours for that stratum. There were 42 weekdays and each weekday stratum contained 5 hours (A.M. or P.M.); thus an expansion factor of 5 times 42 = 210 was used to convert the hourly mean per stratum to the estimate for that stratum. The estimates for the strata were totaled for the estimate of angling hours for the season. The variance for each stratum was totaled to obtain the pooled variance for the seasonal estimate. The standard error of the seasonal estimate was determined as the square root of this pooled variance.

4. Calculation of estimate of angling trips, and its variance and standard error: The estimate of angling trips is found by dividing the seasonal estimate of angling hours by the mean hours-per-trip for interviewed anglers. The variance and standard error of the estimate of angling trips is found by use of the following formulae:

Variance ($s^2_{\bar{x}}$) of estimated trips =

$$\text{estimated trips}^2 \left(\frac{\text{variance of hours per trip}}{\text{hours per trip}^2} + \frac{\text{variance of estimated hours}}{\text{estimated hours}^2} \right)$$

Standard error ($s_{\bar{x}}$) = $\sqrt{s^2_{\bar{x}}}$

5. Calculation of estimate of rainbow trout harvest, and its standard error: The estimate of trout catch is found by multiplying the estimate of total trips by the mean trout-per-trip factor. The standard error of the estimate of the trout harvest is found by use of the following formulae:

Standard error ($s_{\bar{x}}$) of estimated trout catch = square root of [(trout-per-trip^2 times variance of estimated trips) + (estimated trips^2 times variance of trout-per-trip)].

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