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FURTHER RESULTS FROM SPRING AND FALL PLANTINGS OF LEGAL-SIZED, HATCHERY-REARED TROUT IN STREAMS AND LAKES OF MICHIGAN[1]

[1] Contribution from the Michigan Institute for Fisheries Research.

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ABSTRACT

Further tagging experiments in Michigan with spring and fall plantings of brook trout (Salvelinus fontinalis), brown trout (Salmo trutta), and rainbow trout (Salmo irideus) from which recoveries were made during the 1942 trout season confirmed the conclusion that spring release of adult or near-adult hatchery-reared brook trout and rainbow trout is more desirable than the fall planting of fish of a similar size. In some instances fall stocking of brown trout may furnish as good fishing in the following season as does spring planting.

Recoveries of planted fish past the first season of availability ranged from 0.0 to 2.5 per cent to the second season and from 0.0 to 0.5 per cent to the third season.

In either spring or fall planting of legal-sized fish, no advantage was gained in scattering the fish widely over the stream areas stocked.

Eighty-five per cent or more of the planted trout were caught within 10 miles of the point of release, regardless of the season or method of planting. Brown trout moved the least and rainbow trout the most. About one-fourth of the brook trout tended to move 3 to 10 miles downstream, and the majority of the remainder were caught within 3 miles of the locality of release. More rainbow trout than any other species were recaptured 10 or more miles from the point of release.

Fall plantings of adult brook trout in lakes were recovered at the rate of 56.7 per cent (range 13.0 to 88.1 per cent). Unfortunately, a small percentage of the anglers removed an average of 89.4 per cent of the total catch during the opening weeks of trout season. The average recovery from two spring plantings of brook trout in East Fish Lake in Michigan was 68.5 per cent.

A brief review of the literature substantiates the conclusions reached as a result of the Michigan experiments. Differences in experimental procedure are pointed out, and some reasons are offered for the failure of fish planted in streams in the fall to survive the winter season.

Introduction

Previous experiments described by Shetter and Hazzard (1941, 1942) demonstrated that, in the majority of Michigan trout streams, from two to six times as many hatchery-bred trout were caught from spring plantings as were caught from plantings made in the fall of the year. As will be pointed out later, this conclusion is, in general, consistent with the results of other investigations in Michigan and in other trout streams

of the United States. In lakes where suitable thermal and chemical conditions for trout exist, we found that legal-sized rainbow trout might be planted in the fall of the year with the expectancy that from 20 to 70 per cent would be recovered by anglers in succeeding seasons.

This report presents additional information from data gathered chiefly during the 1942 trout season on the success of planting adult hatchery-reared trout at different seasons in Michigan streams and lakes. Evidence available on the percentage of marked fish planted which were taken by anglers in the second and third season after release is included, as well as a comparison of the relative merits of "spot" and "boat" planting. An analysis is presented of the movements of the hatchery-reared trout after release in the fall of 1941 and the spring of 1942. A brief review is given also of the results of other investigators on the general subject of planting trout of legal size.

Six streams, located in different sections of Michigan, were planted with jaw-tagged trout. In the lakes studied, where trout were already present, the fish in the plantings were fin-clipped to make the hatchery trout recognizable. In lakes where trout were not found previously, and which were planted with trout for the first time, marking was unnecessary. The 1942 data on the recoveries of marked fish obtained from the streams were in part furnished voluntarily by cooperative anglers while others were secured through the efforts of members of the Fish Division and Field Administration Division.

Fishermen were made acquainted with the purpose of the tagging experiments and their locations through the use of stream-side posters, newspaper publicity, and a descriptive paragraph in the fishing-law

summary provided with each license. From the content of numerous letters reporting tag recoveries, it appears that all three forms of publicity aided in securing tag returns from anglers.

Financial considerations, and also a lack of trained personnel, made it impossible to establish creel censuses on the streams studied in 1942. Therefore the total catch in any of the sections of streams planted with tagged fish is not known. Since the releases made at both seasons were under the same angling pressure, the relative numbers of fish reported from the spring or fall planting are significant in the determination of the proper time of release, even though not all tagged fish caught were reported.

The data on the lakes were obtained either through complete creel censuses or censuses limited to the opening week-end or opening day of the trout season

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Results from plantings in streams

Brook trout, Salvelinus f. fontinalis.—Five hundred jaw-tagged brook trout were released in the fall of 1941 and the same number in the spring of 1942 in the West Branch of the Sturgeon River just south of the town of Wolverine in Cheboygan County (Table 1). Of the fall planting, four (0.8 per cent) were later caught and reported, and of the spring planting, 18 (3.6 per cent) were reported as captured by angling. In comparison with previous planting experiments with brook trout, these releases yielded a relatively small number of returns, for which fact no definite reasons can be given. Lighter angling pressure on this stream in 1942 than in previous seasons may have influenced the results.

On the Middle Branch of the Ontonagon River (Gogebic County), 150 legal-sized brook trout were tagged and released at each season. Twelve returns, or a recovery of 8.0 per cent, were reported from the 1941 fall planting in the 1942 fishing season, while 17 (or 11.3 per cent) were returned from the 1942 spring planting.

For the two streams combined, an average recovery of 2.5 per cent was made from the 1941 fall plantings, and of 5.4 per cent from the spring plantings (release of 650 tagged fish at each season).

Table 1.—Results from fall and spring (pre-season) planting of tagged trout of legal size in Michigan streams, based on fish reported captured during the 1942 trout season. (Figures in parentheses indicate average total length in inches.)

Stream	Brook trout						Rainbow trout						Brown trout					
	Number planted		Number recovered		Percentage recovery		Number planted		Number recovered		Percentage recovery		Number planted		Number recovered		Percentage recovery	
	1941 Fall	1942 Spring	1941 Fall	1942 Spring	1941 Fall	1942 Spring	1941 Fall	1942 Spring	1941 Fall	1942 Spring	1941 Fall	1942 Spring	1941 Fall	1942 Spring	1941 Fall	1942 Spring	1941 Fall	1942 Spring
Portage Creek	...	...	...	...	...	...	100 (7.1)	100 (9.6)	2	17	2.0	17.0	25 (6.4)	25 (9.8)	0	3	0.0	12.0
Dowagiac Creek	...	...	...	...	...	...	250 (6.8)	250 (9.5)	3	28	1.2	11.2	50 (6.4)	50 (10.2)	0	2	0.0	4.0
Baldwin Creek	...	...	...	...	...	...	250 (7.8)	250 (8.4)	14	28	5.6	11.2	250 (8.9)	250 (8.3)	18	16	7.2	6.4
Main Au Sable	...	...	...	...	...	...	250 (9.5)	250 (10.6)	23	51	9.2	20.4	250 (8.3)	250 (9.0)	18	32	7.2	12.8
West Branch, Sturgeon	500 (8.4)	500 (9.2)	4	18	0.8	3.6	...	...	...	...	...	...	...	...	...	...	...	...
Middle Branch, Ontonagon	150 (6.9)	150 (9.1)	12	17	8.0	11.3	150 (6.8)	150 (8.2)	3	11	2.0	7.3	...	...	...	...	...	...
Totals or weighted averages	650	650	16	35	2.5	5.4	1,000	1,000	45	135	4.5	13.5	575	575	36	53	6.3	9.2

Rainbow trout, Salmo gairdnerii irideus.—Two trout streams in the extreme southwestern part of Michigan (Portage Creek in Kalamazoo County on the outskirts of Kalamazoo, and Dowagiac Creek in Cass County) were included in the experiments of 1941-42, since it seemed possible that the over-the-winter mortality of adult fish might be much lower than that previously noted in streams farther north where the winters are more severe. Accordingly, fall and spring plantings of legal-sized rainbow trout and brown trout were made in each. Dowagiac Creek, although ditched for a drain throughout most of its length, has favorable trout habitats and temperature conditions in the vicinity of the city of Dowagiac. Portage Creek has a normal stream channel and favorable temperatures for about 3 miles south of the Kalamazoo city limits.

In Portage Creek the results from planting 100 tagged rainbow trout at both seasons of the year were as follows: percentage of recovery by anglers on fall-planted fish, 2.0 per cent (Table 1); on spring-planted fish, 17.0 per cent.

In Dowagiac Creek 250 tagged rainbow trout were planted in the fall of 1941, and a like number in the spring of 1942. During the 1942 trout season, three (1.2 per cent) were recovered from the 1941 fall planting, and 28 (11.2 per cent) were reported as recaptured from the 1942 spring planting.

From plantings of 250 tagged rainbow trout each in the spring and in the fall in Baldwin Creek (Lake County), twice as many (28 or 11.2 per cent) were recovered from the spring introduction as from the fall planting (14 or 5.6 per cent) during the 1942 trout season.

The stocking of 250 tagged rainbow trout both in the spring and the

fall in the Main Au Sable River (Crawford County) just below the town of Grayling yielded the following results during the 1942 trout season: from the fall planting of 1941, 23 recoveries (9.2 per cent); from the spring planting of 1942, 51 recoveries (20.4 per cent).

In the Middle Branch of the Ontonagon River 150 tagged rainbow trout were planted at each season. Three recaptures (2.0 per cent) were reported during the 1942 season from the fall planting of 1941, and 11 recoveries (7.3 per cent) were made from the spring planting of 1942.

The trend of the results on the two southern streams (Portage Creek and Dowagiac Creek) was the same as for the northern rivers. Several times as many tagged rainbow trout from the spring plantings as from fall releases appeared in the anglers' catches in the 1942 season (see Table 1).

The combined results from the five streams were as follows: 1,000 tagged rainbow trout were planted at each season; 4.5 per cent of the fish of the fall planting of 1941 were recovered during the 1942 season, and 13.5 per cent of the spring planting (or three times as many) were recovered during 1942.

Brown trout, Salmo trutta.— Experiments which involved the planting of tagged, legal-sized, hatchery-bred brown trout were conducted on four streams. In the two southernmost streams (Portage Creek and Dowagiac Creek), no recoveries were reported during the 1942 season from the fall plantings of 1941. Similar plantings in the spring of 1942 yielded 12.0 and 4.0 per cent respectively to the 1942 anglers reporting on those streams.

In Baldwin Creek, 250 tagged brown trout were planted at each season. During 1942 more fall-planted fish than spring-planted fish

were reported for the first time in the writer's experience (18 or 7.2 per cent from the 1941 fall planting and 16 or 6.4 per cent from the spring planting).

Two hundred fifty tagged brown trout were planted in the Main Au Sable just below the town of Grayling in the fall of 1941 and the same number in the spring of 1942. During 1942, 18 (7.2 per cent) of the fall-planted fish were reported as recaptured, while 32 (12.8 per cent) of the spring release of 1942 were recovered.

A comparison of the number of recoveries of brown trout from the fall and spring plantings in the southern and northern streams indicates that the survival from fall stocking was actually the poorer in the southern waters; in fact, only spring-planted brown trout have been recaptured. However, the number of brown trout used in the southern streams was small, and the average size of the fall-planted fish was not as large as was desirable. These factors may have influenced the results with brown trout in these two streams.

The combined results of the experiments with brown trout of legal size were as follows: fall plantings of 1941--36 (6.3 per cent) of 575 fish were recovered; spring plantings of 1942--53 (9.2 per cent) of 575 fish were recaptured.

"Carry-over" or survival of hatchery-reared trout through one or more seasons

A summarization of the results of almost all recent plantings of marked legal-sized hatchery-reared trout is presented in Table 2. Data from the West Branch of the Sturgeon River and Portage Creek have not been included as no reports of recoveries of tagged fish have been received other than those obtained during the 1942 trout season (the first season

Table 2.—A comparison of the results from spring and fall plantings of brook, brown, and rainbow trout in Michigan streams. Figures in parentheses indicate percentages of recovery. Where no recovery was made the corresponding place in the table has been left vacant.

Stream	Species and season when first became available		Number planted		Number recovered first season		Number recovered second season		Number recovered third season	
			Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Main Au Sable	Rainbow	'41	499	471	98 (19.6)	51 (10.8)	3 (0.6)	1 (0.2)	...	...
	Rainbow	'42	250	250	51 (20.4)	23 (9.2)	1 (0.4)	...	...	...
	Brown	'41	500	500	76 (15.2)	40 (8.0)	2 (0.4)	1 (0.2)	...	2 (0.4)
	Brown	'42	250	250	32 (12.8)	18 (7.2)	1 (0.4)	2 (0.8)	1 (0.4)	...
Baldwin Creek	Rainbow	'41	500	498	51 (10.2)	38 (7.6)	2 (0.4)	1 (0.2)	...	...
	Rainbow	'42	250	250	28 (11.2)	14 (5.6)	1 (0.4)	...	...	...
	Brown	'41	448	500	54 (12.1)	31 (6.2)	3 (0.7)	1 (0.2)	...	...
	Brown	'42	250	250	16 (6.4)	18 (7.2)	1 (0.4)	...	...	...
Dowagiac Creek	Rainbow	'42	250	250	28 (11.2)	3 (1.2)	1 (0.4)	...	...	...
	Brown	'42	50	50	2 (4.0)	...	1 (2.0)	...	1 (1.0)	...
Middle Branch, Ontonagon	Rainbow	'42	150	150	11 (7.3)	3 (2.0)	...	...	...	...
	Brook	'42	150	150	17 (11.3)	12 (8.0)	...	...	...	...
Kinne Creek[1]	Brown	'39	994	...	98 (9.6)	...	10 (1.0)	...	1 (0.1)	...
	Brown	'41	201	...	56 (27.8)	...	5 (2.5)	...	...	...
	Rainbow	'40	250	...	85 (34.0)	...	1 (0.4)	...	...	...
	Rainbow	'41	203	...	77 (37.9)	...	5 (2.5)	...	...	...
	Brook	'41	100	...	23 (23.0)	...	2 (2.0)	...	1 (1.0)	...
All plantings	Rainbow		2,352	1,869	429 (18.2)	132 (7.1)	14 (0.6)	2 (0.1)	...	...
	Brown		2,693	1,550	334 (12.4)	107 (6.9)	23 (0.9)	4 (0.3)	3 (0.1)	2 (0.1)
	Brook		250	150	40 (16.0)	12 (8.0)	2 (0.8)	...	1 (0.4)	...
	All species		5,295	3,569	803 (15.2)	251 (7.0)	39 (0.7)	6 (0.2)	4 (0.1)	2 (0.1)

[1] No fall plantings were made in this stream.

of availability). Information from Kinne Creek (a privately-owned trout stream on the properties of the Wingleton Club in Lake County) has been included.

Study of the table indicates that, as might be expected, the largest percentage of the planted fish is recovered during the first season of availability regardless of the season. The data from Kinne Creek probably represent the maximum "carry-over" which could be secured. Members of the Wingleton Club are required by their own rules to record each day's catch in a book kept in the ice-house. The stream is blocked quite efficiently near its confluence with the Pere Marquette River by a self-cleaning rotary screen which keeps all fish planted in Kinne Creek in the stream until removed by angling or by natural death. Here small but significant percentages of recovery in the second season after planting have been noted -- from 0.4 per cent of a planting of 250 rainbow trout to 2.5 per cent of a planting of 203 rainbow trout. Other recoveries were 2.5 per cent of a release of 201 brown trout and 2.0 per cent from a planting of 100 brook trout. These percentages of recovery during the second season after planting are, for the most part, higher than encountered in the experiments conducted on public waters, where the percentages during the second season after planting have varied between 0.0 and 1.6 per cent (the 2.0 per cent recovery on the 1942 planting of brown trout in Dowagiac Creek in 1943 is not considered very significant, since only 50 fish were "available" and only one was recovered). This lower percentage of recovery during the second season after planting on public waters is probably due in part to more intensive angling.

Excluding the data from Kinne Creek (because there were no fall

plantings in that stream), it appears that there is more than twice the chance of survival to the second and third seasons for spring-planted fish as there is for fall-planted fish (18 recoveries in the second and third seasons for spring-planted fish, 8 recoveries for fall-planted fish). There was some indication that boat planting possibly might have been a factor in the survival to the second and third seasons, as 16 of those reaching the second and third seasons were from boat plantings, while only 10 recoveries came from spot plantings.

Apparently very few hatchery-reared trout survive to reach the third open season after planting. Of marked hatchery fish planted since the spring of 1939 (approximately 10,000) we have records of only seven recoveries which were made during the third season after release. Five of these fish were brown trout and two were brook trout. Two of the brown trout came from a fall planting in 1940 in the Main Au Sable River, and another from a spring planting in Kinne Creek in 1939, while two brown trout from the 1942 spring releases in Dowagiac Creek and the Main Au Sable have been reported in 1944. Both of the brook trout were recovered from spring plantings--one from a release in Kinne Creek in 1941, the other from a planting on the Pine River in 1939 (not shown on Table 2). It would appear from the data at hand that there is more chance for season-to-season survival of spring-planted trout than for trout placed in the streams in the fall of the year, although the percentage of survival will vary with the species of trout, and from stream to stream. Among the three species, season-to-season survival appears to be best among brown trout.

Comparison of results of "spot" plantings and "boat" (scatter) plantings

At each season of planting approximately one-half of each species of

trout was released at a single spot, while the other half was distributed by boat above and below the locality of the "spot" planting. In other words, the fish released from the boat were scattered over from 1 to 3 miles of stream above and below a road bridge or landing.

The sorting of the 1942 recoveries as to whether they originated from "spot" plantings or "boat" plantings yielded no conclusive information. On some streams, and in some seasons, and for certain species, higher percentages of recovery were noted for "boat" plantings and in other situations the reverse was true (Table 3).

Theoretically, the fish distributed by boat should have been somewhat more difficult to recover, since they were spread originally over a much greater area of stream than were the "spot-planted" fish. The logical expectation is that a small number of anglers could remove a large number of hatchery trout that were planted by the "spot" method if the fish chose to remain "schooled up" at the point of planting. However, the 1942 data indicate a slightly higher catch per angler from spring stocking of "boat-planted" brown and rainbow trout. Furthermore, a slightly lower catch per angler was reported for recoveries from "boat-planted" brook trout. From the fall releases of 1941, "boat-planted" brown trout and rainbow trout yielded 0.1 fewer fish per angler reporting than did "spot" planting, and the yield per angler reporting marked brook trout was the same for the "spot" and the "boat" methods.

One phase of the problem of planting adult trout in streams which has not received a thorough test is a comparison of the results between "spot" and "boat" plantings made during the open trout season. It will be necessary in the future for the hatchery supervisors to know how widely the available stock must be dispersed over a stream during the

Table 3.— Comparison of results from "spot" planting and "boat" plantings of legal trout, 1942 trout season, on Michigan trout streams. (Figures in parentheses show number of anglers reporting indicated numbers of fish.)

Stream	Number of recaptures reported from spring release						Number of recaptures reported from fall release					
	Rainbow trout		Brook trout		Brook trout		Rainbow trout		Brown trout		Brook trout	
	Boat	Spot	Boat	Spot	Boat	Spot	Boat	Spot	Boat	Spot	Boat	Spot
Main Au Sable	32 (24)	19 (17)	16 (9)	16 (13)	... ...	... ...	16 (14)	7 (5)	8 (6)	10 (8)	... ...	... ...
Baldwin Creek	15 (13)	13 (13)	3 (3)	13 (9)	... ...	... ...	6 (6)	8 (7)	8 (6)	10 (8)	... ...	... ...
Dowagiac Creek	10 (9)	18 (14)	2 (2)	[1]	... ...	... ...	3 (2)	[1]	[1]	[1]	... ...	... ...
Portage Creek	... ...	17 (13)	... ...	3 (3)	... ...	... ...	... ...	2 (2)	... ...	[1]	... ...	... ...
West Branch Sturgeon	... ...	... ...	... ...	... ...	9 (8)	9 (9)	... ...	... ...	... ...	... ...	1 (1)	3 (3)
Middle Branch Ontonagon	8 (8)	3 (3)	... ...	... ...	6 (6)	11 (6)	2 (2)	1 (1)	... ...	... ...	6 (6)	6 (6)
Totals	65 (54)	70 (60)	21 (14)	32 (25)	15 (14)	20 (15)	27 (24)	18 (15)	16 (14)	20 (16)	7 (7)	9 (9)
Total planted	450	550	275	300	325	325	450	550	275	300	325	325
Percentage recovered	14.4	12.7	7.0	10.7	4.6	6.1	6.0	3.2	5.8	6.6	2.1	2.8
Marked fish caught per angler reporting	1.4	1.1	1.5	1.3	1.1	1.3	1.1	1.2	1.1	1.3	1.0	1.0

[1] No fish caught from plantings. Other blanks indicate no plantings.

open season so that the maximum number of fishermen can be benefited. Experiments on this phase of the problem will be conducted as soon as personnel is available.

Movements of the planted trout

The information available on the movements of the hatchery-reared trout of legal size after release in the fall of 1941 or the spring of 1942 is presented in Table 4. Not all recoveries were usable because of insufficient data on locality. The table shows the season, method of planting, the number of fish returned with sufficient locality data from each planting, and the distribution of these recoveries. The 1942 returns are summarized by species and season of planting, and the percentages of fish which were retaken at various distances from the release point are given. For purposes of comparison, similar data compiled from previous work on Michigan trout streams (Shetter and Hazzard, 1942) are included at the bottom of the table.

In studying this table the reader should remember that no effort has been made to offset possible inequalities in angling pressures on the various sections of stream areas listed in the table. To obtain a more accurate picture of the migrational tendencies of these fish, it would be necessary to know how many units of fishing effort were expended in the area of planting, and both above and below the area of planting.

Furthermore, any boat-planted trout recovered within the limits of the planted area was considered not to have moved. It was not practical to make a list of 250 or 125 planting locations and tag numbers while

Table 4.— Numbers and percentages of fall- and spring-planted trout of legal size recovered at various distances and directions from points of planting in nine Michigan trout streams. (Percentages are given in parentheses.)

Year of recovery	Species of trout	Season and year of planting	Method of planting	Recoveries with locality data	Numbers of fish moving			
					Upstream		Downstream	
					3-10 miles	3-0-3 miles	3-10 miles	over 10 miles
1942	Brook	Spring, '42	Boat	14	3 (21.4)	7 (50.0)	4 (28.6)	...
			Spot	19	1 (5.4)	15 (78.9)	3 (15.7)	...
		Fall, '41	Boat	7	1 (14.3)	4 (57.1)	2 (28.6)	...
			Spot	9	...	6 (66.7)	2 (22.2)	1 (11.1)
		All plantings combined		49	5 (10.2)	32 (65.4)	11 (22.4)	1 (2.0)
1942	Brown	Spring, '42	Boat	16	...	16 (100.0)	...	...
			Spot	26	...	22 (84.6)	3 (11.5)	1 (3.9)
		Fall, '41	Boat	13	...	11 (84.6)	...	2 (15.4)
			Spot	16	1 (6.2)	14 (87.5)	...	1 (6.3)
		All plantings combined		71	1 (1.4)	63 (88.8)	3 (4.2)	4 (5.6)
1942	Rainbow	Spring, '42	Boat	57	...	39 (68.5)	10 (17.5)	8 (14.0)
			Spot	62	2 (3.2)	44 (71.0)	8 (12.9)	8 (12.9)
		Fall, '41	Boat	23	1 (4.3)	17 (73.9)	4 (17.5)	1 (4.3)
			Spot	17	1 (15.9)	14 (82.3)	1 (5.9)	1 (5.9)
		All plantings combined		159	4 (2.5)	114 (71.7)	23 (14.5)	18 (11.3)
Totals, 1942	Brook	Spring, '42	Both	33	4 (12.1)	22 (66.7)	7 (21.2)	...
		Fall, '41		16	1 (12.5)	10 (62.5)	4 (25.0)	1 (12.5)
	Brown	Spring, '42	Both	42	...	38 (90.5)	3 (7.1)	1 (2.4)
		Fall, '41		29	1 (3.5)	25 (86.2)	...	3 (10.3)
	Rainbow	Spring, '42	Both	119	2 (1.7)	83 (69.8)	18 (15.1)	16 (13.4)
		Fall, '41		40	2 (5.0)	31 (77.5)	5 (12.5)	2 (5.0)
1938, 1939, and 1941[1]	Brook	Spring	Both	908	104 (11.4)	385 (42.3)	407 (45.0)	12 (1.3)
		Fall		152	21 (15.0)	69 (45.3)	57 (37.6)	5 (3.0)
	Brown	Spring	Both	122	2 (2.0)	113 (92.0)	7 (6.0)	...
		Fall		53	2 (4.1)	49 (91.8)	2 (4.1)	...
	Rainbow	Spring	Both	356	...	220 (61.7)	93 (26.3)	43 (12.0)
		Fall		61	2 (3.8)	44 (71.7)	13 (21.7)	2 (3.8)

[1] Results from Shetter and Hazzard (1942).

distributing fish from a rapidly drifting boat. It is likely that an unknown number of boat-planted fish actually may have moved anywhere from 1/2 to 3 miles farther than listed in the tables, as their movement up- or downstream, if recovered outside the planting area, was measured arbitrarily from the point of recovery to the nearest end of the stream section covered by the planting boat.

For all species and for both seasons of planting combined, it can be stated that 85 per cent or more of the fish recovered (for which adequate locality data are available) are captured within 10 miles of the point or area of release. The average distance moved by fall-planted trout was slightly greater for brook trout and brown trout but less for rainbow trout than by fish of the same species planted in the same stream areas in the spring of the year. Apparently, then, fall release resulted in little or no advantage in securing a wider distribution over the stream area.

Among the planted brook trout, there was a tendency for almost one-fourth or more of the fish to move from 3 to 10 miles downstream, regardless of the time or method of planting. The great majority of the remainder was captured within 3 miles of the planting locality (see Table 4).

From the data on movements of brown trout, one can conclude that over 85 per cent of the fish in any planting will be caught within 3 miles of the locality of release, and that of the remainder, the majority will be captured from 3 to 10 miles downstream from the planting area. Brown trout will travel considerable distances occasionally, however. For example one tagged brown trout released in the Main Au Sable near Grayling was recovered later 29 miles away by stream in the mid-course

of the South Branch of the Au Sable (15 miles down the Main Au Sable, 14 miles up the South Branch).

The rainbow trout consistently disperses itself over a greater area than the other species if it has opportunity to do so. It can be observed in the table, however, that from 60 to 80 per cent of the planted fish are taken within 3 miles of the point of planting. When this species does migrate, it usually travels farther than the others, sometimes going to the Great Lakes, and often to the lower sections of the streams. This tendency is reflected in the higher percentage of fish moving 10 or more miles.

From a comparison with previous data (Shetter and Hazzard, 1942), it will be noted that, in general, the distribution pattern of the recovered fish was much the same for the present and earlier studies. The chief differences between the two were as follows: for brook trout and rainbow trout, a higher percentage of fish was captured within 3 miles of the point of release and a lower percentage was taken 3 to 10 miles from the planting spot in the more recent work than in the earlier investigation; for brown trout, the percentages of recovery at various distances from the planting point were similar in both experiments, except in the earlier work there were no records of fish recovered more than 10 miles from the area of release.

The information available on the relative merits of "spot" and "boat" planting suggests that neither method has any great advantage over the other when pre-season plantings are made either in the spring or fall. Therefore, according to our data on the movements of planted trout, the best method of stocking a stream with "keeper" trout would be to make

"spot" releases of moderate numbers of fish at approximately 3-mile intervals.

Results from plantings in trout lakes

The results from experimental plantings of adult hatchery-reared brook trout in the fall of 1940 and of 1941 in suitable lakes in general paralleled the findings of Shetter and Hazzard (1942) with regard to rainbow trout of legal size planted in lakes in the fall. A tabular summary of information for the lakes on which creel-census data (taken during the 1941 and 1942 trout season) are available is presented in Table 5. Information from six fall plantings indicate that in lakes where conditions are favorable for brook trout, anywhere from 13.9 per cent to 88.1 per cent will be recovered by the anglers (average survival, 56.7 per cent) in the season following the fall of release. Individual weights and lengths of fish caught and observations of the census takers showed that the fall-planted trout made considerable growth over winter and that they were generally in good condition.

Spring plantings of adult brook trout in lakes gave even higher percentages of recovery to the fishermen. Two releases of marked fish in the spring in East Fish Lake (Montmorency County) gave an average recovery of 68.5 per cent (57.4 per cent in 1941, 79.5 per cent in 1942) from plantings of 247 and 249 fish in 1941 and 1942, respectively. Comparable numbers of adult fish released in the falls of 1940 and 1941 were recovered by angling in the following seasons at rates of 13.9 and 53.5 per cent--or an average recovery on the fall plantings of 33.8 per cent.

The data obtained in previous years concerning the success of plantings

Table 5.—Recovery of legal-sized brook trout in Michigan lakes during the trout seasons of 1941 and 1942 from plantings made in the preceding fall.

Lake	Number planted	Number recovered	Percentage of recovery	Total marked trout captured opening day	Percentage of total recovery on opening day
South Twin Lake [1]	590	427	72.3	340	79.6
North Twin Lake [1]	456	402	88.1	368	91.5
Holland Lake [2]	200	136	68.0	129	...
Kimes Lake [3]	1,000	422	42.2	422	...
East Fish Lake 1941	243	34	13.9	32	94.1
East Fish Lake 1942	250	133	53.5	123	92.4

[1] To July 1 only. An unmarked midseason planting interfered with further calculations

[2] Creel census for first two days of 1942

[3] Creel census records for opening day only, 1942

of rainbow trout in lakes, and the results from plantings of brook trout in lakes discussed above, demonstrate that very high percentages of adult fish planted in trout lakes in the fall of the year are available to and are taken by anglers in the season following release. The one unfavorable result of such a planting program has been that from 80 to 94 per cent (average 89.4 per cent for the lakes under complete creel census) of the total trout catch for the whole season were taken on the opening day on lakes where adult brook trout were stocked in the fall of 1941. Results of a comparable nature were noted in lakes of the Pigeon River Forest which were stocked with legal-sized rainbow trout (unpublished data). As far as these small "made" trout lakes are concerned, a small percentage of the total anglers using the lakes takes the majority of the fish planted in them.

Findings of other investigators

At this point it is of interest to summarize the results published by authors who have investigated the problems connected with the stocking of legal and near-legal trout. Since the work of Cobb (1934) in Connecticut, a number of studies dealing with this pertinent problem have been carried out in widely scattered sections of the United States and reported in various publications. For the convenience of the reader, the salient information secured in these experiments is recorded in Table 6, in such a form that a comparison of results can be made with greater ease. The table includes the following items: author, publication date, state or area in which experiments were conducted, species of trout, size of fish, number of plantings, percentage of recovery from spring, fall, and open-season plantings, the type of mark used, and the method of recovery.

Table 6.— Percentages of recovery obtained by anglers from plantings of legal- and near-legal-sized trout in streams at various seasons of the year in various states.

Author and publication date	State or area	Species of trout experimented on	Number of plantings	Total length of fish (in inches where given)	Percentage of recovery by anglers of plantings			Type of mark used	Method of collecting data
					Spring	Fall	Open season		
Cobb, 1934	Connecticut	Brook Brown	Several	Legal	...	...	33	Belly-tag	Lottery
Hoover and Johnson, 1938	New Hampshire	Brook	1	Legal	...	...	76	Gill-cover tag	Creel census
Nesbit and Kitson, 1937	Massachusetts	Brown	4	8-9	9.1 11.7	3.1 2.3	...	Internal tag	Voluntary
		Rainbow	2	7 1/2-8	14.9	1.5	...	"	
Lord, 1936	Vermont	Rainbow	1	6-12	...	27.9	...	Fin-clip	"
Shetter and Hazzard, 1942	Michigan	Brook	18	7-13	[1] 25.5	[1] 4.4	[1] 25.4	Jaw-tag and Fin-clip	Creel census " " " "
		Brown	10	7-13	[1] 11.3	[1] 5.8	[1] 13.0		
		Rainbow	18	7-13	[1] 19.6	[1] 4.9	[1] 25.7		
Smith, Jr., 1941	Michigan	Brook	5	7-9	[1] 18.0	[1] 0.5	...	Jaw-tag	" "
Smith, Jr., 1944	Minnesota	Brook	4	7-10	26.2 19.6	2.4	5.0	Jaw-tag	" "
		Brown	5	7-10	28.0 8.6	21.7 1.4	9.6		
Schneberger and Williamson, 1943	Wisconsin	Brook	2	7-13	82.0	28.2	...	Fin-clip	Incomplete creel census
		Rainbow	2	7-15	30.5	48.4	...	Fin-clip	
Chamberlain, 1943	Pisgah National Forest	Brook	14	5-9	[1] 58.8	[1] 6.4	...	Fin-clip	Creel census
		Brown	6	5-9	[1] 15.6	[1] 14.3	...	Fin-clip	" "
		Rainbow	14	5-9	[1] 44.5	[1] 9.2	...	Fin-clip	" "
King, 1942	Great Smoky Mountain National Park	Brook	2	Legal	50	...	64.6	Fin-clip [4]	" "
		Rainbow	2	Legal	?	...	67.1	Fin-clip	" "
Gee, 1940	New Mexico	Rainbow	1	8	58.8	...	...	Tag	Creel census
Gee, 1942	New Mexico	Rainbow	6	6-9	[2] 28.2-72.0	2.2	...	Jaw-tag	" "
		Cutthroat	3	6-11	...	7.7	[1] 47.4	Jaw-tag	" "
		Wild cutthroat	2	6-9	[1] 42.6	...	...	Jaw-tag	" "
Trembley, 1944	Pennsylvania	Brook	2	Legal	55.8	47.0	...	Jaw-tag	" " [5]
		Brown	2	Legal	46.7	56.4	...	Jaw-tag	" " [5]
		Rainbow	2	Legal	60.0	46.4	...	Jaw-tag	" " [5]
Heacox, 1944	New York	Brown	10	Legal and sublegal	[2] 3.07-5.81	[2] 7.38-8.73	...	Fin-clip	Random creel census

[1] Average percentage of recovery from two or more experiments

[2] Range in percentage of recovery from several experiments

[3] Self-locking paper clip

[4] Spring planting marked by punching hole in caudal; mark unsatisfactory on rainbow trout

[5] Only marked fish recorded

Several investigators have conducted experiments involving the planting of marked trout of legal size during the open season. For brook trout, the experiments of Cobb (1934), Hoover,and Johnson (1937), Hazzard and Shetter (1939), and King (1942) demonstrated a very rapid rate of removal within 1 to 4 weeks. Percentages of recovery varied from 5.0 in Minnesota (Smith and Smith, 1944) to 76.0 in New Hampshire (Hoover and Johnson, 1938). The Minnesota figure is the only one below 25 per cent, and it is possible the low recovery on that particular group of summer-planted brook trout was the result of a severe flood shortly after the release.

Legal-sized brown trout were marked and released during the open season by Cobb (1934), Hazzard and Shetter (1942), and Smith and Smith (1944). Lower percentages of recovery (varying from 9.6 to 33.0 per cent) than with brook trout and rainbow trout were recorded for such plantings. The above-mentioned authors all noted that the hatchery-reared brown trout were not removed by angling as rapidly as were brook trout or rainbow trout.

Legal sized rainbow trout planted during the course of the angling season appear to have an excellent chance of recovery by anglers. Percentages of recovery in Michigan, Tennessee, and New Mexico (in the latter state on the native Rio Grande cutthroat trout, Salmo clarkii spilurus) ran from 25.7 to 67.1 (Shetter and Hazzard, 1942; Gee, 1940 and 1942; King, 1942). Hatchery rainbow trout usually entered the catch in fair numbers up to 8 weeks after release, except in Gee's experiments in the Southwest, where the majority of the marked hatchery fish recaptured often were taken out within 3 weeks.

The results of experiments by various individuals concerning the comparative efficiency of fall and spring plantings of brook trout in streams can be summarized as follows. Six investigators in five different states (see Table 6) found spring planting of legal-sized brook trout to be superior

to fall planting by margins varying from about 20 to 2,000 per cent. In Spring Creek, Pennsylvania, Trembley (1944) determined that percentages of recovery from fall plantings compared favorably with those obtained from spring planting, and inferred that winter conditions were extremely favorable in that particular stream because of the large amount of spring water present. It should be pointed out, however, that a measurably greater percentage of spring-planted brook trout were taken than of fall-planted brook trout even in Trembley's study.

The stocking of legal-sized rainbow trout in streams in the spring has, according to most records, proven to be a far sounder management procedure than fall stocking of this particular species. In Massachusetts, New Mexico, North Carolina, and Michigan, recoveries of marked fish from spring plantings outnumbered recoveries from fall plantings by a ratio of from 5 to 36 to 1. Only in Wisconsin and Pennsylvania were the results radically different. Schneberger and Williamson (1943) obtained recoveries of 30.5 per cent on a spring planting and 48.4 per cent on a fall planting of rainbow trout on the Deerskin River in Wisconsin. They remarked, however, that numerous survivors from the fall stocking were in poor condition and were left at the streamside by the anglers. Trembley (1944) recorded a recovery of 60.0 per cent for spring-planted, legal-sized rainbow trout as against a 46.4 per cent recovery for the fall-planted fish from Spring Creek, Pennsylvania,—an excellent recovery for the fall planting, yet still about one-fourth less than for those released in the spring of the year. Lord (1936) reported a recovery of 27.9 per cent from a fall planting of rainbow trout in a Vermont stream, but gave no comparable date for spring planting.

As will be noted from an inspection of Table 6, the results from the plantings of legal-sized brown trout in the spring and fall are somewhat at variance with those for other species. In Massachusetts, Nesbit and Kitson (1937) found that fall plantings of this species were inferior to spring plantings by a ratio of about 3:1. In Michigan the comparison was found to be 2:1 in favor of spring planting in one set of experiments, and 1.4:1 in another. Chamberlain (1943), in his extensive work on all species on the Pisgah National Forest found the ratio to be about 1:1 for spring and fall plantings of legal brown trout. Trembley (1944) secured the best results, as far as fall planting is concerned, from legal brown trout in Spring Creek in Pennsylvania. Here the ratio of recoveries of fall-planted fish to those of spring-planted fish in the anglers' catch was found to be slightly more than 1.2 to 1.

In one stream (Knife River) in the Lake Superior drainage of Minnesota, Smith and Smith (1944) found fall plantings of tagged adult brown trout were recovered at a rate of 1.4 per cent, while marked fish planted in the spring were recaptured at a rate of 8.6 per cent. In a southeastern Minnesota stream (Duschee Creek) tagged brown trout released in the fall were recovered in the following season at the rate of 21.7 per cent, and spring plantings of similar numbers of tagged brown trout were recaptured at the rate of 28.0 per cent. The authors ascribed the excellent showing of the fall planting in Duschee Creek to an abundant supply of spring water which kept the stream open during most of the winter (cf. Trembley, 1944).

From marking experiments on brown trout conducted in connection with a random creel census on the East Koy and Wiscoy Creeks in New York,

Heacox (1944) reported the following results: for fall planting, a recovery of 7.35 to 8.73 per cent; for spring planting, a recovery of 1.19 to 5.81 per cent. Heacox also mentioned that in both seasons in which the creel census was conducted that the most recently planted fish were not the first to be removed by angling.

It should be mentioned that not all of the experiments summarized in Table 6 have been conducted in a similar manner. The reader who studies the various reports listed will note that in certain of the experiments more fish were planted in the spring, or more in the fall, or that the fish planted at one season were of a much greater average size than those planted at another season. Differences in size frequently can be attributed to the fact that fish of the same stock will be slightly larger in the spring of the year than during the preceding fall. It is the author's belief, however, that equal numbers of fish of approximately the same size planted at the various seasons will give the most reliable comparison of recovery percentages. It has been noted for example (Hazzard and Shetter, 1941; Gee, 1942) that smaller plantings often will yield higher percentages of recovery to the anglers than will larger plantings. It is not impossible that the size of the planting influenced the results of Trembley in Pennsylvania and of Heacox in New York where unequal numbers of fish were stocked in the spring and fall. In the New York experiments from two to four times as many marked fish were released in the spring as in the fall, while in Pennsylvania considerably more marked fish were planted in the fall than in the spring.

The work of Kelez (1937), although conducted on coho salmon fingerlings, suggests that size at time of release may be an important factor in the survival to maturity. He released two lots of marked coho fingerlings

from the same hatch. One lot measured 1 7/8 inches (average length) in May 1934; the other averaged 4 inches in November 1934. The proportion of large fish to small fish later recovered as adults was 65 to 1. Since the trouts and salmons are closely related, it is not unreasonable to hold that percentages of recovery might be affected by a great variation in average size between a group of trout planted in the fall and another group released in the spring.

Another factor that may affect the validity of the comparison of results recorded by different workers has been the variation in the legal size for trout in the states where the experiments were conducted. According to a summary published by Outdoor Life in April 1938, two of the states (California, Minnesota) had no legal length; seven states (New Mexico, North Carolina, Pennsylvania, Connecticut, Massachusetts, New Hampshire, and Vermont) had a 6-inch size limit, while five states (Michigan, Wisconsin, New York, Tennessee, and Arizona) required anglers to release trout under 7 inches. In north Carolina, rainbow trout and brown trout were protected up to a size of 8 inches, but brook trout were legal at 6 inches. Some variation in percentages of recovery might be expected between trout planted at sizes of 6, 7, and 8 inches.

Although comparatively poor results (in terms of fish later creeled by the angler) have been noted from fall plantings in streams, good to excellent percentages of survival have been recorded when legal-sized trout have been released in lakes where conditions are favorable for their establishment. Table 7 presents a brief summary of results obtained by seven investigators in four different localities. Very good recoveries of (27.0 to 56.7 per cent) have been observed for adult brook trout and

Table 7.—Percentages of recovery obtained by anglers from plantings of legal- and near-legal-sized trout in lakes and ponds at various seasons of the year in various localities.

Author and publication date	State	Species of trout in experiment	Number of plantings	Total length of fish (inches)	Percentage of recovery by anglers of plantings			Type of mark	Method of collecting data
					Spring	Fall	Open season		
Nesbit and Kitson, 1937	Massachusetts	Brown	2	9.0, 8.3	2.2	1.1	...	Belly tag	Voluntary
		Rainbow	2	7.8, 8.0	9.2	4.3	...	Belly tag	
Shetter and Hazzard, 1941	Michigan	Rainbow	6	7-14	...	[1] 27.0	[1] 48.0	Tag and fin-clip	Creel census and voluntary
Shetter, present study	Michigan	Brook	8	7-10	[1][5] 68.5	[1] 56.7	...	Tag and fin-clip	Partial and complete creel census
Needham, 1937	California	Rainbow	1	5.7	...	...	17.3	Fin-clip	Creel census
Needham and Sumner, 1942	California	Brook	1	5.5	...	...	22.7	Fin-clip	Creel census
Vestal, 1943	California	Rainbow	4	4.6	...	...	[2][3] 18.2-52.6	Fin-clip	Incomplete creel census
Keil, 1938	New York	Rainbow and Ouananiche [4]	5	8-10	...	[1] 50.0	...	Not marked	Creel census

[1] Average percentage of recovery from several experiments.

[2] Range in percentages of recovery from several experiments.

[3] Estimated from a sample of the catch taken at one boat landing on June Lake.

[4] Salmo salar sebago

[5] Data from Institute For Fisheries Research Report #848 (unpublished).

rainbow trout planted in lakes in the fall of the year. It was noted in East Fish Lake in Michigan that the survival to the creel was higher for spring-planted brook trout than for fall-planted fish — even though the survival of the fall-planted fish was good. Whether or not spring plantings would give yields any higher than those listed for certain of the fall plantings in Table 7 will have to be determined by further experimentation. If the cost of carrying such fish in hatchery ponds over the winter is excessive, then the lakes should be stocked in the fall.

In the only experiment which involved the release of brown trout in ponds, Nesbit and Kitson (1937) found that spring releases yielded twice as many fish to the angler as fall plantings.

The release of brook trout and rainbow trout in lakes during the open season in Michigan and California gave yields varying from 17.3 to 52.6 per cent of the number planted.

Possible causes of mortality among fall-planted adult trout in streams

The higher survival to the creel of spring and open-season plantings of legal-sized fish released in streams has not been determined nor explained by any worker, as yet. Some possible contributing factors are discussed in the following paragraphs.

The variation in results obtained from plantings in lakes and streams suggests that the environment in winter is not as favorable for trout in streams as in lakes. From this one might infer that if streams contained more deep, quiet pools (approaching lake conditions), survival of fall plantings to the following spring would be better.

So far as is known, cannibalism is not an important factor in the

survival of legal-sized trout. Although many of the lakes contained some large trout when the experimental plantings were made, the percentage of survival of fall plantings in lakes has been much higher than in streams.

Trout resident in streams probably are subject to a larger amount of predation by birds and mammals in winter than are those which live in lakes, since most lakes are deeper and will freeze over. In severe winters, stream-inhabiting mergansers are known to account for a part of the over-winter losses, and in some localities mink and otter may cause some loss.

Competition for available food and space apparently is an important factor in determining the success of a fall planting. In Michigan, creel censuses indicate that the majority of streams studied to date have moderately large populations of naturally spawned trout, as proved by the relatively low percentage of the total catch made up of marked hatchery fish. In these same streams, recovery percentages on fall plantings of trout have been low (Shetter and Hazzard, 1941). In certain streams of New York (Heacox, 1944), Pennsylvania (Trembley, 1944), and North Carolina (Chamberlain, 1943) creel census or other reports indicate that the native trout populations are small, since 80 or more per cent of the total catch has been observed to consist of marked hatchery-reared trout. These same streams are among those reported to furnish a good survival of fall-planted fish. The lack of competition from naturally reared fish may be the explanation for the much better survival of fall plantings in such localities.

The effect of floods caused by cloudbursts or sudden spring thaws should be given more consideration as a factor in the reduction of the number of catchable trout. That a flood caused by a cloudburst can eliminate entirely a fall planting of brook trout has been recorded by

Chamberlain (1943). Further evidence on the severe effect of floods was given by Smith and Smith (1944). The percentages of recovery on open-season plantings of tagged brook trout and brown trout in Duschee Creek, Minnesota, were 5.0 and 9.6 respectively. The authors stated that the plantings were followed by a heavy flood. The unsuitable conditions brought about as a result of the high water probably accounted for the comparatively low percentages of recovery from this open-season planting. Fall plantings would be more likely to be affected by floods than other plantings because of the relationship between the time of release, the usual time of flood, and the opening of the fishing season. It is not impossible that many trout from releases made at any season are lost when flash floods occur and carry fish from good trout habitats into the lower reaches of streams where temperature or other conditions are not suitable, or where a large population of predacious fish resides.

In all probability, all the factors just mentioned contribute to the decimation of an autumn release. The net result is usually a comparatively small number of legal fish remaining for the angler. The spring and open-season plantings have been more successful probably because there was less time for natural catastrophes to operate on the fish before they were subjected to angling.

Conclusions

From an analysis of the results of marking experiments conducted in Michigan and in numerous other localities throughout the United States to determine the proper season at which to release trout of legal size, the following conclusions appear to be warranted:

1. In the planting of brook trout and rainbow trout, 6 inches or more long, in streams significantly larger percentages of survival to

the creel have been noted in the majority of experiments for spring and open-season plantings. Where fall plantings of these species have shown returns almost as good as spring plantings (Pennsylvania), the investigator ascribed the better-than-average survival of the fall plantings to an abundant supply of spring water which ameliorated normal winter conditions in the streams in question.

2. It is suggested by the experiments involving brown trout of legal size, both in Michigan and elsewhere, that this species, when planted in streams, seems to survive winter conditions better than do brook trout and rainbow trout. In some localities fall plantings of brown trout apparently yield as many or more fish to the angler as spring plantings of similar numbers of fish. The localities where fall plantings gave as good or better results than spring releases, had either an excellent spring-water supply (Spring Creek, Pennsylvania; Duschee Creek, Minnesota) or a very low population of native trout (East Koy and Wiscoy Creeks, New York; South Mills Creek, North Carolina). In the Michigan experiments with brown trout, from 1 1/2 to 2 spring-planted fish were recovered for every fall-planted fish. It is of interest to note that the percentages of recovery of plantings of brown trout at any season were the lowest for any of the three species.

3. The carry-over to subsequent seasons following the first season of availability (although always small) was noted to be the greater for spring-planted fish in Michigan, Pennsylvania, and New York, despite the variance in results during the first season of availability. The fact that fall plantings showed the higher percentage of carry-over past the first season of availability in Chamberlain's experiments in North Carolina possibly was a result of the former Forest Service policy of closing

several of the experimental streams for 1 or 2 years in every 5.

4. As far as can be determined from the data at hand, neither "spot" not "boat" planting has demonstrated any great superiority over the other in releases made in the fall or in the spring before the season opens. The relative merits of the two methods should be tested on plantings of "keeper" trout in streams during the open season.

5. In Michigan trout streams, the 1942 data indicated that 85 per cent or more of the planted trout that were recaptured were taken within 10 miles of the locality of release, and that from 45 to 90 per cent were taken within 3 miles of the point of release. Brook trout planted either in the spring or the fall had a slight tendency to move downstream from 3 to 10 miles. A greater percentage of rainbow trout tended to move over 10 miles in a downstream direction. Brown trout were the least migratory of any of the fish during the 1942 work.

6. Results from creel censuses and marking experiments on lakes suitable for trout in Michigan and elsewhere have proven that from 13 to 88 per cent of fall-planted brook trout and rainbow trout will be removed by angling in following seasons, a much better return to the angler than has been found for fall plantings in streams. The worst feature of such a management program, at least in Michigan, is that an average of about 90 per cent of the season's catch on these trout lakes is removed during the first 2 weeks of the open season by a very small percentage of the total number of anglers who use the lake. This situation requires correction, either by lowering the creel limit on such waters, or by special regulations, or other means.

7. The following possible explanations were advanced for the failure

of fall plantings in streams to furnish good fishing in following seasons:

a. Lack of suitable habitat in streams in winter,

b. Predation by birds and mammals,

c. Competition between fall-planted trout and native trout for food and space,

d. Losses of unknown magnitude caused by floods.

8. It would appear that the proper time to plant legal-sized trout has, in general, been demonstrated adequately to be in the spring or during the open season. The studies of various workers have proven too, that better returns to the angler come from releases of adult fish rather than fry or fingerlings. If it is assumed that planting legal-sized trout is a justifiable procedure, the questions to be answered in the future, if we are to utilize these legal trout to the highest degree are as follows:

a. Which streams and lakes are to be planted, and with what species?

b. What is the fishing pressure?

c. What is the approximate population of wild trout?

The first question has been, and is being answered by lake and stream surveys in a number of states.

The second question can be answered only by accurate creel-census studies, which are (or were before the war) pursued with vigor in numerous states and areas. A sampling technique is needed which is reasonably accurate, yet which is inexpensive in comparison with the intensive or "complete" type of creel census. It will be financially impossible to cover the major trout streams of any of the larger states by the present intensive creel-census methods. Some method of measuring angling pressure and total catch must be devised, however, if the danger

of overstocking is to be avoided. The studies of Chamberlain (1943) on the Pisgah National Forest furnish an excellent example of how easily the carrying capacity of a stream may be misjudged.

The third question is a challenge to the field investigators. Some progress has been made in recent years through the development of the electric "shocker" (Haskell, 1941) for use in studying populations of trout streams. The method of conducting population studies in lakes by netting and fin-clipping (Schnabel, 1938) is laborious and time-consuming. More rapid and accurate field techniques must be developed for both types of research.

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