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RESEARCH  
REPORT 54

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A COMPENDIUM OF RESEARCH ON  
ANGLING REGULATIONS FOR BROOK TROUT  
CONDUCTED AT LAWRENCE CREEK, WISCONSIN



Department

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Resources

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## ABSTRACT

The major findings, conclusions and management implications derived during 13 years of testing and evaluating experimental angling regulations applied to the fishery for wild brook trout (Salvelinus fontinalis) in Lawrence Creek are presented. Four general types of regulations were tested: size limits, bag limits, fish refuges and restrictions on fishing methods.

The size limit, if wisely applied, is the best single regulation for preventing excessive angler harvest of brook trout populations. A good "rule of thumb" is a size limit set at the length attained by 30% of the trout population in May, or 40% in June, or 50% in September (excluding age 0). This is 7 inches for the population in Lawrence Creek.

Bag limits provide no protection until the limit is reached, and since most of the catch of wild brook trout consists of 1 or 2 trout/trip, very restrictive bag limits would be needed to substantially reduce the catch. Angling effort appeared to be influenced by restrictions on the catch.

Angling regulations that allow some harvest or fishing opportunity every year from all fishable trout waters are clearly preferable to elimination of all fishing through creation of fish refuges.

Fishermen were attracted by "fly fishing only" regulations, and enjoyed high quality fishing, but there was little difference in other aspects of the fisheries in the flies-only zone versus the any-lure zone, and no detectable responses by the trout populations due to the flies-only restriction.

## ACKNOWLEDGMENTS

During the 13 years of conducting the trout research project at Lawrence Creek, many employees of the Wisconsin Department of Natural Resources contributed their skills and energies to the project. I acknowledge and thank them for their various contributions.

Special credit is due to James McFadden, the first project leader, who developed a solid foundation for subsequent research and reported many of the basic findings in his classic 1961 monograph, "A population study of the brook trout, Salvelinus fontinalis". John Brasch was mainly responsible for initiating the research project and for administering it during the first 3 years. Lyle Christenson continued this task during the last 10 years. Mr. Christenson and my fellow biologists then in the Cold Water Group, Oscar Brynildson, Ray White, and John Mason, also deserve special recognition for their professional advice and assistance in field work, data interpretations, and report preparations and revisions. Clarence Todd served capably and faithfully as project technician throughout the study. I also acknowledge the thousands of cooperative anglers who made their vital contributions to this project. Mrs. Elaine Sellin typed the various rough drafts and tables of this report.

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## INTRODUCTION

This report summarizes the major findings, conclusions and management implications derived during 13 years of testing and evaluating experimental angling regulations applied to the fishery for wild brook trout (Salvelinus fontinalis) in Lawrence Creek. Much of this information has been previously published (McFadden, 1956 and 1961; Hunt, Brynildson and McFadden, 1962; Hunt and Brynildson, 1964; and Hunt, 1964, 1966). The intent of this report is to consolidate the most useful information in these several papers, and to augment it with previously unpublished findings derived during the last 4 years of the study.

The contents is organized mainly under major headings descriptive of the 4 general types of fishing regulations tested: size limits, bag limits, restrictions on fishing methods, and fish refuges (prohibition of any fishing). Most of the supporting data are included in the Appendix rather than the body of the report, and information has also been drawn from the published reports cited above.

Lawrence Creek and our methods of investigation there have been described in the papers cited above and by White (1967) and Hunt (1969). In brief, the stream is 3.3 miles long, has an average width of 23 feet and a surface area of approximately 10 acres. It supports a dense population of wild brook trout and has a reputation for good fishing. Stream flow is quite stable within the year and from year to year. The water is moderately hard (total alkalinity approximately 160 ppm). Gradient is less than 10 feet/mile, and the bottom type is predominantly sand with the two major spawning areas concentrated in short stretches of the upper two study sections. Lawrence Creek is located centrally in Wisconsin but at the southern end of the present distribution of brook trout streams in the state. The growth rate of brook trout in Lawrence Creek probably exceeds the average for the state because of its southerly location and relatively fertile environment.

The stream was divided into 4 study sections (A-D) with no barriers between sections to prevent free movement of trout.

The two most important methods employed were precise estimates of the trout population with electrofishing gear before and after each fishing season and a compulsory, registration-type, creel census of all anglers. Each year age 0 brook trout captured during the electrofishing inventories were permanently marked with fin-clips. Within 3 years approximately 75% of the population consisted of known-age individuals, and thereafter the necessity to collect scale samples for aging was largely eliminated. Anglers obtained free daily permits at the creel census station near the stream. They could choose any section of stream open to fishing, but permits were issued for only one section/trip. All catches were presented to the census clerks for examination when the daily permits were returned.

Each year the opening and closing dates of the fishing season at Lawrence Creek coincided with the statewide dates, but at Lawrence Creek fishing was permitted only from 6:00 a.m. to 10:00 p.m. to facilitate operation of the census station. The various regulations tested and the years in which they were in effect were as follows:

- 1955:           6-inch size limit  
                daily bag of 10
  
- 1956-57:       no size limit  
                no bag limit  
                no fishing in section A
  
- 1958-60:       9-inch size limit  
                daily bag of 5  
                no fishing in section A
  
- 1961-67:       8-inch size limit  
                daily bag of 5  
                fly-fishing-only in sections C and D

Sport fishing for wild brook trout, the backbone of the trout fishery in Wisconsin, will not be maintained without an integrated and flexible management plan aimed at protecting both the environment and the trout populations. Our research at Lawrence Creek demonstrated that even a dense population of wild brook trout can be overharvested by sport fishing at levels of fishing effort that already exist in Wisconsin. Unfortunately, in the predator-prey relationship that exists between fishermen and brook trout there appear to be no natural controls effective enough to prevent such overharvest. In fact, the kind of mortality that angling inflicts upon brook trout populations is inversely density dependent. At any given level of angling effort, the rate of angling mortality increases as the density of the trout population decreases. Or, to put it another way, depletion of a sparse population requires proportionately less fishing effort than is required to deplete a dense population. Therefore, until such time as anglers voluntarily restrict their harvest to safe levels, it is essential that laws, in the form of angling regulations, be imposed to prevent overfishing. Such angling regulations might also be used to perpetuate and encourage the cultural qualities of sportsmanship traditionally associated with trout fishing, but their most basic prerequisite is the biological necessity of protecting an adequate number of spawners.

All of the commonly applied angling regulations tend to reduce the number of trout harvested, but the mere presence of fishing restrictions on the books does not assure they are doing the job intended. Excessive harvests occurred at Lawrence Creek two seasons and almost occurred another season even though there were regulations on the length of the fishing season, fishing methods and daily fishing hours, and on the size and number of fish that could be kept

during one of the 3 seasons. However, our research at Lawrence Creek also provided some useful facts for improving the application of trout fishing regulations to prevent overfishing, and as more information is obtained on the total trout resource of the state, these facts should become increasingly applicable.

### SIZE LIMITS

As Allen and Cunningham (1957) stated in their discussion of trout fishing regulations in New Zealand, the direct effect of size limits is to cause anglers to return to the water trout that they might keep if it were legal to do so. Presumably, enough of these released undersized trout will survive long enough to contribute to the fishery by being caught later at a larger size or by adding to subsequent generations by spawning.

Three size limits were tested at Lawrence Creek (6, 8 and 9 inches) and during 2 successive seasons there was no minimum size limit. The 6-inch limit was the first one tested because it was the normal state-wide size limit. Our evaluation of this size limit provided a baseline for later reference to results obtained from testing other size limits that applied only at Lawrence Creek.

#### Summary of Significant Findings

(1) During the 2 seasons (1956-57) when there was no size limit in effect, few anglers kept trout less than 6 inches long. Consequently, the size distribution of the catch these 2 seasons was similar to that recorded when a 6-inch limit was in effect in 1955 (Fig. 1).

(2) During seasons when size limits of 8 or 9 inches were in effect, only 25% of the trout creeled were an inch or more larger than the prevailing size limit (Fig. 2).

(3) No age 0 (young-of-the-year) brook trout were harvested, even during the 2 seasons when no size limit applied (Table 1).

(4) Because most of the age I+ trout, which constituted the harvested portion of the population, were included in the size range from 6 to 10 inches, a change in the size limit of an inch or two greatly increased or decreased the percentage of trout that were legal-sized. For example, when the 1967 fishing season began, approximately 44% of the trout population consisted of 6- to 10-inch fish, and only 2% of the trout exceeded 10 inches. If the size limit had been set at 6, 7, 8 or 9 inches, the proportion of legal-sized trout would have been 46%, 30%, 16% or 5%, respectively.

(5) When the 6-inch limit prevailed, at least 1 legal trout was creeled on 47% of the angling trips (Table 2). When the size limit was increased to 8 inches, only 34% of the angling trips were "successful", and the proportion of successful trips dropped to 17%

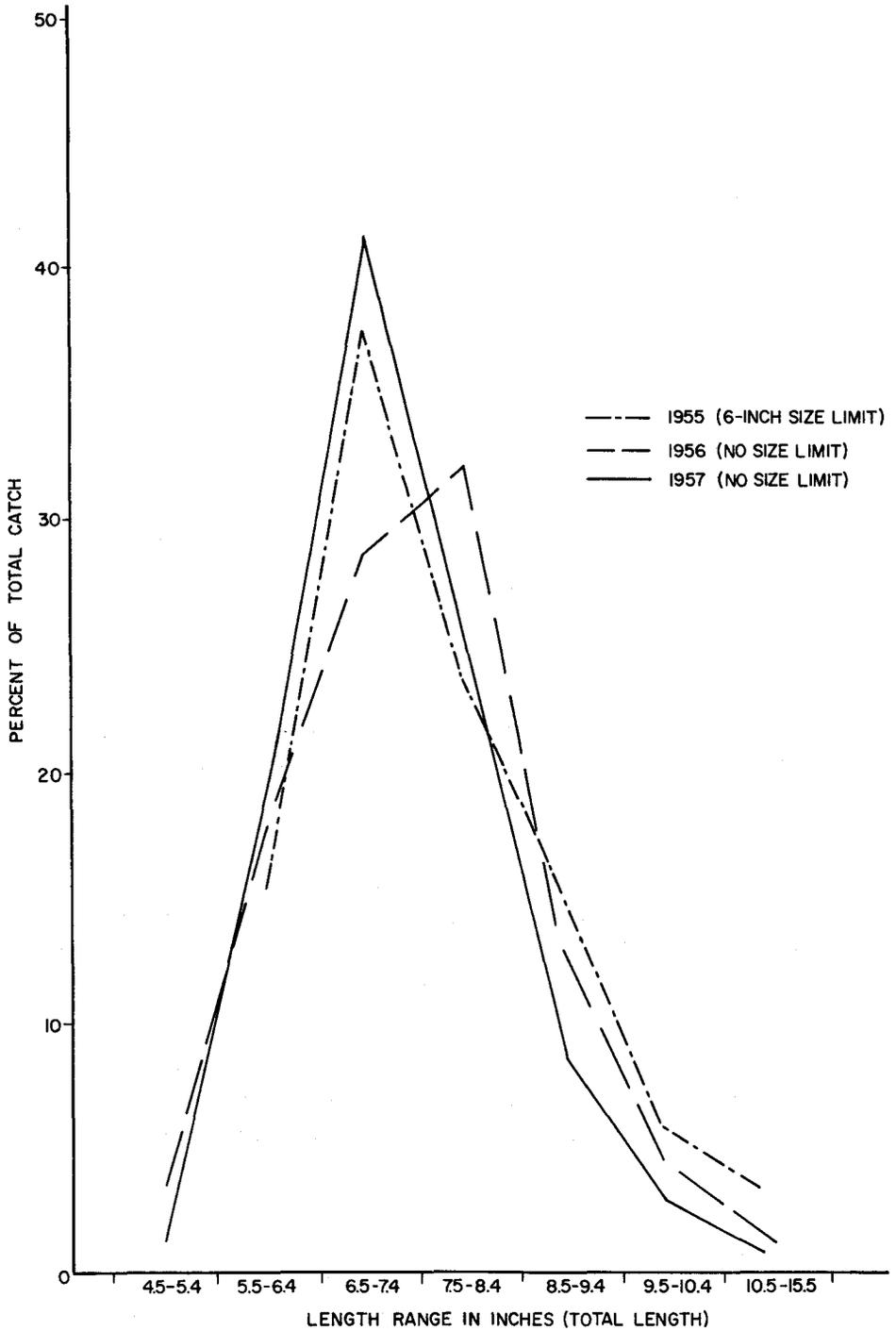


FIGURE 1. Length frequency distributions of the catches of brook trout during the 1955-57 fishing seasons at Lawrence Creek.

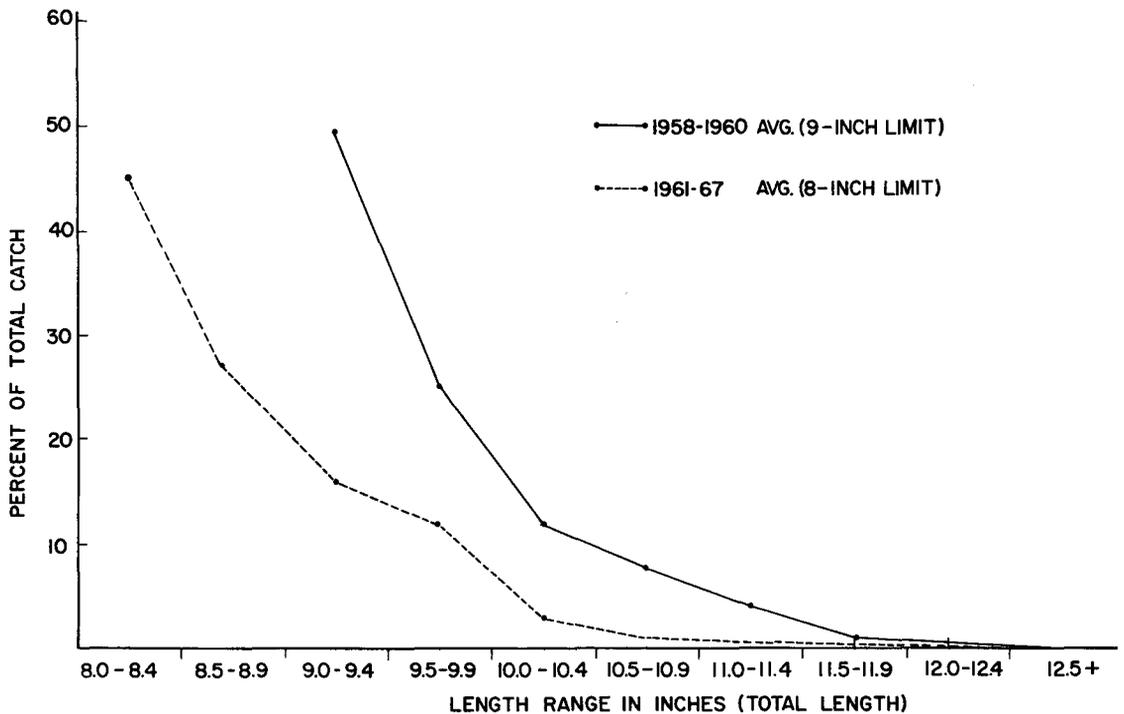


FIGURE 2. Length frequency distributions of the catches of brook trout during the 1958-60 and 1961-67 fishing seasons at Lawrence Creek.

when the size limit was increased only 1 more inch (to 9 inches). When there was no size limit, the proportion of successful trips was similar to that recorded when the 6-inch limit applied. Catch/hour under the 6, 8, and 9-inch limits averaged 0.69, 0.34, and 0.13, respectively.

(6) During the two seasons (1956-57) when there was no size limit, the number of trout harvested represented 59% and 65% of the preseason population (Table 3). These rates of exploitation greatly exceeded the long-term equilibrium level that this brook trout population could sustain.

(7) During the seasons when there was an 8-inch limit, exploitation ranged from 6% to 12% and averaged 9%. When the 9-inch limit prevailed, exploitation was only 1% to 8%/season and averaged 4% (Table 3).

## Conclusions and Management Implications

(1) The size limit, if wisely applied, is the best single regulation for preventing excessive angler harvest of brook trout populations. The size limit applies to every trout caught, and it can be related to a rather stable biological parameter, growth rates of the trout populations.

(2) The present statewide size limit of 6 inches is too low for brook trout populations exhibiting growth rates similar to that of the Lawrence Creek population. Although the angler harvest was not excessive in Lawrence Creek for the season when a 6-inch limit was tested, excessive harvest could have occurred if more anglers had fished or if the trout population that year had not been as large as it was. Since few anglers chose to keep brook trout less than 6 inches long, the 6-inch limit was only a little better than no size limit at all.

(3) A "rule of thumb" that provides an approximation of a good size limit for brook trout is this: The size limit should be set at the length attained by 30% of the trout population in May, or 40% in June, or 50% in September (excluding age 0). For the brook trout population in Lawrence Creek, a 7-inch limit would be dictated by this rule of selection. However, before biologically sound regional size limits can be applied in Wisconsin, it will be necessary to substantially augment existing information on growth rates of brook trout populations. A concerted effort should be made soon to obtain such information from a statewide representation of streams.

### BAG LIMITS

In theory, daily bag limits set arbitrary upper limits on the catches of individual anglers regardless of their skill or angling effort. Presumably by limiting the catches of individuals, a cumulative effect of limiting the total harvest is also realized and more trout will survive to spawn or be caught at larger sizes than would be true if no bag limits existed.

Bag limits have also been proposed for such nonbiological reasons as distributing the total catch more evenly among anglers, as arbitrary goals for the anglers to attain ("I got my limit!"), and as a means to prevent fish-hogging and waste by encouraging anglers to fish for sport not numbers of fish.

At Lawrence Creek, bag limits of 5 to 10 per day were tested, and during two seasons (1956-57) there was no bag limit. These were the two seasons when there was also no minimum size limit. Consequently, anglers could keep all the trout they caught if they desired. The daily limit of 10, in effect in 1955, represented the normal statewide bag limit for trout.

## Summary of Significant Findings

(1) A bag of 10 trout was attained on only 50 (3%) of the angling trips in 1955, the season when this bag limit applied (Table 4).

(2) When there was no bag limit, 10 or more trout were creeled on 4% of the angling trips. Catches in excess of 10/trip increased the seasonal harvest by 5% in 1956 and 11% in 1957 (Table 4).

(3) Within the ranges of angling pressure and trout density observed at Lawrence Creek, theoretical reductions in the bag limit appeared to provide about the same proportional protection for sparse trout populations as for dense ones (Fig. 3). This type of relationship is not biologically desirable. Ideally, a bag limit regulation should provide proportionately more protection as the number of trout decreases.

(4) The daily bag of 5/day was tested in conjunction with rather high size limits (8 and 9 inches) for brook trout. Limit catches of trout over 9 inches were made on less than 1% of the angling trips and catches of 5 trout over 8 inches long were made on only 6% of the angling trips (Table 4).

(5) During all seasons and regardless of the bag limit allowed, most of the harvest was accounted for by catches of 1-3 trout/trip (Table 4).

(6) During all seasons and regardless of the liberality of the bag and size limits, more than 50% of the anglers failed to catch a single wild brook trout (Table 4).

(7) During all seasons most of the limit catches were taken by a few skillful anglers who fished several times each season at Lawrence Creek. Their catches/hour of effort were usually several times greater than those recorded by anglers who caught only 1 or 2 trout/trip. The difference between anglers who consistently caught several trout/trip and those who caught few or no trout/trip, was largely one of angling skill, not persistence, and angling skill became an increasingly important factor as the fishing regulations were made more restrictive (Table 5).

(8) Among the skillful anglers, the effect of a bag limit which they could reasonably attain may have been a stimulus to keep fishing until the limit was reached (Hobbs, 1948). More limit catches of 5 or 10 were made than catches of 1 or 2 less than the allowable limit (Table 4).

## Conclusions and Management Implications

Bag limits provide no protection until the limit is reached. In contrast to the size limit, the bag limit does not apply to every trout caught. Since most of the catch of wild brook trout is probably accounted for by anglers creeling 1 or 2 trout/trip, very

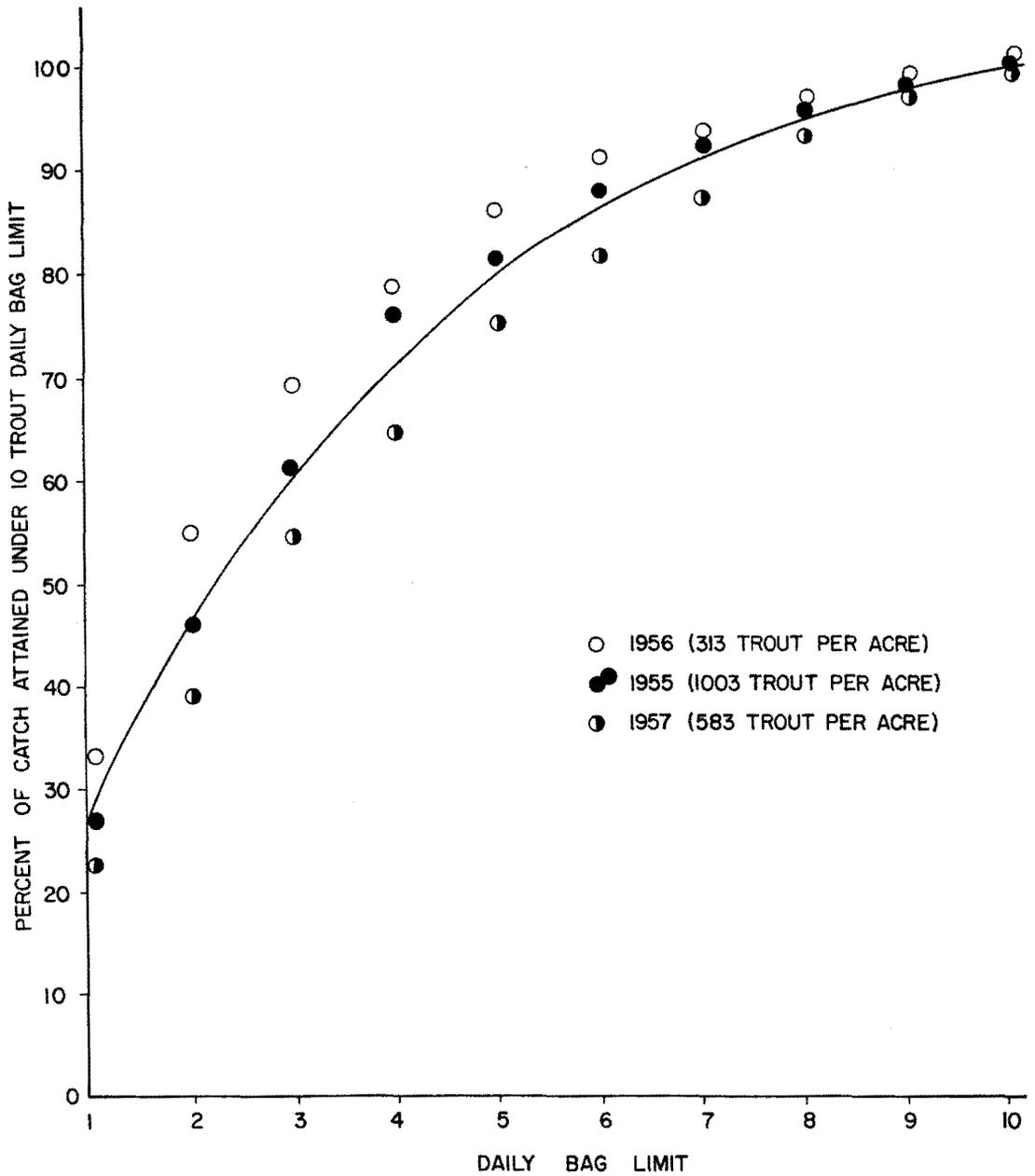


FIGURE 3. Theoretical effect of daily bag limits of less than 10 in reducing the catches of brook trout made during the 1955-57 fishing seasons at Lawrence Creek. Preseason trout population densities are listed in the legend.

restrictive bag limits would be needed to effect substantial reductions in the catch, and especially where bag limits are applied to broad geographical regions (statewide). For example, if angling effort remained unchanged, cutting the bag limit from 10 to 5 would probably reduce the total catch by only 20%, not 50%.

The experiments at Lawrence Creek were not designed to evaluate the psychological reactions of anglers to various bag limits, but circumstantial evidence suggested that angling effort was influenced by the restrictiveness of the bag limit. Even though few anglers were able to catch a limit of 10 trout, the opportunity to catch only 5 rather than 10/trip may have caused part of the decline in fishing pressure that occurred after the bag limit of 5 was adopted. If this hypothesis is valid, application of bag limits that differ over the course of a season, or that differ regionally within the state should be tested as a means to control one of the most important factors determining the size of the harvest -- the number of anglers fishing a given stream or region of streams.

### FISH REFUGES

Fish refuges have been proposed as a means to insure the survival of some spawning trout which, hopefully, will produce a surplus of progeny that will immigrate to the adjacent fishing water and bolster the depleted fish population there. During a 5-year period (1956-1960), the upper mile of Lawrence Creek was designated a fish refuge and an intensive effort was made to mark trout in this refuge zone and in the zone of fishing water below. All trout creel were examined for markings, and information on the movement of trout into and out of the refuge was also obtained during each electrofishing census of the trout population. Information to evaluate the success of the refuge experiment was also available from the creel census the year prior to establishment of the refuge.

#### Summary of Significant Findings

- (1) The brook trout population in the refuge increased substantially during the first 2 years of the experiment, but then it declined during the last 3 years to a level comparable to that present when the refuge was established (Fig. 4).
- (2) Twice as many catchable-sized trout moved into the refuge as moved out (2,789 vs. 1,122). More young-of-the-year moved out than moved in, but the emigrants from the refuge increased the total number of trout in the fishing water by only 5% or less.
- (3) The buildup and decline of the trout population in the refuge was largely due to changes in the survival rates of the resident population, not to gains or losses of trout into or out of the refuge (Table 6).

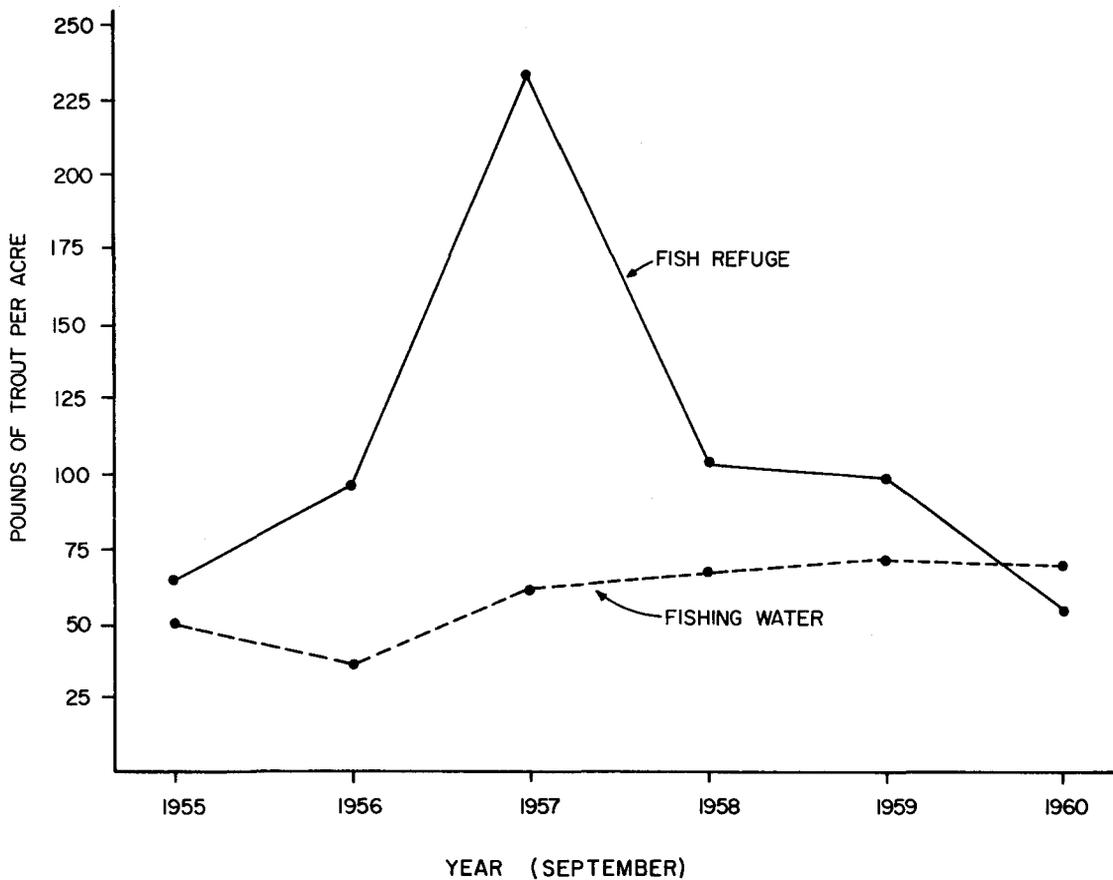


FIGURE 4. Standing crops of brook trout in the fish refuge of Lawrence Creek compared to those in the fishing water.

(4) Only 1% of the catch (45 of 4,695) consisted of trout that had emigrated from the refuge. During the fishing season when the refuge zone had been open to fishing, 21% of the total catch was made there. Most of the trout born in the refuge stayed there throughout their life.

Conclusions and Management Implications

As a means of providing better trout fishing, the mile-long head-water refuge was a failure. Many trout that could have been harvested or fished over were lost to natural mortality because they did not leave the refuge. The experiment did show that angling had been a critical factor limiting the density of the trout population in the refuge zone. However, despite the stockpiling response to elimination of all angling mortality, large-scale emigration did not occur.

Angling regulations that allow some harvest or fishing opportunity every year from all fishable trout waters are clearly preferable to elimination of all fishing through creation of fish refuges.

The possible use of fish refuges for periods of a year or 2 has not been explored in Wisconsin. In such instances, however, the emphasis would not be on "seeding" the adjacent fishing water but maximizing the opportunity of the resident trout population to take advantage of the growth potential of the state's more productive streams. This technique would probably have a rather restricted use, but it appears to be a procedure worth trying as a means of producing high quality fisheries and more efficient utilization of the inherent growth potential of trout populations. Better use of the growth potential in Wisconsin's more fertile trout streams could also be realized by alternately opening and closing upper and lower portions of streams on July 1st each year rather than allowing fishing all summer long. The bulk of the wild trout caught each season are yearlings or 2-year-olds. If such fish were periodically protected for the latter half of 1 summer and the first half of the following summer many more pounds of larger-than-average trout would be produced and eventually cropped.

#### RESTRICTIONS ON FISHING METHODS

Nearly all sport fishing in public waters is limited to some modification of hook and line gear. This in itself represents an often overlooked but radical limitation on the efficiency of capture as compared to the improvement that could be attained by employing electrofishing gear, chemical poisons or anesthetics, nets, seines, or explosives -- all of which are used legally by commercial fishermen or scientists. Any further restriction on the various methods of hook and line fishing, imposed either legally or voluntarily, will further tend to reduce the total catch of trout from a body of water regardless of what methods are eliminated. This is because over the course of a fishing season, the variable conditions of weather and water make each method more efficient on some days than all other methods (Allen and Cunningham, 1957). Moreover, most anglers are more proficient at 1 method of fishing than several methods. If their favored method is prohibited, they must then choose to fish elsewhere or fish less proficiently.

Recently, as the number of trout fishermen has tended to increase and fishing quality has tended to decrease, 2 fishing restrictions are receiving increasing emphasis. One involves the concept of releasing all or nearly all of the trout caught. This type of trout fishing has been labelled "fishing for fun" by many anglers and authors, but as Stroud (1964) has convincingly demonstrated, "catch and release fishing" is a much more appropriate designation because most fishing is done for recreation not economic gain. The second concept receiving increasing emphasis is prohibition of bait fishing and the attendant high mortality it inflicts on trout that are hooked and released. However, even the

high mortality rate inflicted on undersize trout hooked and released by bait fishermen could be substantially reduced if such anglers could be educated to cut their lines and release undersize, deeply hooked trout with the hooks still in them. As Mason and Hunt (1967) demonstrated, approximately 2/3 of such released trout would probably survive and continue to grow.

Some trout water has now been restricted to "fly fishing only" or "artificial lures only" in at least 25 states, but such restrictions are not widespread in any state (Wallis, 1963). Wherever the emphasis is on "catch and release fishing", bait fishing is also prohibited, but in many "fly fishing only" waters substantial harvests are permitted.

At Lawrence Creek fly fishing was the only method permitted in the lower 2 (the "flies-only zone") of the 4 study sections during 7 successive seasons (1961-67). In the other 2 sections (the "any-lure zone"), all of the commonly accepted methods of trout fishing, including fly fishing, were allowed. Thus, fly fishermen could choose to fish in any of the lower sections, but anglers using spinning lures or fishing with bait could choose only 1 of the upper 2 sections. As in other years, all anglers were required to pick up a daily permit at the creel census station near the stream, and only 1 section could be fished/trip.

"Catch and release fishing" was not specifically tested, but during the 3 seasons when a 9-inch size limit was being tested, the fishing approached a catch and release condition. Only 6% of the trout caught were legal-sized.

### Summary of Significant Findings

#### Fly Fishing Only:

(1) Under the conditions of fishing pressure, catch, and trout densities that prevailed at Lawrence Creek, fly fishing had no uniquely beneficial biological effects that could be detected. Changes in standing crops, survival rates, reproduction, and growth of the trout populations in the 2 fishing zones appeared to be independent of the methods of angler harvest (Tables 7-9).

(2) In both zones hooking mortality inflicted on released trout was apparently compensated for by a decrease in mortality due to other causes. Summer mortality unaccounted for by trout harvested was not consistently higher in the any-lure zone under the prevailing conditions of hooking and releasing up to 50% of the trout population (Tables 8-10).

(3) Angling exploitation was similar in both fishing zones, averaging about 10% of the preseason population and ranging from 7-11% in the any-lure zone and 5-12% in the flies-only zone (Table 10).

(4) In both fishing zones, cropping tended to exceed recruitment during the first half of the season, but during the second half recruitment predominated. By the end of the fishing season, there tended to be more legal trout remaining than were harvested and more than were present at the beginning of the season (Table 11).

(5) In both fishing zones, the number of legal and sublegal (6-8 inches) trout tended to increase during the 7-year period, but the ratio of sublegal trout to legal trout in the flies-only zone versus the any-lure zone did not increase. The assumed lower hooking mortality of released trout in the flies-only zone did not detectably benefit the number of sublegal trout escaping all causes of mortality (Table 11 and Figs. 5 and 6).

(6) Improved standing crops of trout in the 2 fishing zones reflected better-than-average rates of overwinter survival and relatively low angler exploitation rather than differences in the methods of fishing employed (Tables 10 and 12).

(7) Fly fishermen were definitely attracted to Lawrence Creek by the fly-fishing-only restriction. More fly fishermen were registered in 1967 than in any previous year despite the fact that the total number of anglers in 1967 was 30% lower than the record high total registered in 1955. During 6 fishing seasons prior to the adoption of this regulation, fly fishermen accounted for 16-28% of the angling trips/season and 14-22% of the seasonal catches. After its adoption, they accounted for 39-55% of the trips/season and 40-66% of the seasonal catches (Table 13).

(8) Nearly all of the fly fishermen chose to fish in the flies-only zone. However, despite the increase in fly fishermen and their concentration in the lower half of the stream, this portion received less fishing pressure than it did when all types of angling were permitted there.

(9) Angling effort was always greater in the any-lure zone and the number of trout creelcd there was greater during 6 of the 7 seasons. However, the catch/hour of legal trout was always higher in the flies-only zone and the catch/hour of trout released was also higher in the flies-only zone during 5 of the 7 seasons. Catches of legal trout averaged 0.29 and 0.41/hour in the any-lure zone and flies-only zone, respectively, and catches of trout that were released averaged 1.43 and 1.66/hour in the two zones over the 7-year period (Table 10 and Figures 7-8).

(10) The average length of trout creelcd/season in the flies-only zone was always slightly larger and averaged 8.8 inches versus 8.6 inches in the any-lure zone for the 7-year period. Approximately 4.9 trout were released/trout creelcd in the any-lure zone. In the flies-only zone, the ratio was 4.0 to 1 (Table 10).

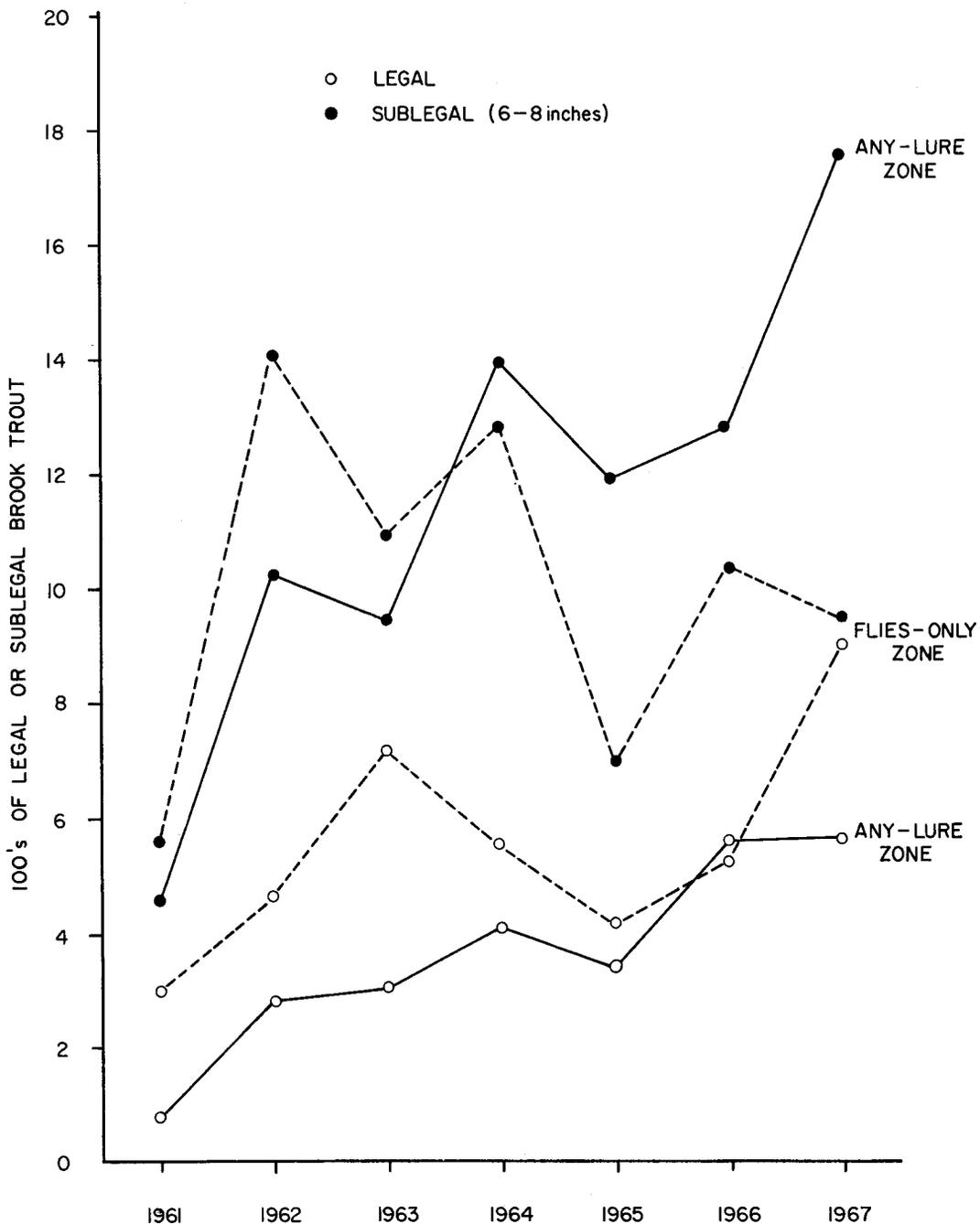


FIGURE 5. Number of legal and sublegal (6- to 8-inch) brook trout in the any-lure and flies-only zones of Lawrence Creek at the beginning of the 1961-67 fishing seasons.

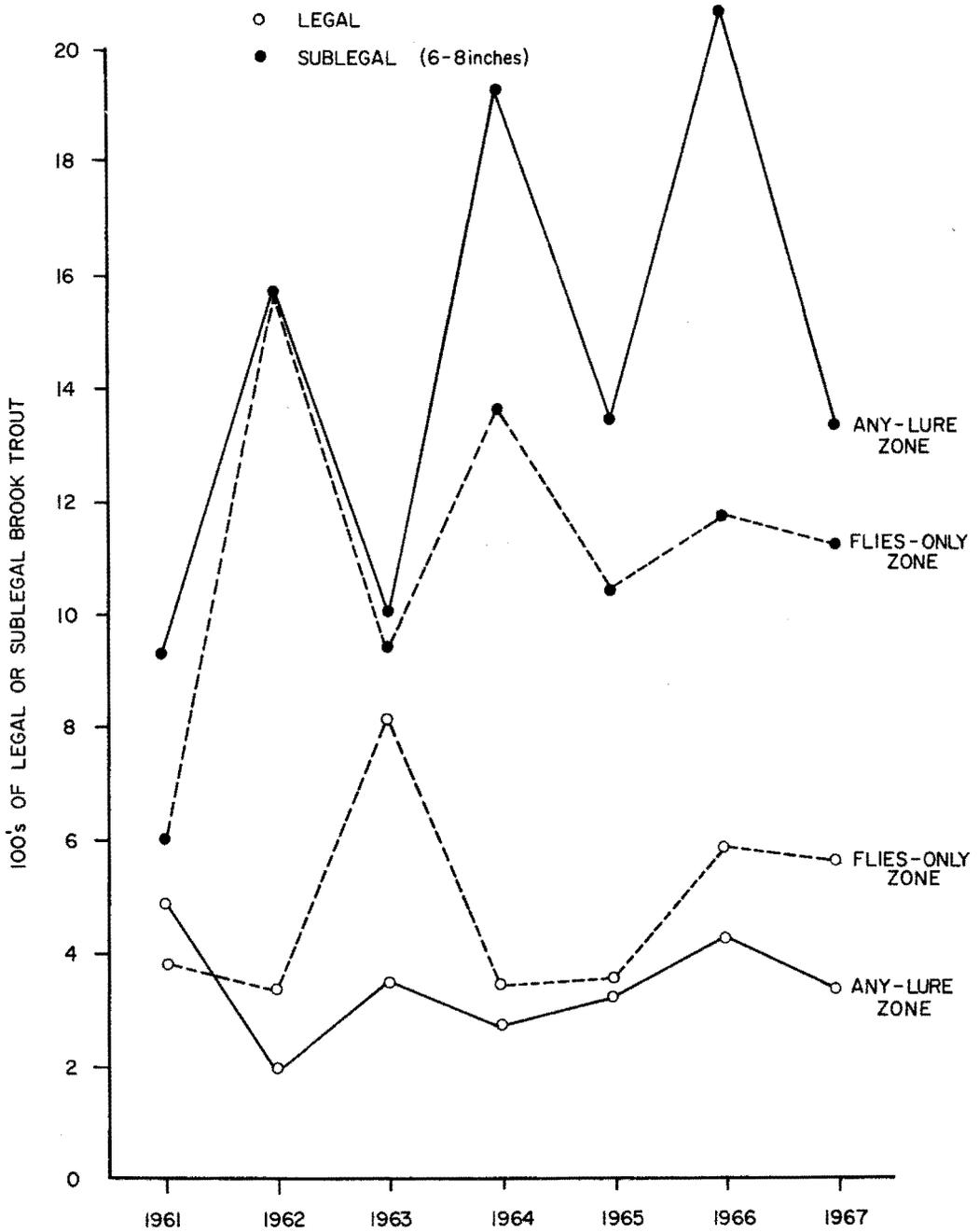


FIGURE 6. Number of legal and sublegal (6- to 8-inch) brook trout in the any-lure and flies-only zones of Lawrence Creek at the end of the 1961-67 fishing seasons.

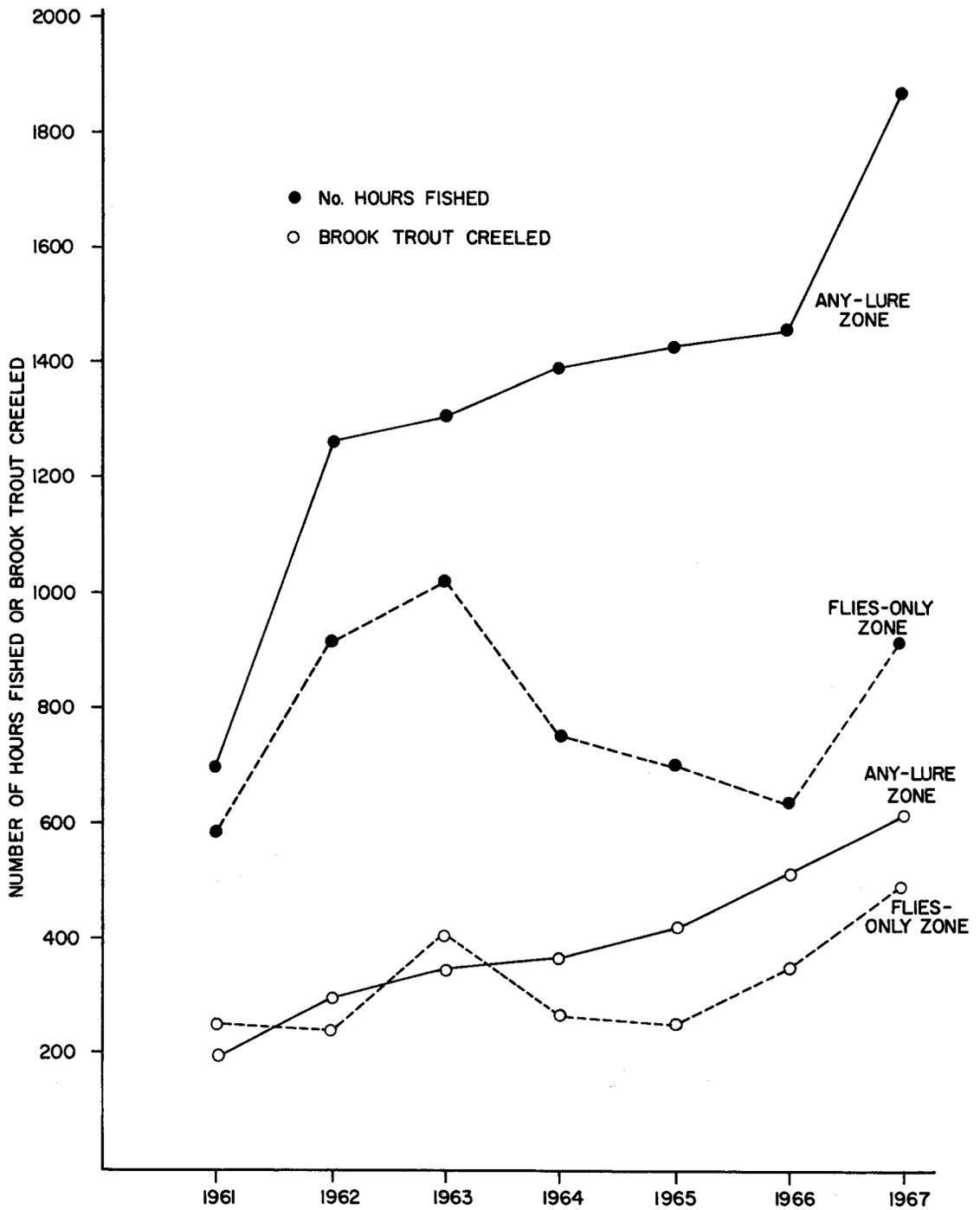


FIGURE 7. Angling effort and catch in the any-lure and flies-only zones of Lawrence Creek during the 1961-67 fishing seasons.

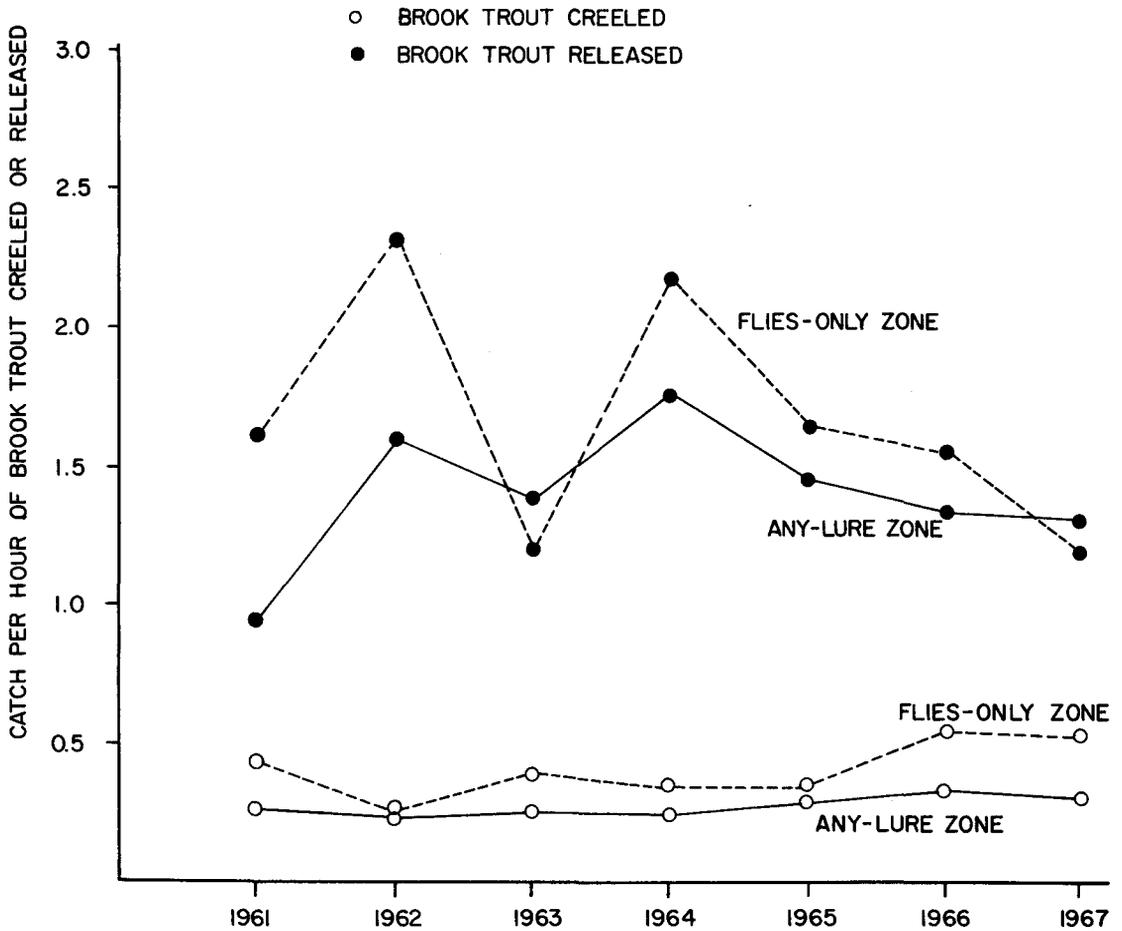


FIGURE 8. Catch/hour of brook trout creeled or released in the any-lure and flies-only zones of Lawrence Creek during the 1961-67 fishing seasons.

(11) Less than 1% of the fly fishermen reported releasing all legal-sized trout caught.

Catch and Release Fishing:

(12) During the 1958-60 fishing seasons, when a high size limit was in effect, the angler harvests were equivalent to only 4%, 8%, and 1% of the preseason trout populations. These compare to exploitation rates of 32%, 59%, and 65% during the preceding 3 seasons when regulations were very liberal (Table 3).

(13) During the 1958-60 seasons, an average of only 6% of the trout caught were legal-sized. Anglers released approximately 15 trout for every trout creeled.

(14) Despite an average catch-rate of 1-3 sublegal trout/hour on an easily fished, aesthetic stream, the reaction of anglers was generally negative during the 1958-60 seasons. Angling pressure declined from the 400-500 hours/acre characteristic of the 1955-57 seasons to only 250, 215, and 137 hours/acre during 1958-60, respectively. Catches/hour of legal trout also declined radically, from the averages of 0.69, 0.47, and 0.89 trout/hour during 1955-57 to 0.13, 0.16, and 0.09 trout/hour during the 1958-60 seasons (Table 2).

(15) During the entire 1960 season only 85 brook trout were cropped as compared to a catch of 512 on the opening day of the 1955 season when the normal statewide size and bag limit regulations prevailed. The total catch that year was 3,040.

### Conclusions and Management Implications

Designation of part of Lawrence Creek for "fly fishing only" proved to be popular among fly fishermen. They were attracted by the regulation, and they enjoyed high quality fishing for wild brook trout without abusing the trout population. However, except for the fishing methods, there was little difference in other aspects of the fisheries in the flies-only zone versus the any-lure zone, and there were no detectable responses by the trout populations that could be attributed to the presence or absence of the flies-only restriction. In both zones the amount of fishing pressure and the restrictive impact of the 8-inch size limit and bag limit of 5 overshadowed effects on the harvests and residual populations related to fishing methods. The only difference associated with fishing methods that may have had some impact on the fisheries in the two fishing zones was the consistently higher catch/hour by fly fishermen versus all anglers using the any-lure zone. The greater success rate in the flies-only zone may have been only a reflection of the slightly greater number of legal trout normally present there or the possible attraction of better-than-average fly fishermen to Lawrence Creek in response to the flies-only regulation.

If such a regulation does attract expert fly fishermen, and if nearly all of them keep the legal trout they catch, as they did at Lawrence Creek, the imposition of a flies-only regulation may not, of itself, prevent overexploitation.

At the present time in Wisconsin, this regulation appears to be more practical for managing trout fishermen than trout populations. Its application would appear to be biologically valid only in conjunction with an intensive catch and release fishery, a fishery where nearly every trout is likely to be caught one or more times. Where the emphasis is on a substantial harvest, there is little biological justification at present for limiting this harvest to fly fishermen only.

The general reaction of anglers to catching and releasing large numbers of 6-8 inch brook trout was definitely negative. Apparently, if such recreation is to be favorably accepted in Wisconsin, the

average size of trout released must be considerably larger. In Wisconsin, this type of fishery would, therefore, be limited to a few of the most productive lakes and streams containing fast-growing brown or rainbow trout. If an emphasis is placed on "catch and release fishing" on a season-long basis, it must be recognized that very little of the trout flesh produced will be cropped. Since natural mortality and angling mortality tend to compete, very few of the trout hooked and released unharmed will live long enough to reach trophy size. A large part of the harvestable surplus of trout flesh produced will be lost. This voluntary loss must be balanced against the additional sport provided by the greater number of larger-than-average trout such specially designated waters can maintain for a longer period each fishing season.

Even though many states now have some form of special regulations designed to emphasize the unharmed release of all or nearly all of the trout captured, there has been little biological evaluation of the validity of continuing to apply such restrictions (personal communication with 18 fish and game agencies). Moreover, among the studies that have been conducted, it is difficult to find consistent conclusions. Unfortunately, in many instances where fly-fishing-only rules have been adopted to protect released under-sized trout, higher size limits and lower bag limits have also been instituted simultaneously. In such situations it is impossible to relate any beneficial responses by trout populations solely to the flies-only rules. The most notable exception to this type of multiple change of fishing regulations is the excellent study reported by Shetter and Alexander (1962). In this study the normal statewide regulations of a 7-inch size limit and daily bag of 10 applied to all 4 study sections of Hunt Creek, but in 2 of the sections only fly fishing was permitted during a 5-year period. In Hunt Creek, as in Lawrence Creek, the flies-only rule influenced angling pressure and choice of fishing zones, but it caused no biologically important responses by the trout populations.

Perhaps the most valid judgement at this stage is that each proposed application of such special regulations must be carefully scrutinized on its own merits, taking into account both its biological and social implications. Furthermore, because of the varied success that has resulted to date, additional application of such special regulations should not be initiated without a definite plan to study and evaluate the consequences.

## APPENDIX

TABLE 1

Percentage of the Total Number and Total Weight of the Yield  
of Brook Trout Accounted for by Various Age Groups During  
the 1955-67 Fishing Seasons at Lawrence Creek

Year	Age Group								Size Limit
	I		II		III		IV+		
	Number	Weight	Number	Weight	Number	Weight	Number	Weight	
1955	62.5	44.4	35.5	49.0	1.9	5.9	0.1	0.7	6 inches
1956	47.9	33.5	50.0	59.9	1.9	5.2	0.2	1.4	
1957	89.9	82.6	8.2	13.3	1.3	3.6	0.1	0.5	None
1958	7.2	6.2	82.0	76.7	9.9	13.7	0.9	3.4	
1959	4.5	3.8	79.8	81.1	15.2	14.6	0.5	0.5	9 inches
1960	8.2	7.0	27.0	23.7	64.8	69.3	0.0	0.0	
1961	24.2	19.7	74.4	77.7	0.7	1.2	0.7	1.4	8 inches
1962	14.8	13.0	74.8	71.0	10.4	16.0	--	--	
1963	3.5	2.9	86.3	85.3	8.8	9.3	1.4	2.5	8 inches
1964	7.5	5.9	66.1	62.1	24.8	28.5	1.6	3.5	
1965	7.2	5.9	71.8	69.1	15.6	16.9	5.4	8.1	
1966	8.8	7.6	70.5	68.2	18.9	21.3	1.7	2.9	
1967	2.2	2.1	76.8	74.2	19.2	21.1	1.8	2.6	

TABLE 2

## Indices of Angling Quality for the 1955-67 Fishing Seasons at Lawrence Creek

Year	Size Limit (Inches)	Yield		Angling Effort		No. of Trout Released	Catch/Hour		Percent "Successful" Trips	Trout Released/ Trout Creeled		Size Limit
		Number	Pounds	Trips	Hours		Creeled	Released		Creeled	Limit	
1955	6	3,040	537	1,712	4,653	2,435	0.69	0.52	47	0.8	6 inches	
1956	0	1,360	220	1,313	3,051	376	0.47	0.13	34	0.3	None	
1957	0	2,778	431	1,249	3,168	685	0.89	0.22	44	0.2		
1958	9	223	68	758	1,847	3,704	0.13	2.00	19	16.6	9 inches	
1959	9	243	77	728	1,560	1,846	0.16	1.18	19	7.6		
1960	9	85	27	434	1,007	2,572	0.09	2.55	12	30.2		
1961	8	442	107	592	1,279	1,593	0.35	1.25	32	3.6	8 inches	
1962	8	540	131	896	2,173	4,143	0.25	1.91	27	7.7		
1963	8	752	169	874	2,324	2,551	0.33	1.10	36	3.4		
1964	8	625	149	881	2,141	4,097	0.30	1.91	30	6.6		
1965	8	671	157	858	2,122	3,243	0.32	1.53	33	4.8		
1966	8	862	203	826	2,087	2,950	0.41	1.41	41	3.4		
1967	8	1,111	266	1,178	2,784	3,565	0.40	1.28	37	3.2		
Avg. 1956-57		2,069	326	1,281	3,110	530	0.68	0.18	39	0.3	None	
	1958-60	184	57	640	1,471	2,707	0.13	1.06	17	18.1	9 inches	
	1961-67	715	169	872	2,130	3,163	0.34	1.48	34	4.7	8 inches	

TABLE 3

Percentage of the Preseason Population of Brook Trout  
Harvested According to Age Group During  
the 1955-67 Fishing Seasons at Lawrence Creek

Year	Age Group			Stream Total for All Adult Trout (I+)	Size Limit
	I	II	III+		
1955	24.4	71.7	42.2	32.2	6 inches
1956	45.6	85.2	35.4	59.0	None
1957	62.0	100.0	72.2	64.6	
1958	0.3	19.8	42.8	3.9	9 inches
1959	1.0	11.2	30.6	8.2	
1960	0.1	12.8	29.1	1.2	
1961	3.0	39.8	40.0	9.9	8 inches
1962	0.9	36.3	51.9	5.5	
1963	0.6	26.9	58.8	10.5	
1964	0.6	32.5	41.2	6.8	
1965	1.0	25.5	57.6	9.4	
1966	1.1	34.5	46.4	9.6	
1967	0.5	28.8	52.1	11.9	
Avg. 1956-57	57.7	91.7	50.0	62.7	None
1958-60	0.6	14.1	31.7	3.5	9 inches
1961-67	1.1	32.0	49.7	9.1	8 inches

TABLE 4

Frequency of Various Catches of Brook Trout Per Trip  
During the 1955-67 Fishing Seasons at Lawrence Creek \*

Catch/ Trip	Fishing Season												
	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
	Number of Angling Trips												
0	912	882	683	614	588	383	401	646	566	617	578	484	717
1	188	153	136	88	80	32	78	114	130	103	110	131	168
2	156	96	91	31	34	7	45	50	61	63	64	65	90
3	103	55	58	12	9	6	25	36	43	35	35	49	52
4	94	37	50	3	10	3	16	16	19	23	27	31	68
5	63	32	44	5	7	3	27	34	55	40	44	66	83
6	58	15	28										
7	33	8	31										
8	24	5	22										
9	31	8	18										
10	50	8	16										
11+		14	72										
Total Trips	1712	1313	1249	758	728	434	592	896	874	881	858	826	1178

\*1955: Bag limit of 10  
1956-57: No bag limit  
1958-67: Bag limit of 5

TABLE 5

Distribution of Trips and Catch Among Anglers  
Making Various Numbers of Trips During  
the 1955-64 Fishing Seasons at Lawrence Creek

Year	Trips/ Season	Number of Anglers	Percentage of Anglers	Percentage of Total Trips	Percentage of Total Catch	Catch/ Hour	Bag Limit
1955	1-2	881	87.8	58.8	31.4	0.34	10
	3-4	73	7.3	14.5	18.9	0.77	
	5-9	32	3.2	12.2	20.5	1.16	
	10+	17	1.7	14.5	29.2	1.36	
1956	1-2	936	93.9	78.9	46.9	0.27	None
	3-4	45	4.5	11.1	21.9	0.80	
	5-9	12	1.2	5.8	18.8	1.54	
	10+	4	0.4	4.2	12.4	1.35	
1957	1-2	711	91.0	65.6	36.9	0.55	
	3-4	45	5.8	12.3	16.3	1.06	
	5-9	14	1.8	6.5	15.0	2.15	
	10+	11	1.4	15.6	31.8	1.86	
1958	1-2	368	85.8	57.8	33.7	0.08	
	3-4	38	8.8	16.6	15.2	0.10	
	5-9	17	4.0	13.7	16.6	0.16	
	10+	6	1.4	11.9	34.5	0.24	
1959	1-2	355	87.9	56.8	24.3	0.06	
	3-4	26	6.4	12.2	7.7	0.10	
	5-9	16	4.0	15.2	26.3	0.26	
	10+	7	1.7	15.8	41.7	0.38	
1960	1-2	297	93.4	77.0	42.9	0.04	
	3-4	12	3.8	9.0	6.6	0.06	
	5-9	8	2.5	11.5	31.9	0.23	
	10+	1	0.3	2.5	18.7	0.59	
1961	1-2	306	89.7	59.1	20.5	0.11	5
	3-4	22	6.5	3.4	15.1	0.36	
	5-9	6	1.8	7.9	13.1	0.86	
	10+	7	2.0	21.0	51.3	0.91	
1962	1-2	464	89.0	62.3	28.6	0.11	
	3-4	37	7.1	14.0	16.9	0.26	
	5-9	12	2.3	9.7	17.6	0.54	
	10+	8	1.6	14.0	36.9	0.72	
1963	1-2	456	89.6	65.2	40.0	0.21	
	3-4	33	6.5	12.7	9.7	0.21	
	5-9	12	2.3	8.8	13.1	0.47	
	10+	8	1.6	13.3	37.2	0.89	
1964	1-2	433	86.9	60.2	39.5	0.20	
	3-4	40	8.0	15.4	15.5	0.29	
	5-9	18	3.6	13.7	20.7	0.42	
	10+	7	1.5	10.6	24.3	0.68	

TABLE 6

Percentage Mortality and Survival of Age I+ Brook Trout  
in the Refuge Zone Versus the Fishing Water Zone of Lawrence Creek

Year (April-Sept.)	"Refuge" Zone			"Fishing Water" Zone		
	Natural Mortality	Angling Mortality	Survival	Natural Mortality	Angling Mortality	Survival
1955*	32	12	56	27	39	34
1956	39		61	24	59	17
1957	33		67	2	64	34
1958	48		52	47	4	49
1959	70		30	50	8	42
1960	79		21	57	1	42

\* The refuge was established after the 1955 fishing season ended. Angling mortality, natural mortality and survival rates for 1955 are included for comparative purposes when both zones were open to fishing.

TABLE 7

Standing Crops of Brook Trout in the Any-Lure Zone  
and Flies-Only Zone of Lawrence Creek During 1961-67\*

Number of Trout in April										
	Any-Lure Zone				Flies-Only Zone					
	I	II	III	Σ I+	I	II	III	Σ I+		
1961	2,026	220	4	2,250	1,576	607	9	2,232		
1962	4,073	467	22	4,562	4,494	646	86	5,226		
1963	2,657	893	34	3,584	1,987	1,516	97	3,600		
1964	4,330	610	128	5,068	3,195	659	272	4,090		
1965	3,380	1,110	94	4,584	1,623	779	151	2,553		
1966	4,548	985	183	5,721	2,367	779	172	3,342		
1967	3,660	1,588	180	5,445	2,272	1,372	227	3,889		

Number of Trout in September										
	0	I	II	III	Σ 0+	0	I	II	III	Σ 0+
	1961	9,375	1,421	93	2	10,891	4,938	939	168	1
1962	4,382	2,186	97	5	6,670	3,229	2,337	106	17	5,689
1963	5,753	1,256	278	11	7,298	4,614	1,132	472	26	6,249
1964	6,974	2,576	198	42	9,790	2,706	1,806	247	82	4,848
1965	5,779	1,683	248	29	7,741	2,673	1,455	239	37	4,408
1966	5,910	2,614	343	33	8,901	2,282	1,501	357	56	4,202
1967	6,158	1,642	424	30	8,256	1,737	1,520	442	98	3,810

\* Any-lure zone = 1.86 miles and flies-only zone = 1.44 miles

TABLE 8

Percentage Mortality and Survival of Age I and II Brook Trout  
in the Any-Lure Zone and Flies-Only Zone of Lawrence Creek During 1961-67

		Any-Lure Zone			Flies-Only Zone		
		Angling*	Natural	Survival	Angling*	Natural	Survival
		Mortality	Mortality		Mortality	Mortality	
Age I	1961	3	27	70	2	37	61
	1962	1	45	54	1	47	52
	1963	1	45	54	1	43	56
	1964	1	40	59	1	42	57
	1965	--	--	--	--	--	--
	1966	1	42	56	2	35	63
	1967	1	55	44	1	33	66
	Avg. 1961-67	1	42	57	1	40	59
Age II	1961	54	4	42	35	37	28
	1962	51	28	21	25	59	16
	1963	37	29	34	23	29	48
	1964	43	25	32	23	40	37
	1965	27	51	22	23	46	31
	1966	38	27	35	30	24	46
	1967	30	44	26	20	40	32
	Avg. 1961-67	40	30	30	27	39	34

• Mortality accounted for by the angler harvest only

TABLE 9

Average Lengths in September of Ages 0-II Brook Trout  
in the Any-Lure Zone and Flies-Only Zone  
of Lawrence Creek During 1958-67

Year *	Average Total Length in Inches					
	Any-Lure Zone			Flies-Only Zone		
	0	I	II	0	I	II
1958	3.6	6.7	8.3	3.7	7.0	9.5
1959	3.7	7.1	8.5	3.8	6.8	7.7
1960	3.9	7.1	8.7	3.8	7.2	9.3
1961	4.0	7.5	9.1	3.9	7.4	9.2
1962	3.9	6.9	8.4	3.7	6.9	8.7
1963	4.0	7.0	8.6	4.1	6.9	8.3
1964	3.7	6.7	8.3	3.8	6.8	8.2
1965	4.0	7.1	8.2	3.9	6.9	8.5
1966	4.1	6.9	8.2	4.0	7.2	8.6
1967	4.0	6.7	8.2	3.9	6.7	8.5
Avg. 1958-60	3.7	7.0	8.5	3.8	7.0	8.8
1961-67	3.9	7.0	8.4	3.9	7.0	8.7

\* The flies-only restriction was in effect during the 1961-67 fishing seasons. Age-specific growth data for 1958-60 are presented for comparative purposes.

TABLE 10

Creel Census Statistics for the Any-Lure and Flies-Only Zones  
of Lawrence Creek for the 1961-67 Fishing Seasons\*

Item	1961	1962	1963	1964	1965	1966	1967	Avg.
Angling Trips:								
Any-Lure Zone	310	499	481	560	569	551	771	534
Flies-Only Zone	282	397	393	321	289	275	407	338
Angling Hours:								
Any-Lure Zone	698	1,262	1,305	1,390	1,426	1,455	1,868	1,343
Flies-Only Zone	581	911	1,019	751	696	633	916	787
Trout Creeled - Number:								
Any-Lure Zone	187	300	340	364	420	512	614	392
Flies-Only Zone	255	240	405	262	251	350	497	323
Trout Creeled - Pounds:								
Any-Lure Zone	19	68	76	84	94	117	139	85
Flies-Only Zone	28	63	94	65	63	86	127	75
Trout Released - Number:								
Any-Lure Zone	658	2,022	1,326	2,461	2,096	1,959	2,466	1,855
Flies-Only Zone	933	2,121	1,225	1,636	1,147	991	1,099	1,307
Catch/Hour - Legal:								
Any-Lure Zone	.27	.24	.27	.26	.29	.35	.33	.29
Flies-Only Zone	.44	.26	.40	.35	.36	.55	.54	.41
Catch/Hour - Released:								
Any-Lure Zone	.94	1.60	1.38	1.77	1.47	1.35	1.32	1.43
Flies-Only Zone	1.60	2.32	1.20	2.18	1.65	1.57	1.20	1.66
Percent of Stock								
Cropped:								
Any-Lure Zone	8	7	11	7	9	9	11	9
Flies-Only Zone	12	5	11	6	10	11	13	10
Released:								
Any-Lure Zone	29	44	37	49	46	34	45	41
Flies-Only Zone	42	41	34	40	45	30	28	37
Ratio - Trout Released								
to Trout Creeled:								
Any-Lure Zone	3.5	6.7	5.2	6.8	5.0	3.8	4.0	4.9
Flies-Only Zone	3.7	8.8	3.0	6.2	4.6	2.8	2.2	4.0
Percent "Successful"								
Trips:								
Any-Lure Zone	26	27	31	27	32	39	33	31
Flies-Only Zone	39	27	41	35	35	47	45	38
Avg. Length of Trout								
Creeled - Inches:								
Any-Lure Zone	8.6	8.7	8.6	8.5	8.5	8.6	8.5	8.6
Flies-Only Zone	8.8	8.9	8.7	8.9	8.7	8.8	8.8	8.8

\* Any-lure zone = 1.86 miles and flies-only zone = 1.44 miles

TABLE 11

Number and Ratios of Legal Sized and Sublegal (6-8 Inch) Brook Trout  
in the Any-Lure Zone and Flies-Only Zone of Lawrence Creek During 1961-67

Item	1961	1962	1963	1964	1965	1966	1967	Avg.
Preseason No. of Legal Trout:								
Any-Lure Zone	81	284	300	411	337	558	561	
Flies-Only Zone	298	468	719	550	412	524	903	
Midseason No. of Legal Trout:								
Any-Lure Zone	118	125	313	289	238	433	380	
Flies-Only Zone	260	209	479	344	215	493	516	
Postseason No. of Legal Trout:								
Any-Lure Zone	496	188	349	270	318	424	332	
Flies-Only Zone	386	338	815	341	358	589	563	
Preseason No. of Sublegal Trout:								
Any-Lure Zone	458	1,024	943	1,395	1,191	1,282	1,754	1,150
Flies-Only Zone	563	1,410	1,096	1,283	694	1,038	946	1,004
Midseason No. of Sublegal Trout:								
Any-Lure Zone	1,239	1,662	1,309	2,157	1,601	2,138	1,522	1,661
Flies-Only Zone	1,024	2,079	1,372	1,711	1,026	1,502	1,088	1,400
Postseason No. of Sublegal Trout:								
Any-Lure Zone	931	1,578	1,001	1,927	1,346	2,069	1,338	1,456
Flies-Only Zone	603	1,571	935	1,364	1,047	1,171	1,125	1,117
Legal: Sublegal Preseason Ratio:								
Any-Lure Zone	1:5.6	1:3.6	1:3.1	1:3.4	1:3.5	1:2.3	1:3.1	
Flies-Only Zone	1:1.9	1:3.0	1:1.5	1:2.3	1:1.7	1:2.0	1:1.1	
Legal: Sublegal Midseason Ratio:								
Any-Lure Zone	1:10.5	1:13.3	1:4.2	1:7.5	1:6.7	1:4.9	1:4.0	
Flies-Only Zone	1:3.9	1:9.9	1:2.9	1:5.0	1:4.8	1:3.0	1:2.1	
Legal: Sublegal Postseason Ratio:								
Any-Lure Zone	1:1.9	1:8.4	1:2.9	1:7.1	1:4.3	1:4.9	1:4.0	
Flies-Only Zone	1:1.6	1:4.6	1:1.5	1:4.0	1:2.9	1:2.0	1:2.0	

TABLE 12

Overwinter Survival\* of Brook Trout in the Any-Lure Zone  
and Flies-Only Zone of Lawrence Creek During 1960-67  
as Compared to Survival During the Winters of 1955-60

Winter	Percent Survival		
	Any-Lure Zone	Flies-Only Zone	Entire Stream
1960-61	33	43	37
1961-62	42	86	58
1962-63	54	63	59
1963-64	69	65	69
1964-65	47	53	49
1965-66	74	76	75
1966-67	61	93	71
Avg. 1960-67	54	68	60
1955-60	49	56	51

\*. Since there are no barriers between zones, overwinter changes in the trout populations in the two zones reflect movement as well as survival. Only the values for the entire stream reflect true survival.

TABLE 13

Distribution of Seasonal Angling Trips and Catch  
for the 1955-1967 Fishing Seasons According to the Methods  
of Fishing Employed at Lawrence Creek

Angling Season	Angling Trips			Brook Trout Creeled		
	No. of Trips	Percent by Fly Fishermen	Percent by Bait Fishermen	No. of Trout	Percent by Fly Fishermen	Percent by Bait Fishermen
1955	1,712	25	61	3,040	22	68
1956	1,313	16	71	1,360	14	77
1957	1,249	19	65	2,778	16	74
1958	758	24	53	223	19	62
1959	728	21	53	243	14	60
1960	434	28	52	85	14	45
1961	592	55	38	442	66	28
1962	896	49	40	540	47	49
1963	874	49	39	752	57	36
1964	881	42	46	625	46	43
1965	858	41	40	671	40	45
1966	826	39	46	862	43	42
1967	1,178	40	50	1,111	46	43
Avg. 1955-60	1,032	22	59	1,288	17	64
1961-67	872	45	43	715	49	41

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