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GROWTH AND SURVIVAL OF TROUT STOCKED IN A NORTHERN WISCONSIN SPRING POND

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ABSTRACT

The purpose of this study was to determine growth and survival of June- and fall-stocked trout in Sportsman Lake, a 0.7-ha spring pond in Shawano County. We stocked different numbers and sizes of trout to determine which combinations would provide reasonably high survival and fast growth from time of release to the following spring. We made five fall stocks and two June stocks of domesticated brook trout (Salvelinus fontinalis). In one of the fall stocks we included wild brook trout and in another, domesticated rainbow trout (Salmo gairdneri).

Survival of fall-stocked trout to the following spring ranged from 48 to 77 percent and was directly related to the mean size of trout when released. All fall-stocked trout grew overwinter and their average weight ranged from 53 to 110 g in spring. Growth rates were inversely related to trout density. We hypothesized that trout growth rates were a function of food density and levels of trout predation on the benthos. Changes in trout biomass from fall to the following spring varied from -25 to +35 percent; biomass changes depended upon growth and survival. When the pond was stocked with more than 100 kg/ha of trout, the overwinter change in biomass was negative. Results suggested when trout weighing more than 50 g each were stocked in fall at stocking rates less than 100 kg/ha overwinter growth rates and survival would be high and biomass would increase.

Survival to spring of fingerling brook trout stocked in June 1972 and 1973 was 40 and 17 percent, respectively. Low survival of the 1973 stock was due in part to illegal winter fishing. In spring, the 1972 stock averaged 69 g each and the 1973 stock averaged 97 g. Differences in growth rates were related to trout densities. Biomass of the 1972 stock increased from 20 kg/ha in June to 81 kg/ha the following April; the 1973 stock increased from 21 to 48 kg/ha over the same period.

Costs of June stocks were about $137/ha and costs of fall stocks ranged from $265 to $392/ha when trout were valued at $3.30/kg. Based on overwinter changes in biomass of trout and relative costs of stocking, June fingerlings provided satisfactory populations in spring at the lowest cost. In spring, values of June-stocked trout ranged from $160 to $265/ha and values of fall-stocked trout ranged from $255 to $365/ha. Differences between values of fish in spring and production costs were high for June stocks and for 65-g trout stocked at moderate rates in fall. However, production costs of June stocks were about half those of fall stocks.

Brook and rainbow trout fed upon the same benthic invertebrates, though at somewhat different rates. Forage fish were abundant in the pond, but were not heavily utilized by trout. Whenever Daphnia were available, (especially those 1 mm and larger), brook and rainbow trout consumed them in large numbers.

Detailed management recommendations include: (1) size of trout to stock in spring ponds, (2) stocking rates, (3) desirability of fish barriers and their design, (4) utilization of potential pond productivity through multi-species management, and (5) introduction of forage species for improved growth rates of trout.

INTRODUCTION

Spring ponds of northern Wisconsin provide a substantial amount of sport fishing for trout; since 1967, the Fish Management Section has been actively pursuing a rehabilitation program on these waters. Dredging filled-in spring ponds has created much living space for trout and increased fishing opportunities. Many dredged ponds have adequate spawning areas and sport fisheries are sustained by wild trout populations, mostly brook trout (*Salvelinus fontinalis*). Where spawning areas are lacking or of insufficient size, domesticated trout are stocked.

Harvest of stocked trout from spring ponds appears to vary greatly both among and within ponds. Since harvest is dependent upon growth and survival of stocked trout, we sought to develop guidelines for stocking domesticated trout in ponds that lacked spawning areas. Specifically, the purpose of this study was to determine growth and survival of domesticated trout stocked in summer and fall.

We conducted the study in Sportsman Lake, Shawano County, from 1967 to 1975. We made five fall stocks and two summer (June) stocks of domesticated brook trout; wild brook trout and domesticated rainbow trout (*Salmo gairdneri*) were included in two of the fall stocks. We chose to stock in summer or fall rather than spring to utilize the pond's potential overwinter production. Stocked spring ponds are often heavily fished and domesticated brook and rainbow trout are readily caught, hence trout survival through summer is typically low and few fish survive to the next year. We stocked different numbers and sizes of trout to determine which combinations would provide reasonably fast growth and high survival from time of release to the following spring. Electrofishing provided data for estimating population sizes and during each winter we sampled populations by ice-fishing. Food habits of trout were studied and the zooplankton was sampled several times during the study. However, emphasis was on maximizing numbers of desirable size trout at the beginning of the fishing season while minimizing stocking rates.

STUDY SITE

Sportsman Lake was dredged in 1966 to increase living space for trout. Approximately 2,500 m^3 (2 acre-feet) of sediments were removed from part of the pond basin. The pond was chemically treated with Antimycin A in September 1967 and a fish barrier was installed in the outlet. After dredging, the surface area was 0.7 ha and the maximum depth, 2.4 m.

The major water source is from aquifers and the mean outlet discharge is about 0.2 m^3/sec. Surface waters have an alkalinity of 210 ppm as $CaCO_3$ and the pH range is 7.6 to 8.3. Continual inflow of groundwater (6^{o}C) maintains relatively moderate water temperatures throughout the year. During summer, water temperatures rarely exceed 18^{o}C at the surface and 10^{o}C at 2 m. Even during the coldest winter periods, about 5 percent of the pond surface remains free of ice.

A dairy barn is located about 150 m from the pond. Surface runoff from the barn area apparently contributes nutrients to the pond and stimulates nuisance algal blooms during months of open water. Concentrations of nutrients in Sportsman Lake are considerably higher than in other spring ponds in this portion of the state. Because of the high nutrient input into Sportsman Lake, we feel that its potential fish productivity is higher than other spring ponds not influenced by similar human activity.

The benthic community is composed mostly of chironomids, amphipods, and snails. Chara spp., the most common aquatic plant, occurs throughout the shallow areas of the pond. Stocked trout account for most of the fish biomass. Some brook sticklebacks (Culaea inconstans) and central mudminnows (Umbra limi)survived chemical treatment and their densities apparently increased as the study progressed.

METHODS

We stocked the pond annually from 1967 to 1974, except for 1971 (Table 1). Five of the seven releases were made in fall. In 1972 and 1973 we stocked fingerling brook trout in June, and in May 1972, we stocked legal-sized brook trout to provide fishing for the first two months of the season. The final release was made in October 1974 at which time two groups of different-sized brook trout were used to examine their survival in relation to mean size at stocking. All domesticated trout were less than 12 months old when stocked; they came from the Langlade or Crystal Springs hatcheries. Wild brook trout, stocked in 1969, were collected from a nearby stream and were about 14 months old, yet similar in size to the hatchery trout. When sufficient numbers of trout were available, we selected trout within a 25 mm range for stocking. A sample of over 100 trout from each stock was weighed and measured just prior to release. A single fin or combination of two fins were removed to facilitate subsequent identification. In 1968 and 1969, some of the domesticated brook trout were marked with Floy anchor tags prior to stocking. In this report, tagged and untagged fish are treated as a single stock since differences in growth and survival between groups were not appreciable. Results of the tagging experiments have been reported elsewhere (Carline and Brynildson 1972).

We collected trout at night with an AC boom shocker. We weighed, measured, and applied a temporary finclip to all trout that were captured. Bailey's modification of the Petersen method was used to calculate population sizes (Ricker 1958). The proportion of marked trout in each sample was used to calculate confidence limits for point estimates (Adams 1951). Instantaneous rates of growth (G) and mortality (Z) were calculated according to Ricker (1958). In analyzing relationships between growth, survival, and trout density, initial biomass or number of trout includes recently stocked trout plus carryovers. Mean biomass or number were calculated by averaging respective values at the beginning and end of the sampling interval.

Each time we sampled the fish population, about 10 trout were killed for stomach analyses. We also collected stomachs from trout caught by anglers. We sampled zooplankton populations with a number 10 mesh cone net at irregular intervals. The net was slowly lowered in the water near the deepest part of the pond and then slowly pulled to the surface. At least two cone net samples were taken each time we collected zooplankton.

RESULTS AND DISCUSSION

Growth and Survival

Fall Stocks. All fall-stocked fish grew overwinter, although growth rates varied considerably among stocks (Table 2). For example, the 1967 stock, the first one following dredging and chemical treatment, had the lowest growth rate. In 1968, we stocked 1,436 trout/ha, about half as many as in 1967, and growth rates were nearly three times greater than those of the 1967 stock.

By spring, mean weights of fall-stocked trout ranged from 53 to 110 g and lengths ranged from 178 m to 223 mm (Fig. 1). Mean sizes of trout in spring were a function of size at stocking and overwinter growth rates. Oversummer growth rates were about 1.5 to 3.0 times greater than overwinter rates. It was difficult to compare summer and winter growth, because the sport fishery was size selective. There was a tendency for the larger trout to be caught early in the season when fishing pressure was most intense. For example, in spring 1975 there were two lots of marked brook trout in the pond. We estimated 703 trout in the smaller size group (marked A) and 327 in the larger size group (marked ALV), a ratio of about 2.1:1. During the morning of the 1975 opening day, anglers caught 79 trout from the smaller size group (A) and 57 of the larger size (ALV), a ratio of 1.4:1. Even though both groups of trout were legal size, fishermen kept 33 percent fewer trout from the smaller size group than expected, based on relative densities of the two groups.

After one full year, most domesticated brook trout exceeded 250 g and 250 mm (about 10 in). None survived two full years after stocking. Overwinter growth of domesticated rainbow trout was slower than that of brook trout, but a few rainbows were still left after two years when they had reached 877 g and 419 mm (16.5 in). We captured two rainbows over 457 mm (18 in), but we rarely found a domesticated brook trout over 300 mm (12 in).

Overwinter growth rates of fall-stocked trout were inversely related to trout density (Fig. 2). This density-dependent relationship was always evident, regardless of whether density was expressed (a) as numbers or biomass of trout or (b) as initial or mean values (Table 3). Wild brook trout grew as well as domesticated ones, while growth of domesticated rainbows was markedly slower than that of brook trout (Fig. 2). The 1967 stock of nearly 2,900 trout/ha had the lowest growth rates. We suspected that reduced food supply from dredging had influenced their growth. Therefore, in 1974 we stocked two different sizes of domesticated brook trout whose total weight was similar to that of the 1967 stock. Trout stocked in 1974 grew slightly faster than the 1967 stock, but differences in growth rates may have simply been the result of sampling errors. Consequently, we concluded that dredging and chemical treatment did not adversely affect growth of the 1967 stock.

Inverse relationships between trout growth and density strongly suggest that intraspecific competition was important. Carline (1975) showed that density-dependent growth of wild brook trout in spring ponds was a consequence of food density. Trout predation influenced abundance of benthic organisms and trout growth was directly related to benthic density. We believe that growth of trout in Sportsman Lake was also food-limited.

Overwinter survival of brook trout ranged from 47.9 to 67.6 percent (Table 2). Wild brook trout, which were Age 1 or 2, had the lowest survival. The single release of domesticated rainbows, the largest of all stocked fish, had the highest overwinter survival, 76.7 percent. Trout survival was primarily a function of their mean length when stocked (Fig. 3). The relationship between survival and mean weight at stocking was similar to that shown in Figure 3. Overwinter survival was not related to any of the density parameters tested (Table 3).

Survival of domesticated brook trout from spring to fall was typically low (Table 2). During the summers of 1968 to 1970, survival ranged from 3.6 to 6.3 percent. Survival of wild brook trout in 1970 was 25.4 percent. We attribute low survival of domesticated trout to angling. Wild brook trout were probably less vulnerable to fishing, hence, survived better than their domesticated counterparts.

June Stocks. There were appreciable differences in growth and survival between the June 1972 and 1973 stocks of domesticated brook trout. Both groups grew at similar rates from June to October when their mean weights were 32 and 39 g, respectively (Table 4). From October to the following spring the 1972 stock reached 69 g and the 1973 stock averaged 97 g. Differences in growth can be attributed to trout densities. Density of the 1972 stock in spring was more than twice the density of the 1973 stock. However, all trout in both groups were legal size (152 mm) when the fishing season opened.

Survival to spring of the June 1972 and 1973 stocks was 40 and 17 percent, respectively. Survival rates differed most during the October to April periods. We estimated that 87.3 percent of the trout present in October 1972 survived to the following spring while only 49.5 percent of the October 1973 population survived overwinter (Table 4). A partial explanation for the 49.5-percent survival may be illegal winter fishing, since we found evidence of poaching in February 1974. Ice-fishing for domesticated brook trout can have a significant impact on a population. During our winter samplings with hook and line, catch rates of 15 trout/hr were common. Although illegal ice-fishing may have increased mortality of the 1973 stock, the 87.3-percent overwinter survival of the 1972 stock seems high. Based on the relationship between mean length and survival of fall-stocked trout, a survival rate of 48 percent would be expected. Narrow confidence limits for the October 1972 and April 1973 population estimates suggest a high degree of precision, but accuracy of either estimate may have been affected by some unobserved bias.

Production Costs

We have chosen to evaluate individual stockings on the basis of change in fish biomass from time of release to the following spring. Change in biomass can be easily converted to economic terms and allows consideration of cost of stocking versus value of the fish after 6 or 8 months in the pond. There are several other criteria we could have used, such as size of harvested trout, catch rate, quality of fishing experience, etc., and in some instances these criteria would have been more appropriate than economic ones. In this instance, we believe economic criteria are the most useful since the fishery was wholly dependent upon stocking, since carryover fish contributed little to the total catch, and since most of the trout were caught in the first two months of the season.

Overwinter change in biomass of fall-stocked trout depended upon their mean size and numbers when stocked and released. In 1967 and 1974, more than 115 kg/ha were stocked and the loss in biomass ranged from 25 to 33 percent (Table 6). When less than 95 kg/ha were stocked, weight gain ranged from 22 to 35 percent; the only exception was the weight loss of wild brook trout stocked in 1969. Both June stocks gained weight. The 1972 release had high survival and increased in weight by 90 percent. Low survival of the 1973 stock was attributed in part to poaching and this group had a 21 percent weight gain.

We used \$3.30/kg (\$1.50/lb) to evaluate each stock. We recognize that production costs for June and fall fingerlings differ, and that production costs as well as distribution costs will vary among hatcheries. We regard \$3.30/kg of trout as merely a convenient approximation.

Costs of fall-stocked trout in Sportsman Lake ranged from \$231 to \$391/ha. Clearly, the pond was overstocked in 1967 and 1974 when the most pounds were stocked, and stocking costs were therefore highest. Most reasonable cost estimates would be about \$250/ha. Costs of June stocks were \$37/ha. When the pond was not overstocked with fall fingerlings value of trout in spring increased by \$40 to \$96/ha, while the value of June stocks increased \$28 and \$127/ha. At a reasonable stocking rate, both June and fall fingerlings provided favorable returns. The major difference was production costs, about \$250/ha for fall fingerlings and \$137/ha for June fingerlings.

Based on trial calculations, it appeared that the largest change in biomass of fall fingerlings would result from stocking 100 kg/ha of 65-g fish. We used regression equations from Figures 2 and 3 to estimate overwinter growth rates and survival of fall fingerlings averaging 35 to 65 g. The expected change in biomass was then converted at $3.30/kg of trout. For fall fingerlings stocked at 35 g, the expected net value (value in spring minus production costs) was -$110/ha (Fig. 4). As size of stocked trout increased, net value continued to increase. Net value became positive when trout weighed 50 g or more at stocking. Larger trout were expected to survive better than smaller ones and this increased survival had the most influence on the ultimate biomass and net value of the stock. If 71 kg/ha of 65-g trout had been stocked, net value of about $143/ha would be expected. At a stocking rate of 100 kg/ha, as shown in Figure 4, net value for 65-g fish was $147/ha. Trout would be expected to grow faster when stocked at 70 rather than 100 kg/ha, but the increased growth rate would not be great enough to compensate for the 30-kg difference in initial biomass.

For June stocks, we plotted the actual net values in Figure 4, $29 and $128/ha. Results of the June 1972 stock were nearly as high as the best returns expected from stocking 65-g fish in fall. In this analysis, the major difference was investment costs; June stocks amounted to $137/ha, or less than half the cost of fall stocking (Fig. 4).

Causes of Mortality

In most studies of fish populations, specific causes of natural mortality are unknown; this study was no exception. Other than the June 1972 stock, overwinter survival was directly related to mean size of trout at the time of release.

Brynildson et al. (1966) found that over-winter survival was significantly higher ($P<.01$) for the largest domesticated brown and rainbow trout fingerlings when stocked during summer and fall in an ice-free section of stream.

At Lawrence Creek, Hunt (1969) found a direct relationship between overwinter survival of brook trout fingerlings and their mean weight in September. He also showed a direct relationship between overwinter survival and water temperature. Hunt suggested that larger fingerlings possessed increased physiological resistance to temperature-associated stress. Winter water temperatures in Sportsman Lake are moderated by groundwater inflow and prolonged periods of low water temperatures as found in Hunt's study, would not occur. We suggest that avian predation was a major factor influencing trout survival. High mortality of salmonids has been attributed to predation, particularly avian, in several studies (Elson 1962; Eipper 1964; Smith 1968 and Alexander and Shetter 1969).

Kingfishers (*Megaceryle alcyon*) were the most common predators at Sportsman Lake while great blue herons (*Ardea herodias*) were also sighted, though less frequently than kingfishers. During spring and fall sampling, we often found trout with beak marks characteristic of kingfisher attacks. Salyer and Lagler (1946) measured 651 trout found in kingfisher stomachs; length range of trout was 25 to 176 mm (mean = 58 mm). All trout that we stocked, except the rainbows, had some individuals within this length range. We hypothesize that kingfisher attacks were more frequently successful on smaller rather than on larger trout and that the relationship between survival and mean size was primarily a result of size-differential predation.

Alexander and Shetter (1969) stocked similar-sized brook and rainbow trout (226 mm) in East Fish Lake during mid-October. Over a 5-year period, mean survival of rainbow trout from October to April was nearly 100 percent and survival of brook trout was 49 percent. High survival of trout held in cages provided indirect evidence that predation was responsible for high mortality of brook trout. They felt that the brook trout's tendency to remain in shallow portions of the lake made them more vulnerable to predation than the rainbow trout which inhabited deep areas of the lake. We noted a similar species distribution in Sportsman Lake. The high survival of rainbow trout in our study may well have been related in part to their habitat selection.

Trout Food Habits

Benthic organisms, mudminnows, and sticklebacks were the predominant food items of trout. By number, snails, amphipods, and chironomids were the most important invertebrate groups consumed (Table 5). If food items were evaluated by weight, forage fish would have ranked among the most important foods. Although brook and rainbow trout shared the same food resources, there were some differences in utilization when food groups were ranked by mean numbers of organisms in trout stomachs. Both trout species fed upon chironomids (mostly immatures) with equal intensity. Rainbow trout consumed more corixids, snails, and zooplankton than did brook trout by ratios of 4:1, 2:1, and 10:1, respectively. Brook trout fed more upon fish and amphipods than did rainbows by ratios of 2:1 and 3:1, respectively. As the study progressed, it appeared that densities of sticklebacks and particularly, mudminnows increased, but consumption of these fish by trout remained the same.

Populations of Daphnia ambigua fluctuated markedly during the study; densities ranged from less than 1/liter to 20/liter. When densities of Daphnia exceeded 4/liter, they were heavily utilized by brook trout. Daphnia populations were high in July 1972 and January 1973; mean frequency of occurrence in trout stomachs ranged from 70 to 90 percent and mean numbers of Daphnia per stomach ranged from 300 to 900, of which 90 percent were 1 mm or larger. Although brook trout are not considered planktivores, they utilized Daphnia when available. With the exception of occasional high incidences of Daphnia in trout stomachs, the food habits shown for brook trout in 1971 (Table 5) were similar to those in other years.

Food habits of trout in Sportsman Lake were similar to those of wild brook trout in other spring ponds. Relatively small benthic invertebrates dominated the diet of all sizes of trout, though sticklebacks were important for the largest fish (Carline 1975). We suspect that the absence of large brook trout in many spring ponds is due in part to the lack of large invertebrates and abundant forage fish.

MANAGEMENT RECOMMENDATIONS

Size of Stocked Trout

Highest returns and lowest investment costs are most likely to result from stocking brook trout in June or July when they average 80 to 90 mm (3 to 4 in) in length and weigh 7 to 12 g. If ponds must be stocked in fall, we suggest selecting the largest available fish and stocking them immediately before freeze-up to reduce the possibility of avian predation.

Stocking Rates

We stocked Sportsman Lake with 2,900 June fingerlings/ha (1,200/acre). This was a hard water pond with substantial nutrient inputs, so that stocking rates for most other spring ponds should be adjusted downward. In ponds with alkalinities over 100 ppm as $CaCO_3$, 2,000 to 2,400 brook trout fingerlings/ha seems reasonable, while soft water ponds could be stocked with 1,700 to 2,000 fingerlings/ha. Recently dredged ponds are not as productive as ponds dredged more than 5 years hence; stocking rates for recently dredged ponds should be adjusted accordingly. Ultimately, experience will provide the best indication of reasonable stocking rates for each pond. Spring electrofishing surveys will allow one to measure growth rates of stocked fingerlings and provide a yardstick for future stockings. Returns of stocked fish from creel surveys do not provide adequate growth data since sport fisheries tend to be size selective.

Barriers

The desirability of a barrier on a pond outlet will be dictated largely by local conditions. A barrier will prevent immigration by wild trout so that stocking will have to be the sole source of recruitment. However, ponds located near warmwater streams are likely to be invaded by northern pike (Esox lucius) and a barrier would be essential.

Barriers will serve to prevent emigration of stocked trout (Carline, unpublished). In one pond without a barrier, nearly all June fingerlings had emigrated within 4 months after stocking. We have stocked wild fingerling brook trout in two spring ponds without barriers; in both instances, emigration of these fish was substantial and few trout remained in the pond a year after stocking when they would have been legal size.

Barrier design should be carefully considered. The structure on the Sportsman outlet allowed only subsurface water to flow out. Surface scum was effectively retained in the pond and continually built up during summer months. When the wind blew from the south, floating debris was distributed over the entire pond surface and fishing was hampered. A barrier that permitted flow of surface waters would have alleviated this problem of surface scum. A drawing of such a barrier installed in Beaver Lodge Pond, Washburn County, is illustrated in Figure 5.

Utilization of Pond Productivity

Although food habits of stocked brook and rainbow trout were similar, we feel that a combination of trout species would provide the most efficient utilization of a pond's productivity. We did not stock brown trout because of local interest in brook trout. Since brown trout are less vulnerable to angling and more piscivorous than brook trout, they may be a good choice for a second species. Growth rates of wild brown trout in other spring ponds generally exceed those of wild brook trout, and brown trout tend to attain much larger sizes than brook trout. However, it is possible that carryover brown trout would prey upon fingerling brook trout. Although overwinter growth of rainbow trout was not as great as that of brook trout, a number of rainbow trout in Sportsman Lake eventually exceeded 300 mm (12 in), a size attained by few brook trout.

Introduction of Food Organisms

In 1971 we stocked several thousand isopods, (Asellus intermedius?) from the Wisconsin River. Apparently reproduction was poor. It wasn't until 1975 that we found a few isopods in trout stomachs and their contribution to the total diet was inconsequential. This species of isopod reproduces best above 20^{o}C and we suspect that the relatively cool waters of Sportsman Lake were not conducive to isopod reproduction. This was the only time we tried introducing additional trout foods into a spring pond.

Although sticklebacks and mudminnows were abundant in Sportsman Lake in 1975 their utilization by trout was low. Other species of forage fish may provide a good food source for trout and experimental introductions of forage fish should be considered in other ponds that have a low diversity of forage species.

SUMMARY

1. We made five fall stocks and two June stocks of domesticated brook trout. Wild brook trout were included in one of the fall stocks and domesticated rainbows in another. Biomass of fall stocks ranged from 70 to 119 kg/ha and June stocks were about 20 kg/ha.

2. All fall-stocked trout grew overwinter and growth rates were inversely related to density.

3. Survival of fall-stocked trout ranged from 48 to 77 percent and was directly related to mean size of trout when released. Brook and rainbow trout that weighed over 60 g each when stocked had the highest survival.

4. When fall stocking rates exceeded 100 kg/ha, trout biomass declined overwinter. When stocked at 70 kg/ha, the overwinter increase in biomass was greatest -- 33 percent.

5. Survival to spring of June stocks was 17 and 40 percent. Lower survival of June stocks was attributed in part to illegal winter fishing.

6. Biomass increases to the following spring of June stocks were 22 and 90 percent.

7. At moderate stocking rates both June and fall fingerlings provided satisfactory spring populations. June fingerlings were the most economical since production costs were about half those for fall fingerlings.

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TABLE 1. Stocking history of Sportsman Lake.

Date	Species	Strain	Number Stocked	Mean Weight(g)
19 Oct. 1967	Brook	Domestic	2,024	40
23 Oct. 1968	Brook	Domestic	1,005	49
24 Oct. 1969	Brook	Wild	449	44
28 Oct. 1969	Brook	Domestic	800	51
10 Nov. 1970	Brook	Domestic	500	50
10 Nov. 1970	Rainbow	Domestic	500	65
9 May 1972	Brook	Domestic	300	95
19 June 1972	Brook	Domestic	2,044	7
13 June 1973	Brook	Domestic	2,025	7
23 Oct. 1974	Brook*	Domestic	1,390	37
	Brook**	Domestic	510	64

*Clipped adipose (A).
**Clipped adipose - left ventral (ALV).

TABLE 2. Growth and survival of trout stocked in Sportsman Lake in fall.

Strain and Species	Date	Population Estimate (95% confidence limits)	Survival per 180 days (%)	Size: Mean Length (mm)	Size: Mean Weight (g)	Biomass (kg/ha)	Overwinter Instantaneous Growth Rates (G/180 days)
Domestic Brook	19 Oct. 1967	2,024--stocked	54.5	155	40	116	
	29 Apr. 1968	1,023 (905, 1,197)	3.6	178	53	74	
	16 Oct. 1968	39 (35, 57)	46.0	251	252	14	0.264
	6 May 1969	16		279	304	7	
Domestic Brook	23 Oct. 1968	1,005--stocked	61.2	173	49	70	
	6 May 1969	568 (464, 721)	4.2	223	110	90	
	6 Oct. 1969	28 (17, 38)	71.1	274	272	11	0.746
	23 Apr. 1970	18 (11, 67)		292	339	8	
Wild Brook	24 Oct. 1969	449--stocked	47.9	170	44	28	
	23 Apr. 1970	214 (172, 352)	25.4	198	80	24	
	14 Oct. 1970	56 (32, 167)	27.8	239	166	13	0.595
	19 Apr. 1971	15		249	192	4	
Domestic Brook	28 Oct. 1969	800--stocked	64.9	178	51	59	
	23 Apr. 1970	528 (421, 639)	6.3	211	94	70	
	14 Oct. 1970	34 (20, 156)	23.1	246	175	9	0.622
	19 Apr. 1971	8		277	277	3	
Domestic Brook	10 Nov. 1970	500--stocked	67.6	183	50	36	
	19 Apr. 1971	378 (292, 509)		213	93	50	0.694
	7 July 1971			223	128		
Domestic Rainbow	10 Nov. 1970	500--stocked	76.7	190	65	47	
	19 Apr. 1971	429 (289, 757)		218	97	60	0.448
	7 July 1971			226	114		
	12 June 1972			338	364		
	Oct. 1972			419	877		
Domestic Brook	23 Oct. 1974	1,390--stocked	48.9	160	37	73	
	15 Apr. 1975	703 (475, 1,330)		185	48	48	0.327
Domestic Brook	23 Oct. 1974	510--stocked	62.0	189	64	46	
	15 Apr. 1975	327 (231, 561)		218	85	40	0.294

TABLE 3. Correlation coefficients for overwinter growth and survival of fall stocked trout in relation to mean size at stocking and trout density. (*P <0.05, **P <0.01, df=6)

Independent Variables	Dependent Variables: Percent Survival	Instantaneous Mortality Rate	Instantaneous Growth Rate
Mean Length at Stocking	0.79*	-0.80*	0.47
Mean Weight at Stocking	0.79*	-0.78*	0.04
Mean Number of Trout	-0.47	-0.65	-0.86**
Mean Biomass of Trout	0.11	-0.20	-0.84**
Initial Number of Trout	-0.54	0.54	-0.89**
Initial Biomass of Trout	-0.30	0.45	-0.85**

TABLE 4. Growth and survival of domesticated brook trout stocked in June.

Date	Population Estimate (95% confidence limits)	Actual Survival (%)	Survival per 180 days (%)	Size: Mean Length (mm)	Mean Weight (g)	Biomass (kg/ha)
19 June 1972	2,044			91	7.0	20
		46.5	27.9			
5 Oct. 1972	939 (814, 1,098)			157	32	43
		87.3	95.0			
19 Apr. 1973	820 (678, 945)			188	69	81
11 June 1973				198	86	
		9.4	9.0			
9 Oct. 1973	77 (60, 112)			239	135	15
		75.3	85.4			
1 May 1974	58			251	185	15
13 June 1973	2,025			88	7.4	21
		34.9	22.9			
9 Oct. 1973	707 (615, 826)			157	39	39
		49.5	56.1			
1 May 1974	350 (298, 427)			201	97	48
22 Oct. 1974				235	146	

TABLE 5. Stomach contents of 54 domesticated brook trout and 51 domesticated rainbow trout collected from February through July 1971.

	Brook Trout			Rainbow Trout		
Organism	Freq. of Occurr. (%)	Percent of all Organisms	Mean number per stomach	Freq. of Occurr. (%)	Percent of all Organisms	Mean number per stomach
Gastropoda	49.7	13.4	1.8	72.6	22.4	4.2
Amphipoda	53.2	47.0	7.8	33.8	16.6	2.6
Daphnia	2.2	4.1	0.4	6.1	19.4	4.8
Other Zooplankton	0	--	--	14.3	7.8	1.2
Chironomidae	46.4	21.3	3.3	64.2	20.7	3.8
Ephemeroptera	5.7	0.4	0.1	0	--	--
Trichoptera	10.2	1.9	0.2	1.6	0.1	*
Odonata	3.4	0.2	*	0	--	--
Corixidae	20.7	3.2	0.4	30.7	5.6	1.4
Coleoptera	16.7	4.7	0.8	30.0	3.9	0.7
Terrestrial insects	4.4	0.4	0.4	22.1	1.6	0.4
Fish	19.3	1.5	0.2	7.7	0.5	0.1

*Less than 0.05.

TABLE 6. Change in biomass and value of June- and fall-stocked trout.*

		Biomass			Value of Trout in $/ha		
Time & Year of Stocking	Species and Strain	At Stocking (kg/ha)	In Spring (kg/ha)	% Change	At Stocking	In Spring	Difference
Fall							
1967	Domestic Brook	116	77	-33	$381	$254	- $127
1968	Domestic Brook	70	89	+37	231	293	+ 62
1969	Domestic Brook	59	71	+22	193	236	+ 43
	Wild Brook	29	24	-15	94	80	- 14
	Total	88	95	+ 8	287	316	+ 29
1970	Domestic Brook	36	50	+40	117	166	+ 49
	Domestic Rainbow	46	60	+31	151	199	+ 48
	Total	82	110	+34	268	365	+ 97
1974	Domestic Brook(A)	73	49	-33	240	160	- 80
	Domestic Brook(ALV)	46	40	-12	151	131	- 20
	Total	119	89	-25	391	291	- 100
June							
1972	Domestic Brook	43	81	+90	141	269	+ 128
1973	Domestic Brook	40	49	+22	131	160	+ 29

*Trout were valued at $3.30/kg.

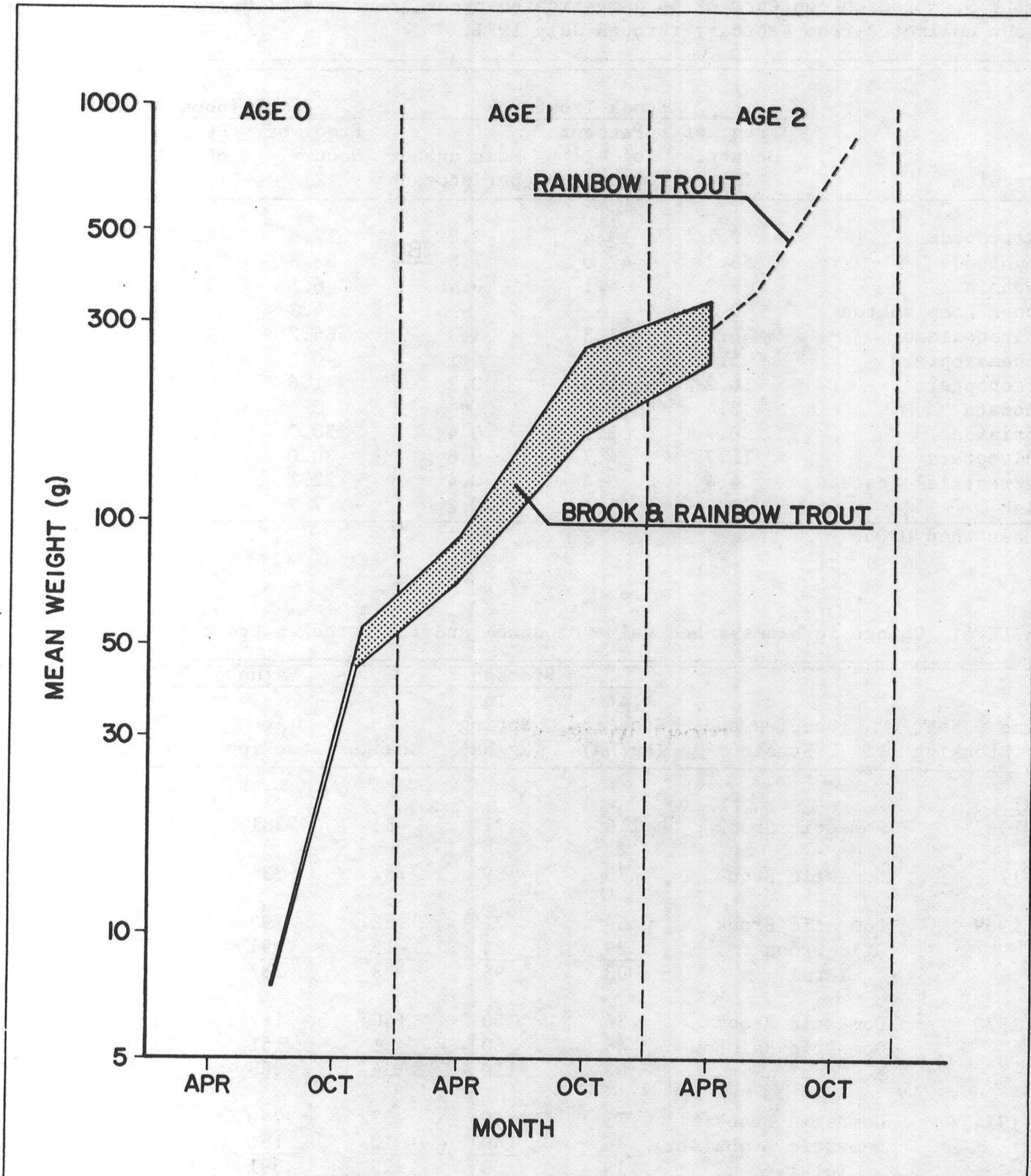

FIGURE 1A. Growth (in weight) of stocked brook and rainbow trout in Sportsman Lake. Hatched areas depict size ranges.

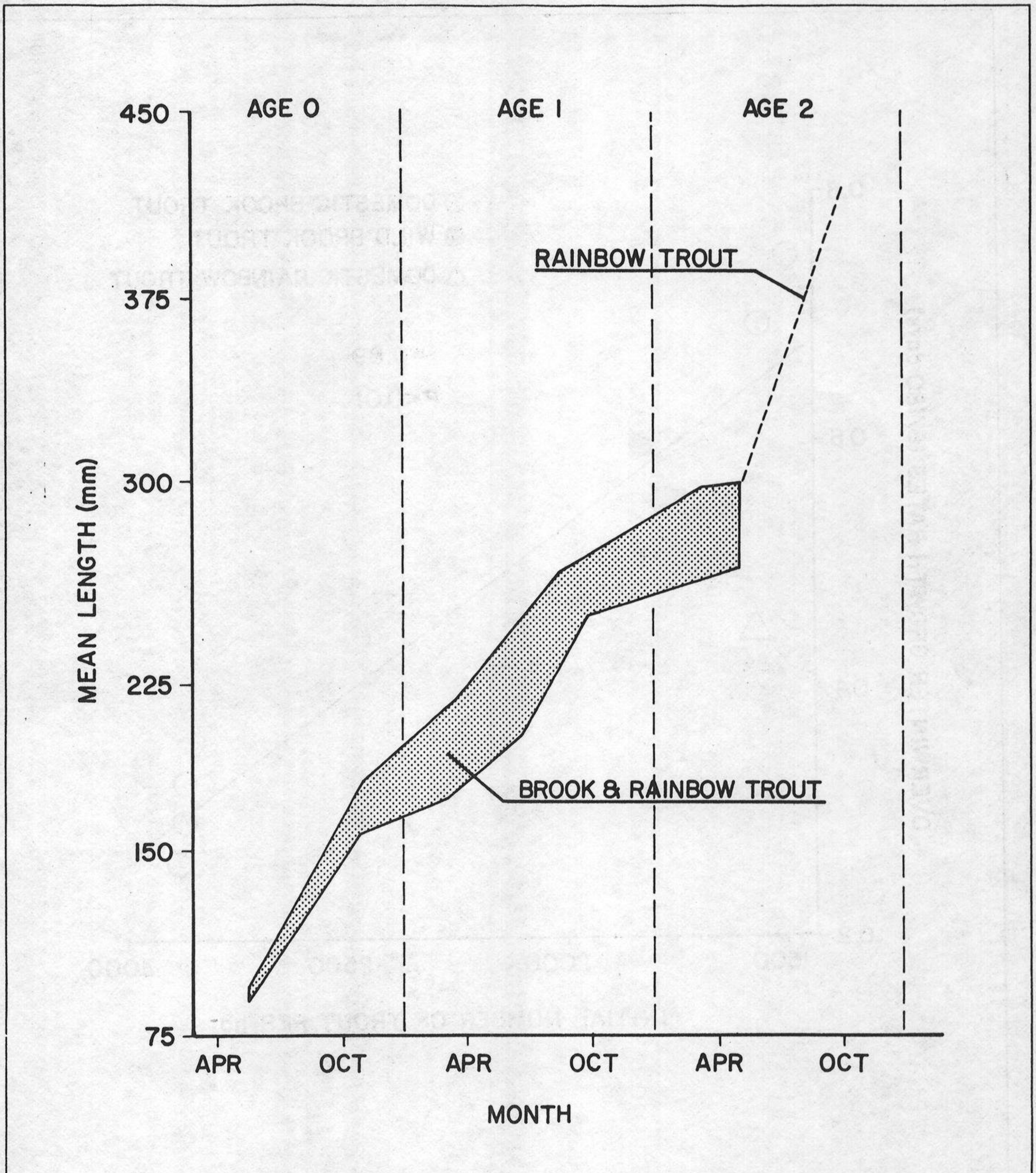

FIGURE 1B. Growth (in length) of stocked brook and rainbow trout in Sportsman Lake. Hatched areas depict size ranges.

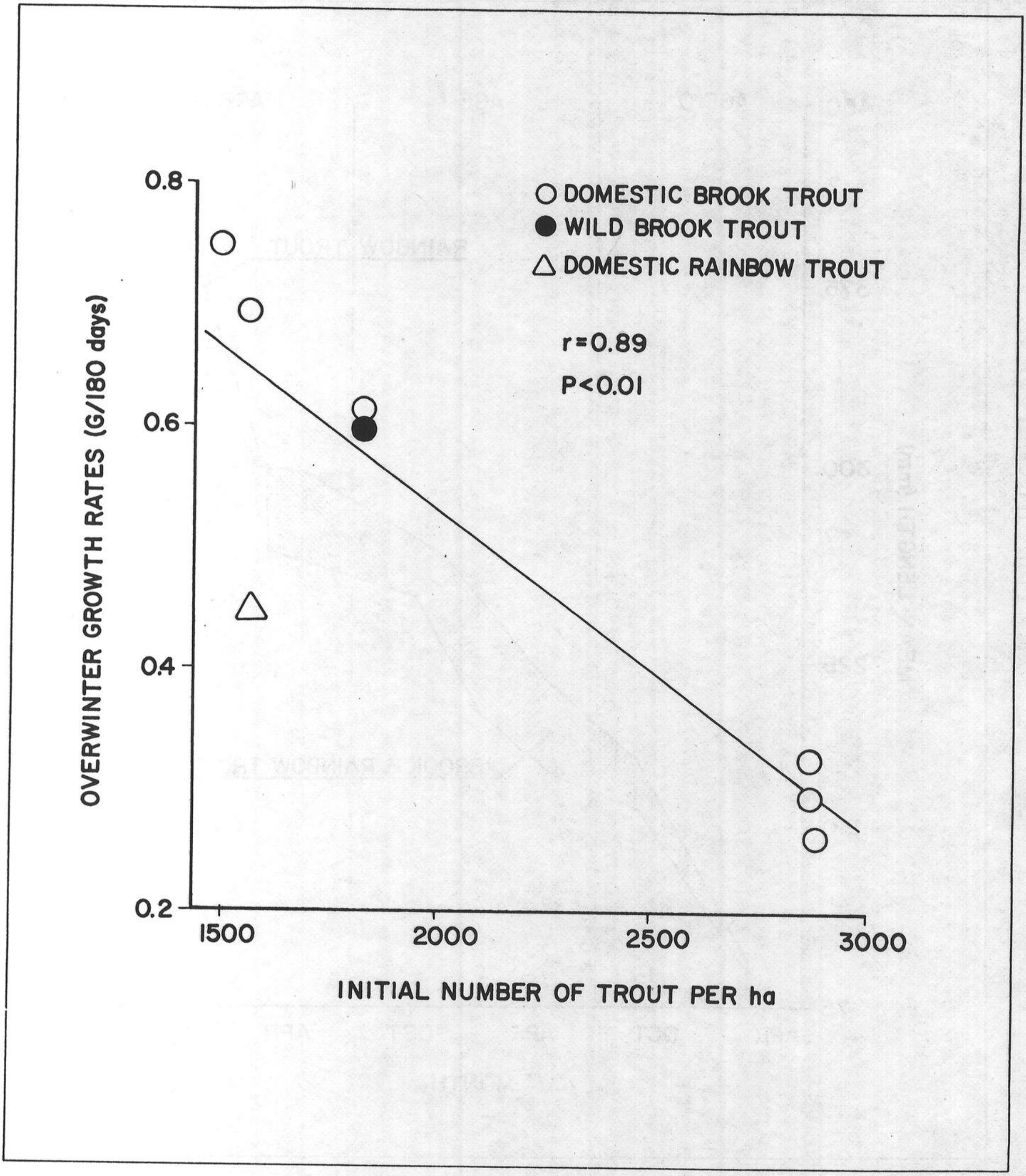

FIGURE 2. Relationship between overwinter growth rates of fall-stocked trout and initial trout density.

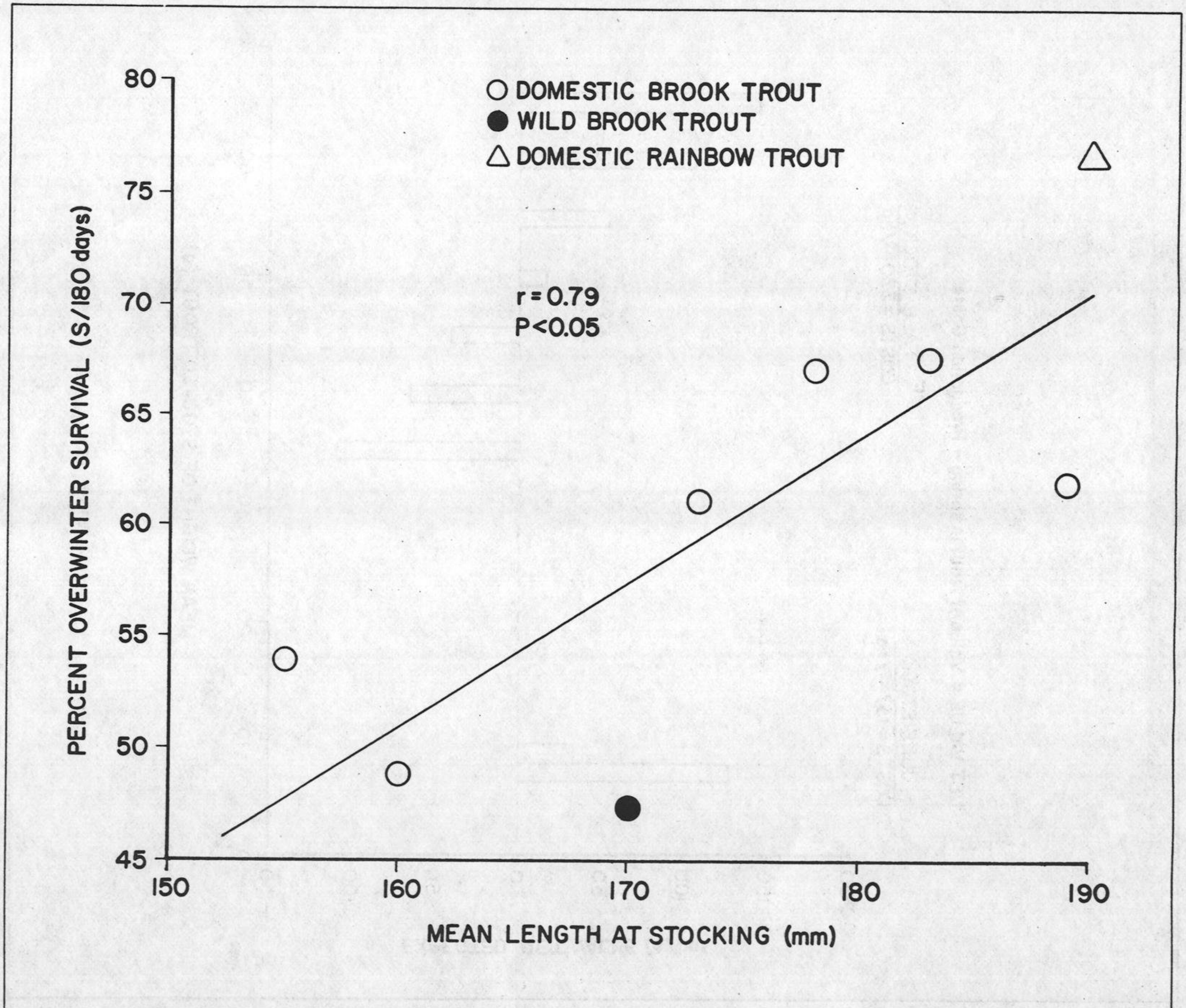

FIGURE 3. Overwinter survival of fall-stocked trout in relation to their mean length at stocking.

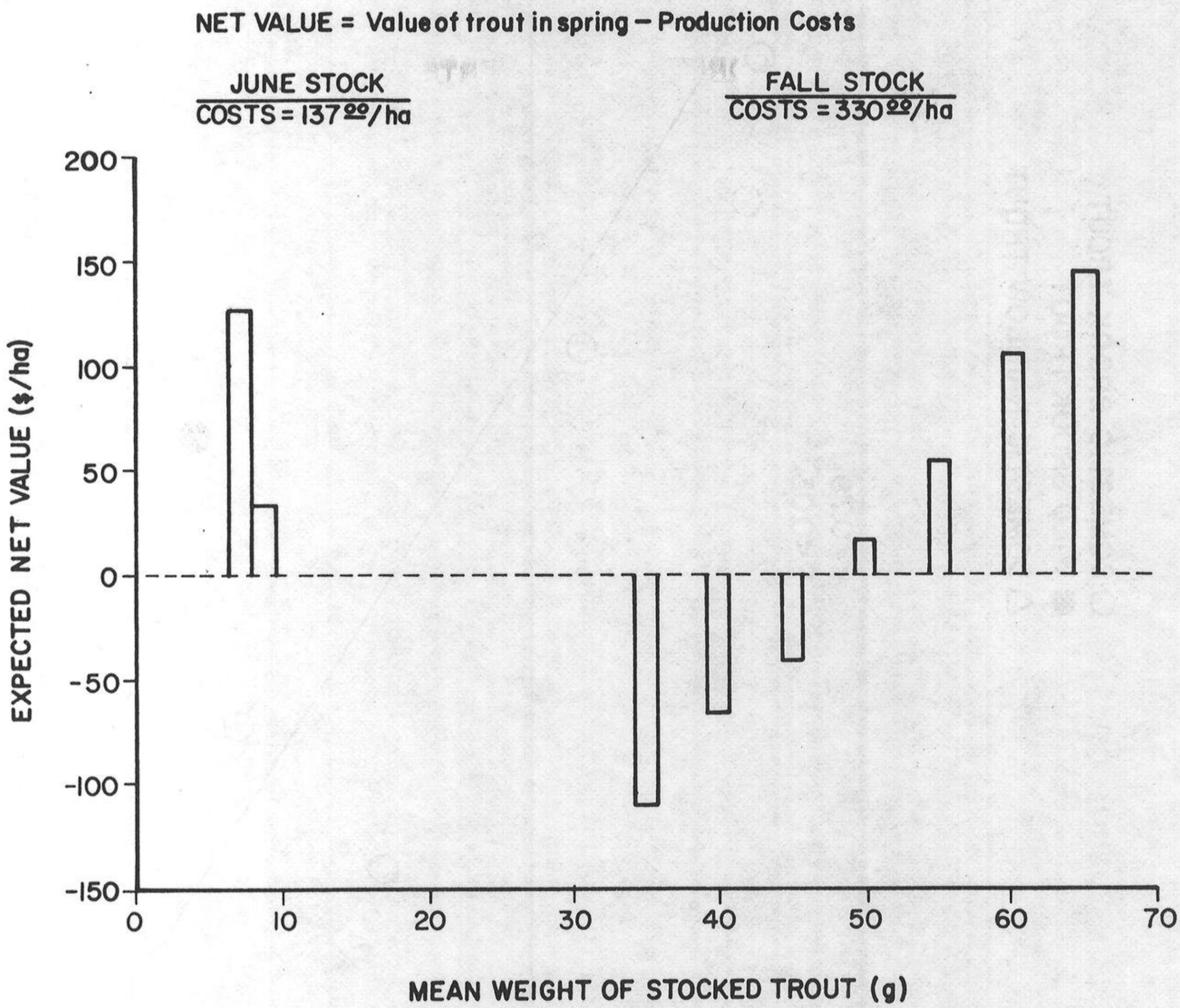

FIGURE 4. Net values of June- and fall-stocked trout in relation to size at stocking. Actual net values of June stocks are illustrated. Expected net values of fall-stocked trout were estimated from relationships shown in Figures 2 and 3 at a stocking rate of 100 kg/ha. Biomass of trout was valued at $3.30/kg.

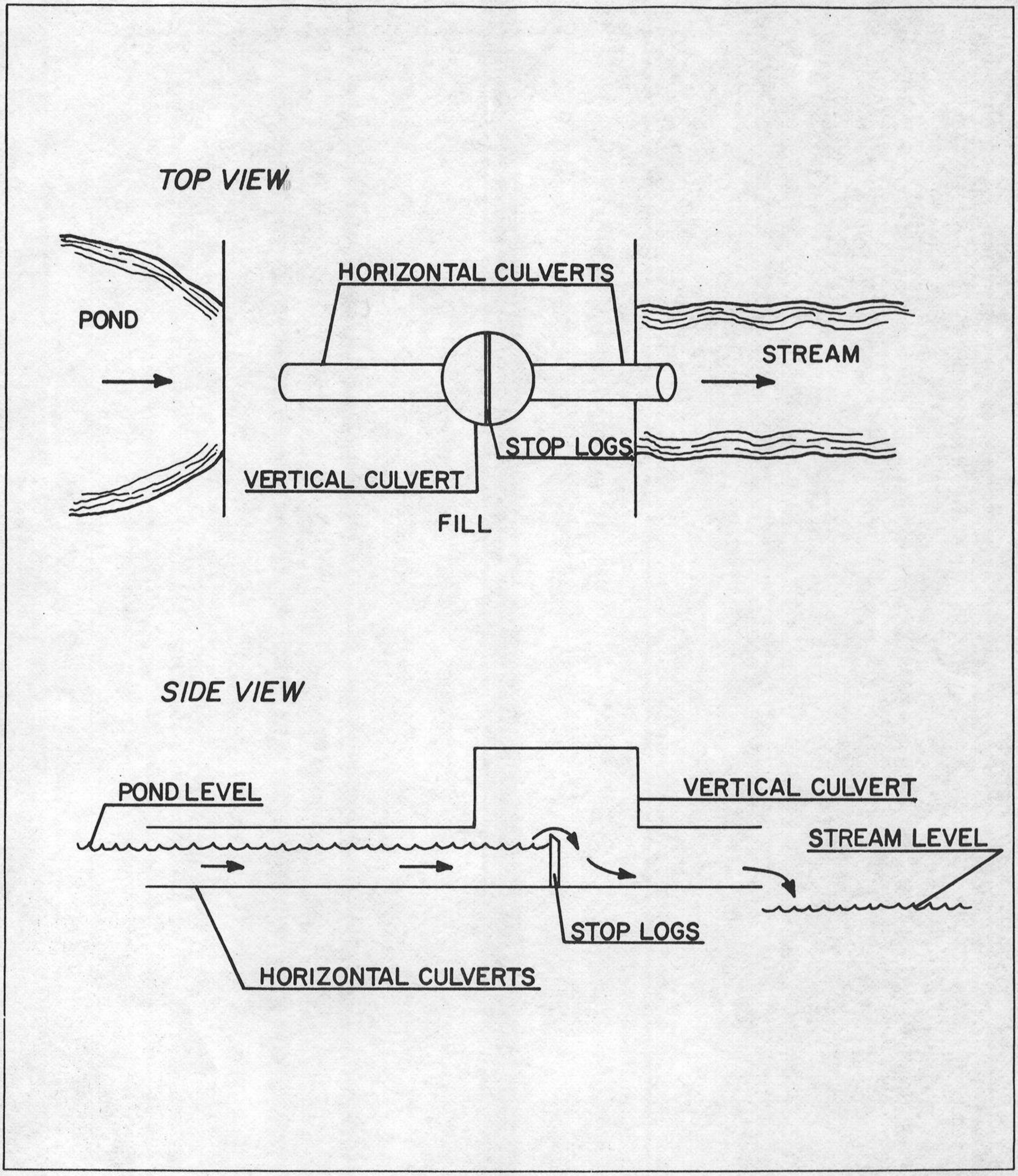

FIGURE 5. Drawing of outlet structure at Beaver Lodge Pond, Washburn County.