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EXPLOITATION, GROWTH, AND SURVIVAL OF THREE STRAINS OF DOMESTIC BROOK TROUT

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ABSTRACT

Three strains of domestic brook trout (*Salvelinus fontinalis*) were stocked in three study lakes at 15-16 months of age. All three strains proved to be so vulnerable to angling that too few survivors were present after six months to warrant continuation of the study. Although some statistically significant differences were found in exploitation, growth, and survival between strains, replacing the standard Osceola strain with the New Hampshire or Assinica strains to improve field performance of stocked brook trout is not justified.

Survival from late April to mid-October 1977 was best in McGee Lake (22.7a) but only 8.2% of the New Hampshire strain, 2.5% of the Osceola strain and 0.9% of the Assinica strain survived from the original stocking of 88.1/a of each strain. Angling exploitation rates for this lake were estimated to be 84%, 82%, and 74% for the Osceola, New Hampshire, and Assinica strains, respectively. In Adams Lake (28.4a) and Hazel Dell Pond (2.3a) angling exploitation probably approached 100% for all three strains. No survivors were found in Hazel Dell Pond in October and only 25 New Hampshire strain and one Assinica strain survived in Adams Lake out of 1,000 of each strain stocked six months earlier.

Bag limit catches of five trout/trip were common during May but catches of 10/trip were rare during June-September. The reduced bag of five during May is a management regulation instigated to help spread out and prolong the harvest of stocked trout in lakes.

Growth of all three strains was exceptionally good in McGee Lake and supports the management decision made to chemically reclaim this lake in 1974 and manage it thereafter as a trout lake. It received 457 hours of angling/acre in 1977. The Assinica strain achieved the best April-October growth followed by that of the Osceola strain. Further stocking of the Assinica strain in public waters can only be justified if it is given special protection with restrictive regulations that would greatly reduce harvest. Such protection would more fully utilize its inherently better growth rate and potential longevity than they were in this study.

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INTRODUCTION

Prior to 1976, nearly all brook trout (*Salvelinus fontinalis*) stocked annually by DNR were derived from a parental stock that has been subjected to selective inbreeding at the Osceola Hatchery in northwest Wisconsin since about 1925. Progeny of this inbred brood stock are both phenotypically and genetically different from wild brook trout (Menzel and Krueger, in press). From a cultural viewpoint such inbreeding has produced a strain that is more docile, easier to raise under hatchery conditions, grows better, has higher food conversion efficiencies, and is more fecund than wild strains of the same species (Vincent 1960). It is common knowledge that such a domesticated strain is also easier for anglers to catch than are its wild counterparts, a factor that may have positive or negative management implications, depending on the goals for a particular sport fishery.

On the minus side, for some management applications, domestic stocks seldom survive more than one or two years after introduction into natural environments. Consequently, where long-term survival is desired in order to sustain a more varied sport fishery including some larger carryover trout, or where survivors are desired to eventually reach maturity and spawn, brook trout of domestic origin (such as the Osceola strain) are seldom satisfactory. Few survive through even one fishing season (Brynildson and Christenson 1961) or, even in the temporary absence of angling mortality, are able to survive in rigorous environments in proportions adequate enough to justify the economic investment (Cordone and Nicola 1970).

Evidence accumulated from field tests during the past two decades indicates a consistent pattern of short-term survival (less than 2 years) for stocks of domestic brook trout. The number of calls for reevaluation of the goals and methods of hatchery culture programs has also escalated. Calaprice (1969), Ayles (1973), Kincaid (1976), and Flick and Webster (1975) have gone on record as favoring new emphases in trout culture programs. They stress greater reliance on random selection of brook stocks from numerically larger lots, more frequent introductions of fish from wild stocks into the "gene pool", and greater use of inter-strain hybrids to increase the fitness of hatchery-reared trout for survival after liberation into natural environments (hybrid vigor).

Especially encouraging management results have been obtained in New York and New Hampshire from experimental stockings of brook trout produced by crossing domestic females with wild males of the Assinica strain, a strain native to the Broadback River system (including Assinica Lake) that drains into the southeast corner of James Bay, Province of Quebec. Flick and Webster (1975), who pioneered introduction of this strain into the U.S., report that in its native range these Assinica strain brook trout reach exceptionally large size for this species (commonly exceeding five pounds and occasionally exceeding 12 pounds), live as long as nine years, and mature two to three years later in life than most strains of brook trout in the U.S. Differences in external color patterns also exist between the wild Assinica strain and strains of both wild and domesticated brook trout in the U.S. Referring to field experiments with Assinica x domestic cross, Flick and Webster reported that it was "singular in performance in what appears to be an expression of hybrid vigor." This and other Canadian hybrids currently under evaluation offer promise in providing a superior fish for growth and survival in natural waters that support sport fisheries dependent on stocking. Lifetime gross production by the Assinica hybrid (total growth of the stock in pounds) was 5.7 times greater and angler yield in relation to biomass stocked was 6.6 times greater than relative performances by stocks of totally domestic strains (comparable to Wisconsin's Osceola strain).

Based on the field tests of this Canadian strain by Flick and Webster, approximately 10,000 eyed eggs of the New York domestic (Randolph strain) x wild Assinica strain were obtained by the Wisconsin DNR in December 1975 for the purpose of testing this wild-domestic cross in Wisconsin waters. A few years earlier a stock of domesticated brook trout of the New Hampshire strain had also been obtained to evaluate their performance in the hatchery and in natural environments compared to capabilities of our "standard" Osceola strain. Negotiations to obtain the New Hampshire strain were initiated in response to persistent problems with outbreaks of disease (especially furunculosis) among brood stocks and their progeny at the Osceola Hatchery (John Klingbiel, pers. communication).

A supply of 212,000 disease-free eggs of the New Hampshire strain were obtained in December 1973 for culture at the St. Croix Falls Hatchery and subsequently raised to spawning size. It was intended that enough progeny to meet annual stocking quotas for brook trout be produced by using only trout of the New Hampshire strain. This goal was reached in the fall of 1976 and nearly all yearling brook trout stocked in 1977 were New Hampshire strain. Rehabilitation of the Osceola Hatchery in 1977 consisted of a series of raceway drawdowns and disinfection treatments, reintroduction of disease-free eggs of the Osceola strain, and eventual return to production of fingerlings and yearlings for stocking as needed.

Although much field testing for growth and survival has been done in a variety of Wisconsin lakes and streams with the Osceola strain (Brynildson and Christenson 1961; Mason, Brynildson, and Degurse 1967), the New Hampshire and Assinica strains have never been field tested in Wisconsin waters. The study reported here represents an initial effort to evaluate these two new strains of brook trout for longevity, growth after stocking, and relative vulnerability to angling in comparison with each other and with contemporary stocks of the standard Osceola strain.

STUDY OBJECTIVES

Specific research objectives were to gather field data on exploitation, growth, and survival for each strain stocked in equal numbers as spring yearlings (15-16 months old). The study was originally planned to run for three years on the assumption that enough trout of each strain, particularly the potentially long-lived Assinica strain, would survive to justify continuation of field sampling.

The management related objective was to assess field performance of each strain in terms of modifying DNR trout culture and stocking procedures if the New Hampshire and/or Assinica strains proved to have growth, survival, or catchability characteristics that would be useful for diversifying or improving sport fisheries dependent on stocking.

STUDY SITES

Several potential study streams and lakes were investigated in the field and some were surveyed with electrofishing gear.

Criteria considered in the selection process included:

1. Good physical-chemical conditions for survival;
2. Moderate levels of angling pressure so that long term survival of stocks would be enhanced if they did not succumb to natural mortality;
3. Few angler access points so that census and interviews with anglers would be simplified;
4. Waters in which electrofishing gear was effective enough to conduct trout population inventories;
5. For streams, or portions of streams, the presence of natural or artificial barriers that would confine stocks to 1-2 miles of stream;
6. Good potential for trout growth, high carrying capacity for large trout, and low abundance of wild trout and piscivorous predators.

During the time available for selection of study sites no streams or stream segments were located that met most study criteria. Two small lakes and one spring pond were located that were judged satisfactory for study purposes and all three were included in the study. Morphometric, edaphic, and biotic features of the three study sites described below are largely based on routine lake survey data obtained from the files of DNR area fish managers for the counties in which the lakes are located.

McGee Lake

McGee Lake in southeast Langlade County has a surface area of 22.7a, a maximum depth of 38 feet, and a volume of 371 acre-feet. Water depth exceeds 20 feet over 27% of its area. Total alkalinity is approximately 134 ppm (July 1969 survey). Numerous springs are evident along the shore and in the lake. Physiologically suitable living conditions for trout exist throughout the lake the entire year. The outlet from McGee Lake flows into Drew Creek, a Class I brook trout stream. However, a structure installed in 1971 prevents movement of fish between the lake and stream, while also functioning as a water level control for the lake. McGee Lake is basically a large spring pond having physical-chemical-biological properties much like the 1-2 acre spring ponds in Langlade County studied by Carline and Brynildson (1977). However, it has a much longer turnover time in terms of water outflow in relation to lake volume.

In 1974 McGee Lake was chemically treated with rotenone and antimycin to rid the lake of several species of warmwater panfish, gamefish, and minnows. During 1975 it was restocked on four occasions with domestic brook trout (178/a total) and stocked again in 1976 with domestic brook trout at a rate of 110/a. Since chemical treatment an abundant population of brook stickleback (*Culaea inconstans*) and a sparse population of mudminnows (*Umbra limi*) have developed. Both constitute an excellent food resource for trout, especially the stickleback. By midsummer aquatic vegetation in the lake is dominated by abundant growth of *Chara sp.*

Although the entire shoreline is owned by the DNR, there is only one authorized public access parking area and boat launching site. This site is too steep to be used for launching boats from trailers.

Adams Lake

Adams Lake in eastern Portage County near Amherst has a surface area of 28.4a, a maximum depth of 44 feet, and a volume of 502 acre-feet (July 1963 survey). About 42% of the lake is more than 20 feet deep. Total alkalinity of this marl-type lake is 220 ppm and pH is 8.4 (October 1974 sampling). Adams Lake is the origin of Leary Creek, a Class I brook and brown trout stream. Dense collections of aquatic vegetation and marsh grasses at the lake outlet probably preclude movement of fish between lake and stream except during brief periods of high runoff.

Since at least 1949 the lake has been annually stocked with rainbow (*Salmo gairdneri*) or brown trout (*Salmo trutta*). During the 1962-76 period only brown trout were stocked at an annual density of approximately 36 legal-sized trout/a in the fall. Several species of minnows, panfish, and white suckers (*Catostomus commersoni*) inhabit the lake but none are considered abundant or stunted in their growth rate. A sparse population of largemouth bass (*Micropterus salmoides*) constitutes the only piscivorous predator of stocked trout other than potential predation by carryover brown trout.

There is only one public access road that leads to a turn-around, small parking area, and a poorly developed boat launching site. Most of the shoreline is privately owned agricultural land. Six private cottages are situated along the northwest shore.

Hazel Dell Pond

Hazel Dell Pond is a 2.3a impoundment near the headwaters of the La Crosse River. Located on the Ft. McCoy military reservation, this pond was constructed about 1944 by military personnel. Its maximum depth is six feet, but most of the pond is only 2-3 feet deep (February 1974 survey). Outlet flow passes over a concrete pad at normal outflow depth of only 1-2 inches (normal outflow is approximately 3.5 cfs). Total alkalinity and pH measured in August 1973 were 20 ppm and 6.5. Several inches of organic matter covers most of the pond bottom. Aquatic vegetation, primarily coontail (*Ceratophyllum demersum*) and filamentous algae (*Spyrogyra sp.*), becomes so abundant by midsummer that it tends to concentrate fishing to the lower and deeper one-third of the pond.

The pond sustains a sparse population of wild brook trout (40-50/a) that reproduces in the inlet stream, but the sport fishery has been primarily dependent on annual stocking of trout, yearling brown trout during 1963-71 and yearling rainbow trout during 1972-76. White suckers dominate the fish biomass. Golden shiners (*Notemigonus c. crysoleucas*), fathead minnows (*Pimephales p. promelas*), and mudminnows are also common.

This small trout pond was chosen primarily because of its remote location, history of fishing dependent on trout stocking, ease of counting angler vehicles entering via the single access trail, and potential for cooperative creel census assistance from the federal biologist stationed at Ft. McCoy. No boats are allowed for fishing and a special daily or annual fishing permit must also be obtained free of charge from the military administrator in charge of Ft. McCoy.

METHODS

Lots of brook trout of each strain to be stocked were hand-counted and fin-clipped at the St. Croix and Osceola hatcheries on April 22, 1977. Samples of 50 of each strain were also individually measured for length (to nearest 0.1 inch) and weight (to nearest gram). Six days later Adams Lake and McGee Lake were stocked. Stocking of Hazel Dell Pond was purposely delayed until May 16, the first Monday after the second weekend of the 1977 trout fishing season. The traditionally highest angling effort is associated with the two opening weekends. Delayed stocking increased the likelihood that some stocked trout would survive through the fishing season and thus provide growth data for each strain through their first summer of life in this pond and, possibly, through the subsequent winter. Stocking densities were 652/a in Hazel Dell Pond (500 of each strain), 264/a in McGee Lake (2,000 of each strain) and 106/a in Adams Lake (1,000 of each strain).

Survival through the 1977 fishing season was determined by conducting Petersen population estimates (Chapman modified) using a 230 volt A.C. boom shocker to collect trout for the marking and recapture samples on successive nights. A composite estimate was made for each lake by combining mark-recapture data for all strains as there was no reasonable justification based on differences in size or behavior between strains not to do so. This composite estimate of abundance was then apportioned by strain according to the ratios of strain-specific fin clips in the mark-recapture samples. A separate estimate was made of trout captured that were not fin-clipped (either wild trout or carry-over trout from stockings prior to 1977).

Post season estimates of survivors were made October 12 at Hazel Dell Pond, October 13 at McGee Lake, and October 17 at Adams Lake. The recapture collections of trout to determine electrofishing efficiency were made October 14 on McGee Lake and October 18 on Adams Lake. No recapture effort was made on Hazel Dell Pond because no stocked brook trout were collected on October 12. All trout captured were examined for fin-clips and individually measured for length and weight before being released.

Estimates of angler use and yield for Adams Lake and McGee Lake were based on season-long operation of axle counters installed on the main access road to each lake (Model 160, JR Traficounter), plus periodic interviews by trained technicians with anglers who had completed their fishing trip. Interview periods were selected to increase the probability of contacting anglers above the level expected from a random choice of interview periods.

During on-site observation and interview periods census personnel also gathered data on incremental changes in the axle count recorder, number of vehicles (axles) entering and leaving, angler vehicle vs. nonangler vehicle ratios, vehicle vs. boat trailer ratios, angler/car ratios, bank angler vs. boat angler ratios, and counts of angler cars at other locations around McGee Lake (even though such cars were not legally parked). These data were subsequently used to derive "correction factors" for adjusting monthly axle counts to estimates of anglers/month. This basic derived estimate of anglers/month was then multiplied by on-site data obtained from interviews to obtain estimates of hours of fishing, catch rates, harvest by strain, and other pertinent fishing statistics for evaluating the sport fishery.

The planned creel census at Hazel Dell Pond had to be cancelled when the federal biologist stationed at Ft. McCoy suddenly moved to accept employment elsewhere. Maintenance of the axle counter and interviews with anglers was dependent on his voluntary assistance. His position was not filled during the 1977 fishing season, no volunteer could be found as a substitute, and project funds were not sufficient to cover hiring someone for the task. Thus, emphasis for this study site was focused only on growth and survival of each strain through the 1977 fishing season.

RESULTS

McGee Lake

The Sport Fishery - On-site interviews with anglers were conducted on 42 days (29%) of the 147-day trout fishing season. Interview days/month varied from seven to nine and averaged 5.0 hours/interview period. Census technicians obtained information from 445 anglers who had finished fishing. This interview portion of the creel census covered approximately 13% of the estimated total angling trips, resulted in examination of 16% of the estimated total harvest, and covered approximately 8% of the total fishing hours (assuming a 16-hour "fishing day").

Angling effort on McGee Lake was estimated to be 456.6 hr/a or 147.7 trips/a (Table 1). As with most stream or lake sport trout fisheries in Wisconsin, angler use was skewed toward the first month of the five-month fishing season (when 55% of the total fishing hours and 59% of the total fishing trips occurred)(Fig. 2). For the entire season the average fishing trip lasted 3.05 hours. Based on monthly averages the length of a trip generally tended to get longer as the season progressed.

Monthly harvest of brook trout was even more skewed than angling effort, as might be expected for a fishery largely dependent on stocked trout. Of the total seasonal harvest (234.5/a), 77% was cropped in May (Fig. 1). Anglers fishing from shore accounted for 15% of the seasonal harvest and boat-anglers accounted for 85%. Seasonal catch rates for these two groups of anglers were 0.50 trout/hr for boat-anglers and 0.62 trout/hr for shore-anglers. Best fishing success was in May for both categories of anglers (Table 1). Anglers fishing from boats accounted for 88% of the angling hours for the season (Fig. 2). Shore fishing was most popular in May (19% of monthly total) when 87% of the seasonal total for such fishing occurred. All trout caught were not kept. Boat-anglers released one trout for each seven kept (28.7/a for the season) and shore-anglers released one trout for every six kept (5.5/a for the season).

Seasonal harvests of the three brook trout strains being tested were estimated to be 74.1/a for the Osceola strain, 72.1/a for the New Hampshire strain, and 64.9/a for the Assinica strain (Table 1). Yield estimates for the Osceola and New Hampshire strains were not significantly different at the 5% level but yields of both strains were significantly greater (X^2 at 1% level) than the yield for the Assinica strain. Angler exploitation rates were 84%, 82%, and 74% for the Osceola, New Hampshire, and Assinica strains, respectively.

Of the total harvest for each strain, 78% (Osceola), 73% (New Hampshire) and 79% (Assinica) were accounted for during May (Fig. 3). From a combined harvest of 161.7/a in May, harvest in successive months declined to 18.8/a in June, 19.7/a in July, 7.8/a in August and only 2.2/a in September. No Assinica strain brook trout were observed in catches examined in August.

Augmenting the catch of domestic test strains was a 23.4/a harvest of brook trout comprised of domestic fish stocked prior to 1977 and some wild brook trout from year classes spawned in McGee Lake. These fish represented only 10% of the total yield, but many were in the 15-19 inch size range. Anglers interviewed reported stories of a few catches of brook trout over 20 inches but the largest specimen observed in the creel census measured 19.3 inches. Catches of five trout/trip during May were common, especially by boat-anglers (Table 2). During the June-September period, however, when the daily bag limit was increased to 10, no limit catches were recorded. The largest observed bag was six trout; more than half of the anglers caught no trout during June-September.

Worms were by far the most popular bait type, accounting for 71% of the trout taken by boat-anglers and 76% of those taken by shore-anglers (Table 3). Use of live or dead minnows was not legal as has been the rule for fishing on McGee Lake since it was chemically reclaimed in 1974. If it were legal, fishing with minnows probably would have been common, as was the case for the trout fishery on Adams Lake.

Survival and growth - Sampling for the Petersen population estimates of trout surviving the fishing season was conducted on the evenings of October 13 and 14. A few trout of each strain were captured, measured for length and weight, and released. Recapture efficiency of these released trout was 26%.

During the recapture sampling effort 47 more trout were collected that had not been taken on the "capture run". Growth data were taken on these specimens, too. Thus, spring to fall growth data were collected on 45% of the total estimated "population" of 231 survivors.

The combined "population estimate" of 231 was portioned into strain components based on fin-clip frequencies designating each strain. This portioning derived spring to fall survival estimates of 2.5% for the Osceola strain, 8.2% for the New Hampshire strain, and 0.9% for the Assinica strain (Table 4). Survival rates of the Osceola and New Hampshire strains were significantly greater than survival of the Assinica strain; survival of the New Hampshire strain was also significantly greater than that of the Osceola strain (X^2 at 1% level). Despite being the least exploited by angling, the Assinica strain demonstrated poorest survival. In absolute terms, of the 2,000 of each strain stocked on April 28, only 17 Assinica strain, 50 Osceola strain, and 164 New Hampshire strain individuals survived until October 13.

Incremental gains in length and weight were greatest for survivors of the Assinica strain and least for the New Hampshire strain (Table 4). During the six month period from stocking to recovery sampling, average length of the Assinica strain survivors increased by 49% and average weight increased by 338%. During the same period length-weight gains were 42% and 235% for the Osceola strain and 33% and 146% for the New Hampshire strain. Thus, Assinica strain survivors had grown significantly more than Osceola and New Hampshire strain survivors in both length and weight. Length-weight growth increments for the Osceola strain were also significantly better than those for the New Hampshire strain.

Adams Lake

The Sport Fishery - More frequent interview efforts were conducted at Adams Lake than at McGee Lake but contact periods were shorter. Interviews were made on 63 days (42% of total), ranged from 11 to 16 days per month, and averaged 1.8 hours/interview period. The most important creel census input, however, was the axle counter which operated continuously throughout the fishing season across the only public access road to the boat launching site. Fishery data were obtained from 194 anglers who had completed their fishing trip. The on-site interview effort covered approximately 4% of the total fishing hours during which 9% of the estimated total number of anglers were interviewed and 18% of the estimated total harvest was examined.

Anglers fishing primarily for trout, or those fishing primarily for other species who creeled at least one trout, were included in the census estimate of 175.8 hours of fishing effort/acre, consisting of 73.7 trips/acre (Table 5). The average fishing trip was 2.4 hours in duration. Trip length tended to decrease over the course of the season rather than increase, as was the case at McGee Lake. Approximately 59% of the total fishing effort (Fig. 4) and 65% of the total harvest (Fig. 5) occurred in May. Only 2% of the fishing effort and no harvest occurred in September. Anglers fishing from boats accounted for 82-100% of the monthly effort, 94% of the total for the season, and 97% of the total catch. Trout were caught by shore-anglers during May only.

All three strains were heavily exploited. Seasonal estimates of yield were 41.9/a for the Osceola strain, also 41.9/a for the New Hampshire strain, and 36.5/a for the Assinica strain. The yield for the Assinica strain was significantly less (X^2 at 1% level) than that for the other two strains. Because of an uncorrectable bias in monthly axle counts, all three estimates of yield exceeded the initial stocking density of 35.2/a (by 19% for the Osceola and New Hampshire strains and 4% for the Assinica strain). Such overestimates of angler use and harvest were probably caused by nonangler vehicles crossing the axle counter cable after 10:00 p.m. No provision had been made to ascertain the magnitude of such "axle counts" to derive a correction factor. The resulting error detracts from the usefulness of the exploitation rates in absolute terms but does not obscure the relative difference in exploitation of the Assinica strain as compared to the other two strains, that is in agreement with the pattern of exploitation rates calculated for McGee Lake.

Approximately 70% of the total catch of Osceola strain was taken in May as compared to 58% for the New Hampshire strain and 69% for the Assinica strain (Fig. 6). In June, the New Hampshire strain dominated the catch. Angling effort was very light for the remaining three months of the season; no trout were creeled during the last month, based on 16 days of interview effort. This was the most intensive monthly effort of the season, an effort that was intensified to contact the few trout anglers still coming to Adams Lake.

Catches of five trout/trip by boat-anglers were much more common in May on Adams Lake (60% of total trips that month) than on McGee Lake (34%). Shore-anglers also did better on Adams Lake, where 25% made limit catches in May, than they did at McGee Lake where only 16% made limit catches during that month. During the June-September period a few limit catches of 10 were also observed during the creel census at Adams Lake (Table 6).

As a legal bait on Adams Lake minnows accounted for 38% of the catch by boat-anglers. Only 28% of the catch were taken on worms. Most of the anglers fishing from shore used worms for bait (Table 7).

Survival and Growth - No Osceola strain brook trout and only one Assinica strain specimen was captured during two evenings of electrofishing to collect population estimate data (October 17-18). Eleven brook trout of the New Hampshire strain were collected on the "capture run". Six of these were recaptured the following evening, plus the single Assinica trout captured and released, plus eight more New Hampshire strain individuals not caught on the capture run. These data were used to derive population estimates of one Assinica strain, 25 New Hampshire strain, and no Osceola strain brook trout surviving from the introduction of 1,000 of each strain six months earlier (Table 8).

Based on measurements of 19 survivors April-October growth data for the New Hampshire strain indicated a pattern of poorer growth in Adams Lake than in McGee Lake. Length-weight increments were 1.9 inches and 79 grams in Adams Lake vs. 3.1 inches and 230 grams of growth for survivors in McGee Lake. Coefficient of condition (R) in October averaged 1.69 for the Adams Lake sample and 2.05 for the McGee Lake sample (Tables 4 and 8).

Hazel Dell Pond

No sport fishery or growth data were obtained for the study strains stocked in this small impoundment. All stocked trout of all three strains were either caught, died, or moved out. This small, easily electrofished pond was sampled for more than two hours the evening of October 12. Thirty-four wild brook trout were collected, including young-of-year as small as 3.0 inches, but no stocked trout were captured. It is possible that some of the stocked trout moved out via the outlet stream, through its almost intermittent diffuse flow to Alderwood Pond about 1.4 miles downstream. This somewhat larger pond was also thoroughly electrofished but no stocked brook trout were captured. An outlet barrier prevents movement of fish downstream from this pond. A second possibility is that some of the stocked trout moved from Hazel Dell Pond up the small inlet stream which is the source of origin of the sparse stock of wild brook trout persisting in Hazel Dell Pond. This possibility was not investigated.

I conclude, based on what field investigation was done, that angler exploitation on this small, easily fished pond was probably close to 100% for all three study strains.

DISCUSSION AND MANAGEMENT IMPLICATIONS

This evaluation of field performance provided no startling implications to support any substitution of the New Hampshire or Assinica strains for the Osceola strain in order to meet conventional stocking quotas of brook trout for release into Wisconsin public waters. Some differences were detected in angling vulnerability, growth, and survival among the three strains, but for all put and take fisheries, and most put-grow-and-take fisheries, these differences between strains are probably not great enough to markedly alter the quality of a given sport fishery or the quantitative economic return on the stocking investment.

All three strains proved to be highly vulnerable to angling exploitation, so vulnerable, in fact, that too few survived the first fishing season to warrant continuation of the study for another year or two as originally planned. The Assinica cross probably grew better than the other two strains, but few survivors were left at the end of the fishing season to accurately assess growth of this strain. Unless given additional regulatory protection, it is unlikely that the faster growth rate and potential longevity of the Assinica strain can be efficiently used to diversify sport fisheries for brook trout in Wisconsin. However, this strain may be worth further testing in a stream or lake subject to catch-release regulations that severely restrict the harvest, or in the group of trout lakes in Bayfield County that are being managed to provide public fishing every other year.

In McGee Lake the New Hampshire strain demonstrated slightly lower vulnerability to angling than the Osceola strain but its growth rate was not quite as good. Some small improvement in late season angling success could be realized by using the New Hampshire strain rather than Osceola strain for routinely stocked waters that receive low angling use. A slightly higher proportion of such stocked fish would be expected to escape being caught during the period of traditionally heaviest harvest in May and June, thereby bolstering abundance of the fishable stock remaining for the last three months of the season. In practice, however, the modest increase in late season abundance may not be noticeable to the average angler. Perhaps the best use of the New Hampshire strain would be continuation of its propagation for cross-breeding with the Osceola strain. The progeny would be used to fill routine stocking quotas. Both strains are relatively easy to raise under hatchery conditions and cross-breeding would circumvent some of the undesirable genetic consequences of continuing to rely on one increasingly inbred strain.

Other results from this study can be valuable in improving management of sport fisheries for trout in Wisconsin even though these results do not relate directly to the objectives of this study. I refer particularly to information obtained from the creel census phase that quantifies some of the characteristics of a sport fishery for stocked trout. Such data, derived from a season-long census effort, are

still relatively rare for Wisconsin fisheries. For example, the high frequency of limit catches of five trout in May lends support to the hypothesis that this bag limit restriction helps to spread out the harvest among more anglers and extends the period of desirable catch rate. It is highly probable that fishing quality would have been worse after May on Adams and McGee lakes if the bag limit had been 10/day that month.

Results from this study also support the management decision to chemically reclaim McGee Lake in 1974 and manage it thereafter as a trout lake. It is now an exceptionally fine trout lake. Even though it was stocked at 2.5 times the density for Adams Lake (88/a vs. 35/a), growth of stocked brook trout was much better in McGee Lake. McGee Lake also received much heavier angling use than did Adams Lake (457 hr/a vs. 175 hr/a) despite its more isolated location. Both angling effort and yield for McGee Lake in 1977 approach the high end of the range of such values characteristic of sport fisheries for wild brook trout on several spring ponds in the same county (Carline and Brynildson 1977). Month by month distributions of angling effort and catch for Adams and McGee Lakes, illustrated in Figure 7, also have useful management value. The more that is known about such basic characteristics of sport fisheries the better they can be managed to meet public expectations within the biological and administrative constraints imposed on management.

LITERATURE CITED

Ayles, G. B.
1973. Comparative growth and survival of matched plantings of wild and domestic rainbow trout in prairie potholes. Fish. Res. Bd. Can. Tech. Rep. No. 382. 13p.

Brynildson, O. M. and L. M. Christenson.
1961. Survival, yield, growth, and coefficient of condition of hatchery-reared trout stocked in Wisconsin waters. Wis. Dep. Nat. Resour. Misc. Res. Rep. No. 3. 23p.

Calaprice, J. R.
1969. Production and genetic factors in managed salmon populations. p. 377-388. In: Symposium on Salmon and Trout in Streams. Univ. of British Columbia Inst. of Fish. H. R. MacMillan Lectures in Fish. 1968.

Carline, R. F. and O. M. Brynildson.
1977. Effects of hydraulic dredging on the ecology of native trout populations in Wisconsin spring ponds. Wis. Dep. Nat. Resour. Tech. Bull. No. 98. 40p.

Cordone, A. J. and S. I. Nocola.
1970. Harvest of four strains of rainbow trout (*Salmo gairdneri*) from Beardsley reservoir, California. Calif. Fish & Game 56: 271-287.

Flick, W. A. and D. A. Webster.
1975. Performance of wild, domestic, and interstrain hybrids of brook trout (*Salvelinus fontinalis*) in natural ponds under experimental management. J. Fish. Res. Bd. Can. 32.

Kincaid, H. L.
1976. Effects of inbreeding on rainbow trout populations. Trans. Amer. Fish. Soc. 105(2): 273-380.

Mason, J. W., O. M. Brynildson, and P. E. Degurse.
1967. Comparative survival of wild and domestic strains of brook trout in streams. Trans. Amer. Fish. Soc. 96(3): 313-319.

Menzel, B. W. and C. C. Krueger.
Genetic effects of stocking upon wild brook trout populations. In press.

Vincent, R. E.
1960. Some influence of domestication upon three stocks of brook trout (*Salvelinus fontinalis* Mitchell). Trans. Amer. Fish. Soc. 89(1): 35-52.

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TABLE 1. Summary of some important creel census statistics for the brook trout fishery on McGee Lake* during 1977.

Item	May	June	July	August	Sept.	Total
Angling hours/acre						
Boat anglers	204.0	68.1	72.9	35.6	20.5	401.1
Shore anglers	48.5	1.3	5.3	0.0	0.4	55.5
Total	252.5	69.4	78.2	35.6	20.9	456.6
Angling trips/acre						
Boat anglers	67.9	22.7	17.6	13.1	4.1	125.4
Shore anglers	20.7	1.1	2.1	0.0	0.4	24.3
Total	88.6	23.8	19.7	13.1	4.5	149.7
Trout creeled/acre						
Boat anglers	148.8	19.7	20.4	7.8	3.5	200.2
Shore anglers	32.3	0.4	1.5	0.0	0.1	34.3
Total	181.1	20.1	21.9	7.8	3.6	234.5
Trout creeled/acre						
Osceola strain	57.7	4.7	4.1	6.3	1.3	74.1
N. Hampshire strain	52.8	6.1	10.4	1.5	1.3	72.1
Assinica strain	51.2	8.0	5.2	0.0	0.5	64.9
3-strain Total	161.7	18.8	19.7	7.8	2.1	211.1
Other**	19.4	1.3	2.2	0.0	0.5	23.4
Catch/hour						
Boat anglers	0.72	0.29	0.28	0.22	0.17	0.50
Shore anglers	0.67	0.31	0.28	0.00	0.25	0.62
Trout Released/acre						
Boat anglers	28.3	0.39	0.0	0.0	0.0	28.7
Shore anglers	5.5	0.0	0.0	0.0	0.0	5.5
Total	33.8	0.39	0.0	0.0	0.0	34.2

*Surface area = 22.7 acre.
**Carryover domestic brook trout stocked prior to 1976 plus some brook trout of wild origin.

TABLE 2. Frequency distribution of various bag sizes in the brook trout sport fishery on McGee Lake during 1977.*

No. of trout Creeled/trip	% of Angler Trips in May**		% of Angler Trips in June-Sept.[1]	
	Boat	Shore	Boat	Shore
0	23.9	47.0	52.1	77.8
1	16.2	15.7	23.5	11.1
2	8.1	10.8	12.6	11.1
3	10.7	7.2	6.7	
4	7.3	3.6	1.7	
5	33.8	15.7	2.5	
6			0.9	
7				
8				
9				
10				

*Based on interviews with 445 anglers who had completed their fishing trip.
**Daily bag limit was 5 in May.
[1]Daily bag limit was 10 during June-Sept.

TABLE 3. Angling effort, yield, and catch rates according to types of bait used by boat anglers and shore anglers in the sport fishery for brook trout on McGee Lake during 1977.*

Bait Type	Boat Anglers					Shore Anglers				
	Effort		Yield		Catch/ hr.	Effort		Yield		Catch/ hr.
	Hr/a	% of Total	No/a	% of Total		Hr/a	% of Total	No/a	% of Total	
Worm	279.5	69.7	141.8	70.8	0.50	43.9	79.1	26.2	76.4	0.60
Fly	15.9	4.0	17.1	8.5	1.08	1.5	2.7	1.6	4.7	1.10
Lure	0.6	0.1	1.2	0.6	2.00	0.1	0.2	0.0	0.0	0.00
Combination	105.1	26.2	40.1	20.1	0.38	10.0	18.0	6.5	18.9	0.65
Total	401.1		200.2			55.5		34.3		
Average					0.50					0.62

*Fishing with live or dead minnows was prohibited on McGee Lake which was chemically treated with rotenone and antimycin A in 1974 and restocked with brook trout in 1975, 1976, and 1977.

TABLE 4. Survival and growth characteristics of three strains of brook trout in McGee Lake between 28 April and 13 October 1977.

Item	Brook Trout Strain		
	Osceola	N. Hampshire	Assinica
No./a stocked	88.1	88.1	88.1
No./a surviving	2.2	7.2	0.7
% survival	2.5	8.2	0.9
Length (inches)			
At stocking	8.9	9.3	7.7
At recovery	12.6	12.4	11.5
Increment	3.7	3.1	3.8
% gain	42	33	49
Weight (grams)			
At stocking	118	158	72
At recovery	395	388	315
Increment	277	230	243
% gain	235	146	338
Coef. of Condition (R)			
At stocking	1.89	1.61	1.59
At recovery	2.13	2.05	2.05
% gain	13	27	29

TABLE 5. Summary of some important creel census statistics for the brook trout fishery on Adams Lake* during 1977.

Item	May	June	July	August	Sept.	Total
Angling hours/acre						
Boat anglers	99.6	27.9	23.5	11.5	3.5	166.0
Shore anglers	4.1	0.4	5.3	0.0	0.0	9.8
Total	103.7	28.3	28.8	11.5	3.5	175.8
Angling trips/acre						
Boat anglers	33.3	9.3	15.7	4.3	2.5	65.1
Shore anglers	2.4	0.2	6.0	0.0	0.0	8.6
Total	35.7	9.5	21.7	4.3	2.5	73.7
Trout creeled/acre						
Boat anglers	74.7	31.2	2.4	8.2	0.0	116.5
Shore anglers	3.8	0.0	0.0	0.0	0.0	3.8
Total	78.5	31.2	2.4	8.2	0.0	120.3
Trout Creeled/acre						
Osceola strain	29.3	6.0	1.5	5.1	0.0	41.9
N. Hampshire strain	24.1	15.1	0.6	2.1	0.0	41.9
Assinica strain	25.1	10.1	0.3	1.0	0.0	36.5
Catch/hour						
Boat anglers	0.75	1.12	0.10	0.71	0.00	0.70
Shore anglers	0.93	0.00	0.00	0.00	0.00	0.39
Trout released/acre						
Boat anglers	7.4	1.9	0.0	0.0	0.0	9.3
Shore anglers	0.1	0.0	0.0	0.0	0.0	0.1
Total	7.5	1.9	0.0	0.0	0.0	9.4

*Surface area = 28.4 acres.

TABLE 6. Frequency distribution of various bag sizes in the brook trout sport fishery on Adams Lake during 1977.

No. of trout Creeled/trip*	% of Angler Trips in May**		% of Angler Trips in June-Sept.[1]	
	Boat	Shore	Boat	Shore
0	13.8	12.5	52.8	100.00
1	9.2	12.5	7.5	
2	6.2	25.0	3.8	
3	5.4	12.5	1.9	
4	5.4	12.5	1.9	
5	60.0	25.0	11.3	
6			15.1	
7			1.9	
8			0.0	
9			0.0	
10			3.8	

*Based on interviews with 194 anglers who had completed their fishing trip.
**Daily bag limit was five in May.
[1]Daily bag limit was 10 during June-Sept.

TABLE 7. Angling effort, yield, and catch rates according to types of bait used by boat anglers and shore anglers in the sport fishery for brook trout on Adams Lake during 1977.

Bait Type	Boat Anglers					Shore Anglers				
	Effort		Yield		Catch/	Effort		Yield		Catch/
	Hr/a	% of Total	No/a	% of Total	hr.	Hr/a	% of Total	No/a	% of Total	hr.
Worm	59.2	35.7	32.1	27.6	0.54	8.2	83.7	2.8	73.7	0.34
Minnow	58.2	35.1	44.5	38.2	0.76	1.6	16.3	1.0	26.3	0.62
Lure	11.4	6.9	9.4	8.1	0.82					
Fly	0.6	0.4	0.5	0.4	0.83					
Combination	36.6	21.9	30.0	25.7	0.82					
Total	166.0		116.5			9.8		3.8		
Average					0.70					0.39

TABLE 8. Survival and growth characteristics of three strains of brook trout stocked in Adams Lake between 28 April and 17 October 1977.

Item	Brook Trout Strain		
	Osceola	N. Hampshire	Assinica
No./a stocked	35.21	35.21	35.21
No./a surviving	0.00	0.92	0.04
% survival	0.00	0.03	0.001
Length (inches)			
At stocking	8.9	9.3	7.7
At recovery	--	11.2	10.2
Increment	--	1.9	2.5
% gain	--	20	32
Weight (grams)			
At stocking	118	158	72
At recovery	--	237	186
Increment	--	79	114
% gain	--	50	158
Coef. of Condition (R)			
At stocking	1.89	1.61	1.59
At recovery	--	1.69	1.75
% gain	--	5	10

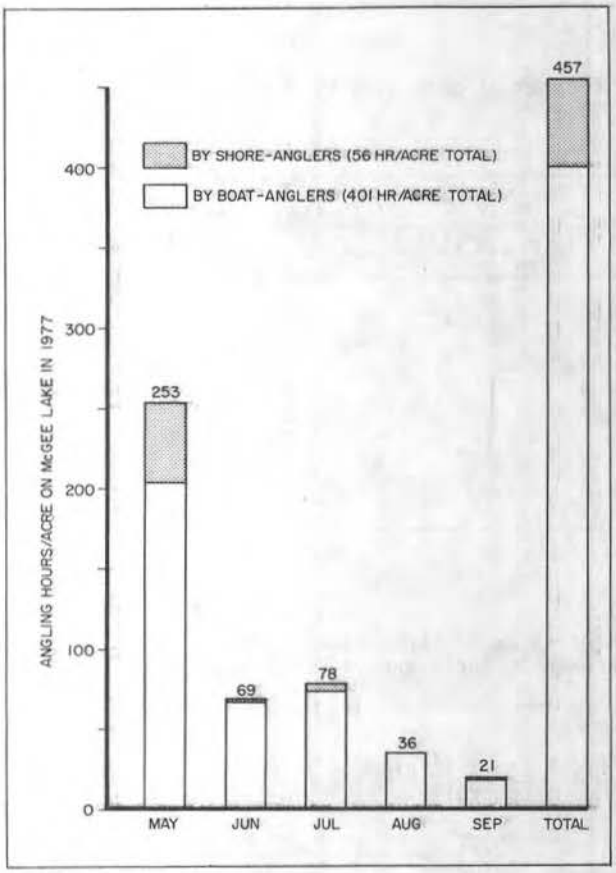

Figure 1.
Monthly and total angler harvest of brook trout by boat-anglers and shore-anglers fishing at McGee Lake during the 1977 trout fishing season.

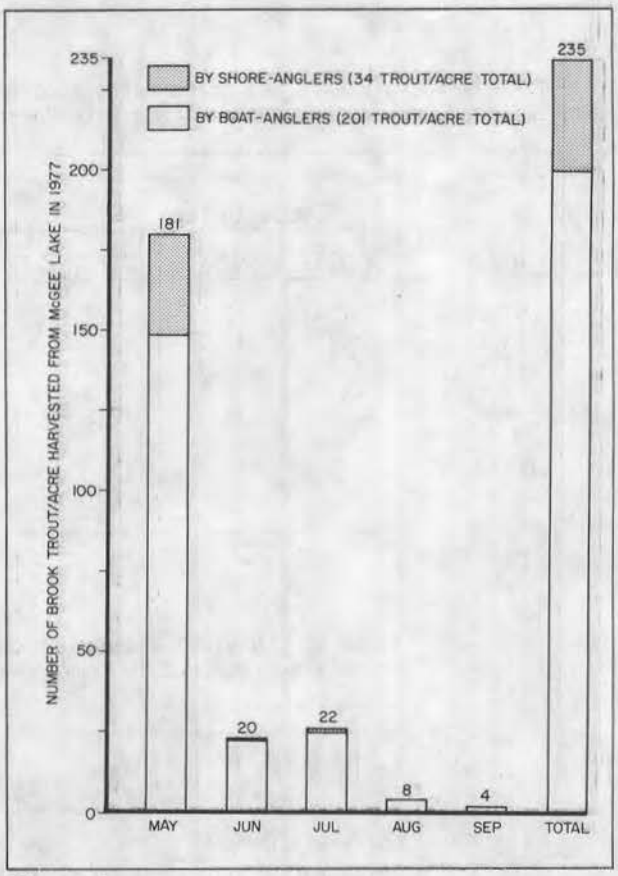

Figure 2.
Monthly and total fishing effort by boat-anglers and shore-anglers fishing at McGee Lake during the 1977 trout fishing season.

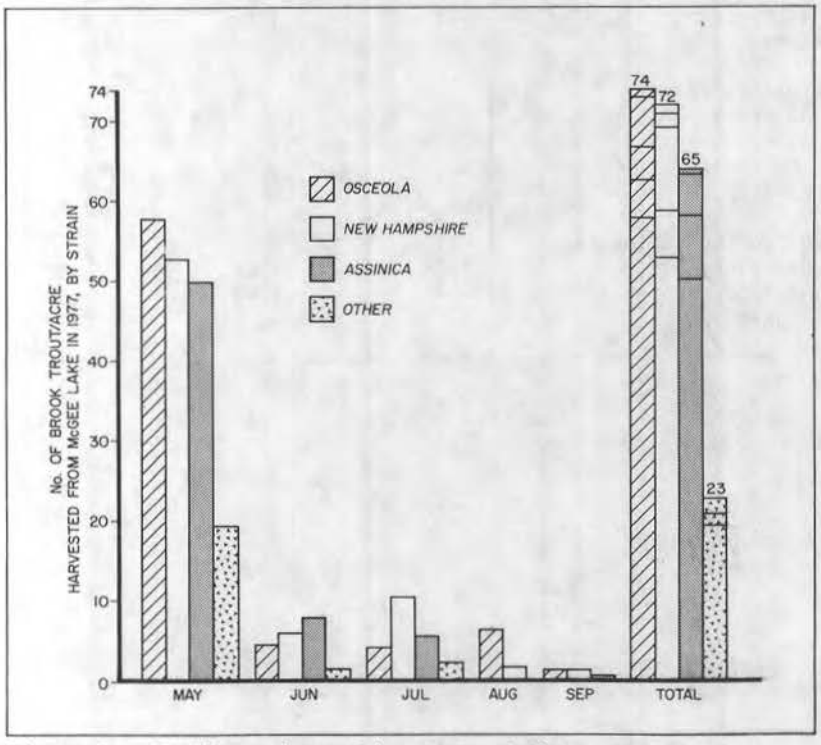

Figure 3. Monthly and total harvests of three strains of brook trout during the 1977 trout fishing season after being stocked in McGee Lake on 28 April 1977.

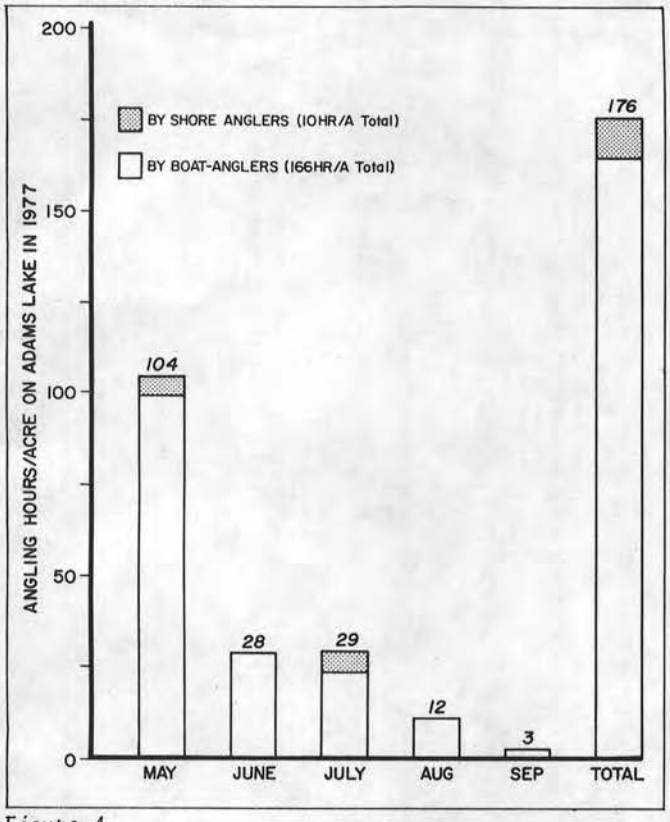

Figure 4.
Monthly and total fishing effort by boat-anglers and shore-anglers fishing at Adams Lake during the 1977 trout fishing season.

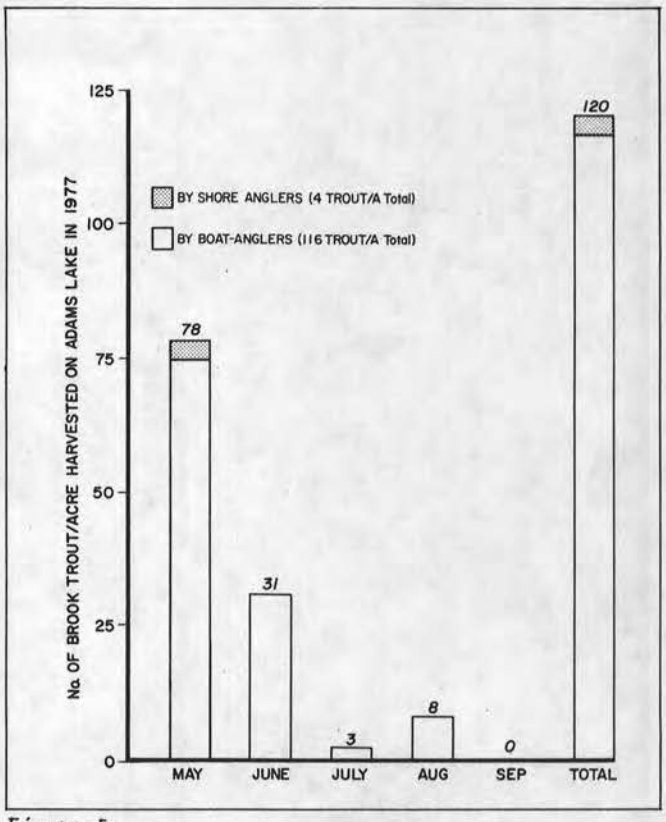

Figure 5.
Monthly and total angler harvest of brook trout by boat-anglers and shore-anglers fishing at Adams Lake during the 1977 trout fishing season.

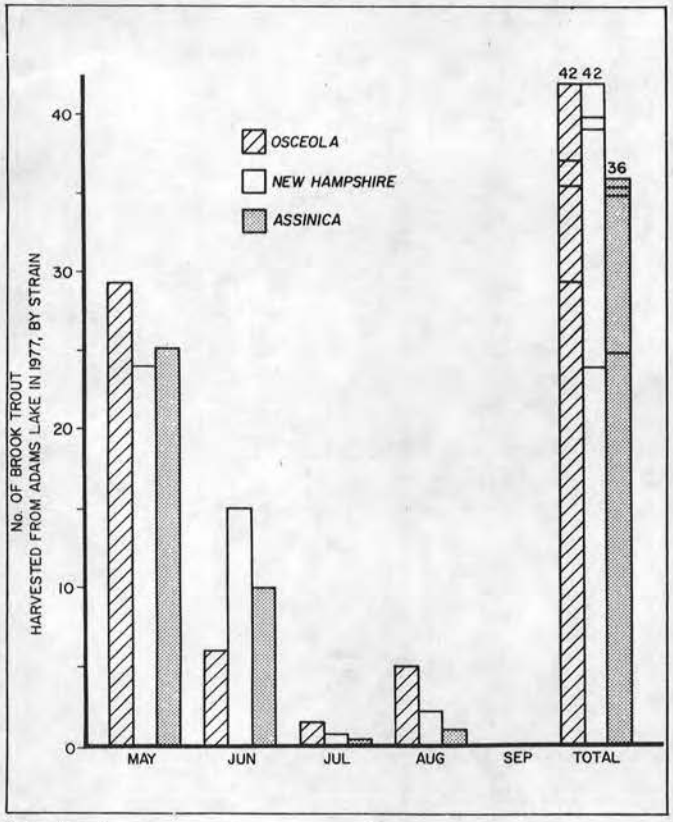

Figure 6.
Monthly and total angler harvest of three strains of brook trout during the 1977 trout fishing season after being stocked in Adams Lake on 28 April 1977.

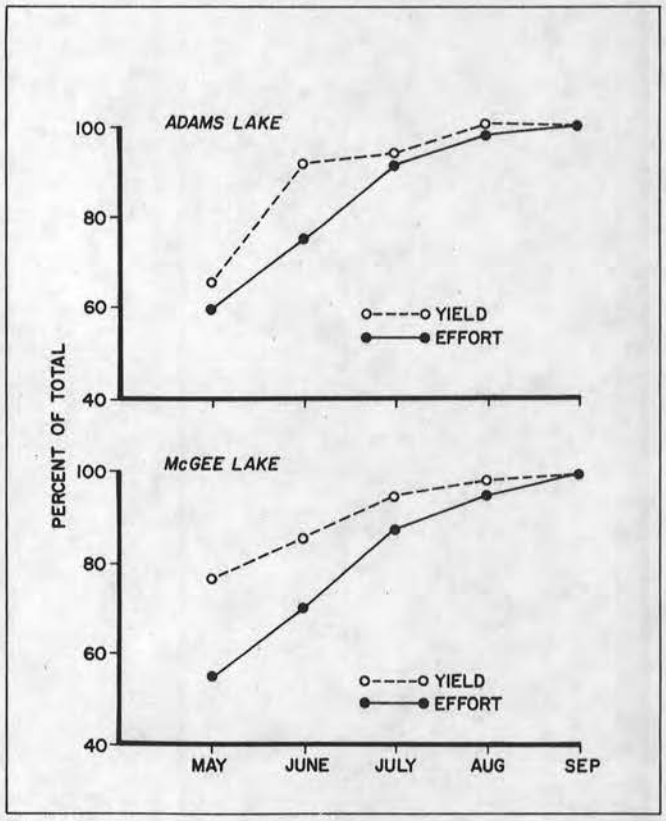

Figure 7.
Cumulative monthly percentage of angling hours and yield of stocked brook trout (three strains combined) for the sport fisheries on Adams Lake and McGee Lake during 1977.