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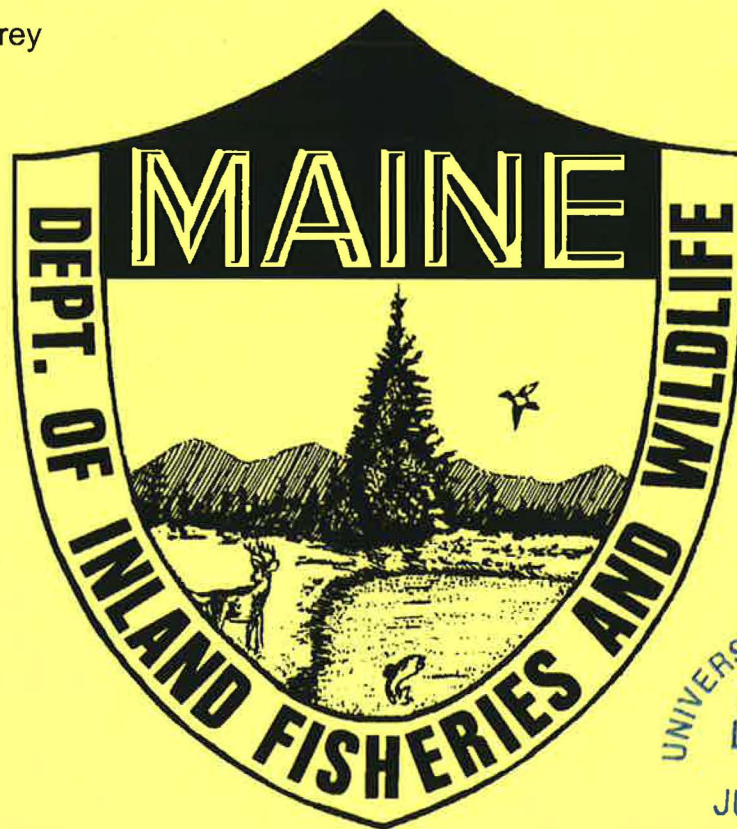
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By Timothy C. Obrey



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FISHERY INTERIM SUMMARY REPORT SERIES NO. 99-12

EFFECTS OF COMPETITION REMOVAL AND RESTRICTIVE  
REGULATIONS ON WILD BROOK TROUT IN LITTLE MOXIE POND

by

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## INTRODUCTION

Little Moxie Pond is a 73-acre wild brook trout pond. Competing species present include white sucker (*Catostomus commersoni*), creek chub (*Semotilus atromaculatus*), and golden shiner (*Notemigonus crysoleucas*). In 1994, Little Moxie Pond was included in a study designed to gather baseline information from various Maine trout ponds. The pond was trapnetted each fall to determine total biomass of trout and other competitors. The brook trout population responded dramatically to the removal of competitors during the netting process. New regulations were imposed to protect the improving trout fishery. However, as the trout fishery recovered, angler use and harvest increased, resulting in a decline in the fishery. Although much of the data reported herein has been included in reports summarizing the trout pond study (Bonney 1998), this report will focus on the results from only Little Moxie Pond.

## STUDY AREA

Little Moxie is a headwater pond in the Piscataquis River watershed. The 73-acre pond is located in East Moxie Twp., Somerset County. It is homothermous with a mean depth of 5 feet and maximum depth of 9 feet. Daily mean temperatures exceeding 77°F have been recorded. Prior to 1994, white suckers were a major competitor with the wild brook trout population. Other minnow species were present at much lower densities. Trout spawning probably occurs in gravelly areas along the shoreline of the pond. There is one small tributary on the southwest shore that contains limited trout spawning habitat. The pond can be accessed with a 2-wheel drive vehicle to within a few feet of the water. Most anglers fish from canoes or small car-top boats. The shoreline is mostly undeveloped; only one camp can be seen from the pond.

KEYWORDS: AGE & GROWTH, AGE FREQUENCY, BIOMASS, ANGLER EFFORT, BKT, HARVEST, MEAN SIZE, POPULATION ESTIMATE, WHS

In 1994, the pond had a 10-inch minimum length limit with no gear restrictions and a general law bag limit of five fish. In 1996, a two fish limit with a minimum length of 10 inches and only one may exceed 12 inches and artificial lures only were adopted. A two fish limit with a minimum length of 12 inches and only one may exceed 14 inches was adopted in 1998.

## METHODS

Techniques used to evaluate the effects of competition removal and new trout regulations included trapnetting, clerk and voluntary creel surveys, and angler use estimates. Trapnetting occurred after the conclusion of the open water fishing season, usually around the third week of October. It took on average 10 days to complete a trout population estimate with a confidence interval of  $\pm 20\%$  ( $p < 0.05$ ). Up to four Johnson Pond style fyke nets were used during the annual netting. All brook trout, except recaptures, were measured and weighed. Sex was determined by observation of secondary characteristics. A subsample of scales was taken to determine age composition and growth. A top caudal clip was applied to identify recaptures. All non-trout species were weighed and removed. A subsample of each species was measured to determine average size and to estimate total numbers removed. In 1994, these non-target fish were moved to an off-site location. After 1994, the fish were placed in an area where the nutrients from decomposition would drain into the pond. Brook trout population estimates were calculated for only fish greater than 4 inches to eliminate young-of-the-year. Estimates by inch class were calculated; these ratios were then applied to the total estimate to determine size class strength. Mean weights by inch class were also applied to these estimates to determine trout biomass.

Stratified random counts were made in 1994, 1995, and 1998 to estimate angler use. The total number of counts from May to September ranged from 52 in 1994 to 88 in 1998. In 1994, anglers were also interviewed for catch information. The clerk angler survey was very inefficient at those levels of use, so a voluntary survey box was maintained from 1995 to 1998.

Surface water temperatures were recorded on dates of angler counts and during trapnetting in 1994 and 1995. In 1998, a recording thermometer was placed in the pond from May to October.

## RESULTS

### *Fall Trapnetting*

As many as four trapnets were tended daily from 10/13/94 to 10/24/94 for a total of 931 net-hours. A total of 11,003 white suckers weighing 2,082 lb were caught and removed from the pond. An additional 89 lb of minnows were caught and removed. An estimated 671 age I+ and older trout, weighing 89 lb, remained in the pond after the 1994 fishing season. Competing species accounted for 96% of the total biomass (Table 1 ). Of the estimated  $671 \pm 102$  trout, only 34 (5%) exceeded the minimum length limit of 10 inches and only 4 (<1%) were 12 inches or larger (Figure 1). Mean lengths at age (Table 2) were less than those for other study waters (Bonney, 1998) and below regional averages of brook trout sampled in the fall (Table 3 ).

In 1995, four nets were set for a total of 1,051 net hours. A total of 7,100 white suckers weighing 1,395 lb and an additional 56 lb of minnows were removed from the pond. An estimated  $416 \pm 66$  brook trout weighing a total of 89 lb were remaining in the pond. Competing species represented 94% of the biomass handled in 1995. There was an increase in the number of larger brook trout in the pond compared to 1994. In 1995, an estimated 86 (21%) trout exceeded the minimum length limit of 10 inches and of those 41 (10%) were greater than 12 inches. Although the mean length of age 1+ trout declined slightly in 1995, those for ages II+ and III+ increased.

In 1996 new regulations were adopted for Little Moxie Pond. Previously the pond had a 10 inch minimum length limit with no gear restrictions and a general law bag limit of 5 fish. In 1996, a 2 fish limit with a minimum length of 10 inches and only 1 may exceed 12 inches and artificial lures only were adopted.

Four nets were set for a total of 928 net hours in 1996. Only 188 white suckers weighing 99 lb were captured and removed. An additional 12 lb of minnows were removed. This represented just 19.1% of the biomass in 1996. An estimated  $1,343 \pm 185$  brook trout weighing 470 lb remained in the pond after the fishing season. A substantial increase in the number of larger trout was documented in 1996. Of the estimated 1,343 trout, 431 (32%) were longer than 10 inches and 228 (17%) exceeded 12 inches. There were also considerable increases in the mean lengths of all ages (I+ - IV+) sampled. Mean lengths for ages II+ and III+ now exceed regional averages.

In 1997, four nets were set for a total of 656 net hours. The number of suckers removed increased slightly in 1997 to 300 fish; however, the total pounds continued to decline to just 78 lb. These individuals were mostly small suckers that probably were not vulnerable to trapnetting the previous year. There was also a dramatic increase in the number of golden shiners captured in 1997. The total weight of minnows removed was 49 lb. Therefore, non-trout species represented 35% of the biomass handled in 1997. The estimated number of trout was  $888 \pm 142$  fish. Larger trout were less abundant at the end of the fishing season compared to 1996. Only 216 (24%) were greater than 10 inches and 69 (8%) were greater than 12 inches. Growth rates were still very good.

In 1998, there was a regulation change at Little Moxie Pond. The regulation changed from a two fish limit, minimum length of 10 inches and only one may exceed 12 inches to a two fish limit, minimum length of 12 inches and only one may exceed 14 inches. The artificial lures only regulation remained in effect.

In 1998, four trapnets were set for a total of 761 net hours. Only 25 white suckers weighing 8 lb were caught and removed. An additional 18 lb of minnows were removed. For the first time the total weight of minnows removed exceeded suckers. Non-trout species comprised just 6% of the total biomass handled this year. The 1998 estimate of  $1,419 \pm 269$  trout was the highest since the beginning of the project. Even more encouraging was the estimated number of trout over 10 inches. After one season with the new regulation, 765 (54%) were



greater than 10 inches and 166 (12%) exceeded 12 inches. Mean lengths at ages I+ and II+ were above regional averages, while age III+ trout were slightly below average.

Growth rates improved after just 2 years of competition removal. A Duncan test revealed age I+ and age II+ trout in 1994 and 1995 were significantly smaller than those taken in 1996-1998. In 1996, age III+ were significantly larger than those in 1995 and 1998 fish. Sample sizes for age III+ in 1994 and 1997 were too small to test. The smaller age III+ fish in 1998 may not be a reflection of poor growth but rather to the excessive harvest as the larger, faster growing fish were removed during the open water season. The mean condition factor for age III+ fish in 1998 was 0.96. Although slightly lower than past years, this would not indicate poor growth.

### *Creel Surveys*

In 1994, under a 5 fish bag limit and 10-inch minimum length limit anglers released only 2 (5%) of the 43 legal trout reported in the clerk survey. Although catch rates from the clerk and box surveys cannot be directly compared, the percentage of legal fish released in the 1995 box survey was also very low. Only 6 (13%) of the 48 legal fish reported were released. These figures are much lower than the average release rates (58%) for other trout ponds reported by Bonney (1998).

Catch rates began to increase in 1996 after 2 years of competition removal and the adoption of new trout regulations (Table 4). Anglers were then forced to release more legal-size fish under the two fish limit. Data from the voluntary box survey indicate that catch rates for trout of all sizes has steadily increased from 1995 to 1998. In 1995 the catch rate for trout of all sizes was 0.95 trout/angler. The catch rate increased each subsequent year to a high of 2.52 trout/angler in 1998.

Catch rates for fish longer than 10-inches increased annually from 1995 to 1998 (Table 4). This same trend was observed in the trapnetting data. However, population estimates from trapnetting show a decline in the number of fish greater than 12 inches in 1997, then a slight



increase in 1998, while voluntary box records indicate steadily improving catch rates for fish of this size until 1997 then a slight decline in 1998.

### *Use Estimates*

Ground angler counts were made in 1994, 1995 and 1998. In 1994 a total of 52 counts were taken. The total estimated use for the season was  $195 \pm 87$  angler-days (2.67 angler-days/acre). In 1995, fifty-five counts were made. The estimate for the season was  $270 \pm 126$  angler-days (3.70 angler-days/acre). The confidence intervals are overlapping for these two years. Confidence intervals were 45% and 47% in the first 2 years; therefore more counts were scheduled in the 1998 season to try to improve precision. In 1998, eighty-eight counts were taken during the open water season. The estimate for 1998 was  $884 \pm 177$  angler-days (12.1 angler-days/acre). The point-estimate may be high due to variance in activity curve data over the period of the open water season. Monthly estimates derived from month-specific activity curve data may better reflect actual use. The sum of monthly estimates was 814 angler-days, lower than the season long estimate but well within the confidence interval.

### *Harvest Estimates*

Harvest estimates were calculated using the voluntary survey box data and ground angler counts. In 1995, an estimated 276 anglers harvested 139 trout and released 35 legal and 71 sublegal fish. Eighty-four (60%) of the fish were harvested in May. In 1998, an estimated 814 anglers harvested 99 trout and released 962 legal and 1,031 sublegal fish. Only 28 (28%) were harvested in May.

### *Water Temperatures*

In 1994 and 1995, water temperatures were taken at the time of the angler counts (Figures 2 and 3). In 1998, a recording thermometer was placed in the pond and the daily mean temperatures are presented in Figure 4. There was a drought in the summer of 1995 and water temperatures ranged in the mid 70's to over 80°F from late June to mid August. The water level in the pond was very low during this time, resulting in stress and higher than normal mortality

rates. Unpublished trapnetting results from Brown Pond, a similar trout pond in the area, also indicate higher mortalities in 1995.

## DISCUSSION

After just 2 seasons of trapnetting and removal of competing species, brook trout exhibited substantial increases in survival of age I+ fish. During the entire study period age I+ trout averaged less than 10 inches in length and therefore were not subject to harvest, although there would be some associated hooking mortality with releasing sublegal fish. In 1994 and 1995, the mean number of age I+ trout in the pond was 306 fish. Since that time there has been a two-fold increase in the mean number of age I+ trout at the end of the season. Despite increased survival and growth rates, restrictive regulations have not been effective in maintaining the quality of the fishery. Use dramatically increased during the study period from 195 angler-days in 1995 to over 800 angler-days in 1998. Although no estimate was available, it was obvious from personal observation that use began to increase in 1996 as fish size and abundance improved. Harvest rates were at their highest in 1996 and 1997. Even with a two fish limit, anglers were removing high percentages of age III+ and all age IV+ fish. In 1996, there were an estimated 355 age II+ trout and 93 age III+ trout in the pond (Table 5). These fish exhibited high mortality rates between the fall of 1996 and the fall of 1997. By the close of the 1997 fishing season only 30 age III+ trout were remaining in the pond, representing a total mortality rate of 92% for this age class. No age IV+ trout were taken in 1997, representing 100% mortality. In addition, 70% of the age II+ trout did not survive the open water season. Some natural over-winter/post-spawning mortality occurred but probably at a low level compared to harvest. For example, in 1997, an estimated 595 age I+ fish were present in the fall. Under the new 12 inch minimum length limit all of these fish were protected for the open water season in 1998 at age II+. The 1998 estimate of age II+ trout was 563 fish. This represents about a 5% mortality from the fall of 1997 to fall 1998, some of which may be hooking related. Clearly, at Little Moxie Pond, angler harvest and hooking mortality are the most important factors influencing the abundance of wild trout population.

Generally, catch data from voluntary box surveys tend to be higher than the actual catch. However, anglers who fill out cards tend to release a higher percentage of legal fish. Therefore, voluntary box data may be used to follow trends in catch but are probably not the best for calculating harvest. Although harvest estimates have been presented, the best indicator of harvest may be post-season population estimates.

The fishery was at its qualitative best in 1996, when few age II+ and just 37% of age III+ and 76% of age IV+ were harvested. Anglers were able to catch larger fish throughout the summer and into the fall. However, these fish were quickly removed the following spring as a results of increased fishing pressure. The more restrictive regulations adopted in 1998 have initially reduced harvest. Total mortality figures in 1998 were very similar to those observed in 1996. If these trends continue there should be an increase in the number of age III+ and age IV+ fish in the 1999 fishery and post-season trapnetting.

After 2 consecutive years of trapnetting and removal of suckers and minnows, there was a substantial increase in trout biomass (Figure 5). Nearly 50 lb/acre of non-trout species were removed in 1994 and 1995. The following 3 years a total of just 3.6 lb were caught and removed. Total estimated pounds of trout increased from a low of 89 lb in 1994 to 470 lb in 1996.

It is concluded that removal of competing species would have positive management implications on other similar waters by increasing brook trout survival, abundance, and growth. It is unclear how long these benefits will last once trapnetting ceases.

## RECOMMENDATIONS

1. Continue to monitor the trout population and use at Little Moxie Pond through trapnetting and ground angler counts for the next 2-3 years. Data collected during this period should be adequate to evaluate the current regulations under heavy fishing pressure.
2. Continue to remove competing species should also continue during the regulation evaluation. This should help maintain growth rates if the trout population continues to increase. However, after regulation changes have been thoroughly evaluated, removal of competing species should stop. The pond should be trapnetted periodically to determine the rate of recovery of competitor species and the effects on the trout population. This could be an important management technique for many other ponds in the State, depending on the duration of the benefits.

## ACKNOWLEDGMENTS

We are grateful to Ken Jobe for his dedication to this project. Ken has conducted all of the creel surveys, angler counts, and with help from Tom Dudac, has completed all of the fall trapnetting since the beginning of the project in 1994. Ken's dedication to the restoration and understanding of wild trout fisheries in Maine is unsurpassed. We are also thankful to Trout Unlimited for providing the majority of the funding for this project. TU's support made it possible to collect the necessary data to fully evaluate this pond. This information will be valuable to trout management statewide.

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March 1999

## REFERENCES

Bonney, Forrest . 1998. Evaluating Restrictions Imposed on Wild Brook Trout Populations in Maine Lakes to Restore Age and Size Quality. Maine Department of Inland Fisheries and Wildlife. Progress Report Series No. 98-4.

Table 1. Total biomass of fish caught during trapnetting at Little Moxie Pond 1994-1998.

Year	Lb WHS Removed	Lb CCB Removed	Lb GLS Removed	Total Lb Removed (non-trout)	Total Lb BKT	Lb/acre Removed (non-trout)	Lb/acre BKT	% non- trout	% BKT
1994	2,082	12	77	2,171	89	29.7	1.2	96%	4%
1995	1,395	27	29	1,451	89	19.9	1.2	94%	6%
1996	99	5	7	111	470	1.5	6.4	19%	81%
1997	78	3	46	127	233	1.7	3.2	35%	65%
1998	8	10	8	27	444	0.4	6.1	6%	94%



Table 2. Mean lengths (mm) and SE by age class from trapnetted brook trout in Little Moxie Pond 1994-1999.

Year		Age I+			Age II+			Age III+			Age IV+			Age V+	
	N	Mean Len	SE	N	Mean Len	SE	N	Mean Len	SE	N	Mean Len	SE	N	Mean Len	SE
1994	44	148	4	64	227	5	5	301	4	1	405	--	0	--	--
1995	24	134	3	52	252	5	28	343	5	0	--	--	1	447	--
1996	81	199	5	51	289	6	25	362	5	6	430	5	0	--	--
1997	66	200	4	24	268	8	7	378	11	0	--	--	0	--	--
1998	37	214	6	49	277	2	14	331	7	0	--	--	0	--	--

Table 3. Mean lengths (mm) and SE of fall samples of brook trout in the Moosehead Lake Region.

Age	N	Mean Length	SE
I+	951	211	2
II+	758	267	2
III+	359	357	2
IV+	71	437	4
V+	10	470	21

Table 4. Catch rate data from voluntary survey box at Little Moxie Pond 1995-1998.

	1995	1996	1997	1998
All BKT/hr	0.246	0.534	0.721	0.732
BKT > 10 inches/hr	0.094	0.260	0.465	0.538
BKT > 12 inches/hr	0.022	0.130	0.261	0.210
BKT > 14 inches/hr	0.004	0.062	0.121	0.073
BKT > 16 inches/hr	0.000	0.010	0.041	0.030

Table 5. Post season population estimates of brook trout by age class for Little Moxie Pond 1994-1998.

Year	Age I+	Age II+	Age III+	Age IV+	All
1994	378	287	6	2	673
1995	233	148	33	1	415
1996	885	355	93	8	1,341
1997	595	262	30	0	887
1998	670	563	182	0	1,415

Figure 1. Post season estimates of brook trout in certain size groups in Little Moxie Pond 1994-1998.

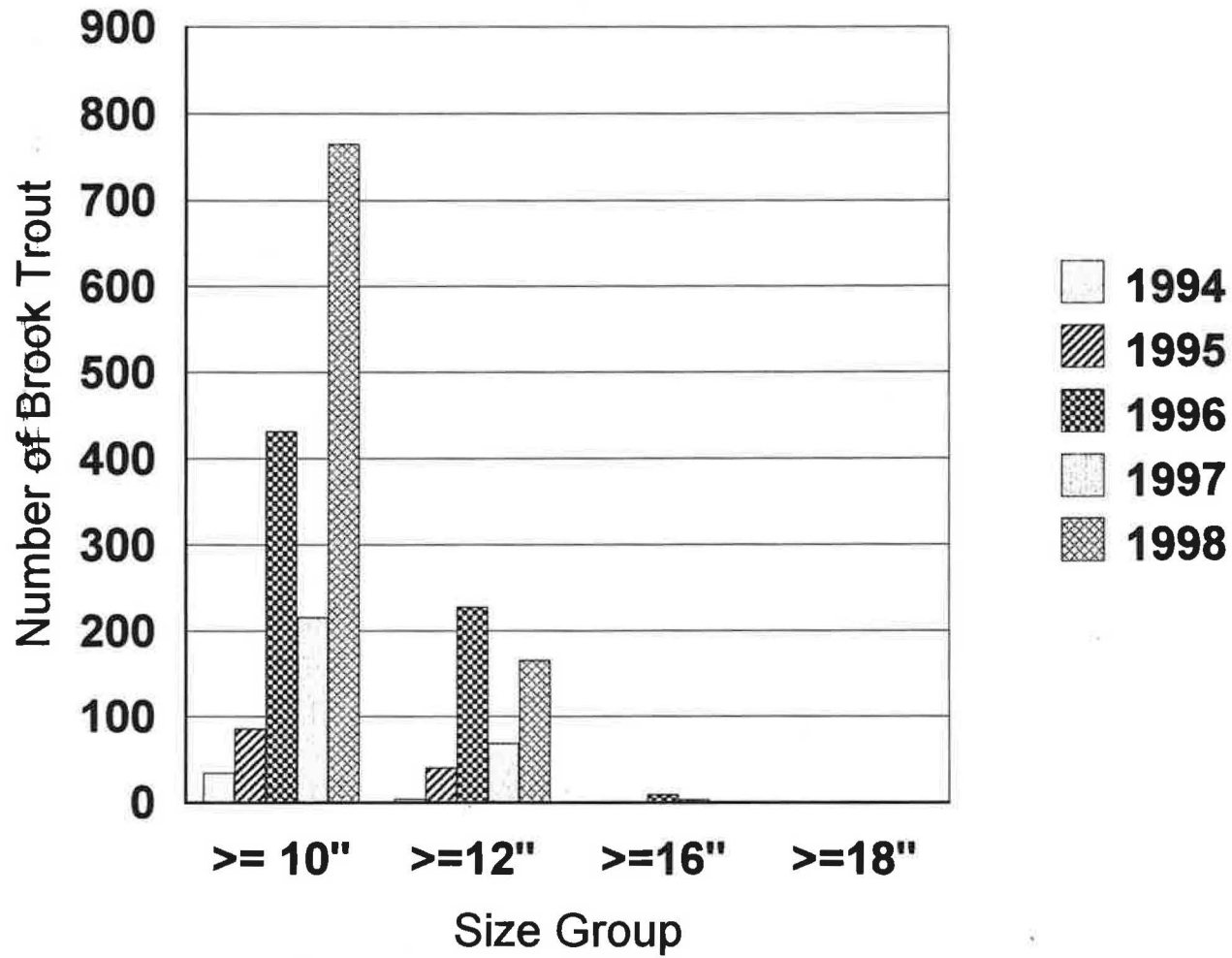


Figure 2. Surface water temperatures for Little Moxie Pond 1994.

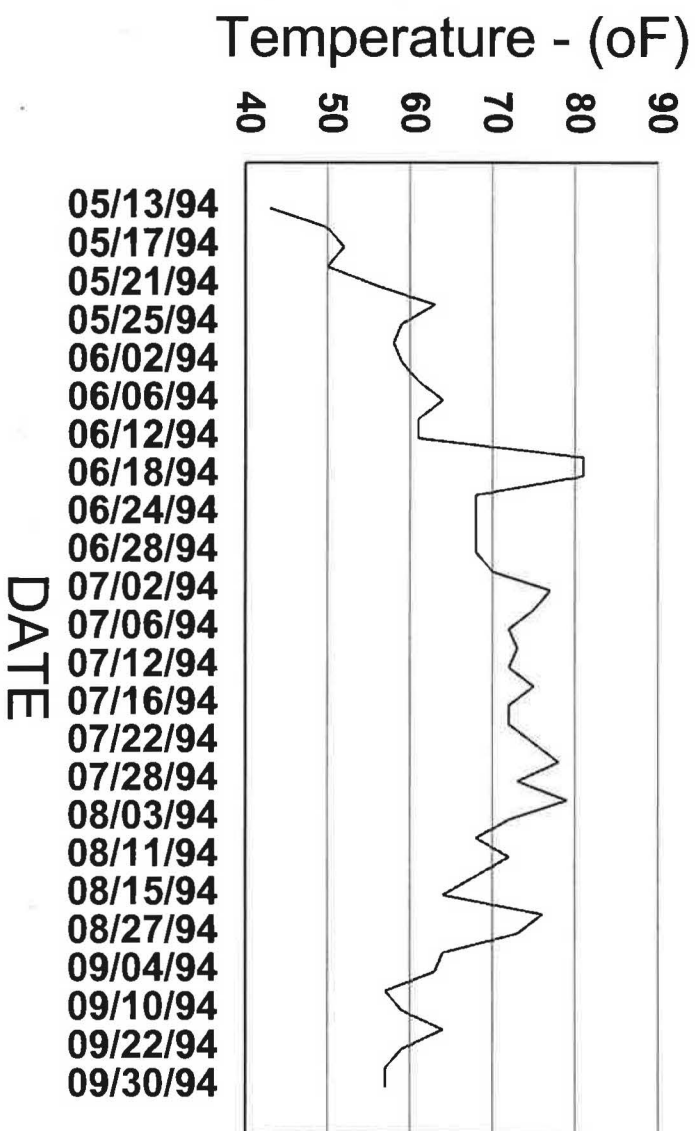


Figure 3. Surface water temperatures for Little Moxie Pond 1995.

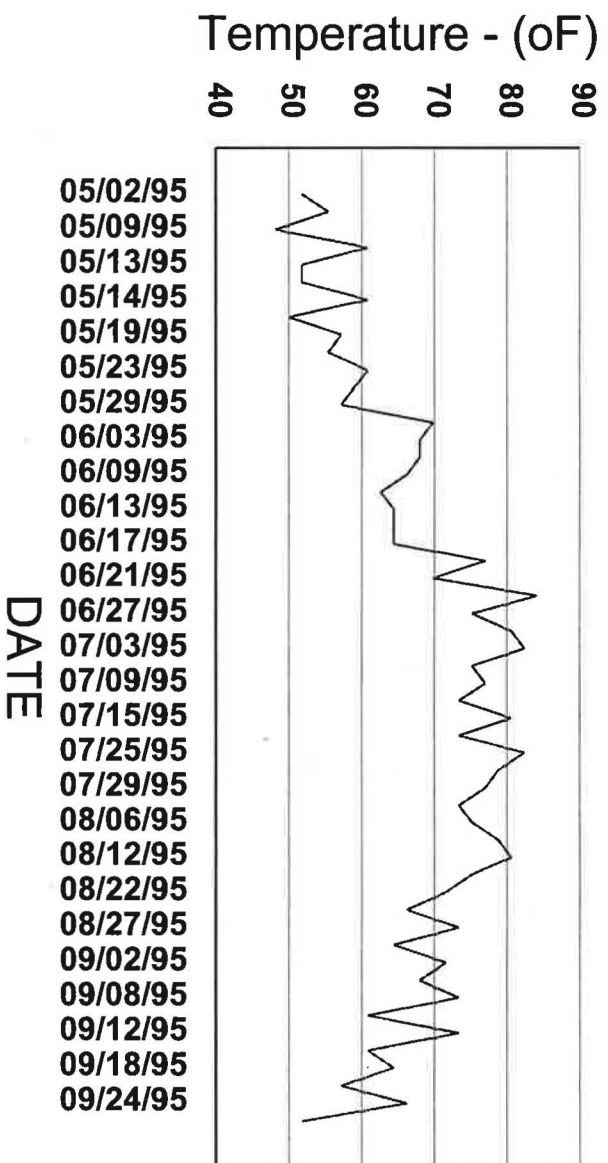




Figure 4. Daily mean surface water temperatures for Little Moxie Pond 1998.

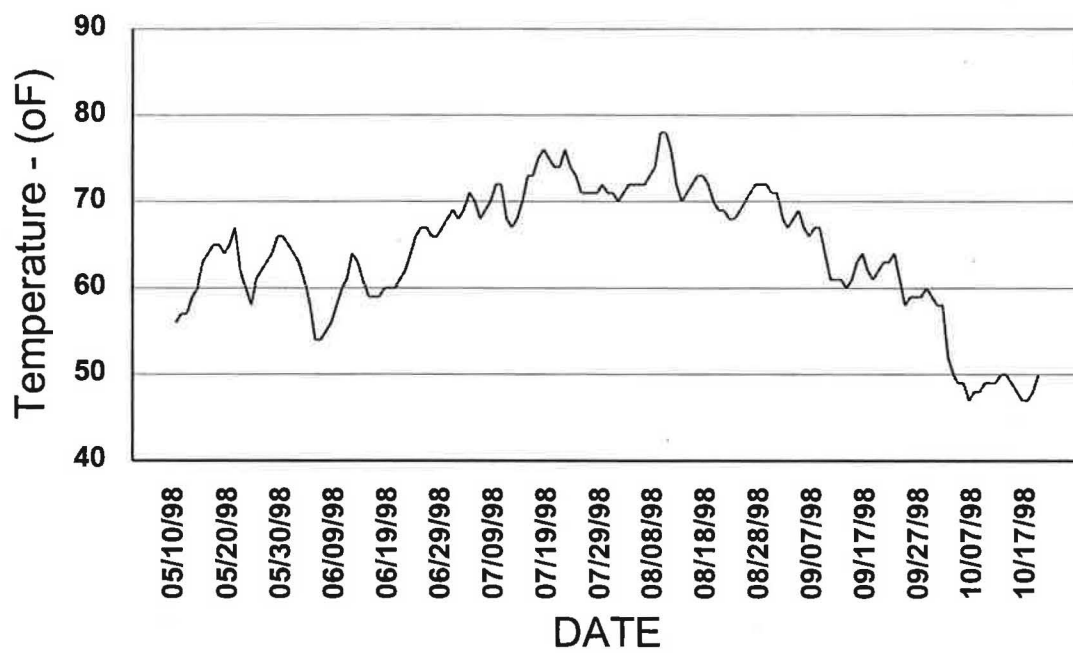
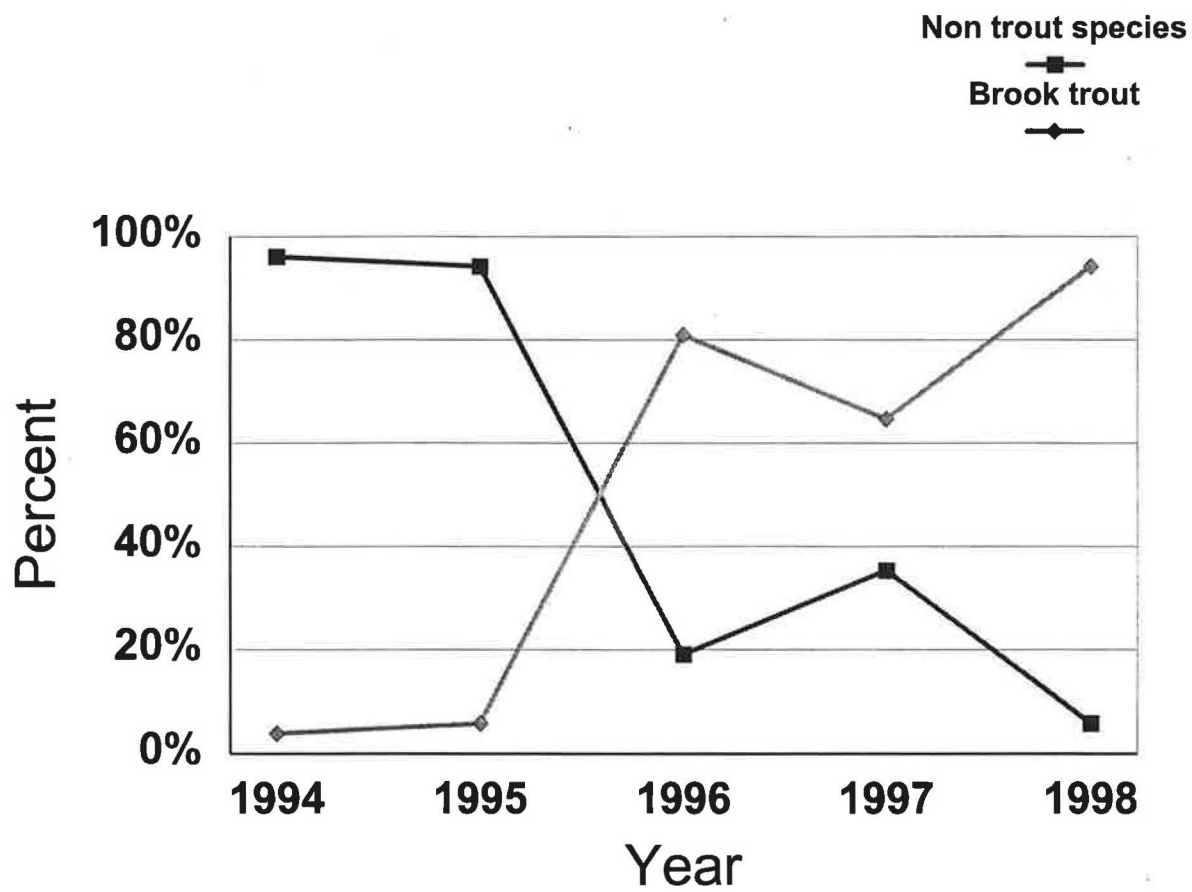


Figure 5. Biomass of fish handled during fall trapnetting at Little Moxie Pond 1994-1998.



# COOPERATIVE STATE FEDERAL PROJECT

This report has been funded in part by the Federal Aid in Sport Fish Restoration Program. This is a cooperative effort involving federal and state government agencies. The program is designed to increase sport fishing and boating opportunities through the wise investment of anglers' and boaters' tax dollars in state sport fishery projects. This program which was funded in 1950 was named the Dingell-Johnson Act in recognition of the congressmen who spearheaded this effort. In 1984 this act was amended through the Wallop-Breaux Amendment (also named for the congressional sponsors) and provided a threefold increase in Federal monies for sportfish restoration, aquatic education and motorboat access.

The Program is an outstanding example of a "user pays-user benefits", or "user fee" program. In this case, anglers and boaters are the users. Briefly, anglers and boaters are responsible for payment of fishing tackle excise taxes, motorboat fuel taxes, and import duties on tackle and boats. These monies are collected by the sport fishing industry, deposited in the Department of Treasury, and are allocated the year following collection to state fishery agencies for sport fisheries and boating access projects. Generally, each project must be evaluated and approved by the U.S. Fish and Wildlife Service (USFWS). The benefits provided by these projects to users complete the cycle between "user pays — user benefits".



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