Ohio Department of Natural Resources
Division of Wildlife

Evaluation of Muskellunge Management in Clear Fork Reservoir*

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ABSTRACT

We examined some aspects of the population dynamics of adult muskellunge in Clear Fork Reservoir, Richland County, Ohio. Data obtained from spring trap-net surveys conducted from 1983-1988 were used to determine population size, age structure, growth rates, and mortality rates. Fish greater than 60 cm were tagged to provide movement, growth, survival, and exploitation information. We also determined growth, survival, and handling mortality of large (minimum 25 cm) stocked fingerlings 23-37 days post stocking and in spring (April) following stocking. Creel surveys were conducted from 1983-1985 to determine angling effort, catch data, and angler characteristics. Voluntary catch information from Ohio Huskie Muskie Club applications and concessionaire records were also used to assess the components of catch. The reservoir tailwater was surveyed to determine numbers, sizes and ages of emigrating muskellunge, as well as the time of year muskellunge emigration occurred.

Strength of the age 3 and 4 year classes was the major factor influencing both numbers of muskellunge captured in trap nets and catch per unit of effort. Males and females were fully recruited to trap nets at ages 3 and 4 respectively. Adult population estimates ranged from 1,146 in 1983 to 461 in 1988. Growth rates were good and relatively consistent and

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did not appear to be density dependent. Females grew faster and lived longer than males. Mortality rates of males were higher than those of females.

Immediate mortality of stocked fingerling muskellunge (0-72 h post-stocking) was low (0-10%). Fall population estimates of age-0 muskellunge indicated survival ranged from 30-75.6% and average 58%. Spring population estimates indicated overwinter mortality was minimal. Post-stocking growth was directly related to stocking date.

Emigration was dependent on the quantity of water flowing over the dam and time of year high flows occurred. Peak emigration normally occurred during April and early May. Muskellunge ranging from 28.9 cm to 118.5 cm in length and from 1 to 10 years of age emigrated from the reservoir. Tagging data indicated a minimum of 6.1% of the adult population emigrated during the study.

Muskellunge fishing pressure averaged 24,924 angler hours. Muskellunge anglers comprised approximately 18% of the total anglers, fished an average of 4.4 hours per trip, and traveled an average of 75 to 83 km to fish Clear Fork Reservoir. Muskellunge angler catch rates increased from .021 to .035 fish per hour during the period 1983-1985, with the majority (78%) of the fish being released.

Angler catch data derived from voluntary returns indicated they were somewhat biased in regard to kept vs. release ratios, total number of fish caught, and tag reporting. Minimum explotation rates, based on tagged fish, ranged from 2.6% to 10.3%, indicating excessive harvest did not occur.

CONTENTS

BACKGROUND

With the exception of the flathead catfish (Pylodictis olivaris) the muskellunge (Esox masquinongy) is Ohio's largest native game fish. Attainment of a large size and the fine fighting qualities of this predaceous species stimulated an interest in its management in the late 1800s. During this period native Ohio muskellunge populations declined significantly, especially in the Lake Erie drainage area, as a result of urbanization and draining of the vast marshlands for agriculture. Muskellunge populations in the Ohio river drainage basin were negatively impacted by pollution and detrimental land use practices, but not as severly as the Lake Erie basin populations.

Initial efforts to manage muskellunge in Ohio consisted of stocking rivers and streams with hatchery produced fry from other states. With the increase of reservoir construction for flood control and water supply in the 1930s, interest in establishing muskellunge populations in these areas increased. This renewed interest in the species resulted in attempts to propagate muskellunge at Ohio hatcheries beginning in 1948. Propagation efforts were not successful until 1953 when 2,235 muskellunge fingerlings were reared and stocked.

Over the next decade, muskellunge were stocked in 37 lakes and 6 rivers and streams. Evaluations of the success of these stocking efforts were sporadic and complicated by the variation in the numbers and sizes of fingerlings stocked annually. From 1964-1981, statewide muskellunge stockings ranged from 7,000 to 25,000 fingerlings, at various densities (7-12 per hectare), and various sizes (5.1-22.9 cm) annually. During this period, studies by Erickson (1968) and Gall (1973) indicated stocking success to be directly related to the size of fingerlings planted.

Research by Johnson 1976 and Stein et al. 1981 also found larger fingerlings had higher survival rates.

During the winter of 1981-82, the Division of Wildlife revaluated its muskellunge program in view of substantial production costs and its inability to determine survival of year classes stocked at different sizes, densities, and times. A task force was formed to develop a muskellunge program with measurable goals and objectives. This study was directed toward collecting data necessary to determine if these program objectives were being attained. The primary objective was to determine if stocking 25 cm fingerling muskellunge at a rate of five per hectare would provide a population capable of supporting an annual harvest of at least one 76 cm muskellunge per four hectares of water at our primary muskellunge fisheries; Rocky Fork, Clear Fork, Leesville and Piedmont Lake. Clear Fork Lake was chosen as the study site because it's muskellunge population is the source of spawn for our hatchery program and a tagging study was already ongoing.

This study should allow the Division of Wildlife to better utilize its resources and provide a quality muskellunge fishery for Ohio anglers.

STUDY OBJECTIVE

To determine if stocking 25 cm fingerling muskellunge at the rate of five per hectare will provide a population capable of supporting an annual harvest of at least one 76 cm muskellunge per four hectares of water at Clear Fork Reservoir.

STUDY AREA

Clear Fork Reservoir, located in Richland and Morrow counties approximately 11.2 km southwest of Mansfield, Ohio, was constructed by the City of Mansfield in 1947-1949 to provide water storage for municipal and industrial use. The reservoir is fed by the North and West branches of the Clear Fork Branch of the Mohican River. The Mohican River is within the Muskingum River basin, in the Ohio-Mississippi River watershed. At Lexington the river drains a maximum of 24,800 hectares of agricultural and forest land. The soils in the watershed are predominantly deep, poorly to moderately well drained low lime glacial tills of the Wisconsin Age.

At normal pool elevation, 366.4 m above sea level, Clear Fork Reservoir has a surface area of approximately 400 hectares and a storage capacity of 15.7 million cubic meters. Maximum water depth is 6.1 m and mean depth is 3.0 m. The shoreline is 24.8 km long with a shoreline development index of 3.25. Water flows out of the reservoir over an open spillway at the southeast end. Annual maximum water level fluctuations are usually less than 1 m. Water quality in the reservoir watershed, as measured at Butler, is good (Southeast Ohio Water Plan, 1978). Pertinent climatological parameters for Richland County include an annual average rainfall of 91 cm, with June receiving the greatest amount of precipitation and October the least. January is the coldest month with a mean daily maximum air temperature of 2.2°C, and July the warmest with a mean daily maximum of 30°C.

The western basin has several small shallow mud bottom bays. Shoreline along the western end has extensive submergent vegetation and fallen trees. The central basin contains several small islands and dense beds of vegetation, primarily Myriophyllum spp. and Ceratophyllum spp.. The shoreline along the central basin has several stump-covered areas and

the substrate varies from mud to sand and gravel. The eastern basin, characterized by a steeper sloping shoreline with sand and gravel substrate, contains fewer emergent and submergent aquatic macrophytes.

Filled in 1950, the reservoir was initially stocked by the Ohio Division of Wildlife with walleye (Stizostedion v. vitreum), largemouth bass (Micropterus salmoides), and white bass (Morone chrysops). In 1956 the lake was stocked with channel catfish (Ictalurus punctatus). Muskellunge were initially stocked in July of 1965 and since that time has been the only species stocked in Clear Fork Reservoir. Other important fish populations that developed naturally after the reservoir was filled were white crappie (Pomoxis annularis), bluegill (Lepomis macrochirus), gizzard shad (Dorosoma cepedianum) and carp (Cyprinus carpio).

The City of Mansfield developed and maintains parking areas, shelter houses, restroom and picnic facilities, a fishing pier for handicapped people, and a single 2-lane boat ramp. A private concessionaire operates a campground, marina and concession stand adjacent to the boat ramp under a lease agreement with the city.

PROCEDURES

Adult Population

Trap nets

Data obtained from trap-net surveys conducted each spring (1983-1988) were used to determine the population size, age structure, growth rate, and mortality rate of adult muskellunge at Clear Fork Reservoir. Trap nets with leads, wings, and tunnel designed to fish water 4.3 m or 1.8 m were set in late March or early April each year. The netting period varied from 18 days in 1983 to 31 days in 1988 and averaged 27 days. Total netting effort ranged 2,112 net hours in 1983 to 4,176 net hours in 1984 and averaged 3,536 hours.

Seven or eight 1.8 m nets were set in shallow bays, primarily along the south shore. Location of these nets remained the same each year with two exceptions. Net 1 was moved to site 11 in 1988 and net 9, added in 1985, was moved to site 10 in 1987. Net 2, the 4.3 m net, was set in the old river channel and remained in that location throughout the study. Net locations are shown in Figure 1.

Nets were lifted daily and all muskellunge captured were placed in 151 L tanks and transported to the boat ramp (Figure 1). All fish were measured to the nearest mm, (total length) weighed to the nearest 0.1 kg, sexed, and a scale sample was taken from the area immediately above the pelvic fin, midway between the lateral line and the dorsal midline. In addition, all muskellunge greater than 60 cm were tagged with sequentially numbered aluminum strap tags locked loosely around the preopercle (Johnson 1971) and marked with a fin clip to monitor tag loss.

Age and Growth

All scales were cleaned, mounted between glass slides, and aged independently by two readers on an Eberbach Model 2700 microprojector at a magnification of 40X. Average growth by sex was determined from direct measurements of length of known age fish.

Population Estimates

The number of muskellunge age-3 and older (hereafter referred to as the adult population) was estimated each spring from trap net catch, mark and recapture data. The estimate was computed using the modified Schnabel multiple census method described in Ricker (1975).

Mortality Rates

Estimates of mortality were calculated using regressions from trap-net catch-per-unit-of-effort (CPUE) data. Natural logarithms of CPUE (fish per trap net hour) were regressed against age to determine slopes for individual year classes and for all years combined. The slopes were then converted to survival using relationships from Ricker (1975). Separate estimates were calculated for males and females due to their difference in age at full recruitment to the trap nets.

Stocked Fingerling Muskellunge

Stocking

Advanced fingerling muskellunge were stocked each year (1982-1987) at the rate of 5/hectare with the exception of 1983 when the rate was 4.3/hectare and 1985 when the rate was 2.5/hectare. All muskellunge fingerlings were pond raised with the exception of those stocked in 1985 when, due to the unavailability of pond reared fish, trough reared fish were stocked. Prior to stocking, all fingerlings were marked with either a pectoral or pelvic fin clip and a randomly selected subsample of 50 or 100 was measured to the nearest millimeter and weighed to the nearest gram. The fingerlings were then transported to the reservoir and point-stocked at the boat ramp (Fig. 1). Date of stocking ranged from 20 August in 1986, to 14 October in 1982 and lake water temperature ranged from 26.6°C in 1986 to 16.7°C in 1984.

Survival of Stocked Fingerlings

Immediate mortality due to handling or temperature shock was estimated by placing a subsample of 30 fingerlings in a floating creel (109 x 109 x 69 cm) and holding them for a minimum of 72 h. The creel was checked daily for dead or dying fish and all fish remaining at the end of the period were released into the reservoir.

Survival of stocked fingerling muskellunge was estimated each year (1983-1987) both in the fall, 23-37 days post stocking, and in April of the spring following stocking. These estimates were computed using Chapman's modification of the Petersen method described in Ricker (1975).

Pulsed DC shocking units were used to sample fingerling muskellunge during all surveys. During the fall marking period, the entire shoreline was surveyed at least once and the western end of the reservoir, where approximately 80% of the fingerlings were sampled, was surveyed at least twice. Effort during the marking period ranged from 15 to 18 hours. All fingerling muskellunge captured were measured, weighed (1986-87), and given a fin clip. During the recapture period the entire shoreline was surveyed once. All fingerlings captured were examined for marks and measured. Due to relatively high water transparencies, almost all fall surveys were conducted after dusk.

Surveys conducted for the spring estimates were similar with two exceptions. Almost all spring surveys were conducted during daylight hours and the fingerlings marked during the previous fall were used as marked fish at large (M) for the spring estimates.

Emigration

An electrofishing boat using pulsed DC was used to survey the tailwaters of Clear Fork Reservoir to sample emigrating muskellunge. In 1983, the surveys were conducted biweekly from 13 April to 18 October with one additional survey run on 1 December. From 1 April 1984 to 30 June 1987, surveys were conducted weekly or biweekly, depending on river stage, from mid March or early April until water ceased flowing over the dam, subsequent surveys were then conducted monthly or during periods when the reservoir water level was above spillway height.

The surveys extended from the dam to a logjam approximately 0.5 km downstream. All muskellunge captured were measured, weighed, sexed, checked for tags and finclips, and a scale sample was collected. Non-tagged muskellunge greater than 60 cm were tagged with preopercle tags and those less than 60 cm were fin clipped. In addition, signs were posted requesting anglers to return tags from all harvested muskellunge, thus providing a minimum exploitation rate for muskellunge in the tailwater.

Two additional surveys were conducted after the emigration study was completed on 30 June 1987. On 27 August and 2 September 1987, two months after a major flood had occured, the tailwater area was sampled and all captured muskellunge were transferred back into the reservoir. One additional survey was conducted on 20 April 1988 to determine numbers of muskellunge remaining in the tailwater.

Angler Catch And Harvest

Creel Survey

A creel survey of boat and shore anglers was conducted at Clear Fork Reservoir 1983-1985. Surveys were stratified into weekday and weekend mornings (7.5 h) and weekday and weekend afternoons (7.5 h). Survey periods were randomly selected with the stipulation that morning and afternoon periods of the same day were not selected and, when possible, no weekday was excluded in a given month.

Creel surveys lasted from 26 (1985) to 29 (1983) weeks, with the starting dates ranging from 8 April to 20 April and ending from 13 October to 28 October. During 1983, one weekend day and one or two weekdays were censused each week during the first 10 weeks and during the last 19 weeks two weekend days and three weekdays were sampled each week. In 1984 and 1985, one weekend and one or two weekdays were sampled each week.

To make the estimates as accurate as possible, the reservoir was divided into three nearly equal segments (Fig. 1.). During each sample period the creel clerk made three counts of the anglers in each segment. Between counts the clerk interviewed as many anglers as possible, making an attempt to obtain a representative sample of boat and shore anglers in all three segments.

All anglers interviewed were asked what species they were seeking, their country or state of residence, and the one way distance they traveled to the reservoir. In addition, in 1984 and 1985, the boat license number of anglers seeking muskellunge was recorded to determine a minimum number of individual muskellunge anglers. The clerk identified and counted all fish harvested by interviewed anglers and measured and obtained scale samples from all harvested muskellunge. The clerk also asked anglers how many fish of each species they had caught and released.

Total boat and shore angling effort was estimated from the instantaneous angler counts; catch per unit of effort was derived by dividing observed catch by sampled angling hours. Total catch was derived by multiplying catch per unit of effort by total effort. A more detailed explanation of the creel survey methods can be found in Isbell (1989).

Other Catch Assessment Methods

In addition to the creel census, an angler catch record book, scale envelopes and Ohio Huskie Muskie Club applications were made available at the concession stand and anglers were encouraged to measure, weigh and take a scale sample from all muskellunge caught. This procedure was continued after the creel census was terminated in 1985. The Ohio Huskie Muskie Club is a Division of Wildlife sponsored club which requires anglers to submit catch information and a scale sample to the Division in order to be recognized for catching a trophy (> 76 cm T.L.) fish. Scale samples

returned by anglers were aged by the same method as those collected from trap nets.

FINDINGS

Adult Population

Trap Netting

Netting effort varied from 2,112 net hours in 1983 to 4,176 net hours in 1984 and averaged 3,536 net hours during the six year study period. Numbers of individual adult (age-3 and older) muskellunge captured ranged from 145 in 1983 to 375 in 1987 and CPUE ranged from 0.053 in 1988 to 0.091 in 1987 (Table 1). While the number of muskellunge captured in a given year was obviously affected by netting effort, the strength of the age-3 and age-4 year classes was the major factor influencing both the numbers of muskellunge captured and the CPUE.

Of the 1,552 individual adult muskellunge captured during the study, age-3 fish contributed 48% (740) of the catch, age-4 fish 33% (513) and fish age-5 and older contributed only 19% (299) of the total catch. For all muskellunge captured, males (51.5%) and females (48.5%) were represented in approximately equal numbers. However, there were major differences between the numbers of males and females captured at various ages. This was due to the fact that males were fully recruited at age-3 while females were not fully recruited until age-4 and the mortality rate was higher for males than for females. Thus, of the 740 age-3 fish captured, 491 (66%) were males and 249 (34%) were females. By age-4, the percentage had changed to 41% (208) males and 59% (305) females and for age-5 and older fish only 34% (101) were males while the percentage of females in the catch had increased to 66% (198).

Some age-2 muskellunge were captured each year, but the number caught was not always an accurate indicator of the strength of the year class.

Numbers of age-2 fish captured was more closely associated with the average size of these fish.

Population Estimates

The adult muskellunge population varied widely during the study period, with estimates ranging from 1,146 in 1983 to 461 in 1988 (Table 2). The low numbers of muskellunge marked and recaptured and the resulting wide confidence limits, indicate the 1983 estimate was not very precise and was probably too high. From 1984 through 1988, the netting period was extended, increasing the numbers marked and recaptured, thus improving the accuracy of the estimates.

In all years, the adult population was composed primarily (68% to 87%) of 3 and 4 year old fish. Since there was not enough data to compute estimates for muskellunge 5 years old and older, we obtained an estimate by subtracting the estimated number of 3 and 4 year old fish from the total estimate. This indicated that the number of older fish declined from 1984 through 1988.

Age and Growth

Growth rates of adult muskellunge were relatively consistant throughout the study period and total numbers of fish in the population did not appear to affect growth. There was, however, some indication that growth of fish in a year class following a strong year class was slightly depressed, as fish of the 1980, 1983, and 1985 year classes grew somewhat slower than fish of the larger 1979, 1982, and 1984 year classes (Tables 3 and 4).

Females grew faster and lived longer than males. By age-3 females were larger than males and continued to grow faster than males in all subsequent years (Figure 2).

Mortality Rates

Male and female muskellunge were fully recruited to trap nets at ages 3 and 4 respectively. Mortality rates of male muskellunge were higher than those of female muskellunge. Pooled estimates for males (ages 3-8) was 64% and 47% for females (ages 4-10). Mortality rates of individual year classes (1979-1984) for males varied from 57% to 85% and for females (1979-1983) ranged from 51% to 76%. Mortality rates for individual year classes are depicted in Figure 3.

Stocked Fingerling Muskellunge

Due to differences in hatchery production, both the time of stocking (20 August to 14 October) and the average length (253 mm - 303 mm) of the stocked fingerlings varied during the study. Dates, numbers, mean lengths and mean weights of the stocked muskellunge fingerlings are displayed in (Table 5).

Immediate mortality due to handling and transportation stress varied from 0-10% (Table 6). Highest immediate mortality occurred in 1986 when the lake water temperature was 26.6°C on the stocking date. This was higher than the 25°C recommended by Mather and Wahl (1989) as the upper limit for stocking muskellunge fingerlings.

Population estimates from data collected during electrofishing surveys conducted 24-38 days post stocking indicated survival ranged from 30% in 1985 to 75.6% in 1984 and averaged 58% during the 5-year study period (Table 7). Estimates of population abundance in the spring following stocking were similar to fall estimates in three of the five years, indicating overwinter mortality was minimal. The two exceptions were the 1984 and 1985 year classes. The spring estimate for the 1984 year class was significantly lower than the fall estimate, declining from 1478 to 976. In contrast, the spring estimate for the 1985 year class increased from 300

to 453. Subsequent evaluations of the strength of these year classes indicated the fall estimates were more accurate, as the 1984 year class appeared to be the strongest year class produced and the 1985 year class was extremely small. Population estimates, 95% confidence limits and survival for both fall and spring are listed in Table 7.

Post-stocking growth of fingerling muskellunge was directly related to stocking date. Mean growth of fingerlings in the three year classes stocked 25 September - 4 October was only 2.6 cm by spring, while the average growth of fingerlings in the two year classes stocked by 1 September was 9.5 cm. Thus, the mean lengths at age-1 for the 1983-84 year classes, stocked at a mean length of 30.3 cm in October, were approximately the same as those of the 1986-87 year classes, stocked at a mean length of 25.6 cm by 1 September. Mean lengths and weights (when available) of muskellunge fingerlings 24-38 and 197-254 days post stocking are presented in Table 8.

Emigration

Numbers of muskellunge emigrating from Clear Fork Reservoir varied widely between years, depending on the quantity of water flowing over the dam and time of year high water flows occurred. In normal years, the majority of muskellunge emigrated during April and early May, the time when adult muskellunge are most active. While some emigration occurred during periods of lower (10-15 cm) flow, significant numbers of muskellunge did not emigrate until the water level in the reservoir approached or exceeded 30 cm above spillway level. From mid-May until winter, a period when apparently few muskellunge emigrated, the lake level was seldom high enough to permit emigration. There was one extraordinary exception to the normal lake level patterns. On 2 July, 1987 approximately 25 cm of rain fell in the water shed, raising the water level nearly 5 m above spillway level.

While no accurate estimate of the number of muskellunge that emigrated from the reservoir was possible, it became apparent that large numbers of muskellunge had emigrated. Since the emigration portion of this study terminated prior to this event, no surveys were conducted immediately following the flood. However after complaints were received regarding anglers snagging muskellunge in the tailwater, an electrofishing survey was conducted to remove excess muskellunge. On 27 August and 2 September, two months after the flood, 96 muskellunge were captured and returned to the lake. This represented a catch rate more than three times that of any previous survey.

For the entire (1983-88) period, 318 individual muskellunge were captured in the tailwater (Table 9). Ages of these fish ranged from 1 to 10 and their lenghts ranged from 28.9 cm to 118.5 cm.

Of these 318 individuals, 243 (76.4%) were age-3 and older, and by age groups made up almost the same percentage of the catch in the tailwater as they did in the trap net catch (Table 9). The fact that age-1 and age-2 muskellunge did not emigrate from the reservoir in proportion to their abundance was thought to be related to behavioral differences, as younger fish tended to remain in the upper end of the reservoir. Therefore, their chance of emigrating was reduced.

Of the 1,269 individual adult muskellunge tagged in the reservoir during the study, 68 were recaptured in the tailwater and 10 additional tagged fish were recaptured at Pleasent Hill Reservoir, approximately 32 km downstream. These data indicate that at a minimum, 6.1% of the adult muskellunge emigrated during the study.

Angler Catch and Harvest

Creel Survey

Total annual fishing pressure averaged 93,619 hours (231 hours/hectare) during the 1983-1985 period. Muskellunge anglers comprised 14.7 to 20.7% of the total anglers, fished an average of 4.4 hours per trip and expended an average of 24,924 hours (62 hours/hectare) of effort annually seeking muskellunge. The great majority, 98 to 99%, of muskellunge anglers were boat anglers.

The average distance traveled (one way) by a muskellunge angler to fish Clear Fork Reservoir ranged from 75 km in 1983 to 83 km in 1985. Over 70% of the muskellunge anglers traveled more than 32 km, while only 33% of the largemouth bass, sunfish, catfish, whitebass, yellow perch and "anything that bites" seekers traveled that far. Muskellunge anglers came from 45 of 88 Ohio counties and 4 other states during the three year period.

Creel clerk records of individual boats, identified by their boat license number, indicated a minimum of 218 and 123 different boats containing muskellunge anglers were observed in 1984 and 1985 repsectively. As the average number of muskellunge anglers per boat was 1.5 and 1.75 in 1984 and 1985 respectively, the minimum number of individual muskellunge anglers was 327 in 1984 and 215 in 1985.

The number of times an individual boat was seen during the survey period ranged from 1 to 16 in 1984 and 1 to 4 in 1985. In 1984, 64% of the boats were observed only once and 95% on 5 or fewer occasions, while in 1985 74% were seen once and 95% on 3 or fewer occasions.

Estimates of annual muskellunge fishing pressure and muskellunge angler characteristics are displayed in Table 10.

The estimated harvest of muskellunge increased from 111 in 1983 to 208 in 1985. Numbers of released fish also increased from 248 in 1983 to 1,401 in 1985 (Table 11). On an average, 96.6% of the muskellunge were caught by anglers seeking muskellunge with anglers seeking largemouth bass catching 2.3% and other anglers catching the remaining 1.1%. The great majority (90.6%) of the muskellunge were caught in the middle (location No. II) and the eastern (location No. III) end of the reservoir (Fig. 1). Muskellunge anglers caught muskellunge at rates ranging from .021 per hour (48 hours/muskellunge) to 0.035 (28 hours/muskellunge). As the catch rate increased, the percentage of the catch harvested dropped from 30.9% in 1983 to 23.3% in 1984 and to 12.9% in 1985.

The estimated harvest of muskellunge greater than 76 cm was 74 in 1983 and 75 in 1984. In 1985, after the recruitment of the 1982 year class into the fishery, the harvest estimate increased to 139 muskellunge.

Other Methods of Catch Assessment

Ohio Huskie Muskie Club & Concessionaires Records Angler catch data derived from both Huskie Muskie Club applications and the concessionaire record book indicated a minimum of 162, 337, and 580 muskellunge were caught in 1983, 1984, and 1985 respectively (Table 12). While both the number of fish caught and the number harvested increased over the three year period the percentage of the catch which was harvested declined each year, dropping from 31.4% in 1984 to 15.7% in 1984 and 13.4% in 1985. Correspondingly, the percentage of muskellunge released increased significantly as the 1982 and 1983 year classes were recruited into the fishery at age-2 in 1984 and 1985 respectively. The rate of release was directly related to the size of fish caught. An average of 96.6% (range 94.3-97.8%) of fish less than 76 cm were released. The average release rate for muskellunge ranging from 76 cm to 102 cm was 73.7%, with the

annual release rate increasing from 57.5% in 1983 to 79.8% in 1984 and 83.9% in 1985. For muskellunge 102 cm or longer, the average release rate was 20.9% (range 18.5 to 24.3%). The low release rate for these large muskellunge was due to their desirability as a trophy.

Data derived from Ohio Huskie Muskie Club catch records and the concessionaire log book catch records in 1986 and 1987 are depicted in Table 13. More fish were reported caught through the club applications both years. Concessionaire records indicated a larger proportion, 36.1% in 1986 and 31.3% in 1987, were kept than did club records which indicated only 9.7% and 14.9% were kept. This relationship was true for each of the three size ranges of muskellunge recognized by the club. In addition, more tagged muskellunge, 32 vs. 15 in 1986 and 50 vs. 26 in 1987, were reported through concessionaire records than Huskie Muskie Club records. In 1986 only 25 of 81 (30.8%) of the muskellunge greater than 76 cm reported caught in the concessionaire records were also submitted via Huskie Muskie Club applications. Thirty percent of the 110 muskellunge reported caught in the concessionaires records in 1987 were also reported through the club.

The rate of exploitation, based on the harvest of 76 cm and larger muskellunge divided by the population estimate each spring, varied from 2.6% to 7.6% depending on the source i.e., Huskie Muskie Club data, concessionaire records or both. These minimum estimates are extremely low, indicating excessive harvest of muskellunge is not a problem at Clear Fork Reservoir.

Age Composition of Angler Catch The age compositions of angler caught muskellunge from Clear Fork Reservoir from 1983 through 1987 are displayed in Table 14. All age groups 1-13, with the exception of age-12 fish, were

represented in the catch. Age groups 2 and 3 provided the majority of the fishery in all years including 1987 when the weak 1985 year class (age-2) contributed only minimally to the fishery.

Tag Returns Of the 1,269 muskellunge age-3 and older, tagged in Clear Fork Reservoir from 1983-1988, 204 (16%) were subsequently caught by anglers during the study period. Of these, 129 (10.2%) were harvested, while the remaining 75 (5.9%) were released. Of the 621 tagged females, 82 (13.2%) were harvested and 41 (6.6%) were released, while only 47 (7.3%) of the 658 tagged males were harvested and 34 (5.2%) were released. The age structure of tagged muskellunge caught by anglers during the study period is displayed in Table 15. These data indicate both male and female muskellunge age-4 and older were more often harvested than released. This is most evident for both sexes age-7 and older.

Exploitation rates of age-3 and older muskellunge based on the number of tagged fish harvested during the year in which they were marked ranged from 3.2% in 1987 to 10.3% in 1983 with an average value of 6.1%.

ANALYSIS

Survival and Growth of Stocked Fingerlings

Survival of stocked muskellunge fingerlings was monitored each year (1983-1987). Immediate mortality attributed to handling and transportation stress was considered to be minor, ranging from 0 to 10%. However, results of population estimates conducted approximately 1 month post-stocking and the spring following stocking indicated mortality during the fall and winter approached 50% with almost all mortality occurring during the first month post-stocking. Causes of this relatively high mortality were not determined, but did not appear to be directly related to size of fingerlings stocked, stocking date or lake water temperature at time of stocking. Fingerlings ranging from 25 cm to 30 cm stocked from 20 August

to 4 October at lake temperatures ranging from 26.6°C to 16.5°C all experienced similar mortality rates during the first month post-stocking. In 1985, the only year in which mortality exceeded 50%, stocking procedures differed substantially from other years. The stocking rate was lowered from 5 to 2.5 fingerlings per hectare, 25 cm fingerlings were stocked approximately a month later than in other years when 25 cm fingerlings were stocked, and the fingerlings were reared in troughs rather than in ponds. While we have no reason to believe the lower stocking rate was in any way responsible for the increased mortality, the rearing technique, the later stocking date for the 25 cm fingerlings or a combination of these factors could have influenced survival.

Post-stocking growth of muskellunge fingerlings was directly related to time of stocking. Thus at age-1, 25 cm fingerlings stocked by 1 September were as large or larger than 30 cm fingerlings stocked a month later. Since no differences in mortality were detected between these two groups, it appears to be more economical to stock smaller fingerlings as early in the year as possible to take advantage of growth occurring in the reservoir.

Excluding the 1985 year class, our data indicated the stocking of 2,000 (5/hectare) 25 cm to 30 cm muskellunge fingerlings resulted in approximately 1,000 (2.5 /hectare) muskellunge averaging nearly 33 cm in length surviving to age-1. While no estimates of survival of the 7.5 cm to 20 cm fingerlings stocked at the rate of 12 and 10 per hectare in 1980 and 1981 were made, comparisons of abundance at age-3 between those two year classes and year classes established after 1981 indicated survival of the 1980 and 1981 year classes could not have exceeded 20%.

Accurate assessments of survival and growth rates for stocked year classes were not possible between the ages of 1 and 3, as we were unable to

adequately sample 2 year old fish either in trap nets or by electrofishing. However, at age-2+, muskellunge became vulnerable to angling and in all years the number of 2 year old fish in the anglers catch was closely related to the estimated size of the population at age-1. In addition, the percentage of 2 year old fish in the anglers catch was quite similar to the percentage of 3 year old fish captured in trap nets the following spring (Figure 4). These data, while not providing accurate estimates of survival, did indicate survival for muskellunge from age-1 to age-3 was consistent for all year classes and that angler catch rates of 2 year old fish can be used to predict year class strength.

Growth of muskellunge between the ages of 1 and 3 varied slightly from year to year, with individuals in year classes which followed a strong year class growing slightly slower than individuals in the preceeding year class. Thus it appears that growth of muskellunge between the ages of 1 and 3 was more closely related to the size of the preceeding year class than to the size of their own year class.

Size and Age Structure of Adult Population

Members of all age groups 3-10+ were normally represented in both the trap net and anglers catch each year. However, 3 and 4 year old muskellunge always comprised from 73% to 89% of the trap net catch and 65% to 82% of the age-3 and older muskellunge reported by anglers. Both total numbers and the percentage of the population comprised of 3 and 4 year old fish increased as year classes established by stocking large fingerlings were recruited into the adult population (Figure 5). In contrast, muskellunge age-5 and older declined, not only in percentage of the population, but in actual numbers. This suggests mortality rates of older fish increased as numbers of younger fish in the population increased. Our data indicate mortality rates did increase, particularly for the 1982 and

1983 year classes. However, two unusual events which occurred during the study were at least partially responsible for the increases in mortality of older age groups. The first event took place in 1985, when relatively large numbers of adult fish died as a result of an outbreak of a bacterial disease. The other unusual event occurred in 1987, when during a major flood a significant number of adult muskellunge emigrated from the reservoir. The impact these two events had on the older age groups, particularly the 1982 and 1983 year classes, made it impossible to accurately assess their contribution to the age 5 and older age group. Therefore, we were unable to determine if increasing recruitment at age-3 will also increase recruitment to older age groups or will merely result in increased mortality rates for older fish.

Observed differences between male and female growth rates, mortality rates and longevity all affect the size and structure of the adult population. Female muskellunge grow faster, have higher survival rates and live longer than males. Because few 2 year old muskellunge were sexually mature, we were unable to determine when differential growth first occurred. However, at age-3 average lengths and weights of females exceeded those of males by 4 cm and .8 kg respectively (Figure 2). Thus while the majority of females attained the desired harvest size (76 cm) at age-3, few males reached this size until age-4. Females continued to grow faster than males and most attained what anglers consider "Trophy Size" (102 cm and 9.2 kg) by age-6, while no male was ever known to attain this size. These data point out the fact that female muskellunge not only provide the majority of the 76 cm muskellunge available to anglers, but also provide all "Trophy Size" muskellunge.

While differential growth was evident at age-3, differences in survival between males and females did not appear to occur until after

males became sexually mature at age-3. Although it was not possible to determine an accurate sex ratio at age-3 because only males were fully vulnerable to trap nets, the large numbers of males sampled indicated they were at least as abundant as females. However, at age-4, when both sexes were fully vulnerable, the male to female sex ratio was .68:1 and for muskellunge age-5 and older the ratio further declined to .52:1. These data indicate differential survival started at age 3 and male mortality rates continued to exceed those of females in all subsequent years.

Further evidence of accelerated male mortality was indicated by the fact that the maximum age attained by male muskellunge was 9 and only 13 (1.6%) of the trap net sampled males attained an age of 7 or older. In contrast, the maximum age for a female was 13 and 51 (6.8%) of the females attained the age of 7.

Catch and Harvest Assessment

Fishing pressure, total catch, and catch rates all increased significantly during the study. Harvest, however, did not increase in proportion to the increase in total catch, a finding which contradicts the original assumption of the study objective that an increase in harvest would occur if recruitment increased. The smaller increase in harvest was attributed primarily to the change in the age structure of the population as year classes derived from the introduction of large fingerlings entered the fishery. As these strong year classes were recruited, the number of 2 and 3 year old muskellunge caught by anglers increased dramatically which was exemplified by their contribution to the catch increasing from approximately 55% in 1983 to over 80% in 1985. During this same time, there was almost no change in the numbers of muskellunge age-4 and older in the anglers catch. Thus, while numbers of smaller muskellunge available to anglers increased, the number of large muskellunge, particularly "Trophy

Size" fish, remained constant or declined. However, due to excellent growth, many muskellunge attained a length of 76 cm, the minimum size recognized by the Ohio Huskie Muskie Club, during their third growing season. As one of the objectives of the club is to promote catch and release fishing, the majority of these fish were released. In fact, the release rate of fish from 76 cm to 102 cm increased 26% from 1983 to 1985. This change was probably caused by the increased pressure by muskellunge anglers who perceived that since they were catching more fish than ever before, their chances of catching a "Huskie Muskie" (102 cm or larger) were also increased. Therefore, because of the catch and release nature of the Clear Fork muskellunge fishery, a set harvest goal is unrealistic and in this situation a population density goal or a total catch goal would have been more appropriate.

It appears creel surveys overestimated muskellunge catch, but did show the trend of increasing catch through time. Due to the relatively low density of the muskellunge population compared to other sport fish populations, it is difficult to obtain a large enough sample to estimate catch and harvest accurately in an economical manner.

The Ohio Huskie Muskie Club was formed by the Division of Wildlife in 1962 to obtain information on the harvest of muskellunge from Ohio waters (Pelton, 1963). The Division thought this harvest information could be used to evaluate stocking success at all muskellunge lakes. Therefore, we attempted to compare club returns to creel surveys and concessionaire records to determine if data derived from club applications was biased in any way. We feel data based on Huskie Muskie Club returns from Clear Fork Reservoir are adequate to provide the information needed to evaluate stocking success. However, this does not appear to be true for all major muskellunge fisheries in Ohio. To obtain the data necessary to evaluate

our program at all areas, we need to increase the percentage of anglers who submit applications with scale samples. Presently, muskellunge anglers who belong to an organized club have a greater tendancy to release fish and submit applications than do other anglers. In addition, some concessionaires and marina operators are more aggressive in encouraging and assisting anglers to fill out applications. Other problems include inaccurate or incomplete reporting of muskellunge catches. However, with a strong effort by the Division in communicating with all muskellunge anglers, we should be able to increase the rate of returns and decrease the amount of inaccurate reporting so these data will be more useful in evaluating our muskellunge program.

MANAGEMENT IMPLICATIONS

1) Stock large fingerlings as early as environmental conditions will permit to take advantage of in lake growth potential.

2) Promote the submission of accurate and complete catch records of all muskellunge through the Ohio Muskie Club. All data could then be entered into a central file to be used to evaluate stocking success at all muskellunge lakes.

3) Creel surveys are good for estimating pressure, but they lack accuracy for estimating catch harvest. In addition, our experience was that surveys by one creel clerk were superior to those accomplished by a team.

4) As muskellunge is a long lived species, studies designed to evaluate the contribution of stocked year classes to the population or catch should extend for a minimum of 10 years.

REASEARCH NEEDS

1) Explore the possibility of producing sexless muskellunge that will have growth and survival characteristics of females.

2) Investigate methods of reducing costs of raising fingerlings and the possibility of reducing stocking size to 20 cm.

3) Develop an electrofishing index similar to that used for walleye and saugeye to evaluate muskellunge stocking success.

4) Develop a habitat suitability index of Ohio's muskellunge lakes.

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Table 1. Age distribution and catch per net hour (CPUE) of male and female muskellunge caught during April trap-net surveys, 1983-1988.

Sex	Year caught	Age								Total	CPUE
		3	4	5	6	7	8	9	>10		
Male	1983	47	26	6	3	4	0	0	0	86	.0407
	1984	72	65	12	5	1	0	0	0	155	.0371
	1985	102	23	30	9	2	0	1	0	167	.0404
	1986	81	26	6	3	2	1	0	0	119	.0458
	1987	154	15	5	2	2	0	0	0	178	.0431
	1988	35	53	3	4	0	0	0	0	95	.0223
	Total	491	208	62	26	11	1	1	0	800	.0377
Female	1983	3	38	8	5	0	1	3	1	59	.0279
	1984	21	44	31	8	3	1	2	0	110	.0263
	1985	76	31	21	13	8	0	0	4	153	.0371
	1986	24	56	7	10	7	2	2	2	110	.0424
	1987	122	43	12	7	8	4	0	1	197	.0477
	1988	3	93	10	12	0	2	2	1	123	.0301
	Total	249	305	89	55	26	10	9	9	752	.0354

Table 2. Schnabel population estimates, 95% confidence limits in parenthesis, of muskellunge abundance at Clear Fork Reservoir, 1983-1988.

Year	Age group			Total
	3	4	5*	
1983	**	**	**	1146 (653-3033)
1984	239 (164-383)	233 (171-335)	221	693 (549-903)
1985	558 (408-813)	125 (79-231)	256	939 (747-1218)
1986	329 (220-550)	331 (198-673)	139	799 (592-1137)
1987	689 (553-883)	246 (131-629)	142	1076 (873-1360)
1988	81 (49-158)	284 (222-376)	96	96 (461-587)

*Values are calculated by subtracting age group 3 and 4 estimate from Total estimate.

**Numbers of muskellunge marked and recaptured were too small to compute an estimate.

Table 3. Mean observed length (mm) at age of marked female muskellunge captured in trap nets in Clear Fork Reservoir, 1983-1988. Standard deviation of mean length in parenthesis.

	Age										
Year	3	4	5	6	7	8	9	10	11	12	13
1974							1101 (24.8)				1156 (--)
1975						1042 (--)	1076 (61.5)	1127 (77.4)	1130 (--)		
1976						1055 (--)		1131 (--)			
1977				1009 (37.3)	1028 (21.2)		1079 (79.2)				
1978			969 (52.3)	1038 (25.9)	1042 (24.5)	1140 (100.4)		1128 (--)			
1979		900 (34.2)	971 (37.5)	1033 (31.4)	1053 (23.5)	1129 (29.5)	1109 (25.4)				
1980	724 (63.0)	862 (39.0)	923 (35.6)	999 (38.1)	1047 (44.5)	1075 (13.4)					
1981	775 (21.0)	872 (34.7)	957 (23.7)	1031 (23.4)							
1982	773 (34.3)	901 (36.8)	962 (29.0)	1026 (35.5)							
1983	759 (33.2)	859 (31.2)	943 (33.1)								
1984	775 (34.0)	882 (36.8)									
1985	747 (23.9)										
Mean Length	772	881	954	1023	1045	1104	1093	1128	1130		1156
Number	249	305	89	54	25	10	9	6	1		1

Table 5. Date, number, mean length (mm) and weight (g), with standard deviations in parenthesis, of muskellunge stocked in Clear Fork Reservoir, 1982-1987.

Date stocked	Number stocked	Number per hectare	Mean length	Mean weight
14 Oct. 1982	2000	5.0	275(17.9)	--
4 Oct. 1983	1729	4.3	303(18.6)	143(29.7)
2 Oct. 1984	2021	5.0	302(21.1)	152(35.7)
25 Sept. 1985	1000	2.5	254(21.3)	84(23.5)
20 Aug. 1986	1981	5.0	260(17.5)	80(19.4)
1 Sept. 1987	1990	5.0	253(31.0)	84(34.0)

Table 4. Mean observed lengths (mm) at age of marked male muskellunge captured in trap nets in Clear Fork Reservoir, 1983-1988. Standard deviation of mean length in parenthesis.

Year class	Age 3	4	5	6	7	8	9
1976					954(33.1)		979(--)
1977				938(41.6)	970(--)		
1978			875(28.0)	907(21.8)	913(27.6)	942(--)	
1979		840(25.5)	872(27.9)	898(34.7)	913(17.7)		
1980	690(25.1)	782(25.4)	829(22.3)	859(23.4)	879(9.1)		
1981	735(25.2)	799(30.5)	847(42.3)	903(3.5)			
1982	732(26.4)	819(24.9)	879(18.3)	877(19.4)			
1983	719(32.0)	797(27.3)	850(30.5)				
1984	736(25.8)	812(26.2)					
1985	724(24.5)						
Mean Length	727	804	849	897	922	942	979
Number	491	208	62	26	11	1	1

Table 6. Immediate (0-72 h) mortality of stocked muskellunge fingerlings due to stocking stress, 1983-1987.

Year	Number dead after 72 hours	Percent mortality	Water temperature°c
1983	1	3.3	19.0
1984	1	3.3	16.7
1985	0	0.0	20.6
1986	3	10.0	26.6
1987	0	0.0	21.2

Table 7. Fall and spring Petersen population estimates of age-0 muskellunge stocked in Clear Fork Reservoir, 1983-1987.

Year	Fall			Spring		
	Days at large	Population estimate(95%CL)	Percent survival	Days at large	Population estimate(95%CL)	Percent survival
1983	24	960(547-2541)	57.4	204	1080(669-2265)	64.6
1984	34	1478(915-3098)	75.6	197	976(753-1352)	50.0
1985	36	300(186-630)	30.0	212	453(284-919)	45.3
1986	37	1050(674-1735)	58.9	254	998(629-2025)	56.0
1987	38	1300(758-2449)	65.3	226	1108(799-1713)	55.7

Table 9. Age distribution of individual muskellunge captured the tailwater of Clear Fork Reservoir 1983-1988 and a comparison (by % of catch) of the age distribution of adult muskellunge captures in the tailwater and those captured in trap nets in Clear Fork Reservoir.

Age	Number sampled	Percent of total sample	Percent of catch	
			Age-3 and older from tailwater	Age-3 and older from reservoir
1	33	10.4		
2	42	13.2		
3	110	34.6	45.2	47.7
4	81	25.5	33.3	33
5	30	9.4	12.3	9.7
6	12	3.8	4.9	5.2
7	4	1.2	1.6	2.4
8	4	1.2	1.6	.7
9	1	.3	.4	.6
10	1	.3	.4	.4

Table 8. Mean length (mm), and weight (g), standard deviation in parenthesis, of age-0 muskellunge at stocking, 24-38 days post-stocking, and 197-254 days post-stocking.

Year class	Date stocked	Length and weight					
		At stocking		24-38 days post-stocking		197-254 days post-stocking	
1982	14 Oct.	275 (17.9)	---	---		298 (18.8)	---
1983	4 Oct.	303 (18.6)	143 (29.7)	305 (21.4)	---	323 (20.9)	166 (39.9)
1984	2 Oct.	302 (21.1)	152 (35.7)	321 (21.2)	---	331 (20.8)	---
1985	25 Sep.	254 (21.3)	84 (23.5)	273 (28.9)	---	283 (15.8)	94 (18.9)
1986	20 Aug.	260 (17.5)	80 (19.4)	303 (22.0)	---	372 (26.0)	277 (64.0)
1987	1 Sep.	253 (31.0)	84 (34.0)	296 (33.7)	128 (51.7)	331 (33.0)	186 (68.0)

Table 10. Muskellunge fishing pressure and angler characteristics at Clear Fork Reservoir 1983-1985.

Year	1983	1984	1985
Total muskellunge hours (% of total hours)	18,119 (23.0)	26,236 (29.0)	30,419 (27.6)
Total muskellunge anglers interviewed (% of total anglers)	938 (14.7)	839 (19.9)	322 (20.7)
Mean trip length (hours)	4.1	4.5	4.5
% Muskellunge angler boat/shore	99.5/.5	99.0/1.0	98.0/2.0
Average distance traveled (km)	75	80	83
Number of Ohio counties from (max. = 88)	43	45	39
Number of other states from	1	2	1
Number of individual boats seeking muskellunge	--	218	123
Average number of muskellunge angler/boat	--	1.5	1.75

Table 11. Muskellunge catch and harvest estimates from Clear Fork Reservoir from 1983-1985. Numbers in parenthesis indicate 90 percent confidence levels.

Year	1983	1984	1985
Estimate harvest	111 (±36)	175 (±69)	208 (±109)
Estimate released	248 (±55)	577 (±132)	1401 (±561)
Estimated total catch	359	752	1609
Catch per hour (hours/fish)	.021 (48)	.029 (39)	.035 (28)
% Caught by muskellunge seekers	94.0	96.4	99.6
Estimate harvest of ≥ 76cm	74	75	139
Estimate harvest of ≥ 101.6cm	18	19	26

Table 12. Number of muskellunge harvested and released, grouped in size ranges recognized by the Ohio Huskie Muskie Club derived from concessionaire and Ohio Huskie Muskie Club applications from Clear Fork Reservoir, 1983-1985. Percent of the total catch harvested or released in each year is in parenthesis.

Fate	Size range	Year 1983		1984		1985	
Harvested	< 76cm	4		4		6	
	> 76< 101.6 cm	31		27		44	
	> 101.6 cm	16		22		28	
	Total	51	(31.4%)	53	(15.7%)	78	(13.4%)
Released	< 76 cm	65		172		263	
	> 76 < 101.6 cm	42		107		230	
	> 101.6 cm	4		5		9	
	Total	111	(68.6%)	284	(84.3%)	502	(86.6%)
	Total catch	162		337		580	

Table 13. Number of muskellunge harvested and released, grouped in size ranges recognized by the Ohio Huskie Muskie Club from concessionaire records (CON) and Huskie Muskie Club applications (HMC)from Clear Fork Reservoir, 1986-1987. Percent of the total catch harvested or released in each year is in parenthesis.

		Year			
		1986		1987	
Fate	Size range	HMC	CON	HMC	CON
Harvested	< 76 cm	3	5	0	1
	> 76 < 101.6 cm	23	40	12	30
	> 101.6 cm	10	7	16	15
	Total	36(9.7)	52(36.1)	28(14.9)	46(31.3)
Released	< 76 cm	182	48	42	36
	> 76 <101.6 cm	143	42	115	65
	> 101.6 cm	7	2	2	0
	Total	332(90.3)	92(63.9)	159(85.1)	101(68.7)
	Total catch	368	144	187	147

Table 14. Age composition of angler caught muskellunge in Clear Fork Reservoir, 1983-1987.

Age	Year				
	1983	1984	1985	1986	1987
1	6	5	15	2	13
2	42	156	208	199	18
3	20	52	161	124	114
4	27	27	23	29	25
5	3	25	9	12	13
6	6	10	18	10	3
7	2	4	9	5	9
8	4	1	2	5	2
9	3	1	2	2	1
10	1	1		1	0
11		2			1
12					0
13					1
Total	114	284	447	389	200

Table 15. Age structure (by sex) of tagged muskellunge captured by anglers at Clear Fork Reservoir, 1983-1988.

Fate	Age 3	4	5	6	7	8	9	10+	Total
Harvested									
Males	15	13	7	4	6	2			47
Females	17	18	15	11	11	2	5	3	82
Released									
Males	21	9	3	1					34
Females	21	11	4	3	2				41

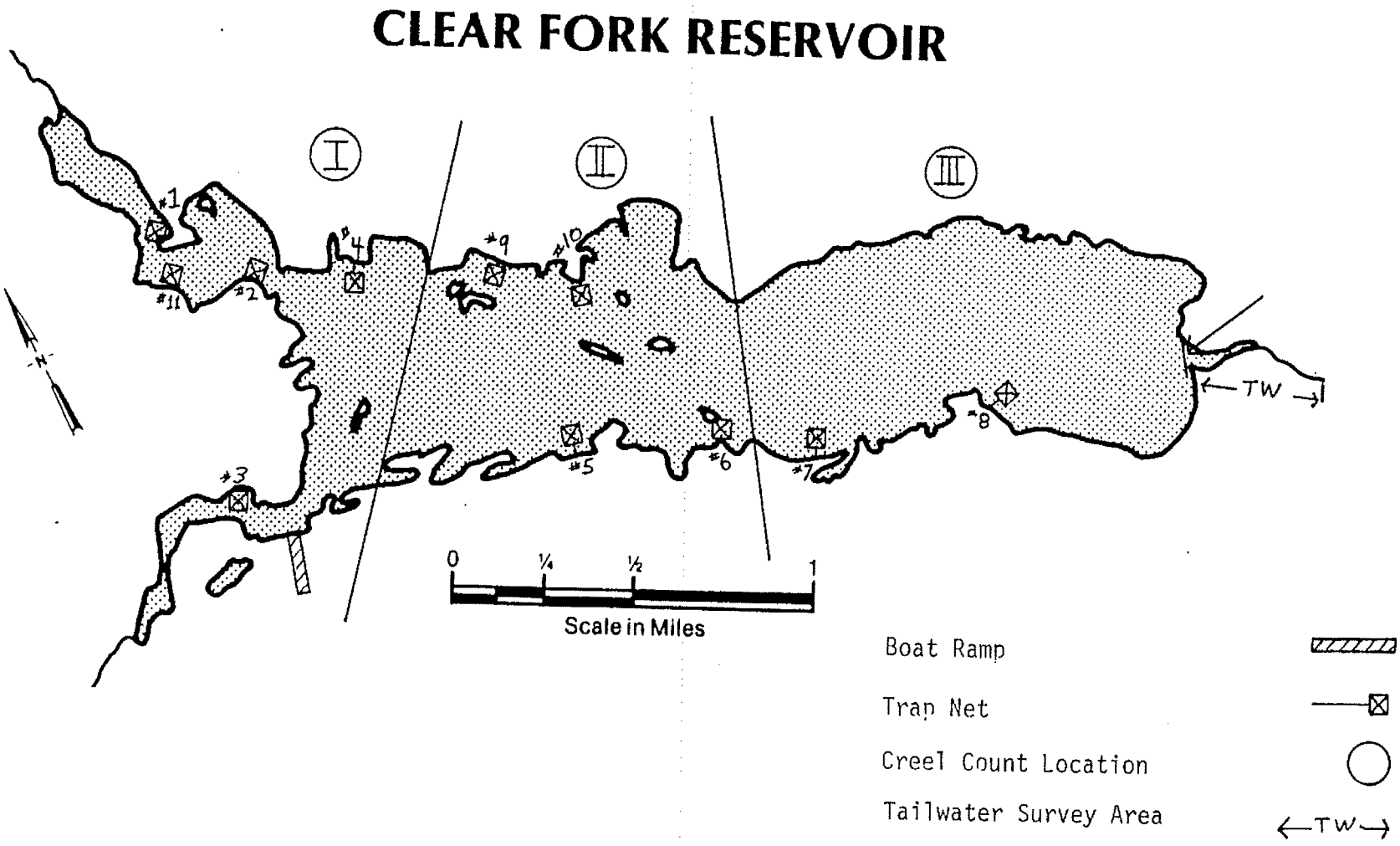


Figure 1. Map of Clear Fork Reservoir depicting the three creel count locations, boat ramp, trap net sites (1-11) and the tailwater survey area.

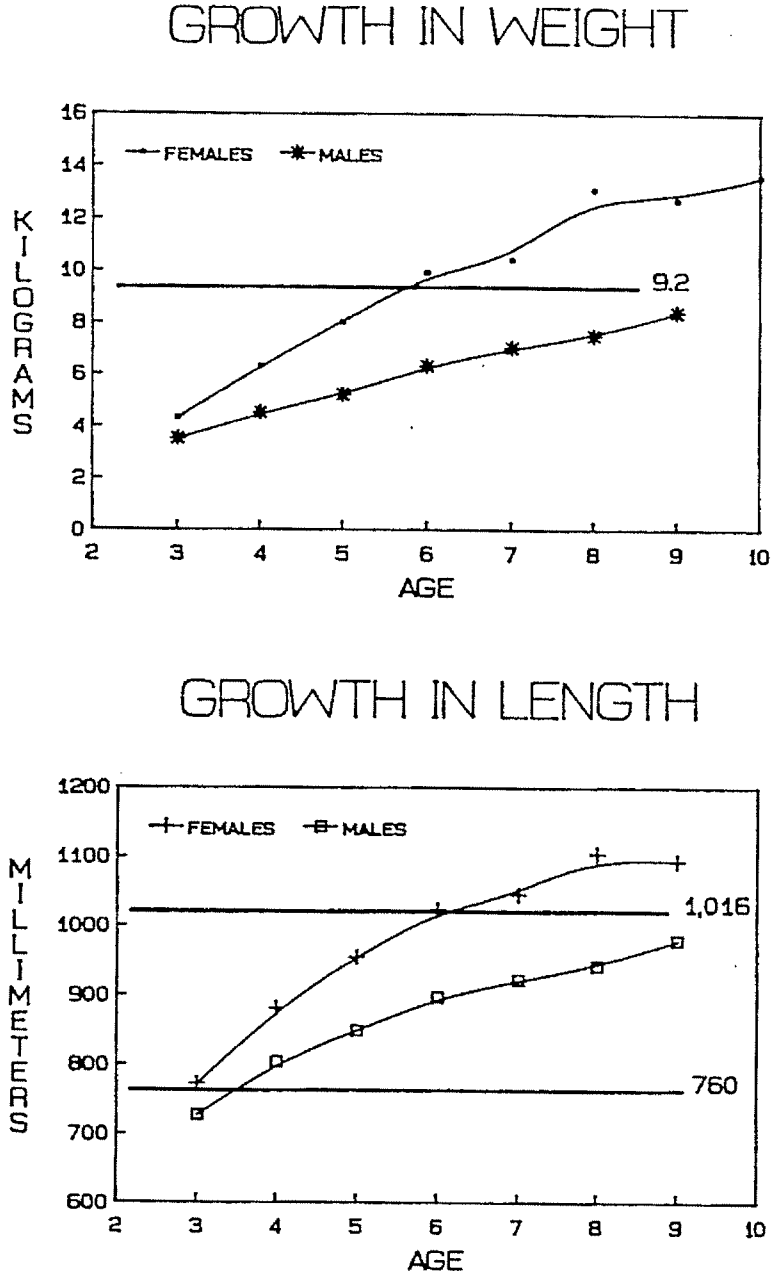
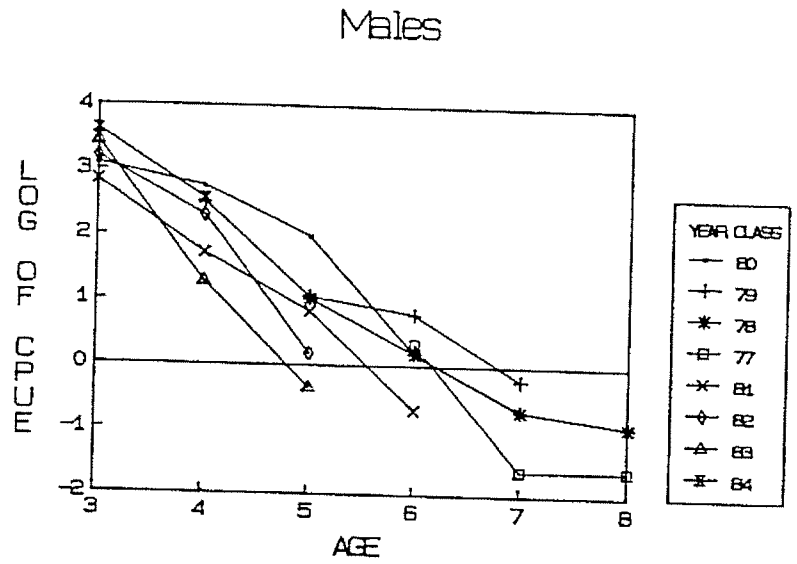


Figure 2. Average length (mm) and weights (kg) of trap net caught male and female muskellunge at age from Clear Fork Reservoir, 1983-1988. The horizontal lines 9.2 (kg) and 1016 (mm) indicate weight and length of a muskellunge "Huskie Muskie" as defined by the Ohio Huskie Muskie Club. The horizontal line 760 mm indicates length of "Honorable Mention" muskellunge.



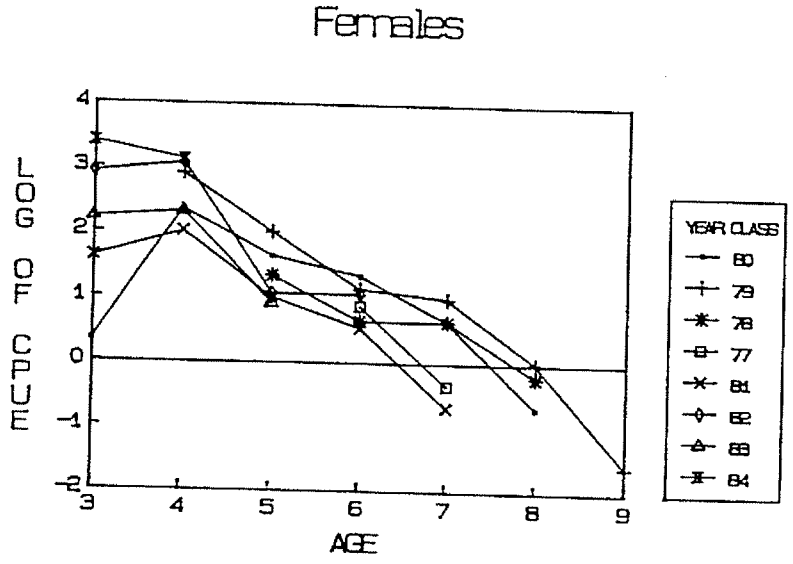


Figure 3. Mortality rates of male and female muskellunge, by year class (77-84), sampled in trap nets at Clear Fork Reservoir 1983-1988.

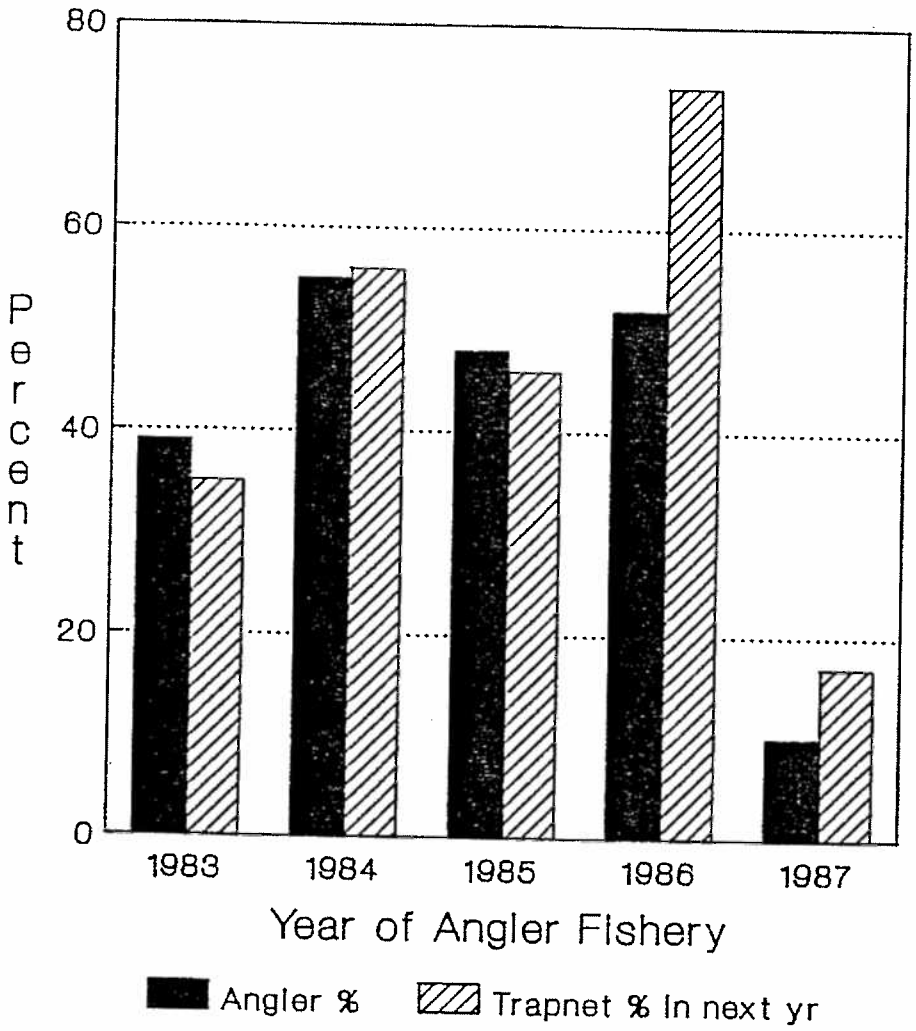


Figure 4. Percent of age 2 muskellunge caught by anglers, from 1983-1987, compared to age 3 muskellunge caught in trap nets the following spring.

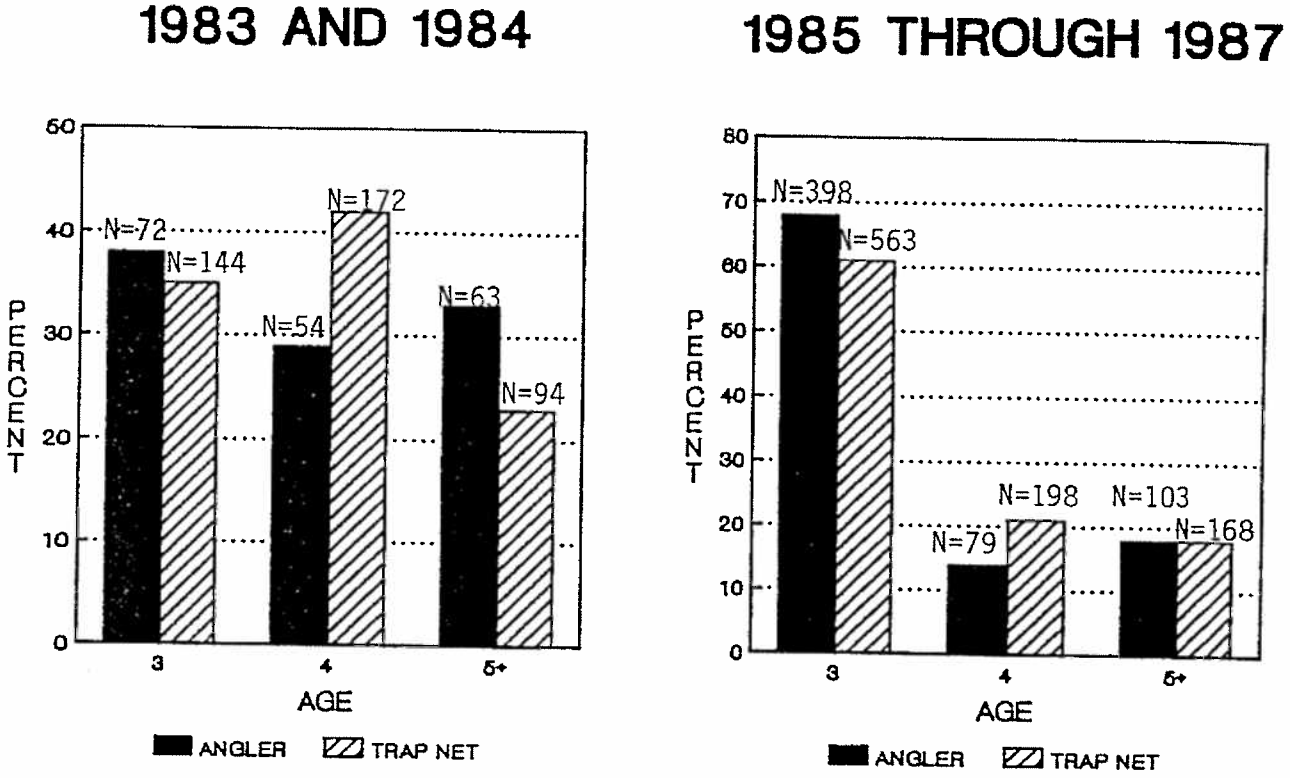


Figure 5. Comparison of percentage composition, by age group, of adult muskellunge captured by anglers and trap nets before (1983-1984) and after (1985-1987) recruitment of year classes established from stocking large fingerlings.

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