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Evaluation of Hybrid Striped Bass Introductions in Herrington Lake

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ABSTRACT

Hybrid striped bass were introduced into Herrington Lake (2,610 acres) to increase the yield of sport fish by a minimum of 10% or 1 lb/acre. Annual hybrid striped bass introductions began in 1979 with stocking rates varying from 15-32 fish/acre. A stocking evaluation study in 1979-1986 involved the use of annual cove-rotenone sampling, experimental gill netting, and a non-uniform probability creel survey. A total of 557 hybrid striped bass collected by gill netting was used to develop a length-weight relationship and to examine relative condition factors. Subsamples of these fish were used to examine both age and growth and food habits. Hybrid striped bass averaged 16.8 in long and 2.23 lb following 2 years of growth. Young hybrid striped bass (age 0+ and 1+) fed primarily on 2-3 in threadfin shad; older hybrids fed on larger prey, mainly 5-9 in gizzard shad. Impacts of hybrid striped bass introductions on forage levels were negligible based on comparisons of available prey to predator (AP/P) models. The creel survey revealed that the goal of increasing the sport fish harvest by 1 lb/acre of hybrids was attained for every year following the liberalization of creel and size limits on hybrids in 1982. The harvest of hybrids in 1980-1985 was dominated by age 0+ (26.5%) and age 1+ (56.5%) hybrids during the months of June (19.7%) and October (40.1%). The 15-in minimum size limit and 5 fish/day creel limit on hybrids was modified in 1982 to a 20 fish/day aggregate limit with white bass with no more than 5 fish to exceed 15 in long.

The hybrid fishery continues to develop as fish from several year classes are now trophy size (≥10 lb). Annual stockings of 20 hybrids/acre will be continued in Herrington Lake to maintain the excellent put-grow-take fishery.

INTRODUCTION

Hybridization of genus Morone began in South Carolina in 1965 by crossing male white bass Morone chrysop with female striped bass Morone saxatitis (Stevens 1965). Other experimentation with crosses have included the crossing of the male white perch Morone americanus, with female striped bass, yellow bass male Morone interrupta with female striped bass, and the reciprocal cross of the original hybrid using male striped bass with female white bass (Bayless 1967). Researchers have also attempted many other combinations involving F_2 progency of the original hybrid, original backcrosses, reciprocal backcrosses, etc.

Hybridization work in the late 1960's diminished as many state agencies began massive stocking programs of the pure-bred striped bass. Ware (1974) speculated that hatcheries lost interest in hybrid production due to the threat of deformed backcrosses occurring in the wild or from the increased availability of striped bass fingerlings. Recently, renewed interest has been generated for hybrids due to unsuccessful development of striped bass fisheries in many locations. Work by Coutant (1985) has suggested that a combination of high temperature and low oxygen causes direct mortality through primarily summer kills, making many southern reservoirs unsuitable for adult striped bass.

The hybrid striped bass (white bass male x striped bass female) has been used recently by many states. This cross is most practical due to the high frequency of striped bass females and readily available ripe white bass males during the partial overlap of spawning times. Hybrids have been noted for their rapid growth in early life stages, good survival, less tendency to migrate, high susceptibility to angling, propensity to feed on clupeid fishes, and good survival in both oligotrophic to eutrophic lakes. Successful hybrid fisheries have now been developed in many natural lakes in Florida, reservoirs in Georgia, South Carolina, Texas, etc., and many river systems in the southeastern United States.

Striped bass were introduced in Herrington Lake from 1973-1978 with a very limited success. Limiting factors included a lack of fishing interest for striped bass and high natural mortality during the late summer (Axon 1979). Axon recommended introducing hybrids into Herrington Lake since striped bass introductions failed to meet our management objective of increasing the sport fish harvest by 1 lb/acre and/or increase the sport fish yield (lb) by at least 10 percent. This study, a federally funded Dingell-Johnson project (D-J Project F-40), was initiated in 1979 to evaluate this hybrid introduction.

DESCRIPTION OF THE AREA

Herrington Lake is a 2,610 acre (summer pool) impoundment on Dix River, located in central Kentucky. The lake was built in 1926 by Kentucky Utilities and has since been operated for hydroelectric power generation. The mean depth of 78 ft and maximum depth of 249 ft makes Herrington Lake one of the deepest lakes in the state. The shoreline is characterized by steep limestone bluffs with a limited littoral zone.

Physio-chemical data on Herrington Lake were collected in 1973 by U.S. Environmental Protection Agency (USEPA 1977) and Kentucky Division of Water (1984). The Division of Water rated the trophic state of Herrington Lake as eutrophic based on the Carlson Trophic State Index for chlorophyll-a. This trophic status can be explained by a high ratio (71:26) of agriculture to silviculture acreage within the watershed and several point source discharges of domestic sewage within the drainage. High nutrient loads also contributed to the de-oxygenated hypoliminion and the relatively shallow thermocline of approximately 10-12 ft in depth during summer thermal stratification.

MATERIAL AND METHODS

Kentucky Department of Fish and Wildlife Resources (KDFWR) lacks a source of broodstock striped bass to produce hybrids; therefore, fry were received from various sources throughout the southeast. Fry were generally received by air shipment and reared to the fingerling stage at both the Minor Clark Fish Hatchery at Morehead, Kentucky or the Frankfort National Fish Hatchery. Hybrid striped bass were stocked in Herrington Lake at various sizes and rates from 1979-1985 (Table 1). Stocking rates ranged from 15.2-32.0 fingerlings per acre from 1979-1986, with the stocking rates stabilized at approximately 20 fingerlings per acre from 1983-1986. Fingerlings stocked in 1982 and 1983 were reared in the Richloan State Fish Hatchery and the Welaka National Fish Hatchery in Florida, respectively. The 1982 stocking was deemed very poor since many of these fish were dead on arrival at the lake. These fish had been held in a raceway for 5-7 days prior to transport and required a long hauling distance.

Cove-rotenone studies were conducted in July-August in two coves (upper and lower lake) from 1979-1985. The cove site in the upper lake was standardized throughout the study; however, the lower lake site was changed in 1982 due to the addition of a private boat dock within the area (Figure 1). Total acreage of the study sites varied from 3.72 acres in 1979 to 5.03 acres in 1985 due to the fluctuating water levels in this hydroelectric lake.

Cove rotenone procedures were similar throughout the study. The cove was blocked prior to 0800 hours on the first day with a 0.5-in block net, and emulsified rotenone (2.5 or 5%) was dispersed via a boat venturi at a rate of 1 ppm. Surfacing fish were dipped for 3 successive days and sorted to both species and inch-group with weights of fish gathered on the first day only. Data from the two studies were combined and presented as per acre values.

Gill netting was conducted from 1979-1986 with two types of gear. Two experimental gill nets, 450 ft long by 8 ft deep and containing three 150-ft panels of 0.75-, 1.25-, and 1.75- in mesh, were fished at standard locations in the lower lake (Figure 1) during similar time periods, generally in early October from 1979-1986. This same gear was also fished at other locations in the lake throughout the study to locate hybrid striped bass for various reasons. Additional gill nets, 300 ft X 15 ft with uniform mesh sizes of 3.0 or 3.5-in, were employed in the lower lake during 1984-1986 to sample older and larger hybrid striped bass. All nets were floated approximately 4 ft from the surface and were fished perpendicular to the bank. The 450 ft experimental nets were typically set by blocking the complete width of the lake or lake arm.

Hybrid striped bass, captured from gill nets, were measured to nearest 0.10 in and 0.01 lb. Stomach contents were examined from randomly selected hybrids of each in group. Scale samples from hybrid striped bass were removed from an area below the lateral line near the posterior edge of the pectoral fin. Scales were later viewed on an Eberbach scale projector and appropriate measurements were obtained to determine back-calculated growth rates using the direct proportion method.

A non-uniform probability creel survey (Pfeiffer 1966) was conducted from 1981-1985 during the months of March through October. The lake was divided into two equal areas and probabilities were assigned to each half-day period based on known fishermen pressure from other major reservoirs; the week was divided into 14-half day periods. In 1981, the creel survey was conducted one day per week by two conservation officers, each surveying one of the areas. A departmentally-hired creel clerk worked a half-day period in one area for 4 d per week from 1982-1985. The survey period was divided into an interview time period and a randomly selected 2-h instantaneous fisherman count. Standard creel data information was compiled utilizing a Fortran program (1981-1984) and a Statistical Analysis System (SAS) program in 1985.

RESULTS

Age and Growth

A total of 557 hybrids was used to calculate a length-weight relationship (Figure 2). The length-weight equation for hybrids was $\log W = -8.0816 + 3.1799 (\log L)$. Sampled hybrids ranged in length from the 6 to 26-in group with average weights of 0.12 and 8.70 lb, respectively. The legal minimum size hybrid (15 in) weighed an average of 1.90 lb.

Insufficient numbers among the various size ranges were collected to make an annual comparison of length-weight relationships; therefore, the relative condition factor (Kn) for age 0 and age 1+ hybrids was used for growth comparisons. This comparison was deemed valid since all hybrid weights were essentially obtained at the same time (early fall) each year and the largest samples were for these two age groups.

Mean yearly Kn values (Table 2) for age 0+ hybrids ranged from 0.75 (1979) to 1.24 (1984), while age 1+ hybrids ranged from 1.00 (1980 and 1986) to 1.07 (1984). Small sample sizes in some years precluded statistical analysis of variance within the age groups; however, there was a significant difference ($P < 0.0001$) between pooled age 0+ and age 1+ Kn values.

A total of 235 hybrids was utilized in average back-calculated lengths by age (Table 3). Aged hybrids represented year classes 1979-1985 (except 1980 - a non-stocking year). Mean lengths at ages 1-5 were 9.9, 16.8, 20.0, 22.3, and 24.2 in, respectively. Yearly linear growth increments were not compared, although fish from all year classes were a minimum of 15-in in length at the end of their second growing season. Lengths after the first year of hybrid growth ranged from 6.7 to 11.1 in.

Limited gill netting for larger fish in 1984-1986 resulted in a 25.2 in fish being captured; this fish was age 5+ (1981 year class), the oldest hybrid captured. Representatives from the oldest year class (1979) were not sampled the last 2 years of the study. Most of the larger hybrids collected were representatives of the 1981 year class, indicating the relative strength of this year class. Mean weights of age 0-5+ fish in the fall at capture were: 0.49, 2.23, 3.67, 6.88, 8.31, and 8.30 lb, respectively.

Food Habits

Stomach contents from hybrids were analyzed from fish captured in the fall, except for spring 1982. A total of 193 hybrid stomachs were field examined for major food items. Data on food items are presented in Figure 3 as percent frequency of occurrence by the major age groups of hybrids. Both age 0+ and age 1+ hybrids fed heavily on 2-3 in shad. Most of these 2-3 in shad appeared to be threadfin shad (due to lack of a gizzard); however, identification to species was not always possible. Despite the lack of a good sample size of older fish (N=20), there appeared to be a shift in diet to larger shad (5-9 in), primarily gizzard shad, as hybrids matured. The only other food items located in the hybrid's fall diet were crayfish and an incidental 2-in catfish. Spring 1982 stomach contents are not given, yet age 1 hybrids were feeding exclusively on invertebrates, primarily chironomid larvae along with occasional mayfly larvae.

Fish Populations

The total fish standing crop at Herrington Lake, derived from cove-rotenone studies, ranged from 470 lb/acre to 1,057 lb/acre (Table 4); with a mean standing crop of 632 lb/acre. Standing crop values were generally influenced by changes in the forage fish standing crop; 54% of the total standing crop biomass was in forage fish biomass. Forage fishes in Herrington Lake were primarily gizzard and threadfin shad, which comprised 42.2% and 11.8% of the total fish biomass, respectively. Other forage species contributed an insignificant amount to the standing crop. The extreme variation in both gizzard shad (129-660 lb/acre) and threadfin shad (13.6-105 lb/acre) biomass failed to indicate any definite trend.

Principal game fish in Herrington Lake included black basses (primarily largemouth bass), white bass, both white and black crappie, and the newly introduced hybrid striped bass. Cove-rotenone studies were relatively ineffective in sampling most of these species except for largemouth bass. Largemouth bass standing crop values ranged from 10.3-25.4 lb/acre, with a mean value of 18.3 lb/acre.

The available prey-predator (AP/P) model (Jenkins and Morias 1977) was utilized to analyze the impacts of hybrid striped bass introductions on the prey base. Historical Herrington Lake cove-rotenone data (1973-1978) was available to allow a comparison of the pre-hybrid striped bass AP/P with a post-hybrid striped bass AP/P. The basic assumption was that pelagic predators were equally sampled among all the years. Also, it was assumed that the impacts of the striped bass introductions from 1974-1978 on the forage base were also negligible, since the striped bass population and fishery failed to develop (Axon 1979).

Plots of the average AP/P values for pre- and post-hybrid stockings are shown in Figures 4 and 5. The straight diagonal line in the graphs is the theoretical desirable ratio of 1:1 in which there is sufficient available prey for every inch group of predators; therefore, all points lying above this line imply there is sufficient prey available for a given size predator. This model assumes that any fish regardless of species can be prey during some course of its lifetime and various prey species are adjusted on the basis of mouth size (Lawrence 1957). Both AP/P plots are well above the theoretical 1:1 ratio, indicating no prey shortage occurred in Herrington Lake during all the years examined. Examination of the actual data to derive these plots revealed there were higher AP/P values during the post-stocking period for every inch group except the 2-3 in group. Reductions in 2-3 in prey were reflected in the relative abundance of the two shad species. The question remains if reductions in 2-3 in prey were related to the introduction of hybrid striped bass.

The aforementioned plots were based on averages; therefore, individual yearly data for 2-3 in prey were plotted in Figure 6. There was a precipitous decline in prey between 1979 and 1980, a leveling between 1980 and 1983, and a dramatic increase from 1984 to 1985. Quantitative data on the hybrid population was lacking, yet during this time, there was no correlation between the CPUE from gill netting for young-of-year hybrids and 2-3 in prey ($P = 0.31$, $r = 0.506$). Dramatic changes in spring lake elevations occurred during this study time frame; however, there was no correlation between 2-3 in prey and average spring pool elevations ($P = 0.11$, $r = 0.65$) or the average spring headwater inflow values ($P = 0.86$, $r = 0.08$).

Gill netting

Gill netting with experimental gill nets was most effective for age 0+ and 1+ hybrid striped bass. Large mesh nets (3.0- to 3.5-in) were only used during the last 3 years (1984-1986) to sample the larger (>20 in) hybrids. Table 5 represents the yearly and total catch and length frequency of hybrids regardless of mesh size. A plot of the length frequency (Figure 7) depicts a bi-modal peak at the 11-in group and 17-in group, which corresponds to age 0+ and age 1+, respectively.

Catch per unit effort (CPUE) by year class for hybrids in the experimental gill nets are presented separately in Table 6. The best CPUE was 35.3 for the 1981 year class, followed by 25.4, 22.2, and 16.8 for the 1985, 1983, and 1982 year classes, respectively. Yearly CPUE was generally dictated by age 0+ CPUE and not by age 1+ CPUE. There was a significant partial correlation between year-class CPUE and stocking density (P = 0.05, r = 0.52).

The CPUE for age 0+ hybrids varied from 0.3-25.0 per net night; however, there were problems associated with using this CPUE as an index for survival of age 0+ hybrids. All gill netting was conducted in the fall following a June stocking time; yet, stocking sites were varied during certain study years. Stocking sites were moved to upper-reaches of the lake in 1983 and 1984, since high-water conditions produced high discharge rates from emergency spillways increasing the chances of emigration of young fish. In 1984, age 0+ hybrids were not sampled in the lower lake but were sampled in the mid-lake section. The 1984 year class, however, was well represented in the sample of fish captured in the lower lake in 1985. In 1986, age 0+ hybrids were also poorly sampled (0.3 fish/net night) in the lower lake despite being stocked in the lower lake. Our level of sampling effort (4 net nights) failed to locate any age 0+ hybrids in mid-lake reaches.

Harvest

The estimated harvest of fish in Herrington Lake during 1981-1985 ranged from a high of 203,511 fish (81.4 fish/acre) in 1985 to a low of 95,717 fish (39 fish/acre) in 1984 (Table 7). The mean annual catch rate averaged 0.90 fish/h and ranged from 0.77 fish/h in 1983 to 1.06 fish/h in 1985. The highest yield was in 1982 at 40.3 lb/acre; the lowest yield was 17.8 lb/acre in 1984. Fluctuations in both numbers and pounds of fish harvested followed the same trend as total fishing pressure (Figure 8). There was no correlation between total spring fishing pressure and average lake elevations in the spring ($p = 0.17$ $r = -0.72$) or headwater inflows ($p = 0.41$, $r = -0.48$), although the use of average values for this comparison potentially masks weekly and monthly trends for the same.

Groups of fish dominating the harvest by weight were black basses, other sunfish, and crappie that represented 33.7, 15.5, and 14.3% of the yield, respectively. There was some shifting by some species in the relative contribution to the creel; however, black basses were consistently the dominant fish group by weight in the harvest throughout the study. The most dramatic change in the creel by any fish was for white bass. The yield of white bass was less than 1 lb/acre from 1981 through 1984; in 1985, the yield abruptly increased to 8.1 lb/acre (23% of total harvest). White bass were traditionally very important in the Herrington Lake fishery (x harvest = 2.9 lb/acre) until a massive die-off in December 1980. The cause of this die-off could not be diagnosed by Auburn University fish disease specialists. Although adult white bass numbers had significantly declined, exceptional spawns were noted in 1984 and 1985. The white bass fishery definitely rebounded from a 4-year period of low numbers; however, the possibility of some mis-identification by the creel clerk between white bass and hybrid striped bass cannot be discounted. Also, the possibility of back-crossing of hybrids with pure-bred white bass made identification of some fish difficult.

Black bass (primarily largemouth bass) followed the same trend through time as total harvest and total fishing pressure. Black bass harvest could not be correlated to changes in pool elevation ($p = 0.12$, $r = 0.78$) or average headwater inflow ($p = 0.58$, $r = 0.34$), yet the relationship between black bass harvest (lb) and black bass pressure rates approached the significant level ($P = 0.06$, $r = 0.87$). Catch rates for black bass varied from 0.22 bass/h (1983) to 0.42 bass/h (1981) and averaged 0.28 bass/h during the 5 creel-survey years.

Hybrid striped bass harvest (lb/acre) followed the previously described trend through time as the total harvest of all species. The yield of hybrid striped bass was 0.9, 5.5, 2.4, 1.4, and 2.4 lb/acre during 1981-1985, respectively. These harvest rates represented additions of 5.2, 15.8, 9.7, 8.5, and 7.3%, respectively, to the annual total fish yields for each of the 5 years. Annual harvest rates (not shown) for hybrids by anglers fishing for hybrids were 4.32, 0.71, 0.37, 0.24, and 0.50 fish/h for years 1981-1985, respectively.

The harvest of hybrid striped bass was affected by changes in creel limit regulations implemented in August 1982. Initially, in 1979, there was a statewide 15-in minimum size limit on hybrids and a daily creel limit of five fish. Prior to the regulation change, there were many sub-legal hybrids appearing in the creel. Identification problems associated with white bass forced a special regulation for Herrington Lake in 1982, permitting a 20-fish limit (in aggregate) of white bass and hybrids with no more than five fish of this limit to exceed 15 in in length.

Table 8 depicts the monthly number of hybrids harvested by age. The best harvest months were October (40.1%) and June (19.7%). The annual harvest was dominated by age 0+ (26.5%) and age 1+ (56.5%) hybrids. Older fish, age 2-5, comprised 14.1, 2.1, 0.6, and 0.2% of the total harvest, respectively. October fishing success was generally improved by the surface feeding behavior of hybrids in the fall and the recruitment of the age 0+ fish into an acceptable-size range (10-13 in) for most anglers.

Information on harvest locations of hybrids from the lake was recorded by the creel clerk in

1984-1985. Data were not complete; however, hybrid harvest was reported throughout the lake from spring to late fall. The majority of the harvest consistently occurred in the lower one-third of the lake. The lower harvest of hybrids in other portions of the lake seems to be related to fishing pressure, since gill netting consistently located hybrids throughout the lake in spring and fall. The lake section near the dam was best for trolling for larger hybrids and surface casting for the smaller age 0+ and 1+ hybrids; therefore, more fishing pressure was exerted in this area. Also, there may be a greater concentration of hybrids in the lower one-third of the lake during much of the fishing season since threadfin shad are suspected to concentrate in the lower section of the lake. A winter creel survey was never conducted, but a localized winter fishery developed in a cove near the dam where a hot-water effluent from a coal-fired power plant entered the lake. Creel data in the headwater was generally poor, but reconnaisance fish sampling trips located a mixture of hybrids and white bass in the river during the spring spawning season. Anglers indicated they were primarily catching white bass, but hybrids were present in their creel.

DISCUSSION

Survival of introduced hybrids in Herrington Lake was not measured, since catch rates from experimental gill nets were not felt to be consistently reliable as an indicator of relative abundance. There was extreme variation in catch rates for age 0+ hybrids during years when stocking rates were stable at approximately 20 fingerlings/acre. A factor associated with comparing success of various stocking rates is variation in size and condition of fish being stocked. Fingerling stockings consisted of multiple-sized fish, 500 fish/lb vs 3,000 fish/lb between years and sometimes within years, thus making comparisons difficult. Hybrids hauled from other states, such as Florida in 1982 and 1983, were stressed by the hauling time, possibly influencing relative survival of hybrid stockings in those years. Regardless of the aforementioned problems, there was a significant partial correlation between stocking rates and year class CPUE; unfortunately, stocking rates were not varied significantly through time to evaluate an optimal stocking density. Germann and Bunch (1983) reported that survival of hybrids was enhanced with lower stocking rates in Clarks Hill Reservoir. Relative mortality appeared to increase when the stocking rate exceeded nine fingerlings/acre and, below this level, rates were similar. The CPUE data for striped bass gill netted from Herrington Lake at the same net sites were available from 1973-1978 (Axon 1979); CPUE for hybrids generally surpassed catch rates for striped bass, implying hybrids exhibited a better survival than striped bass.

Relationships between numbers of hybrids stocked and average size at time of stocking could not be related to other parameters. Randall (1978) found hybrid condition factors to decline following a constant stocking rate of 10 fingerlings/acre, but he related this decline to the development of insufficient forage through time due to hybrid introductions. Differences among hybrid condition factors at Herrington Lake were attributed to smaller sample sizes for particular years, since there was no discernable trend in stocking numbers and condition factors. Striped bass survival and average size at ages 1 and 2 in Watts Barr Reservoir were inversely related to stocking density and directly related to size at stocking (Van Den Avyle and Higgonbotham 1979). The principal advantage of stocking larger fingerling striped bass in Watts Bar Reservoir was improved survival, since average length of age 3 and older hybrids was not related to stocking size. Insufficient data on survival and multiple stockings of various sized fish within years preclude similar comparisons for Herrington Lake hybrid introductions. However, the strongest year class, based on netting CPUE and contribution to the creel, was the 1981 year class, which was a year when some of the smallest (3,000 fingerlings/lb) and largest (220 fingerlings/lb) hybrids were stocked. The question remains why survival was better for this year class. Austin (personal communication 1985) believes timing of hybrid stockings is generally a neglected factor. East Fork Lake hybrids that exhibited the best condition in the fall following stocking were the ones that were immediately available to prey on the shad spawn, since age 0+ gizzard shad quickly outgrow age 0+ hybrids (Austin 1986). Stocking success could be improved if the peak shad spawn could be monitored and predator stockings such as hybrids were planned accordingly, irregardless of stocking size and to some extent the density. This level of stocking sophistication does not exist within most state agencies.

Hybrid growth rates in Herrington Lake were compared to other available growth data in the literature (Table 9). There is some overlap in first and second year growth among the various states; however, Herrington Lake hybrid length following the third year equalled or surpassed all the available growth literature. Recent published growth data from Tennessee, which approximates the same length growing season in Kentucky, were not available; however, Bishop (1967) reported that 27 month-old hybrids ranged in size from 17.2-20.7 in long and 2.8-5.2 lb. Herrington Lake hybrids averaged 16.8 in and 3.67 lb at the end of their second growing season which compares favorably to the Tennessee weights, but Herrington Lake hybrid lengths appear slightly less. Axon (1979) did not report average back-calculated lengths for striped bass introduced in Herrington Lake (1973-1978);

however, most of his yearly growth data for striped bass exceeded average back-calculated length of hybrids at Herrington Lake for the first 3 years of life. Growth rates for hybrids have generally been considered to exceed growth rates for striped bass for the first 2 years of life (Ware 1974), yet this did not seem to be true for Herrington Lake.

Results of hybrid food habits were similar to other studies (Germann 1982) (Williams 1970) (Crandall 1978) in which shad were the predominant food item. Results also agreed with Ott and Malvestuto (1981) in which hybrids failed to utilize prey items in accordance with the maximum hypothetical prey size (Lawrence 1957), but consumed 2-3 in shad regardless of their ability to gulp larger-sized prey. Most of these 2-3 in shad were identified as threadfin shad; the absence of gizzard shad was probably due to the lack of this species within that size range. Growth rates of gizzard shad are not known, but it is generally assumed that gizzard shad are larger than 2-3 in during the fall when these data were collected. The contents of age 1 hybrid stomachs were examined on one occasion during the spring that indicated these fish had shifted to an invertebrate diet, presumably due to low numbers of preferred-size shad. This ability to switch to other food items if appropriate-size prey are not available was also documented in an Oklahoma lake (Gilliland and Clady 1981). Only 20 larger hybrids (7-10 lb) were examined for food items. There appeared to be a preference for shad larger than 2-3 inches, as stomachs contained 5-9 in gizzard shad.

Impacts of hybrid introductions on forage levels in Herrington Lake were negligible based on comparisons of AP/P models from pre- versus post-hybrid introductions despite the relatively high stocking rate of 20 hybrids/acre during the latter years of this study and the feeding habits of hybrids. Several fold differences in the age 0+ clupied biomass, the major component of the 2-3 in prey in the AP/P model, could not be explained. Aggus (1979) discussed the positive effects of high water levels during spawning and the relationship to reproductive success of many fish species, yet there was no significant correlation between Herrington Lake spring pool elevations (or headwater inflows) and the abundance of 2-3 in prey. However, Aggus (1979) qualified this relationship between high water levels and spawning success by stating it is strongly influenced by the timing and duration of flooding. Dewey and Moen (1982) reported the abundance of age 0+ shad in reservoirs to be influenced by water levels, weather conditions, larval recruitment, interspecific competition, and other factors. The hybrid predator base in Herrington Lake increased since 1979 due to the recruitment of more year classes into the population; yet prey substantially increased in 1985. Therefore, the observed difference in age 0+ shad biomass was considered to be natural and independent of the hybrid introductions, although threadfin shad were the principal diet item. Recognizing the sampling bias associated with estimating pelagic predator biomass with cove-rotenone estimates, the yearly AP/P ratios were consistently above the theortical 1:1 ratio. This indicates there were no deficiencies in available prey for the various sizes of predators. Consistently, good condition factors also reinforced the fact that sufficient prey was available for both age 0+ and age 1+ hybrids. Significant differences observed between age 0 and age 1 hybrid condition factors were likely related to the shorter time period age 0 fish had been on a fish diet since both age groups essentially consumed the same size prey.

Good survival and growth of hybrids, due in part to an abundance of available-size forage, resulted in the development of an excellent hybrid fishery in Herrington Lake. Hybrids exhibit many of the same behavioral characteristics of their parental white bass; white bass fishing on Herrington Lake was a well understood tradition. Hybrids seemed to be distributed throughout the lake with no evidence of a temperature preference as found with adult striped bass (Coutant and Carroll 1980). Windham (1986) found that hybrid striped bass in the summer select temperature ranges of 77-82.4°F and oxygen concentrations of $\geq$4 mg/l. Summer temperatures and dissolved oxygen levels within these ranges existed in the lower epiliminion of Herrington lake, but the harvest was primarily in the early summer and fall when surface water temperatures were cooler and hybrids were caught in shallower depths. Recently, a winter fishery developed in the lower lake near a periodic warmwater effluent. Hybrids were also frequently harvested as they migrated upstream into the headwaters during the white bass spawning run.

Changes in total sport fish harvest (both pounds and number of fish) followed the same trend as total fishing pressure in Herrington Lake. Only black bass data were tested statistically and there was a significant correlation at the 0.10 level between harvest and pressure; however, both total fish and hybrid harvest followed the same trend through time as black bass. Jenkins (1971) reported angler effort to have an obvious positive relation to total harvest, with an unknown interdependence between the two variables. His regression analysis among 103 reservoirs indicated that angler effort explains 77% of the variability in total harvest and that, as fishing pressure increases, rate of harvest decreases. Martin (1957) reported an inverse relationship between fishing pressure and bass catch per unit of effort in Virginia waters. At Herrington Lake, black bass catch rates remained stable from 1982-1985 and hybrid catch rates seemed to fluctuate independent of fishing pressure.

Reasons for changes in fishing pressure are not understood. There were no significant correlations between spring fishing pressure and spring lake elevations or headwater inflows. Low total fishing pressure in 1981 could be reflective of survey design and intensity of sampling. A full-time creel clerk was utilized from 1982-1985 and conservation officers were used one day per week in 1981. A plausible explanation for the decline in fishing pressure was the filling and opening of a new Corps of Engineers lake, Taylorsville Lake, within 50 mi of Herrington Lake. The increase in fishing pressure in 1985 may indicate the return of anglers to their traditional lake. The affects of standing crop on fishing pressure were difficult to assess since standing crop data were obtained in the late summer following the greatest fishing pressure during the spring season. Black bass standing crop data were deemed reliable; therefore, yearly black bass standing crop data were tested with the following year's black bass harvest data to check this aforementioned phenomenon. There was no correlation ($p = 0.18$, $r = 0.24$) between the two variables. Fishing pressure and harvest for both black bass and all fish in Herrington Lake were apparently influenced by a multitude of interdependent environmental, biological, and sociological variables.

The objective of the hybrid striped bass introduction in Herrington Lake was to increase the weight of sport fish harvested by at least 10% or a minimum of 1 lb/acre. The goal of 1 lb/acre was attained for every year following the liberalization of creel and size limits in 1982. Hybrids represented a minimum addition of 10% to the yield only in 1982 when the strong 1981 year class recruited into the fishery. Hybrids were harvested at a rate of 5.5 lb/acre and provided a 13.5% addition to the total harvest, by weight in 1982. However, an equal number of sub-legal members of this year class was also harvested in June prior to the size limit change in August. Size limit changes were initiated in 1982 primarily for sociological reasons, since most fishermen were confused with identification of the hybrids. Also, at the time of this change, there was new biological information regarding the relative life-span of hybrids. Germann and Bunch (1983) reported hybrids to have a life expectancy similar to white bass with expectations of most hybrids living only 3-4 years. Contrarily, Snyder et al. (1983) and Champeau (1984) reported hybrids in Florida to live longer than previously expected and there were problems associated with scale aging of hybrids. Hybrids' propensity to migrate through the lake was an additional factor considered in liberalizing the size and creel limits since a significant emigration was documented in 1983 and 1984 following the opening of Herrington Lake flood gates.

The Herrington Lake hybrid fishery compared favorably to other documented hybrid fisheries based on total catch and success rates. Axon and Whitehurst (1985) reported the harvest of hybrids from other lakes equalled or exceeded 0.89 lb/acre and averaged 5.1% of the total fishery during 6 creel-survey years, with the highest reported poundage at Lake Bastrop (TX) at 1.96 lb/acre. Success rates from other studies include 0.46-0.54 fish/man-h in the Apalachicola River (Young 1984), 0.21 f/man-h in Lake Gibson winter fishery and 0.5 to 1.0 fish/man-h for other Florida lakes (Ware 1975), 0.15 fish/man-h in East Fork Lake in Ohio (Austin 1986), and 0.16 fish/man-h in Clark Hill reservoir (Williams 1984). Harvest rates (0.24-4.32 fish/man-h) for Herrington Lake equalled or exceeded harvest rates for these other lakes. Angler satisfaction is also dependent upon the size of the fish caught and/or harvested; the fishery was dominated by age 0+ or age 1+ hybrids having an average-size 9.9 and 16.8 in, respectively. The weighted average size of hybrids creeled in 1981-1985 was 13.4 in and 1.45 lb. Even though the mean size was not large, anglers are satisfied with the current harvest regulations and fishing. The creel survey was terminated in 1985, and 1986 was probably the best year for hybrid harvest. Fishing reports from anglers, boat dock owners, and local bait shops indicated that larger hybrids in the 8-10 lb class

(1981 year class) were harvested throughout the summer, which has definitely improved the quality of the fishery. The presence or build-up of these larger hybrids was attributed to the relative strength of the 1981 year class.

Conclusions and Recommendations

Hybrid stockings in Herrington Lake have been successful and should be continued at the current level of 20 fingerlings/acre. Hybrids are very acceptable to the public since they are easy to catch and they exhibit a notorious fighting ability, and their relative physical size is not perceived as a threat to other major sport fishes. Good growth and survival and minimal impact on available forage indicates there was little if any competition with other major sport fishes for food resources. A successful put-grow-take fishery for hybrids was developed that utilizes the abundance of pelagic water in the lake. The hybrid generally provides a more stable fishery than white bass. White bass populations tend to fluctuate with periodic strong year classes in response to optimal spring spawning conditions. The potential for a trophy fishery (hybrids >10 lb) also exists in Herrington Lake if flood gates remain closed for several successive years, preventing the emigration of large hybrids into the Kentucky River. Cost-benefit ratios were not calculated for the Herrington Lake hybrid fishery, but the total hatchery cost for this annual stocking is approximately

$1,600. One can safely assume this fishery is very cost-effective based on the low hatchery costs.

The following recommendations were made based on findings of this study and literature review:

(1) The Kentucky Department of Fish and Wildlife Resources (KDFWR) needs to locate a reliable source of hybrid fry for our own hybrid fingerling production and not transport hybrid fingerlings long distances. Ideally, KDFWR should gain self sufficiency in hybrid production by obtaining our own striped bass broodstock for making the cross.

(2) Continue to stock Herrington Lake at 20 hybrid fingerlings/acre due to the eutrophic state of the lake and the availability of threadfin shad as forage base.

Careful consideration should be given prior to stocking hybrids in other Corps of Engineers impoundments that lack threadfin shad in their forage base. Future lakes without threadfin shad should contain a minimum of 50 lb/acre of gizzard shad and the AP/P model should indicate no existing deficiency in prey.

Lakes less than 300 acres should not be stocked except to create an urban fishery where gizzard shad are present.

(4) Candidate hybrid lakes (including urban lakes) should contain adequate boat access, as greater

than 50% of the fishing pressure and harvest is expected by boat fishermen.

(5) Size limits on hybrids should be eliminated and liberal creel limits (>10 fish/day) should be imposed.

(6) Initial stocking of hybrids should consist of 20-25 fingerlings/acre to establish a strong year class and stimulate interest in the fishery. Annual stockings should not exceed 10 fingerlings/acre for a maintenance level in lakes not containing threadfin shad.

(7) Any new hybrid lake should be evaluated in terms of contribution to the creel in the first and second years following the introduction.

(8) Forage levels, food habits, growth, and survival should be closely monitored in an evaluation study.

Annual stockings of 10 fingerlings/acre in lakes without threadfin shad should be adequate to provide a fishery which meets the objectives of yield. This stocking rate has been used by many other southern states and this coincides with relative mortality rates reported by Germann and Barrch (1983).

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HERRINGTON LAKE

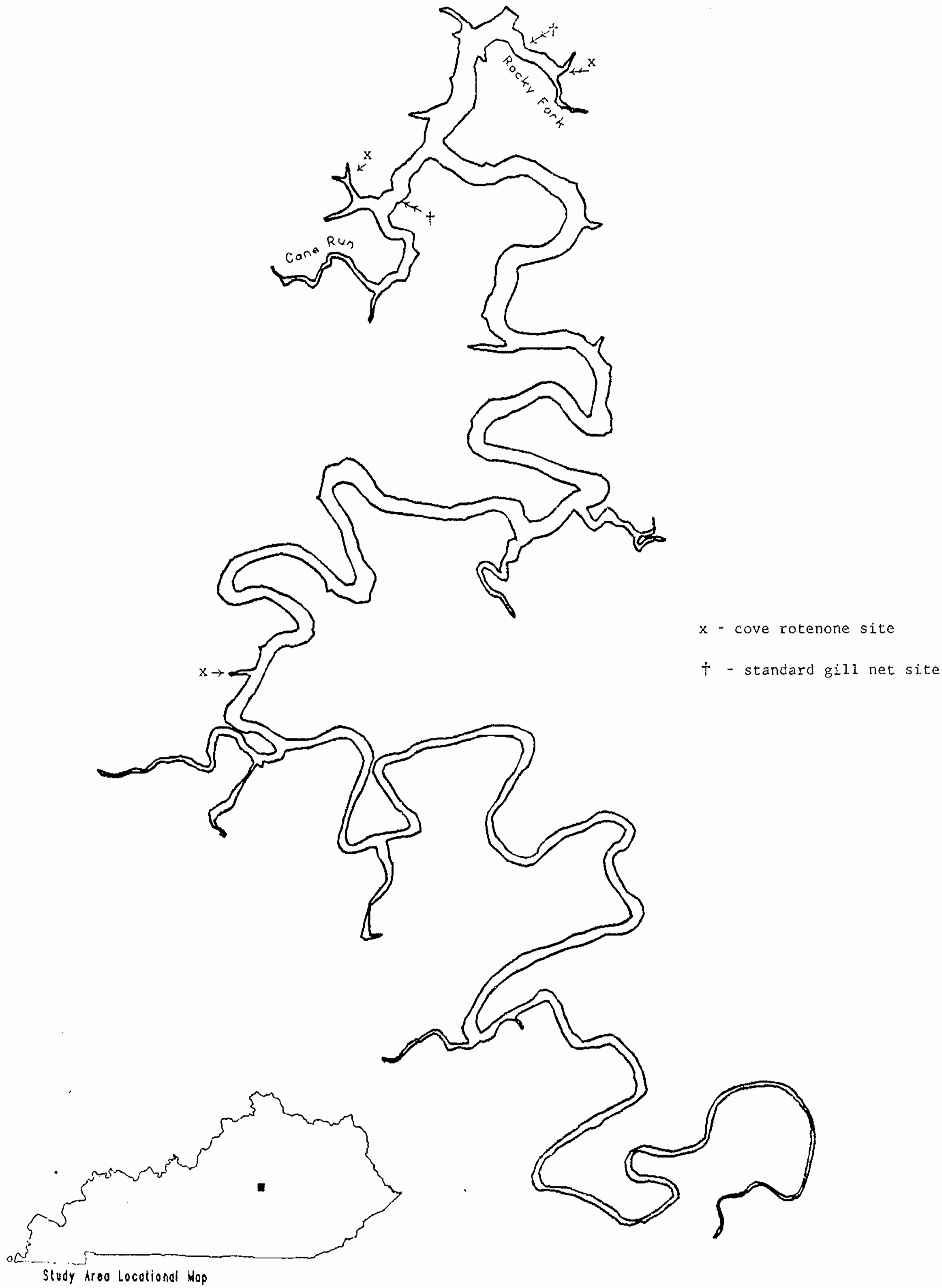

Figure 1. Map of Herrington Lake depicting cove-rotenone and standard gill net sites.

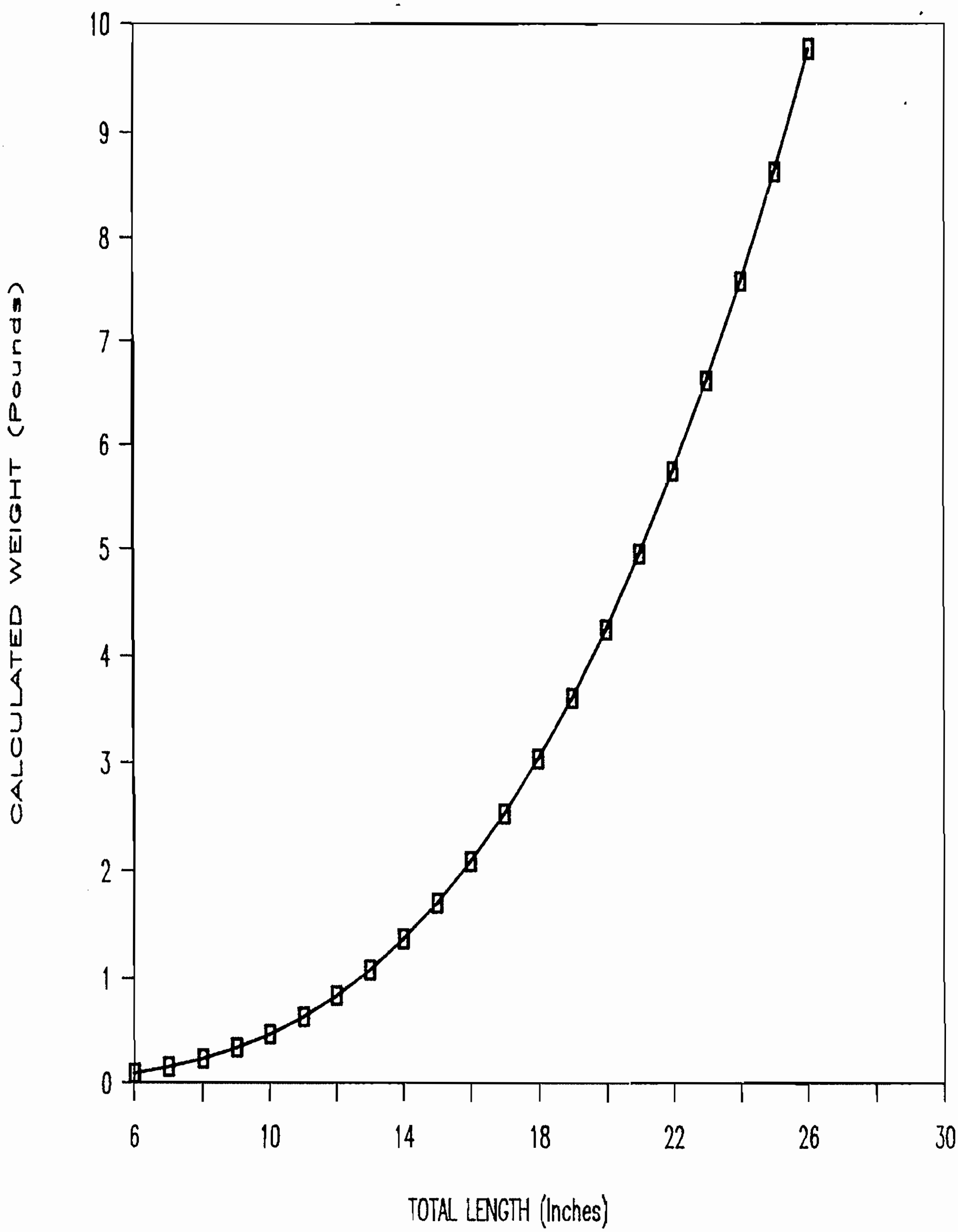

Figure 2. Length-weight relationship for hybrid striped bass in Herrington Lake, 1979-1986.

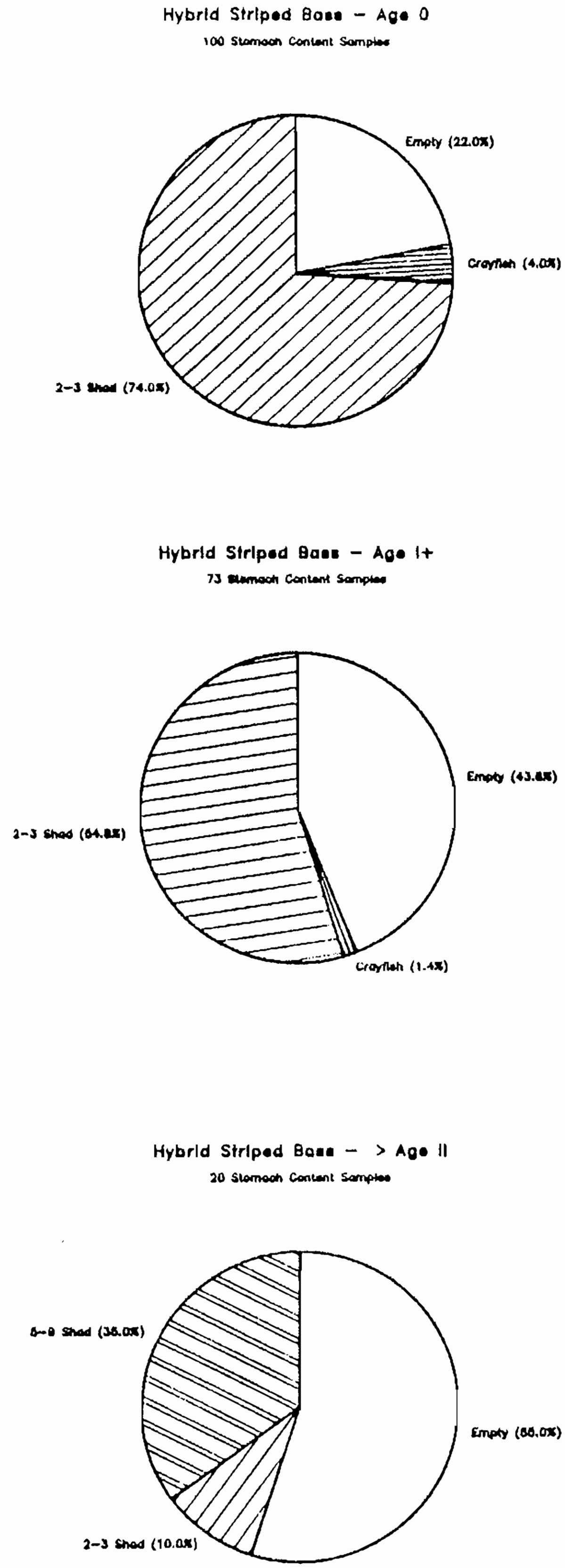

Figure 3. Percent frequency of occurrence of food items in stomachs of hybrid striped bass from Herrington Lake, 1979-1986.

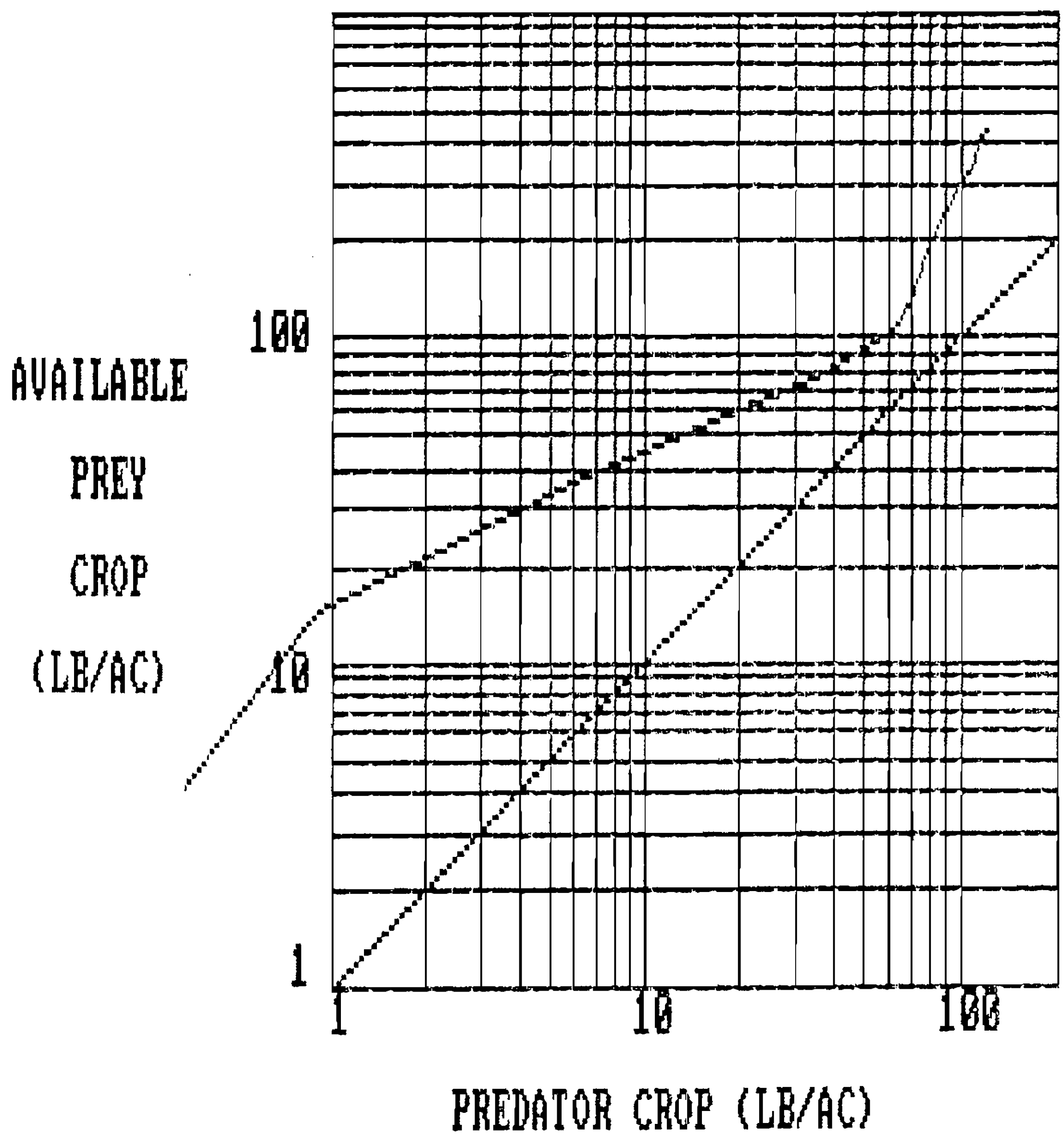

Figure 4. Plot of average AP/P during pre-hybrid striped bass stocking years (1974-1978) in Herrington Lake. The straight diagonal line is the theoretical desirable ratio of 1:1.

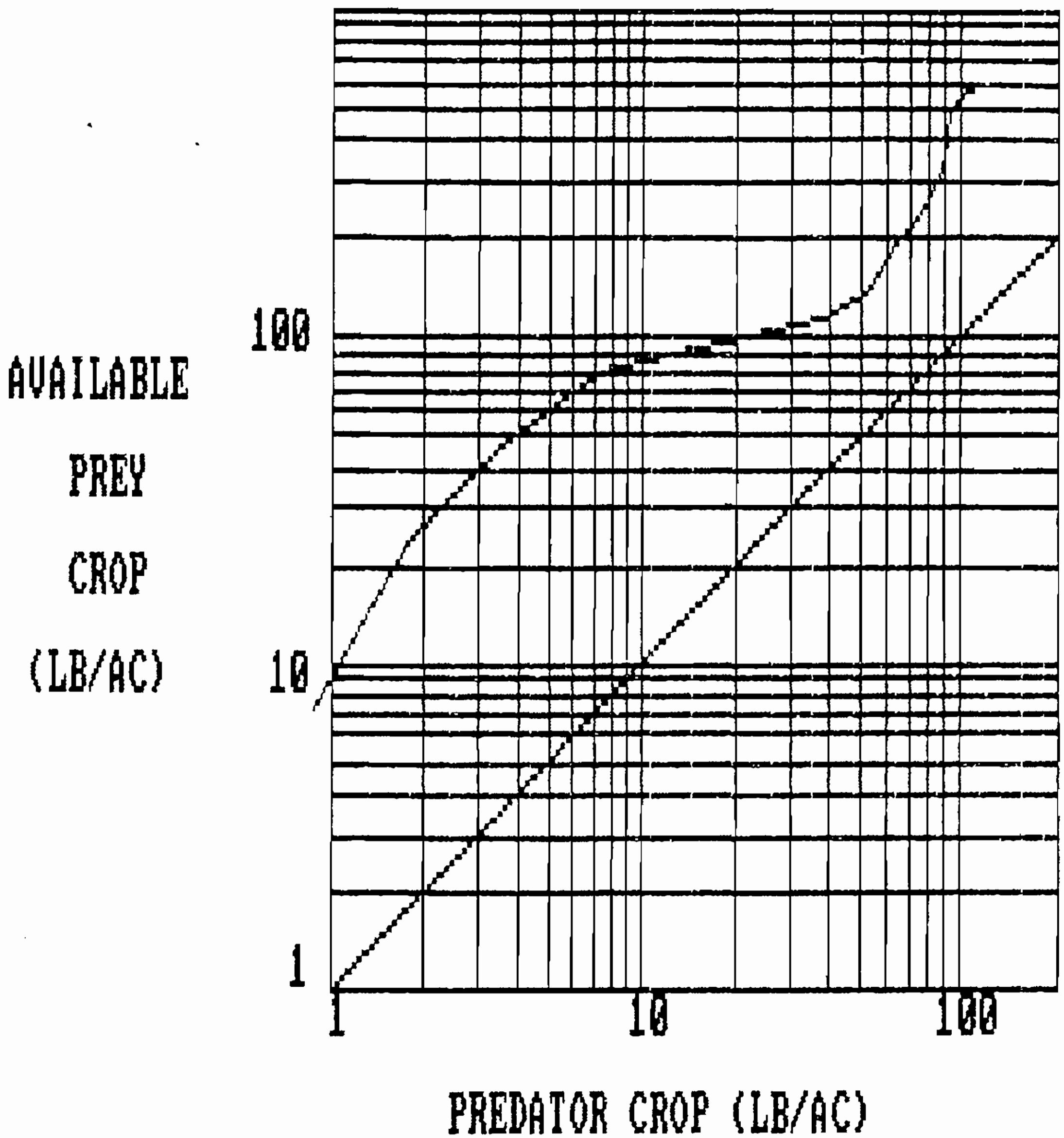

Figure 5. Plot of average AP/P during hybrid stocking years (1980-1985) in Herrington Lake. The straight diagonal line is the theoretical desirable ratio of 1:1.

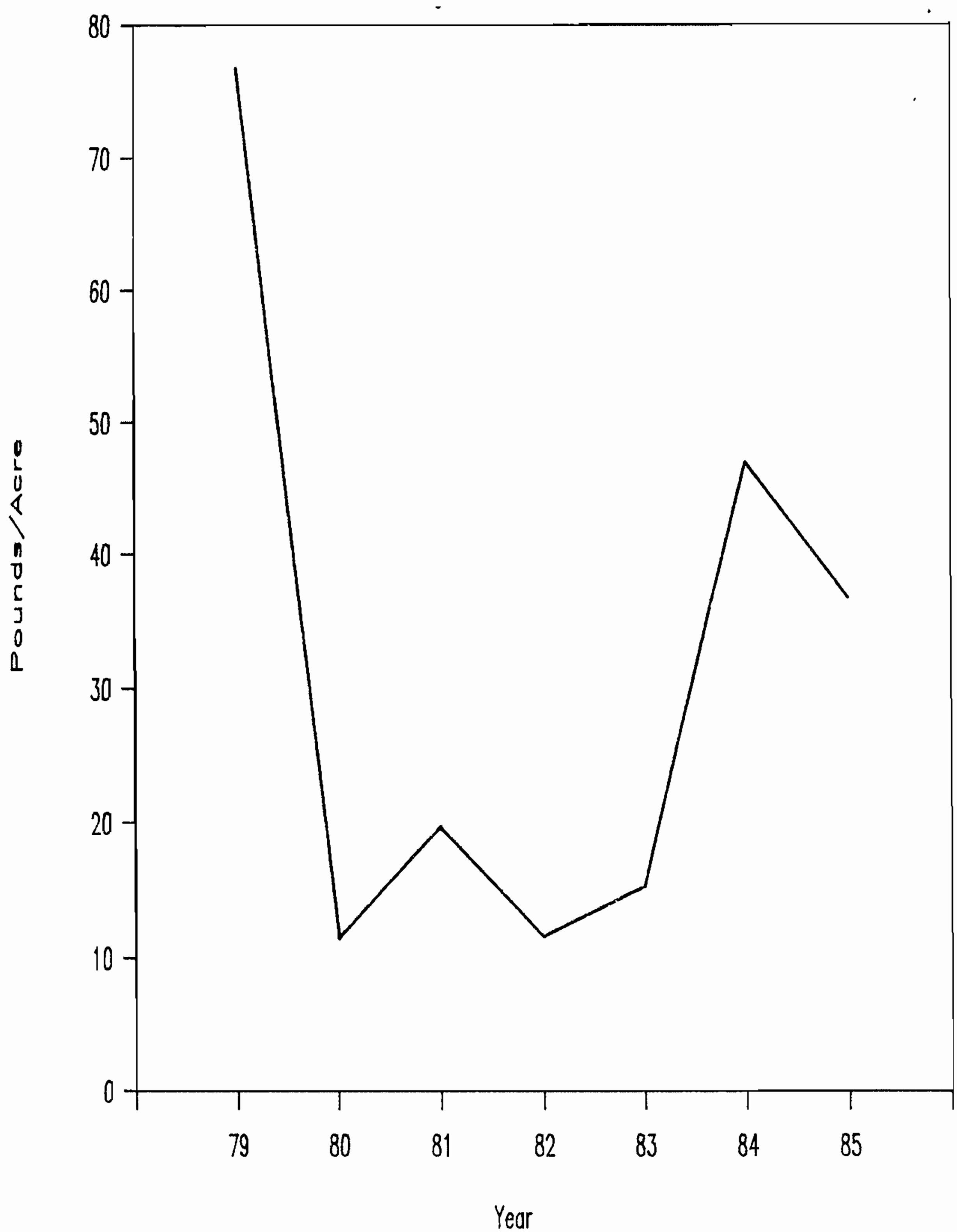

Figure 6. Variation of fingerling-size prey (primarily clupeids) based on cove rotenone data in Herrington Lake in 1979-1985.

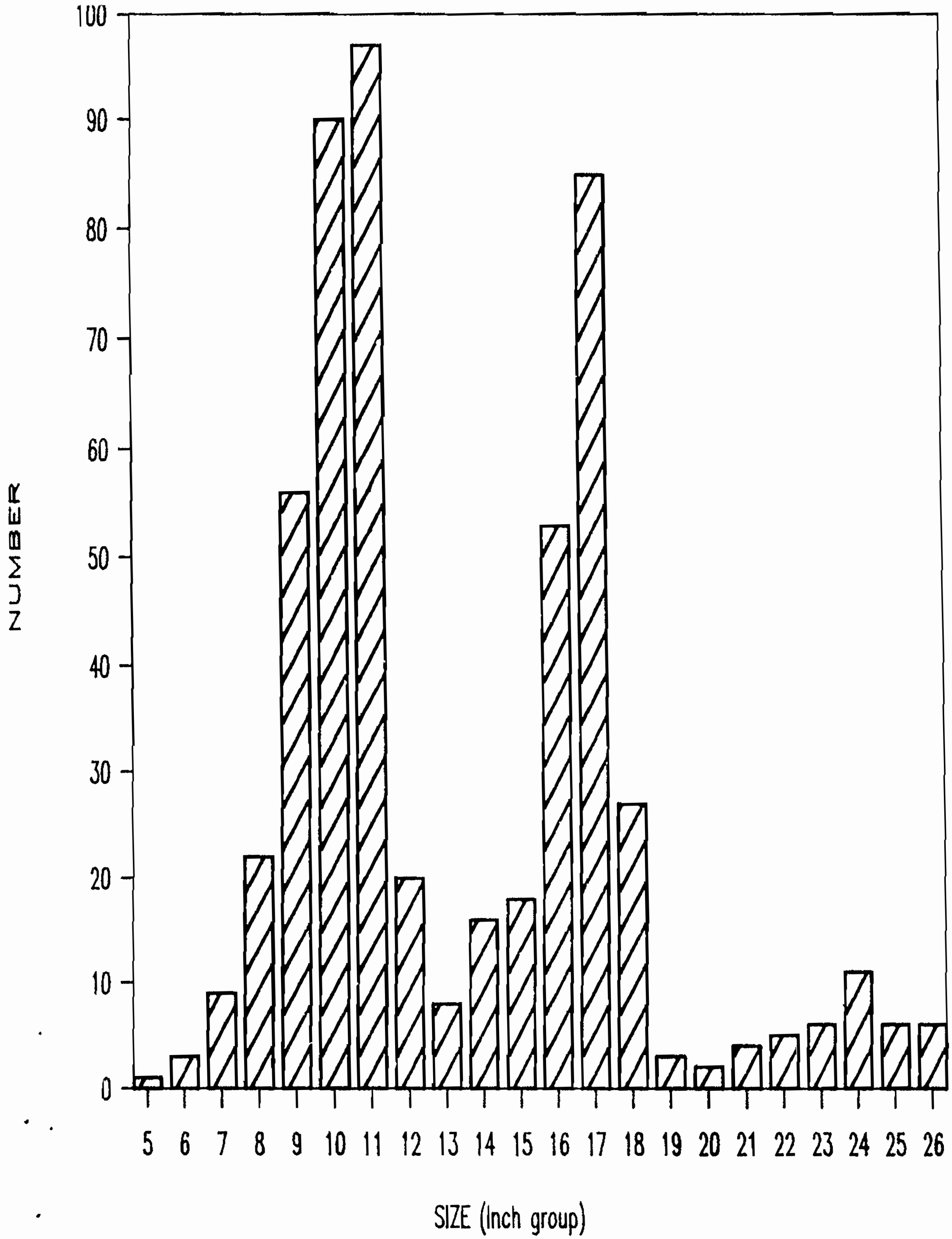

Figure 7. Plot of hybrid striped bass length frequency caught during gill netting in Herrington Lake in 1979-1986.

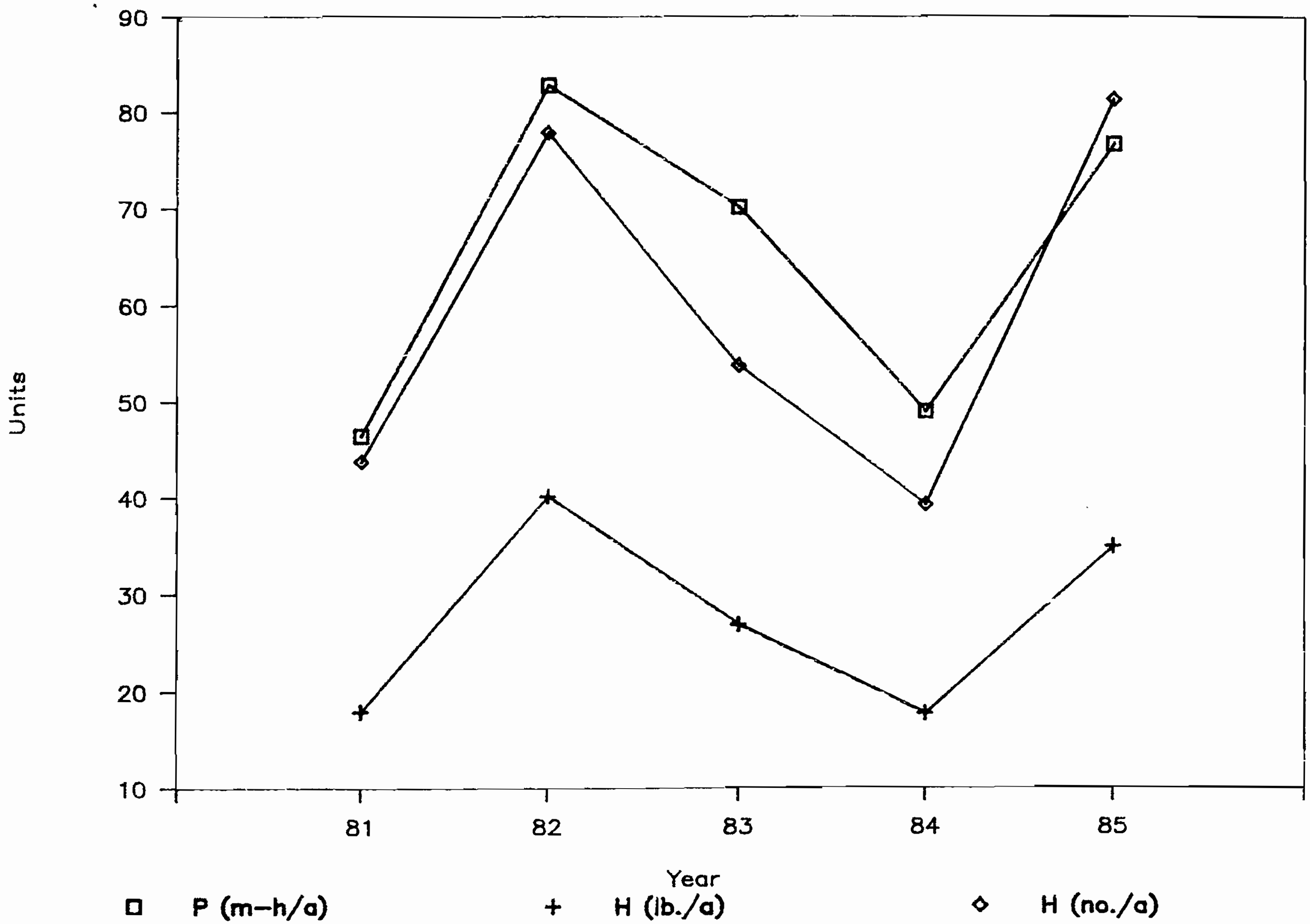

Figure 8. Relationship between angler fishing pressure per acre and harvest, both number and pounds of fish per acre, in Herrington Lake in 1981-1985.

Table 1. Hybrid striped bass stockings in Herrington Lake (2,500 acres).

Year	Number	Number/acre	Number/lb	Source
1979	38,000	15.2	675	Minor Clark Fish Hatchery
1981	73,980	29.5	3000/lb (50,000) 220 lb (23,980)	Frankfort National Fish Hatchery
1982	80,130	32	100-1800 lb (80,000) unknown (130)	Richloan State Fish Hatchery - Florida Frankfort National Fish Hatchery
1983	50,000	20	1800 lb (20,000) 517 lb (30,000)	Welaka National Fish Hatchery - Florida Frankfort National Fish Hatchery
1984	56,200	22.5	852 lb	Frankfort National Fish Hatchery
1985	52,000	20.8	1,181 lb	Frankfort National Fish Hatchery
1986	51,000	20.4	500/lb	Minor Clark Fish Hatchery

Table 2. Mean relative condition factors (Kn) for age 0 and age 1 hybrids from Herrington Lake, 1979-1986.

Year	Mean Kn	
	Age 0(n)	Age 1(n)
1979	0.75 (2)	
1980		1.00 (11)
1981	1.01 (100)	
1982	0.95 (66)	1.01 (37)
1983	1.08 (36)	1.04 (26)
1984	1.24 (1)	1.07 (53)
1985	1.02 (108)	1.06 (14)
1986	1.03 (3)	1.00 (47)

Table 3. Back-calculated length (in) at age for hybrid striped bass from Herrington Lake.

Year	Age 1	2	3	4	5
1985	9.8				
1984	8.4	15.5			
1983	9.8	17.3	16.8		
1982	10.9	17.4	20.6	23.3	
1981	11.1	17.1	20.0	22.2	24.2
1979	6.7	15.0	19.9		
Mean	9.9	16.8	20.0	22.3	24.2
Number	232	60	35	15	12
Smallest	5.1	13.9	16.5	19.7	23.0
Largest	13.2	19.2	21.4	23.3	25.2
Std Error	0.1	0.2	0.2	0.3	0.2
95% Con Lo	9.7	16.5	19.6	21.8	23.7
95% Con Hi	10.1	17.1	20.4	22.9	24.7

Table 4. Standing crop values (pounds per acre) derived from cove rotenone samples taking at Herrington Lake from 1979-1985.

	1979	1980	1981	1982	1983	1984	1985
GAME FISHES							
White bass	36.8	10.4	0.1	t	0.3	7.9	3.3
Hybrid striped bass	1.6		33.2	0.6	0.1	0.8	0.9
Striped bass	0.3						
Largemouth bass	10.3	19.3	23.1	25.4	15.8	14.6	20.0
Smallmouth bass	0.2	t	0.4	0.2			
Spotted bass	2.1	2.8	7.4	2.9	1.8	2.4	1.6
Black crappie	0.9		0.3	0.9	3.5		0.8
White crappie	16.6	15.9	8.4	8.1	7.5	7.9	4.7
Total	69.0	48.4	73.0	38.2	29.0	33.3	31.2
FOOD FISHES							
Channel catfish	5.5	1.0	2.2	4.2	3.8	1.9	8.2
Flathead catfish	10.1	15.1	14.4	10.4	14.8	12.3	15.6
Total	15.6	16.1	16.6	14.6	18.6	15.2	23.7
PREDATOR FISHES							
Longnose gar	2.9		2.5	t	t	0.9	2.0
American eel	0.5						
Total	3.3		2.5	t	t	0.9	2.0
PISCIVOROUS TOTAL	87.9	64.5	92.1	52.7	47.7	49.4	57.0
PANFISHES							
Rockbass	t			0.1	0.2		t
Bluegill	25.9	39.6	33.8	28.9	29.7	22.7	36.1
Green sunfish	5.5	3.8	6.0	2.2	2.7	3.8	0.5
Hybrid sunfish			t	t			t
Longear sunfish	26.7	19.5	23.0	10.4	7.9	13.1	12.2
Warmouth		0.2	0.5	0.3	0.6	0.6	0.7
Redear sunfish	t		0.1				
Total	58.2	63.1	63.4	41.9	41.1	40.1	49.4
COMMERCIAL FISHES							
Smallmouth buffalo	81.2	84.8	158.5	167.7	208.3	180.2	163.7
Carpsuckers	0.6	1.0	0.6	4.4	3.2	3.3	1.5
Redhorses	1.1	0.5	1.2	1.2	0.3	1.4	0.8
Bullhead		t					t
Drum	14.2	23.4	20.8	16.5	24.0	25.2	18.2
Carp				5.9	4.2	3.1	
White sucker					0.2		
Spotted sucker				0.3			
Total	97.1	109.7	181.1	195.8	240.2	213.5	184.2
FORAGE FISHES							
Gizzard shad	304.6	183.1	659.9	166.1	228.3	196.7	128.5
Threadfin shad	104.7	59.3	60.3	13.6	86.4	95.2	101.8
Shiners	0.1	t	t	t	0.1	0.1	0.1
Darters	0.6	0.3	0.2	0.4	0.2	0.2	1.0
Brook silverside	t	t	t	t		t	t
Misc. cyprinids		t	t	0.1	t	0.1	0.1
Topminnows					t	t	

Table 4 continued.

	1979	1980	1981	1982	1983	1984	1985
Total	410.1	242.7	720.4	180.1	315.0	292.3	231.4
NON-PISCIVOROUS TOTAL	565.3	415.5	964.9	417.8	596.3	545.9	465.1
GRAND TOTAL	653.2	480.0	1,057.0	470.6	644.0	599.3	522.1

t $<$ 0.05 lb.

Table 5. Length-frequency of hybrid striped bass caught by gillnetting in Herrington Lake from 1979-1986.

Year	Inch group																						Total
	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	
1979		1	5	4																			10
1980											8	2	1										11
1981					3	27	59	11						1									101
1982						10	22	4			2	3	24	8									73
1983					6	11	16	4					14	11	1	1	3						67
1984	1	1	1			1					1	27	24	1		1		2	4	2			66
1985		1	3	18	46	41			7	14	2	5	3				1	3	2	5	1		152
1986					1			1	1	2	5	16	19	6	2					4	5	6	68
Total	1	3	9	22	56	90	97	20	8	16	18	53	85	27	3	2	4	5	6	11	6	6	548

Table 6. Catch per net day[a] for each year class (total number in parentheses) of hybrid striped bass in the fall of 1979 and 1981-1986 at Herrington Lake.

Year netted	Year class							Total
	1979	1981	1982	1983	1984	1985	1986	
1979	1.7 (10)							1.7 (10)
1980	1.8 (11)							1.8 (11)
1981	0.3 (1)	25.0 (100)						25.3 (101)
1982		9.3 (37)	9.0 (36)					18.3 (73)
1983		1.0 (4)	7.3 (29)	8.8 (35)				17.0 (68)
1984			0.3 (1)	13.2 (53)	1.0 (4)			14.3 (58)
1985			0.2 (1)	0.2 (1)	6.2 (31)	20.8 (104)		27.4 (137)
1986					0.3 (3)	4.6 (46)	0.3 (3)	5.2 (52)
Total	3.3 (22)	35.3 (141)	16.8 (67)	22.2 (89)	7.5 (38)	25.4 (150)	0.3 (3)	111.0 (510)

[a]Net day is equivalent to one experimental net set for a 24-h period.

Table 7. Sport fish harvest, and fishing pressure[a] (man-h/acre) for principal species in Herrington Lake in 1981-1985 (values in parentheses are per acre values).

	Black basses	White bass	Hybrid striped bass	Crappie	Sunfish	Channel catfish	Flathead catfish	Drum	Buffalo	Gar	Carp	Total
1981												
Number	15,422 (6.2)	660 (0.3)	3,644 (1.5)	9,698 (3.9)	74,823 (29.9)	2,343 (0.9)	334 (0.1)	2,305 (0.9)	477 (0.2)	99 (t)		109,802 (43.9)
Percent	14.0	0.6	3.3	8.8	68.1	2.1	0.3	2.1	0.4	t		
Lb	17,953 (7.2)	263 (0.1)	2,173 (0.9)	4,062 (1.6)	10,118 (4.1)	2,573 (.10)	424 (0.2)	2,891 (1.2)	4,535 (1.8)	240 (t)		45,230 (18.1)
Percent	39.7	0.6	4.8	9.0	22.4	5.7	0.9	6.4	10.0			
Pressure	13.9	0.61	0.12	4.81	10.86	2.23		0.56	0.20	0.41		46.5
1982												
Number	27,585 (11.0)	626 (0.3)	7,438 (2.9)	28,777 (11.5)	117,924 (47.2)	3,068 (1.2)	58 (t)	8,804 (3.5)	566 (0.2)	212 (t)	566 (0.2)	195,026 (78)
Percent	14.1	0.3	3.8	14.8	60.5	1.6	t	4.5	0.3	0.1	0.3	
Lb	35,302 (14.1)	512 (0.2)	13,646 (5.5)	16,746 (6.7)	15,017 (6.0)	6,190 (.25)	225 (t)	9,495 (3.8)	2,142 (0.9)	1,150 (0.5)	514 (0.2)	100,812 (40.3)
Percent	35.0	0.5	13.5	16.6	14.9	6.1	0.2	9.4	2.1	1.1	0.5	
Pressure	37.2	t	3.5	11.0	14.8	t		0.29	0.08			82.8
1983												
Number	20,689 (8.3)	576 (0.2)	2,702 (1.1)	24,963 (10.0)	77,749 (31.1)	1,517 (0.6)	1,679 (0.7)	4,736 (1.9)	179 (t)			134,817 (53.9)
Percent	15.3	0.4	2.0	18.5	57.7	1.1	1.2	3.5	0.1			
Lb	23,020 (9.2)	414 (0.2)	6,014 (2.4)	10,943 (4.4)	12,589 (5.0)	3,269 (1.3)	4,945 (2.0)	5,715 (2.3)	587 (0.2)			67,539 (27.0)
Percent	34.1	0.6	8.9	16.2	18.6	4.8	7.3	8.5	0.9			
Pressure	33.6	t	1.8	15.1	12.2							70.2
1984												
Number	12,979 (5.2)	1,188 (0.5)	1,842 (0.7)	13,122 (5.2)	56,489 (22.6)	1,706 (0.7)	2,482 (1.0)	5,865 (2.4)	52 (t)			95,717 (39.4)
Percent	13.6	1.2	1.9	13.7	59.0	1.8	2.6	6.1	t			
Lb	14,758 (5.9)	517 (0.2)	3,445 (1.4)	4,736 (1.9)	5,414 (2.2)	2,526 (1.0)	5,631 (2.3)	6,951 (2.8)	610 (0.2)			44,588 (17.8)
Percent	33.1	1.2	7.7	10.6	12.1	5.7	12.6	15.6	1.4			
Pressure	20.9	0.2	2.2	4.4	9.5	t	t	t	t			49.0

Table 7 continued.

	Black basses	White bass	Hybrid striped bass	Crappie	Sunfish	Channel catfish	Flathead catfish	Drum	Buffalo	Gar	Carp	Total
1985												
Number	19,389 (7.8)	36,457 (14.6)	4,989 (2.0)	31,559 (12.6)	100,359 (40.1)	2,458 (1.0)	944 (0.4)	7,147 (2.9)				203,511 (81.4)
Percent	9.5	17.9	2.5	15.5	49.3	1.2	0.5	3.5				
Lb	23,269 (9.3)	20,173 (8.1)	6,079 (2.4)	16,757 (6.7)	8,524 (3.4)	2,750 (1.1)	1,995 (0.8)	7,658 (3.1)				87,631 (35.1)
Percent	26.6	23.0	6.9	19.1	9.7	3.1	2.3	8.7				
Pressure	27.6	8.8	2.5	12.1	11.0							76.7

t < 0.05% or < 0.05/acre.

[a]Total pressure for the year will not be additive for the species shown, since man-h of fishermen having no preference (anything fishermen) are not included.

Table 8. Monthly harvest by age group of hybrid striped bass in Herrington Lake from 1981-1985.

Year	Age group	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total	Percent of yearly total
1981	0							816	1,292	2,108	97.0
	2							28	37	65	3.0
1982	0							14		14	0.2
	1	837	402	654	2,418	61	291	195	2,359	7,216	97.0
	2		10		33				164	207	2.8
1983	0							253	246	499	18.5
	1		53	177	311	56	114	56	33	800	29.6
	2		69	257	309	178	288	51	190	1,342	49.6
	3		24			38				62	2.3
1984	0								471	471	25.6
	1		20	61	551		44	23	15	714	38.8
	2				72	175	132			380	20.6
	3		38	70	81	43	47			277	15.0
1985	0							82	1,901	1,983	38.1
	1			162		880	76	27	933	2,078	41.7
	2		165	65		35	228	165	38	696	14.0
	3			65						65	1.3
	4		124							124	2.5
	5		41							41	0.8
Total		837	946	1,511	3,775	1,466	1,226	1,711	7,679	19,142	
% of total		4.4	4.9	7.9	19.7	7.7	6.4	8.9	40.1		

Table 9. Comparisons of hybrid striped bass lengths (in) at age with this study.

	Total length (in) at age				
	1	2	3	4	5
Texas-statewide average (Prentice and Durocher 1981)	16.6	18.5	20.0	20.5	
Florida (Ware 1974)	14.3	17.6			
Clarks Hill (Germann and Bunch 1983)	11.0	16.9	19.3	21.1	23.5
Alabama public fishing lakes (Moss and Lawson 1982)	9.1	13.9	18.3	21.5	
Illinois (Douglas 1986)	6.0	12.4	13.8		
Ohio-East Fork Lake (Austin and Hurley 1986)	5.6	13.2	18.8		
Kentucky (Herrington Lake only)	9.9	16.8	20.0	22.3	24.2