ARKANSAS GAME AND FISH COMMISSION

STRIPED BASS MANAGEMENT PLAN

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EXECUTIVE SUMMARY

The Arkansas Game and Fish Commission expends an estimated $35,600 in the culture and stocking of striped bass and hybrid bass. This expenditure generates an estimated $16.7 million into the states economy. This is a cost benefit ratio of 1:46 (Citations in main body of report)

In large reservoirs, striped bass occupy open water that is seldom used by native predators. Without stripers, these lakes often become infested with huge stocks of adult gizzard shad. This can suppress production of smaller sized prey for black bass, and other native predators. Conversations among fisheries biologist inevitably include the importance of abundant prey small enough for a black bass to consume, and how adult gizzard shad prevent adequate production of such prey.

In the 60's, biologists were excited with the prospect of a fish that could prey upon large gizzard shad. The introduction of stripers for this purpose proved effective, and trophy fisheries that inland states had never seen, seemed like a desirable bonus. But biologists and fishermen alike soon became worried about these huge fish eating black bass and other predators. Biologists quickly determined through repeated scientific experimentation that this was not the case.

In spite of strong opposition by unconvinced anglers, biologists have continued stocking because of the two-fold benefit it provides to Arkansas' natural resources.

Maintenance of that two-fold benefit, in the face of opposition, is the major impediment to this valuable program.

Stripers do have the potential to compete with black bass and other native predators for prey. This situation occurs rarely. In most cases the stripers will cease feeding if open water prey is not available. They then become progressively emaciated and may die if their prey is not restored.

A major objective of this management is to prevent this situation, and if that fails, to implement reduction or cessation of stocking stripers and hybrids until favorable conditions return. The above objective will use the same criteria to determine an upward progression of stocking rates based on prey abundance and other biological variables.

Current stocking rates range from 2 – 6 per acre, and lakes are currently ranked in a priority for stocking based on unspecified biological knowledge of the striper lakes, and the availability of fingerlings.

New stocking rates are proposed on a three-tier level according to specific biological criteria presented later in this report. Tier 1 lakes will receive 0 to 2 per acre, Tier 2 lakes 3 – 7. The Tier 3 stocking rate of 8 – 12 will require the best of conditions and availability of fingerlings.

Waters now being stocked, in order of decreasing lake size are: Ouachita, Greer's Ferry, Beaver, Norfork, DeGray, Maumelle, Hamilton, Greeson, Catherine, DeQueen, and Little River.

The committee did an extensive search of the scientific literature, which, along with our own data and experience, was used to guide our proposals.

INTRODUCTION

The excitement of “deep-sea-fishing” in a freshwater environment provides a treasured angling experience. Anglers spend an estimated $16.7 million annually fishing for striped and hybrid bass in Arkansas. They are managed for several reasons. They provide a trophy angling experience and add diversity to the fishery resources of the state. This helps bring out-of-state tourism dollars into the state. Non-resident anglers spend an estimated $11.0 million annually fishing for stripers and hybrids. Secondly, they inhabit the deep-cool-water habitats of large reservoirs that are seldom occupied by native species. This makes wise use of habitat that would otherwise go under utilized. Finally, they help control the gizzard shad to produce a more edible sized prey for native species (Harper and Mamminga 1986).

The introduction of striped bass and their hybrids have not been without problems. Many anglers oppose stocking this large salt-water predator, fearing their impact on more popular native sport species. Bass and crappie fishermen frequently pressure the Arkansas Game and Fish Commission to discontinue the practice. Conversely, the striper anglers want more stocking. The purpose of this plan is to provide reasonable and scientifically based criteria for annual stocking allocations, and to evaluate the success of the plan by the same criteria.

MISSION STATEMENT

The mission of the Arkansas Game and Fish Commission is to wisely manage all the fish and wildlife resources of Arkansas while providing maximum enjoyment for the people. The goal of the striped/hybrid bass program is to provide a quality striped bass fishery, with trophy-sized fish, without detrimentally impacting native species.

HISTORY

The original range of the anadromous striped bass is from the St. Lawrence River in Canada to northern Florida, and along the Gulf coast from western Florida to Louisiana (Raney et al., 1952). During the 1940’s, after the Santee-Cooper Reservoir system was created in South Carolina it was discovered that the striped bass (Morone saxatilis, Walbaum) could complete its life cycle in fresh water (Stevens, 1958). Efforts by biologists to establish striped bass fisheries in inland bodies of water were conducted by many states. Those efforts attempted to establish a sport fishery and provide a biological control for clupeid fishes primarily in large man-made reservoirs. The San Francisco Bay area was stocked with yearling fish in 1879 and 1881 from New Jersey. The stockings resulted in a successful anadromous striped bass fishery within 10 years along the coast of central California (Raney et. al., 1952).

Between 1956 and 1960 the Arkansas Game and Fish Commission stocked adult, sub-adult, yearling, fingerling, and fry sized striped bass in an effort to establish a population in several Arkansas lakes with special emphasis on Lake Ouachita (Bailey, 1976). These efforts revealed that reservoir striped bass fisheries could only be maintained by annual stockings of hatchery-reared fish. It also was determined that fingerling sized fish were the most practical for population maintenance.

By the 1970’s artificial spawning and rearing techniques were developed to levels where the culture and stocking of striped bass and hybrid striped bass could be an effective tool for the fishery biologist (Stevens et al., 1965; Stevens, 1966,1967; Bayless, 1972). The establishment of reservoir populations of striped bass and hybrid striped bass in Arkansas had been accomplished and a new put-grow-and-take sport fishery had been established in many lakes. It was quickly realized that these fish could reach trophy size and they subsequently became a sought after sport fish.

LABOR REQUIREMENTS AND EXPENDITURES FOR STOCKING

With the exception of a reproducing population in the Arkansas River, all other populations are maintained by stocking fingerlings. Management in large reservoirs is directed at trophy sized (25 pounds and up) fish. Hybrids are occasionally stocked in lakes with stripers when growth rates are high and a good forage base of shad exists. The current striped bass state record of 64.5 pounds attests to this trophy management, as does the current hybrid bass world and state record of 27 pounds 5 ounces. Smaller Arkansas lakes and one tailwater are stocked to establish a striper or hybrid fishery, but have less potential for producing trophy fish.

The fishing opportunity below each of the dams on the Arkansas River is well known. Stripers up to 15 pounds are common in the river, and the numbers are abundant. The Arkansas River including Lake Dardanelle is also the states top rated black bass fishery according to the *Arkansas Tournament Information Program* (Fielder and Moore 1995-1999), a compilation of statewide black bass tournament information.

Labor requirements for the striped bass program are considerable. The spawning project requires collecting broodstock from the wild. A crew of 4-6 people may take up to three weeks to collect sufficient broodstock. Labor devoted to hatching eggs, rearing the fry, harvesting the ponds, and hauling the fish to the stocking sites uses approximately 200 person-days. Total person-day expenditures for rearing and stocking the fish are approximately $35,640. This expense generates $16.7 million dollars in the state economy and is a 1:46 cost benefit ratio.

There are eleven bodies of water currently being stocked with 2" fingerling striped and/or hybrid striped bass.

CURRENT STOCKING OF 2 INCH FINERLING STRIPED (STB) AND HYBRID (HYB) BASS PER ACRE (AC)

LAKE	ACRES	STB/AC	TOT. NO.	FREQ.	HYB/AC	TOT. NO.	FREQ.
OUACHITA	40,000	5	200,000	ANNUAL	0	0	0
GREER'S FERRY	33,500	0	0	0	5	167,500	ANNUAL
BEAVER	30,000	7	210,000	ANNUAL	2	60,000	3RD YR
NORFORK	22,000	7	154,000	ANNUAL	2	44,000	ANNUAL
DEGRAY	13,400	0	0	0	6	80,400	ANNUAL
MAUMELLE	8,900	0	0		3	26,700	3RD YR
HAMILTON	7,460	5	37,300	3RD YR	OR 3	26,700	3RD YR
GREESON	7,300	5	36,500	3RD YR	0	0	0
CATHERINE	2,264	5	11,320	3RD YR	0	0	0
DEQUEEN	1,680	0	0	0	6	10,080	3RD YR
LITTLE RIVER	300	0	0	0	33.3	10,000	3RD YR

The combined creel limit for these species is six fish statewide. Special combined creel limit of three is in effect on lakes Ouachita, Beaver and Norfork.

Gill netting has traditionally been the chosen method of monitoring a striped bass and hybrid fishery. However, the use of gill nets on many of these reservoirs has proven ineffective for evaluating stock densities due to the high variability of the catch data. Gill netting can detect presence and absence of a year-class and provide sufficient numbers of fish for age-and-growth analysis. Volunteer anglers are being used on Beaver Lake and Lake Ouachita to obtain valuable data on catch-rates, age, and size-structure. Working with anglers in this fashion is also good public relations. Little time is being spent sampling specifically for stripers.

In summary, good fisheries have been achieved on ten reservoirs and one tailwater, by stocking of 2" fingerlings at 3 to 7 per acre. The scientific literature indicates we could improve some of these fisheries by stocking 10-12 fingerlings per acre (Moore et. al. 1991).

SIGNIFICANCE OF THE RESOURCE

This fishery contributes to the State's economy by providing income to fishing guides and a variety of businesses, which include sales of boats and tackle normally associated with ocean fishing. Since stripers are stocked in only a few locations, anglers travel more, often from other states, for the opportunity to hook one of these magnificent fish. This results in greater expenditures for food, fuel, restaurants, motels, and related businesses. According to **The 1996 Economic Impact of Sport Fishing in Arkansas**, 763,878 anglers spent 9,661,166 days fishing in Arkansas. Resident anglers spent $191,342,385 fishing. **The 2000 Responsive Management Survey** showed 3% of resident anglers fish most often for stripers and hybrids. Resident anglers spent an estimated $5.7 million fishing for these species. Non-resident anglers spent $110,486,567 fishing (in 1996), and ten percent of them (in 2000) said they most often fish for these species. Non-resident anglers spend an estimated $11.0 million fishing for stripers and hybrids. Together, resident and non-resident anglers spend an estimated $16.7 million fishing for these species.

MANAGEMENT ISSUES

Since their introduction into freshwater systems, striped bass have been a subject of controversy. Harper and Namminga (1986) found that as the striped bass population expanded in Lake Texoma, Oklahoma the gizzard shad population changed over a seven-year period (1976-1982). Initially the shad were composed almost entirely of adults at 535 kg/ha and 4,143 fish/ha. Over the seven-year period it changed to being almost entirely young and intermediates (less than 140mm) at 1,169 kg/ha and 92,508 fish/ha. They also reported unchanged or slightly improved populations and angler catches of native predators during the same period.

Another study on Lake Powel, Arizona showed that in the absence of pelagic threadfin shad in 1985, the condition of adult striped bass declined to starvation levels (K-fl = 0.90 for adults and 1.07 for juveniles). Most of the adult stomachs were empty. Age I and II stripers fed on zooplankton and were in better (though still poor) condition than the adults. Bluegill and green sunfish were important food items at one sample site during November (Gustaveson et. al. 1985). The authors also reported angler catches of striped bass increased dramatically when the threadfin shad population declined. They reported that aerial stocking of 137,070 (2-4") and 783 (10-15") smallmouth bass from 1982-1985 resulted in a self-sustaining population in 1985. If predation on littoral fishes had been significant, it is unlikely this smallmouth population could have been achieved in 1985 during the absence of a pelagic forage base.

Filipek (l984), during a 2-year food habit study on 3,000-ha Lake Hamilton, found the striped bass diet consisted of 92.8% shad with the remainder of the diet made up of rainbow trout, sunfish, minnows, and crayfish. This study was unique in that a 20% reduction in the surface area of the lake occurred during the study. This exposed shoreline dwelling species to the stripers, but the stripers continued to feed almost exclusively on shad.

Based on these and similar studies, fish managers conclude that stripers feed almost entirely on shad. When they cannot find shad they generally cease feeding, become thin and emaciated, and often starve to death. This is especially the case during the summer when they are confined to a limited amount of water where the temperature and oxygen levels meet minimum requirements to keep them alive.

Condition values (K- values) are not routinely collected on sampling procedures of the Fisheries Division. Ware (1971) found on Florida Lakes that K-tl-factors ranged from 1.31 to 2.79, with numbers below 1.80 indicative of poor condition and visually these fish looked very thin. Numbers below 1.70 were indicative of potential mortality, and fish had large heads with emaciated bodies and concave stomachs. Data from Lake Greeson (Filipek 1985) showed K-factors for Age I and II fish ranged from 0.82 to 1.18 using the formula K= W (in grams) x 100,000 divided by L cubed in mm. These fish appeared thin. We did not find much information on striped bass K-values in our literature search. Additional research needs to be done on this variable before we could use it in this plan.

Miranda, et al (1998), estimated that in Norris Reservoir, North Carolina, if competition for prey between stripers and the other predators in the lake were eliminated by discontinuing the practice of stocking stripers, the remaining predators could increase by 5-10%. That increase would be divided among eight remaining predators in Norris Lake including smallmouth bass, spotted bass, largemouth bass, black crappie, walleye, sauger, channel catfish, and flathead catfish. If the increase were equally divided that would be a little more than a 1% increase for each remaining predator. Norris Reservoir contained good levels of prey (1,245 kg/ha/year of cluepeids and 70 kg/ha/year of lepomids) during this study. Although the chances are small, we feel that competition for prey could exceed that in the Norris study and that a prey base should be carefully monitored in striper and/or hybrid lakes.

Our principal means of prey base evaluation is rotenone sampling (AP/P ratios and density and biomass of each prey species in 25mm increments). Silver (1986) showed rotenone sampling was highly variable (compared to trawling) in estimating threadfin shad biomass on Lake Norman, North Carolina. Average standing crops from trawling ranged from 16.5 kg/ha in 1979 to 26.3 kg/ha in 1980, with an 11% coefficient of variation for each estimate. Cove rotenone samples taken at six locations produced average standing crop estimates that ranged from 8.4 kg/ha in 1979 to 33.0 kg/ha in 1980, with coefficients of variation from of 91 to 191%.

Fisheries District 1 rotenone estimates of threadfin shad populations on Beaver Lake over the six-year period 1995-2000 in kg/ha were 13.1, 4.2, 16.8, 29.2, 4.0, and 12.5 respectively. This committee feels that 5 kg/ha of group 1-7 (up to 175mm) clupeids is a minimal amount of prey (estimated from August cove-rotenone samples) to sustain stockings of striped bass. However, due to the variable nature of rotenone sampling on clupeids, we feel that 3 consecutive years of data need to be averaged to estimate cluepeid biomass, to reduce possible variability on a single year. We feel this is currently more reasonable than the high cost of purchasing a number of trawling vessels. However trawling is preferable depending on what we are willing to spend on equipment and the additional person-hours required performing the sampling to improve the accuracy of our data.

Another useful measurement of available prey is the AP/P ratio (Jenkins 1979). The Division's Fisheries Information Management System calculates this parameter on each rotenone sample we conduct. Jenkins showed that AP/P ratios greater than 1.0 taken from August rotenone samples indicated an adequate prey base for the reservoir. Again due to the variations of rotenone sampling in estimating young shad, we feel it would be better to use a three-year average to reduce the potential variability inherent in a single year.

Length-at-age values are one of the most useful variables to measure in estimating the condition of the striped bass population. There are several reasons for this. It does not depend upon method of capture. It does not depend on catch per unit of effort, which is highly variable. A study done on Lake Mead (Persons and Dreyer 1987) documents the extremes we were able to find in the literature in striped bass length in millimeters at age I through age IV. The following data collected on Lake Mead from 1969 through 1983 illustrates the best and worst growth rates we could find for striped bass. The decline in growth was correlated with a decline in nutrients in the reservoir, and the virtual elimination of threadfin shad in the reservoir (Persons and Dreyer 1987).

AGE	I	II	III	IV
Best (mm)	472	599	694	779
Worst (mm)	184	358	465	549

Length limits are only effective if caught and released fish survive in good numbers. Numerous studies found in the literature show variable hooking mortality for striped bass caught under various conditions. Wilde, et al. (2000) analyzed the results of seven studies on hooking mortality and found it to be directly related to water temperature. They reported that hooking mortality increased rapidly as water temperatures exceeded 25 degrees C. They found 50% of striped bass caught on natural baits die when water temperatures reach 27 C, and this increases to 67% mortality at 31 C. They also found that striped bass caught by artificial bait was 10% less over the same temperature range, and exceeded 50% when water temperatures exceed 29 C. Harrell (1987) working only with fish up to 50.8cm (20") found hooking mortality was 4% in October, 2% in February, 21% in June, and 36% in August. Nelson (1995) working in relatively cooler water (up to 22 C.) found that mortality increased with the amount of bleeding observed, with 9% mortality for fish not bleeding or slightly bleeding, 33% mortality for light bleeders, and 75% for heavy bleeders. Hysmith et al. (1992) working with fish sizes 229-762 mm total length during a two-year period (June 89-June 91) in Lake Texoma, Texas found an overall hooking mortality of 38%. They found hooking mortality was higher in spring (69%), and summer (47%) than in fall (8%) and winter (13%). They also found fish length was directly related to mortality. Fish under 457mm (18") had an overall mortality rate of 28.5%, fish greater than 457mm had an overall mortality rate of 53%, fish between 457mm and 508mm (18-20") had mortality of 33%, and fish over 508mm, 56.4%. This indicates that if we choose to use length limits, 20" should be considered the maximum acceptable length limit. Tomasso (undated abstract) working in aquaculture ponds found no significant difference in mortality related to landing time. Fish hooked and landed in 30 seconds or less faired no better than those played to exhaustion. Overall mortality in this study was 15.8%. Jrettoli and Riddle (undated press release) reported mortality rates over 50% and as high as 67% in July, August, and September in Tims Ford Reservoir, Tennessee. These studies indicate that the use of length limits is of questionable value due to high mortality rates commonly reported in the literature. However, the studies also suggest that if we choose to use length limits as a management tool, 20" should be the standard acceptable minimum size limit, and that the length limit should be removed during July, August, and September.

CURRENT MANAGEMENT TECHNIQUES

Current striped bass management in Arkansas is very basic, and is best described as "put-grow-and-take". Reservoirs to be stocked are qualitatively selected on the professional judgement and experience of fish managers considering suitable water quality, forage, and stocking rates. This method has worked quite well based on the quality of striper fishing in Arkansas. In our review of the literature it is evident that there is no one accepted methodology for the management of this species in the southeastern United States. The success of our program is evident in high angling interest, excellent fishing reports, a state record fish of 64 lbs. 8 oz., and development of a whole striped bass angling culture with it's own jargon, tournament circuit, magazines, and specialized tackle. However, standardized criteria to objectively evaluate Arkansas' program have not been established prior to this report.

Current stocking rates for stripers and hybrids in Arkansas waters varies from 3 to 7 fingerlings per acre of two-inch fingerlings. Rates for fingerling stockings in eight southeastern states ranged from 0.2 to 42 per acre, with the mean being 6 (Carver 1976). A more recent survey of stocking sizes and rates in the southeast could not be found in the available literature. A study of Smith Mountain Lake, Virginia (Moore 1991) showed highest survival rates when stocked at 10 to 12 per acre. Lower or higher stocking rates resulted in less survival. Establishing fingerling-stocking rates based on consistent criteria is a management need in Arkansas.

STRIPED BASS MANAGEMENT PLAN

This initial Striped Bass Management Plan will establish a methodology for evaluation and management of the species. It is obvious from a review of the scientific literature that methods vary considerably from state to state and from lake to lake. Although, this plan will advocate a uniform methodology, it must leave room for growth and experimentation as our knowledge of the species expands. The methodology will focus on growth and condition criteria, which can be consistently measured in each district across the state. Districts able to consistently use other variables may add those to the established criteria to support management decisions.

Goal A. Establish and maintain quality striped bass and/or hybrid striped bass fisheries in Lakes Beaver, Norfork, Greers Ferry, Ouachita, DeGray, Hamilton, Catherine and Greeson.

Goal B. Protect the cool-deep oxygenated water necessary to support these fisheries.

The Objectives listed below show how we plan to achieve these goals.

Objective 1. Monitor the condition of established striped and hybrid bass populations and their prey through observations of angler catch, creel surveys, and use of angler catch diaries. Achieve a 15% return to creel on stocked fingerling fish.

Strategy Statement: Condition of striped bass is a good indicator of population health. Biologist will use angler reports, creel surveys, and where possible, angler diaries to monitor striped bass conditions. Return to creel of 15% is an arbitrary number based on creel surveys at Beaver and Greers Ferry. However, both of these lakes are perceived as containing high quality fisheries, and the return rate will serve as an initial benchmark to measure other fisheries as data becomes available.

Objective 2. Maintain or improve reservoir conditions for striped bass. Identify any limiting factors.

Strategy Statement: Fisheries Division will exploit opportunities to influence reservoir operations to improve water quality and habitat for striped bass and hybrid striped bass.

Objective 3. Determine if length limits are reasonable as a management tool to improve existing populations.

Strategy Statement: Fisheries Division will participate on the Southern Division American Fisheries Society's Striped Bass Management Committee and Reservoir Committee to stay abreast of research in the area of length limits. Length limits are not viewed as a viable management tool in Arkansas Reservoirs at this time due to the problems of hooking mortality.

Objective 4. Culture sufficient striped bass to stock Lakes Beaver, Norfork, and Ouachita annually with 3 – 5 fingerling (2-inch) striped bass per acre. Culture sufficient striped bass to stock Lakes Hamilton, Catherine and Greeson every three years with 3 - 5 fingerling striped bass (2-inch) per acre.

Strategy Statement: Fisheries Division Andrew H. Hulsey State Fish Hatchery is designated striped bass and hybrid striped bass culture facility. Current upgrades to the facilities fish spawning building and earthen ponds will improve culture efficiency and fry survival. Lake Ouachita is the designated source for culture broodstock.

Objective 5. Culture sufficient hybrid striped bass (female striped bass x male white bass) to stock Greers Ferry Lake and DeGray Lake annually with 3 - 5 fingerling (2-inch) hybrid striped bass per acre, and Lakes Beaver, Norfork and Horseshoe and Bear Creek with 3 - 5 fingerling hybrid striped bass per acre every three years.

Strategy Statement: Similar to the culture of striped bass described in Objective 4 above, the Andrew H. Hulsey State Fish Hatchery will culture hybrid striped bass. Lake Ouachita will be the source of female broodstock. Male white bass may come from a variety of local sources.

EVALUATION

This plan will be evaluated over a five-year period ending January of 2007. Creel surveys will be used to evaluate the 15% return-to-creel objective. Condition and growth observations will be incorporated into annual sampling plans by the District Biologists.

Our own stocking records show three to seven 2" fingerlings per acre per year on suitable lakes will establish and maintain a quality striped bass population. Stocking rates for hybrids, owing to hybrid vigor, and better survival may be lower and less frequent. Individual districts may adjust stocking rates in response to reservoir conditions. Based on the findings of Moore, et al. (1991) stocking ten to twelve 2" fingerling stripers per acre results in the best survival rates, whereas higher and lower stocking rates can result in lower survival. However, we recommend a lower stocking rate due to the historical success of this stocking rate and the need to balance the striped bass fishery with other, potentially competing demands on the fishery.

MANAGEMENT GUIDANCE

The following is provided as a guide to fishery managers for evaluating striped bass and hybrid populations for meeting plan objectives.

1. Relative abundance as catch per unit effort obtained by standardized gill samples. Not effective on all lakes.
2. K-factor (plumpness) of the fish. Values in the literature seem inconsistent. This parameter has R-value, but shouldn't be used alone.
3. Creel census studies are valuable information, but due to the high cost are only conducted on a rotating basis among the major reservoirs.
4. Recruitment (survival) can be measured by standardized gill net samples and in some instances by electrofishing. Data tends to be highly variable, even at moderate effort.
5. Mortality rates can be measured by gill net samples but again tends to be highly variable.
6. Growth rate expressed as total length at age is a reliable method to evaluate the condition of striped and hybrid bass. The method of capture does not affect this parameter, so fish collected at tournaments, or by volunteer anglers furnished with a minimal amount of equipment may be used. It is also a very valuable public relations tool to work with the anglers in this manner. This parameter is effective on all of our striped and hybrid bass lakes, and will be used as a standard method for evaluation of the condition of striped and hybrid bass populations. Data collected will be length, weight, and a scale sample (4 or 5 scales taken below the lateral line and behind the pectoral fin) for determination of length at age. Back-calculations will be measured from the scale samples to determine the fish's length at each annulus formation on the scale. Mean length at age for each year class will be compared to the minimum and maximum growth rates shown for Lake Mead earlier in this report. Lakes with growth rates in the lower 25 percentile should not be stocked (or receive a low stocking of 1-2 fish per acre). Lakes in the middle 50 percentile may receive 3-5 fish per acre, depending on prey availability. Lakes in the upper 25 percentile may be considered for bonus surplus stocking if the prey base is suitable. There does not appear to be enough data on hybrid length at age to establish criteria for this species. Districts with hybrids should collect length at age data and compare it with past years to determine stocking rates, provided the lake meets the minimum requirements for prey abundance.

Growth rate ranges for Lake Mead striped bass were selected because they represent the extremes for best and worst growth. These growth rates for ages one through four are shown below.

Age	I	II	III	IV
Best	472	599	694	779
Worst	184	358	465	549
Lower 25th percentile	184-256	358-418	465-522	549-612
Middle 50th percentile	257-400	419-539	522-637	613-737
Upper 25th percentile	401-472	540-599	638-694	737-779

Data currently available on Arkansas lakes

Age	I	II	III	IV
Ouachita	232	472	575	660 (ages II-IV within 50 percentile)
Dardanelle	274	440	563	640 (all ages within 50^{tth} percentile)
Beaver	193	423	576	691 (ages II-IV within 50th percentile)

7. Available prey in terms of AP/P ratios. This parameter was developed by one of the most respected names in North American fisheries management, Dr. Robert Jenkins (Jenkins 1979). It is a standard output on all rotenone samples conducted by the Fisheries Division and is applicable in all fisheries districts. AP/P ratios (available predator/prey ratio) greater than 1.0 collected during August rotenone samples is considered adequate forage. We will use the average of the past three years to reduce the variability of rotenone samples to accurately estimate clupeid biomass.
8. The committee feels that 5 kg/ha of young and intermediate (up to 175mm) shad is the minimum amount of forage to sustain striped bass stockings. This figure must be at least 10 kg/ha to receive surplus stockings. This parameter is a standard output of all rotenone samples conducted by the Fisheries Division and is applicable to all districts. We will use the average of the past three years to reduce the variability of rotenone samples to estimate clupeid biomass.
9. Evaluation of Objective 2 (water quality suitable for striped bass) is a technical job requiring sophisticated equipment of which there is only one unit available in our research section. However, there are sometimes data available from other agencies that could be utilized. The U.S. Geological Survey is currently modeling temperature and oxygen dynamics in Beaver, Bull Shoals and Norfork as part of the minimum flow evaluation. This modeling will be valuable in assessing water quality in these reservoirs, especially related to minimum flow for trout. We feel it is not necessary to collect this kind of data on a routine basis. On years when striped bass water quality has been marginal, we will notice a few individuals that wander outside of the thermal refuge and die. During these times we could perhaps call on our research section to monitor the situation and assess the size of the thermal refuge. This situation always occurs in late summer or early fall. It is usually only a matter of days or weeks before the surface waters cool enough for the stripers to rise out of the deep and thrive in the cooler water now available at the surface.
10. Length limits (Objective 3) are only effective if caught and released fish survive in good numbers. The studies reported earlier indicate that the use of length limits is of questionable value due to high mortality rates commonly reported. However, the studies also suggest that if we choose to use length limits as a management tool, 20” should be the standard acceptable minimum size limit, and that the length limit should be removed during July, August, and September. Our recommendation is that to be considered for a length limit, the lake must show growth rates in the upper 50th percentile of the Lake Mead extremes reported earlier in this report, and the lake must have a three-year average of 10kg/ha to meet forage requirements.

BARRIERS TO ACHIEVING OBJECTIVES

1. **Labor.** The most serious impediment to achieving the goals and objectives in this plan is manpower. The annual striped bass spawning project is the single most labor-intensive project undertaken by the fisheries division. Those assigned to the project each year must let other high priority springtime projects, such as electrofishing sampling for black bass, which has a narrow window for acceptable sampling time. The timing of the project is such that it interferes with other springtime projects that have a narrow window of opportunity, both in the districts and on the hatcheries. The only way to insure all the springtime work gets done is to have more help available in the spring. There are not enough employees in the fisheries division to fulfill our springtime commitments.

2. **Anti-stocking attitudes.** The vehement opposition to stocking striped bass by a small but vocal number of anglers has been prevalent for over 30 years, and is not likely to abate.

3. **Pro-stocking attitudes.** The demand by dedicated striper fishermen, particularly guides, can also be detrimental to prudent stocking of this species. Over-stocking can be detrimental to stripers and native predators alike and should be avoided. Far better to stock a few less than optimum than to overstock and create forage problems that could take several seasons to correct.

4. **Crop failure.** Striped bass fry are extremely fragile and subject to mortality from a variety of environmental factors. It is possible, on any given year, that our best efforts to produce fingerlings for stocking will fail. At these times, procurement from other government agencies and/or commercial producers must be attempted.

5. **Minimum flows for trout.** Current proposals to release additional water for trout below Beaver and Norfork reservoirs could impact the ability of those reservoirs to support striped bass during the late summer. Modeling studies are being conducted by the Corps of Engineers to address these issues.

   Our established objectives and their means of evaluation have addressed all of our goals. However, evaluation of goal 1 is problematic. That goal is to have a quality striped bass fishery. We may already have that. Evaluation of striped bass fisheries has not been standardized throughout the United States or the world. Comparisons for all lakes will not be possible until methods are standardized throughout the southeastern states. Development of this striped bass management plan is a step in that direction, and will give us objective criteria to compare lakes within the state.

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