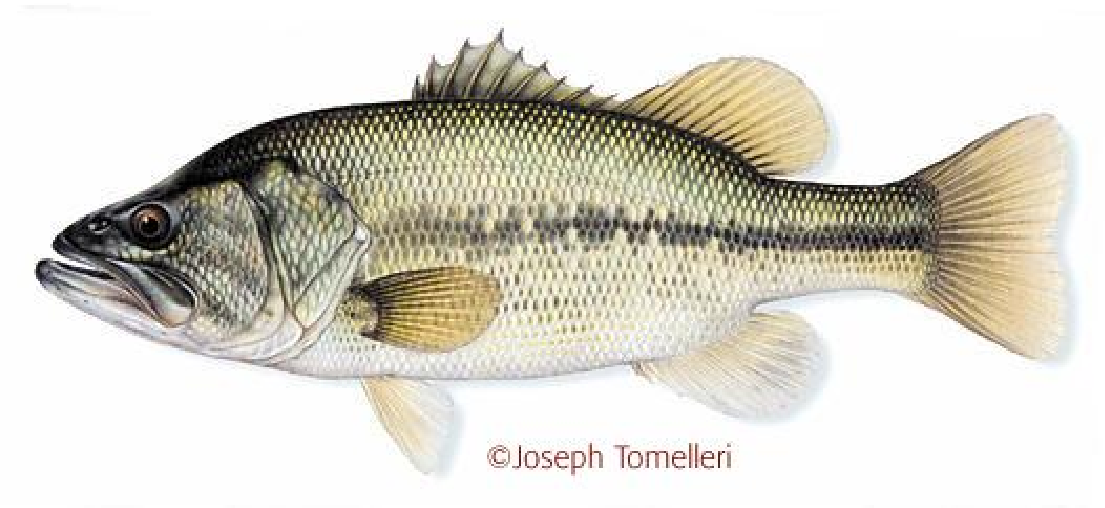
KANSAS DEPARTMENT OF WILDLIFE AND PARKS

LARGEMOUTH BASS MANAGEMENT PLAN



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INTRODUCTION

Largemouth bass *Micropterus salmoides* are one of the most popular sportfish in Kansas. In the state's most recent Licensed Angler Survey, Burlingame et al. (1997) reported that resident and lifetime anglers ranked largemouth bass as their most favored species of fish to catch (31.8% and 37.6%, respectively). These anglers also said they actually fished for largemouth bass most often (31.1% and 39.0%, respectively). Largemouth bass ranked third in preference by non-residents (19.8%) In the Kansas portion of the 2001 National survey of fishing, hunting, and wildlife-associated recreation (USFWS 2002), black bass were ranked third in the total number of anglers and second in the number of days of fishing.

The popularity of bass fishing is not restricted to Kansas anglers. In 2001 black bass were the species most fished for in freshwater (excluding the Great Lakes) in the United States (USFWS 2002). Thirty eight percent of anglers fished for these species (USFWS 2002).

As in most states, catch and release angling for largemouth bass is very popular with Kansas anglers. Creel censuses conducted in 2004 at small impoundments found that anglers released 95% of the bass they caught (Mosher 2004a). While catch and release angling for largemouth bass is assumed in all waters managed by the Kansas Department of Wildlife and Parks (KDWP), it should be stressed that there are also situations where KDWP encourages anglers to harvest small bass to improve the quality of the population in a particular water body. KDWP also recognizes that anglers have a right to harvest bass of legal size so long as the daily creel limit is not exceeded.

Need for a management plan

Three primary needs have been identified as reasons for developing a management plan for largemouth bass in Kansas. The first – and, arguably, the most important - is to devise a plan that outlines how to collect and utilize the best scientific information available to make management decisions concerning largemouth bass. The second is to capture the institutional knowledge of bass management that already exists within the fisheries staff of the agency. It is anticipated that, over the next few years, many of our current fisheries personnel will be retiring. It is important to have a mechanism by which their knowledge and experience can be compiled and conveyed to their successors. The third is to develop a document that can be provided to anglers and other interested parties in Kansas that describes how and why management decisions are made. It is hoped that this information will solicit increased support from our constituents when difficult management decisions must be made and implemented.

Goals and Objectives

For management plans to be most effective, an attempt must be made to integrate and apply ecological concepts, socioeconomic perspectives, research findings, and management techniques (Anderson 1980a).

Goal

To maintain or improve the quality of the largemouth bass angling experience using harvest regulations, habitat management, stocking, and research.

Objectives

1. Establish harvest regulation guidelines for managing largemouth bass

2. Improve the quality of largemouth bass fishing in Kansas reservoirs, state fishing lakes, and community lakes.

3. Utilize the KDWP hatchery system to investigate improved methods of largemouth bass culture

4. Conduct research on various aspects of largemouth bass management

POPULATION SAMPLING

Need for Standardized Sampling Procedures

The desirability of standardized sampling is recognized by the fisheries profession (Willis and Murphy 1996). In general, standardized sampling uses specific techniques to collect samples at similar locations and dates each year. KDWP began standardized sampling of small lakes and reservoirs in 1979 (Mosher 1979; Stafford 1979).

Strategies for sampling small lakes usually differ from those used on reservoirs because of physical and biological differences in the two water types. For example, the number and location of sample sites in small lakes and reservoirs often differ because of impoundment size and shape. More effort is required to adequately collect representative samples from large impoundments because they typically have more habitat types than small impoundments. Sampling dates for small lakes frequently differ from those selected for reservoirs because of thermal differences which influence fish distributions and activity on a given date. Small lakes tend to warm faster than reservoirs in spring and cool more quickly in autumn. As a result, most species of fish spawn earlier in small lakes than in reservoirs. Other physical characteristics that influence the development of sampling strategies include rates of water exchange and sedimentation, water clarity, and lake morphometry. Sampling must be adjusted to account for differences in fish distributions, activity, and vulnerability to a sampling method in a particular environment.

Data Analysis

KDWP maintains an Aquatic Data Analysis System (ADAS) (Hartmann and Mosher 1978; Marteney 2005) to store and summarize data collected by standard sampling. The system stores fishery data in a readily accessible form that can be summarized for biologists to develop and evaluate management plans for each body of water. In addition, these data are used to make regional and statewide evaluations of lake and reservoir fisheries through time.

Statistics generated from standardized data include catch rate or catch per unit effort (CPUE), length frequency, and fish condition. CPUE information is also employed to calculate "density", "preferred" and "lunker" ratings which are used by fisheries managers in compiling annual fishing forecasts. Length-frequency data are categorized using the five-cell Relative Stock Density (RSD) model developed by Gabelhouse (1984a). Fish condition is indexed by Relative Weight *(Wr)* for species with available Standard Weight *(Ws)* equations. More traditional K (Fulton-type) factors are utilized for the remaining species. See Anderson and Newmann (1996) for a discussion of both W*r* and K factors. Five-year fish population trend reports are produced to allow monitoring changes over time.

Sampling Methods

Electrofishing is an efficient sampling procedure to evaluate largemouth bass populations by utilizing catch per unit effort, length-frequency, and body condition (Reynolds and Simpson 1978). The recommended sampling method for this evaluation is spring electrofishing. Hall (1986) and McInerny and Degan (1993) found that electrofishing catch rates of largemouth bass ≥200 mm showed a significant positive linear relationship to population density estimates (number/hectare). Jacobs et al. (1995) determined that bass angling and electrofishing catch rates were related and that electrofishing could, therefore, be used to infer the quality of angling in each lake**.** Although catch rates may vary among impoundments, (Appendix A, Appendix B), biologists should establish objective CPUE values for each impoundment. It should be understood, however, that the size selectivity inherent in electrofishing can bias estimates of reproduction, growth, and mortality (Reynolds 1996). When interpreting PSD and RSD, biologists should be aware that both values may be biased by sampling conditions and regimes. Electrofishing samples should be conducted annually on lakes with length limit regulations to evaluate their effects. Adhering to specific protocol concerning sample collection, as recommended in the 4th edition of the Department's Fish Survey Techniques for Small Lakes and Reservoirs (Marteney and Mosher 2004), will allow complete, accurate data collection and interpretation**.** <u>Minimum</u> electrofishing effort for state fishing lakes and other small impoundments will be 1 hour or one complete lap of the shoreline- divided into discrete 10 minute sampling intervals. Recent research has also shown that 10-minute electrofishing segments on larger impoundments have produced comparable results to sampling the entire shoreline (Miranda et al. 1996). Most large impoundments would have a <u>minimum</u> of 10 standard locations using the 10 minute electrofishing option. Selectively sampling areas of known good bass habitat, while ignoring areas of marginal bass habitat, will yield CPUE values that do no accurately reflect the population of the entire lake. Such information is misleading to anglers who rely on fishing forecasts and other Department generated information to select the waters that wish to utilize.

However, fisheries managers also need to compare data collected by electrofishing to creel census and tournament catch data (where all are available). By relying solely on electrofishing data, important information may be overlooked.

POPULATION ASSESSMENT

Characteristics of a Good Population

To achieve the goal of this plan, it is important to maintain bass populations in a "balanced" (Swingle 1950; Anderson 1976) state thereby improving the quality of bass fishing for anglers. The quality of a largemouth bass population is related to its' density (number per acre), biomass (weight), condition factor and size distribution.

A good largemouth bass population is one that performs as intended, whether maintaining quality bass angling or by functioning as a management tool to enhance panfish quality. Good populations have sufficient levels of density, growth, longevity, size structure, and recruitment to accomplish population goals.

Density

True population density (number of fish per acre) is rarely measured. Instead density is indicated by electrofishing CPUE. Number of fish per hour sampled provides a relative abundance value that can be compared to samples from previous years or from other waters. Largemouth bass CPUE varies greatly depending upon water type and clarity, population density, and other environmental conditions. Kansas reservoirs with CPUE exceeding 30 bass per hour would be considered good bass waters, whereas smaller lakes and ponds routinely have stock catch rates greater than 70 fish per hour.

Growth Rate and Age Structure

Growth of largemouth bass is variable (Table 1) and related to a number of factors such as relative abundance and vulnerability of prey, and physical and chemical variables of water quality such as turbidity, temperature, and dissolved oxygen (Anderson 1975). Fish length is highly correlated to fish weight. However, within a population there can be considerable variation in weights between fish of the same length. To adjust for this variation, *Wr* (Wege and Anderson 1978) is used to determine the condition, or well-being of individuals within a population.

Size Structure and Body Condition

Structural indices, PSD (Anderson 1976) and RSD (Wege and Anderson 1978), describe size characteristics of fish populations. PSD is the percentage of stock length individuals that exceed quality length (Anderson 1978). Gabelhouse (1984a) added additional size categories of preferred, memorable, and trophy to complete the length categorization system for largemouth bass. PSD ranges of 40-60 (Reynolds and Babb 1978) and 40-70 (Willis 1984) were suggested as objectives for balanced largemouth bass populations. Further, Willis (1984) proposed the following RSD goals; 10-40 for RSD-P (preferred), and 0-10 for RSD-M (memorable). Anderson (1976) suggested that balanced stocks of largemouth bass in small impoundments would exhibit a PSD of 45 to 65. Gabelhouse (1987) suggested that fisheries managers strive to maintain a PSD of 20-40 and *Wr* of 85-95 for largemouth bass if there is interest in maximizing the production of large bluegills. Anderson and Neumann (1996) suggested that mean *Wr*s of 100 across the five length categories can be considered optimum both ecologically and physiologically.

Recruitment

Recruitment is the number of bass surviving their first year of life. It is an important factor in determining the success of harvest restrictions because these fish form the stock base from which the harvestable size bass will grow. An estimate of recruitment is the number of age-1 bass captured in spring electrofishing.

Table 1. Mean total length (mm) at annulus formation for largemouth bass collected in Kansas SFL's in the spring 2000 (Mosher, KDWP unpublished data).

State Fishing Lake	1	2	3	4	5	6	7	8	9	10
Atchison	151	229	292	362	389	415	429	440		
Barber	160	262	304	393	472	474		495	522	
Bourbon	114	206	288	355	368	390				
Brown	134	236	293	324	345					
Butler	138	197	282	324	382	404	431	435		
Chase		250	329	371	408			501		
Cowley	123	222	267	326	356	422	462	433	498	
Crawford	160	252	299	368	409	437	504		483	535
Finney			277	297	318		492			
Ford		220	319	346	389					
Geary	133	241	318	369	397	448	485	499		
Hain	127	261	310	333	361	452				
Jewell	118	179	285	352	377	394	425	417	465	
Kingman	202	234	268							
Leavenworth	141	227	293	332	377	429				
McPherson		191	253	286						
Montgomery	145	246	324	365	394	456	500	505		
Osage				340	389	452	425			
Ottawa		229	286	341	401	420	466	526	587	
Pottawatomie No 1	133	231	289	317	364	377	403	483	540	
Pottawatomie No 2	118	224	305	343	366	388	435			
Rooks	106	211	318	370	386	419				
Scott	152	250	274	338	366	378		523		
Shawnee	129	241	308	351	375					
Sheridan	163	218	308	330	351	359	379	458		
Washington	119	240	312	361	403	426	482			550
Wilson	159	221	314	345	418	447	469	510		

<u>Modeling</u>

Fish population modeling can be an effective tool to evaluate appropriate harvest restrictions on specific water bodies prior to their actually being implemented (Baker et al 1993). Modeling allows managers to predict yield, harvest, and the resultant population structure at different levels of harvest restriction. The modeling tool used by KDWP is Fishery Analyses and Simulation Tools© (F.A.S.T.) (Slipke and Maceina 2000). F.A.S.T. is a Windows-based population dynamics computer model developed by the Department of Fisheries and Allied Aquacultures at Auburn University. It enables fisheries managers to predict the effects of changing length and creel limits on angler catch, size of fish caught, and numbers of fish. Besides yield, F.A.S.T. provides a variety of predicted population parameters including the number of fish harvested and dying naturally, mean weight and length of harvested fish, number in the population above and below some lengths of interest, total number of fish and biomass in the population, stock density indices, and number of age-1 fish. With age, length, and weight data, F.A.S.T. can compute von Bertalanffy growth equations, length/weight equations, total mortality using unweighted and weighted catch-curves regressions, and stock density indices (PSD; RSD) and *Wr*. When deciding if a harvest restriction would be effective in achieving management objectives, modeling is an effective tool.

LARGEMOUTH BASS CULTURE AND STOCKING

While largemouth bass are native to rivers in eastern Kansas (Cross and Collins 1995), stocking by government agencies and private individuals have established the species in reservoirs, lakes and streams throughout the state (Figure 1).

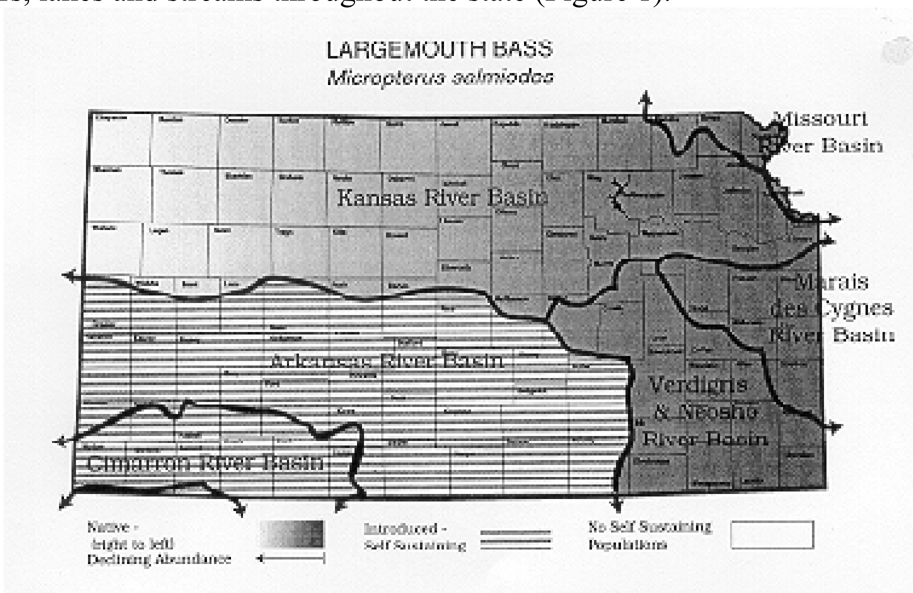

Figure1. Distribution of largemouth bass in Kansas

Culture Facilities and Techniques

The Meade Fish Hatchery has been the primary Kansas hatchery to produce largemouth bass for fry stockings or fingerling culture for the past 30 years. The state's largemouth bass broodfish are kept on station at Meade year round.

These broodfish are trained to accept artificial feed and are maintained and reared to large sexually mature fish on this diet. In addition, the diet of these fish is supplemented with live forage. This forage consists of koi carp, bluegill fingerlings, and adult fathead minnows. This addition to their diet provides micronutrients that are not provided in commercial feed.

Extensive culture techniques used for the spawning of largemouth bass at Meade has been traditional and are somewhat outdated. In May, broodfish are harvested from holding ponds, visually inspected for secondary sexual characteristics, and placed in spawning ponds at favorable ratios and numbers. Sexing of broodfish is done in the spring when ripe females should have distended abdomens and males freely emit milt when stripped. On bass larger than 13 to 15 inches, the scaleless area around the urogenital opening is also examined to assist in sex determination. This scaleless area is almost circular in males but elongated in females. However, Benz and Jacobs (1986) correctly sexed only 53% of fish by examining the urogenital opening. The surest way to sex broodfish is to insert a glass capillary tube into the urogenital vent to remove eggs or milt in the spring of the year pre-spawn.

Prior to the filling, nesting material is placed on the spawning pond bottoms to provide male fish with nesting substrate. This usually consists of 1¼" washed river rock in plastic or rubber tubs. No other human intervention on the success of spawning activities is exercised, aside from water level manipulations, if warranted.

After pairing, bi-weekly monitoring for nests is conducted by hatchery personnel. After nests are detected, hatchery personnel check daily for swim-up fry along the edges of the spawning ponds. After swim-up fry are observed, harvest procedures are initiated. Over the years of production at Meade, harvest of bass fry has consisted of traditional trapping fry in winged-wall fry traps, seines, and pond draining.

Hatchery production reports from 1977 to 1987 (when the described culture methodologies were used) point out one underlying theme - that fry production was either a boom or bust venture. Large numbers of bass fry were occasionally produced, but many years yielded little success. In the text of these reports, weather patterns were the most common explanation for the success or failure of that year's production. Cold fronts would lower water temperatures in the spawning ponds, causing males to abandon their nests and result in hatching failure. Other reasons noted were too warm of weather, small broodfish, diseased broodfish, copious amounts of vegetation, and possible persistence of pesticide residue in ponds prior to filling.

At Meade, pond space is a limiting factor in spring fish production activities. In 2006, all largemouth bass broodfish on station were sexed through the capillary tube method. Males were then freeze-branded on the left side of the caudal peduncle for 15-20 seconds to permanently mark them for future identification. Post spawning, males and females are separated and placed into separate holding ponds and held until the following spring. This separation provides flexibility in pairing the broodfish. It should allow timelier and more continuous spawns over a shorter time frame and result in more uniform fry for stocking.

It is suggested that culture methods be changed to an intensive approach, much like Texas, Illinois, and Missouri. This method involves the pairing of two fish in a confined area where conditions are controlled by human intervention. Water temperature is manipulated to an optimal level of 17-21° C through the use of heaters and chillers to induce the fish to spawn. After eggs are deposited and fertilized on nesting material, they are collected by the culturist and kept in temperature controlled tanks or placed in hatching jars to continue maturation until they hatch. The resulting fry can be kept in similar age cohorts thereby reducing cannibalism. This method would ensure more consistent returns of fry culture, eliminating the boom or bust phenomenon. Additionally, fewer broodfish will need to be maintained and weather problems experienced in the past will also be eliminated as a variable.

This technique would give the culture system the advantage of spawning fish earlier in the year. It has been shown that largemouth bass hatched early in the year have a competitive advantage over later-hatched individuals (Miranda and Muncy 1987; Miranda and Hubbard 1994; Phillips et al. 1995; Pine et al. 2000) in impoundments where species such as gizzard shad *Dorosoma cepedianum* can quickly grow too large to be preyed upon. These age-0 fish added more body mass and better survived the first year starvation period in the fall-winter period, thus improving recruitment.

Largemouth bass genetics

There are two recognized subspecies of the largemouth bass- the northern largemouth bass (NLMB) *Micropterus salmoides salmoides* and the Florida largemouth bass (FLMB) *Micropterus salmoides floridanus* (Childers 1975). While morphological differences exist (Chew 1975, Kassler et al. 2002), these two subspecies can best be differentiated by using vertical starch gel electrophoresis (Phillip et al. 1983, Kassler et al. 2002).

The native range of the largemouth bass was restricted to the southeastern and central U.S. (MacCrimmon and Robbins 1975, Philipp and Claussen 1995) including the eastern third of Kansas (Cross and Collins 1995). In 1949 the Florida subspecies of the largemouth bass was identified (Bailey and Hubbs 1949, cited Philipp and Claussen 1995). The FLMB evolved in and was restricted to the subtropical climate of the Florida peninsula (Childers 1975). However, when occupying the same water these two subspecies interbred readily. An intergrade zone between the subspecies was found in parts of South Carolina, Georgia, Alabama, and northern Florida. The northern subspecies occupied the remainder of the species' original range (Philipp and Claussen 1995). Since the FLMB was first identified, fish stocking efforts have greatly extended the intergrade zone until it now includes much of the southern U.S.

In the original habitats, FLMB were observed to grow larger than the northern subspecies. For this reason, the Florida subspecies were widely introduced into waters that contained populations of the northern subspecies. The Texas Parks and Wildlife Department stocked FLMB to alter the genetic composition of largemouth bass populations since 1972 (Buckmeier et al. 2003). The Oklahoma Department of Wildlife Conservation also began stocking of FLMB in the 1970s (Gilliland 1992). By 1987, FLMB bass alleles were found in 93% of Oklahoma reservoirs. In 27% of those reservoirs >50% of the largemouth bass had FLMB alleles (Gilliland and Whitaker 1989). Researchers in Texas and Oklahoma have concluded that the survival of supplementally stocked FLMB fingerlings has been shown to influence the genetic makeup of populations (Kulzer et al. 1985, Gilliland and Whitaker 1989) and produce increases in the production of trophy bass (Forshage et al. 1989, Gilliland 1992, Horton and Gilliland 1993).

Suitability of Florida largemouth bass to Kansas waters

Fisheries managers sometimes assume that introducing new genes into a population through stocking will result in increased growth, survival, or other superior qualities (ie. hybrid vigor). Unfortunately, this is not always true. In some cases, the resulting population may exhibit a lack of fitness to their environment (outbreeding depression) (Philipp et al. 2002). Outbreeding depression results when the progeny from parents with different genetic makeup have lower fitness than progeny from parents sharing the same genetics. In this case, adaptive genes in wild populations are displaced by genes that are adapted to some other locality or environment. Childers (1975) noted that genes less suited to the local environment are easily introduced into populations that interbreed readily, but are removed very slowly by the forces of natural selection. A loss of important genetic variation is often the result of fish stocking programs that inadvertently permit or deliberately promote introducing non-native individuals.

Cooke et al. (2001) found that hybrids produced by crossing northern largemouth bass from different regions of the Midwest exhibited reduced performance compared to locally adapted stocks– not hybrid vigor. While evaluating first year growth, Isely et al. (1987) concluded the NLMB x FLMB hybrids exhibited no hybrid vigor when compared to either of their parental stocks.

Because most Kansas waters with suitable habitat for largemouth bass are already occupied by NLMB, it is logical to assume that any introductions of FLMB would quickly result in a population consisting of the two subspecies and their hybrid. Numerous studies have been conducted to evaluate the performance of FLMB and NLMB x FLMB hybrids. Studies designed to determine their suitability to northern latitudes seem most appropriate for this discussion.

Affects of Temperature

FLMB evolved in latitudes that experience subtropical climate. Researchers have attempted to determine how well the subspecies would perform at latitudes with a climate that is less hospitable.

Under laboratory conditions, Carmichael et al. (1988) found that among largemouth bass maintained at a low temperature (36ºF) mortalities were 48% for FLMB, 4-5% for hybrids, and 0% for NLMB. Overwinter mortality of FLMB was greater than NLMB while mortality of their hybrids was intermediate in central Illinois (Phillip and Witt 1991). They found overall mortality of all stocks increased with increasing severity of the winter and that effects on FLMB were most dramatic. In a northeastern Oklahoma reservoir that received heated effluent of an electrical generating plant Rieger and Summerfelt (1978) reported overwinter mortality of FLMB (45-98%) was greater than NLMB (0-34%) and appeared to be dependant upon lowered lake temperatures. Gilliland and Whitaker (1989) found that highest percentage of bass with FLMB alles in the southern portion of the state where water temperatures were higher, and that the mean number of bass with FLMB alleles was highly negatively correlated with freezing temperatures. In a later study, Gilliland (1992) reported that survival, mean length, and mean relative weights of bass with FLMB alleles was lowest in the northern and western portions of Oklahoma, and concluded that climatic conditions were the most likely explanation. Using heating degree days (HDD, the sum over all days fall to spring of the difference between 65° F and the average daily temperature), he recommended that stocking FLMB be discontinued in Oklahoma north of diagonal boundary from the southwest to the northeast of the state and to limit hatchery stocking to that portion of the state which shows the greatest potential for producing trophy bass.

FLMB have been reported to spawn earlier than NLMB (Chew 1975). In mixed populations, early spawning would give FLMB an advantage in acquiring preferred spawning sites, having the ability to utilize available food supplies, and being able to prey upon bass fry that hatch later. In northern latitudes, however, early spawning could lead to poor nesting success because of late winter storms and low water temperatures. Cichra et al. (1982) found juvenile FLMB to be less tolerant of cold shock than NLMB. Isely et al. (1987) found that peak NLMB spawning occurred 11 days before the peak of FLMB in Illinois ponds. They reported that NLMB produced a faster growing first-year cohort going into their first winter.

Growth and Condition

Published comparisons of growth rates of NLMB, FLMB, and their hybrids yield differing conclusions and appear influenced primarily by latitude. Some early investigators attributed the superior growth of FLMB to favorable environmental conditions. For example, Clugston (1964) concluded, “There is very little evidence to indicate that the southern subspecies of largemouth bass is genetically superior to northern form as far as growth is concerned.” Later studies suggest that differences in growth rates may exist. However, the age of the fish, the length of the studies, and the latitude at which the studies were conducted should be considered when making comparisons of their results.

Inman et al. (1978) found that hybrid and FLMB achieved the best growth over a 3-year period in a Texas pond. Isley et al. (1987) reported that FLMB in Illinois research ponds were spawned earlier and grew larger during their first year of life. When Kleinsasser et al. (1990) also studied growth rates in Texas ponds, they found NLMB x FLMB hybrids were significantly heavier and had significantly higher *Wr*s than either of the pure subspecies during their second year of life. They also reported that pure FLMB were significantly shorter and exhibited smaller length and weight increases than the NLMB or their hybrids.

However, Gilliland (1992) found that while first year growth of FLMB in Oklahoma reservoirs generally exceeded that of NLMB their body condition (*Wr*) was generally poorer.

Conversely, Philipp and Witt (1991) reported that NLMB exhibited greater second- and third-year growth than FLMB or their hybrids in Illinois ponds. They speculated that FLMB may not store fat as NLMB do because in Florida the winters are seldom severe enough to need such reserves. Phillip (1992) proposed that FLMB "are confronted with an energy deficit during lengthy northern winters, because they fail to alter their metabolic strategy from one of maximizing somatic growth to one of shunting energy into storage reserves for overwintering". Graham (1973) found that when young-of-year NLMB and FLMB were stocked together in Missouri ponds, NLMB grew larger than FLMB during the next two years – indicating a possible early growth rate advantage. Interestingly, Zolezynski and Davies (1976) also found superior early growth of NLMB to FLMB in Alabama ponds. In a 3 month study in Missouri ponds (Johnson 1975, cited Johnson and Graham 1978) evaluated the growth of two size groups of NMLB and FLMB. One size group ranged from 291-314 mm (11.5-12.4 in); the other was 405-464 mm (16.0-18.3 in). He found no significant difference in growth of NLMB and FLMB in either size group.

Susceptibility to Disease

One affect of introducing FLMB genes into a largemouth bass population may be an increase in the population's susceptibility to disease. Goldberg et al. (2005) measured the susceptibility of two populations of NLMB and their hybrids to largemouth bass virus (LMBV). They found that mortality of second generation (F2) hybrids was 3.6 times higher than either first generation (F1)hybrids or their wild parental stock. They suggested that introductions of non-native fish may decrease the resistance of populations to disease just as new diseases are being introduced by stocking of infected individuals. They further speculated that the large-scale movement of FLMB outside their native range and across the southeastern states may be a factor contributing to the epidemic of LMBV associated fish kills that have been documented in U.S. waters (Goldberg 2002).

Catchability

Some studies have shown that FLMB are less susceptible to angling than NLMB. Zolezynski and Davies (1976) found that FLMB were significantly harder to catch in Alabama ponds. NLMB were generally more susceptible to angling whereas FLMB were most difficult to catch in two of three trials held in Texas (Kleinsasser et al. 1990). Garrett (2002) also reported that NLMB in Texas ponds were "innately easier to catch" than FLMB x NMLB hybrids. Rieger et al. (1978) also found that age I and age II were significantly more vulnerable to angling in Oklahoma ponds. However, Inman et al. (1978) found no apparent difference in the catchability of NLMB and FLMB.

If all other factors (eg. growth, mortality, and disease resistance) are equal, susceptibility to angling could be an important consideration when making management decisions (Funk 1972). Bass that are more difficult to catch might live longer and be more likely to achieve trophy size (Maceina et al. 1988). Conversely, in situations where the maximizing of catch rates is desired, stocking bass that are more vulnerable to angling might be beneficial (Garrett 2002).

Kansas' experience with Florida largemouth bass

LaCygne Reservoir

The first (and only known intentional) introduction of Florida largemouth into Kansas' public waters occurred in 1979. At that time, 27,500 FLMB fingerlings were stocked into LaCygne Reservoir which was 9 years old and had no records of any prior stocking of largemouth bass. However, largemouth bass (presumably northern strain) were first sampled in the lake in November 1971.

Because LaCygne is a power plant cooling reservoir, the thermal effluent it receives may result in mid-summer water temperatures ≥92° F and while the stocking was based on the belief that FLMB would be better adapted to the warm water of the lake, exhibit better growth rates, and provide a quality bass fishery more typically found in the southeastern U.S.

In 1996 the population was tested for FLMB alleles. Results showed that 25% of the fish sampled were pure NLMB, 4% were pure FLMB, 29% were F1 hybrids, and 42% were hybrids whose generation could not be determined (FX) (Mosher, KDWP unpublished data). If conditions at LaCygne favored FLMB, it would be expected that their proportion would be greater than the 2% found. Rieger and Summerfelt (1978) reported a FLMB overwinter mortality of 98% with water temperatures as low as 38.8º F in a thermally enhanced northeastern Oklahoma reservoir. It is probable that winter water temperatures reached this level during plant outages at LaCygne in the early 1980s. The continued presence of any pure FLMB is probably explained by their movement into thermally protected areas of the reservoir. Gibbons et al. (1972) found more largemouth bass in the heated effluent than in the unheated effluent of a nuclear power plant coolant lake in South Carolina. Johnson and Fulton (1999) reported that 62.3% of largemouth bass sampled in a northeastern Arkansas lake had some FLMB alleles 18 years after its' only stocking of FLMB. These findings support the conclusion by Childers (1975) that maladaptive genes are easily introduced but slowly removed from a population by natural selection.

It was noteworthy that the two largest tested fish were pure NLMB, and that although NLMB comprised 25% of the total sample, they comprised 43% of the bass sampled >400 mm; FLMB were all < 380 mm. These data suggest that even in a thermally enriched lake FLMB in Kansas do not exhibit better long term growth rates than NLMB. This would support the findings of other studies conducted in northern latitudes (Graham 1973, Johnson 1975, Johnson and Graham 1978, Philipp and Witt 1991).

The impact of introducing FLMB on the genetic makeup of the largemouth bass populations of Sugar Creek and the Marais des Cygnes River downstream from LaCygne Reservoir was not investigated. Gelwick et al. (1995) found that in streams throughout Oklahoma 4% of the bass collected had FLMB alleles. While this number may not be particularly high, it reaffirms the concern that introducing new genes into a lake-dwelling population may subsequently have negative impacts on stream populations.

Whether a result of genetics, extended growing season, harvest restrictions, or a combination of those factors, LaCygne has consistently produced large bass. Seven of Kansas' ten largest largemouth bass collected by electrofishing were taken there (KDWP, unpublished data). In addition, 55% of largemouth bass caught in Kansas reservoirs between 1979 and 1999 that were submitted for Master Angler Awards (≥ 584 mm) were caught at LaCygne. None of those fish were tested for FLMB alleles, so their genetic makeup is unknown.

Statewide genetic inventory

In 1998 and 1999 a statewide genetic inventory of Kansas sportfish was undertaken. As part of that inventory, nine populations of largemouth bass were analyzed. The analysis indicated the presence of FLMB alleles in two of the nine populations (Kassler 1999). The presence of FLMB genes in 28% of the largemouth bass sampled at the LaCygne Reservoir site was expected because of the l979 stocking (see above). Unexpected, however, was the discovery that 97% of largemouth bass hatched and reared at the Meade Hatchery that were analyzed also displayed FLMB alleles.

Meade Hatchery serves as the state's sole source of brood stock for largemouth bass production. The occurrence of FLMB alleles at the hatchery was sufficiently high to indicate that a high proportion of brood stock had introgressed between NLMB and FLMB. To eliminate the possibility of inadvertently introducing FLMB alleles into other populations through stocking, all the brood stock at Meade Hatchery were immediately destroyed and replaced with fish from populations that Kassler (1999) found to contain pure NLMB alleles.

Although it was unknown when FLMB alleles were inadvertently introduced into the brood stock, it was assumed that genetic contamination had occurred in some of the public waters that had been stocked with largemouth bass. Fortunately, not all largemouth bass stocked in Kansas were from that source. During years of poor survival or year class failure, bass were procured from Colorado, Iowa, Montana, Nebraska, South Dakota, and Wyoming – northern states which, presumably, had NMLB brood stock. To determine the extent of genetic contamination, a project was initiated in 2000 to genetically analyze largemouth bass populations residing in public waters that had been stocked during the prior ten years (Mosher et al. 2002). Largemouth bass samples were collected from 44 populations that represented Federal reservoirs, SFLs, and the Meade Hatchery. No FLMB alleles were found in the largemouth bass sampled from eight Federal reservoirs. At SFls FLMB alleles were found in 13 of the 35 populations tested and, where detected, bass with FLMB alleles comprised 3 – 12% of the population. Because of the immediate replacement of all brood stock upon discovery of FLMB alleles, all bass at Meade Hatchery were to found to be of pure NLMB stock.

<u>Future Actions</u>

Stocking largemouth bass will be necessary to establish the species in new and renovated waters in Kansas. However, it would be irresponsible to introduce fish with no regard to their genetics (Philipp 1992). The introduction of FLMB alleles into NLMB populations may have provided fisheries benefits in southern states, but little published evidence exists to suggest that they would be an asset in Kansas waters. Our limited experience with FLMB in Kansas shows that their performance (and that of the hybrids produced by their interbreeding with NLMB) is poorer than that of NMLB.

In the future, research using largemouth bass with FLMB alleles may be initiated. Such research should only be conducted using certified triploid FLMB (Garrett 2002). An alternative is to develop and maintain a line of tetraploid FLMB broodstock (Fries et al. 2002) at the Meade Hatchery. Any offspring produced by crossing this broodstock with normal diploid individuals would be triploid and therefore functionally sterile (Garrett et al.1992).

At the Black Bass Symposium held at Tulsa, Oklahoma in 1975, Dr. William Childers warned about the risks of failing to protect the genetic integrity of the black bass species (Childers 1975). He stated: "I strongly recommend that the Florida largemouth bass not be introduced into northern waters, that the northern states prohibit such introductions by law, and that such laws be enforced."

It is recommended that stocking done without regard to the genetics of the fish being introduced should be eliminated. Largemouth bass acquired by KDWP should be of known genetic stock. Further, regulations should be enacted to forbid the importation and stocking of FLMB, and require genetic and health certifications to ensure that all largemouth bass imported into Kansas by private or commercial sources are pure NLMB and disease free.

Stocking Priorities

To best utilize the largemouth bass produced at Kansas' hatchery facilities, a stocking score sheet (Appendix C) has been developed. This score sheet will help develop a stocking priority when demand exceeds the supply of fish.

Stocking Guidelines

Stocking is a popular and much-used fisheries management practice. Reasons for stocking include introduction in new or renovated waters, supplementing existing populations, correcting prey imbalances, and responding to pressure from anglers (Buynak and Mitchell 1999).

Stocking New and Renovated Waters:

Fisheries managers stock largemouth bass in new or renovated waters to establish populations. High fertility, a lack of competition and predation, and an abundance of refuge for young fish (in the form of flooded vegetation) allow these newly stocked fish to thrive and exhibit unusually high rates of reproduction, growth, and survival. Largemouth bass in small Kansas impoundments typically have a high reproductive potential and insufficient natural reproduction is seldom a problem. To establish the species in new or renovated bodies of water, stocking up to 100 fingerling, 500 fry, or 25 intermediate size largemouth bass per acre for a maximum of three years should be sufficient (Table 2).

Supplemental Stocking:

The utility of stocking largemouth bass into established populations has long been questioned (Meehean 1948; Bennet 1970). While anglers view stocking largemouth bass as a way to improve fishing success and the majority approve of it (Stephen 1993), there are little quantitative data to support their beliefs. In a literature review of the stocking of black bass, Loska (1982) found low return of stocked fish to creel and concluded they provided little benefit to the fishery. Boxrucker (1986) reported that creel census data indicated angler catch and harvest rates were unaffected by supplemental stocking of largemouth bass fingerlings.

Under some circumstances, stocking largemouth bass has been shown to be beneficial in low density bass populations. However, stocking fingerling bass into established populations is usually unsuccessful. Loska (1982) found that returns improved with an increase in size of fish stocked. However, contributions to the fishery of 5 years of stocking 106-114 mm bass at densities of 9.8 to27.8 fish/acre declined rapidly three years after stocking ceased (Buynak and Mitchell 1999). Willis, et al. (1987), found higher survival when mean length of largemouth bass stocked exceeded 8 inches but questioned its economic feasibility. Stephen (1993) reported that 3 years of supplemental stocking of intermediate sized (132-165 mm) bass did not bolster year class strength at two Kansas reservoirs. Buynak et al. (1999) found that stocking ten pellet-reared bass ranging from 280 to 315 mm per acre did not result in any significant increase in CPUE of any size group of bass. They suggest that stocking subadult (290-315 mm) bass be considered only for social reasons because they observed no long-term improvements. Lasenby and Kerr (2000) state that, in the long term, bass stocked above the ecosystem carrying capacity will not contribute to the population. Loska (1982) concluded that the only situation in which stocking bass into existing populations is warranted is following pollution or naturally caused mortality of adults and fingerlings. He further states that while stocking bass appears to be a valuable management tool, it has very limited application. Later, Baker et al. (1993) stated that if maintenance stocking is necessary to provide a bass fishery, managing that body of water for bass is probably neither cost effective nor appropriate.

Supplemental stocking of largemouth bass adults (8-12 in) might be an option in those smaller lakes that have a high density of other centrarchids that would compete with bass fingerlings or prey upon them. Often times, fisheries managers can meet the necessary needs of larger fish with transfers from overpopulated situations [See Aquatic Nuisance Species section].

Recommended Stocking Rates:

Table 2. Recommended stocking rates for largemouth bass in new or renovated Kansas waters

SIZE	TYPE OF STOCKING	STOCKING DENSITY	WATER TYPE
FRY	INITIAL	500/ACRE	ALL IMPOUNDMENTS
FINGERLING	INITIAL	100/ACRE	ALL IMPOUNDMENTS
INTERMEDIATE	INITIAL	25/ACRE	ALL IMPOUNDMENTS

Stocking Techniques:

Fry, fingerling, and intermediate bass should be released into areas where they can find suitable cover and prey. Vegetation or brush is best.

Stocking Evaluations:

If stocking of intermediate size largemouth bass is continued in reservoirs, it should be supported with a detailed proposal outlining the goals and objectives, duration, and methods that will be used to assess success. Oxytetracyclene (OTC) marking (Hoffman and Bettoli 2005) should be used on bass fry and fingerlings in situations where natural reproduction cannot be separated from stocked fish. Marking of intermediate sized and larger bass may be done using freeze branding (Fay and Pardue 1985; Lajeone and Bergerhouse 1991) subcutaneous latex injections (Lotrich and Meredith 1974; Catalano et al. 2001) or coded wire tags (Buckmeier 2001).

Future supplemental stocking utilizing hatchery reared bass should be considered experimental. Requests for experimental supplemental stocking should be supported with a detailed proposal outlining the goals and objectives, duration, and methods that will be used to assess the success of the project.

Aquatic Nuisance Species (ANS)

The importation and relocation of fish by Department employees is often critical to address specific management recommendations and to fulfill the Department's mission. However, these actions present risks that may potentially jeopardize that mission. An objective method to determine the level of risk associated with any fish importation and relocation is needed. A risk assessment matrix for aquatic importation should be included in the agency's *Kansas Fish Stocking Guidelines* (Kansas Wildlife and Parks 1997).

MANAGEMENT ACTIONS

Harvest Regulation Guidelines

Fisheries management philosophy has changed over the past forty years. Most bass populations are not as dependent upon restrictive harvest regulations to keep from being over-exploited. Modern management, in most bass waters, focuses on improving the quality of the angling experience (bigger fish) instead of providing fish for consumption. Regulations can be used to reduce the total number of fish caught and harvested: selectively harvest, or protect, certain portions of the population: or encourage a more equitable distribution of the harvest among anglers (Baker et al. 1993).

Success of fisheries management strategies are now judged by more than the weight of fish taken from a body of water. Sizes and numbers of fish caught and released, are now integral components.

However, in some instances fish harvest restrictions play an important role in managing the quantity of fish and quality of fish populations. With harvest restrictions, high angler use can be maintained without sacrificing quality of fish populations. Studies have found that, with proper handling, most fish can be caught and released several times, creating more angling benefits than would be derived with immediate harvest (Barnhart 1989).

The most effective fisheries management program would have harvest restrictions ideally suited to that water's productivity and variable fish recruitment, growth, and mortality rates. Even though no two water bodies provide the same conditions, each of the state's impoundments can be categorized, and an appropriate set of harvest restrictions can be established for those categories. It is the task of the district fisheries biologist to identify types of fish communities and establish corresponding harvest restrictions in those categories to allow effective management. Regulations should be as few and as simple as possible and should be standardized to minimize confusion within the angling public. They should not be implemented unless they can measurably improve the quality of angling or the affected fish population. For any regulation to work, a high degree of voluntary angler compliance is necessary. If anglers are unaware of or do not understand the need for a regulation, high noncompliance rates will render the regulation ineffective (Gigliotti and Taylor 1990). Compliance can be enhanced if the angling public and all 'involved' Department personnel understand the need for a new harvest restriction. Before a new harvest restriction is implemented, fisheries personnel should coordinate with all Department staff responsible for the water body and inform the area angling public.

The following guidelines are intended to provide reasonable harvest restrictions that can be implemented on state-owned and managed waters, including federal reservoirs, state fishing lakes, and city and county lakes. Not all impoundments produce bass populations that will benefit from more restrictive length or creel limits.

Length and creel limits are the most effective tools for regulating largemouth bass harvest. Maintenance of good growth is imperative.

Experimental Regulation Peer Reviews

Proposals for length or creel limits not contained in this document are considered experimental and must be submitted through the chain of command to the Regulation Review Committee. Proposals should be supported with a detailed description of the goals and objectives, duration, and methods that will be used to evaluate the desired regulation change. Individuals proposing experimental regulations should be prepared to make a presentation to the committee with supporting data (size structure, age/growth, creel census, etc.) to justify the regulation change. The committee will then provide Division administrators with recommendations on appropriateness.

Post-regulation effects (such as changes in the bass population structure) should be evident within a relatively short time (3-5 years); indirect effects (such as changes in growth rates) may take much longer (probably as long as 8-10 years) to manifest themselves. In addition, appropriate sampling regimes must be developed to assess the effectiveness of new harvest restrictions and accompany the proposal.

Length Limits

15-inch minimum length limit (MLL)

Because harvest seldom has a significant effect on bass populations in Kansas (Appendices A, B, and C), this length limit should be established on the majority of waters managed by KDWP. There is now a statewide 15-in. MLL for black bass in state waters unless posted otherwise.

This restriction would be used in two different situations. In impoundments with limited bass recruitment and moderate bass growth a 15-inch MLL would be used to make wise use of a limited resource, ideally with each bass caught and released several times before being harvested.

This restriction would also be used in impoundments with high bass recruitment and potential to produce good sunfish populations. The restriction intentionally crowds bass to maintain heavy predation on small sunfish so that survivors grow well. Few bass would be expected to achieve lengths in excess of 15 inches. If, however, bass PSD falls below 20, competition between small bass and adult bluegill may be excessive; a switch to a slot length limit should be made to reduce bass densities.

18-inch minimum length limit

This restriction is best suited for large impoundments which exhibit limited bass recruitment, good bass growth, heavy bass fishing pressure, and an interest in catch-and-release bass fishing. With few notable exceptions, Kansas reservoirs seldom meet all of these criteria. Appendix D shows that few bass are being harvested at any Kansas reservoir and that implementation of a MLL more restrictive than the statewide 15-in MLL is seldom justified. Fisheries managers desiring to establish or maintain a currently imposed 18-in MLL should compile adequate data (size structure, age/growth information, and creel census results) to justify this decision.

The use of an 18-inch MLL might be a valuable tool to prevent overharvest of largemouth bass in newly opened small impoundments. Mosher (2002) reported that 18-in MLL's were effective in maintaining dense populations of largemouth bass <18 inches in newly renovated lakes. However, he found that by protecting large numbers of intermediate-sized bass in SFL's (which typically exhibit a high bass recruitment rate) using an 18-inch MLL for extended periods resulted in slower growth and fewer bass over 18 inches. He concluded that too many fish were protected by the length limit, and that those populations may have suffered from too much competition. He recommended that, in newly established largemouth bass fisheries, 18-inch length limits be replaced with a more liberal (eg. 15-inch minimum or 13 -18 in slot) limit when moderate to high numbers of intermediate-sized fish become present.

Long-term use of 18-inch MLL in small impoundments appears to be of questionable utility if the maintenance of a quality bass fishery is the manager's primary objective. However, if the manager decides to continue the use of such a regulation, the decision should be supported by sufficient data (size structure, age/growth information, and creel census results) to justify its' continuation.

13- to 18-inch slot length limit (SLL)

Slot length limits (SLL) were designed to reduce competition in populations with ample recruitment by allowing harvest of small fish. Past studies that evaluated a 12-15 inch SLL on black bass (Gabelhouse 1984b; Mosher 1986; Mosher 1991) showed that anglers harvested few largemouth bass in lakes with that regulation, while numbers of small fish increased and length at age decreased. If "quality" bass fishing is desired, and production of "quality" sunfish populations is infeasible, not an objective, or if sunfish are to be sustained on artificial feed, a 13- to 18inch SLL would be appropriate. This restriction is suitable for waters with moderate to high bass recruitment. It is expected to produce a higher harvest of bass below the protected length range because many anglers already self-impose minimum length limits of 12 inches. Theoretically, allowing harvest of bass up to 13 inches should reduce bass densities and maintain better growth within the protected length range. Mosher (2002) found that, despite an opportunity to harvest larger fish, anglers fishing Kansas SFL's with 13-18 inch SLL's voluntarily released a larger proportion of largemouth bass below the slot then they had under 12-15 inch SLL's. However, he reported that a mean of 35% of the largemouth bass harvested in lakes with a 13-18 inch SLL were 12 to 13 inches long and accounted for 21% of the mean total harvest of the SFL's studied.

Even though anglers appeared reluctant to harvest small bass under a less restrictive slot length limit, numbers of small bass decreased and their growth improved. Predation by bass protected by the slot length limit may control the numbers of smaller fish. The implication is that high numbers of small bass results in low numbers of quality-sized bass (Mosher 2002).

If harvest of fish below the protected length range remains insufficient, the protected length range might be adjusted. This adjusted restriction would be considered experimental and should be thoroughly evaluated through spring electrofishing samples, to include age and growth analysis of bass populations, and creel surveys. Fisheries management and research personnel should establish sampling regimes required to evaluate this restriction.

Creel limits

Creel limits are usually set to prevent anglers from harvesting more fish than would be ethical. They are also sometimes used to distribute the harvest among anglers over a longer duration. Creel limits are biologically effective only if set at levels low enough to affect most anglers. Creel limits are management tools that have little effect on most largemouth bass populations in Kansas (Appendix D, Appendix E, Appendix F). The increasing popularity of "catch-and-release" fishing for bass has resulted in reducing harvest rates of largemouth bass to nearly insignificant levels in most Kansas lakes. Mosher (2004a, 2006a) reported creel census information that showed that anglers at state fishing lakes and community lakes released 96 % of the largemouth bass they caught in 2004 and 2005. Likewise, anglers at Kansas reservoirs released 97% of the largemouth bass they caught (Mosher 2004b, Mosher 2006b).

Anecdotal evidence suggests that creel limits may be more effective in urban settings where anglers may be inclined to harvest fish. If creel census information indicates that bass harvest is excessive, a reduction to 2/day may be warranted.

Creel limits of 2/day may also be appropriate for new or renovated lakes that are exposed to a "grand opening". At such events, naive fish populations can be overharvested in a matter of days by high numbers of anglers. If this more restrictive creel limits is adopted, its' use should be temporary. If angler use continues to be exceptionally high, the restrictive creel limits might be extended beyond the opening year. However, such a decision should be supported by sufficient data (ie. CPUE, creel census and size structure information) to justify its' continuation. For anglers to accept such restrictions for an extended duration, average size of the few fish harvested must be large.

Creel limits of < 5/day are not appropriate on lakes with a 13-18 SLL. The reason for initiating a SLL is to encourage the harvest of small bass. A lowered creel limit effectively negates any benefits accrued from the SLL.

BASS MANAGEMENT IN RESERVOIRS

In Kansas reservoirs, quality largemouth bass angling has traditionally been ephemeral. Largemouth bass evolved in river ecosystems and their reproductive success depends on extensive, prolonged flooding. The species is highly successful in new reservoirs for two reasons. First, productivity at all trophic levels is exceptionally high due to flooding and release of nutrients from inundated terrestrial vegetation and soils. These nutrients result in abundant foods of varied sizes and types (both aquatic and terrestrial). Secondly, flooded terrestrial vegetation affords refuge for young bass. Under new reservoir conditions, large numbers of young-of-the-year (YOY) bass grow rapidly because of abundant food or little competition, avoid predators because of cover, and grow to a size that is of interest to anglers.

Unfortunately, these optimum conditions are relatively short lived (Kimmel and Groeger 1986). Within five to ten years, reservoir fish populations typically stabilize at a less productive level. After a brief period of years, most Kansas reservoirs can be characterized as being windswept, turbid and lacking in aquatic vegetation. Terrestrial vegetation present in newly flooded basins, particularly the finer components which help stabilize the shoreline and provide spawning and nursery habitat for warmwater fishes, is lost. The loss of this cover is believed related to observed declines in the abundance of sunfish species, such as largemouth bass, which are heavily dependent on stable sheltered shorelines. Under these less favorable conditions, largemouth bass still produce large numbers of young. However, this lack of cover may result in reduced food availability and higher predation on young bass (Aggus and Elliot 1975). Strong year classes of largemouth bass in old reservoirs are limited to years when flooding of terrestrial vegetation is extensive and prolonged (Ploskey, 1986). The result is a decrease in survival of young bass and a gradual decline in the quality of bass fishing. Jenkins and Morias (1971) found that sportfish harvest was negatively correlated with reservoir age.

The heyday of reservoir construction in Kansas was from the mid-1950s to the mid-1980s. Bass anglers had the luxury of taking advantage of the high quality fishing which nearly all new reservoirs enjoy. As one reservoir aged and the quality of bass fishing began to decline, a newly impounded lake assumed the role of the "hottest" bass reservoir in the state. As a result, bass anglers came to expect high catch rates of quality bass. In addition, fisheries managers in the state spent very little time trying to develop techniques to sustain largemouth bass populations in their aging reservoirs.

Changes in funding mechanisms in the early 1980s brought about a virtual halt in construction of new reservoirs in Kansas. Faced with this new reality, bass anglers were forced to witness first-hand the decline in the quality of bass angling in their lakes with little or no prospect of "new" water. They, along with fisheries managers, have recognized the need to begin intensively managing those reservoirs that appear to have the highest potential to increase bass reproduction and survival. To increase recruitment of largemouth bass in old reservoirs, some form of water level management must be considered, intensive habitat improvement must be initiated, or new experimental bass stocking pursued.

Habitat Manipulation

Water level Fluctuation

Reservoir drawdowns have been a popular management tool to reestablish littoral habitat in the form of submerged terrestrial vegetation. Several studies have documented the increase in abundance of nest-building game species such as largemouth bass during high-water years (Martin et al. 1981; Ploskey 1986; Meals and Miranda 1991). The increase in abundance has been attributed to increased spawning substrate, protective cover, availability of nutrients, and abundance of invertebrates in submerged terrestrial vegetation. Similarly, Miranda et al. (1984) reported that inundated terrestrial vegetation in West Point Reservoir, Alabama-Georgia, had a positive influence on year class strength of largemouth bass, but growth was negatively influenced. This suggests that carrying capacity and food availability must be increased concurrently with standing stock of largemouth bass. Aggus and Elliott (1975) found that age-0 largemouth bass grew faster and switched to piscivory sooner when flooded terrestrial vegetation was abundant. Shirley and Andrews (1977) found that differences in density and growth between two year classes of largemouth bass were directly correlated with the rise in water level and inundation of terrestrial vegetation.

Water level management plans in Kansas have typically consisted of a spring rise to flood terrestrial vegetation, a summer drawdown of approximately 4 feet to allow regrowth of vegetation and concentrate predators and prey, an autumn rise of approximately 2 feet to flood some terrestrial vegetation and attract waterfowl, and a winter drawdown to once again concentrate predators and prey and protect remaining vegetation from water damage. The objectives of this plan, as implied by Groen and Schroeder (1978), have been to increase population densities and growth rates of sport fish, and to improve water quality (transparency), in reservoirs where the normal aging process often induces opposite effects.

Ploskey (1982) recognized the need to look at basin area exposure rather than merely amplitude of fluctuation when considering water level management as a fisheries tool. Plans which have exposed 20% or more of the basin area have proven most successful for Kansas reservoirs.

Largemouth bass population densities appear to be negatively effected by the typical Kansas water level plan (Willis 1986). Spring flooding of vegetation probably enhances spawning success and provides a good food supply for young bass. However, the July drawdown may remove these small bass from structure necessary as escape cover or protection from physical damage of wind and waves. Aggus and Elliott (1975) reported the importance of maintaining high water levels for most of the summer if large spawns of largemouth bass are to recruit.

Unfortunately, lake-level drawdowns are not practical for many municipal water supply reservoirs or western Kansas reservoirs where an adequate water supply rarely exists. Water level manipulation in reservoirs sufficient to benefit largemouth bass is generally beyond the control of the KDWP.

Therefore, for reservoirs where lake level manipulations are not plausible, alternative methods for establishing littoral habitat, such as aquatic vegetation, are needed to increase sport-fish production.

Aquatic Vegetation

Numerous researchers have studied aquatic macrophytes and their effects on fish populations and communities. In general, increased species diversity (Keast et al. 1978; Killgore et al. 1989; Bettoli et al. 1993) and higher densities (Killgore et al. 1989; Bettoli et al. 1993) of fish are associated with vegetated areas relative to non-vegetated areas. The elevated diversity and abundances are attributed to the shelter (Colle and Shireman 1980; Savino and Stein 1982) and increased production of invertebrates (Aggus and Elliott 1975; Chilton 1990) that macrophyte beds provide.

Aquatic vegetation may also affect growth rates of age-0 largemouth bass. Aggus and Elliott (1975) and Shelton et al. (1979) found that growth rates of age-0 largemouth bass increased in areas with aquatic vegetation. Although aquatic vegetation may enhance growth of age-0 largemouth bass by increasing availability of invertebrates and reducing predation, these benefits may be offset by increased intra and interspecific competition (Miranda et al. 1996). Thus, growth rates of age-0 largemouth bass may decrease in densely vegetated reservoirs. For example, Bettoli et al. (1992) suggested that abundant submersed vegetation in Lake Conroe, Texas, prevented largemouth bass from efficiently feeding on other fishes. Therefore, growth was reduced throughout the first year, and recruitment to the fishery was negatively influenced. Similarly, Savino and Stein (1982) reported that largemouth bass predation success decreased with increased habitat complexity (250-1000 stems/m^2) in laboratory pools. Conversely, Killgore et al. (1989) found no changes in largemouth bass size by increasing or decreasing plant density in the Potomac River, Virginia.

Several authors have indicated that the optimal amount of aquatic vegetation is between 20 and 36% of total lake surface area, and values above and below this negatively influence largemouth bass survival, abundance, and recruitment (Durocher et al. 1984; Wiley et al. 1984). Durocher et al. (1984) reported a significant positive relationship between percent-submerged vegetation and standing crop of adult largemouth bass and numbers recruited to harvestable size. Their analysis also indicated that a reduction of aquatic vegetation below 20% surface area coverage would result in a concurrent reduction in largemouth bass recruitment and standing crop. Similarly, Wiley et al. (1984) established that largemouth bass biomass was maximal at vegetation coverage near 36%.

Results have been mixed regarding the effects of aquatic vegetation on largemouth bass population characteristics. However, there does appear to be an optimal level of aquatic vegetation for maximum largemouth bass production, but this value can vary among water bodies and species of vegetation. A proper understanding of the interactions between fish communities and aquatic vegetation is essential for proper management of fisheries resources.

Kansas reservoirs are severely lacking in aquatic vegetation. There are a number of reasons that this condition exists. Most Kansas reservoirs are less than 50 years old which, in an ecological sense, is very young. While they cover large areas of potential aquatic plant habitat, these reservoirs have inundated lands that do not have large numbers of aquatic plant propagules to colonize that habitat (Smart et al. 1996). In addition to being ecologically young, Kansas reservoirs are inhospitable environments for the establishment of aquatic plants. Most are operated for flood control and municipal water supplies, and can experience wide fluctuations in water levels. Wave action resulting from basin morphometry (gradually slope bottoms), fairly flat topography, lack of trees along shorelines, and exposure to relatively high average winds often causes large areas with shifting bottom substrates and high turbidity which make plant establishment difficult. These barren littoral areas are inhospitable habitats for nest-building fishes such as largemouth bass (Summerfelt 1975). Large numbers of aquatic herbivores (eg. common carp *Cyprinus carpio,* painted turtles *Chrysemys picta,* and slider turtles *Trachemys scripta*) are also present in most Kansas reservoirs. Dick et al. (1995) found that some species of aquatic turtles feed heavily on aquatic plants and can, potentially, limit the standing crop of the species on which they prefer to feed. Also, herbivory by crayfish, insect larvae, muskrats, nutria, and beaver has been shown to be a significant factor affecting establishment and growth of submersed aquatic plant communities (Doyle et al. 1997).

Attempts at establishing aquatic vegetation in reservoirs have met with some success (Doyle et al. 1997). Vegetation establishment efforts in Kansas reservoirs have used the techniques described by Smart et al. (1996) and Smart et al. (1998). While a variety of aquatic plant species have been introduced into Kansas reservoirs, water willow *Justicia americana* appears to be the species most readily adaptable to their fluctuating water level conditions. Water willow provides important littoral habitat for largemouth bass and other species by forming dense stands that spread along shorelines and grows in water up to 1.2 m deep (Penfound 1939). Strakosh (2005) provides information that could be used to select candidate reservoirs for water willow establishment based on expected water level fluctuations and could be used to manage water levels in reservoirs where water willow currently exists.

Artificial Habitat Structures

Fisheries managers have enhanced natural structure or built artificial structure in otherwise barren areas to attract fish and improve fishing. Brushpiles, stakebeds, or tire reefs are most often used for this purpose in freshwater. Wege and Anderson (1978) found that growth of adult largemouth bass was higher in ponds containing brush attractors, tire beds or stake beds. They speculated that the structures may have increased growth by creating conditions which facilitated capture of prey, and by improving the conversion of food for growth by the associated reduced physical activity. Prince and Maughan (1979) noted largemouth bass were plentiful around artificial tire reefs in Virginia. Prince et al. (1975) reported that properly constructed artificial structures increased angler success and may result in increased harvest.

A variety of plastic structures designed to imitate aquatic vegetation are also commercially available. In an evaluation of one such product, Mosher (1985) found that structures made from natural materials were more effective in attracting largemouth bass and were much less expensive.

There are potential problems associated with artificial habitat structures. Building them can be time consuming, and they are often bulky and difficult to place within a lake. In addition, because these structures may improve catch rates, the potential for overharvest of bass may be increased in waters where bass stocks are relatively low.

Tournament Fishing

Tournament bass fishermen are an important component of reservoir fisheries in Kansas. Although there are organized tournaments for walleye, channel catfish, crappie, and even white perch, the majority of tournaments and fishing clubs in Kansas are dedicated to the pursuit of largemouth bass.

Tournament organizations were among the first to promote the "catch and release" attitudes common today. Competitive fishing promotes fishing popularity and conservation practices. Large tournament organizations have promoted sport fishing through magazines, newspaper articles, and television shows.

Tournaments directly benefit local economies and KDWP. Visitors attending the 1996 BASS Masters Classic injected an estimated $15.1 million into the Birmingham, AL area (Green 1997). Tournaments in Kansas are significantly smaller, but are able to positively affect local economies through food, fuel, and lodging expenditures. The development and purchase of expensive tackle, boats, and motors and associated equipment is driven by tournament anglers. The majority of excise taxes that support Federal Aid in Sportfish Restoration, the primary funding source for KDWP fisheries programs, are derived from the purchase of these items.

The effects of tournament fishing on bass populations themselves are unknown. There is no evidence suggesting that they have caused stock depletion in any of the state's waters. Conversely, the potential is there for them to significantly affect largemouth bass resources. State agencies across the United States have identified both positive and negative aspects of bass tournaments (Schramm et al. 1991a). The most common complaints voiced by non-competitive anglers are:

1. **Access conflict between tournament and non-competitive anglers.** Large or multiple tournaments, particularly on the larger reservoirs, held at the same access site can tie-up a boat ramp and parking area, making it difficult for other boaters to use the area.

2. **Mortality resulting from tournament events.** Tournament mortality studies (Schramm et al 1987; Gilliland 1997; Weathers and Newman 1997; Wilde 1998) suggest higher delayed mortality rates during warm weather tournaments. Tournament organizers must be aware of potential high mortality rates in the warm summer months and should consider limiting tournament activities during this time.

Tournament Permitting

A fishing tournament, when conducted on KDWP-managed lands and water, requires a special event permit if one of the following conditions exist:

1) an entrance, admission or participation fee is charged
2) food, merchandise, or service is offered for sale
3) the exclusive use of a facility or a specified land or water is required
4) an organized or advertised competition will be conducted
5) sound will be amplified that may disrupt area users
6) temporary structures, other than blinds or common camping equipment, will be erected

Applications for special event permits are available at Department offices. Each application for a special event permit shall be made to the Department not less than five weekdays before the event. The special event permit fee is negotiated based on event type, required services, and lost revenue; the maximum fee is $200. Payment must accompany each application.

KDWP policy regarding tournament fishing.

1. At their present level, competitive fishing events are a legitimate use of the resource and no special regulations or use restrictions should be required. Most tournament organizers impose regulations which are often more restrictive than the KDWP's. Bass anglers, and in particular bass tournament fishermen, are highly visible users but represent a small percentage of the total anglers in the state. There is little information nationwide documenting the effects of tournament fishing on bass resources. Although there is the potential for high mortality rates in the warm summer months, there is no evidence suggesting competitive fishing on its own has or is leading to depletion of adult bass in Kansas waters.

2. Continue to promote, develop, and utilize the Bass Tournament Monitoring program. This program lets bass anglers know that KDWP is committed to a partnership with them to preserve and enhance the bass resources in the state. By maintaining this policy of open communication, KDWP will continue to encourage clubs to participate. Working with the Kansas B.A.S.S. Chapter Federation to encourage support by its clubs, the annual report summarizing catch data can be used by participating clubs in selection waters for future tournaments.

3. Continue to promote the live release of tournament caught bass. Tournament anglers have the right to keep (harvest) fish under the same regulations as non-competitive anglers. To conserve the resource, nearly all clubs and tournament organizations require the live release of all bass by participants. Proper organizational procedures can help reduce catch and release mortality (Weathers and Newman 1997; Gilliland and Schramm 2002), and KDWP will continue to provide information which educates competitive anglers on the best methods and procedures that enhance fish survival upon release.

4. Maintain open communications with competitive fishing organizations and clubs. The direct involvement of KDWP can enhance the Agency's visibility to this user

group. Competitive anglers can be extremely valuable allies to KDWP as they are generally well organized and dedicated to promoting sportfishing and conservation practices. Continued involvement will open the door to further data collection opportunities and enhance an atmosphere for greater understanding and communication between resource stakeholders (Schramm et al. 1991b; Schultz 2003). In addition, sampling bass tournaments directly has proven to be an extremely inexpensive way of monitoring population densities and structures of adult bass populations on our larger lakes (Jacobs et al. 1995).

Harvest Regulation Exemptions

In the past, organized bass tournament anglers have petitioned the Department for exemptions from or modifications to existing length and creel limits. Such requests were controversial (Guy et al. 1999). They placed the Department in the uncomfortable position of having to choose whether it should give a particular user group (tournament bass anglers) what some might consider special privileges. To determine the opinions of Kansas anglers about competitive fishing in general, the 1987 Kansas licensed angler survey (Schultz 1995) asked five questions that dealt with that topic. In all instances, most respondents (mean=43.8%) were neutral in their support or opposition to competitive fishing events. Only the question asking for opinions on for-profit enterprises had more respondents opposing (41.4 %) than those supporting it (12.1%) (Table 4).

Table 4. Percent of 1987 Kansas resident licensed anglers supporting and opposing various types of competitive fishing events. Survey response rate was 58% (5,135 individuals) (Schultz 1995).

Event type	No Response	Strongly Oppose	Oppose	Neutral	Support	Strongly Support
Local club Tournaments	5.0	2.9	3.9	43.3	33.9	11.0
Non-profit Fishing Derbies	5.8	2.2	3.4	42.6	35.3	10.6
Business promotion of Tournaments	6.1	5.6	9.5	45.7	26.6	6.4
Professional angler circuits	6.0	7.3	9.5	47.2	22.8	7.3
For- profit enterprises	6.3	19.0	22.4	40.4	9.1	3.0

In 1995, the Kansas B.A.S.S. Chapter Federation requested an exemption to the 18-inch minimum length limit for largemouth bass on reservoirs where their tournaments would be held. The Department anticipated a possible sociological problem because the requested exemption would only apply to tournament anglers. Therefore, a survey was conducted (Guy et al. 1999) to determine the attitudes of resident largemouth bass anglers (in sporting clubs and not affiliated with a sporting club) and general anglers (not targeting largemouth bass or in sporting clubs) with respect to special exemptions for tournament anglers. The survey concluded that Kansas anglers approve of largemouth bass tournaments on Kansas reservoirs. However, they found that the majority (>60%) of Kansas anglers (club, non-club, and general) did not believe that competitive fishing tournaments for largemouth bass should receive special exemptions to the current harvest regulations.

The current statewide creel limit on black bass is 5/day. However, beginning in 2007 an experimental regulation (known as Bass Pass) was enacted that allows participants in registered bass tournaments – held between Sept. 1st and June 15th - to possess two bass that meet the statewide minimum length limit but are under the special length limit for the body of water at which the tournament is being held. The two fish that would have previously been illegal to possess must be released immediately after the tournament.

The Bass Pass was designed to allow competitive bass anglers to conduct tournaments on lakes with high minimum length limits and to keep them from running afoul of the State's possession limits. A Bass Pass allows an angler to continue to fish with a full creel. If they catch a larger fish than one already in possession, they can release and replace it with the larger fish.

Current data (Stephen 2004) suggests that tournament anglers seldom catch more than five bass longer than 15 inches.

Tournament Catch Information

KDWP recognizes that competitive fishing events are legitimate recreational activities. Data submitted by tournament directors has been compiled by the Department since 1977 (Willis and Hartmann 1986). This information has been collected at little expense to the agency and has proven useful to assess the size structure and density of largemouth bass populations. These data have also been used to monitor statewide trends in largemouth bass populations, to document population trends in individual impoundments, and to evaluate the effects of management (Appendix G).

The higher the sum of individual event catches, the more reliable any catch statistic computed. The Department therefore encourages as high of voluntary participation in our monitoring program as possible.

Currently, there are three ways of reporting tournament catch information. It can be submitted electronically via the tournament catch report form on the KDWP web site, the back of the beginning page of the special event application has a report form that can copied and mailed to the suggested address, or a standard reporting booklet can be used. The booklet can be mailed to angling groups upon request.

While tournament catch information can be useful in making fishery management decisions, it should not be taken at face value. Gabelhouse and Willis (1986) found that tournament bass anglers, non-tournament bass anglers and non-bass anglers each caught different sizes of largemouth bass in different proportions and different rates (fish/ angler hr.).

BASS MANAGEMENT IN SMALL IMPOUNDMENTS

In addition to the 24 federal reservoirs in the state, the KDWP manages approximately 40 State Fishing Lakes (SFL's) and nearly 250 community lakes and other small waters, ranging from less than 1 acre to 1,200 acres. These waters that can be classified as a pond or a small reservoir, depending on the size, are collectively grouped as small impoundments and are managed with different guidelines than the larger reservoirs. There are several factors which vary greatly between reservoirs and small impoundments and each should be considered when formulating an appropriate management plan.

In general, the management objectives regarding largemouth bass in the state's small impoundments include (1) Provide a healthy largemouth bass population using length and creel limits to prevent overharvest, (2) Maintain a largemouth bass density sufficient to control bluegill, crappie, and other fish species which may easily become overpopulated, and (3) In rare instances, manage the largemouth bass population to provide a trophy fishery.

Properly managed small impoundments in Kansas should experience greater fishing pressure, higher catch rates, and higher yield than reservoirs by surface acre. Appendix B summarizes creel data from Kansas SFL's from 1995 to 2005. Anglers fishing reservoirs harvested, on average, < 0.5 fish/acre. In SFL's, the average was between 1and 3 fish/acre, and community lakes averaged 0 to 1 fish/acre. One thing to note with the community lakes is that many are managed with stricter regulations which lead to reduced harvest rates.

Mosher (1991) reported the effects of a 15-inch MLL and a 12-15 inch SLL on Kansas SFL's. Both regulations helped to decrease harvest and increase the total number of largemouth bass, but in some instances, the fish were too well protected and growth rates slowed. Increasing the slot limit to 13-17" was suggested as a method to increase harvest of fish under the slot limit, while still protecting a significant portion of the population. The current recommended SLL of 13-18" is offered as a good management option for small impoundments where some harvest is desired while also protecting a significant portion of the population when good recruitment is realized (Mosher 2002). New or renovated lakes should install an 18-inch MLL to allow moderate to high numbers of intermediate size fish to develop before switching to a SLL or 15-inch MLL (Mosher 2002). Refer to the Length Limits section for more information on selecting the proper length limit.

New or recently renovated small impoundments will benefit most from a stocking schedule to include largemouth bass, bluegill, channel catfish, and fathead minnows. Redear sunfish may also be included if habitat conditions are sufficient, and larger impoundments (> 100 acres) can function well with the addition of saugeye, wipers, or crappie. Most small impoundments less than 30 acres, however, are best managed with a more basic species composition.

Largemouth bass are generally stocked in new or renovated lakes following the stocking of other species. One suggested plan is to stock 500 bluegill fingerlings/acre during the fall and100 largemouth bass fingerlings/acre the following spring. Another option which will yield quicker returns to the angler would include the stocking of 25 adult bluegill per acre during the fall and 10 intermediate largemouth bass per acre the following year. Most SFL's and other small impoundments are able to adequately maintain healthy largemouth bass numbers when overharvest is kept in check and supplemental bass stocking is not necessary.

BASS MANAGEMENT IN PONDS

While the bulk of Kansas' approximately 100,000 ponds are privately owned, they offer some of the best fishing the state has to offer. However, improperly managed ponds can result in some of the worst fishing. KDWP has published a booklet *Producing Fish and Wildlife in Kansas Ponds***.** This publication provides pond owners and anglers with information to effectively manage fish and wildlife resources associated with ponds.

Due to lack of resources and manpower constraints, KDWP biologists are encouraged to provide technical assistance but must use their own discretion when it comes to assisting private pond owners with population sampling and other management activities. The Natural Resources Conservation Service (NRCS) and Kansas State University can also provide technical assistance to landowners for various conservation practices.

RESEARCH / RESOURCE NEEDS

Research Needs

1) Evaluate the effectiveness of supplemental stocking early spawned largemouth bass in Kansas reservoir to supplement natural recruitment and enhance year class abundance.

Need: Supplemental stocking of largemouth bass in Kansas reservoirs has been unsuccessful. The literature suggests that bass spawned early in the season grow larger and are more likely to recruit to Age-1 (Miranda and Muncy 1987; Miranda and Hubbard 1994; Phillips et al. 1995; Pine et al. 2000)

Objective: To evaluate the survival of early-spawned largemouth bass and their ability to meaningfully enhance year classes in Kansas reservoirs. Evaluate whether use of wild captured adult bass is preferable to using hatchery broodstock. Determine whether stocking early- spawned bass is logistically and economically feasible.

2). Evaluate the effectiveness of stocking triploid hybrid largemouth bass (Northern strain *Micropterus salmoides salmoides)* X Florida strain *M.s. floridanus*) to provide larger largemouth bass in select Kansas waters.

Need: Kansas bass anglers have expressed a desire to catch bigger largemouth bass. The Florida strain has been shown to generally produce larger fish (Forshage and Fries 1995). However, Florida strain largemouth bass have been shown to adapt poorly to low temperatures found in northern waters and experience high rates of mortality. (Childers 1975). By introducing triploid hybrids the risk of introducing Florida strain alleles into the wild population will be minimized.

Objective: To evaluate the survival and growth of triploid hybrid largemouth bass and determine their ability to increase the number of larger individuals present in Kansas lakes and reservoirs.

3) Determine whether largemouth bass virus (LMBV) is present in Kansas bass populations.

Need: LMBV is the only virus known to cause a lethal disease in largemouth bass. The disease usually occurs during the summer and typically affects adult fish (Grizzle and Brunner 2003). It is unknown whether LMBV is present in Kansas' largemouth bass populations.

Objective: To determine whether LMBV is present in wild largemouth bass populations in Kansas.

Resource Needs

1) **Develop hatchery facilities needed to consistently produce largemouth bass in sufficient numbers to meet yearly stocking demands.**

Need: Current hatchery facilities used for largemouth bass production are of insufficient size and are subject to inconsistent annual production. Facilities to intensively culture bass would improve both the quantity and quality of largemouth bass produced.

Objective: To increase the efficiency of largemouth bass fry and fingerling production. To produce a more consistent supply of largemouth bass.

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Appendix A. Spring electrofishing CPUE (Fish/Hr) for largemouth bass ≥ 8-in TL from Kansas Reservoirs from 2001 to 2005. Lake names in bold print have an 18-in or larger MLL.* = No electrofishing sample collected. (Data taken from KDWP ADAS archives)

Lake	2001 (Hr)	2002 (Hr)	2003 (Hr)	2004 (Hr)	2005 (Hr)
Big Hill	34 (3.0)	38 (1.9)	30 (3.0)	34 (3.1)	13 (4.4)
Cedar Bluff	58 (7.0)	56 (6.4)	42 (7.0)	25 (6.5)	17 (6.0)
Cheney	*	*	*	*	*
Clinton	3 (4.5)	9 (6.4)	15 (7.0)	7 (6.7)	6 (7.4)
Council Grove	*	*	*	*	*
El Dorado	10 (2.9)	15 (1.0)	6 (2.6)	14 (3.1)	14 (3.7)
Elk City	*	*	*	*	*
Fall River	21 (0.7)	30 (0.2)	33 (0.7)	31 (0.5)	*
Glen Elder	1 (3.5)	3 (3.1)	3 (0.8)	*	1 (1.9)
Hillsdale	12 (3.5)	13 (6.4)	31 (2.7)	24 (5.0)	25 (3.1)
John Redmond	*	*	*	*	*
Kanopolis	*	*	*	8 (1.0)	*
Kirwin	11 (2.4)	29 (0.7)	10 (3.0)	5 (3.8)	*
LaCygne	70 (1.3)	53 (1.9)	78 (1.4)	55 (1.4)	59 (1.8)
Lovewell	*	*	*	*	5 (2.9)
Marion	*	*	*	*	*
Melvern	33 (0.9)	18 (1.4)	12 (2.4)	14 (2.5)	15 (1.4)
Milford	1 (1.7)	6 (13.9)	(8.6)	3 (10.3)	9 (3.4)
Perry	6 (6.8)	9 (7.9)	11 (7.3)	8 (8.3)	10 (13.3)
Sebelius	111 (3.2)	171 (1.9)	59 (3.4)	36 (4.3)	19 (4.3)
Toronto	29 (1.0)	53 (1.3)	22 (0.6)	63 (0.7)	*
Tuttle Creek	*	9 (2.9)	7 (4.3)	*	*
Webster	32 (2.8)	80 (1.5)	27 (3.6)	4 (3.2)	*
Wilson	12 (5.8)	10 (3.2)	4 (3.1)	2 (2.0)	29 (2.0)

Appendix B. Spring electrofishing CPUE (Fish/Hr) for largemouth bass ≥ 8-in TL from Kansas State Fishing Lakes from 2001 to 2005. Lake names in bold print have an 18-in MLL. Lake names in italics have a 13-18 in SLL. * = No electrofishing sample collected (Data taken from KDWP ADAS archives).

Lake	2001 (Hr)	2002 (Hr)	2003 (Hr)	2004 (Hr)	2005 (Hr)
Atchison SFL	200 (1.1)	120 (1.6)	150 (1.2)	176 (1.0)	240 (1.0)
Barber- Lower SFL	*	*	48 (0.7)	36 (0.8)	85 (0.7)
Barber- Upper SFL	*	*	*	*	*
Black Kettle SFL	*	*	40 (0.5)	40 (0.7)	24 (0.7)
Bourbon SFL	*	28 (2.9)	50 (1.5)	91 (1.1)	75 (0.8)
Brown SFL	150 (1.3)	148 (0.8)	155 (1.1)	133 (1.1)	149 (1.1)
Butler SFL	115 (1.4)	*	98 (1.0)	165 (0.6)	178 (0.8)
Chase SFL	34 (1.0)	*	18 (1.0)	28 (1.0)	29 (1.5)
Clark SFL	*	*	79 (2.5)	84 (1.7)	101 (1.0)
Concannon SFL	*	*	*	*	*
Cowley SFL	93 (1.0)	141 (1.0)	75 (1.1)	138 (0.6)	131 (1.3)
Crawford SFL	74 (2.1)	119 (1.8)	65 (2.4)	33 (3.8)	25 (2.8)
Douglas SFL	58 (1.9)	*	46 (1.6)	*	*
Finney SFL	*	*	*	*	*
Ford SFL	*	*	64 (0.7)	83 (0.5)	91 (0.3)
Geary SFL	19 (4.5)	39 (3.3)	46 (2.2)	21 (2.6)	20 (3.1)
Goodman SFL	*	*	20 (0.6)	*	35 (0.4)
Hain SFL	*	*	*	*	*
Hamilton SFL	*	*	*	*	*
Hodgeman SFL	*	*	*	*	*
Jewell SFL	23 (2.6)	24 (0.7)	47 (1.0)	12 (0.4)	*
Kingman SFL	153 (1.0)	83 (1.5)	46 (2.2)	50 (2.0)	67 (1.7)
Kiowa SFL	*	*	40 (0.5)	32 (0.3)	88 (0.3)
Leavenworth SFL	158 (1.7)	159 (2.1)	183 (2.3)	128 (1.3)	136 (1.7)
Lyon SFL	*	*	*	69 (0.5)	202 (0.5)
McPherson SFL	75 (1.7)	81 (1.5)	165 (1.0)	83 (2.0)	67 (1.0)
Meade SFL	*	*	63 (0.5)	78 (1.1)	120 (0.5)
Miami SFL	*	22 (1.2)	36 (0.9)	14 (1.4)	168 (1.6)
Middle Creek SFL	46 (1.5)	32 (1.6)	35 (1.7)	52 (0.9)	41 (1.2)
Montgomery SFL	78 (2.3)	121 (1.9)	46 (1.4)	82 (1.6)	32 (3.1)
Nebo SFL	55 (1.3)	48 (1.2)	48 (1.0)	77 (1.1)	79 (1.1)
Neosho SFL	71 (2.3)	162 (1.0)	52 (3.3)	124 (0.8)	78 (1.5)
Osage SFL	74 (0.7)	70 (1.2)	94 (0.7)	35 (1.1)	32 (0.9)
Ottawa SFL	74 (1.5)	67 (1.4)	34 (1.3)	50 (2.3)	*
Pott SFL #1	90 (1.0)	96 (0.9)	116 (0.8)	212 (0.5)	245 (0.6)
Pott SFL #2	109 (1.0)	71 (1.0)	91 (0.9)	66 (1.0)	60 (1.0)
Rooks	48 (0.3)	*	*	*	*
Saline SFL	*	*	*	*	*
Scott SFL	*	*	80 (1.4)	44 (1.9)	132 (0.7)
Shawnee SFL	90 (1.0)	93 (1.2)	77 (1.0)	83 (1.0)	91 (1.0)
Sheridan SFL	180 (0.5)	164 (0.5)	109 (1.0)	112 (0.5)	153 (1.0)
Washington SFL	64 (1.1)	11 (3.0)	24 (1.8)	10 (2.4)	*
Wilson SFL	50 (1.4)	62 (0.7)	167 (0.4)	91 (0.8)	36 (1.9)
Woodson SFL	*	95 (0.8)	110 (0.5)	44 (0.7)	43 (1.0)

Appendix C. Scoring sheet used to determine priorities for stocking largemouth bass in Kansas waters.

LARGEMOUTH BASS STOCKING SCORE SHEET

Region __________ Lake __________________________ Date ____________Size Requested __________

LARGEMOUTH BASS RANKING CRITERIA

1. Governing body charges fees (in addition to State Fishing License) for angling in this water body

A. Yes – Skip to **LARGEMOUTH BASS TOTAL SCORE** and enter a **ZERO (0)**
B. No – Proceed to question #2

2. Age of Lake (maximum of 15 pts)

A. New or Renovated (15 pts)
B. Old Lake (5 pts) ___________

3. Ownership of Lake (maximum of 5 pts)

A. State or Federal (5 pts)
B. Local Government/ C.F.A.P. (3 pts) ___________

4. Management Considerations (maximum 15 pts) *CHOOSE ONE*

A. Special Project (15 pts)
B. Improve Predator/Prey (10 pts)
C. Trophy Regulations (5 pts)
D. No Special Management (0 pts) ___________

5. Habitat (maximum 30 pts) *TOTAL OF A & B*

A. Water Clarity (mean annual Secchi)

1. > 2ft. (15 pts)
2. 1-2 ft (10 pts)
3. < l ft. (0 pts)

B. Structure (Standing timber, Aquatic Vegetation, etc)

1. "Good" structure (15 pts)
2. Some Structure (8 pts)
3. Little or No Structure (0 pts) __________

6. Population Dynamics (maximum 10 pts) *TOTAL OF A & B*

A. Bass Population Condition (Mean Wr of S-Q LMB)

1. >95 (5 pts)
2. 80 – 95 (3 pts)
3. < 80 (0 pts)

B. Bass Population Density (# Bass/ hr. electrofishing)

1. <35 (5 pts)
2. ≥35 (0 pts) __________

7. LMB Stockings – Historical Success (maximum 10 pts)

A. Good Success (10 pts)
B. Moderate Success (5 pts)
C. Poor or No Success (0 pts) __________

8. Last LMB Stocking (maximum 5 pts)

A. Introductory Stocking (5 pts)
B. > 3 yrs (3 pts)
C. 2 – 3 yrs (2 pts)
D. Last year (0 pts) __________

9. Public Interest as reflected by creel census (maximum 10 pts)

A. High (10 pts)
B. Moderate (5 pts)
C. Little or Unknown (0 pts) __________

LARGEMOUTH BASS TOTAL SCORE __________

(maximum 100 pts)

Appendix D. Creel census estimates of the number of largemouth bass harvested and released (Mar. – Oct) per acre from Kansas reservoirs between 1995 and 2005. Lake names in bold print have an 18-in. or larger MLL. (Data taken from annual Federal Aid reports)

Lake	Year (s) Censused	# Harvested/Acre	(mean)	# Released/Acre	(mean)
Big Hill	2002, 1997, 1995	0.27, 0.01, 0.04	(0.10)	18.21, 13.8, 9.66	(13.89)
Cedar Bluff	2003, 2002, 2000, 1998, 1996	0.2, 0.14, 0.55, 0.02, t	(0.18)	5.54, 3.29, 10.78, 3.4, 0.59, 0.55	(4.83)
Cheney	2002, 1997, 1996, 1995	0, 0, 0.01, t	(t)	0, 0.02, 0.03, 0.01	(0.02)
Clinton	2003, 1998, 1996	0, 0.06, 0.03	(0.03)	0.26, 0.11, 0.73	(0.37)
Council Grove	1999	0		0.04	
El Dorado	1998	0.08		0.09	
Fall River	2003	0		0.15	
Glen Elder	2004, 1998, 1997, 1996	t, 0.03, t, t	(0.01)	0.18, 0.10, 0.03, 0.03, 0.09	(0.11)
Hillsdale	2004, 2002, 1999, 1995	0.02, 0.04, 0.08, 0.04	(0.04)	4.12, 0.62, 1.61	(2.12)
Kanopolis	2004, 1999	0, t	(t)	0, 0.02	(0.01)
Kirwin	2005, 2000, 1997, 1996, 1995	0, 0.02, 0.06, 0.47, 0.05	(0.12)	0, 1.06, 2.05, 2.09, 1.07	(1.25)
LaCygne	2005, 2000, 1999, 1998	0.09, 0.27, 0.43, 1.61	(0.60)	1.15, 0.72, 1.0, 6.21	(2.27)
Lovewell	2005, 1999, 1995	0.01, 0, 0	(t)	0.06, 0.01, 0	(0.02)
Marion	2001, 1997, 1996, 1995	t, 0.02, 0.02, 0.03	(0.01)	0.27, 0.21, 0.04, 0.40	(0.23)
Melvern	2005, 2004, 2003, 2002, 2001, 2000, 1999	t, 0.01, 0.01, 0, t, t, t	(t)	0.57, 0.35, 0.59, 0.66, 0.17, 0.32, 0.2	(0.41)
Milford	2005, 2000, 1997, 1996	t, 0.01, 0.07, 0.09	(0.04)	0.30, 0.34, 0.04, 0.04	(0.18)
Perry	2004, 2001, 1998	0, t, 0.02	(t)	0.05, 0.01, 0.22	(0.09)
Sebelius	2005, 2003, 1999, 1995	0.09, 0.77, 0.45, 0.34	(0.41)	0.61, 21.04, 19.91, 17.39	(14.74)
Toronto	2002	0		0.03	
Tuttle Creek	None				
Webster	2002, 1997, 1996	0.04, 0.05, 0.76	(0.28)	0.79, 1.23, 1.32	(1.11)
Wilson	2001, 1998, 1997, 1996, 1995	0.01, 0.17, 0.12, 0.01, 0.08	(0.07)	0.42, 0.47, 0.57, 0.59, 0.47	(0.50)

Appendix E. Creel census estimates of the number of largemouth bass harvested and released (Mar.-Oct.) per acre from Kansas State Fishing Lakes between 1995 and 2005. Lake names in bold print have an 18-in MLL. Lake names in italics have a 13-18 in SLL. (Data taken from annual Federal Aid reports)

Lake	Year (s) Censused	# Harvested/Acre (mean)	# Released/Acre (mean)
Atchison SFL	2001, 1996	1.94, 6.12 (4.03)	69.41, 111.74 (90.58)
Barber- Lower SFL	None		
Barber- Upper SFL	None		
Black Kettle SFL	None		
Bourbon SFL	2004, 1996	3.8, 1.71 (2.75)	54.73, 17.19 (35.96)
Brown SFL	2004, 1999	2.08, 1.47 (1.77)	30.9, 169.27 (100.09)
Butler SFL	2003, 1995	3.79, 0.81 (2.30)	46.6, 1.87 (24.24)
Chase SFL	1997	0.66	6.13
Clark SFL	None		
Concannon SFL	1997	1.68	2.07
Cowley SFL	2000, 1996	1.18, 1.1 (1.14)	14.86, 24.94 (19.90)
Crawford SFL	2000, 1999, 1997, 1996, 1995	1.81, 0.16, 0.13, 1.57, 12.27 (3.18)	15.73, 33.89, 25.03, 23.15, 27.95, 20.5 (29.25)
Douglas SFL	1997	0.14	1.86
Finney SFL	None		
Ford SFL	1998, 1995	3.3, 7.72 (5.51)	45.03, 255.35 (150.19)
Geary SFL	2001, 1995	2.44, 1.33 (1.88)	20.36, 2.4 (11.38)
Goodman SFL	None		
Hain SFL	None		
Hamilton SFL	None		
Hodgeman SFL	None		
Jewell SFL	2001, 1996	2.42, 2.14 (2.28)	9.05, 36.93 (22.99)
Kingman SFL	1999	2.16	101.11
Kiowa SFL	1997	0.62	10.1
Leavenworth SFL	2000, 1997	0.84, 4.08 (2.46)	167.72, 377.79 (270.26)
Lyon SFL	1997	0.48	3.36
McPherson SFL	1997	3.26	43.63
Meade SFL	1996	32.55	32.65
Miami SFL	2005	1.12	30.17
Middle Creek SFL	2003, 1998	0.83	17.1, 12.49 (14.80)
Montgomery SFL	1999	11.5	36.23
Nebo SFL	2002	0	13.24
Neosho SFL	2003	0.92	41.57
Osage SFL	2005, 1998	0.62, 0.07 (0.35)	19.93, 17.36 (18.65)
Ottawa SFL	1999	1.32	9.05
Pott SFL #1	2000	5.9	76.36
Pott SFL #2	2004	0.17	9.98, 49.19 (29.59)

Appendix E. (Continued)

Rooks	None		
Saline SFL	2001	0	0.95
Scott SFL	1996	2.07	41.97
Shawnee SFL	2003, 1996	2.26, 0.56 (1.41)	8.2, 10.56 (9.38)
Sheridan SFL	2000	0.24	9.27
Washington SFL	1997	7.72	2.46
Wilson SFL	1996	2.78	35.06
Woodson SFL	1999, 1995	2.92, 0.62 (1.77)	23.53, 23.12 (24.33)

Appendix F. Creel census estimates of the number of largemouth bass harvested and released (Mar. – Oct.) per acre from Kansas Community Lakes between 1995 and 2005. (Data take from Federal Aid reports)

Lake	**Year(s) Censused**	**# Harvested/Acre (mean)**	**# Released/ Acre (mean)**
Bone Creek Reservoir	2005, 2000, 1999	2.3, 0.01, 0.06 (0.79)	36.17, 19.75, 52.21 (36.04)
Carbondale City Lake	1998	0	1.67
Centralia City Lake	2000	0.1	7.48
Eskridge - Lake Wabaunsee	2001	0.5	1.74
Eureka City Lake	1999	0.09	7.83
Fort Scott City Lake	1999	0.08	10.88
Governor's Cedar Lake	1996	12	325
Governor's Pond	1996	9	27
Great Bend - Memorial Park	1997	6.38	59.46
Gridley City Lake	1998	0	82.88
Herrington City Lake - New	1999	0.15	0.15
Herrington City Lake - Old	1999	0.4	1.00
Holton - Banner Creek	2002, 1999	0, 0.25 (0.12)	33.96, 34.83 (34.40)
Jeffrey Energy Center - Auxillary	1999	0.33	0.64
Jeffrey Energy Center - Makeup	1999	0.3	5.56
Sedgwick Co. - Lake Afton	1996	0.57	4.77
Lake Shawnee	2002	0.1	38.7
Lebo City Lake	2002	0	39.59
Marion Co. Lake	1997	0.93	7.66
Mound City Lake	2001	3.3	5.56
Pleasanton -East	2004, 1997	0, 0.28 (0.14)	4.97, 3.2 (8.17)
Pleasanton -West	2004	0	67.87
Sabetha - Pony Creek	2003, 1997	1.3, 0.42 (0.86)	77.35, 18.07 (47.71)
Salina - Lakewood	2002, 1995	1.9, 3.17 (2.53)	1.8, 107.67 (54.74)
Sherman Co. - Smoky Garden	2003	1.91	29.27
Topeka - West Lake	1997	4	2.68
Wichita - KDOT East	1997	0	3.00
Wichita - KDOT West	1997	0.67	104.9
Wichita - Zoo Park	1995	1.52	22.31
Winfield City Lake	2002, 1995	0.3, 0.05 (0.17)	33.96, 0.26 (17.11)
Wyandotte Co. Lake	2005	0.09	10.42

Appendix G. Annual tournament statistics on black bass in Kansas reservoirs, as reported by Kansas bass clubs, 1993-2004 (Data taken from KDWP annual tournament reports by J. Stephen)

Statistic	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	12-year mean	2004 deviation from mean (%)
Tournaments reported	155	143	153	148	170	160	174	149	88	65	53	32	124	-74
Total Angler days	3,815	3,815	3,750	3,139	3,240	3,488	3,442	3,238	2,129	1,609	1,557	572	2,816	-80
Total Angler hours	30,523	30,517	29,998	25,115	25,920	27,902	27,532	25,902	17,029	12,874	12,456	4,572	22,528	-80
Bass over 12 inches	3,887	4,298	6,145	5,467	6,684	7,291	9,106	9,141	7,832	5,202	4,667	1,649	5,947	-72
Pounds of bass over 12 inches	9,496	9,936	12,308	11,350	14,091	15,768	19,111	18,976	15,545	10,247	9,308	3,340	12,456	-73
Mean pounds per bass over 12 inches	2.2	2.0	1.9	2.0	2.1	2.2	2.1	2.2	2.1	2.3	2.1	2.1	2.1	0
Bass over 12 inches per hour	0.13	0.21	0.45	0.28	0.31	0.28	0.31	0.34	0.36	0.31	0.26	0.26	0.29	-11
Pounds of bass over 12 inches per hour	0.31	0.33	0.41	0.45	0.54	0.57	0.69	0.73	0.91	1.25	1.33	0.73	0.69	6
Bass over 20 inches	256	203	171	159	222	210	279	292	170	137	142	61	192	-68
Hours per bass over 20 inches	119	150	175	158	117	133	99	89	100	94	88	68	116	-41
Largest bass (lbs)	8.7	8.8	9.5	7.4	8.1	7.7	8.2	8.8	8.8	7.3	7.7	8.2	8.3	-1