

LOUISIANA DEPARTMENT OF WILDLIFE & FISHERIES



**OFFICE OF FISHERIES
INLAND FISHERIES SECTION**

WATERBODY MANAGEMENT PLAN PART B

LAKE BISTINEAU

**WATERBODY EVALUATION &
RECOMMENDATIONS 2023**

CHRONOLOGY

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WATERBODY EVALUATION

STRATEGY STATEMENT

Recreational

Sportfish species are managed to provide a sustainable population while providing anglers with the opportunity to catch or harvest numbers of fish adequate to maintain angler interest and efforts. Bass anglers are afforded the opportunity to catch an occasional trophy fish through the introduction of Florida Bass (*Micropterus salmoides*).

Commercial

Lake Bistineau does not support large numbers of most rough fish species that normally comprise a commercial fishery. Flathead (*Pylodictis olivaris*) and Channel Catfish (*Ictalurus punctatus*) are present in good numbers in the lake and are managed for their recreational value.

Species of Special Concern

No threatened or endangered fish species are found in Lake Bistineau.

EXISTING HARVEST REGULATIONS

Recreational

Statewide regulations have been in effect for all species since impoundment. The recreational fishing regulations may be viewed at the link below:

<http://www.wlf.louisiana.gov/regulations>

Commercial

Use of gill nets, trammel nets, fish seines, and hoop nets are prohibited on Lake Bistineau. The commercial fishing regulations may be viewed at the link below:

<http://www.wlf.louisiana.gov/regulations>

SPECIES EVALUATION

Largemouth Bass

Lake Bistineau has long been popular for recreational fishing activities. Annual aquatic vegetation and leaf litter accumulations throughout the years have led to habitat problems from the buildup of these organic materials on the lakebed. Degraded spawning substrate, poor water quality and reduced angler access have adversely impacted sportfish populations and recreational fishing activities in the lake. Annual drawdowns were conducted on Lake Bistineau from 1966 to 1971 in an effort to control the water hyacinth on the lake. Figure 1 depicts fisheries standing crop estimates from rotenone sampling during the period of 1970 through 2000. Standing crop estimates derived from rotenone sampling during 1970 to 1975 indicate a relatively low production of recreational and forage fishes during this period. It is unclear whether the drawdowns or the habitat problems associated with the overgrowth of

water hyacinth had a greater impact on the fish populations. Standing crop estimates indicated more abundant fish populations beginning in 1975. The drawdown in 1975 could have been an important factor in the dramatic increase in forage production, as aquatic habitats have been shown to improve following drawdowns (Lantz, 1967). Fish populations peaked in 1977 and slowly declined thereafter. Forage fish production increased sharply again following the drawdown in 1983. However, the recreational fish populations did not respond to this increase in forage production, likely due to the decline in habitat on the lake.

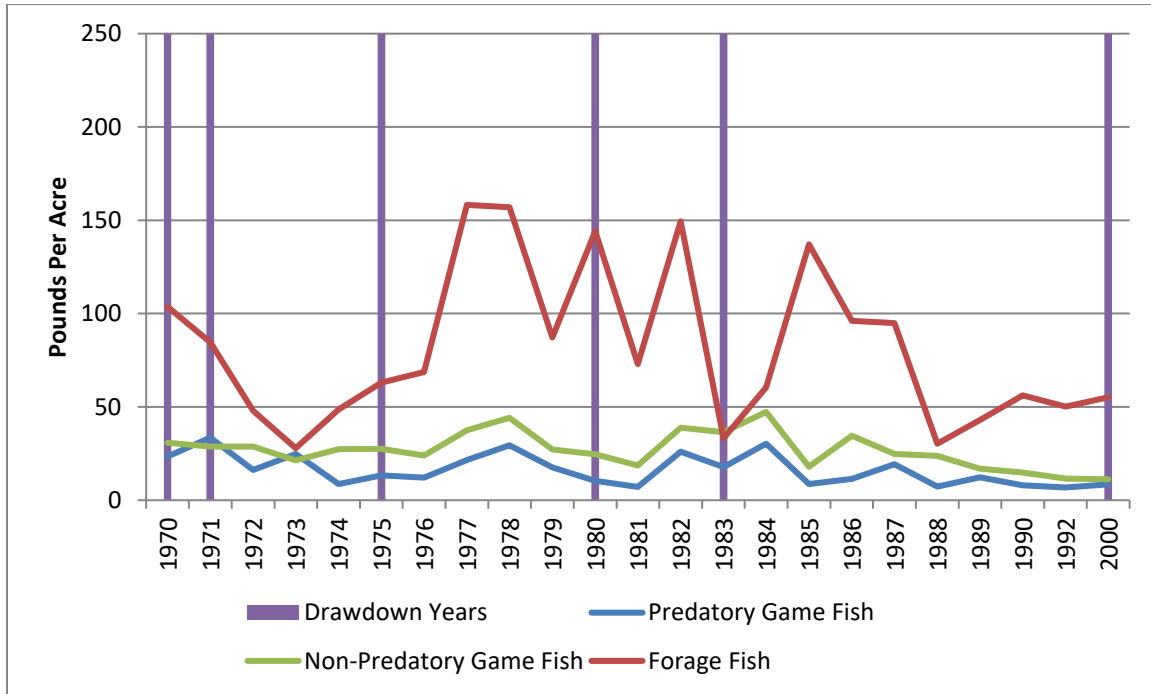


Figure 1. Standing crop estimates of fish production in pounds per acre from Lake Bistineau, Louisiana as determined from rotenone samples taken from 1970 – 2000.

Catch-per-unit-of-effort (CPUE: fish/hr.) trends derived from electrofishing samples indicate that declining habitat quality on Lake Bistineau may have negatively impacted several species of sportfish in the lake, including sunfish, crappies, and bass. The CPUE for quality-size or greater Largemouth Bass (*Micropterus nigricans*)[those $\geq 12''$ in total length (TL)] from spring electrofishing samples is shown in Figure 2. Numbers of quality-size Largemouth Bass collected by electrofishing began a steady decline following the spring of 2000. This trend continued until spring 2006 when their relative abundance began to increase. Figure 3 indicates that the CPUE of stock and sub-stock-size Largemouth Bass from spring electrofishing samples followed a similar trend, with the population rebounding following the drawdowns in 2004 and 2005. The CPUE of Largemouth Bass under 12" TL in the 2012 sample increased greatly from previous years following the extended drawdown from September 2009 through January 2012. Recruitment remained high in the 2013 spring sample as the strong year class from the extended drawdown period grew to stock-size ($\geq 8''$ TL), the substock-size fish ($< 8''$ TL) declined to more normal levels. The 2013 spring sample showed

a significant increase in both quality- (≥ 12 " TL) and preferred-size (≥ 15 " TL) Largemouth Bass.

It is well documented that drawdowns stimulate fisheries production in southern waterbodies. Anecdotal information provided by Lake Bistineau anglers point to increased angling success for several sportfish species following the drawdowns of 2004 and 2005, which were implemented for fisheries habitat improvement. Many anglers reported greater catches of sunfish following these drawdowns, including catching significant numbers of bedding sunfish for the first time in many years. Largemouth Bass and crappie anglers also reported good angling success following the drawdowns. Anglers continue to report increased success as the frequency of mid-summer drawdowns for salvinia control has increased. LDWF sampling results support the angler's reports. When trend lines are applied to spring electrofishing results, Largemouth Bass show a steady increase in CPUE over the last 15 years (Figure 3). Seine haul samples also indicate good reproduction of young-of-the-year (YOY) Largemouth Bass, crappie, and bream following the drawdown years. A similar trend was also noted for Largemouth Bass captured in gill nets (Figure 5).

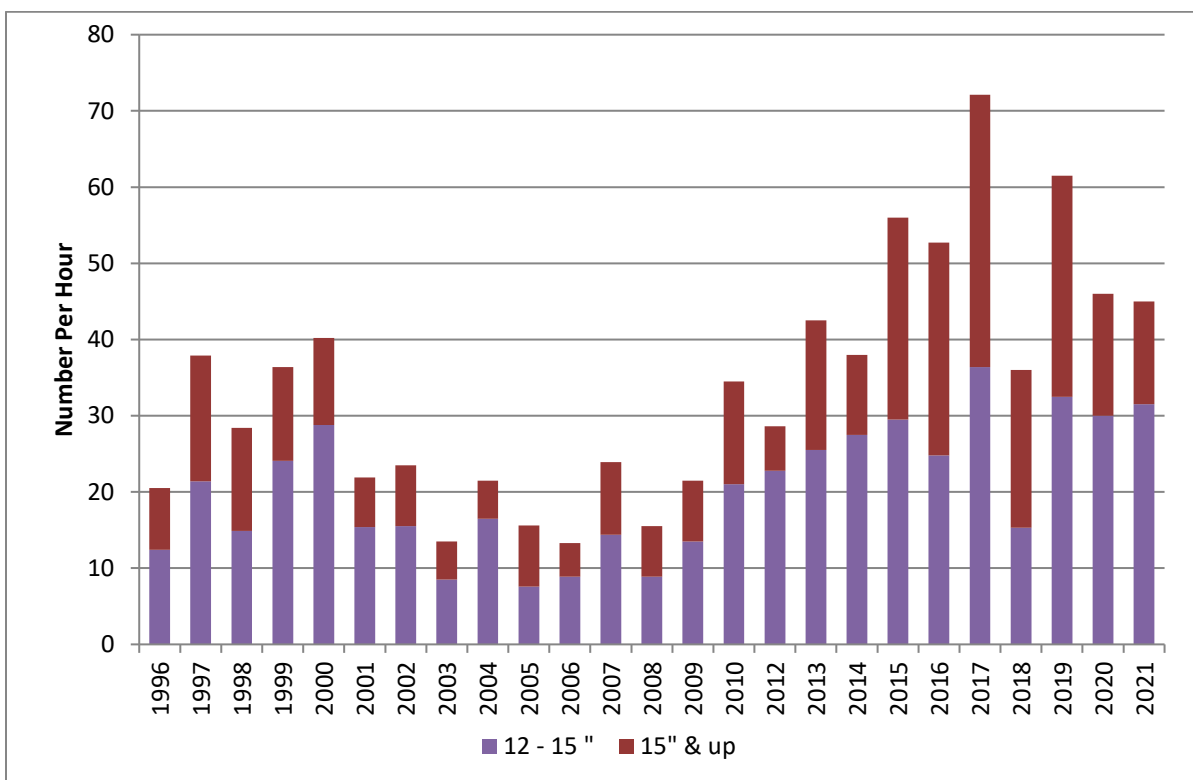


Figure 2. The catch-per-unit-of-effort (CPUE) of quality-size (12-15") and preferred-size or larger (≥ 15 ") Largemouth Bass from Lake Bistineau, Louisiana from 1996 – 2021 spring samples.

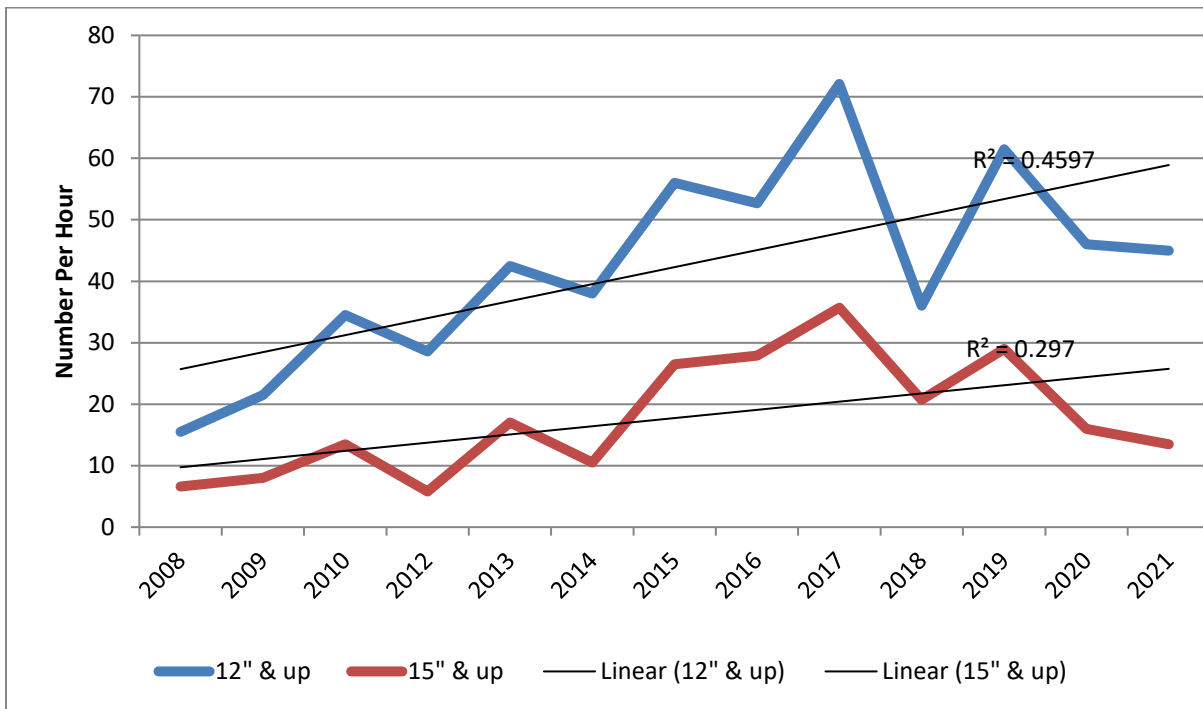


Figure 3. The catch-per-unit-of-effort (CPUE) of quality- size or larger ($\geq 12''$ TL) and preferred-size or larger ($\geq 15''$ TL) Largemouth Bass from Lake Bistineau, Louisiana from 2008--2021 spring samples-post mid-summer drawdown implementation.

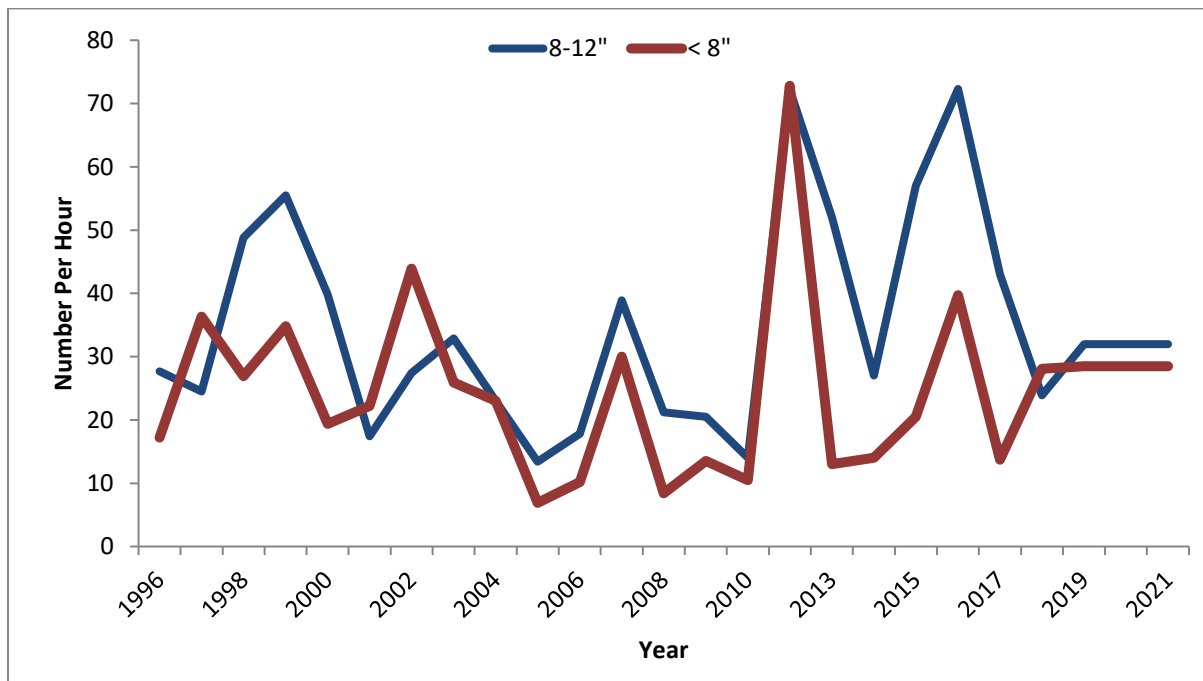


Figure 4. The catch-per-unit-of-effort (CPUE) for stock- (8'' - 12'' TL) and substock-size ($\leq 8''$ TL) Largemouth Bass from Lake Bistineau, Louisiana from 1996 – 2021 spring samples.

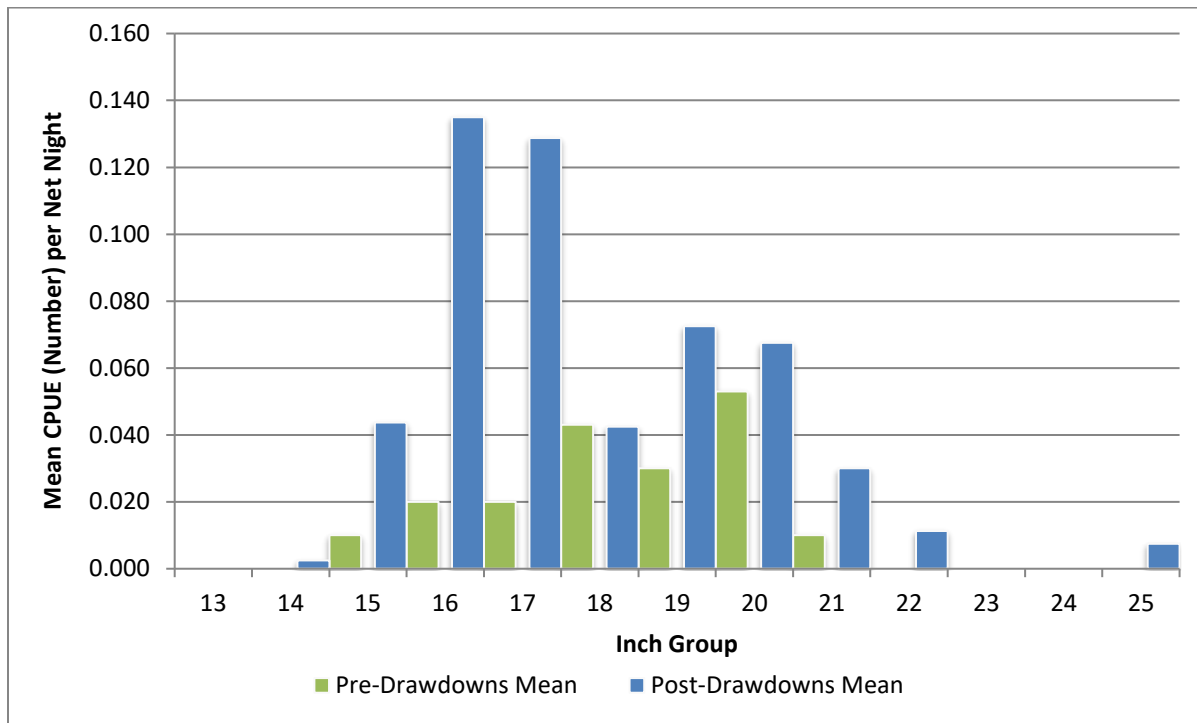


Figure 5. The catch-per-unit-effort (CPUE) for Largemouth Bass from Lake Bistineau, LA, from gillnets for pre-drawdowns (1996, 2004, 2005) and post-drawdowns (2008, 2015, 2017, 2018).

The average catch per seine haul of YOY fish is depicted in Figure 6. Seine sampling conducted from 2001 to 2009 indicates adequate forage in the lake through the 2007 sample. Samples collected in 2009 were likely biased due to giant salvinia (*Salvinia molesta*) coverage present at many of the sample sites. From the observed increase in numbers of individuals captured in 2007, sunfish populations responded well to the 2004 and 2005 drawdowns.

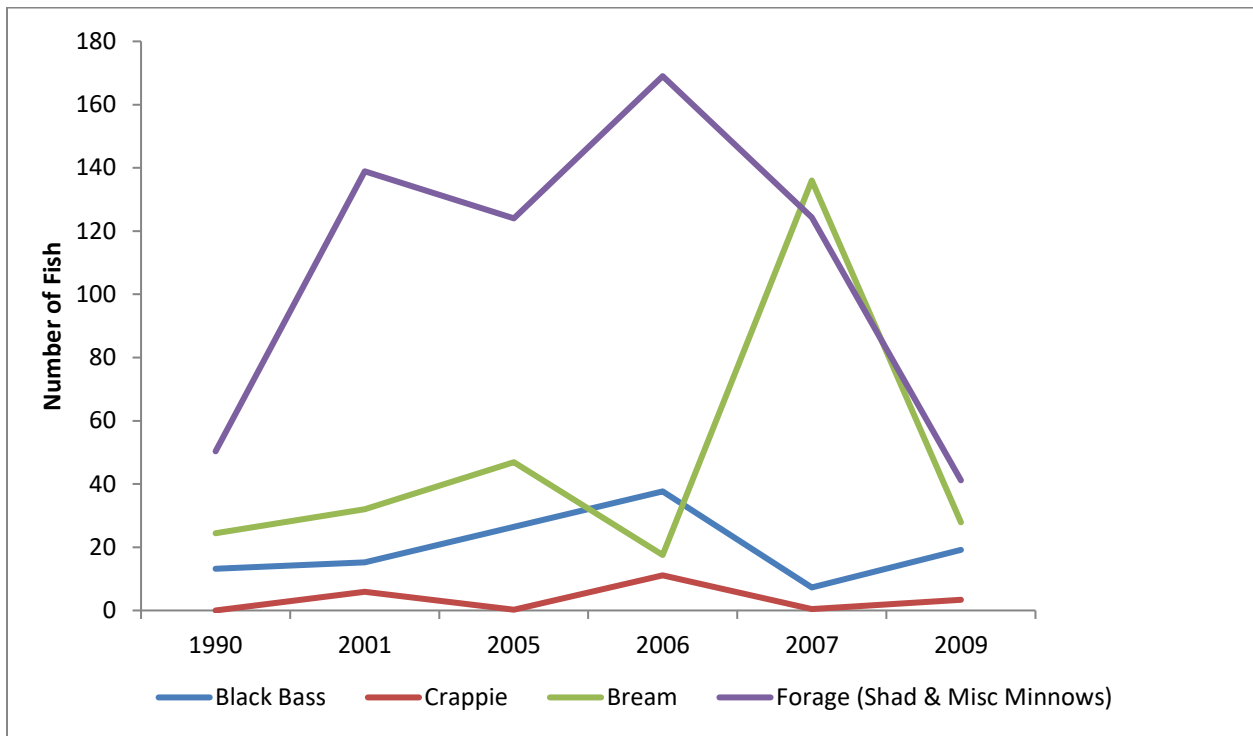


Figure 6. Catch per seine haul of small fish ($\leq 5''$ TL) which included YOY Largemouth Bass, forage species (e.g., shad, minnows), crappie, and bream captured in Lake Bistineau, LA from 1990 – 2009.

Forage fish are those that are available for use as food by predatory fishes. In general, all individuals up to six inches in total length are considered forage fish, particularly when discussing prey items for Largemouth Bass. Community assemblage samples, including forage fish, are collected in conjunction with fall standardized electrofishing samples. Standard procedures for collecting these samples were changed in 2011 in an attempt to get a more representative sample of the entire lake. Prior to this time, samples were only collected at one location each year. Shorter duration samples are now collected at several locations each fall. Community assemblage sampling conducted by electrofishing during the fall season from 2011-2022 resulted in a mean catch of 41.37 pounds per hour of forage fishes. Figure 7 shows the mean number per hour of forage fish species collected for Lake Bistineau from 2011-2022.

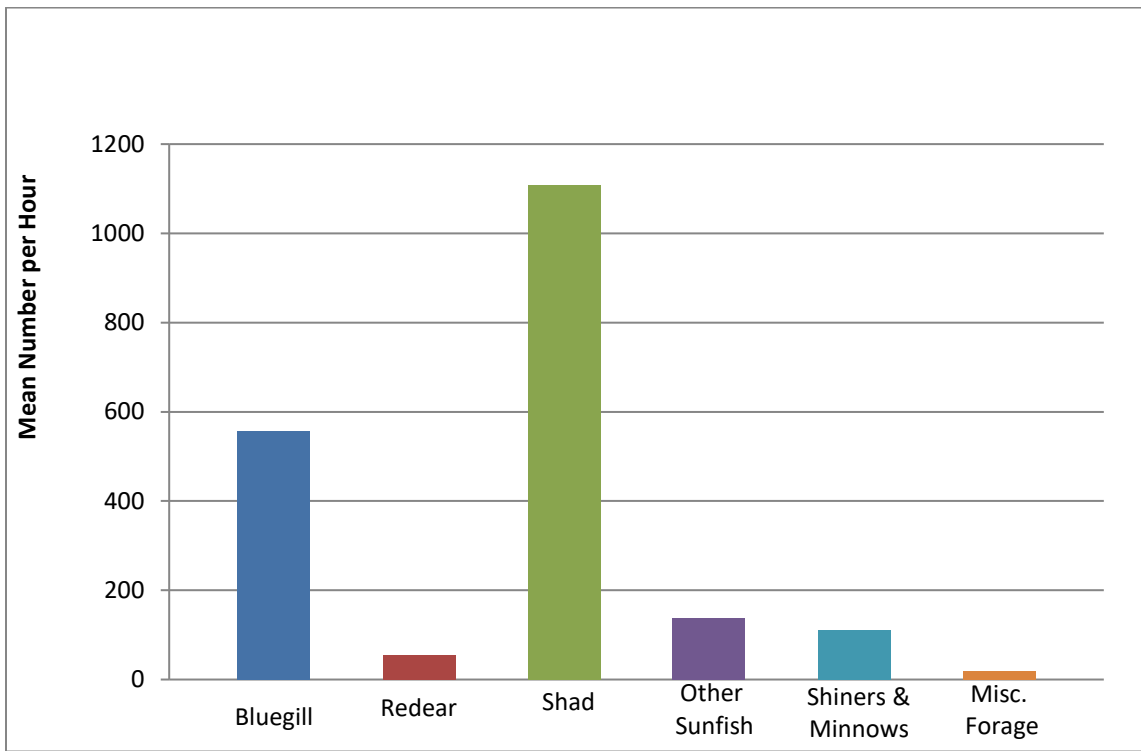


Figure 7. The mean catch-per-unit-of-effort (CPUE) of fishes $\leq 5''$ TL captured in Lake Bistineau, LA, for community assemblage samples from 2011-2022.

Community assemblage sampling results, combined with relative weight (W_r) results for Largemouth Bass, indicate that Lake Bistineau continues to have adequate forage to sustain a healthy fishery. Predation rates on these fishes should be high during drawdown periods. The improvements to bottom habitats and the subsequent increase in spawning activities of all species associated with drawdowns are sufficient to provide ample forage for the predator fish of Lake Bistineau. Figure 8 below shows the change in W_r 's of Largemouth Bass collected from spring electrofishing on Lake Bistineau since the frequency of mid-summer drawdowns has increased. There has been a marked increase in W_r 's of all size Largemouth Bass since 2006, and especially for those sizes sought by anglers (12-20-inches TL). To further illustrate the change that has been observed, the mean W_r for Largemouth Bass 12-20-inches TL collected from fall electrofishing has increased from 96.44% (1990-2003) to 102.82% of the normal or standard weight (2006-2022).

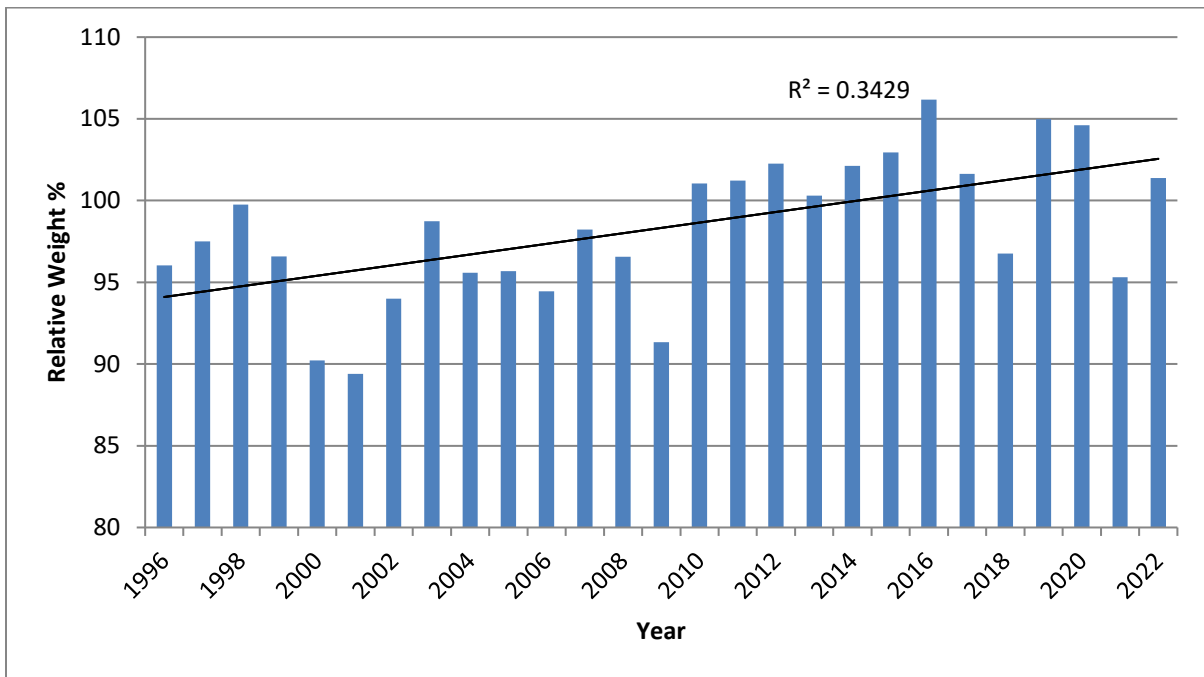


Figure 8. The mean Wr's of quality- and preferred-size Largemouth Bass (12-20" TL) from Lake Bistineau for spring electrofishing samples 1996-2022.

Proportional stock density (PSD) and relative stock density (RSD) are size-related structural indices used to numerically describe fisheries length-distribution data. Proportional stock density compares the number of bass of quality-size (≥ 12 inches TL) to the number of bass of stock-size (≥ 8 inches TL). The PSD is expressed as a percentage. A fish population with a high PSD consists mainly of larger individuals, whereas a population with a low PSD consists mainly of smaller fish. Relative stock density compares the number of bass of a given size range to the number of bass of stock-size. Another common calculation used in fisheries management is RSD-Preferred (RSD-P). This value compares the number of Largemouth Bass ≥ 15 inches TL to the number of stock-size Largemouth Bass in the population. This is also commonly called RSD-15 values. Ideal PSD and RSD-P values for a balanced Largemouth Bass population range from 40-70 and 10-40, respectively. Fall electrofishing samples indicated that the Lake Bistineau Largemouth Bass population typically fell below the desired ranges for both statistics prior to the implementation of regular mid-summer drawdowns for the control of giant salvinia. Starting in 2006, PSD's and RSD's began to increase and have been above or within the desired ranges every year since 2009 (except 2011). The 2011 PSD and RSD values are lower due to an excessively large number of YOY bass collected that fall, following the extended 2010 drawdown and drought (Figures 9 and 10).

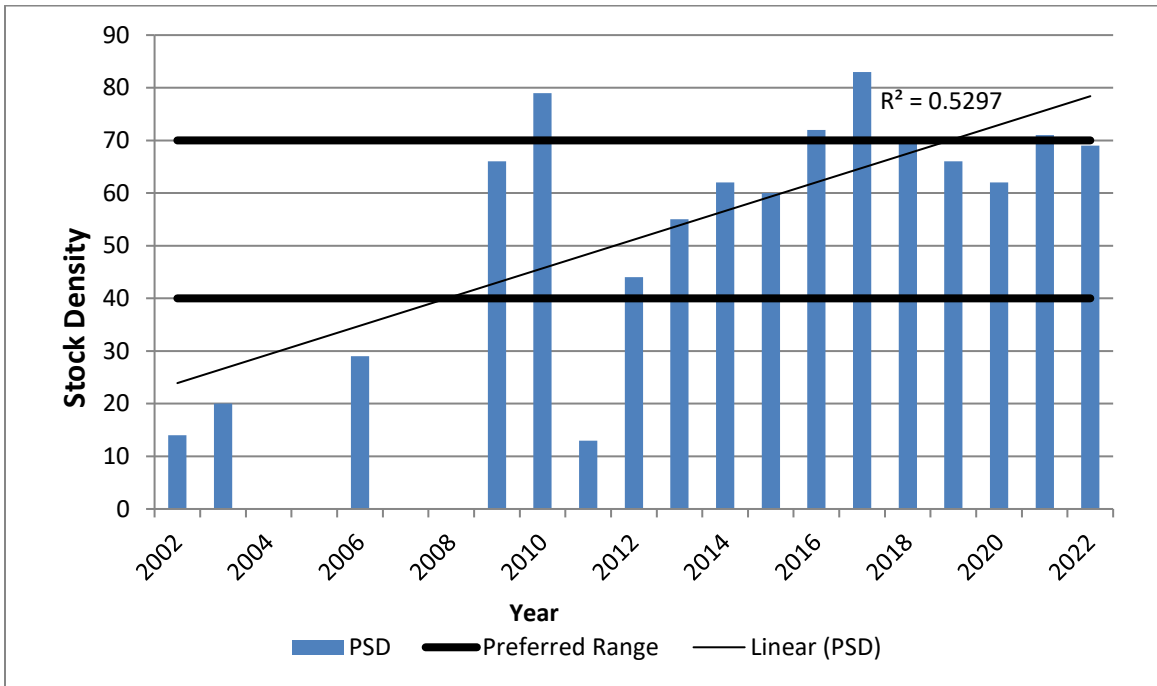


Figure 9. Proportional stock density for Largemouth Bass collected on Lake Bistineau, LA during fall electrofishing from 2002 to 2022.

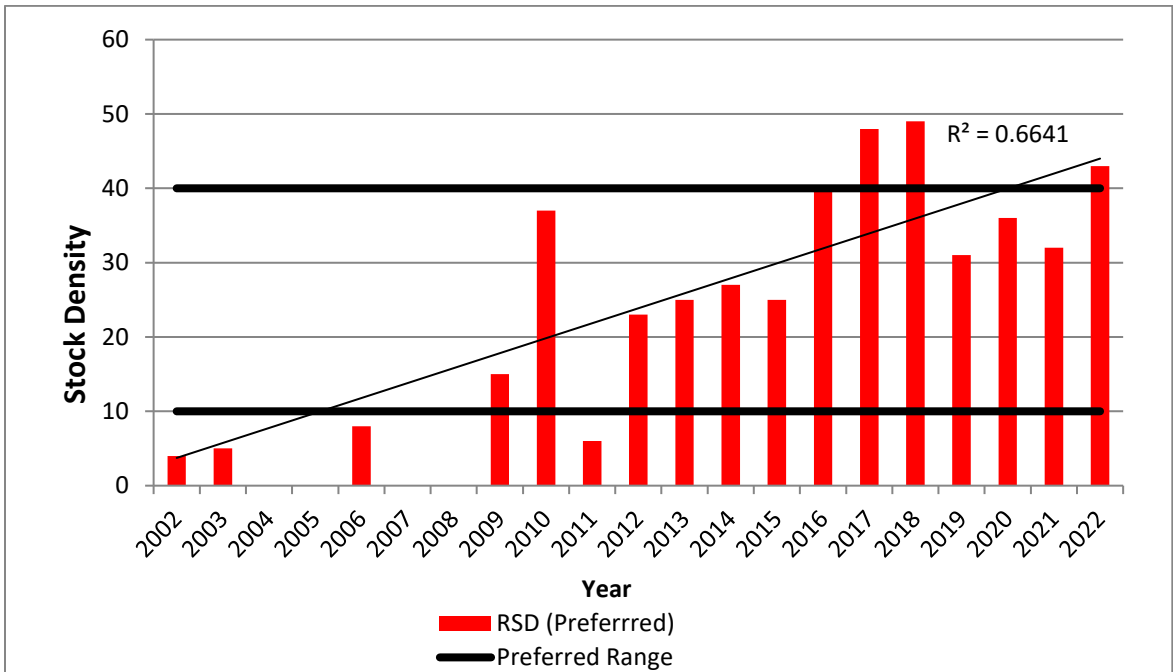


Figure 10. Relative stock density (preferred) for Largemouth Bass collected on Lake Bistineau, LA during fall electrofishing from 2002 to 2022.

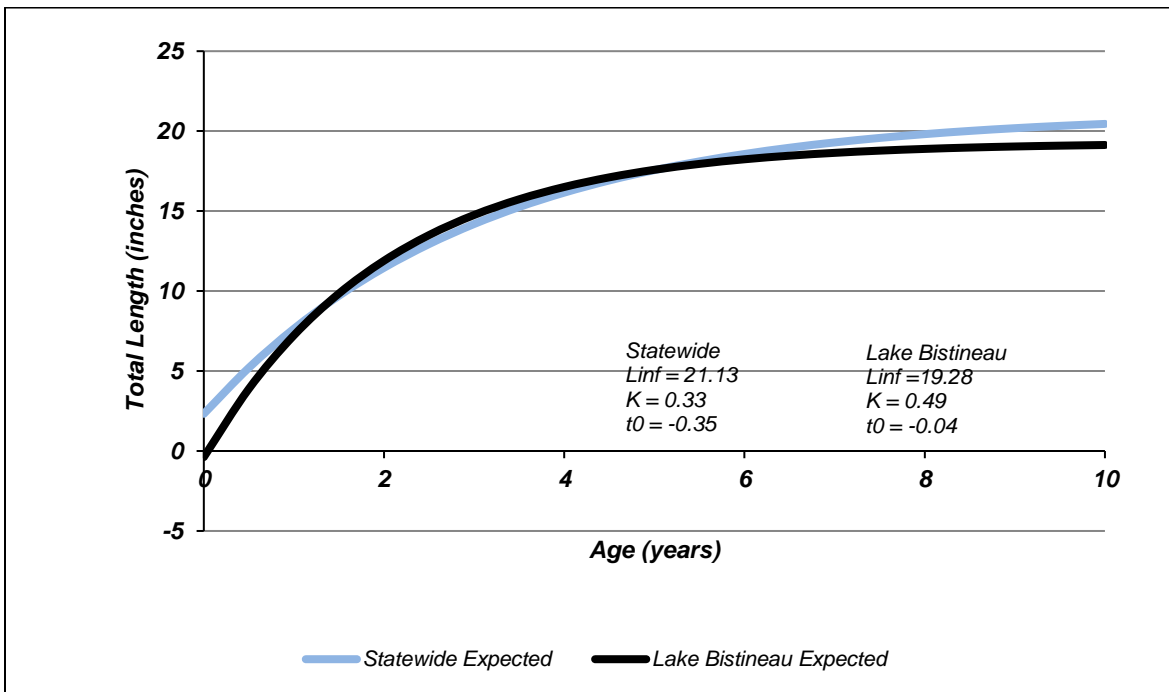


Figure 11. Predicted total length-at-age of Largemouth Bass collected from Lake Bistineau, LA 2016-2018 (n=1,512) as compared to rates for statewide stock assessments (2009-2012)).

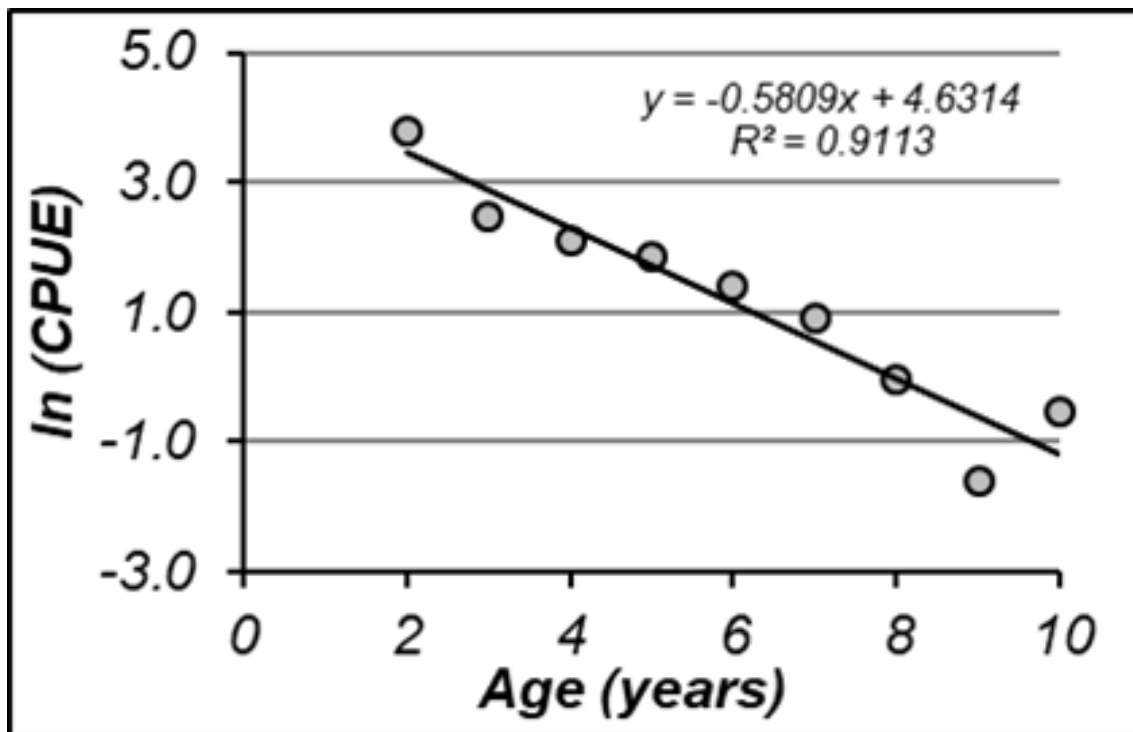


Figure 12. Annual mortality (AM) and corresponding survival rate (S) of Largemouth Bass from Lake Bistineau, LA for samples collected in Spring 2016-2018 (n=1,512).

In Figure 12, un-aged fish in samples were assigned ages from an annual age length key. $-Z$ = slope of descending catch curve; S = survival rate; AM = annual total mortality (which includes mortality due to fishing and natural causes); N = sample size. The survival estimate of 56% and the mortality estimate of 44% were derived from catch-at-age projections from the age-length key.

Age and growth samples from Largemouth Bass in Lake Bistineau were collected in 2001, 2002, 2006, and 2010. The samples indicate good growth rates for all ages (Figure 11). Predicted growth rates for Largemouth Bass from Lake Bistineau (von Bertalanffy; $t_0 = -0.6443$, $L_{inf} = 485.996$, and $k = 0.38203$) closely relate to the statewide predicted average growth rate (von Bertalanffy; $t_0 = -0.2676$, $L_{inf} = 494.4469$, and $k = 0.4320$). Growth rates exceed the statewide average for ages 1-4 and are slightly lower for older bass. This slower growth in older fish may be explained by relatively low sample sizes of these age classes. Figure 12 depicts the mortality and corresponding survival rates for Largemouth Bass. These values were derived from the descending slope of the catch curve and are 37% and 63%, respectively.

Largemouth Bass Genetics

Florida Bass stocking began on Lake Bistineau in 1998 when Bass Life Associates, Inc. funded the purchase of 468,328 fingerlings. Prior to 1998, the lake was maintained as a refuge for the native Largemouth Bass and free from the Florida genotype. Stocking was continued annually from 1998 until 2003. Stockings were sporadic between 2004 and 2013, as the frequency of mid-summer drawdowns increased. When it became apparent that the bass fishery was responding positively to the drawdowns and that drawdowns were likely to occur frequently, annual stockings of Florida Bass were continued. To date, more than 3 million Florida Largemouth Bass have been stocked into Lake Bistineau. Results from genetic testing are shown in Table 1. Genetic analysis has shown an increase in the Florida genome even with the sporadic nature of stockings from 2003 - 2013. There has been an increase in the number of Largemouth Bass greater than 20 inches TL collected in gill nets since 2005, including two bass captured in 2008 that exceeded 14 pounds.

Table 1. Genetic Analysis of Largemouth Bass from Lake Bistineau, LA from 1989 – 2018.

Year	Number	Northern	Florida	Hybrid	Florida Influence
1989	60	100%	0%	0%	0%
1990	15	100%	0%	0%	0%
1995	34	100%	0%	0%	0%
1997	73	100%	0%	0%	0%
2001	52	94%	6%	0%	6%
2002	51	90%	0%	10%	10%
2006	64	92%	0%	8%	8%
2010	80	80%	1%	19%	20%
2016	179	80%	4.5%	15.5%	20%
2017	212	84%	1.9%	14.2%	16%
2018	209	81%	3.8%	15.3%	19%

Crappie

The crappie population on Lake Bistineau is comprised primarily of Black Crappie (*Pomoxis nigromaculatus*). White Crappie (*Pomoxis annularis*) were occasionally collected during rotenone sampling conducted from 1970 – 2000. The number of available-size crappie (>7” TL) collected during rotenone sampling was highest during the 1970’s when drawdowns were more frequently conducted on the lake. Few crappie were collected in the early 1980’s (see Figure 13). It is difficult to determine the reason for the change in population, but severe infestations of water hyacinths during the early 1980’s may have been a factor. There also seems to be a general reduction in the crappie population from the period 1970 – 2000 which is typical of the decreased fisheries production in an aging reservoir. Crappie reproduction was fairly consistent most years with very high numbers of fingerling crappies collected in rotenone samples in 1978 and 1984 (Figure 14). The high number of fingerling crappie in the 1984 sample is likely due to the drawdown in 1983, in association with record cold temperatures. Coverage of water hyacinth had been problematic prior to the drawdown and freeze in 1983. The 1978 rotenone sample indicated even higher numbers of fingerling crappie. This is following a drawdown in 1975 and occurred during a time when aquatic vegetation was not a major problem on Lake Bistineau. Crappie size distribution from frame net sampling during 1991 is shown in Figure 15. Length structure for crappies 7” TL and larger is represented by a classic bell curve on the right side of the graph.

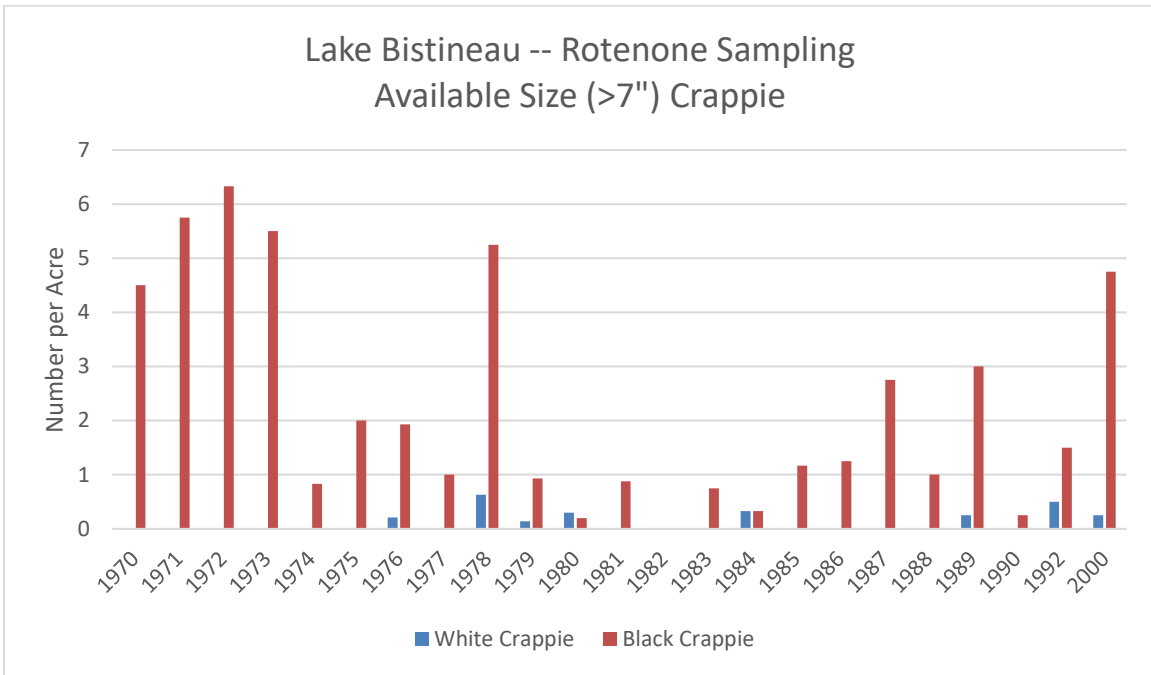


Figure 13. Estimated number per acre of available size crappies derived from biomass (rotenone) sampling on Lake Bistineau, LA, from 1970 – 2000.

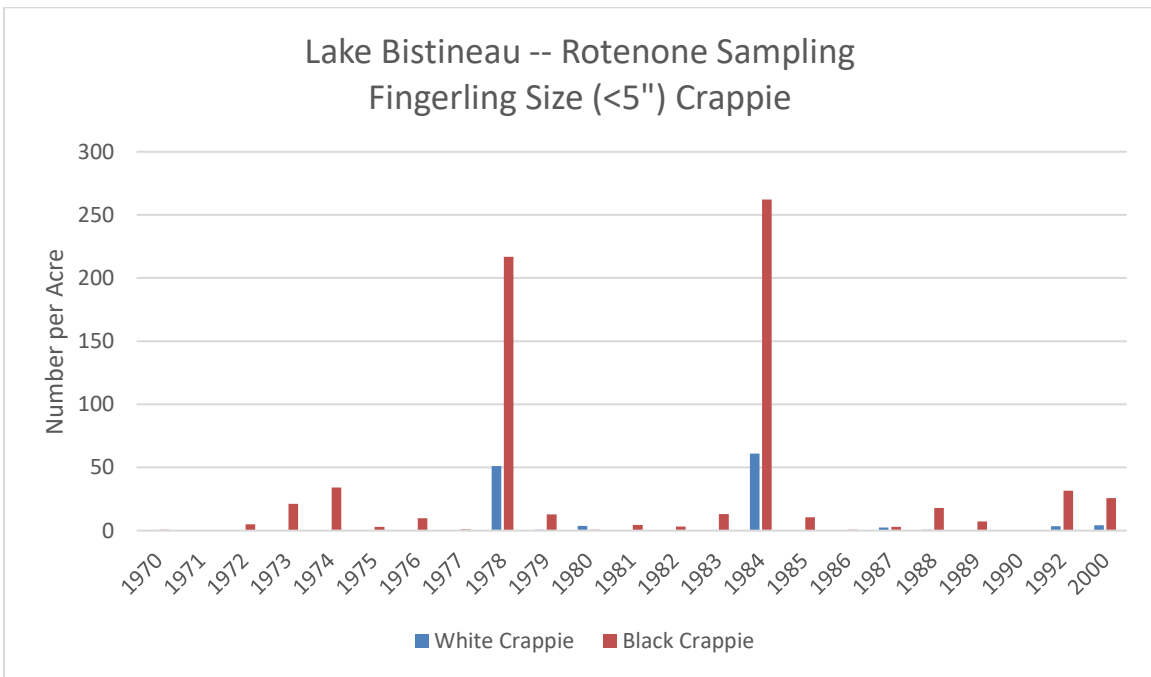


Figure 14. Estimated number per acre of young-of-the-year (YOY) crappies derived from biomass (rotenone) sampling on Lake Bistineau, LA, from 1970 – 2000.

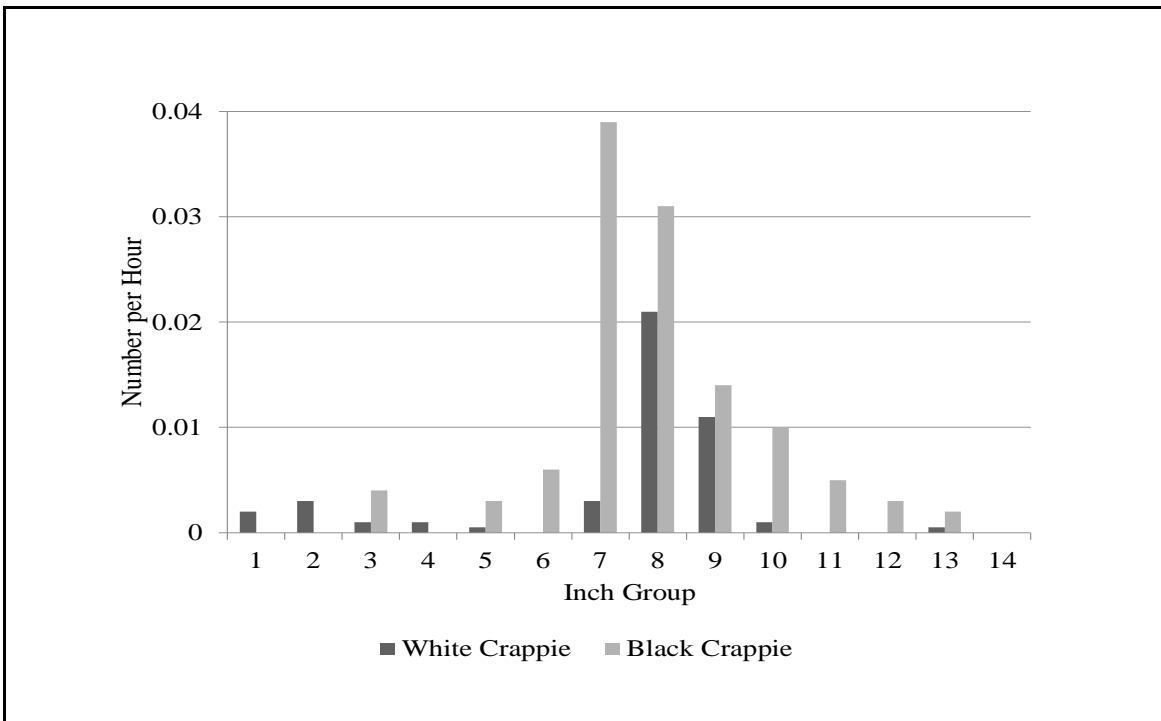


Figure 15. The CPUE (number per net hour) of Black and White Crappies collected from frame nets on Lake Bistineau, LA, 1991.

Anecdotal information suggests that angler catches on Lake Bistineau indicate a more abundant crappie population than historic LDWF data would suggest. In recent years, LDWF has used lead net gear to collect crappie to gain better information on the population. Lead nets were first fished on Lake Bistineau from 2016-2018, and results indicate an abundant and diverse crappie population.

The Lake Bistineau crappie population is dominated by Black Crappie (90%), but White Crappie (10%) are common and are relatively more abundant in the larger size ranges (>12" TL). Stock-size crappies (5"-8" TL) are by far the most abundant, which indicates that successful reproduction is not a limiting factor. Interestingly, the relative weights of the stock-size crappies (Mean $W_r=80.8$) are much lower than the larger preferred-sized fish (Mean $W_r=99.3$). Perhaps the crappie population is experiencing some signs of crowding at young ages, where available forage may be somewhat limited. With the annual drawdowns, crappie reproduction should be responding positively. Fortunately, the fish become more crowded during drawdowns, and these small crappies are subject to high levels of predation, which likely thins the population by the time they reach larger sizes (Figures 16 and 17).

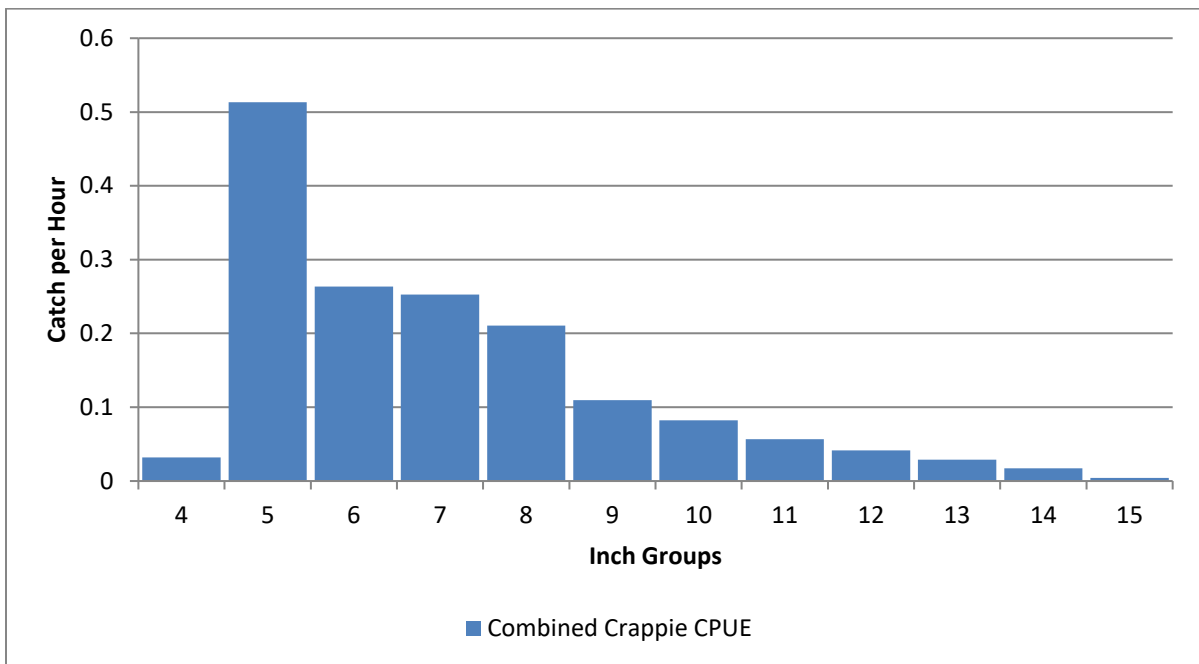


Figure 16. The CPUE (catch per hour) by inch group of combined crappie species (Black and White) collected in lead nets fished on Lake Bistineau, LA, 2016 to 2018.

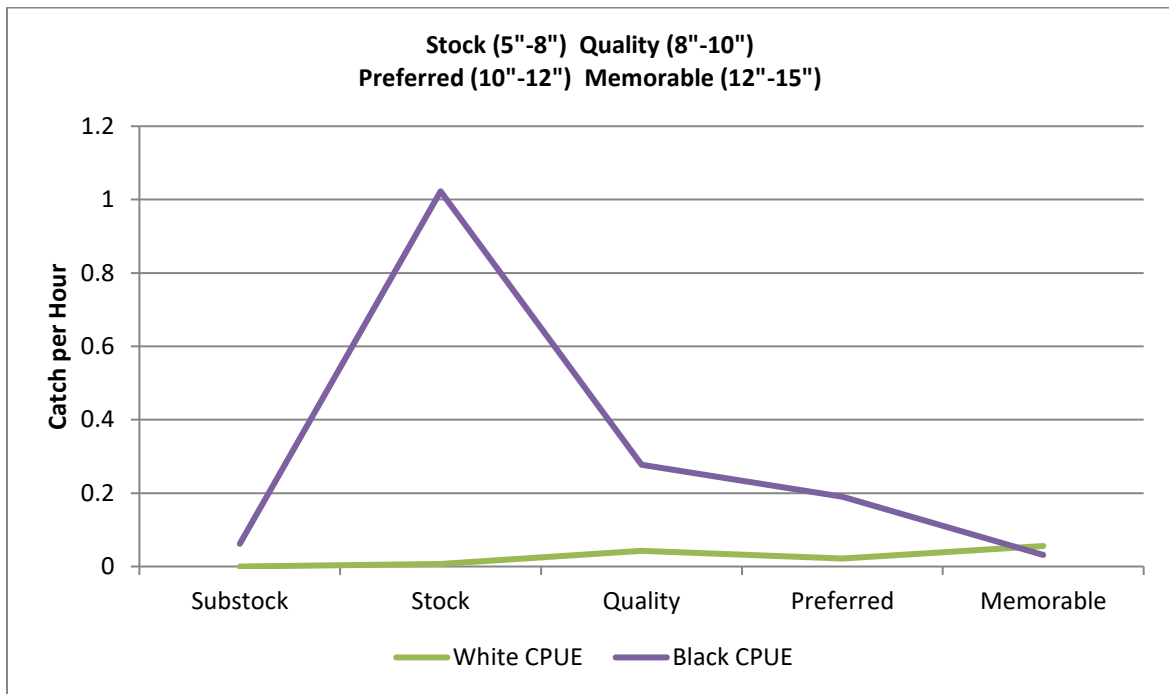


Figure 17. The CPUE (catch per hour) of selected size groups of combined crappie species (White and Black) collected in lead nets fished on Lake Bistineau, LA, 2016 to 2018.

Catfish

Lake Bistineau does not support large populations of commercial fish other than catfish. No significant commercial fishing activity occurs on Lake Bistineau due to the restrictions on commercial gear in the reservoir. Channel Catfish and Flathead Catfish are commonly sought by recreational anglers using trot lines, set lines, yo-yo's, and rod and reel.

Channel Catfish and Flathead Catfish collected from rotenone sampling from 1970 through 2000 are depicted in Figure 18. Rotenone sampling conducted from 1976 to 1992 indicates robust populations of Channel Catfish and Flathead Catfish in the lake. Sampling from 1970 through 1975 indicates relatively low catfish populations. Lake Bistineau underwent a series of annual drawdowns from 1966 to 1971 in an effort to control water hyacinth. The population of Channel Catfish and Flathead Catfish improved significantly following the drawdown in 1975. Results from 1976 show a marked increase in these fish along with most sportfish species in the lake. The lake continued to support good populations of catfish for a number of years.

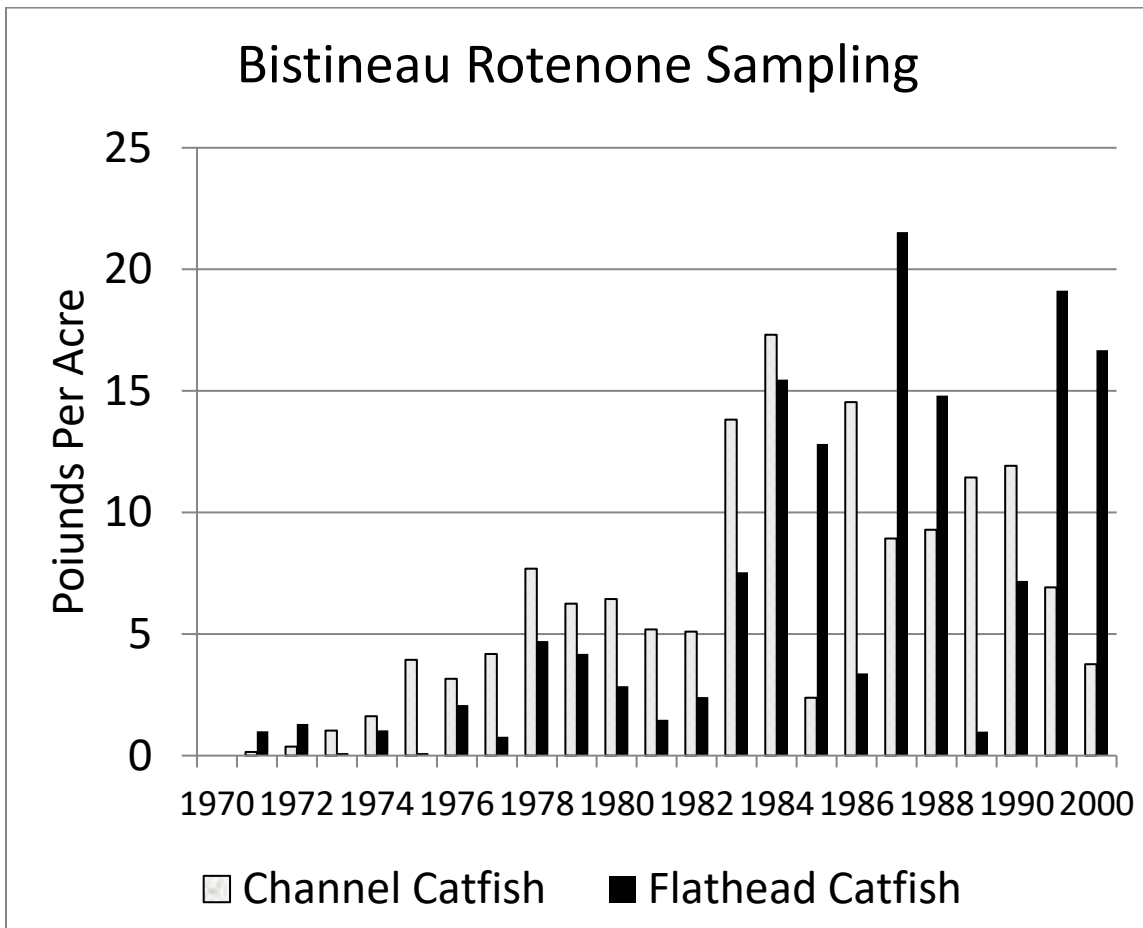


Figure 18. Estimated standing crop of Channel Catfish and Flathead Catfish in pounds per acre derived from rotenone sampling on Lake Bistineau, LA from 1970 – 2000.

Catfish collected utilizing standardized sampling gill nets are shown in Figure 19. A decline is indicated from gill net sampling of 1996 and rotenone sampling of 2000. The population again began to increase in the 2005 gill net samples and climbed higher in the 2008 gill net samples. A fall / winter drawdown was conducted in 2000 for vegetation control and bottom habitat improvement. Midsummer drawdowns were conducted in 2004 and 2005 to for the purpose of improving the bottom fisheries habitats. It is apparent that improvements in Channel and Flathead Catfish populations are positively correlated with the drawdowns. The increase in the Channel Catfish population is likely due to improvements in the bottom substrate and benthic invertebrate production. An increase in sunfish and other forage fishes is likely responsible for the increase in the Flathead Catfish population.

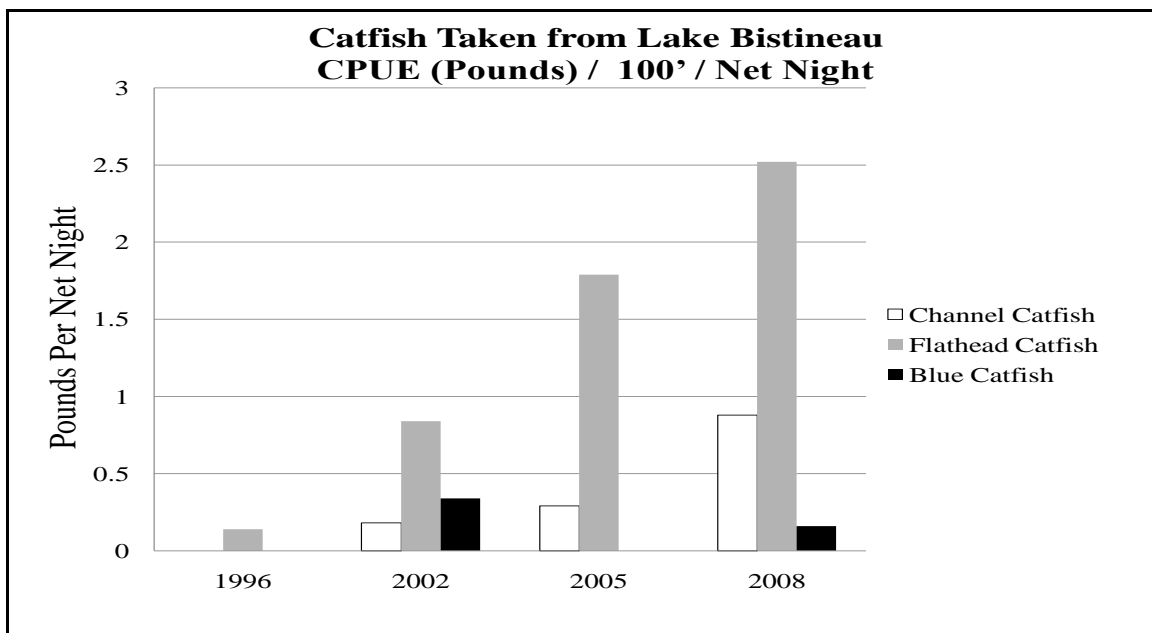


Figure 19. Catch-per-unit-of-effort of catfish depicted by species in pounds per net night taken by gill nets from Lake Bistineau, LA 1996, 2002, 2005, and 2008. All standard sizes; 2.5", 3", 3.5", and 4" square mesh.

Although LDWF uses lead nets to target crappie, the gear can also provide some information regarding the size distribution and relative abundance of catfish species. Figure 20 shows the size distribution of catfish collected from lead nets fished from 2016-2018. Most notable is the abundance of flathead catfish, especially of fish greater than 20 inches TL.

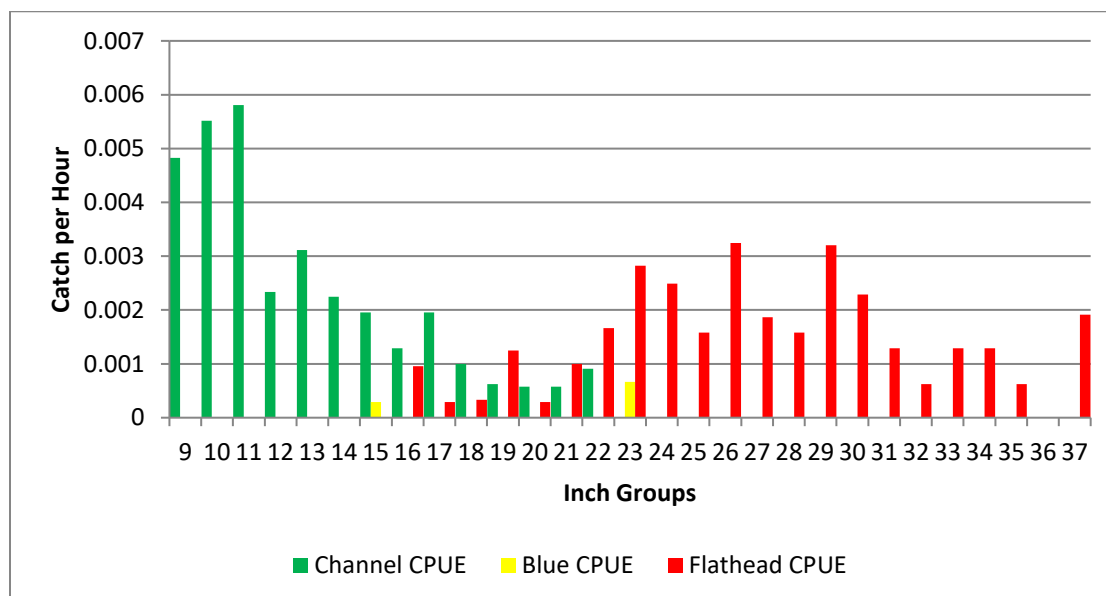


Figure 20. The size distribution (inch groups) and CPUE (catch per hour) of Channel, Blue (*Ictalurus furcatus*) and Flathead Catfishes collected with lead nets on Lake Bistineau, LA, 2016 to 2018.

HABITAT EVALUATION

Aquatic Vegetation

Historical Vegetation

Lake Bistineau is a unique ecosystem. Although a man-made impoundment, the lake environment is more similar to a natural swamp setting. Therefore, the management of Lake Bistineau needs to be unlike other “typical” reservoirs. Lake Bistineau is heavily forested with cypress trees covering approximately 50% of the 15,293 surface acres of the lake. The lake has had problems with aquatic vegetation since-impoundment. Before that time, the natural flow regime included high water levels in the spring and low water levels in the late summer and fall. The large expanses of nutrient-rich shallow water are ideal habitats for many species of aquatic vegetation. Several different species of aquatic vegetation have become problematic over the years. Recently, giant salvinia has caused major problems on the reservoir. At times, the plant has formed dense mats over large areas of the lake adversely affecting fisheries habitat and limiting boating access. Drawdowns have been conducted annually since 2008 in response to the salvinia growth. These annual drawdowns have virtually eliminated all other species of aquatic vegetation on the lake. Only alligatorweed (*Alternanthera philoxeroides*) remains in certain shallow areas.

Historically, one of the primary methods of dealing with aquatic vegetation problems on Lake Bistineau has been the use of drawdowns. The first drawdown for control of aquatic vegetation on Lake Bistineau began in 1945, and drawdowns have been used, with varying degrees of success, since that time. The lake was dewatered in 1951 to allow for the construction necessary to raise the pool level by 4 feet. By 1955, the lake was again experiencing vegetation problems. A proposed management plan was drafted by LDWF biologists calling for annual drawdowns of the lake to improve fishing, improve waterfowl habitat, and to reduce aquatic plants. The plan called for drawdowns of three months’ duration beginning prior to September 1 each year with the gates to be closed between December 1st and 15th. This plan was met with controversy, and never implemented. The aquatic resources in the lake began to decline.

In 1966, a series of five consecutive 5-foot post-Labor Day drawdowns for control of water hyacinths (*Pontederia crassipes*) and other aquatic vegetation was initiated. In 1975, a post-Labor Day drawdown for vegetation control was conducted. Following a mild winter in 1982, water hyacinth coverage increased tremendously and the one spray crew assigned to the lake could not keep pace with the growth. Spray crews from throughout the state were assigned to Lake Bistineau beginning in April 1983. The crews treated over 5,000 acres of water hyacinths, but surveys conducted in August 1983 revealed that 30% (5,160 acres) of the lake surface was completely matted with water hyacinth and an additional 10,320 acres (60%) was moderately infested. A post-Labor Day drawdown in 1983, followed by record cold temperatures in January of 1984, provided excellent control of the water hyacinths.

Hydrilla (*Hydrilla verticillata*) was first observed in 1995. A fall / winter drawdown was attempted in 1996 in response to that discovery. The lake never dewatered significantly due

to heavy rain, but significant control of hydrilla was observed due to high, turbid water the following spring. A post-Labor Day fall / winter drawdown was conducted in 2000. The drawdown was conducted as a dual purpose management action. The dewatering improved fisheries habitat by allowing organic matter on the lake bed to dry and decompose. Aquatic vegetation control benefits were also achieved. Alligatorweed and water hyacinth covered most of the upper end of the lake and was problematic in other areas. Other shallow water areas had extensive coverage of submersed aquatic vegetation. Positive results were achieved prior to heavy rains in November and the subsequent refill of the lake.

Drawdowns conducted in 2004 and 2005 were primarily for consolidation of bottom sediments and reducing organic matter on the lakebed. These drawdowns also impacted the aquatic vegetation on the lake. Prior to the 2004 drawdown, Lake Bistineau had extensive coverage of water hyacinth, alligatorweed and primrose. The upper end of the lake was almost totally blanketed. Many shallow areas throughout the lake also had very extensive coverage of submersed aquatic vegetation. Hydrilla had increased in coverage, although not to problematic levels. Many areas of the lake had become nearly impassable to boat traffic due to the aquatic vegetation and buildup of organic matter on the lake bed. Following the 2004 mid-summer-winter drawdown, much of the submersed vegetation and water hyacinths were significantly reduced. However, alligatorweed and water primrose (*Ludwigia spp.*) expanded in coverage and were problematic in some areas. A drawdown conducted from July 15, 2005, through the end of January 2006 provided control for a short time. Unfortunately, by June of 2006, areal coverage of alligatorweed and water primrose was in excess of 2,000 acres.

Giant salvinia, a free-floating aquatic fern native to Brazil, was discovered on Lake Bistineau in March of 2006. Primary stage plants were found widely scattered over the lower 1/3 of the lake. Early efforts were conducted with the goal of eradication. Spray crews from other LDWF districts were included for assistance. Despite the extensive effort, it soon became evident that the plant was too widespread for eradication to be a possibility.

Giant Salvinia

Giant salvinia has the potential to double in biomass every 3-5 days according to most published research. Growth rates in terms of coverage differ slightly, as the biomass per area increases, as well as the extent of the coverage. LDWF quantified the growth rate of the plant, specifically on Lake Bistineau, during an experiment conducted from June 22 to September 1, 2016. Six floating PVC quadrates (25 square feet each) were lined with screen to keep salvinia from escaping and placed within a protective boom to reduce influence from outside plants. Each plot was stocked with one square foot of salvinia and then monitored. Growth rate (coverage) was measured by collecting all the plants to one side of the plot and measuring the surface area covered by the plants. Over the 71-day experiment, doubling rates (coverage) ranged from 2.165 days to 6.82 days, with an average doubling rate (coverage) of 4.185 days. The biomass of plants doubled every 6.9-7.58 days and salvinia was estimated to grow to densities of up to 30 tons per acre in just 47 days; starting from a beginning coverage of only 4%.

The 2016 experiment provided insight into the growth rates of salvinia on the lake, but may not transfer directly to coverage/biomass expansion rates observed over the entire lake. Within the quadrates, salvinia was not crowded and could expand its coverage without impediment. In many areas of the lake, the plants reach nearly maximum coverage and become “locked” in place as the mat becomes denser. Coverage expansion in these areas is limited, but biomass expansion is not. Nevertheless, salvinia coverage on Lake Bistineau expands at a tremendous rate, doubling biomass every 7-8 days during the prime growing season. Lake Bistineau is heavily forested in many areas, providing sheltered nursery areas where the salvinia grows prolifically. Foliar herbicide applications are difficult in many of these areas.



Figure 21. Photograph of floating enclosures containing giant salvinia for the growth rate experiment conducted on Lake Bistineau, LA near Crow’s Foot, summer 2016.

Spray crews from District 1 spent a large portion of their time during the summer of 2007 making herbicide applications in an effort to control giant salvinia. Crews from other districts were called in to assist beginning in August 2007 and continuing through the fall. Herbicide applications made for giant salvinia control in 2007 totaled 4,156 acres. Despite the effort, giant salvinia increased from 500 acres in April to approximately 4,500 acres in December.

Several nights of subfreezing temperatures in January 2008 caused some damage to the salvinia. Plants in the more open areas of the lake were most affected. Little effect was

observed on salvinia protected by tree canopy. Those plants were still green and even exhibited new growth in many instances. High water caused the removal of a large volume of salvinia as water flowed over the spillway. These natural controls reduced coverage from 4,500 acres to an estimated 2,208 acres for the beginning of the growing season in April 2008. At that time, mats several inches thick had formed in many areas. Recognizing the seriousness of the problem, the LDWF Secretary committed significant resources to Lake Bistineau and designated it as department's testing grounds for salvinia control measures.

Seventeen LDWF spray crews participated in an intensive herbicide application effort during April 7-11, 2008. In that time frame, the crews applied 1,499 gallons of EPA-approved AquaMaster™ herbicide to 2,016 acres of giant salvinia. Eighteen LDWF spray crews treated 2,886 acres of aquatic vegetation with 2,157 gallons of AquaMaster™ herbicide from April 28 to May 1, 2008. For the two efforts, over 4,900 acres of aquatic vegetation were treated with 3,656 gallons of herbicide. Though mats of giant salvinia were thinned, areal coverage was reduced by only 25%. Salvinia coverage increased to 3,340 acres by June 26, 2008 and to 4,500 acres by July 15, 2008.

A drawdown for control of giant salvinia was conducted between July 15, 2008, and January 30, 2009. The lake was dewatered 8 feet at a rate of 2-3 inches per day to minimize the downstream transfer of giant salvinia and to maximize salvinia left on the exposed shoreline. Foliar herbicide applications by LDWF spray crews continued in water accessible by boat throughout the drawdown period.

Estimates made on October 11, 2008, indicate that coverage levels had been reduced to less than 1,000 acres from 4,500 acres when the drawdown began. A type map survey conducted during March 13-19, 2009, indicated 850 acres of giant salvinia present following the drawdown. The majority was located in the mid-lake area which contains old slough channels that could not be reached by boat during the drawdown period.

Giant salvinia increased to 1,500 acres by May 1, 2009, and remained concentrated in the middle section of Lake Bistineau. The largest infestation was located in areas adjacent to Bistineau State Park Areas 1 and 2. Heavy rains and a resulting rise in lake level beginning on May 3, 2009, flushed large quantities of salvinia down to the lower end of the lake. With warming temperatures, salvinia began to expand rapidly. Coverage increased to 4,300 acres by June 5, 2009, despite ongoing herbicide applications and a significant quantity of plant material being flushed over the spillway during a high water event. Foliar herbicide applications were made by LDWF spray crews to over 3,800 acres of giant salvinia in 2009. An additional 800 acres was treated by a private contractor prior to curtailment of foliar herbicide applications in mid-July.

Salvinia weevils (*Cyrtobagous salviniae*) were introduced into Lake Bistineau to aid in the control of giant salvinia. Two enclosures were stocked with weevils in August 2007 and some of the insects survived the first winter and their populations increased within the enclosures. Weevil infested salvinia in the two original enclosures were transferred to floating enclosures

designed to fluctuate with water levels. Weevil infested salvinia was also distributed to areas with limited access to establish “nursery areas”.

Additional weevil-infested salvinia was stocked in October 2008 from a LSU rearing facility near Ghens, Louisiana. A major weevil stocking effort began on June 15, 2009. During the two-week effort, over 78,000 lbs. of giant salvinia infested with over 1.8 million adult weevils were relocated to Lake Bistineau. The weevils were stocked in an area which holds water during drawdowns, and had harbored giant salvinia for over two years. Containment devices were placed to hold the weevil-infested salvinia in the stocking location.

An initial application of Galleon herbicide was made on June 11, 2009. In preparation, SePRO Corporation contracted with Remetrix to conduct bathymetric surveys of the treatment areas. LDWF provided boats and personnel for assistance. Prior to the application, LDWF District 1 personnel deployed and marked approximately 9,500 feet of floating containment devices including 3,400 feet of oil spill containment boom. During this application, 192 gallons of Galleon herbicide were injected into the water in seven different areas of the lake as treatment for over 1,300 acres of giant salvinia. Applications were made by LDWF personnel under the guidance of SePRO representatives. LDWF crews collected follow-up water samples for analysis by SePRO, and documented the condition of giant salvinia in the treated areas. The herbicide was applied utilizing 75% during the initial treatment, with 25% used for a “bump” treatment to maintain the target concentration level of 20 ppb. Utilizing water samples collected at one and two weeks after application, SePRO made the recommendation to abandon treatment in several areas unless additional herbicide was purchased. According to information gained during meetings with SePRO representatives, concentration levels of herbicide had fallen off significantly in most treatment areas just 2 weeks after application. Clark’s Bayou was the only area where concentrations remained at a level with the potential to provide control. A low to moderate Galleon concentration was measured in the upstream portion of Brushy Creek. However, concentration level had fallen off significantly towards the lower end. On July 14, 2009 the decision was made not to proceed with the bump treatment.

Coverage totaling approximately 7,386 acres of salvinia coverage was estimated during a helicopter flight on September 30, 2009. Following an extended high water event from early October through mid-November 2009, salvinia coverage was estimated at 4,606 acres on November 17, 2009. The resulting 37% reduction in coverage can be largely attributed to giant salvinia flushing over the spillway as the lake level rose. At one time during this flood event, Lake Bistineau was approximately 6.5 feet above normal pool level. A second smaller high water event occurred from mid-December through the first few days of January, 2010.

Unusually cold temperatures the first two weeks in January 2010 resulted in most salvinia being encapsulated in frozen mats. Approximately 50% of the north end of the lake froze and most areas under the cypress trees froze. The majority of Lake Bistineau giant salvinia was located in these areas at the time of the freeze event. An inspection on January 12, 2010 revealed significant browning of the tops of the giant salvinia, but green viable plant tissue was observed on examination. Subfreezing temperatures of the prior two winters had imposed

similar damage. Some of the plants to sank after the previous winters, but resurfaced and grew prolifically with warmer temperatures. Giant salvinia coverage was estimated at 3,000 to 3,500 acres in mid-January at the time of the inspection for freeze damage. This reduction from the mid-November estimate of 4,606 acres is most likely to be the result of flushing during the prior high water event.

On March 11, 2010, large amounts of salvinia were observed to be brown in color and in various stages of decay. Some green plant material remained in the mats of dead salvinia. Even though significant amounts remained, it was obvious that much of the salvinia had sunk. Observations from a survey conducted on March 23, 2010, included clear signs that salvinia had been heavily impacted by the freezing weather. There was no sign of regrowth. On April 6, 2010, small amounts of giant salvinia were found throughout the lake. This salvinia was scattered throughout the lake, and likely would only total one or two acres if consolidated. Some remnants of the decaying vegetation remained in many areas of the lake at that time. Further inspections during May indicated salvinia remained at low levels. Giant salvinia coverage expanded in early June and began to exhibit normal growth patterns.

As spring rains began to slow, the lake level continued to fall towards the desired drawdown level of 8 feet below normal pool stage. Terrestrial vegetation such as sedges, grasses and ragweed covered the exposed lake bed as the waters receded. By mid-June of 2010, Lake Bistineau finally reached the target level of 8 feet below normal pool stage from the drawdown initiated on September 16, 2009. At this time, the terrestrial vegetation growing on the lakebed was waist to chest high in many areas. The dense coverage of terrestrial vegetation holds moisture and is not conducive to effective drying of the lakebed. At the time the gates were closed on July 15, 2010, salvinia was flourishing again in most areas of the lake. One control gate was left open due to concerns over rapid inundation of the areas where dense terrestrial vegetation had grown during the drawdown. Submerging large quantities of this terrestrial vegetation at one time would greatly increase biological oxygen demand and increase likelihood of fish kills. The final gate was closed in early August after it became apparent that the lake level was not rising.

The growth of the terrestrial vegetation on the lakebed slowed later in the summer as the drought conditions persisted. As the grass began to die and become increasingly dry, fires occurred on several areas of the lakebed. These fires impacted approximately 1,000 acres, and significantly damaged the cypress timber. Several piers and boathouses were also burned.

The drawdown conditions likely prevented a rapid increase in coverage of giant salvinia throughout the summer as much of the shoreline was unprotected flats where the salvinia could wash up on the shore from wave action and be stranded. Despite foliar herbicide applications and the benefits of the drawdown conditions which persisted throughout the fall of 2010, giant salvinia expanded to approximately 500 acres by mid-October 2010. In early April there had been very little giant salvinia in the lake which had survived the freeze.

Freezing temperatures in early 2011 reduced salvinia to approximately 20 acres. By April, giant salvinia had expanded to the extent that it was necessary to supplement LDWF spray crew's efforts with a contract treatment to 400 acres. In June, 2011 contract applications were made to 600 acres of giant salvinia. In September 2011, contractors treated 700 acres of giant salvinia. A total of 3,508 acres of giant salvinia were treated on Lake Bistineau in 2011.

Lake Bistineau finally returned to pool stage on January 15, 2012, following the closure of the gates on July 16, 2010. The extended drawdown began on September 16, 2009. The winter of 2011 – 2012 was relatively mild in comparison to the previous two years. Salvinia coverage was estimated at approximately 50 acres in January 2012. By April, coverage had expanded to the point that private contractors were utilized to treat 300 acres. An additional 400 acres of giant salvinia was treated by contractors in May 2012. In June, containment boom was placed just north of the Port O' Bistineau to attempt to hold giant salvinia on the north end of the lake. Following placement of the boom, contractors were utilized to treat 800 acres in that area. In July, an additional 700 acres of giant salvinia was treated by contractors. A survey conducted in August 2012 revealed 2,300 acres of giant salvinia on Lake Bistineau. A drawdown was initiated on August 6, 2012. The control gates were closed on October 15th in an attempt to fluctuate the water level. In November, 580 acres of giant salvinia were treated by aerial application.

In January 2013, giant salvinia coverage was estimated at 900 acres. On January 15, 2013, the control gates were again opened to expose additional giant salvinia to desiccation and freezing temperatures. The control gates were closed January 31. A 30-day contract was initiated on February 4, 2013, to be followed immediately by a subsequent 30-day contract. Despite ongoing foliar herbicide applications by LDWF contractors and spray crews, an estimated 3,899 acres of giant salvinia was observed on Lake Bistineau on June 11, 2013. The control gates were opened on June 24, 2013, to begin dewatering the lake to allow the giant salvinia to desiccate. Foliar herbicide applications continued as the lake dewatered. Lake Bistineau was five feet below normal pool level by July 17, six feet low by August 1, and reached the target goal of seven feet below normal pool stage on August 20. Estimates made during a helicopter flight on September 5 showed approximately 850 acres of giant salvinia remained on the lake unaffected by the drying action or herbicide applications. The control gates were closed on December 2, 2013. The lake quickly returned to pool by December 18, 2013, due to rainfall. Two freeze events in the following weeks resulted in moderate ice formation on the lake surface which caused severe damage to much of the remaining giant salvinia.

By March of 2014, an estimated 56 acres of salvinia were observed on the lake. These plants were widely scattered over the entire lake and quickly began to expand as temperatures warmed. LDWF and contracted spray crews treated 1,318 acres of salvinia in the first half of 2014. By mid-July, the salvinia growth had expanded to approximately 1,725 acres, which prompted discussions and action to initiate a drawdown beginning on August 4, 2014. The gates were scheduled to be closed on December 1, 2014, but this date was altered to January 15, 2015 in response to a public opinion survey conducted by the Bistineau Task Force (BTF) in September 2014.

The survey was made available to the public by circulation in several media outlets. Interested individuals could mail in a survey form, complete the survey on-line, or provide the survey and related comments at the BTF's September meeting. All user groups completing the survey expressed a desire to extend the drawdown period beyond the planned December closing date. The January 15, 2015, closing date was chosen as a compromise to the public outcry without extending the date beyond a time where the closing date was not biologically sound. LDWF crews and contractors treated an additional 2,932 acres in the second half of 2014.

In 2014, two containment booms were installed around the public boat launches at the Bossier Parish Public Launch and State Park Area 1. LDWF crews intensely treated the area inside the boom to limit the amount of salvinia present around the launches. This allowed boaters to load and unload their boats with fewer inconveniences from salvinia and helped reduce the threat of transporting salvinia to other waterbodies. Both projects were met with positive response from the public as well as parish and State Park officials.

In November of 2014, LDWF assisted entomologists from the LSU Agriculture Center Red River Research Station with deploying, stocking, and insulating four test plots in the Crow's Foot area of the lake. These test plots were studied to better understand the weevil's response to cold weather and to help develop a more cold-tolerant strain of the insect, if possible. Samples indicated that very few weevils survived the harsh winter of 2014-2015 and the related reduction in salvinia coverage.

Two cold fronts in late February 2015 brought sleet and ice to the area. This greatly reduced the remaining salvinia in the lake following a successful drawdown. By early April, it was estimated that approximately 55 acres of salvinia remained in the lake. Herbicide efforts were continuous on the lake from mid-April through July. As in years past, salvinia began to expand rapidly around Memorial Day and then, again, around mid-July. An aerial survey conducted by LDWF personnel on July 17 estimated 1,781 acres of salvinia on the lake. A drawdown was initiated on August 3, 2015 to combat the growing plant problem.

Following the drawdown and a historic spring flood, only an estimated 70 acres remained on the lake in early April of 2016. Despite treating over 1,700 acres with herbicides, salvinia again expanded to an estimated 1,743 acres by mid-July. LDWF announced a drawdown to begin as planned on July 25. Some shoreline property owners began to express interest in delaying the drawdown until Labor Day to allow for more weekends of recreation. The more open-water portions of the lake on the lower end were relatively clear of salvinia at that time; however, the plants were rapidly expanding over the entire lake. The drawdown was delayed for three weeks and the gates were scheduled to be opened on August 15. During the delay, salvinia expanded to cover 5,852 acres prior to the gates being opened. The majority of public opinions received at the LDWF Region 1 office, prior to the decision to delay and in the months following the decision, overwhelmingly supported an earlier start date to the drawdown. At the conclusion of the 2016 drawdown, giant salvinia was estimated to be 1,807 acres

(November 29, 2016). This marks the largest amount of giant salvinia present going into the winter since the highest on record of 2009.

An estimated 1,414 acres of giant salvinia remained on the lake in February 2017 when the plants began to grow. The 2016/2017 winter was very mild. Despite LDWF crews treating 6,060 acres from February 22-May 1, 2017, salvinia expanded to cover 3,742 acres, which prompted an early drawdown beginning May 1. The lake remained drawn down until late January of 2018, during which time LDWF treated a total of 15,024 acres at a cost in excess of \$1,409,568. An estimated 438 acres of salvinia remained on the lake at the conclusion of the drawdown, which returned salvinia coverage to levels seen in previous years. Herbicide application expenditures in 2017 were the highest on record, to date. Due to the delayed drawdown of 2016, LDWF was forced to spend considerably more funds on Lake Bistineau in 2017, along with a much longer drawdown period to achieve the same results as previous years.

The gates were not closed to conclude the 2017 drawdown until January 26, 2018. The Louisiana Department of Transportation and Development (DOTD) had funds available to make repairs to the outflow channel below the Bistineau spillway. For the repairs to be made, the area below the spillway had to be dry. Therefore, the gates were left open until the contract could be awarded and the contractor mobilized to the area. The repairs were necessary to patch the temporary fix that was put in place in 2008 due to the head cutting. The overflow apron was damaged further during the 2016 flood when the spillway gates were opened against the advice of DOTD engineers. The outflow channel is subject to backwater flooding during high water events from waters leaving the lake combined with rising waters from Red Chute Bayou and the Red River.

While the gates remained open in January, relatively little precipitation fell in the area and the lake remained low (135' MSL). During this time, two freeze events occurred in early January. An estimated 438 acres of salvinia were present on the lake during the freezes. By April, the salvinia had decomposed, and there was an estimated 1-2 acres scattered over the entire lake. Despite ongoing herbicide applications, giant salvinia began to expand coverage rapidly as the weather warmed. By mid-July, salvinia was estimated to cover 1,491 acres. The drawdown began on July 23, 2018, one week later than the recommended start date in the Waterbody Management Plan. The decision to delay the opening date by a week was made to allow recreational users additional time to utilize the lake at full pool.

Herbicide applications continued the remainder of the year, and the drawdown was very successful. Key to the success was beginning the drawdown prior to salvinia becoming well established in the lake. A survey conducted on October 22, 2018, estimated 108 acres of salvinia on the lake. This is the lowest documented coverage of salvinia at the end of the growing season since the plant was first introduced.

In early December, a minor flood event occurred and Lake Bistineau rose to pool stage on December 14, 2018, despite the gates being opened. On December 17, 2018, DOTD closed the gates under an emergency plan to protect the control structure and outflow channel from

erosion damage. The decision was made to discontinue the drawdown, as it was unlikely the gates could be safely opened and the lake dewatered during the upcoming weeks.

Following the very successful drawdown of 2018, conditions on Lake Bistineau were excellent during the spring and early summer of 2019. There were an estimated 12 acres of matted salvinia present on the lake in April, the lowest such estimate ever without a severe winter. However, salvinia began expanding rapidly as the weather warmed, despite foliar herbicide applications. A decision was made to begin drawing the lake down on July 22, 2019. Giant salvinia had expanded to 1,393 acres just prior to the drawdown. At the urging of a concerned citizens group, a containment boom was installed across the entire lake on the upper end of New Orleans Pond just prior to the start of the drawdown. It was believed by the group that salvinia could be trapped along the boom, treated with herbicides, and then released down the lake to increase efficiency of herbicide efforts. This theory sounds plausible, but in reality was very difficult to execute.

Despite a mild winter, the 2019 drawdown was able to successfully reduce salvinia to approximately 250 acres. The boom remained in place across the lake the entire drawdown and throughout the spring. The boom area was sprayed 1-2 times per week through most of the spring and early summer. Despite these applications, salvinia in the area continued to expand. The boom prevented salvinia from moving down the lake where it ends up in less favorable habitat or flows out the lake. Therefore, salvinia expanded more rapidly than previous years and reached an estimated 1,794 acres by June 10th. The 2019 June estimate is the highest on record except for another time when a boom was in place across the entire lake during the spring (2013) and following the disastrous 2016 drawdown delay. This rapid expansion initiated a drawdown starting immediately after the 4th of July holiday (7/5/20). Prior to the drawdown, LDWF crews treated over 1,900 acres of giant salvinia.

Spraying effort during the 2020 drawdown was reduced by budget issues and the Covid-19 pandemic, and was insufficient to keep up with the abnormally high amounts of salvinia present. The boom was not removed from the lake until 8/18/20 after the lake had fallen nearly seven feet. The boom prevented many of the positive, “natural” attributes the drawdown prescription affords by taking advantage of high flow times to move salvinia out of nursery areas and optimal habitat. In an attempt to help with the situation, it was decided to once again try closing the gates to initiate a second rise and fall within the drawdown. This had been unsuccessfully attempted in the past, but held promise with an approaching tropical storm. The gates were closed on 10/19/20 in an attempt to allow water levels to rise and perhaps flush some salvinia from the more difficult areas to treat on the upper end of the lake. Less rainfall occurred than was predicted and the lake only rose 1 foot by December. The decision was made to open the gates again on 12/17/20 to continue the drawdown. Little to no benefit was gained by these effort and by November salvinia had expanded to 3,787 acres based upon a satellite imagery estimate. The lake reached pool stage on 1/9/21 causing DOTD to take emergency action to close the gates and thusly ending the 2020 drawdown. There was an estimated 2,435 acres of salvinia present at the time the lake returned to pool.

A record freeze event occurred around Valentine's Day 2021 where temperatures in the area dipped to 2 degrees Fahrenheit and snow and ice remained on the ground for over one week. Prior to this event, the winter had been very mild and water temperatures were likely above normal on area lakes. Bistineau had considerable flow of water coming through the lake as it had remained above pool stage for a month prior and was rising slightly at the time of the freeze. There was an estimated 1,531 acres of salvinia present on the lake when the freeze occurred. This significant weather event led to ice formation and killing salvinia, but not as severely as originally anticipated. Nonetheless, salvinia was reduced to an estimated 202 acres by early April (a nearly complete reset to the 250 acres present in spring of 2020).

By June, salvinia had expanded to 1,572 acres despite ongoing control efforts. One success achieved during this time was a boom installed across Clark's Bayou near the State Park. The area was kept mostly salvinia free after the boom was installed in April. This was accomplished do to fortunate circumstances of little salvinia present following the freeze followed by weekly herbicide applications. Crews had treated over 100 acres in the area by mid-June. The boom in the location was successful at protecting the public access to the lake via the State Park, so much so that it will be implemented each year going forward.

A boom was once again installed across the entire lake at the urging of a concerned citizens group, but this time placed at the lower end of New Orleans Pond. The boom was put in place just prior to the drawdown. Little salvinia collected upon the boom for treatment. The boom was opened as the lake was rising to take advantage of flushing action. The boom was closed again after the spring rains of 2022.

A drawdown was initiated on July 19, 2021 and reduced coverage to an estimated 655 acres by December. The winter was very mild and dry. The lake remained low and the gates were not shut until 2/4/22. The lake did not return to pool stage until March 29th, when there was an estimated 570 acres remaining on the lake. Atypically low flushing occurred on the lake during the spring since the lake did not return to pool until the end of March and did not rise above flood stage during 2022. Despite ongoing control efforts, salvinia expanded to 3,134 acres by mid-June prompting a drawdown. The drawdown did not begin until 7/25/22 and salvinia expanded to cover 4,668 acres. After the lake was slow to return to pool the previous year, it was determined the best course of action was to close the gates at the beginning of winter to catch as much rainfall as possible and take advantage of natural flushing action. The gates were closed 11/28/22 with an estimated 684 acres of salvinia remaining in the lake. A major freeze event with temperatures dipping into single digits occurred around Christmas which should greatly reduce the remaining salvinia on the lake heading into the 2023 growing season. The lake reached pool stage on 1/5/23.

Salvinia Weevils

A total of 248,565 weevils were stocked into Lake Bistineau in 2017. Many of the weevils were released into floating enclosures, and monitored with the help of entomologists with the U.S. Army Corps of Engineers out of Lewisville, TX. Enclosures were located in Skinner's Slough, Crow's Foot, and Mud Slough. Additional weevils were stocked from a population

obtained from Iatt Lake in central Louisiana. These weevils had successfully over-wintered for two previous years, and may be showing signs of cold tolerant adaptation. LDWF provided over 100,000 of these weevils to local volunteers to distribute around the lake on June 24, 2017. Additional weevils were added to some borrow pits immediately south of LA Hwy 164, and also just north of U.S. Hwy 80 near Dixie Inn. It is unknown at this time whether the Iatt Lake population is exhibiting more cold-tolerance than previous populations, or simply a product of circumstance from two consecutive mild winters. The weevils within the study sites crashed again with the January 2018 freezes, as the populations were eliminated or greatly reduced to nearly zero in all locations.

Salvinia weevil stockings have occurred annually from 2007 through 2017 (except 2010-2011). In excess of 2.6 million weevils have been stocked in Lake Bistineau. Weevil densities have been closely monitored in small enclosures and other isolated areas. To date, salvinia weevils have provided no measurable level of success on Lake Bistineau and have had to be reestablished each year. Therefore, intense stocking and monitoring of weevils in Lake Bistineau and other northwest Louisiana lakes was discontinued in 2018. The LDWF continues to work with Louisiana State University to develop a more cold-tolerant strain of the weevil. Once successfully produced in larger numbers, those weevils will be introduced into Lake Bistineau and their populations closely monitored at test sites.

The LDWF experience has clearly indicated that herbicide applications alone are not effective for control of giant salvinia. However, foliar herbicide applications are recognized as an integral component of a program that includes all available tools for control. An integrated management program that includes physical, chemical, and biological measures has resulted in improved control of giant salvinia. The LDWF technical staff will remain receptive to consideration of any additional tools to add to the integrated management program. Critical evaluation of existing and proposed control measures will continue as part of an effort to combat this exceptionally prolific invasive species.

Considerations for the Timing of Drawdowns

Historical weather and discharge rates analysis:

There are many variables that have to be considered when selecting the timeframe for a drawdown: watershed ratio, recreational opportunities, impacts upon fish spawning and other wildlife, weather conditions, and the cost/benefit ratio of the duration. Ideally, a strategy could be recommended that has a high probability of effectively controlling large amounts of plant material, while providing the additional benefits of drawdowns to the aquatic habitat. Preferably, the timing would not significantly compromise the recreational opportunities that exist on the lake, especially during the prime season for such activities. When discussing recreational use of Lake Bistineau in the summer, it is important to consider that during a drawdown there are still 10,000 acres of water that can be accessed from at least four public launches.

Lake Bistineau is not a typical man-made reservoir, and therefore the management strategies must also not be typical. It has become evident since 2007 that drawdowns will need to be

conducted annually on Lake Bistineau to combat the giant salvinia and keep the plant at acceptable levels that allow recreation to continue on the lake for the majority of the year. The strategy of frequent drawdowns also serves to make conditions more favorable for the following growing season rather than allowing the plant to reach levels that will compromise multiple years.

To have a successful vegetation management plan, one must have realistic and attainable expectations. Giant salvinia will not be eradicated from Lake Bistineau. Salvinia is going to grow and expand on Lake Bistineau every year. The growth will accelerate around Memorial Day and then again in mid-July. Historical trends suggest that summer-time giant salvinia coverage of 1,500 acres corresponds with an exponential increase in the expansion rate of the plants. Once the plants reach this coverage level, salvinia will begin to rapidly form large mats in the open-water portions of the lake that do not dewater. This rapid expansion will continue through October if un-checked by a dewatering. The lake must be managed as a whole ecosystem. Recognizing the cyclical nature of aquatic systems, a plan must be derived that promotes the overall health of the system while trying to balance the interests of multiple user groups.

For Lake Bistineau, the following points are considered for selecting an appropriate opening date for drawdowns:

1. Mid-summer drawdowns have the highest probability for successfully controlling large amounts of giant salvinia. Since the plant is comprised of 95% water, it is killed through desiccation during hot, dry conditions. Once the stranded plants have dried, the salvinia control benefits of that particular dewatering have been fulfilled.
2. Drawdowns slow the expansion of salvinia during the hottest time of the year when the growth is very rapid. A relatively small delay in initiation may result in a much larger amount of salvinia present in the lake. History has shown that the more salvinia present when a drawdown is initiated, equates to more salvinia present when the drawdown is complete.
3. Drawdowns slow the eutrophication process by exposing the bottom sediments. This allows for aerobic decomposition of organics which improves spawning habitat, reduces stored nutrients in soil, slows the rate of build-up, and allows terrestrial vegetation to grow which offers food for waterfowl and other wildlife. The decomposition process occurs more rapidly during warm weather months than during the winter.
4. Reduction of organics on the lake bottom: Salvinia can create up to 100 tons of plant biomass per acre per year.
(<https://agresearchmag.ars.usda.gov/ar/archive/2004/sep/weevil0904.pdf>)
5. A large portion of this material is dying and falling to bottom without decaying. This accumulation continues unchecked until the area is dewatered. Large die offs from freezes or herbicide applications leave large amounts of material on the bottom. The 2014 die off from winter freezes on Black Bayou Lake left nearly a foot of organic material on the lake bottom, primarily consisting of decaying salvinia. Black Bayou Lake did not have drawdown capabilities at that time. Without dewatering, Lake Bistineau would experience similar build-up rates.

6. Fisheries improvements: Better bottom habitat equates to increased spawning success of desirable species such as bass, crappie, and bream. Predatory fish gain an advantage during low water periods in the fall when forage is concentrated, resulting in increased relative weights and growth rates. Additionally, low water periods in the summer increase angler success, and provide a beneficial recreational opportunity during the time of year where fishing becomes tough on most waterbodies. Mid-summer drawdowns also promote the increase in crawfish, crustaceans, and invertebrates that are beneficial food for fish populations. It is critical for successful spawning that water levels be stabilized by early March.
7. Teal hunters have reported good success in recent years while the lake is dewatered. Teal prefer locations with small pockets of water and adjacent flats compared to large expanses of open water.

For Lake Bistineau, the following points are considered for selecting an appropriate closing date for drawdowns.

1. A review of the 30-year average weather patterns for the area reveals that peak winter rains occur in November and December. Closing the gate during that time will allow this water to be retained in the lake. The lake will return to pool sooner, ensuring that water is in the lake for the spring fish spawning and peak fishing seasons. This will allow water to be reintroduced 2-3 months' sooner than past years (Jan. 31, closing date), thus providing a longer period of time each year where the lake will be at pool stage. Since salvinia is mostly dormant this time of the year, the plant populations are not likely to expand until late spring even with the lake at pool stage.
2. If a November/December closing date is chosen, more water will be in the lake for traditional winter recreational opportunities. Anglers can enjoy traditional winter crappie fishing in the deep area of the lake, or utilize yo-yo's to pursue fish around the cypress trees. The use of yo-yo's is very popular on the lake, but is very difficult when water levels are too low to reach limbs for hanging the devices. Waterfowl hunters will be able to hunt the second portion of the season with the lake at full pool. This would allow all hunters to reach their "traditional" blind areas. Newly flooded terrestrial vegetation should offer good food sources to attract more waterfowl.
3. A November/December closing date would significantly increase the likelihood that the lake would be at full pool by late February or early March. This is the peak time for most recreational fishing, especially bass fishing tournaments. Having predictable water levels in the spring would allow tournament organizers to more easily plan events. In recent years, many organizations have chosen not to hold events on Lake Bistineau because water levels and launching locations were not predictable. Local businesses will no doubt benefit from having the lake at full pool for this peak fishing season.
4. Once sufficient drying has occurred, additional benefits from the drawdown are unpredictable and dependent upon weather. As temperatures drop, daylight hours are diminished and precipitation increases in the fall and early winter. Drying conditions become less favorable on the lake bed. The lake will begin to fill even with the gates open due to the large watershed.

5. Significant freeze events that will cause a decrease in salvinia coverage are somewhat rare in the region. The lake has been at pool stage each time these events have occurred except in 2018. Salvinia mats provide calm water that is more easily chilled and frozen. During the 2010 freeze, ice formation was considerably thicker in the salvinia mats than the open portions of the lake. Increased precipitation occurs with these severe cold fronts which increases discharge rates in Bayou Dorcheat, and causes the lake level to rise despite the gates being open.

Lake Bistineau has a large watershed ratio of 60:1. This must be considered when making decisions regarding the proper timing to operate the control gates. Precipitation, daily temperature, lake levels and stream discharge data from 1957-2014 were analyzed and the following figures calculated:

1. Refill rates: the likelihood the lake would refill to pool by April 1 each year under different gate closing scenarios are presented in Table 2.

Table 2. The chance or likelihood (in percent) that Lake Bistineau, LA would refill to pool stage by April 1 under different gate closing scenarios.

Closing Date	Nov. 30	Dec. 31	Jan. 31	Feb. 28
% Chance of refilling by April 1.	88%	88%	79%	60%

2. Dewatering rates: the likelihoods the lake would not reach the target drawdown depth within 60 days are presented in Table 3. It is important to note for the September or October opening date, it was estimated that significantly more water would be remaining in the lake after 60 days.

Table 3. The likelihood that Lake Bistineau, LA would not reach the target drawdown depth within 60 days.

Opening Date	June 1	July 1	Aug. 1	Sept. 1	Oct. 1
% Chance not reaching target drawdown depth in 60 days.	17.5%	5%	2%	10.5%	17.5%

3. Refill of the lake prior to gate closing: With increased rainfall in November, December and January; it was estimated that the lake would return to pool 47% of the time by the end of January even with the gates open. Choosing a closing date at the end of January or February will be unsuccessful nearly half the time.

4. Significant cold events: The 2010 freeze event was significant, and was used as a baseline to determine how often such events might occur. A review of the daily temperature data showed that only 16 such events have occurred since 1957. This is a frequency of only 28% or approximately one out of every four years. Since 1991, only three (13%) such freeze events have occurred
5. Cold events combined with low lake levels: Data was analyzed to determine the likelihood of experiencing both a significant cold event combined with low lake levels if the gates remained open through February. Increased discharge rates were associated with 75% of the significant cold events between 1957 and 2014. It was estimated that the lake would have returned to pool in 57% of these years prior to the freeze event occurring. The likelihood of experiencing both a significant freeze event while the lake remained dewatered was estimated at only 7%. Therefore, a plan to leave the lake drawn down through February/March would be unsuccessful approximately 93% of the time.
6. November 15 is the average first-frost-date for the Shreveport, LA area. This represents the point where drying conditions on the lake bed will continue to decline through the winter. A closing date shortly after first-frost-date would allow for a freezing event prior to refilling the lake, yet taking advantage of winter rains for dispersing and flushing salvinia mats.
7. Lake rising with gates open: gauge height data from 2004-2015 was evaluated to determine the average date when Lake Bistineau levels begin to rise with winter rains. November 13 represents the average date the lake begins to rise over this 11-year period, despite the condition of the gates, open or closed.

Drawdowns are currently the most cost-effective management tool available for Lake Bistineau. The consequences of abandoning drawdowns would include unchecked coverage of giant salvinia, increased accretion of organic material on the lake bottom, and a significant decline in sportfish abundance. Drawdowns may be inconvenient for some user groups, but the consequences of abandoning them are unacceptable. The recreational and economic value of the lake would rapidly decline.

Trends in Recreational Use of Lake Bistineau

Lake Bistineau was historically known as not only a high use fishing lake, but also as a popular destination for local water sport enthusiasts. Over the last 15-20 years, the water sports use of the lake has declined. The decline can be partially attributed to the ever-present threat of salvinia, but can also be related to improvements on other waterways such as the Red River that are closer to metropolitan areas. Lake Bistineau experiences high use in the late-winter through spring, with declining use as the summer continues. Unlike other area lakes, Lake Bistineau sees a spike in use once a drawdown begins. On most lakes, the period from August to January represents the lowest use period. This is not the case on Lake Bistineau, as anglers are drawn to the lake due to high catch rates as the waters recede. Figure 22 below shows the spike in use of the lake once the drawdown begins compared to other lakes in the area. It is

likely that March and April are underrepresented for Lake Bistineau, as this data was collected during a time when the lake was closed due to historic flooding.

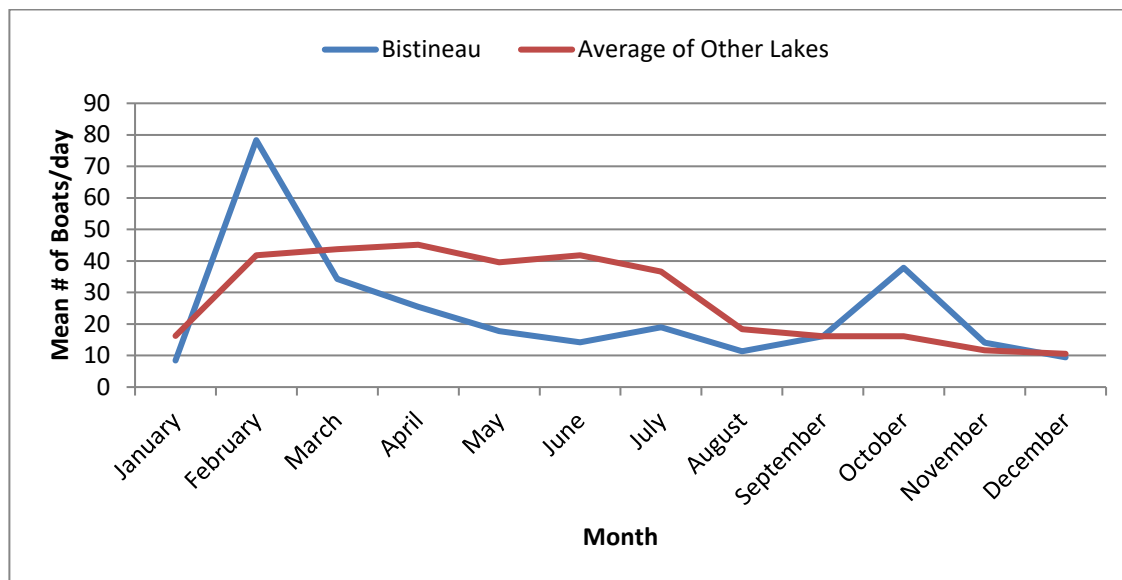


Figure 22. Access point boat count data for Lake Bistineau, LA for 2016 compared to similar data from Cross, Caney, and Caddo Lakes, LA (2010-2015).

Artificial Structure

No artificial reefs have been placed in the lake by the Department of Wildlife and Fisheries. Man-made structures along the shoreline of the lake such as piers and boat houses, in addition to duck blinds and ski platforms in the open water areas do provide additional cover for fish. Some anglers place artificial structures and sunken tree tops in some areas of the lake to attract fish to their favorite fishing spots.

Substrate

The bottom substrate in many areas of Lake Bistineau is composed largely of organic detritus. Leaf litter from the cypress trees along with the overabundant aquatic vegetation in the lake is the major factor contributing to the buildup of organic material. Prior to impoundment, low water levels in the late summer and fall allowed aerobic decomposition of this organic material. With permanent impoundment, this material undergoes a much slower decomposition process through anaerobic activity. As a result, eutrophication has increased as the organic material on the lake bottom slowly decomposes. Spawning substrate was impaired and sportfish populations declined. Two consecutive midsummer drawdowns were conducted in 2004-2005, and 2005-2006 for the purpose of improving substrate. The drawdowns began on July 15 of each year and extended through the end of the following January. The lake was lowered 7 feet (maximum drawdown potential). Positive results were documented. The depth of the organic material was reduced in areas of the lake that were exposed to air. In some areas, sandy ridges were exposed as the organic material dried and decomposed.

Two methods were utilized to quantify the consolidation of the bottom sediments. Prior to implementing the drawdowns, the upper layer of many areas appeared to be comprised mostly

of organic detritus in varying stages of decomposition. One method involved the use of an improvised device termed as the “muckometer.” This device was used to differentiate between soft and hard bottoms while the lake was at normal levels. A 12-inch diameter perforated aluminum disk was mounted on a length of pipe which served as a sleeve for a ½ inch metal rod which slid down to identify the hard bottom. This device was placed vertically in the water until the perforated disk contacted the soft bottom of the lake. The weight of the apparatus defined the depth of the soft bottom. A set screw was then loosened to allow the ½ inch metal rod to slide freely within the sleeve. A pressure scale was then used to apply 10 pounds of pressure to the top of the metal rod. The weight forced the rod through the soft organic material to hard bottom. The set screw was then tightened and measurements made of the rod protruding past the disk providing a rough estimate of organic material depth. Three measurements were made at each station. The results of these measurements are found in Figure 23.

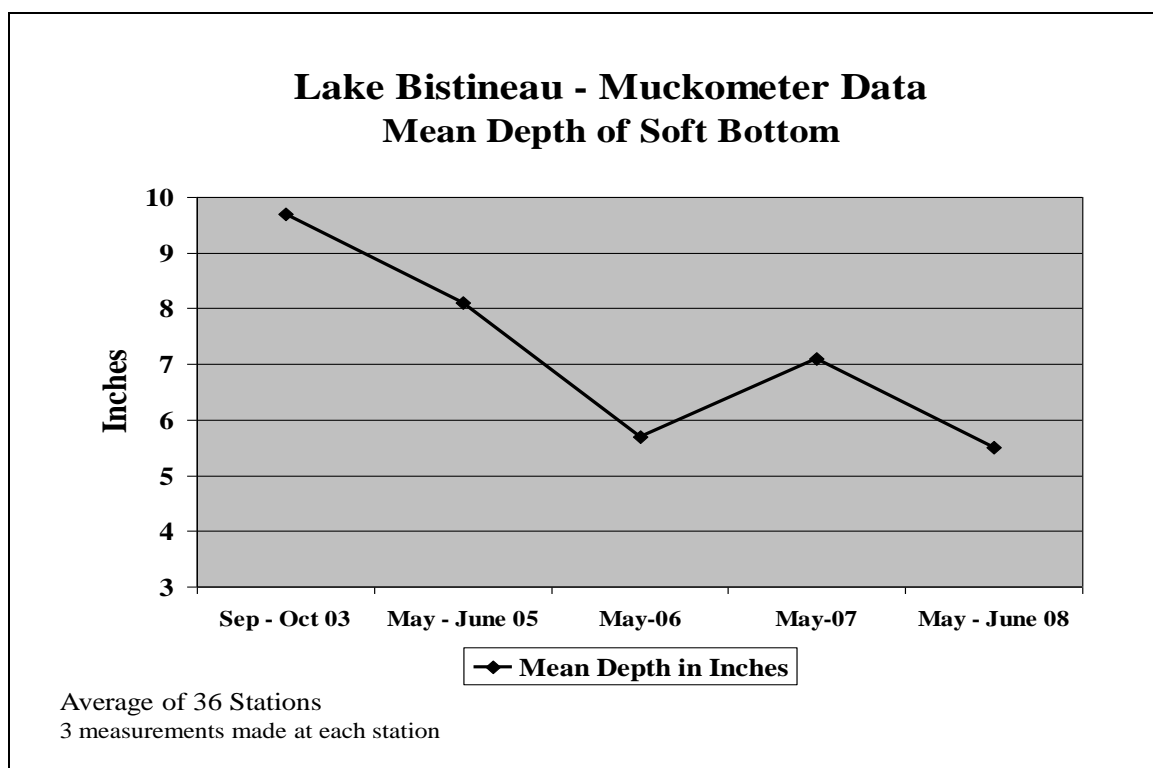


Figure 23. Sediment and organic detritus analysis of the bottoms of Lake Bistineau, LA, from 2003 – 2008. Values are reported in mean depth of accumulated soft bottom sediments and organics.

The results showed compaction of bottom substrates from dewatering the lake each year during mid-summer. Following the 2004 and 2005 drawdowns, the average depth of the soft bottom (organic material) was reduced by 40% for the entire lake bed with more drastic results observed in several locations. The initial sampling was conducted prior to the introduction of giant salvinia. However, measurements taken in 2008 revealed information about the increased rate of build-up of organic material in areas where salvinia mats persisted. Areas where salvinia was present for all of 2007 showed an average increase of 15% in organic

material on the bottom from the measurements taken in early 2006. A similar area of the lake that did not have salvinia present was analyzed over the same time period and showed no increase in the average depth of the soft bottom.

The other method consisted of placing 3/4" PVC stakes in the lake bed during the initial dewatering process of the 2004 drawdown. Stakes were pushed into the lake bed and then hammered in further to point of refusal for further penetration. The stakes were allowed to protrude 1.5 inches above the bottom substrate. After significant drying action occurred during the 2004 drawdown and in subsequent drawdowns, measurements of height that the stakes protruded were made. The difference in the heights roughly equates to the reduction in organic material at the site. Figure 24 provides a graphic representation of the compaction of the lake bed. Both methods indicate a significant consolidation of the bottom sediments following the drawdowns. Conversely, some accretion of bottom sediments occurred during periods when the lake was not influenced by a drawdown.

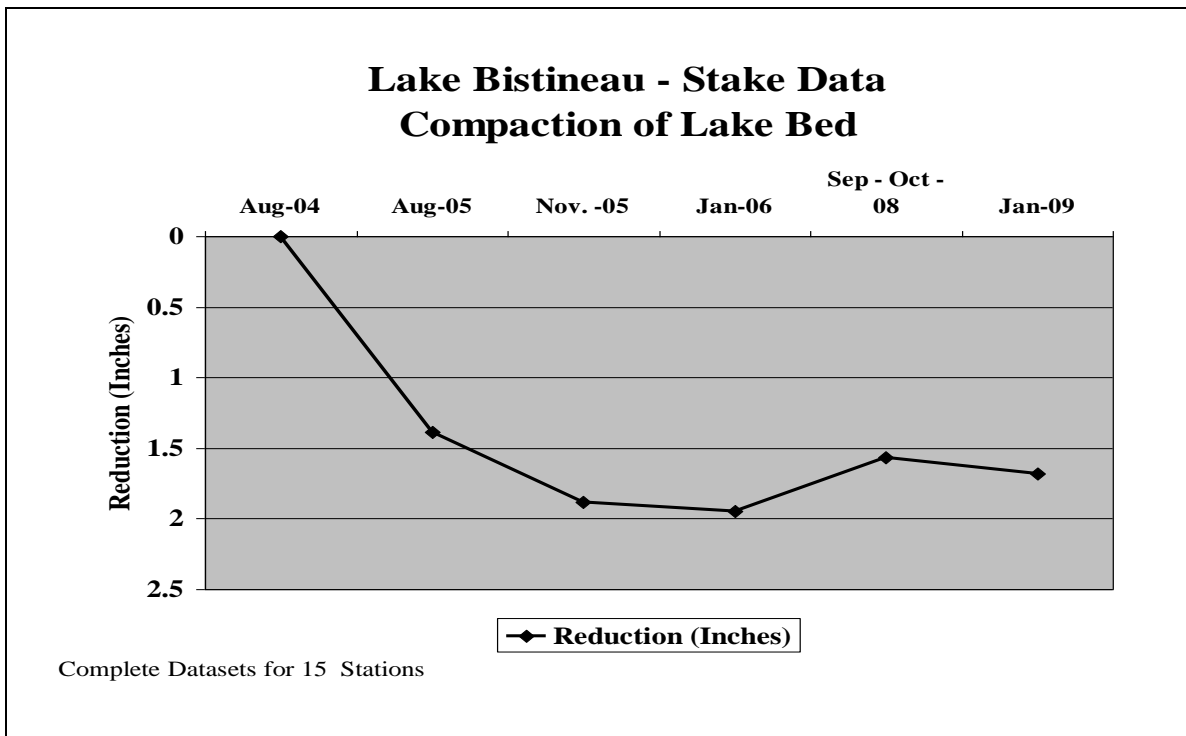


Figure 24. The compaction rates of sediments on the bottom of Lake Bistineau resulting from drying and desiccation of mud and organic detritus during periods of drawdown, for 2004 - 2009. Values are average reduction of the bottom sediments as compared to PVC stakes driven into the lake bed to the point of refusal at 15 different stations.

CONDITION IMBALANCE/ PROBLEM

Three major issues are threatening Lake Bistineau and hindering the successful management of the resources of the lake. The first is overabundant aquatic vegetation. Aquatic vegetation has been a problem since Lake Bistineau was impounded and the water regime changed from the natural fluctuation to permanent impoundment. Over the years, several species of aquatic vegetation have been problematic, but control was eventually achieved. Giant salvinia has proven to be an exception to date. The invasive species was discovered in 2006 and has confounded most control measures due to tremendous reproductive potential.

Habitat degradation has occurred from the accumulation of organic material. Prior to impoundment, natural low water periods during late summer and fall allowed for aerobic decomposition of organic material. The accumulation of organic material reduced quality nesting habitat resulting in an associated decline in sportfish production. Nest building sportfish species have increased abundance in association with recent dewatering events.

The third major issue on Lake Bistineau is the physical, geographical, and structural limitations of the reservoir. Lake Bistineau can be characterized as a permanently flooded swamp. It has expansive areas of shallow water that are prone to infestations of emergent and submersed aquatic vegetation. The dense stands of cypress trees prevent wind and wave action and provide ideal habitat for floating aquatic vegetation. The reservoir has a large watershed which complicates water level control efforts.

CORRECTIVE ACTION NEEDED

The three major issues that exist with Lake Bistineau began when the reservoir was built in an area not suited to be permanently flooded. Making major changes to the reservoir such as re-designing the dam/control structure or removing large expanses of timber are cost-prohibitive, unrealistic, and would provide unknown results. Therefore, making such major changes is not recommended for the control of giant salvinia.

Annual mid-summer drawdowns are needed to mimic the natural water regimes of the area. An annual drawdown strategy would help control excessive aquatic vegetation, reduce the buildup of organic material, and improve aquatic habitats within Lake Bistineau. Currently, drawdowns are the most cost-effective management tool available for Lake Bistineau. The consequences of abandoning drawdowns would include unchecked coverage of giant salvinia, increased accretion of organic material on the lake bottom, and a significant decline in sportfish abundance. Drawdowns may be inconvenient for some user groups, but the consequences of abandoning them are unacceptable. The recreational and economic value of the lake would rapidly decline. The strategy considers the interests of all user groups and attempts to maximize the recreational opportunities that exist on the lake while also improving the overall health and longevity of the lake.

RECOMMENDATIONS

1. LDWF should continue an integrated approach to control giant salvinia on Lake Bistineau. LDWF should use an integrated management program of water level fluctuations, herbicide applications, and biological control measures to achieve combined benefits. This approach is designed to reduce vegetation levels while maximizing the recreational use of the lake for activities such as fishing, boating, duck hunting, water sports, etc. This approach should also slow the eutrophication process on Lake Bistineau.
2. LDWF should conduct annual drawdowns of Lake Bistineau for organic reduction, aquatic habitat improvement, and giant salvinia control. LDWF biologists will estimate giant salvinia coverage in spring (early April), in mid-summer (early July), and at the conclusion of the drawdown (late November), so that data can be maintained to evaluate the program.

The drawdown should be conducted with specific recommendations for dewatering as follows:

- The gates should be scheduled to be opened no later than the third Monday in July each year (July 15-21).
- The target water level for Lake Bistineau drawdowns is eight feet below spillway crest height (maximum drawdown potential).
- Dewatering rate should be 4-6 inches per day.
- The opening date allows for use of the reservoir at full pool for the 4th of July holiday weekend, and allows individuals an adequate time period to remove vessels from the lake and make necessary preparations prior to dewatering.

The gates will be closed on November 30 each year. If November 30 is a Saturday or Sunday, then the gates will be closed on the following Monday. November 15th is the historical average-first-frost-date of the year for the area and represents the point where drying conditions will be diminished on the lake bed.

3. LDWF should continue to conduct public information meetings as necessary at the Region 1 office to update the public on the situation on the lake, and to answer questions.
4. LDWF should conduct strategic foliar herbicide applications to giant salvinia and other noxious aquatic vegetation. The herbicide diquat will be used for giant salvinia control from November 1 through March 31 at 0.75 gallons per acre mixed with a total of 1 quart per acre of a 90:10 nonionic surfactant. Outside of that time frame, giant salvinia will be controlled with a mixture of glyphosate (0.75 gal/acre) and either diquat (0.25 gal/acre) or flumioxazin (2 oz./acre) with Turbulence (or approved equivalent, 0.25 gal/acre) surfactant. Major herbicide applications should only be used in conjunction with a drawdown.
5. The use of water soluble herbicides such as Galleon or Sonar should be considered for treatment of areas where salvinia remains in isolated waters during a drawdown or in other areas where applicable.
6. LDWF should continue scheduled standardized sampling of fish populations.
7. LDWF should continue Florida Largemouth Bass stockings.

8. LDWF should continue existing recreational and commercial harvest regulations until sampling results indicate a biological need to change management strategies.
9. Should LDWF and its research partners develop or discover an ecotype of salvinia weevil that is more cold-tolerant, Lake Bistineau should be the test grounds for field trials of any such weevils. LDWF should closely monitor any such populations of weevils and quantify the results of any such stockings.
10. LDWF should continue marking navigation channels on Lake Bistineau. Local parishes have provided some signs, but additional funding will be necessary to purchase additional signs and other materials necessary to mark the entire lake. LDWF should work to develop partnerships to achieve this goal.
11. LDWF should initiate work to investigate logistics of strategic stump cutting and removal of other navigational hazards present during drawdowns.
12. LDWF should investigate and develop partnerships to expand access to the lake during drawdown periods.
13. A survey should be conducted to clearly define the borders of the Lake Bistineau Game and Fish Preserve. An updated and formal delineation of the boundary is required before any of the existing problems associated with land ownership can be resolved. Any such survey would need to be funded and coordinated with Office of State Lands and the local parishes.
14. LDWF should continue to cooperate with the Louisiana Department of Transportation and Development to develop a project to limit erosion downstream of the Bistineau spillway in the Stumpy Lake and Loggy Bayou Area. Reoccurring erosion problems threaten the integrity of the Lake Bistineau dam and spillway.

Literature Cited

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