PERFORMANCE REPORT

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INLAND FISHERIES DIVISION MONITORING AND MANAGEMENT PROGRAM

2011 Survey Report

Lake Livingston

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SURVEY AND MANAGEMENT SUMMARY

Fish populations in Lake Livingston were surveyed in 2011 using electrofishing and trap netting and by gill netting in 2012. Anglers were surveyed from June 2011 through May 2012 with a roving creel survey. This report summarizes the results of the surveys and contains a management plan for the reservoir based on those findings.

- **Reservoir description:** Lake Livingston is an 83,277-acre mainstream impoundment on the Trinity River in Trinity, Polk, San Jacinto, and Walker Counties, Texas. Constructed in 1969 by the Trinity River Authority (TRA) and the City of Houston, the reservoir has provided water for municipal, agricultural, and industrial purposes. Private and commercial real estate development, as well as Lake Livingston State Park and several TRA public parks, are present in the lower two-thirds of the reservoir.

- **Management history:** All sport fisheries at Lake Livingston are regulated under statewide length and bag limits with the exception of the bag limit (50 fish/angler/day) for channel and blue catfish. Striped bass fingerlings are stocked annually. The tailrace provides TPWD hatcheries with brood-stock for striped bass and palmetto bass production. Primary management challenges include heavy silt loading and management of the invasive aquatic plants giant salvinia, water hyacinth, and water lettuce. Florida largemouth bass are stocked periodically.

- **Fish community**

  - **Prey species:** Gizzard and threadfin shad, inland silversides, and bluegill are the predominant prey species in Lake Livingston. Other less numerous prey fishes include longear sunfish, bullhead minnow, green sunfish, warmouth, redear sunfish, and spotted sunfish.

  - **Catfishes:** Blue, channel, and flathead catfishes are present, with blue catfish being the dominant species. Commercial trotlines are allowed on Lake Livingston. Blue and channel catfish are the most sought-after species group by anglers at Lake Livingston.

  - **Temperate basses:** White bass gill net catch rates have decreased since the 2007-2008 survey, and directed angler effort for white bass has declined. Angler catch and harvest have also declined since the previous survey. Gill net catch rate of striped bass was similar to the 2007-2008 survey. Harvest of striped bass has increased since the previous survey.

  - **Largemouth bass:** Electrofishing catch rates of largemouth bass have been low at Lake Livingston. Degradation of habitat because of heavy silt loading and shoreline bulkhead construction limits the amount of available habitat for spawning and survival of juvenile bass. Directed angler effort, catch, and harvest for largemouth bass has increased since the 2007-2008 survey.

  - **Crappie:** White crappie outnumbered black crappie during previous surveys, but black crappie catch was higher than white crappie catch in 2011. Recent trap net catches of both crappie species have been low but have increased since the 2003-2004 survey.

- **Management strategies:** Statewide length and bag limits will continue to be used to regulate sport fish harvest. Cooperative efforts with the TRA will continue to address invasive aquatic vegetation issues.

INTRODUCTION

This document is a summary of fisheries data collected from Lake Livingston from June 2011 through May 2012. The purpose of the document is to provide fisheries information and make management recommendations to protect and improve the sport fishery. While information on other species of fishes was collected, this report deals primarily with major sport fishes and important prey species. Historical data are presented with the 2011 and 2012 data for comparison.

Reservoir Description

Lake Livingston is located on the Trinity River in Trinity, Polk, San Jacinto, and Walker Counties, Texas contained within the Piney Woods Vegetation Area. Soil types are Kaufman-Trinity, Lufkin-Tabor, Bowie-Kirvin, and Susquehana Associations. These Associations are generally deep and moderately well drained soils made up of clay to sandy loam. Lake Livingston was constructed in 1969 by the Trinity River Authority (TRA) and the City of Houston to provide water for municipal, agricultural, and industrial purposes. Lake Livingston has a surface area of 83,277 acres, a drainage area of approximately 15,700 square miles, and a shoreline length of approximately 350 miles. Rainfall in the watershed averages 48.0 inches per year. There is considerable private and commercial real estate development, as well as Lake Livingston State Park and several TRA public parks, around the lower two-thirds of the reservoir. Monthly water level elevations are reported in Figure 1. Other physical characteristics of Lake Livingston are presented in Table 1.

Management History

Previous management strategies and actions: Management strategies and actions from the previous survey report (Henson and Webb 2008) included:

1. Conduct habitat restoration efforts in littoral areas to improve habitat for sport fish (e.g., largemouth bass) populations at Lake Livingston.
   Action: TPWD is in the process of collaborating with the Lake Livingston Chapter of the Texas Master Naturalist Program and Texas Black Bass Unlimited (TBBU) to develop native plant nurseries to provide plants for habitat restoration efforts. The success of prior restoration efforts is limited to small areas.
2. Continue to monitor striped bass movement through the dam to the tailrace as well as the directed angling effort for striped bass.
   Action: TPWD continued procurement of adult striped bass from the Livingston tailrace for hatchery production of palmetto bass and striped bass fingerlings. TPWD has stocked 2,773,164 striped bass fingerlings in Lake Livingston since 2007.
3. Control the invasive aquatic species water lettuce and water hyacinth to improve recreational access to Lake Livingston.
   Action: TPWD has offered assistance to TRA as needed for monitoring and treating the invasive vegetation. TPWD conducted a vegetation survey during the summer of 2011 and will continue to monitor for these species. Giant salvinia was also discovered in Lake Livingston during summer 2011 and was treated by TRA and TPWD.
4. Monitor the population of blue catfish within the reservoir and promote the increasingly popular fishery.
   Action: TPWD conducts routine gill net surveys to monitor population trends of blue catfish. News releases and interviews with the media have been conducted to promote the fishery at Lake Livingston.

Harvest regulation history: All sport fisheries are regulated under statewide length and bag limits with the exception that the bag limit for channel and blue catfish is 50 fish /day in combination (Table 2). Commercial fishermen are allowed to target blue and channel catfish by pole-and-line, juglines,

throwlines, or trotlines. Further, commercial fishermen are subject to a daily bag limit of 50 blue and channel catfish and a minimum size limit of 14 inches.

Stocking history: The first stockings into Lake Livingston were channel and blue catfish and largemouth bass in 1969 and 1970. Striped bass were first introduced in 1977 and have been stocked annually since with the exception of four years. Florida largemouth bass were first stocked into Lake Livingston in 1975 and were stocked four years consecutively. Florida largemouth bass were not stocked again until 1996. Florida bass fingerlings have been stocked since then in 2000, 2001, 2006, and 2007. ShareLunker largemouth bass fingerlings were stocked in 2011. A complete stocking history is presented in Table 3.

Vegetation/habitat history: Habitat management at Lake Livingston has two major components: invasive aquatic vegetation control and littoral habitat enhancement. The Trinity River Authority is currently treating giant salvinia, water hyacinth, and water lettuce with herbicide throughout the growing season to keep these species under control. In past years, TPWD and TBBU have had some success planting native aquatic vegetation but established areas are limited. Boat docks, bulkheads, and eroded bank are the predominant physical shoreline habitat types. An area of approximately 5,700 acres of standing timber occupies the middle portion of the reservoir.

Water Transfer: Livingston Reservoir was built by the TRA for municipal water supply. The TRA is currently a water wholesaler to the Houston/Galveston metropolitan complex and surrounding areas. Raw water outflow from the Livingston spillway is released back into the Trinity River and eventually drains into Trinity Bay and the Gulf of Mexico.

METHODS

Fishes were collected by electrofishing (2 hours at 24, 5-minute stations) trap netting (15 net nights at 15 stations) and gill netting (15 net nights at 15 stations). Catch per unit effort (CPUE) for electrofishing was recorded as the number of fish caught per hour (fish/h) of actual electrofishing and for trap nets and gill nets as the number of fish per net night (fish/nn). All survey sites (Appendix B) were randomly selected, and all surveys were conducted according to the Fishery Assessment Procedures Manual (TPWD, Inland Fisheries Division, unpublished manual revised 2011).

A roving creel survey was conducted from June 2011 through May 2012. The lake was divided into three sections with one section being surveyed during each three-hour creel period. Surveys consisted of 9 creel days per quarter (4 weekdays and 5 weekend days).

Sampling statistics (CPUE for various length categories), structural indices [Proportional Size Distribution (PSD), as defined by Guy et al. [2007], and relative weight (W_r) were calculated for target fishes according to Anderson and Neumann (1996). Index of vulnerability (IOV) was calculated for gizzard shad (DiCenzo et al. 1996). Relative standard error (RSE = 100 X SE of the estimate/estimate) was calculated for all CPUE statistics and for creel statistics, and SE was calculated for structural indices and IOV. Water level data was provided by the Trinity River Authority (Figure 1).

RESULTS AND DISCUSSION

Habitat: A shoreline habitat and vegetation survey was conducted in June 2011. No changes to shoreline physical habitat were noted since the survey in 2003 (Webb and Henson 2004). As a result of low water levels at the time of sampling (Figure 1), no vegetation was observed in the reservoir (Table 4).

Creel: Directed fishing pressure remained consistent from 2007-2008 (82,760 h) to 2011-2012 (82,954 h), but effort reported in both surveys was lower than effort reported in the 2003-2004 survey (101,132 h) (Table 6). The 2011-2012 survey indicated that total expenditures have increased from $212,890 to

$382,470 since the 2007-2008 monitoring period (Table 6). Catfishes (blue and channel) and largemouth bass were the most targeted species groups during the 2011-2012 survey (Table 5).

Prey species: Clupeids (threadfin and gizzard shad) continue to dominate the forage base in Lake Livingston; gizzard shad is the dominant species of the two (Appendix A). Since the 2007-2008 survey, the electrofishing catch rate of gizzard shad decreased to 137.5/h in the 2011-2012 survey, likely a result of low water levels during sampling. Likewise the catch rate of threadfin shad in electrofishing decreased from 266.5 in 2007 to 47.0 in 2011. Most gizzard shad in the sample were available as prey (IOV = 93.0) (Figure 2).

Inland silversides had the third-highest electrofishing catch rate (22.5/h) (Appendix A) and have become more numerous than they were in the previous survey (Henson and Webb 2008). Bluegill catch rates dropped from 79.5/h in the 2007-2008 survey to 20.0/hr in the 2011-2012 survey (Figure 3). Further, bluegill, the fourth most dominant prey species, were the most abundant of the sunfishes in the 2011 sample. Most individuals captured were less than 6 inches and were available as prey. Another prey species present in the 2011 sample was the longear sunfish with an electrofishing catch rate of 7.5/hr. The low water levels during sampling may have resulted in the reduced CPUE of sunfishes because of limited availability of suitable habitat and accessibility by the gear.

Catfishes: Blue catfish continue to be the dominant catfish species in Lake Livingston. The 2012 gill net catch rate was 34.8/nn which was higher than in 2008 (22.8/nn) and 2004 (23.9/nn) (Figure 4). Length frequency data indicate good size distribution with fish as large as 29 inches. The PSD of the sample was 14 in 2012 and has remained consistent with previous surveys (Webb and Henson 2004; Henson and Webb 2008). The condition (W_r) of the blue catfish exceeded 90 for most size classes. Channel catfish are far less abundant than blue catfish in Lake Livingston. However, CPUE in 2012 (4.1/nn) was higher than it was in 2008 (3.0/nn) and 2004 (2.3/nn) (Figure 5). Most of the fish collected in gill net samples in 2012 were too small to be legally retained. Flathead catfish occur in Lake Livingston but are rarely encountered in gill net surveys. Flathead catfish have not been captured since the 2007-2008 survey (Henson and Webb 2008).

Anglers spent 52,325 hours seeking catfishes (all species combined) (Table 7) and angler harvest was high. Approximately 33,058 blue catfish and 5,567 channel catfish were harvested during the June 2011 to May 2012 creel period (Table 7, Figure 6).

Since 2006, reported commercial landings of blue catfish have increased in both total weight and monetary value (Appendix C). In 2010, commercial fishermen reported the highest total weight (110,682 lbs) and value ($110,549) of blue catfish caught in Lake Livingston, but less total weight (94,554 lbs) and value ($94,398) were reported in 2011. Additionally, the monetary value of individual catfish appeared to decrease from 2006 to 2007, but began to increase from 2007 to 2010.

Temperate basses: White bass continue to be less abundant in the surveys of Lake Livingston. The gill net catch rate of white bass in 2011 (3.1/nn) decreased from the 2008 rate (10.5/nn) (Figure 8). All of the stock-sized fish in the sample were of legal size.

Although striped bass have been stocked in Lake Livingston almost every year since 1977, fisheries monitoring surveys have not documented the presence of a significant population or fishery. In 2004, the catch rate was 2.4/nn, the highest ever observed (Webb and Henson 2004), but the rate decreased in 2008 (1.5/nn) and remained the same in 2012 (Figure 8). Striped bass stocked into the reservoir appear to support a significant striped bass fishery in the tailrace below the dam. This area is used by TPWD to obtain striped bass brood fish necessary to support statewide hatchery production of striped bass and Palmetto bass. Possibly, some of the large striped bass in the tailrace may exhibit anadromy in that during spring some may migrate upstream from the Gulf of Mexico. An in-house research project is

currently being conducted to determine if there is any evidence of anadromy. Striped bass in the reservoir were in good body condition.

Anglers allocated less directed angling effort for both white and striped basses during the 2011-2012 survey (4,925 h) than they did in 2007-2008 (19,913 h) (Table 8). Further, angler catch rate of temperate basses decreased in 2011-2012 to 4.3/h from 4.9/h observed in the 2007- 2008 survey. Anglers harvested fewer white bass than in years prior, and 15.5% of fish released were of legal-size or more; anglers released more fish than documented in the previous surveys (Webb and Henson 2004; Henson and Webb 2008). Anglers harvested an estimated 18,483 white bass which ranged in length from 10 to 13 inches (Figure 9). Creel surveys indicate that anglers in Lake Livingston seldom target striped bass (Webb and Henson 2004; Henson and Webb 2008). During the 2011-2012 survey, an estimated 447 striped bass were harvested (Table 8), and two fish over 18 inches were observed harvested (Figure 9).

Largemouth bass: Electrofishing rates of largemouth bass at Lake Livingston have generally been low (Webb and Henson 2004; Henson and Webb 2008). During the 2003-2004 survey, the electrofishing catch rate of largemouth bass was 16/h, and it increased in the 2007-2008 survey (18/h) with only one legal-sized fish in the sample. During 2011, the electrofishing catch rate further declined (7.5/h), but legal-sized fish represented a higher proportion of the sample (Figure 10). The low electrofishing CPUE of largemouth bass observed in 2011 is probably related to poor aquatic habitat resulting from reduced lake elevation at the time of sampling. Florida largemouth bass fingerlings were stocked in 2000 and 2001 (over 1 million fish) and again in 2006 and 2007 (Table 3) in an attempt to increase the Florida genetic influence in the population. In 2010, Sharelunker largemouth bass fingerlings (2,069) were stocked into Lake Livingston to further increase trophy potential. To date, there has been little change in allele frequencies. Of the 30 largemouth bass collected during the spring 2012, 26% carried Florida largemouth bass alleles, and 74% of the fish collected carried northern largemouth bass alleles. No pure Florida largemouth bass were collected during sampling (Table 10).

From June 2007 through May 2008, directed effort declined to 1,252 hours down from 34,965 h in the 2003-2004 survey; at the time, this represented only 2.2% of total fishing effort. However, in 2011-2012 angler effort increased (13,724 hours) and largemouth bass were the second most targeted species in Livingston (Table 5). Largemouth bass harvest increased to 1,533 fish during 2011 to 2012 creel from 2007-2008 survey (0 fish) but the level is still much lower than the observed harvest observed during the 2003-2004 survey (15,952 fish). Eight largemouth bass were observed harvested in the creel, and anglers released 21.6% of legal bass caught. (Table 9, Figure 11).

Crappie: During 2011, trap net CPUE was similar for black crappie (1.0/nn) and white crappie (0.8/nn) although white crappie are usually more abundant (Figures 12 and 13). All size classes of white and black crappie had relative weights over 100. Length frequency data suggest that crappie recruitment is poorer than reported in the previous surveys (Webb and Henson 2004; Henson and Webb 2008). Creel data indicated a minimal fishery for crappie at Lake Livingston. An estimated 787 h of directed angling effort for crappie was observed at Lake Livingston during the 2011-2012 survey (Table 11), which represents less than 1% of total fishing effort (Table 5). Observed harvests of both crappie species were low, with white crappie having more harvest (811 fish) than black crappie (203 fish) (Figure 14).

Fisheries management plan for Lake Livingston, Texas

Prepared–July 2012.

ISSUE 1: Littoral habitat degradation and siltation have likely contributed to a decline in the largemouth bass population at Lake Livingston. The 2003 to 2004 creel data indicated that largemouth bass were the most targeted species at Lake Livingston. Directed angling effort for this species has increased from 2.2% (2007-2008) to 16.5% (2011-2012), but effort is still lower than reported in years prior to the 2007-2008 survey. The fall 2007 electrofishing length frequency data indicate few legal-size fish in the population, which could account for the relatively low interest in largemouth bass by anglers. Estimated harvest of largemouth bass declined from 15,952 fish in 2003-2004 harvest to only 1,533 in 2011-2012.

MANAGEMENT STRATEGIES

1. Seek funding to underwrite efforts to increase native littoral vegetation in backwaters and creeks where probability of success is highest.
2. Support efforts by TTBU to place structural habitat in Lake Livingston.

ISSUE 2: Striped bass in the Lake Livingston tailrace provide both a popular fishery and a source for brood fish; however, there is only a marginal fishery for striped bass in the reservoir itself despite nearly a million striped bass being stocked into Lake Livingston each year.

MANAGEMENT STRATEGIES

1. Support an in-house research project currently underway to investigate whether stocked striped bass move through the Lake Livingston Dam and into the tailrace.
2. Continue to research the best methods for anglers to utilize the striped bass fishery in the reservoir and provide that information to the public.

ISSUE 3: During previous surveys, Lake Livingston has been infested with the invasive aquatic plants such as water hyacinth and water lettuce at levels that impede access. During the 2011 habitat survey when Lake Livingston water levels were reduced, no aquatic vegetation, either native or invasive, was observed; however, giant salvinia, water hyacinth, and water lettuce are expected to re-infest the reservoir as water levels return to normal.

MANAGEMENT STRATEGY

1. Continue to support the Trinity River Authority's efforts to control giant salvinia, water hyacinth, and water lettuce with funding and labor.

ISSUE 4. Many invasive species threaten aquatic habitats and organisms in Texas and can adversely affect the state ecologically, environmentally, and economically. For example, zebra mussels (*Dreissena polymorpha*) can multiply rapidly and attach themselves to any available hard structure, restricting water flow in pipes, fouling swimming beaches and plugging engine cooling systems. Giant Salvinia (*Salvinia molesta*) and other invasive vegetation species can form dense mats, interfering with recreational activities like fishing, boating, skiing and swimming. The financial costs of controlling and/or eradicating these types of invasive species are significant. Additionally, the potential for invasive species to spread to other river drainages and reservoirs via watercraft and other means is a serious threat to all public waters of the state.

MANAGEMENT STRATEGIES

1. Cooperate with the controlling authority to post appropriate signage at access points around the reservoir.
2. Contact and educate marina owners about invasive species, and provide them with posters, literature, etc. so that they can in turn educate their customers.
3. Educate the public about invasive species through the use of media and the internet.
4. Make a speaking point about invasive species when presenting to constituent and user groups.
5. Keep track of (i.e., map) existing and future inter-basin water transfers to facilitate potential invasive species responses.

SAMPLING SCHEDULE JUSTIFICATION: Electrofishing, trap netting, and gill netting surveys will be conducted every four years to monitor trends in sport fish populations (Table 12). A creel survey will be conducted every four years to monitor angler activity. A complete habitat survey will be conducted every four years with exotic vegetation surveys conducted annually to monitor problem infestations. An angler access survey will be conducted every four years. Other sampling will be conducted in support of research efforts as the need arises.

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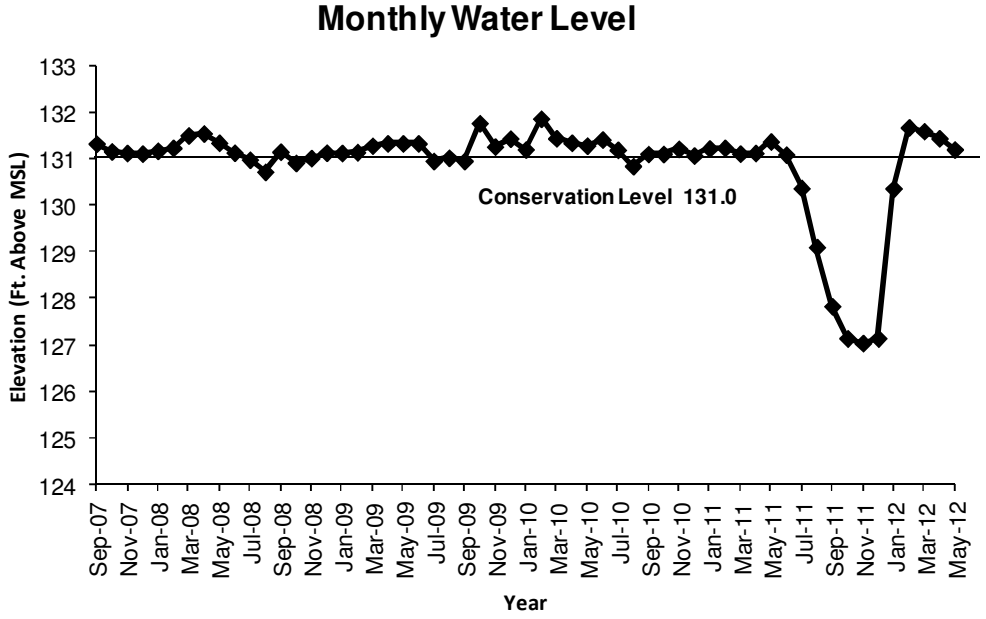


Figure 1. Quarterly water level elevations in feet above adjusted mean sea level (MSL) recorded for Lake Livingston, Texas, September 2007-May 2012.

Table 1. Characteristics of Lake Livingston, Texas.

Characteristic	Description
Year constructed	1969
Controlling authority	Trinity River Authority
County	Polk (location of dam), Trinity, San Jacinto, and Walker
Reservoir type	Main stream (Trinity River)
Shoreline Development Index (SDI)	10.7
Conductivity	200-450 umhos/cm

Table 2. Harvest regulations for Lake Livingston, Texas.

Species	Bag Limit	Minimum-Maximum Length (inches)
Non-commercial Anglers		
Catfish: blue and channel catfishes, their hybrids and subspecies	50[a]	12 - No Limit
Catfish, flathead	5	18 - No Limit
Bass, white	25	10 - No Limit
Bass, largemouth	5	14 - No Limit
Crappie: white and black crappie; their hybrids and subspecies	25	10 - No Limit

[a] Walker, Trinity, San Jacinto, and Polk Counties only

Table 2 (continued). Harvest regulations for Lake Livingston, Texas.

Species	Bag Limit	Minimum-Maximum Length (Length)
Commercial Anglers		
Catfish: blue and channel catfishes, their hybrids and subspecies	50[a]	14 - No Limit

[a] Walker, Trinity, San Jacinto, and Polk Counties only

Table 3. Stocking history of Lake Livingston, Texas. Size categories are Fry =< 1inch, Fingerling (FGL) = 1-3 inches, and Adult (ADU) = Adult.

Species	Year	Number	Size
Blue catfish	1969	159,800	FGL
	2012	21	ADU
	Total	159,821	
Channel catfish	1969	634,905	FGL
	1970	254,000	FGL
	Total	888,905	
Striped bass	1977	884,726	FGL
	1978	117,091	FGL
	1979	224,000	FGL
	1980	283,584	FGL
	1982	341,357	FGL
	1983	189,265	FGL
	1984	1,424,455	FGL
	1985	896,996	FGL
	1986	448,485	FGL
	1987	898,585	FGL
	1988	899,615	FGL
	1989	905,687	FGL
	1992	351,750	FGL
	1993	405,370	FGL
	1994	1,788,670	FGL
	1995	900,833	FGL
	1996	441,079	FGL
	1997	985,431	FGL
	1998	689,849	FGL
	1999	913,952	FGL
	2000	900,264	FGL
	2002	1,392,893	FGL
	2003	1,032,104	FGL
	2004	437,308	FGL
	2005	526,148	FGL
	2006	746,278	FGL
	2007	796,122	FGL
	2008	206,090	FGL
	2009	814,606	FGL

Table 3 (continued). Stocking history of Lake Livingston, Texas. Size categories are Fry =< 1inch, Fingerling (FGL) = 1-3 inches, and Adult (ADU) = Adult.

Striped bass	2010	1,938,340	FRY
	2010	653,019	FGL
	2011	50,687	FGL
	2012	252,640	FGL
	Total	23,737,279	
Largemouth bass	1969	1,018,400	FGL
Florida largemouth bass	1975	26,000	FGL
	1976	22,000	FGL
	1977	250,330	FGL
	1978	753,286	FGL
	1996	889,304	FGL
	2000	501,639	FGL
	2001	500,018	FGL
	2006	201,694	FGL
	2007	200,586	FGL
	Total	3,344,857	
Sharelunker Largemouth Bass	2010	2,069	FGL
Paddlefish	1990	63,232	FGL
	1991	34,132	FGL
	1992	5,136	FGL
	1993	28,003	FGL
	Total	130,503	

Table 4. Survey of littoral zone and physical habitat types, Lake Livingston, Texas, 2011. A linear shoreline distance (miles) was recorded for each habitat type found. Surface area (acres) and percent of reservoir surface area were determined for each type of aquatic vegetation found. Mean water level of the reservoir was approximately 127.8 ft, which was 3.2 feet below conservation pool.

Shoreline habitat type	Shoreline Distance		Surface Area	
	Miles	Percent of total	Acres	Percent of reservoir surface area
Bulkhead	14.5	4.8		
Concrete	5.9	2.0		
Dead trees	10.8	3.6	5,778	6.4
Eroded bank	24.1	8.0		
Featureless	76.2	25.3		
Overhanging brush	3.4	1.1		
Rip rap	5.5	1.8		
Bulkhead/boat dock	108	35.8		
Bulkhead/overhanging brush	0.8	0.3		
Bulkhead/rip rap	0.1	<0.1		
Concrete/dead trees	0.6	0.2		
Eroded bank/dead trees	7.6	2.5		
Eroded bank/rock shoreline	0.5	0.2		
Featureless/boat dock	2.0	0.7		
Featureless/dead trees	37.4	12.4		
Rip rap/boat dock	0.4	0.1		
Bulkhead/boat dock/dead trees	1.2	0.4		
Bulkhead/boat dock/rip rap	0.3	0.1		
Eroded bank/rocky shoreline/dead trees	2.3	0.8		

Although low water level precluded sampling of vegetation in 2011, the exotic species giant salvinia, water hyacinth, and water lettuce are present and at times problematic in the reservoir.

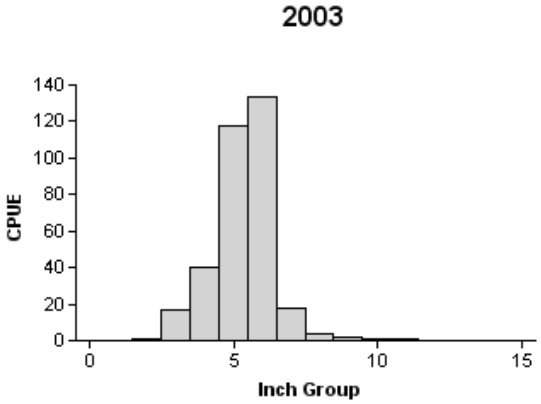
Table 5. Percent directed angler effort by species for Lake Livingston, Texas, 2003-2004, 2007-2008, and 2011-2012.

Species	Year		
	2003-2004	2007-2008	2011-2012
Catfishes	36.6	49.7	63.1
White bass	6.9	23.7	5.9
Sunfishes	0.1	1.9	0.2
Largemouth bass	43.6	2.2	16.5
Crappies	1.5	5.6	0.9
Anything	10.1	7.5	13.3

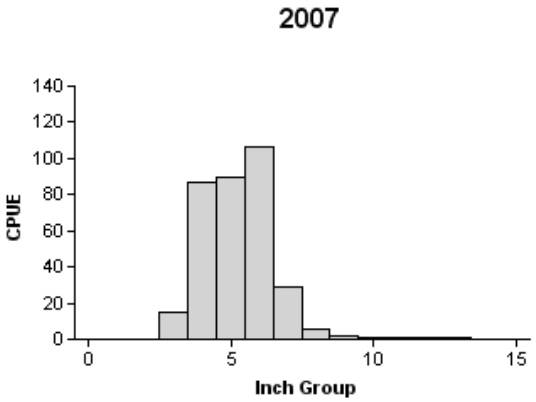
Table 6. Total fishing effort (h) for all species and total directed expenditures at Lake Livingston, Texas, 2003-2004, 2007-2008, 2011-2012.

Creel Statistic	Year		
	2003-2004	2007-2008	2011-2012
Total fishing effort	101,132	82,670	82,954
Total directed expenditures	$233,555	$212,890	$382,470

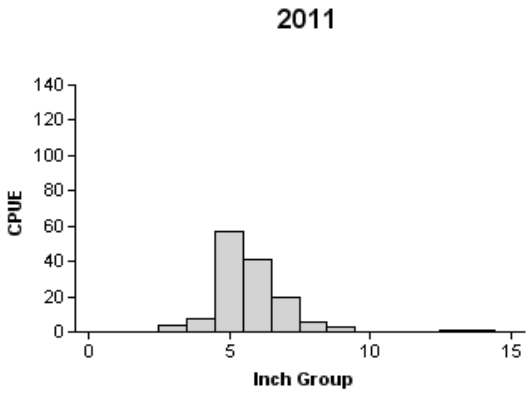
Gizzard Shad



Effort =	2.0
Total CPUE =	333.0 (29;666)
Stock CPUE =	24.5 (31; 49)
PSD =	2 (2)
IOV =	98.0 (0.9)



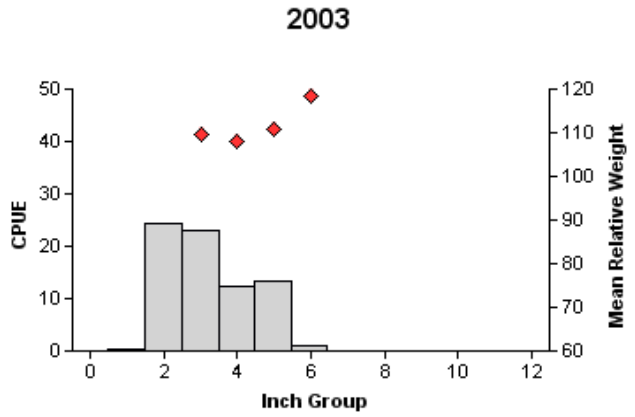
Effort =	2.0
Total CPUE =	337.0 (22; 674)
Stock CPUE =	39.0 (29; 78)
PSD =	5.0 (2.2)
IOV =	97.0 (1.6)



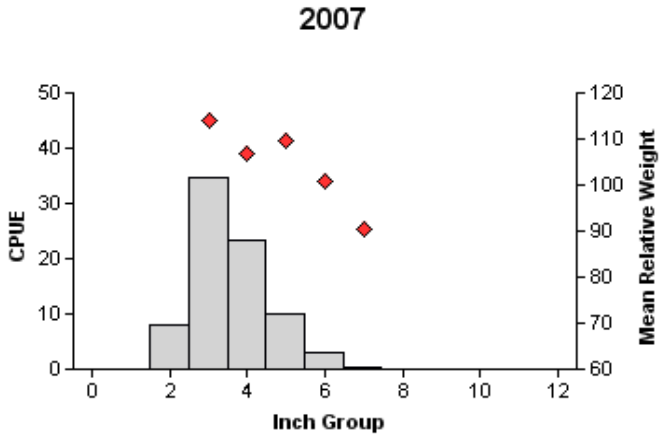
Effort =	2.0
Total CPUE =	137.5 (24; 275)
Stock CPUE =	28.5 (24; 57)
PSD =	4.0 (2.3)
IOV =	93.0 (2.4)

Figure 2. Number of gizzard shad caught per hour (CPUE) and population indices (RSE and N for CPUE and SE for size structure and IOV are in parentheses) for fall electrofishing surveys, Lake Livingston, Texas, 2003, 2007, and 2011.

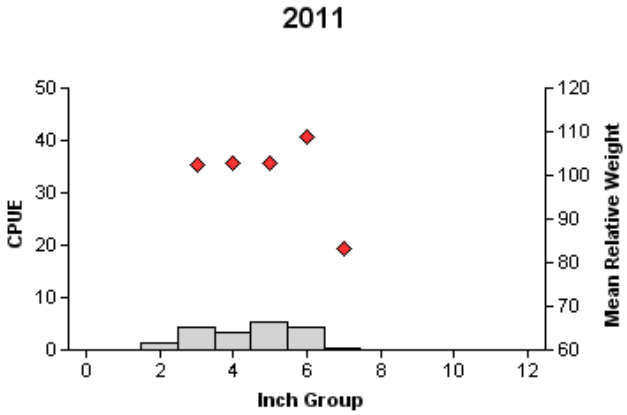
Bluegill



Effort = 2.0
Total CPUE = 75.0 (38; 150)
Stock CPUE = 50.0 (38; 100)
PSD = 2 (1.9)



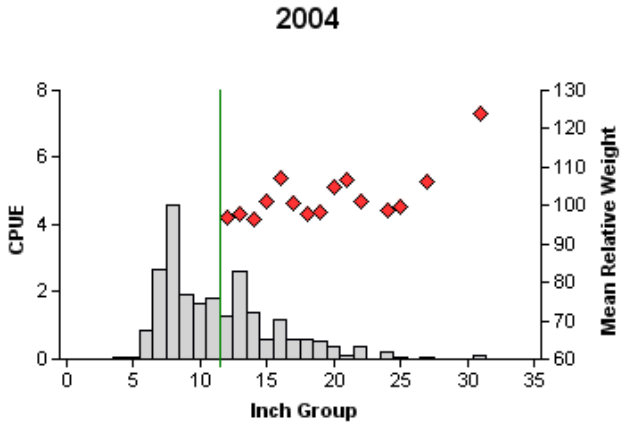
Effort = 2.0
Total CPUE = 79.5 (26; 159)
Stock CPUE = 71.5 (25;143)
PSD = 5 (2.8)



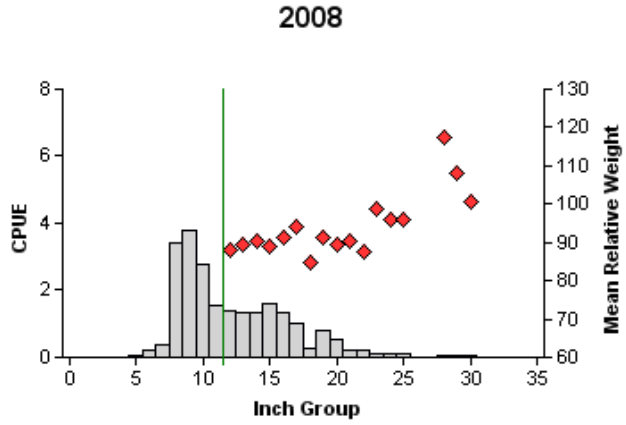
Effort = 2.0
Total CPUE = 20.0 (32; 40)
Stock CPUE = 18.5 (34;37)
PSD = 27 (7.9)

Figure 3. Number of bluegill caught per hour (CPUE, bars) mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Lake Livingston, Texas, 2003, 2007, 2011.

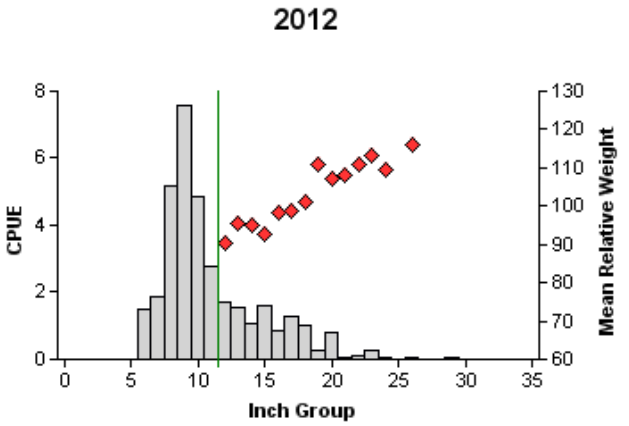
Blue Catfish



Effort = 15.0
Total CPUE = 23.9 (18; 358)
Stock CPUE = 10.2 (16; 153)
PSD = 14 (3.6)
PSD-12 = 100 (0)



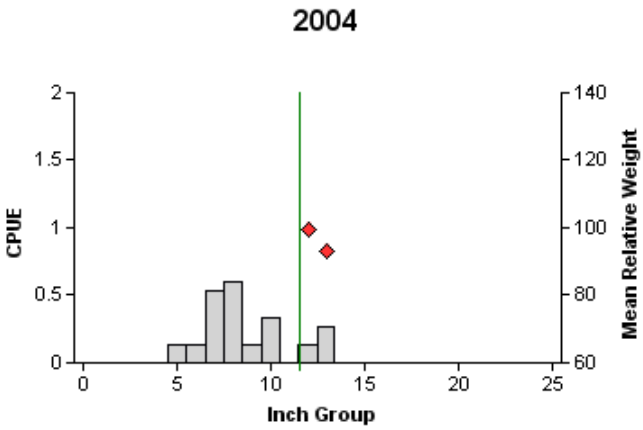
Effort = 15.0
Total CPUE = 22.8 (20;342)
Stock CPUE = 10.6 (16;159)
PSD = 14 (2.5)
PSD-12 = 100 (0)



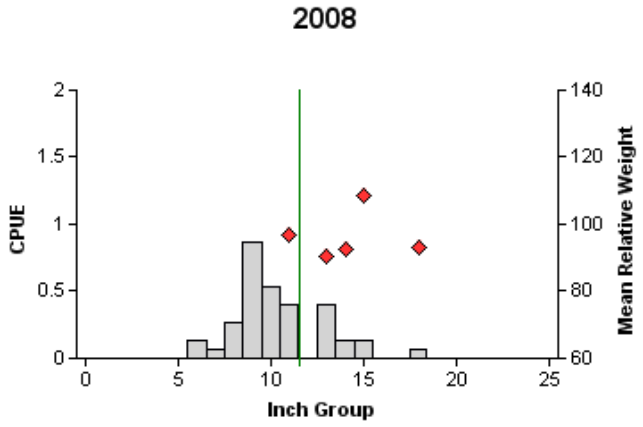
Effort = 15.0
Total CPUE = 34.7 (13; 520)
Stock CPUE = 10.9 (11; 163))
PSD = 14 (3.7)
PSD-12 = 100 (0)

Figure 4. Number of blue catfish caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Lake Livingston, Texas, 2004, 2008, and 2012. Vertical line is minimum length limit at time of survey.

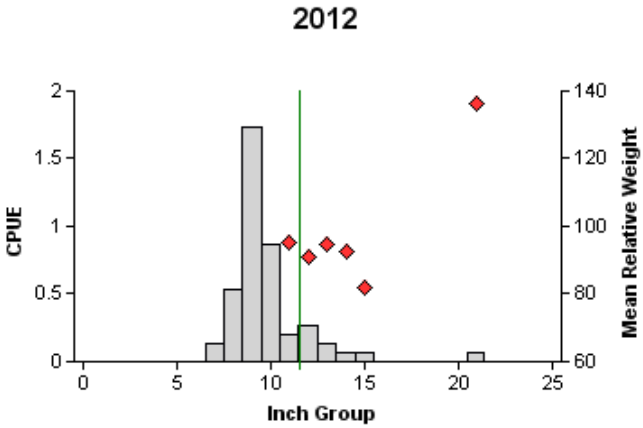
Channel Catfish



Effort = 15.0
Total CPUE = 2.3 (34; 34)
Stock CPUE = 0.4 (41; 6)
PSD = 0 (244)
PSD-12 = 100 (0)



Effort = 15.0
Total CPUE = 3.0 (28; 45)
Stock CPUE = 1.1 (36; 17)
PSD = 6 (5.2)
PSD-12 = 65 (7)



Effort = 15.0
Total CPUE = 4.1 (27; 62)
Stock CPUE = 0.9 (45; 13)
PSD = 8 (7.1)
PSD-12 = 77 (3.7)

Figure 5. Number of channel catfish caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Lake Livingston, Texas, 2004, 2008, and 2012. Vertical line is minimum length limit at time of survey.

Catfishes

Table 7. Creel survey statistics for channel catfish at Lake Livingston from June 2003 through May 2004, June 2007 through May 2008, and June 2011 through May 2012 where directed effort and total catch per hour is for anglers targeting catfish (species combined) and total harvest is the estimated number of channel catfish harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel Survey Statistic	Year		
	2003/2004	2007/2008	2011/2012
Directed effort (h)	29,329.9 (28.9)	28,761.6 (25.3)	52,325 (35.8)
Directed effort/acre	0.32 (28.9)	0.32 (25.3)	0.63 (35.8)
Total catch per hour	1.48 (72.9)	2.38 (36.2)	1.88 (26.8)
Total harvest			
Blue catfish	52,988 (39.0)	44,143 (35.3)	33,058 (49.6)
Channel catfish	1,577 (221.7)	5,404 (90.8)	5,567 (65.1)
Harvest/acre			
Blue catfish	0.58 (39.0)	0.49 (35.3)	0.40 (49.6)
Channel catfish	0.01 (221.7)	0.06 (90.8)	0.07 (65.1)
Percent legal released	14.1	9.9	5.4

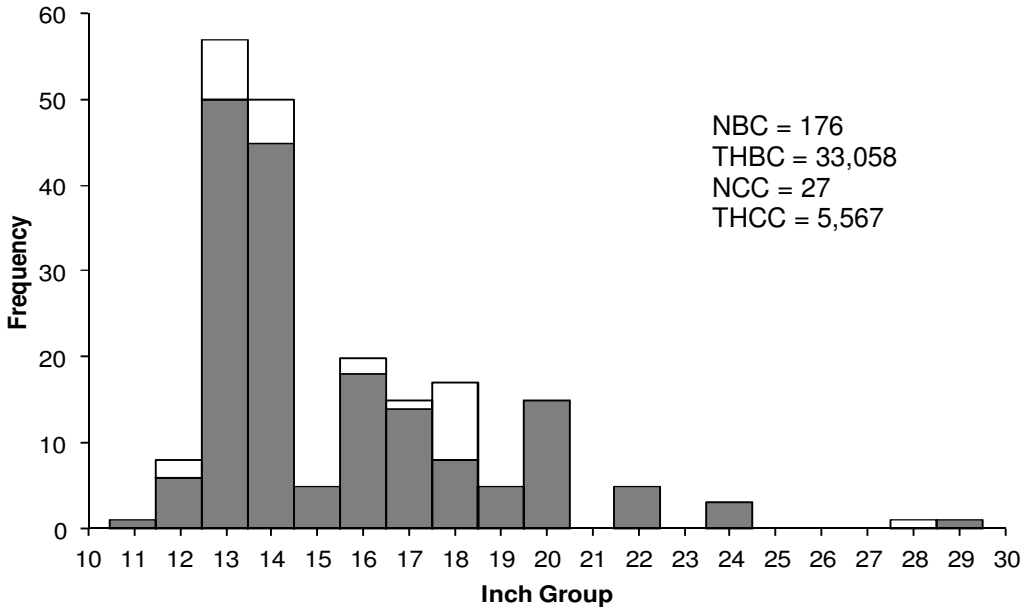
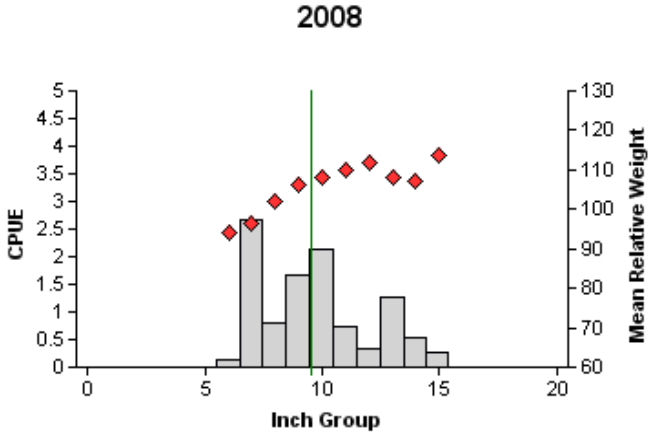


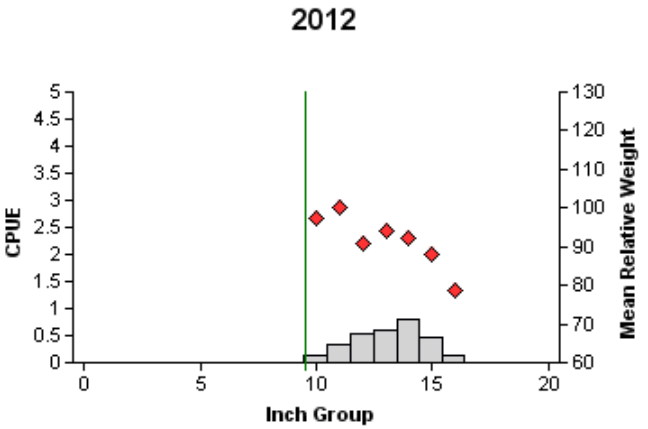
Figure 6. Length frequency of harvested blue (gray bars) and channel (white bars) catfish observed during creel surveys at Lake Livingston, Texas, June 2011 through May 2012, all anglers combined. NBC and NCC are the total number of harvested blue and channel catfish, respectively, observed during creel surveys. THBC and THCC are the total estimated harvest of blue and channel catfish, respectively, for the creel period.

White Bass

Effort =	15.0
Total CPUE =	11.3 (24; 170)
Stock CPUE =	11.3 (24; 170)
PSD =	83 (3.8)
PSD-10 =	68 (9.5)



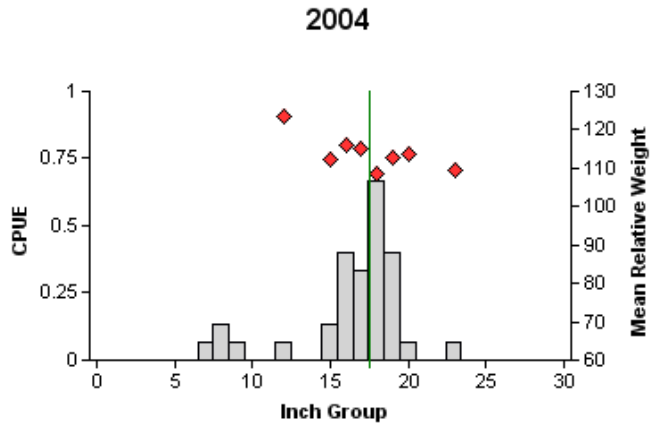
Effort =	15.0
Total CPUE =	10.5 (41;158)
Stock CPUE =	10.5 (41; 158)
PSD =	66 (3.1)
PSD-10 =	50 (4.1)



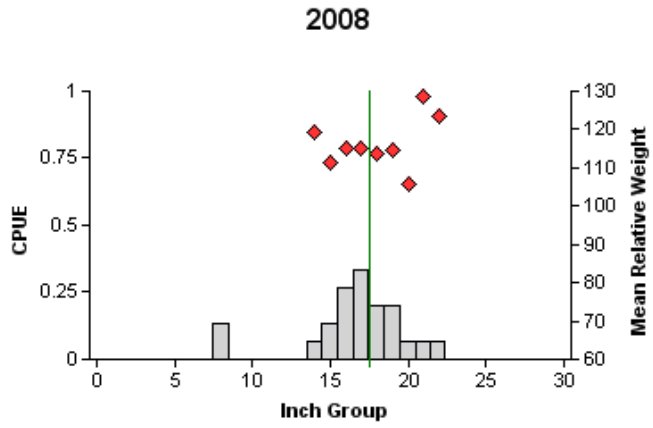
Effort =	15.0
Total CPUE =	3.1 (29; 45)
Stock CPUE =	3.0 (29; 45)
PSD =	100 (0)
PSD-10 =	100 (0)

Figure 7. Number of white bass caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Lake Livingston, Texas, 2004, 2008, and 2012. Vertical line represents minimum length limit at time of survey.

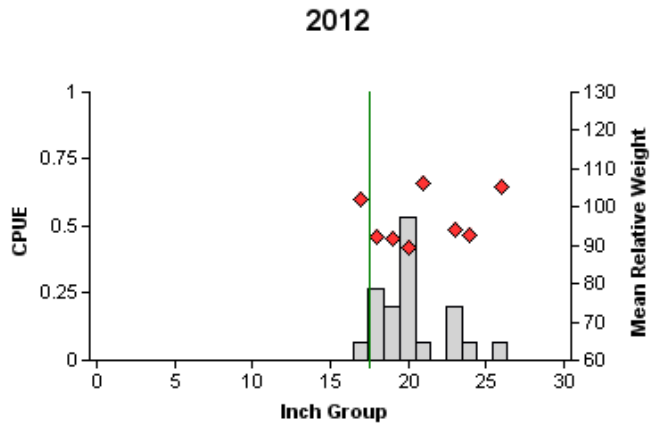
Striped Bass



Effort = 15.0
Total CPUE = 2.4 (27; 36)
Stock CPUE = 2.1 (26; 32)
PSD = 6 (4)
PSD-18 = 56 (10.3)



Effort = 15.0
Total CPUE = 1.5 (35; 23)
Stock CPUE = 1.4 (39; 21)
PSD = 14 (7.9)
PSD-18 = 48 (11.6)



Effort = 15.0
Total CPUE = 1.5 (39; 22)
Stock CPUE = 1.5 (39; 22)
PSD = 64 (8)
PSD-18 = 95 (4.4)

Figure 8. Number of striped bass caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for spring gill net surveys, Lake Livingston, Texas, 2004, 2008, and 2012. Vertical line represents minimum length limit at time of survey.

Temperate Basses

Table 8. Creel survey statistics for temperate basses at Lake Livingston from June 2003 through May 2004, June 2007 through May 2008, and June 2011 through May 2012 where total catch per hour is for anglers targeting each temperate bass species and total harvest is the estimated number of each species harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel Survey Statistic	Year		
	2003/2004	2007/2008	2011/2012
Directed effort for temperate basses (h)		19,913 (24.3)	4,925 (49.4)
White bass (2003)	5,589 (38.7)		
Striped bass (2003)	229 (147.9)		
Directed effort/acre		0.239 (24.3)	0.059 (49.4)
White bass (2003)	0.06 (38.7)		
Striped bass (2003)	0.003 (147.9)		
Total catch per hour		4.9 (44.3)	4.3 (64.1)
Total harvest			
White bass	41,445 (35.0)	30,387 (44.7)	18,483 (54.6)
Striped bass	586 (314.5)	149.0 (671.1)	447 (237.2))
Harvest/acre			
White bass	0.46 (35.0)	0.36 (44.7)	0.22 (54.6)
Striped bass	0.007 (314.5)	0.001 (671.1)	0.01 (237.2)
Percent legal released	14.4	0.1	15.5

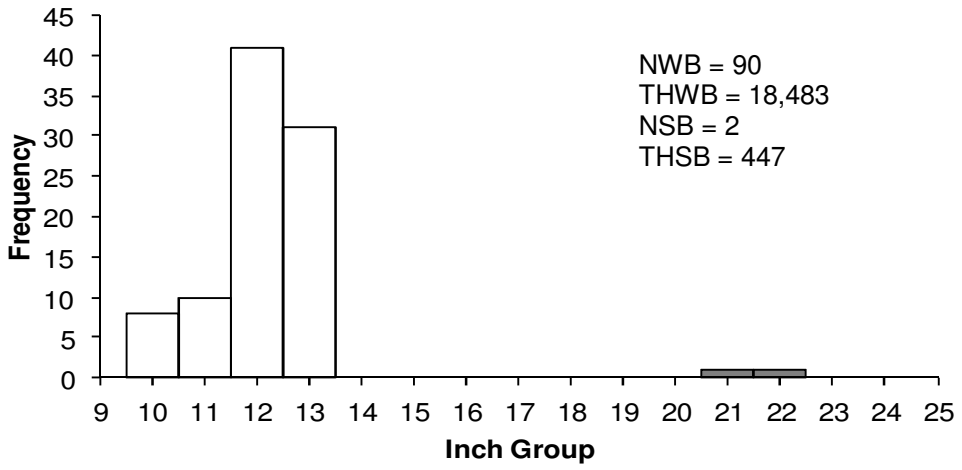
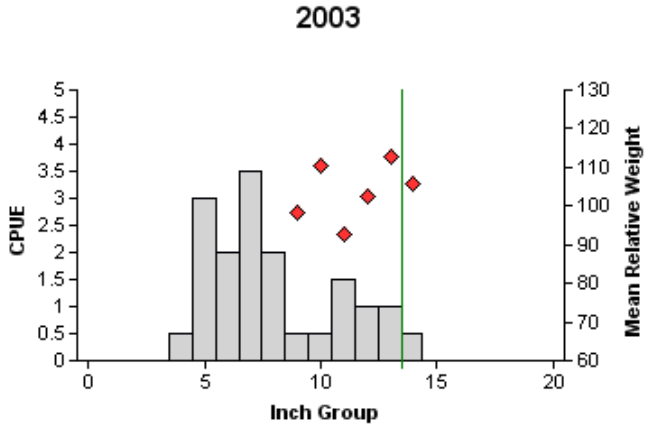
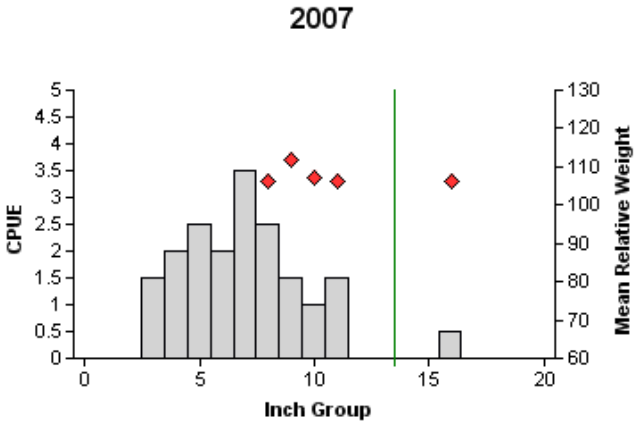


Figure 9. Length frequency of harvested white bass (white bars) and striped bass (gray bars) observed during creel surveys at Lake Livingston, Texas, June 2011 through May 2012, all anglers combined. NWB and NSB are the number of harvested white bass and striped bass observed during creel surveys; THWB and THSB are the total estimated harvests for white bass and striped bass for the creel period.

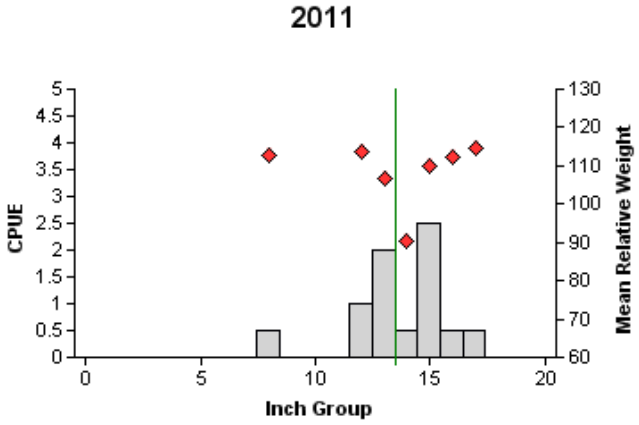
Largemouth Bass



Effort =	2.0
Total CPUE =	16.0 (54; 32)
Stock CPUE =	7.0 (47; 14)
PSD =	36 (12.3)
PSD-14 =	7 (6.6)



Effort =	2.0
Total CPUE =	18.5 (32;37)
Stock CPUE =	7.0 (34; 14)
PSD =	7 (6.2)
PSD-14 =	7 (6.2)



Effort =	2.0
Total CPUE =	7.5 (30; 15)
Stock CPUE =	7.5 (30; 15)
PSD =	93 (6.3)
PSD-14 =	53 (12.4)

Figure 10. Number of largemouth bass caught per hour (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for fall electrofishing surveys, Lake Livingston, Texas, 2003, 2007, and 2011. Vertical line represents minimum length limit at time of survey.

Largemouth Bass

Table 9. Creel survey statistics for largemouth bass at Lake Livingston from June 2003 through May 2004, June 2007 through May 2008, and June 2011 through May 2012 where directed effort and total catch per hour are for anglers targeting largemouth bass and total harvest is the estimated number of largemouth bass harvested by all anglers. Relative standard errors (RSE) are in parentheses. No tournament anglers holding fish for tournament release were encountered during this survey.

Creel Survey Statistic	Year		
	2003-2004	2007-2008	2011-2012
Directed effort (h)	34,965.4 (28.9)	1,253.8 (82.9)	13,724 (33.5)
Directed effort/acre	0.39 (28.9)	0.02 (82.9)	0.16 (33.5)
Total catch per hour	0.49 (22.4)	<0.01	0.95 (32.7)
Total harvest	15,952 (70.9)	0.0	1,533 (92.7)
Harvest/acre	0.18 (70.9)	0.0	0.02 (92.7)
Percent legal released	14.8	48	21.6

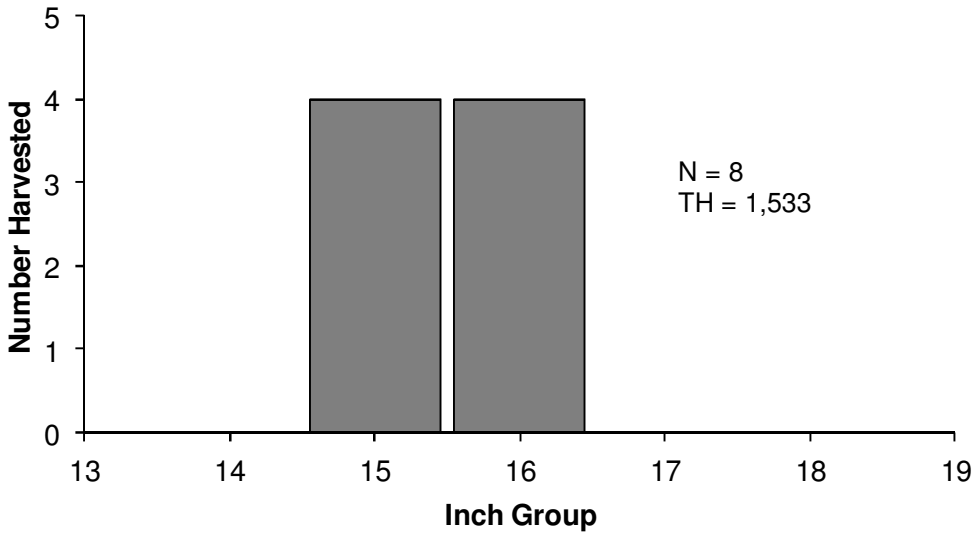
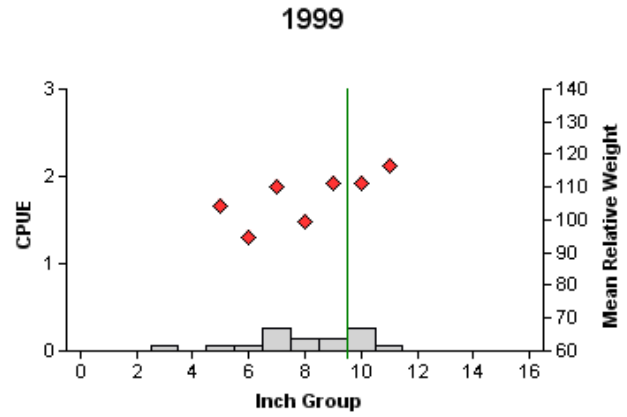


Figure 11. Length frequency of harvested largemouth bass observed during creel surveys at Lake Livingston, Texas, June 2011 through May 2012, all anglers combined. N is the number of harvested largemouth bass observed during creel surveys, and TH is the total estimated harvest for largemouth bass for the creel period

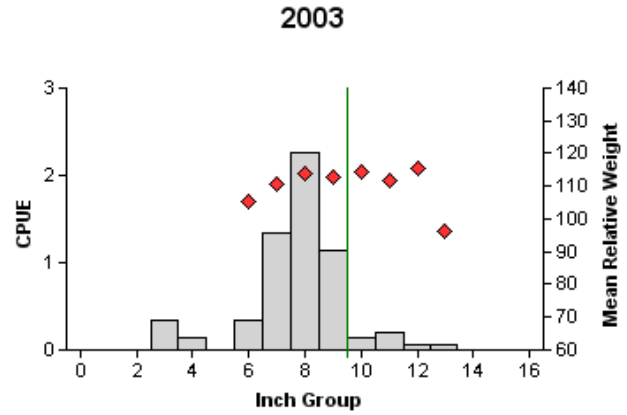
Table 10. Results of genetic analysis of largemouth bass collected by fall electrofishing, Lake Livingston, Texas, 1999, 2001, 2003, and 2007. FLMB = Florida largemouth bass, NLMB = Northern largemouth bass, F1 = first generation hybrid between a FLMB and a NLMB, FX = second or higher generation hybrid between a FLMB and an NLMB.

		Genotype					
Year	Sample size	FLMB	F1	Fx	NLMB	% FLMB alleles	% pure FLMB
1999	33	1	1	3	19	18.2	3.0
2001	17	0	1	12	4	30.8	0.0
2003	21	0	2	9	10	22.6	0.0
2007	30	0			0	30.8	0.0
2012	30	0	0	24	6	26.0	0.0

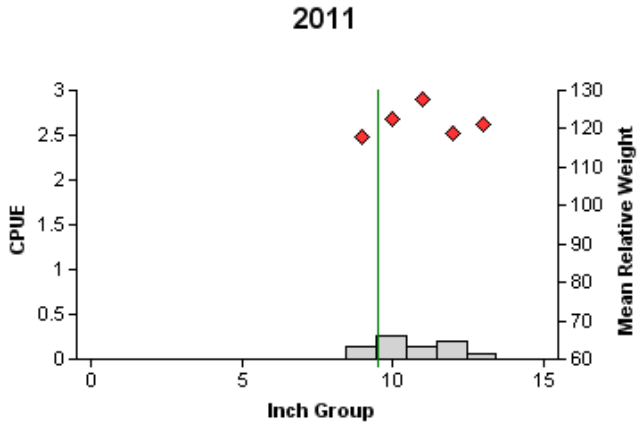
White Crappie



Effort = 15.0
Total CPUE = 1.1 (55; 16)
Stock CPUE = 1.0 (59; 15)
PSD = 60 (15.5)
PSD-10 = 33 (10.4)



Effort = 15.0
Total CPUE = 6.0 (31; 90)
Stock CPUE = 5.5 (34; 83)
PSD = 70 (10.0)
PSD-10 = 8 (4.1)



Effort = 15.0
Total CPUE = 0.8 (57; 12)
Stock CPUE = 0.8 (57; 12)
PSD = 100 (0)
PSD-10 = 83 (3.5)

Figure 12. Number of white crappie caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for trap net surveys, Lake Livingston, Texas, 1999, 2003, and 2011. Vertical line represents minimum length limit at time of survey.

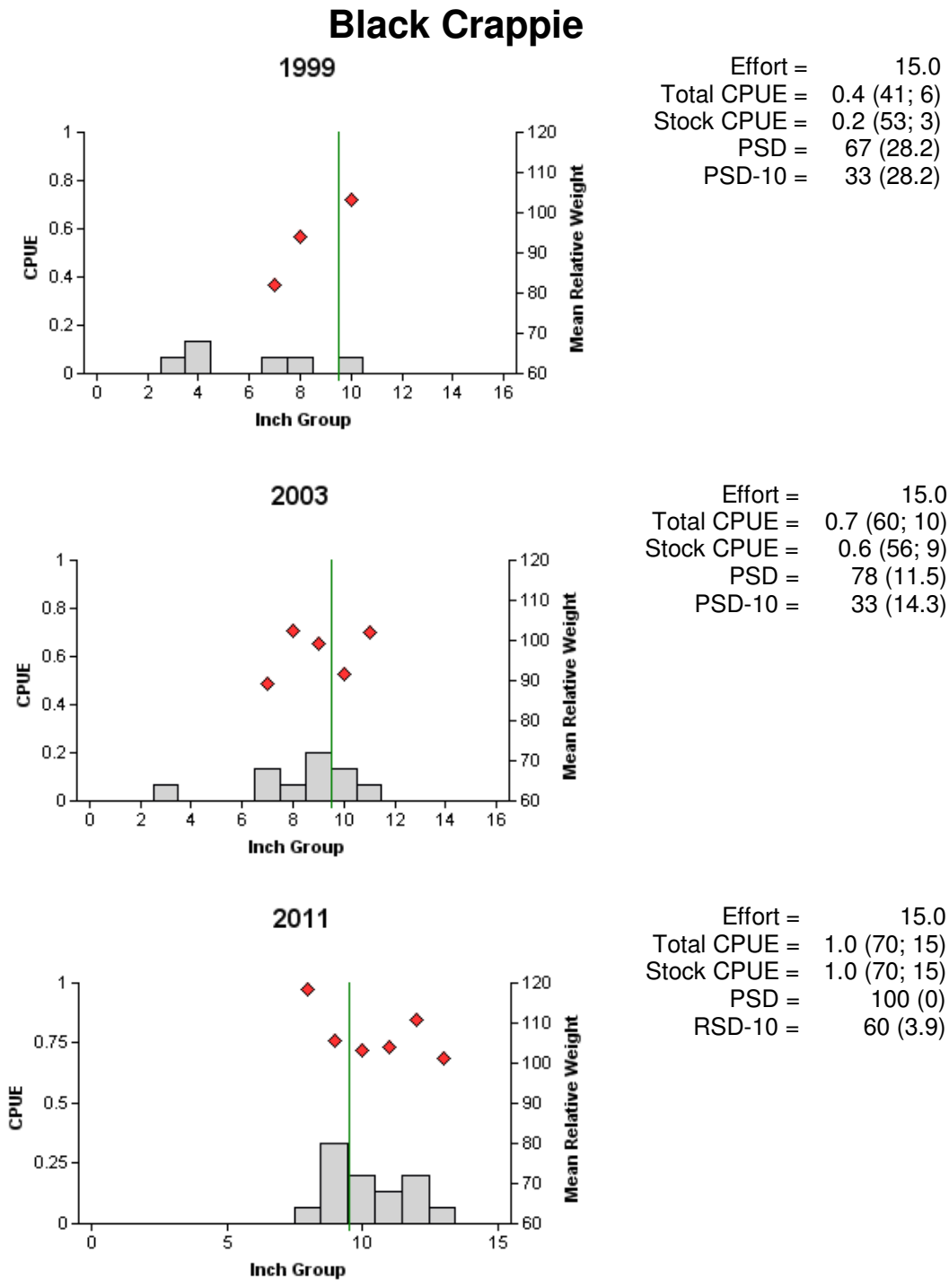


Figure 13. Number of black crappie caught per net night (CPUE, bars), mean relative weight (diamonds), and population indices (RSE and N for CPUE and SE for size structure are in parentheses) for trap net surveys, Lake Livingston, Texas,1999, 2003, and 2011. Vertical line represents minimum length limit at time of survey.

Crappie

Table 11. Creel survey statistics for crappie at Lake Livingston from June 2003 through May 2004, June 2007 through May 2008, and June 2011 through May 2012 where directed effort and total catch per hour are for anglers targeting crappie (species combined) and total harvest is the estimated number of black and white crappie harvested by all anglers. Relative standard errors (RSE) are in parentheses.

Creel Survey Statistic	Year		
	2003/2004	2007/2008	2011/2012
Directed effort (h)	1,180 (75.5)	3,176 (69.9)	787 (124.9)
Directed effort/acre	0.01(14)	0.04 (69.9)	0.01 (124.9)
Total catch per hour	0.0 (0)	0.0	4.5 (0.0)
Total crappie harvested	2,931 (169.5)	0	1,084
Black crappie total harvest (2011)			203 (1,191.6)
White crappie total harvest (2011)			811 (345.7)
Crappie harvest/acre	0.0 (0.0)	0.0 (0.0)	
Black crappie harvest/acre (2011)			0.002 (1,191.6)
White crappie harvest/acre (2011)			0.01 (345.7)
Percent legal crappie released	0.0	n/a	0.0

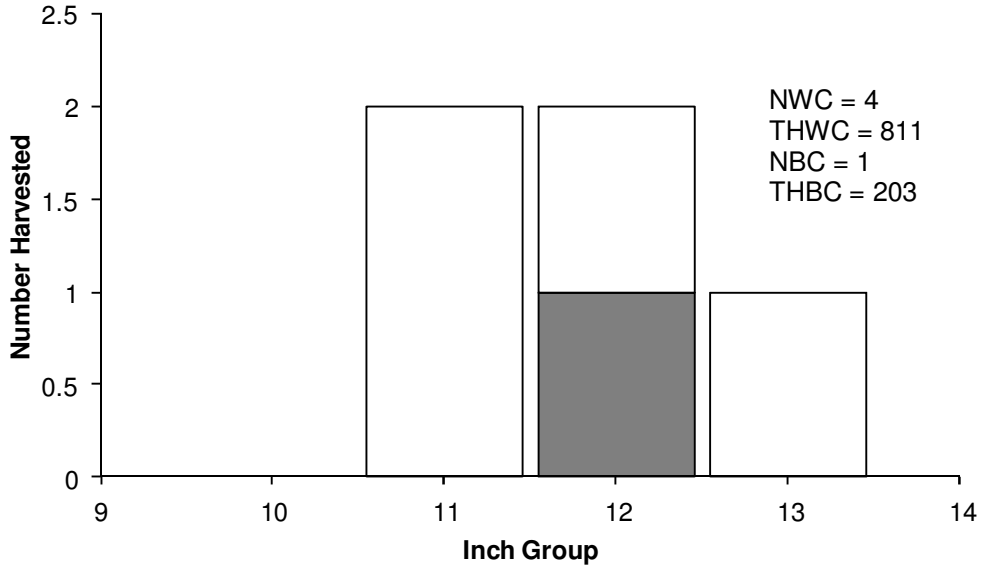


Figure 14. Length frequency of harvested white crappie (white bars) and black crappie (gray bars) observed during creel surveys at Lake Livingston, Texas, June 2011 through May 2012, all anglers combined. NWC and NBC are the number of harvested white crappie and black crappie observed during creel surveys; THWC and THBC are the total estimated harvests for white crappie and black crappie for the creel period.

Table 12. Proposed sampling schedule for Lake Livingston, Texas. Gill netting surveys are conducted in the spring while electrofishing and trap netting surveys are conducted in the fall. Standard survey denoted by S and additional survey denoted by A.

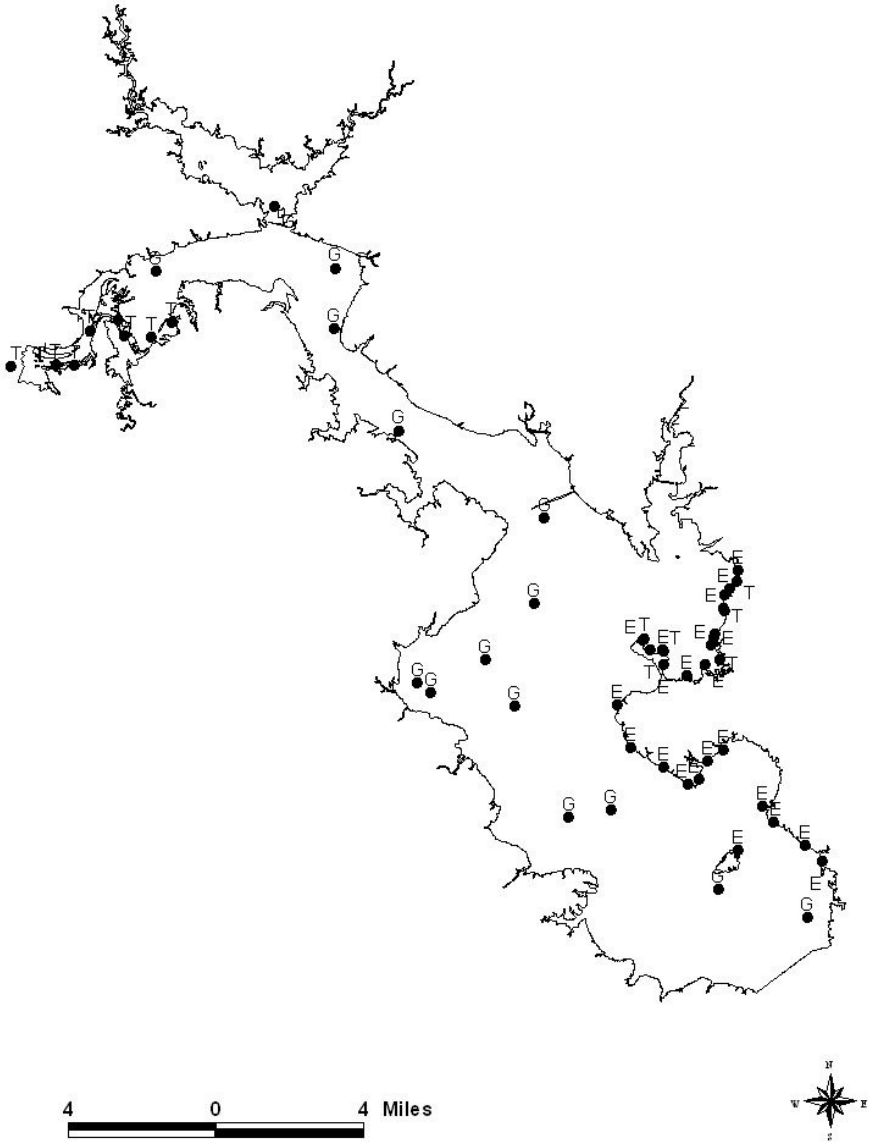
Survey Year	Electrofisher	Trap Net	Gill Net	Creel Survey	Vegetation	Access	Report
Summer 2012-Spring 2013					A		
Summer 2013-Spring 2014					A		
Summer 2014-Spring 2015					A		
Summer 2015-Spring 2016	S	A	S	A	S	S	S

APPENDIX A

Number (N) and catch rate (CPUE) of all target species collected from all gear types from Lake Livingston, Texas, 2011-2012.

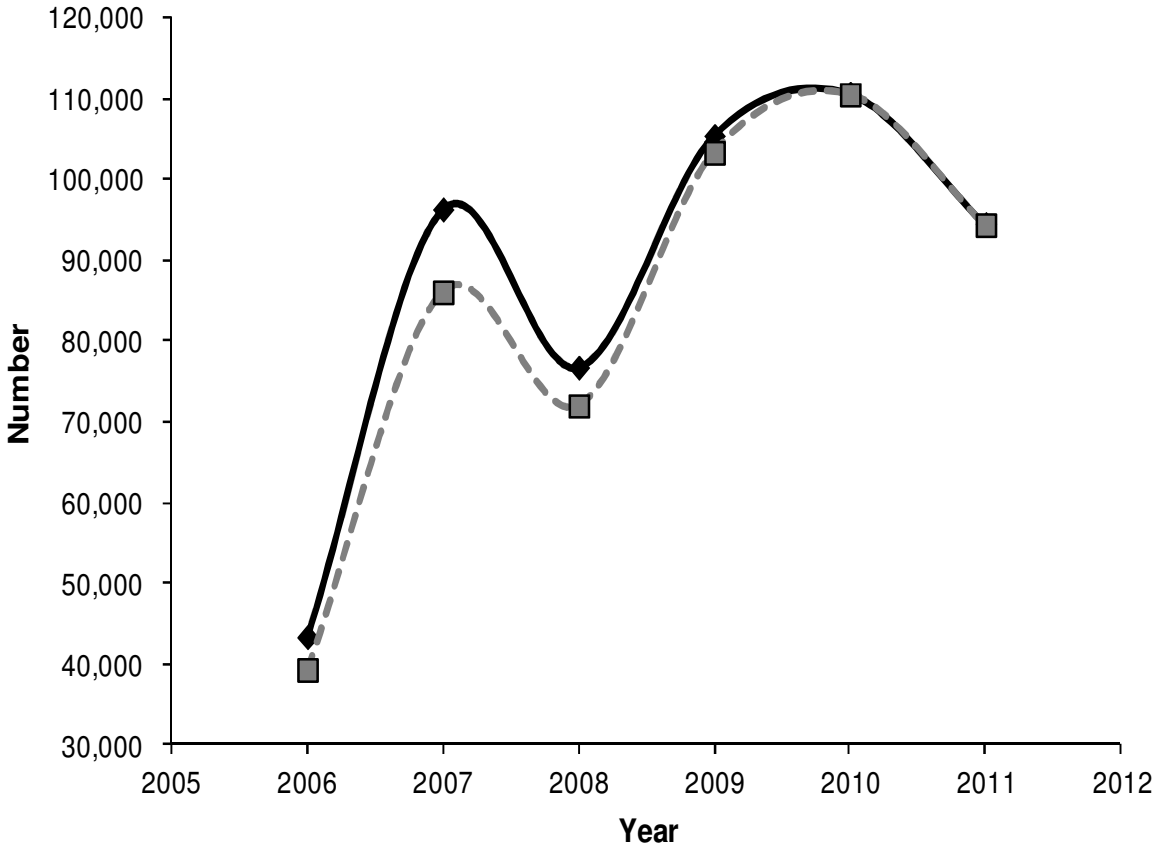
Species	Electrofishing		Gill Netting		Trap Netting	
	N	CPUE	N	CPUE	N	CPUE
Gizzard shad	275	137.5				
Threadfin shad	94	47.0				
Inland silverside	45	22.5				
Blue catfish			522	34.8		
Channel catfish			61	4.1		
Flathead catfish						
White bass			46	3.1		
Striped bass			22	1.5		
Bluegill	40	20.0				
Longear sunfish	15	7.5				
Largemouth bass	15	7.5				
White crappie					12	0.8
Black crappie					15	1.0

APPENDIX B



Location of sampling sites, Lake Livingston, Texas, 2011-2012. E, T, and G indicate electrofishing, trap net, and gill net stations, respectively.

APPENDIX C



Reported commercial landings in total weight (black diamonds) and total monetary value (gray squares) of blue catfish caught in Lake Livingston from 2005-2011.