Montana Department of Fish, Wildlife and Parks
Fisheries Division

Job Progress Report

STATE: Montana **PROJECT: Yellowstone River Drainage Investigations**

STUDY TITLE: Tongue River Reservoir Investigations

PROJECT NO. F-113-R-7

PROJECT PERIOD: April 1, 2010 through March 30, 2011

ABSTRACT

The management goal of 20% of adult crappie greater than 250 mm has not been met since 1998, but abundance and size of available fish continue to offer quality angling. Catch-per-unit-effort (CPUE) of young-of-the-year (YOY) crappie has been variable indicating variable spawning success but abundances of both juveniles and adults remain at acceptable levels. The management goal of two walleye per overnight gillnet set was met in 2010. White crappie and black bullhead accounted for 29% of gillnet catch in 2010. Crappie YOY, yellow perch, and pumpkinseed accounted for over 90% of the seine catch. Catch rates of YOY largemouth bass, smallmouth bass, and yellow perch have increased, likely a result of high reservoir levels for consecutive years. Turtle trapping was discontinued in 2010 but one tagged spiny soft-shell turtle was recaptured in a trap net (i.e. modified fyke net). Coal bed natural gas production has not yet demonstrated an adverse affect on reservoir fish populations and likely will not at the current level of development. New sampling methodology was added to the current monitoring regime in 2010 to improve crappie sampling. Trap nets were used in April, August, and October to explore options for increasing crappie catch. Spring and fall trap netting will continue in 2011 and will follow a more standardized methodology.

INTRODUCTION

Tongue River Reservoir provides a very popular and unique fishing opportunity in the state of Montana. Managed primarily as a crappie fishery, it attracts people from all over the state and region. Crappie are abundant, easy to catch, and with a liberal 30 crappie per day limit, the reservoir attracts anglers of all skill levels. It is particularly popular with families and sustains some of the highest angler days per surface acre of any reservoir in the state (McFarland and Meredith 2004, McFarland 2009). Overall angler satisfaction is moderate and comparable to Fort Peck Reservoir, the other destination reservoir in Eastern Montana (McFarland 2009). Tongue River Reservoir offers angling

opportunity in both summer and winter but use and satisfaction are higher in the summer (McFarland 2009).

There was no daily limit on crappie prior to 1996. From 1996-2000 a daily limit of 15 fish was established to protect the population while the reservoir was drawn down to facilitate rebuilding the dam. After completion of the dam rebuild, storage capacity increased from 68,040 acre-feet to the current capacity of 79,071 acre-feet. This increased capacity raised the maximum water level by approximately six vertical feet. Since 2001, the crappie daily limit has been 30 fish. Region-wide drought conditions from the late 1990s to the early 2000s had impacts on the storage and release of water from the reservoir (DNRC 2009). This reduced the habitat available for fish spawning and rearing, as well as recreational use. Drought conditions have eased in recent years thereby increasing fish habitat and decreasing conflict between user groups.

The development of coal bed methane has had an impact on the Tongue River drainage and reservoir. Wastewater from methane extraction is discharged into the Tongue River above the reservoir. This wastewater is generally of higher salinity and electro conductivity and if contributions are large enough may change the overall salinity and conductivity of water stored in the reservoir. Irrigators concerned with changes in water quality in Tongue River Reservoir have influenced dam operations, resulting in increased discharge during the spring to flush out the saline water prior to the start of the irrigation season. Changes to fish populations have not been documented but may exist as they are difficult to quantify.

Due to the importance of the Tongue River Reservoir fishery an intensive monitoring program has been in place for several decades. Species specific management objectives for Tongue River Reservoir are:

(1) 20% of adult crappie from overnight gill nets > 250 mm (10 inches),
(2) Two walleye per overnight gillnet set, and
(3) Maintain viable populations of other game fish species.

In meeting these objectives Montana Fish, Wildlife and Parks ensures that quality sport fishing opportunities are available at Tongue River Reservoir.

METHODS

This report covers annual trend sampling and additional exploratory sampling efforts at Tongue River Reservoir in 2010. Annual trend sampling was conducted during the month of August using experimental gill nets and bag seines. Additional sampling to increase sample size of crappies was conducted April, August, and October using trap nets (i.e. modified fyke nets). Adult fish were sampled using experimental sinking gill nets with 25 ft panels of 0.75, 1.0, 1.25, 1.5, and 2.0-inch mesh (bar measure) for an overall length of 125 feet. Gill nets were set at standardized locations and fished for approximately 24 hours. Juvenile and forage-sized fish were sampled using a 100 ft bag seine, 8 ft deep, with 0.25-inch mesh (bar measure). The seine was set from a boat and

hauled to shore in a quarter circle pattern to capture fish. Both gill netting and seining consisted of a minimum of 10 net sets/seine hauls distributed between the upper and lower halves of the reservoir. Trap nets had 4 x 6 ft frames with 0.5-inch mesh (bar measure). All fish sampled with exception to April caught fish were identified to species, weighed (g), and measured (total length, mm). Fish caught in April with trap nets were identified to species and enumerated. For abundant species, lengths and weights were collected from a sub-sample of 25-50 individuals.

Length and weight values were calculated for each species. The index catch per unit effort (CPUE) was used to describe the relative abundance of the fish sampled by netting. For gillnet and trap net sampling one net night (approx. 24 hr period) was one unit of effort. For seine sampling, one seine haul was one unit of effort. Proportional size distribution (PSD) was applied to describe the length structure of all game fishes sampled in gill nets. Relative weight (W_r) was applied to describe the body condition of all game fishes sampled in gill nets.

Turtle trapping was discontinued in 2010, but one tagged spiny soft-shell turtle was recaptured in a trap net. Weight, carapace length, and carapace width were recorded.

Reservoir storage (acre-ft) and water level (ft) were obtained from the Montana Department of Natural Resources and Conservation (DNRC) website and personnel (Sam Johnson). Discharge (ft^3/sec) and specific conductance (µS/cm at 25º C) values for the Tongue River upstream and downstream of the reservoir were obtained from US Geologic Service (USGS) website. A Secchi disc was used to measure water clarity (i.e. transparency). A water quality meter (YSI 85) was used to record temperature, dissolved oxygen, specific conductance and salinity in Tongue River Reservoir during annual sampling. A Hanna pH meter was used to record pH. A Garmin hand held GPS unit was used to record latitude and longitude for all fish and water quality sampling locations.

RESULTS AND DISCUSSION

A summary of the annual gill netting can be found in Table 1. A total of 397 fish was sampled using gill nets in August 2010. A summary of seine sampling data can be found in Table 2. A total of 3004 fish was sampled using seines in August 2010.

Crappie

The relative abundance of crappie in Tongue River Reservoir was 11.5 fish per net in 2010. This increase from recent lows (2007-2009) was driven by strong catches of white crappie (Figure 1). The average gillnet catch of adult crappie from 2006 to 2010 ranged from 4.1 to 15.4 fish per net (Figure 1). The five-year (2006 through 2010) and ten-year (2000 through 2010) average catch rates for adult crappie were 8.7 and 10.7 fish per net. In 2004, the five-year (2000 through 2004) and ten-year (1994 through 2004) average catch rates were determined to be 13.5 and 13.3 fish per net (Riggs 2004). The ten-year average catch rate calculated in 2004 was influenced by large catches in 1994 and 2000 (Figure 1). A large portion of the adult catch in 1994 and 2000 was likely from

individual year classes that appeared in seine samples four to five years prior as young-of-the-year (YOY) (Figure 2). The lack of influence by a strong year class since 2000 may explain the lower five and ten year adult crappie average catch rates calculated in recent years. Another large class of YOY crappie was observed in 2008 (Figure 2). If the 2008 YOY recruit to catchable size, adult catch rate should be high around 2012.

The adult crappie catch from gill nets has not met the management objective (20% of crappie greater than 250 mm) since 1998. The management goal has only been met five out of the last thirty years and three of these years were during a low water period (Table 3). From 1996 to 1998, the reservoir was drawn down to facilitate rebuilding the Tongue River Dam (Figure 3). Low water levels during this period reduced available aquatic habitat concentrating fish populations and may have influenced meeting the crappie management objective during this period. However while catch rates of fish greater than 250 mm were high during the low water period, overall catch rates for all size crappie were historically average, discrediting the hypothesis that reaching the management goal was a function of greater sampling efficiency due to low water (Table 3, Figure 1). When plotted together catch rates of YOY and adult crappie do not have a clear relationship with reservoir water levels (Figure 3). The only clear relationship is that large classes of YOY are influential in adult catch rates in the following years as might be expected (Figure 3). Since high catch rates of YOY fish have occurred at varying water levels it seems that production has not been limited by habitat (Figure 3).

PSD values indicate preferred and memorable black crappies were present as well as preferred white crappie (Table 4). Although the two species of crappie are managed together in Tongue River Reservoir, they are not caught in equal proportions. The two species likely prefer different habitats types within the lake and may have different growth rates. White crappie grow faster than black crappie and have a tendency to shift to piscivory at a smaller size (Ellison 1984). Mean W_r values for both crappie species were highest for fish of the preferred length class (Table 4). Sample sizes of crappie in this study were relatively small and conclusions based on the data could not be confidently drawn.

Seine hauls throughout the reservoir have indicated crappie spawning success has been variable (Figure 2). In 2008, the relative abundance of YOY crappie was greater than that observed in 1998, which was considered a relatively strong recruitment year (Riggs 2004). Crappie YOY abundance is cyclic and is likely related to a combination of reservoir water level and other environmental variables during the May-July spawning and nursery period. Reservoir water levels in recent years have been conducive to spawning success.

Methods and effort were not consistent for trap net sampling in the months of April, August, and October. This inconsistency was somewhat inherent as field crews implemented additional sampling with a primary objective of qualifying how and where trap nets should be used to most effectively sample crappie. The secondary objective was to compare trap net catches from different times of the year to current methods using gill nets. The variable methods and effort limited inferences about the second objective but

provided a working knowledge of the gear relative to Tongue River Reservoir that led to a more standardized sampling protocol for exploratory trap netting for the 2011 season. Collections from 2010 suggest that trap nets sample a larger segment of the crappie population and may provide the sample sizes desired if optimal time of sampling is determined (Figure 4, Table 5). Trap net sampling in 2011 will focus on determining the most effective time of year to sample crappie with trap nets.

Walleye

The walleye management objective (two walleye per net night) was met in 2010 (Table 3). This management objective has been met consistently; 4 out of the last 5 and 7 out of the last 10 years (Table 3). Walleye sampled in 2010 were generally small with no fish of preferred size or greater (Table 4). Relative weight for stock sized fish was similar to relative weights observed in 2009. The low PSD value and sample size but stable relative weight suggests that walleye in the reservoir are not small because of a change in food availability but other factors like gear bias, missing cohorts, or harvest pressure.

Other Game Fish

Black bullheads were the second most abundant species sampled in gillnets in 2010 (Table 1). Black bullhead relative abundance was 10.3 fish per net in 2010, similar to the relative abundance in 2009, 9.9 fish per net. Abundances in 2009-2010 were much lower than previous years (2000-2008) when relative abundance was between 30 to 45 fish per net night (Abrahamse 2009). Increase in the average size of bullheads was supported by a slight shift in which PSD size category the majority of bullheads sampled fell into. In 2005 and 2006 the majority of black bullhead sampled were in the stock-to-quality (150 to 229 mm) length class (Abrahamse 2009). In 2008, 2009, and 2010 the majority of black bullhead sampled were in the quality-to-preferred (230 to 299 mm) length class. Body condition in 2010 was similar to that observed in 2009 and mean W_r was greater than those observed prior to 2009 (Table 4). Yellow bullheads were smaller in size and less abundant than black bullheads in 2010 but were the third most abundant species in gill net catches (Table 1).

Channel catfish continue to be caught in low numbers in August gill net samples, with only two fish caught in 2010 (Table 1). Only a dozen channel catfish have been collected in seines over the period 1989-2010 and not all of these have been YOY. No channel catfish have been collected in seines since 1996 (Table 2). Consistent relative abundance values for adults through the years indicate limited spawning and recruitment are occurring (Figure 4). Sample sizes of channel catfish preclude analysis of length structure and body condition.

Gill net and seine collections in 2010 indicate presence of both adult and juvenile largemouth and smallmouth bass (Table 1, Table 2). The relative abundance of adult smallmouth bass in the gillnet samples was low but consistent from 2005 to 2010 (Abrahamse 2009). YOY largemouth bass were abundant in 2009 and 2010 seine samples (Table 2, Figure 5). Increased spawning success of largemouth bass in Tongue

River Reservoir could be correlated to high reservoir levels in recent years (Figure 3). YOY largemouth bass CPUE reached similar levels in 1991 and 1995 (Figure 5). YOY smallmouth bass CPUE remains low compared to 1991, 1996, and 1999 year classes (Figure 5).

Northern pike, a species which was the dominant game species during the 1970's (Elser 1980), and produced the standing State record fish (37.5 lbs) in 1972, were found in low abundance in 2010. Relative abundance in August 2010 gill nets was 0.7 fish per net (Table 1). Catch rates are low but appear to be stable (Figure 4). YOY northern pike were sampled in seine hauls from 2005 through 2007, but have not been sampled since 2008 (Abrahamse 2009). Adult and juvenile catch rates suggest limited natural reproduction has occurred at Tongue River Reservoir in the last decade. Sample sizes of northern pike preclude analysis of length structure and body condition.

Pumpkinseed have become increasingly more abundant in Tongue River Reservoir (Figure 6). Relative abundance of pumpkinseed was 0.1 fish per gill net and 0.3 fish per seine haul in 2003 (Riggs 2003). From 2005 to 2009 pumpkinseed CPUE ranged from 0.7 to 1.7 in gillnet samples and 0.8 to 83.2 in seine samples (Abrahamse 2009). Relative abundances of pumpkinseed in 2010 were 1.6 fish per gill net and 72.9 fish per seine haul (Table 1 and Table 2). Mean W_r values for pumpkinseed were often greater than 100 indicating that they were in extremely good condition (Table 4).

Historically, rock bass have been present in low abundance in the Tongue River Reservoir but have not been sampled since 2000.

Sauger were not collected during 2010 sampling efforts. Elser et al. (1977) noted the first appearance of sauger in the reservoir in 1973 and Riggs (1978) documented high abundance of sauger in sampling efforts. However, sauger abundance has been low since the late 1980s. In 2004, the 10-year average (1994 to 2004) catch was reported to be 0.7 fish/net. One sauger was present in each of the 2005, 2007, and 2009 samples (Table 5). Sauger is a small component of the reservoir fishery. Sauger of this population likely prefer the Tongue River habitat above the reservoir through the growing season and overwinter in the reservoir. Catch rates from the Tongue River above the reservoir with electro fishing gear show similar abundance levels (M. Backes, MTFWP, personal communication).

Yellow perch were abundant in 2009 and 2010. Prior to 2009 the five-year (2004 to 2008) average gillnet CPUE for yellow perch was 0.96 fish per net (Riggs 2004). Relative abundance in 2009 was 2.3 fish per gill net and in 2010 was 3.6 fish per gill net (Table 1). These abundances are only moderate when compared to abundances from the 1990s (Figure 4). In addition, YOY yellow perch were abundant in 2009 (25.4 fish/seine haul) and 2010 (12.0 fish/seine haul) seine samples (Table 2). Increased spawning success of yellow perch in Tongue River Reservoir may be linked to high reservoir levels in recent years (Figure 3).

Turtles

Turtle trapping was discontinued in 2010 but one tagged spiny soft-shell turtle was recaptured in a trap net. Tag number, weight, carapace length, and carapace width were recorded (Table 6).

Water

Tongue River Reservoir water level was high during August 2010 (Figure 3). Reservoir storage was above the post dam reconstruction historical average (1999-2009) in 2010 and exceeded storage capacity during peak runoff (Figure 7). Elevated water levels in 2010 provided an abundance of flooded vegetation. Monthly mean discharge data demonstrates a reservoir filling trend from January to June and a reservoir emptying trend from July to December (Figure 8). Specific conductance is inversely related to discharge, building during periods of low discharge and diminishing as discharge increases (Figure 8). If coal bed methane extraction increases in the Tongue River Reservoir watershed, the increased activity may alter water quality. Response of fish populations will be difficult to quantify, as data collected from the reservoir is inherently variable.

MANAGEMENT RECOMMENDATIONS

Monitoring of Tongue River Reservoir has been conducted for several decades. In that time the sampling methodology and management objectives have remained relatively unchanged. A change in sampling methods could provide valuable information that has been previously unknown and allow greater understanding of the status of the fishery and the processes that impact the fishing opportunities for anglers. Restructuring sampling regime to increase sample size and incorporate collection of aging structures would allow for improved analysis of crappie population dynamics in Tongue River Reservoir. Scales were collected and aged in 1983, 1989, and 2001 with results presented in the 2001-2002 report. Scales were collected in 2003 and summarized but have not been reported. Age data allows additional analysis and provides managers the ability to calculate length-age relationships, growth rates, and estimates of natural mortality. With these tools managers can better evaluate management objectives and develop realistic expectations of crappie size and abundance. It is recommended that age structures be collected in the future and be analyzed and reported with past scale data. Exploratory trap netting should remain part of 2011 collections but follow a more standardized sampling protocol. Results of 2011 trap netting should provide an indication for how the sampling regime can be modified to increase sample size.

Gillnets do not effectively sample bass. If adequate bass sampling were desired, additional sampling methods, such as spring electrofishing, would need to be added to the sampling methodology. Electrofishing may also provide additional samples of crappie if done in the spring when they are abundant in shallow shoreline areas of the reservoir.

Waters referred to:	Tongue River Reservoir 7-21-9000-06
Key Words:	Crappie, Crappie Reproduction, Walleye, Trap net, Sauger, Coal-bed Methane
Prepared by:	Caleb Bollman
Date prepared:	March 1, 2011

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Table 1. Results of 10 overnight experimental gillnet sets at Tongue River Reservoir, August, 2010.

Species	N	CPUE	Mean Length (mm)	Mean Weight (g)	Length Range (mm)	Weight Range (g)	% of Catch
Black bullhead	103	10.3	252	254	183 - 295	100 - 350	25.9%
Black crappie	9	0.9	236	204	192 - 301	80 - 425	2.3%
Channel catfish	2	0.2	608	2620	505 - 710	1160 - 4080	0.5%
Common carp	14	1.4	565	2342	472 - 646	1300 - 3240	3.5%
Northern pike	7	0.7	673	2097	472 - 905	610 - 4900	1.8%
Pumpkinseed	16	1.6	140	71	117 - 167	20 - 120	4.0%
Sauger	0	-	-	-	-	-	0.0%
Shorthead redhorse sucker	16	1.6	421	973	302 - 509	350 - 1580	4.0%
Smallmouth bass	14	1.4	307	520	198 - 481	100 - 1900	3.5%
Walleye	22	2.2	311	337	217 - 507	80 - 1260	5.5%
White crappie	106	10.6	191	108	115 - 292	10 - 330	26.7%
White sucker	0	-	-	-	-	-	0.0%
Yellow bullhead	52	5.2	234	184	189 - 270	70 - 340	13.1%
Yellow perch	36	3.6	218	141	144 - 250	20 - 210	9.1%
Total	397						100%

Table 2. Results of 10 seine hauls at Tongue River Reservoir, August 2010.

Species	N	CPUE	Mean Length (mm)	Mean Weight (g)	Length Range (mm)	Weight Range (g)	% of Catch
Black crappie	1	0.1	102	10	102 - 102	10 - 10	0.03%
Common carp	1	0.1	152	90	152 - 152	90 - 90	0.03%
Green sunfish	27	2.7	72	25	53 - 118	10 - 40	0.90%
Largemouth bass	15	1.5	176	97	130 - 245	40 - 280	0.50%
Northern pike	4	0.4	378	1068	203 - 879	50 - 4100	0.13%
Pumpkinseed	729	72.9	82	38	50 - 152	20 - 90	24.27%
Smallmouth bass	3	0.3	247	303	127 - 382	30 - 700	0.10%
Spottail shiner	14	1.4	91	8	45 - 110	5 - 10	0.47%
White crappie	6	0.6	177	76	107 - 267	10 - 240	0.20%
Yellow bullhead	1	0.1	33		33 - 33	-	0.03%
Yellow perch	839	83.9	122	22	98 - 142	10 - 40	27.93%
Black bullhead YOY	1	0.1	39		39 - 39	-	0.03%
Common carp YOY	2	0.2	55	96	20 - 90	86 - 105	0.07%
Crappie YOY	1162	116.2	50	7	33 - 99	5 - 10	38.68%
Largemouth bass YOY	40	4.0	67	10	52 - 84	10 - 10	1.33%
Smallmouth bass YOY	39	3.9	53		39 - 70	-	1.30%
Yellow perch YOY	120	12.0	59	8	44 - 68	5 - 10	3.99%
Total	3004						100%

Table 3. Summary of management objective results in Tongue River Reservoir. Walleye gillnet catch rates and mean length. Percentage of crappie greater than 250 mm in total length, 1980-2010.

Year	Walleye Catch rate	Walleye Mean Total Length (mm)	% Crappie greater than 250 mm TL
2010	2.2	311	12.3
2009	1.8	364	7.1
2008	2.7	341	2.4
2007	3.0	308	7.9
2006	3.1	371	2.7
2005	1.6	367	4.6
2004	3.5	423	3.4
2003	0.5	448	7.0
2002	2.5	449	0.0
2001	3.9	438	7.5
2000	4.0	424	2.9
1999	8.5	411	13.5
1998	18.0	343	25.0
1997	4.2	384	24.2
1996	5.0	395	20.0
1995	2.4	335	21.2
1994	5.3	349	2.2
1993	1.1	308	0.7
1992	8.4	325	0.8
1991	3.9	383	19.9
1990	4.1	349	2.9
1989	15.7	343	12.8
1988	19.4	332	18.9
1987	5.6	279	4.2
1986	1.6	273	0.0
1985	0.6	463	2.7
1984	0.4	417	1.2
1983	0.2	427	3.4
1982	2.0	397	1.7
1981	5.6	377	27.8
1980	4.3	319	11.4

Table 4. Summary of proportional size distribution (PSD) and mean relative weight (W_r) values for game fish sampled with gillnets, August 2010.

		PSD				W_r			
Species	N	PSD	RSD-P	RSD-M	RSD-T	PSD	RSD-P	RSD-M	RSD-T
Black bullhead	103	90	0	0	0	92	--	--	--
Black crappie	9	78	33	11	0	88	97	90	--
Channel catfish	2	100	50	50	0	98	104	104	--
Northern pike	7	71	43	29	0	78	79	91	--
Pumpkinseed	16	38	0	0	0	120	--	--	--
Smallmouth bass	14	57	36	14	0	94	98	102	--
Walleye	11	36	0	0	0	83	--	--	--
White crappie	90	59	12	0	0	97	90	--	--
Yellow bullhead	52	63	NA	NA	NA	94	--	--	--
Yellow perch	35	86	6	0	0	91	90	--	--

Table 5. Sauger gillnet catch rates from 1988-2010.

Year	Count	CPUE (fish/gill net)
2010	0	0.0
2009	1	0.1
2008	0	0.0
2007	1	0.1
2006	0	0.0
2005	1	0.1
2004	0	0.0
2003	0	0.0
2002	0	0.0
2001	2	0.2
2000	0	0.0
1999	0	0.0
1998	3	0.3
1997	2	0.2
1996	0	0.0
1995	0	0.0
1994	0	0.0
1993	0	0.0
1992	0	0.0
1991	0	0.0
1990	0	0.0
1989	2	0.2
1988	8	0.8

Table 6. Species, tag information, total body weight, carapace length and width from turtle incidentally caught in trap net on 8/10/2010.

			Carapace		
Species	N	Tag Number	Mean Length (mm)	Mean Width (mm)	Mean Weight (g)
Spiny Soft-shell Turtle	1	ST4946	383	291	3450

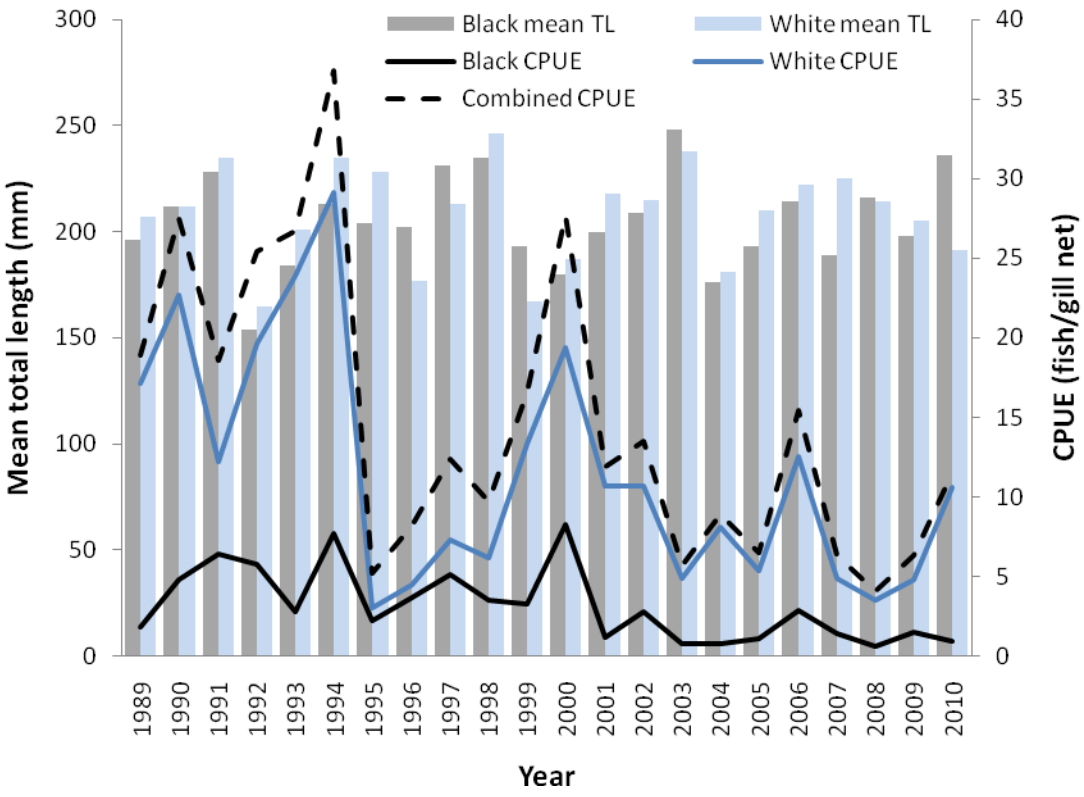

Figure 1. Mean length of white crappie (blue bars) and black crappie (gray bars) measured in total length (mm) on the primary Y-axis; and relative abundance of white crappie (blue line), black crappie (black line) and combined crappie species (dashed black line) measured in CPUE (fish/gill net) on the secondary Y-axis as a function of year on the X-axis from Tongue River Reservoir gillnets, 1989-2010.

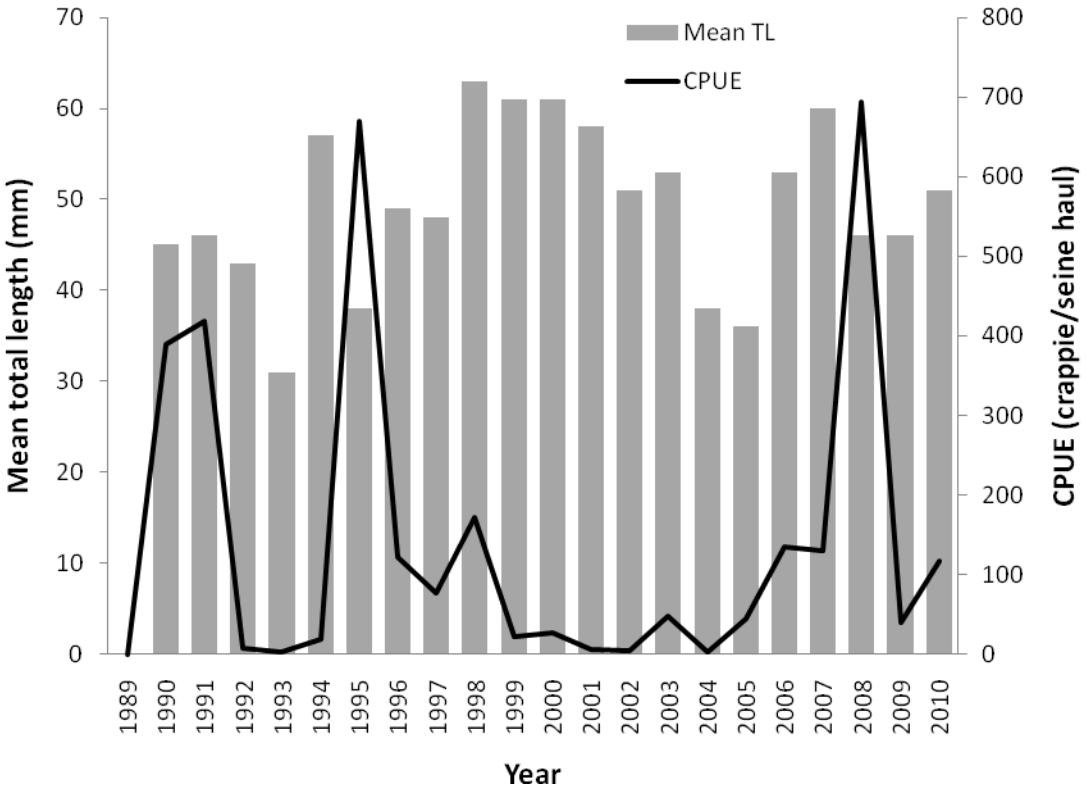

Figure 2. Mean length of young-of-the-year (YOY) crappie combined species (gray bars) measured in total length (mm) on the primary Y-axis; and relative abundance of crappie YOY combined species (black line) measured in CPUE (fish/seine haul) on the secondary Y-axis as a function of year on the X-axis from Tongue River Reservoir seines, 1989-2010.

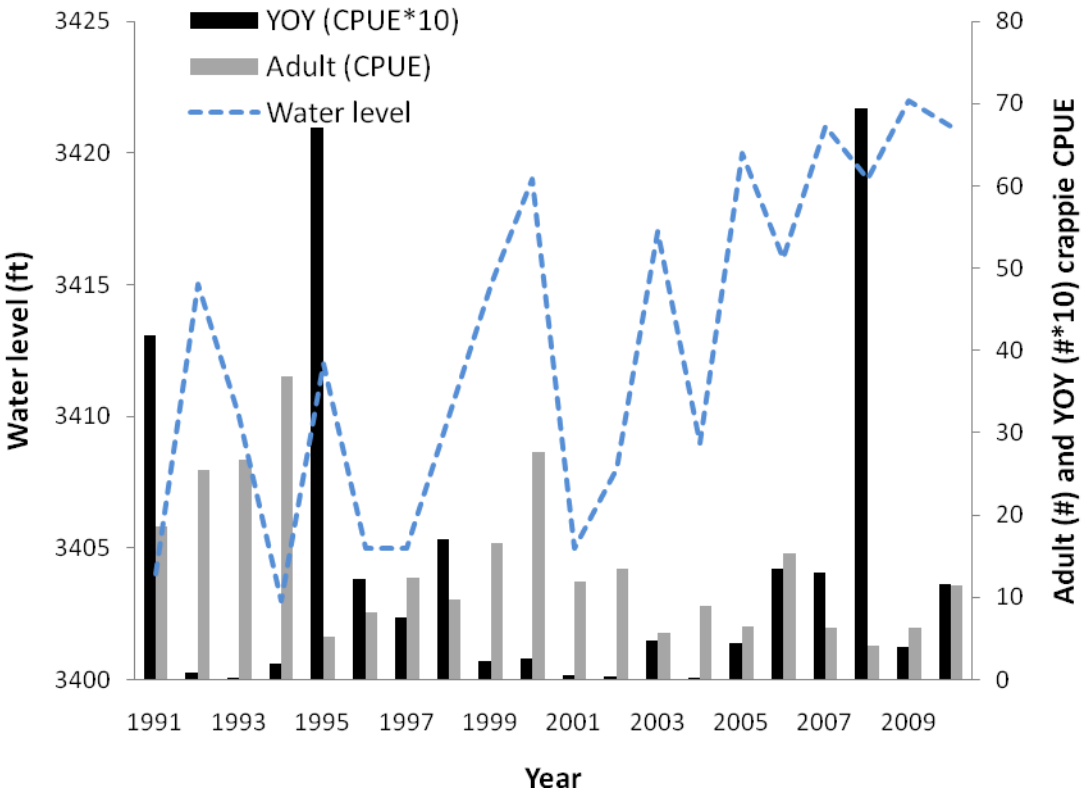

Figure 3. Average reservoir water level for the month of August measured in feet (primary Y-axis), relative abundance of young-of-the-year (YOY) crappie measured in CPUE (fish per seine haul)*10 and relative abundance of adult crappie measured in CPUE (fish per gill net) (secondary Y-axis) as a function of year (X-axis) from Tongue River Reservoir 1989-2010, water level data provided by DNRC.

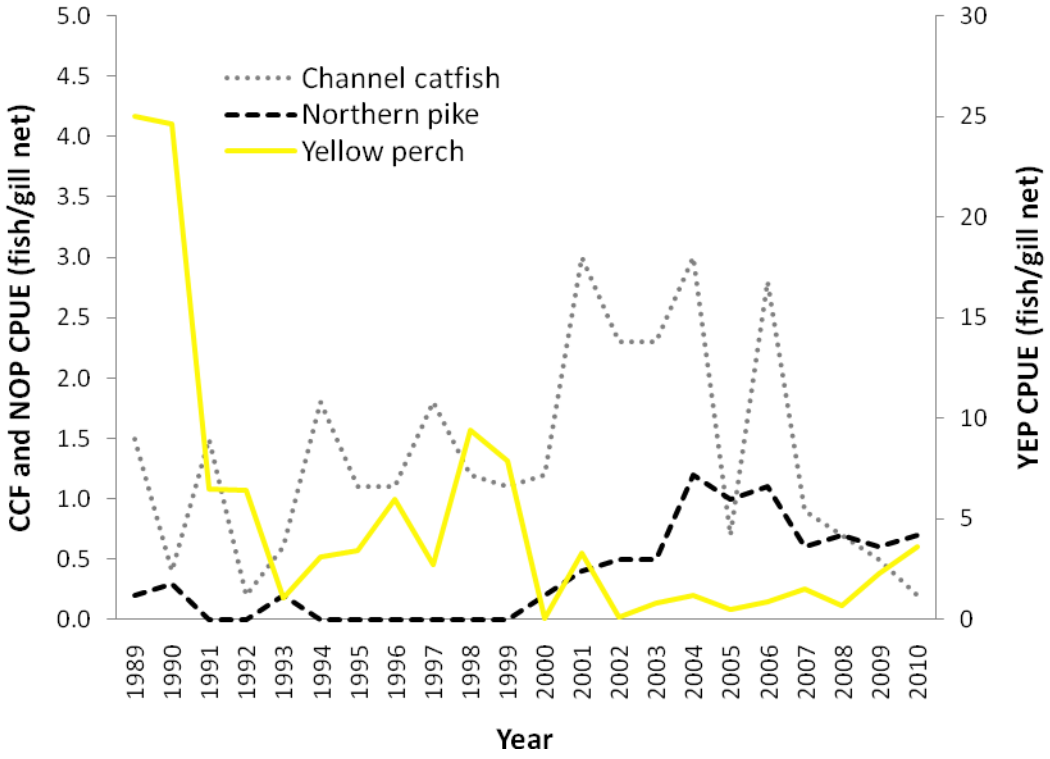

Figure 4. Relative abundance of channel catfish and northern pike (primary Y-axis) and yellow perch (secondary Y-axis) measured in CPUE (fish/gill net) as a function of year (X-axis) in Tongue River Reservoir 1989-2010.

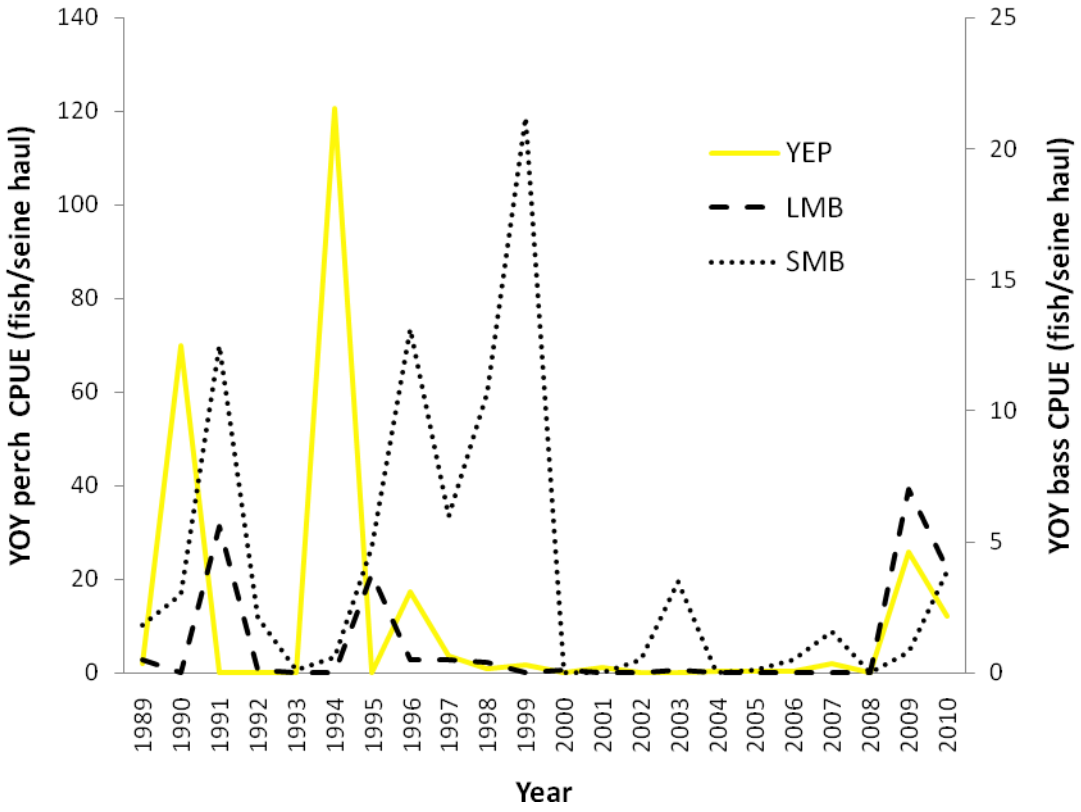

Figure 5. Relative abundance of young-of-the-year (YOY) yellow perch (primary Y-axis), largemouth bass, and smallmouth bass (secondary Y-axis) measured in CPUE (fish/seine haul) as a function of year (X-axis) from Tongue River Reservoir seines, 1989-2010.

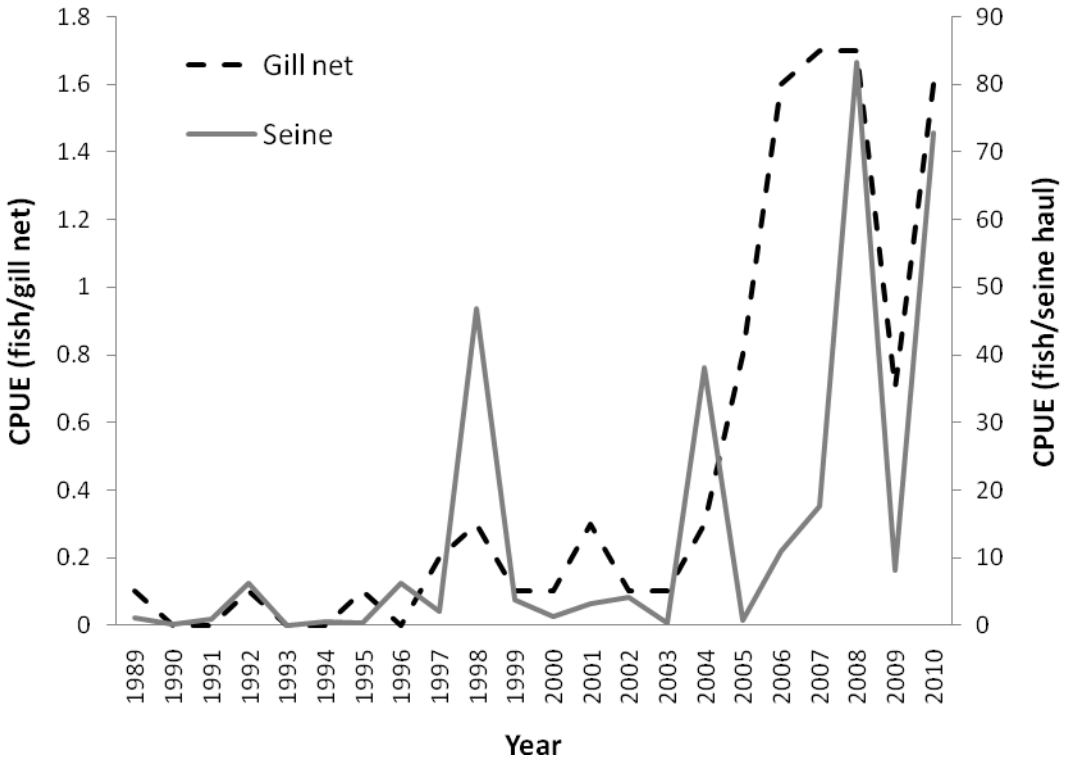

Figure 6. Relative abundance of all pumpkinseed caught in gill nets (primary Y-axis) and seine hauls (secondary Y-axis) measured in CPUE as a function of year (X-axis) in Tongue River Reservoir 1989-2010.

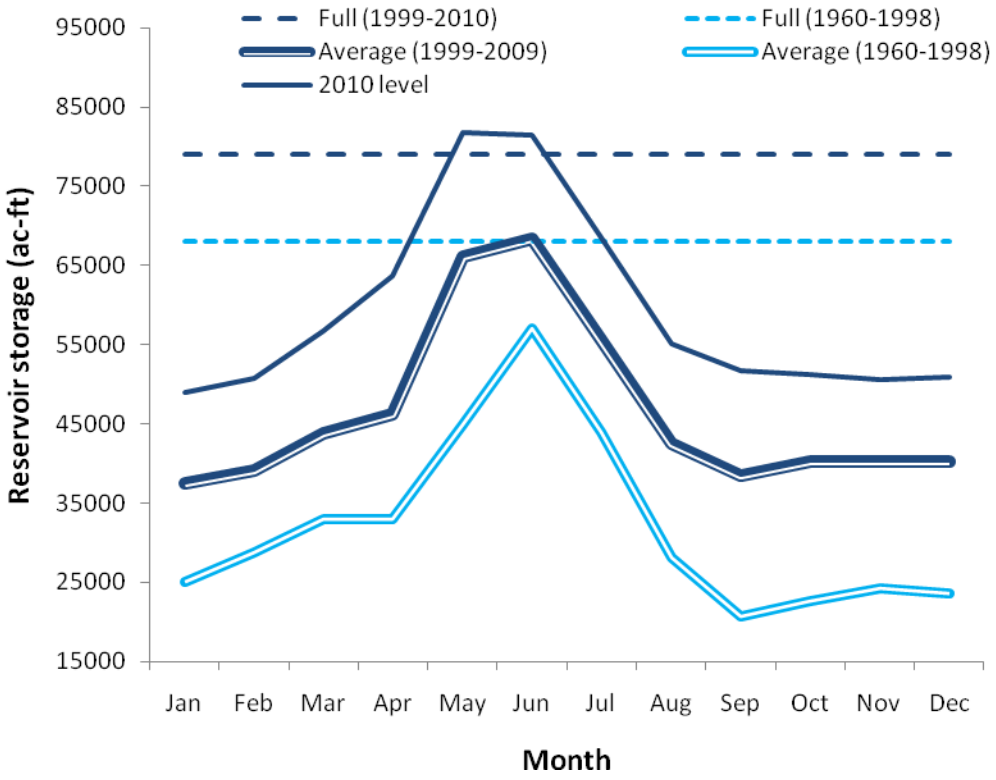

Figure 7. Tongue River Reservoir 2010 storage level measured in acre-feet by month with full pool reference lines and historical mean storage level pre (1960-1998) and post (1999-2009) dam reconstruction, data provided by DNRC website.

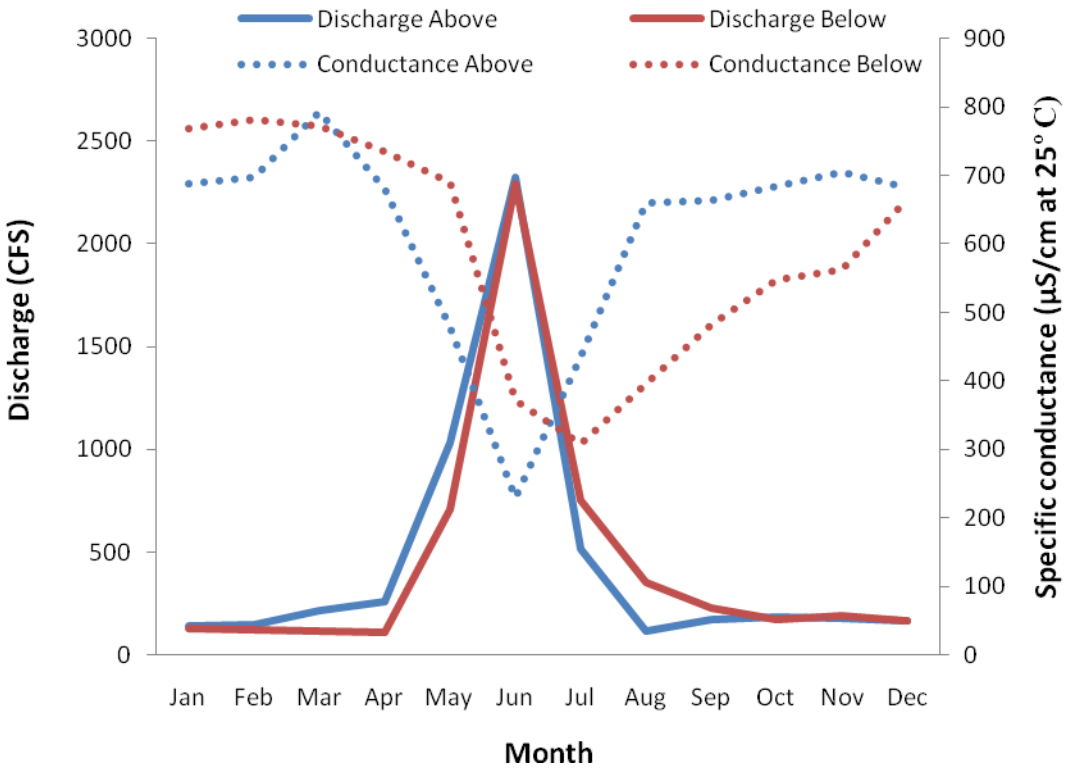

Figure 8. Monthly mean discharge measured in cubic feet per second (primary Y-axis) and specific conductance measured in microseimens per cm at 25º C (secondary Y-axis) by month (X-axis) from USGS gauging stations 06306300 Tongue River at state line and 06307500 Tongue River at Tongue River dam, Decker MT.