FISHERY MANAGEMENT INVESTIGATIONS

IDAHO DEPARTMENT OF FISH AND GAME

FISHERY MANAGEMENT ANNUAL REPORT

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SOUTHEAST REGION
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2012 Southeast Region Annual Fishery Management Report

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

List of Figures (cont.)

ABBREVIATIONS

AWPE – American white pelican
BCT – Bonneville cutthroat trout
BG - bluegill
BWMA – Blackfoot Wildlife Management Area
cfs – cubic feet per second
CP – common carp
CPUE – catch-per-unit-effort
DCC – Double-crested cormorant
EFNA - Edson Fichter Nature Area
g - gram
ha - hectare
hr - hour
IDFG – Idaho Department of Fish and Game
km - kilometer
L - liter
LMB – largemouth bass
m - meter
mg - milligram
mm - millimeter
MMU – Malad Management Unit
n – sample size
NMU – Nounan Management Unit
PIT – Passive Integrated Transponder
PMU - Pegram Management Unit
PSD – Proportional Stock Density
RBT – rainbow trout
RMU - Riverdale Management Unit
s – second
SD – standard deviation
SMB – smallmouth bass
TL – total length
TMU – Thatcher Management Unit
UC – Utah chub
US – Utah sucker
W_r – relative weight
YCT – Yellowstone cutthroat trout
YP – yellow perch

2012 Southeast Region Annual Fishery Management Report

LOWLAND LAKE AND RESERVOIR INVENTORIES AND SURVEYS

ABSTRACT

Johnson Reservoir was identified as an underperforming fishery in 2010. In 2011 and 2012 we stocked at total 234 largemouth bass *Micropterus salmoides* over 270 mm in an attempt to improve the size structure of the bluegill *Lepomis macrochirus* population. Bluegill Proportional Stock Densities (PSD) increased from 2 in 2010 to 31 in 2012. Likewise, largemouth bass PSD increased from 12 to 17. Blackfoot Reservoir's trout population continues to represent about 15% of the catch which was similar to 2011 results but still well below historic levels (25%). Avian predation likely continues to prevent recovery of the Yellowstone cutthroat trout population in Blackfoot Reservoir. In 2012, we PIT tagged 287 rainbow trout *Oncorhynchus mykiss* (RBT) out of 18,900 destined for Chesterfield Reservoir. Over the course of the summer we recovered 86 tags from Blackfoot Reservoir that had been consumed by American white pelicans *Pelecanus erythrorhynchos* (AWPE) and Double-crested cormorants (DCC). These tag recoveries provided an overall avian predation rate estimate of 30% which suggests that at least 5,700 RBT were lost to avian predation. Bear Lake was trawled for Bear Lake sculpin *Cottus extensus* during August. We captured an average of 59 adult sculpin per trawl which converts to a population estimate of about 2 million adult sculpin, well above the minimum sculpin population (1 million) defined in the Bear Lake Management Plan. Adequate numbers and size of kokanee are available for harvest at Devils Creek Reservoir but angler exploitation remains low. Edson Fichter community fishing pond was constructed during the summer of 2011 at a cost of about $270,000. During the 2012 calendar year, a total of 22,000 angler trips were made to fish the new pond. Peak use occurred in June (6,000) and the lowest use occurred during the winter months.

Johnson Reservoir

Introduction and Methods

Johnson Reservoir is located in Franklin County near Preston, Idaho. When full, Johnson Reservoir covers approximately 20 ha and has an elevation of 1,485 m. The reservoir is used primarily for irrigation storage but also provides angling opportunities for largemouth bass *Micropterus salmoides* (LMB), bluegill *Lepomis macrochirus* (BG), yellow perch *Perca flavescens* and rainbow trout *Oncorhynchus mykiss*. Tiger muskies *Esox lucius x E. masquinongy* were stocked in the past to provide a trophy component and to help reduce an over-abundance of BG less than 170 mm. The tiger muskie program, however, was criticized by anglers and was discontinued.

During 2010, we identified Johnson Reservoir as an under-performing fishery due to its high catch rates of undesirable sized BG. Over the past decade, BG Proportional Stock Density (PSD) has been well below what should be observed in a balanced population (40%-60%; Table 1). In an attempt to improve the size structure of the BG fishery we began transferring LMB into Johnson Reservoir to increase predation pressure on the BG population. During 2011 and again in 2012, we collected LMB from surrounding Franklin County reservoirs and relocated them to Johnson Reservoir. All LMB transferred to Johnson were large enough (≥ 275 mm) to have an immediate impact on age-0 and age-1 BG.

Predator and prey populations were monitored using boat mounted electrofishing gear. All fish captured were weighed and measured to the nearest g and mm (total length), respectively, and released. To avoid sampling newly stocked LMB, Both surveys were conducted prior to LMB transfers.

Results and Discussion

The predator enhancement program appears to be having the desired impact on improving the PSD of BG. In 2010 and 2011 (prior to the implementation of this project), the BG PSD was two and six percent, respectively. In 2012, the BG PSD increased substantially to 31%; the highest PSD ever observed (Table 1). However, the current BG PSD (31%) is still below the desired range. Both Guy 1990 and Novinger 1978 suggest a BG PSD of 40% - 60% is needed to spark angler's interest in the fishery. However, Gabelhouse (1984) suggests that a BG PSD of 50% - 80% is needed to promote a high level of angler participation in the fishery. Similarly, the length frequency distribution observed in 2012 also shows modest improvement over what was observed in the previous two years (Figure 1).

Bluegill relative weight (W_r) also improved in 2012. In both 2010 and 2011 BG W_r was similar at 87%. In 2012, BG W_r increased to 98%; significantly higher than in either of the previous two years ($F=56.261$; $df=2$; $P=0.000$) which indicates good body condition and appropriate abundance for the available habitat.

Table 1. Catch-per-hour of electrofishing effort from Johnson Reservoir during 2010, 2011 and 2012. Proportional Stock Density values for largemouth bass (LMB) and bluegill (BG) are shown in parenthesis.

Species	2002	2006	2010	2011	2012
LMB	54(7)	20(0)	108 (12)	217 (26)	179 (17)
BG	305(24)	240(10)	297 (2)	417 (6)	1004 (31)

Historically, LMB PSD has been low in Johnson Reservoir. Largemouth bass PSD has not reached at least 40% (Ideal range 40%-60%) in the last 10 Years (Table 1). Chronically low LMB PSDs likely explain the imbalance in the BG population.

Largemouth bass transfers occurred in June of 2011 and again in October of 2012. The majority of LMB (114) were transferred to Johnson Reservoir in 2011. Finding suitable donor populations of LMB, of the appropriate size (≥ 275 mm), to transfer to Johnson Reservoir proved difficult in 2012. Since all of the fish transferred in 2011 originated from Condie Reservoir, we wanted to "mine" other sources so as not to impact that fishery. We attempted to collect LMB from Glendale Reservoir but were unsuccessful. Apparently when the attempt was made, LMB were too deep to be collected via electrofishing. Ultimately we were able to collect and transfer 22 LMB from Treasureton Reservoir in October (Table 2).

Table 2. Number, mean length and mean weight of largemouth bass transferred to Johnson Reservoir, Idaho, in 2011 and 2012.

Year	Number	Length (mm)	Weight (g)
2011	114	380	726
2012	22	292	502

In summary, the BG population in Johnson Reservoir appears to be responding positively to augmentation of LMB. However, the BG PSD is still below the target of 60%. Therefore, we plan to continue transfers of LMB to Johnson Reservoir and monitor the fishery over the next couple of years. Unfortunately, we do not have the resources to continue this project indefinitely. We are currently exploring another avenue that would provide a long term solution for Johnson Reservoir (see below). Furthermore, we suspect the low LMB PSDs observed at Johnson Reservoir are due to angler exploitation. Quality and larger sized LMB are conspicuously absent from the overall LMB population (Figure 2). It appears that once a fish is recruited to quality size (which is also the size when they can first be harvested) they are for the most part, removed from the population. We think if the minimum length limit was increased from the current regulation of 305 mm (12 inches) to 356 mm (14 inches) we would increase the LMB PSD to 40% – 60% annually (our objective) which in turn would greatly improve the quality of the BG fishery in Johnson Reservoir.

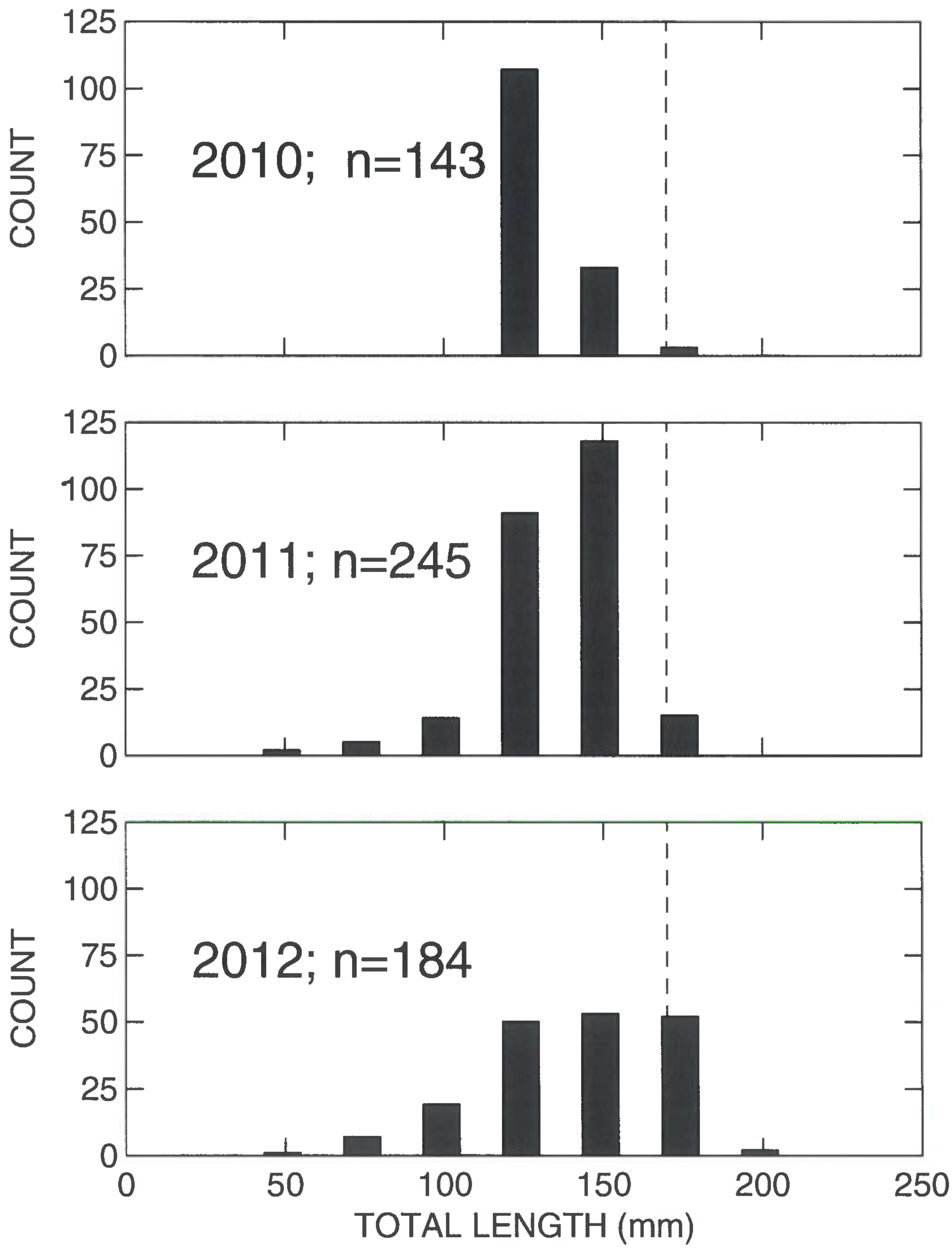

Figure 1. Length frequency distribution of bluegill collected from Johnson Reservoir, Idaho, in 2010, 2011 and 2012. Vertical dashed lines at 170 mm represent quality size for larger bluegill.

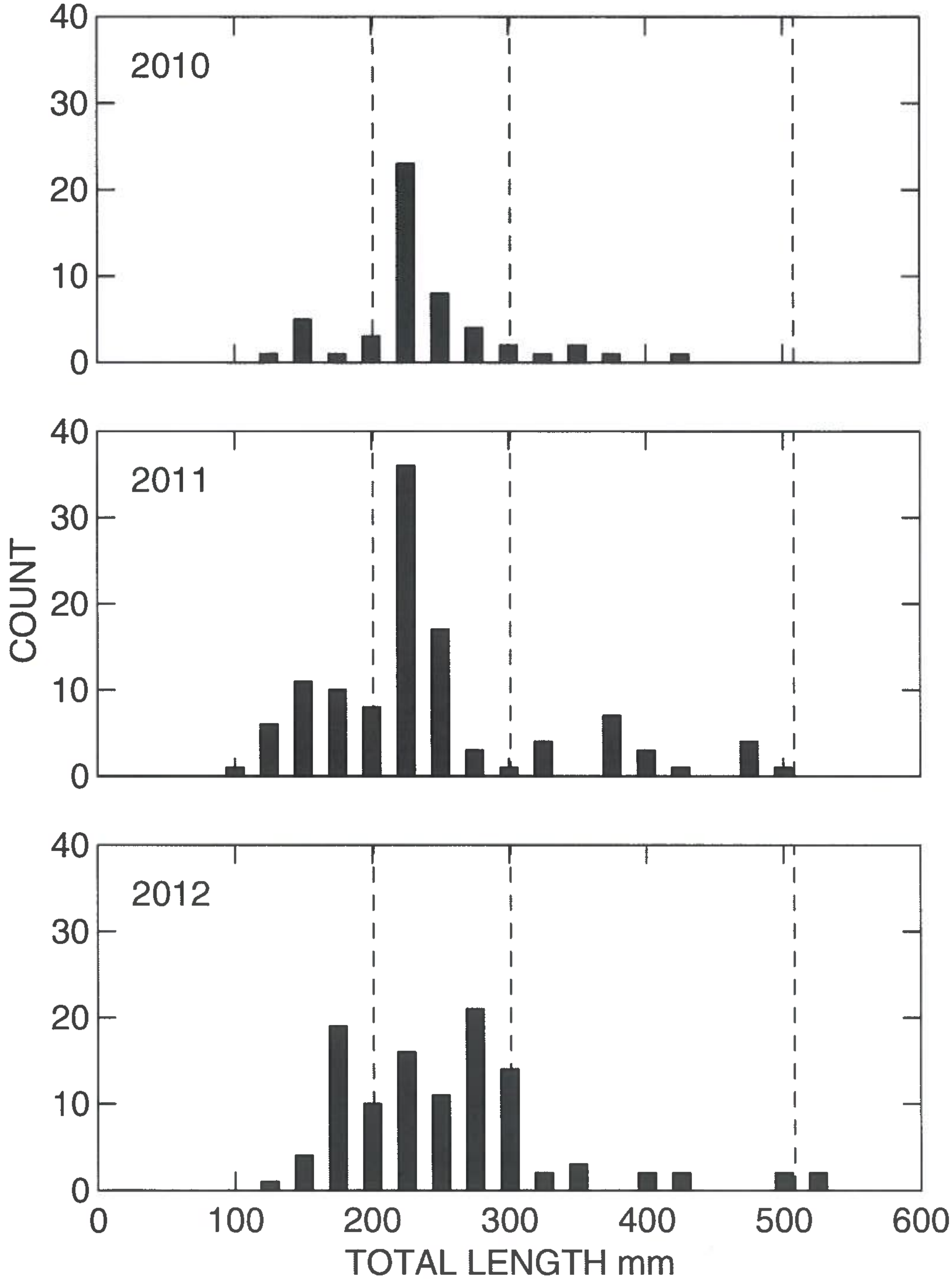

Figure 2. Length frequency distribution of largemouth bass collected from Johnson Reservoir, Idaho, in 2010, 2011 and 2012. Vertical dashed lines at 200 mm, 300 mm and 510 mm represent stock, quality and trophy sizes, respectively, for largemouth bass.

Blackfoot Reservoir

Introduction and Methods

Blackfoot Reservoir is located on the Blackfoot River in Caribou County; north of Soda Springs, Idaho. Its primary use is irrigation storage. The U.S. Bureau of Indian Affairs regulates the dam and reservoir. At full capacity, the reservoir is at 1,865 m elevation, covers 7,285 ha and contains 432,000,000 m^3 of water. Refilling begins in October and continues through spring. Irrigation use begins in June with drawdown beginning as irrigation demand exceeds inflow.

Historically, Blackfoot Reservoir was a premier fishery for large size (>500 mm) Yellowstone cutthroat trout (YCT) *Oncorhynchus clarkii bouvieri*. The fishery slowly deteriorated and eventually crashed in the early 1980s. In 1989, a comprehensive plan to reestablish a fishery for wild Yellowstone cutthroat trout was formulated after several years of study (LaBolle and Schill 1990). It called for elimination of wild cutthroat trout harvest from Blackfoot Reservoir. In order to provide a harvest fishery, large numbers of both hatchery rainbow trout *O. mykiss* (RBT) and hatchery Bonneville cutthroat trout *O. c. utah* originating from Bear Lake were stocked. Attempts were made for Bonneville cutthroat trout to establish their own wild spawning run into the Little Blackfoot River. Bonneville cutthroat trout stocking was discontinued in 1994. Rainbow trout stocking was increased as a replacement. The management plan called for stocking 1 million fingerlings and 100,000 catchable RBT in the spring. In 2003, a bioenergetics study was completed that showed double-crested cormorants *Phalakros auritus sp.* (DCC) and American white pelicans *Pelecanus erythrorhynchos* (AWEP) consumed near equal biomass of trout compared to total stocked biomass (Teuscher 2004). To minimize avian predation impacts, a fall stocking strategy was implemented in 2004.

Predation by the AWPE is threatening a genetically unique population of YCT in the Blackfoot River system. The adult AWPE population at Blackfoot Reservoir increased from a few hundred in 1993 to a peak of 3,416 in 2007 (Brimmer et. al. 2011). This AWPE population represents one of only three breeding colonies in Idaho. Conversely, the adult population of YCT declined from 4,747 in 2001 to about 530 in 2012. Both AWPE and YCT are classified by IDFG as species of special concern. In addition to special concern status, recent genetic work showed that Blackfoot River YCT trout carry unique genetic markers not found in any other YCT population.

The objectives for this study were to evaluate the performance of the fall stocking strategy for RBT and to monitor relative abundance of YCT.

During the summer of 2012 we sampled Blackfoot Reservoir with gill nets (floating and sinking). Gill nets measured 42 m x 2 m with six panels composed of 19, 25, 32, 38, 51, and 64 mm bar mesh. The combination of one floating and one sinking net, fished overnight equaled one unit of gill net effort. Overall, we applied 4 units of gill net effort (Figure 2). All fish captured were identified, enumerated, measured to the nearest mm (total length; TL) and weighed to the nearest g. Occasionally, catches were too large to measure and weigh every fish. In these cases, we sub-sampled a portion of the total catch.

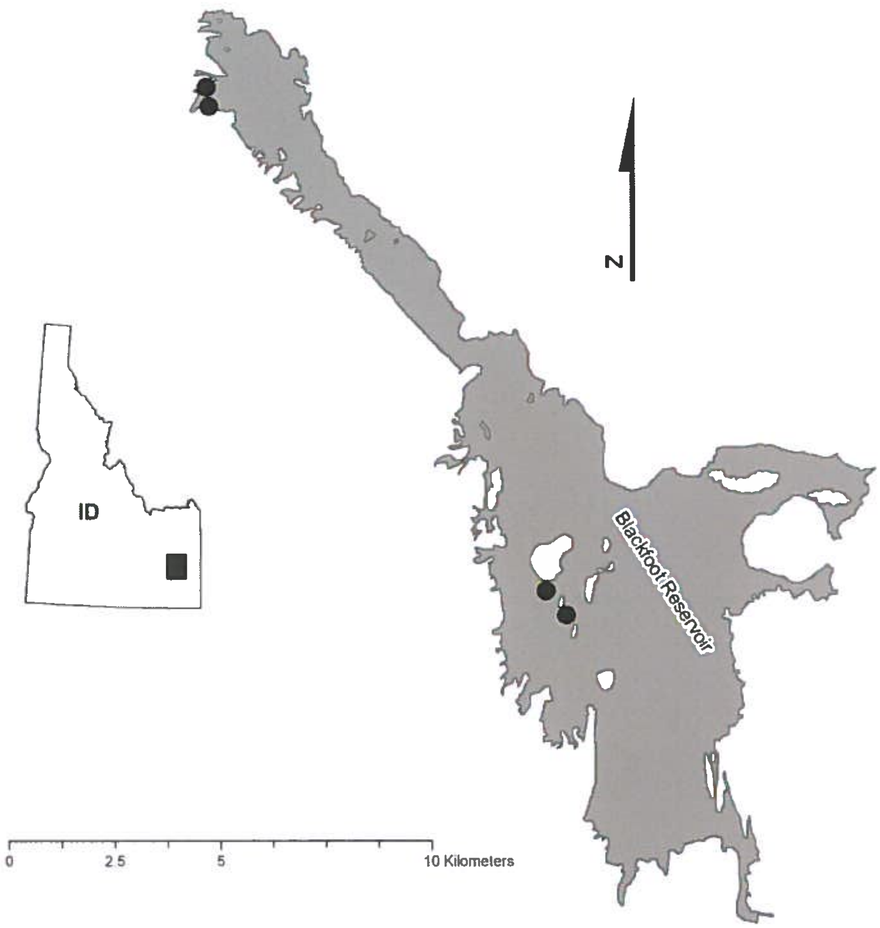

Figure 3. Locations where gill nets (●) were set at Blackfoot Reservoir during the summer of 2012.

Results and Discussion

Our gill net monitoring shows subtle changes in the Blackfoot Reservoir fishery. Over the past three decades, trout have represented <10% of the total catch. Change occurred in 2011 when the trout catch increased to 85 fish and comprised 15% of the total gill net catch. Trout represented 15% of the catch again in 2012 (Table 3). A summary of non-trout species relative abundance is presented in Table 3.

As hoped, RBT continue to recruit to the fishery. We switched to fall stocking (after AWPE have migrated) of RBT in 2004. This stocking effort did not show up in the 2005 sample however these fall plants are now recruiting to the fishery with regularity (Table 3). Of the RBT captured in 2012, the majority were of "quality size" (> 400mm). These fish had a mean length and weight of 445 mm and 990 g, respectively. Analysis of the length frequency histogram suggests that several cohorts were present at the time we sampled but there was substantial overlap between the groups (Figure 4). Currently, the trout fishery appears to be driven largely by the RBT stocking program. Yellowstone cutthroat trout catch continues to be low and has not exceeded four individuals in any of the past five sampling events (Table 3). In 2012, no YCT were sampled by our nets. We believe AWPE predation on YCT adults and juveniles particularly when they are in the Blackfoot River system is preventing this population from reaching its full potential.

Table 3. Summary of gill net data from Blackfoot Reservoir from 1963 to 2012.

Year	Nets	Total catch	RBT	YCT	Total trout	% Trout	UC	US	CP	YP	Total non-trout	% Non-Trout
1963	2					31						69
1964						25						75
1967	4	348			13	4					335	96
1968		270	15	4	19	8	122	129			251	92
1971	20	782	9	16	25	3	456	283	18		757	97
1980	12	865	16	19	35	4	556	272	2		830	96
1991		273	1	7	8	3	216	49			265	97
1997		389	6	6	12	3	351	22	4		377	97
1999	6	1,528	22	1	23	2	1,291	200	7	7	1,505	98
2001	12	954	17	5	22	2	748	101	15	51	932	98
2003	6	454	26	1	27	6	304	123			454	94
2004	8	648	3	3	6	1	528	113	1		648	99
2005	8	476	10	2	12	3	311	148	2	3	476	97
2009	8	973	82	3	85	9	590	235	47	16	973	91
2011	8	424	60	4	64	15	179	165	6	10	360	85
2012	8	225	33	0	33	15	80	97	15	0	192	85

YCT = Yellowstone cutthroat trout, RBT = rainbow trout, UC = Utah chub, US = Utah sucker, YP = yellow perch, CP = common carp

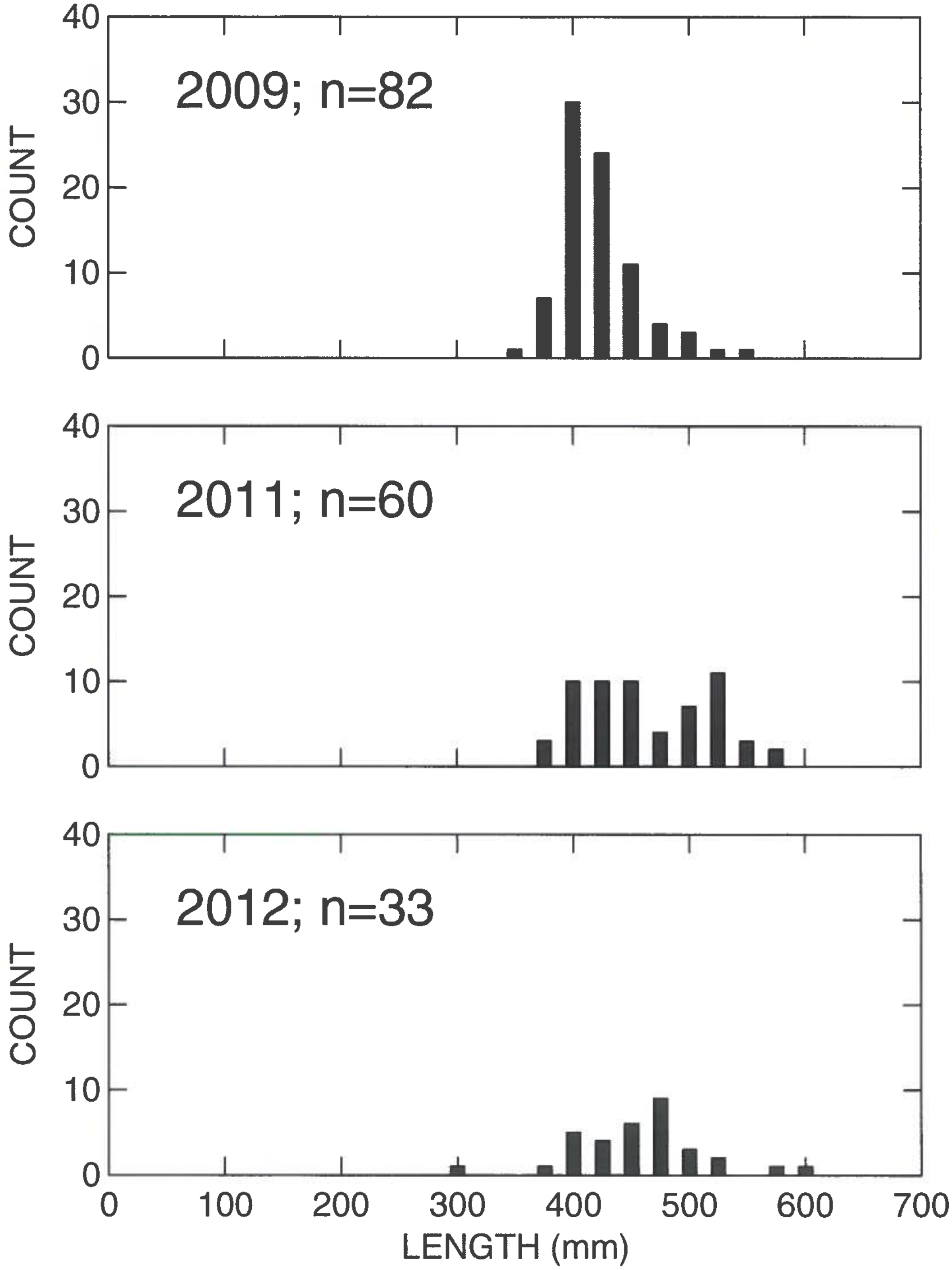

Figure 4. Length frequency of rainbow trout collected from Blackfoot Reservoir during the summers of 2009, 2011 and 2012.

Chesterfield Reservoir

Introduction and Methods

Chesterfield Reservoir is one of the most popular trout fisheries in southeast Idaho. During the 1990s, the fishery was managed under general harvest rules that included a six trout limit with no size or bait restrictions. Those regulations maximized yield from the reservoir. In 1994, anglers fished an estimated 158,000 hr and harvested over 70,000 rainbow trout *Oncorhynchus mykiss* (RBT). Despite the popularity of the fishery, anglers began requesting more restrictive harvest regulations to allow more fish to grow to quality size (> 400mm). In response to angler requests and creel analysis that showed harvest would be significantly reduced under more conservative bag limits, the trout limit was reduced from 6 to 3 fish per day in 1998. The bag limit was reduced a second time to 2 trout in 2002.

Over the past decade, American white pelican *Pelecanus erythrorhynchos* (AWPE) and double-crested cormorant (DCC) use of Chesterfield Reservoir has increased (Brimmer et al. 2011). Concerns have arisen regarding the predation impacts these birds may be having on the RBT fishery in Chesterfield Reservoir. The objective was to estimate total predation by AWPE on RBT in Chesterfield Reservoir.

During 2012, we PIT (passive integrated transponder) tagged RBT stocked in Chesterfield Reservoir. Half Duplex 23 mm tags purchased from ORFID (www.oregonrfid.com) were used to monitor predation rates. On May 21st, we randomly selected 287 RBT from a larger group of 18,900 fish from Hagerman State Fish Hatchery that were to be stocked into the reservoir; PIT tagged them; and released them back into the raceway that would be loaded for Chesterfield Reservoir. These fish were stocked in Chesterfield Reservoir on May 23rd. In addition to the tagged group of RBT mentioned above, we also PIT tagged and fed 100 RBT to AWPE that were actively foraging on Chesterfield Reservoir. Feeding events occurred on June 19th and 20th and again on July 10th. See Appendix A. for feeding and predation rate estimate details. We attempted to recover PIT tags at three locations during the summer and fall of 2012. The first area we recovered PIT tags from was a small island located at the north end of Chesterfield Reservoir. American white pelicans loafed on this island while at the reservoir. The second and third locations were from Gull and Willow Islands located on Blackfoot Reservoir. See Appendix A. for tag recovery methods.

Results and Discussion

Overall, we recovered 148 out of 387 PIT tags deployed at Chesterfield Reservoir in 2012. Of the 287 tags that went out with RBT stocked in May, 86 were recovered from the avian nesting colony on Blackfoot Reservoir. Of the 100 PIT tagged RBT fed to AWPE, we recovered 62; 13 from Gull Island and 42 from Willow Island. We were unable to assign a recovery location to seven of the 62 tags recovered. The majority (≈ 80%) of AWPE nested on Willow Island and 20% on Gull Island in 2012. The recoveries of tags fed to AWPE mirror these proportions. However, tag recoveries from the 287 RBT stocked, do not. Of the 62 tags recovered (with known recovery locations), 90% of the "at large" RBT tags were recovered from Gull Island and 10% from Willow Island suggesting an additional avian predator is having an impact on the Chesterfield fishery. DCC also nest at Blackfoot Reservoir and nest exclusively on Gull Island (where the majority of "at large" RBT tags were recovered) and have been observed foraging at Chesterfield Reservoir in relatively high numbers. Therefore, it appears DCC prey on Chesterfield RBT at a higher level than previously thought.

As mentioned above, we planned to estimate total predation by AWPE. However, due to significant predation impacts by DCC (and no DCC were fed PIT tagged fish), we were unable to do so. However, we were able to estimate an overall (AWPE and DCC combined) avian predation rate. Based on total “at large” tag recoveries from the nesting islands, we estimated the avian predation rate to be about 30% which translates to a loss of at least 5,700 RBT in 2012. The predation rate estimated in 2012 was similar to the 2011 estimate of 32%. The similar predation rates observed over the last two years suggests that DCC predation on Chesterfield RBT is not a new but has been occurring for some time.

Our results show both AWPE and DCC are having significant impacts on the Chesterfield RBT fishery. Therefore, in 2013 we plan to include DCC along with AWPE in feeding trials so that a total predation estimate can be achieved.

Bear Lake Sculpin Trawling

Introduction and Methods

Bear Lake is a 28,328 ha lake located in northern Utah and southeast Idaho. The Utah-Idaho border roughly bisects the 32 km long lake in half and the lake is 8-13 km in width. It has a maximum elevation of 1,806 m above sea level. The maximum depth, when at full pool, is 63 m and average depth is 26 m. Most of the lake bed is covered in fine marl sediment. Primary and secondary production is thought to be limited by precipitation of calcium carbonate, which strips phosphorous from the water column Birdsey (1989). The precipitate also gives the lake its famous turquoise iridescence.

St. Charles, Swan, Big Spring, and Fish Haven creeks are the primary natural tributaries to the lake. In addition to the natural tributaries, Bear River is diverted into Bear Lake. In 1911, a canal was constructed to divert the Bear River at Stewart Dam into Bear Lake. The water delivery system stores spring runoff water in Mud Lake which gravity flows into the northeast corner of Bear Lake. Rocky Mountain Power operates, through a legal decree (Kimball Decree), the top 6.4 m of the lake as irrigation storage. The stored water is pumped out of the lake during the summer irrigation season and delivered back to the Bear River through the outlet canal.

Bear Lake’s fish community supports four endemic species: Bonneville whitefish (*Prosopium spilonotus*), Bear Lake whitefish (*Prosopium abyssicola*), Bonneville cisco (*Prosopium gemmifer*), and Bear Lake sculpin (*Cottus extensus*). In addition to the four endemic species, Bear Lake provides habitat for one of two remaining native adfluvial stocks of Bonneville cutthroat trout (*Oncorhynchus clarkii utah*).

In 2010, the Bear Lake Management Plan (Plan) was finalized (Tolentino and Teuscher 2010). The Plan specifically outlined a monitoring program for Bear Lake sculpin. Bear Lake sculpin (sculpin) have been monitored since the 1980’s first by Utah State University and later by the State of Utah. In 2010, Idaho Department of Fish and Game took over monitoring responsibilities. The management objective for Bear Lake sculpin, as stated in the Plan, is to maintain a minimum population of 1-2 million adult sculpin which translates to a mean density of 25 – 50 age-1(or older) sculpin captured per trawl. If sculpin numbers fall below a mean density of 25 adult sculpin per trawl (1 million sculpin) then lake trout (*Salvelinus namaycush*) stocking will cease and cutthroat trout stocking may be reduced until the sculpin population rebounds. Bear Lake sculpin monitoring occurs biennially with the next sampling effort scheduled for 2014. For complete details on the Bear Lake Management Plan see Tolentino and Teuscher 2010.

Bear Lake sculpin were sampled during the new moon phase in August. We sampled sculpin with a semi-balloon otter trawl with a head rope of 4.9 m attached to two otter boards. The net had a mesh size of 12.7 mm with the cod-end containing a 5.0 mm mesh liner. We sampled at three locations (First Point, Gus Rich, and Utah State Marina; Figure 4) and at two depths: where the top of the thermocline intersected with the lake bed (10.5 m; shallow) and where the bottom of thermocline intersected with the lake bed (20.5 m; deep). At each location a total of 6, 20- minute trawls were conducted (3 at the top and 3 at the bottom of the thermocline) for a total of 18 trawls. While trawling, boat speed was maintained as close to 1 m/s as possible. Trawling began at about 2100 hrs. and ended at approximately 0400 hrs. All adult (>35 mm) Bear Lake sculpin and non-target fish encountered were counted and measured (total length) to the nearest mm and released. Young-of-the-year sculpin were counted and released.

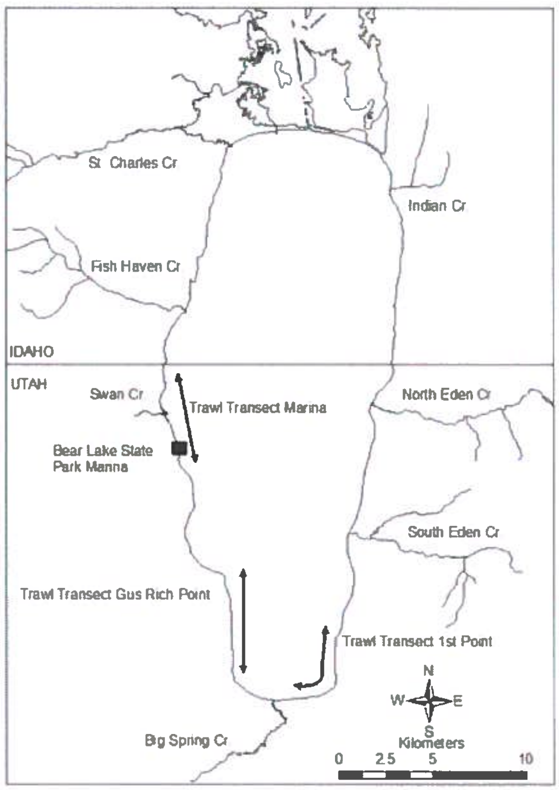

Figure 5. Locations within Bear Lake, Idaho/Utah, where Bear Lake sculpin were sampled via bottom trawl in 2012.

Results and Discussion

Sculpin trawling occurred from August 20th through 21st 2012. Adult sculpin density was highest in deep trawls (see methods section) and averaged about 104 adult sculpin per trawl whereas mean adult sculpin density was considerably less in shallow trawls (15/trawl; Figure 5). Utah State Marina had the highest overall mean adult sculpin density of 146/trawl followed by First Point at 19/trawl and Gus Rich at 13/trawl. The overall mean adult sculpin (≥ 35mm) catch per trawl was 59, which converts to a population estimate of about 2 million adult sculpin, well above the minimum sculpin population as defined in the Plan (Tolentino and Teuscher, 2010). Furthermore, a strong cohort of sculpin (≤ 34mm) was encountered during our trawling efforts suggesting the population is currently robust and should be for the next several years.

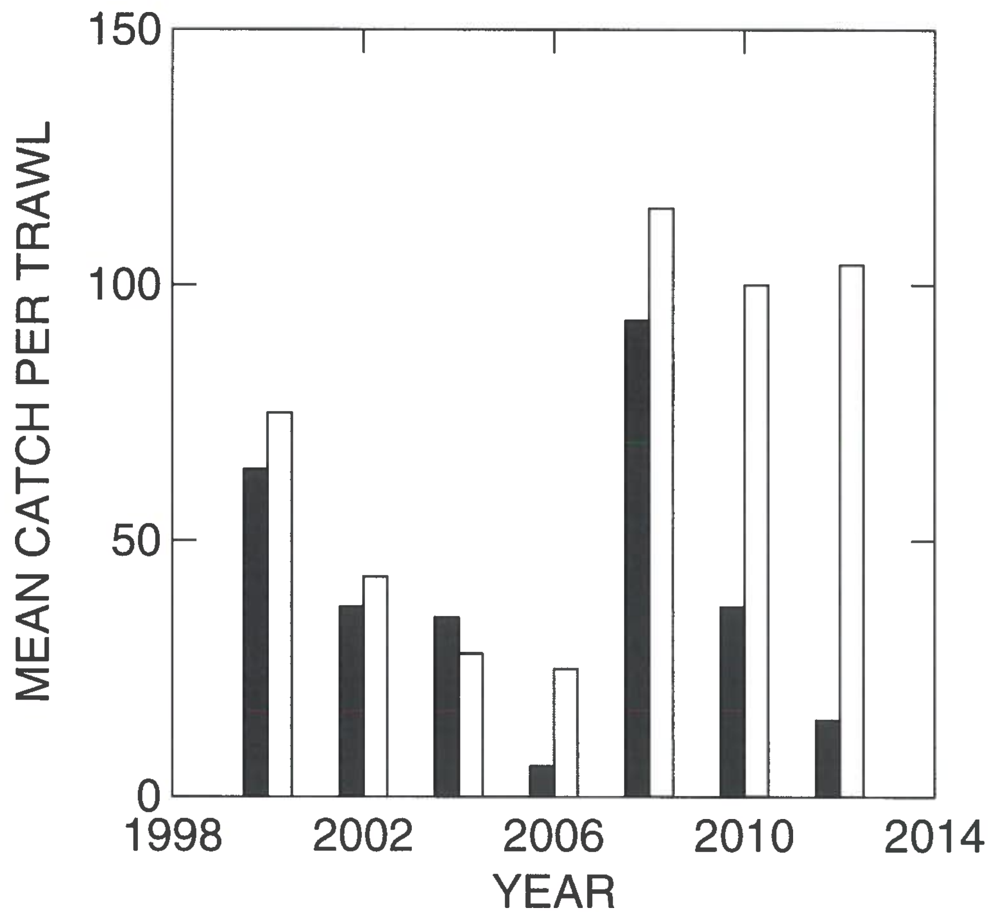

Figure 6. Mean Bear Lake Sculpin catch per trawl. Black bars represent samples collected from the top of the thermocline where it intersected with the lake bed (10 m) and the white bars represent samples collected from the bottom of the thermocline where it intersected with the lake bed (18 m). All trawls were 20 minutes in duration.

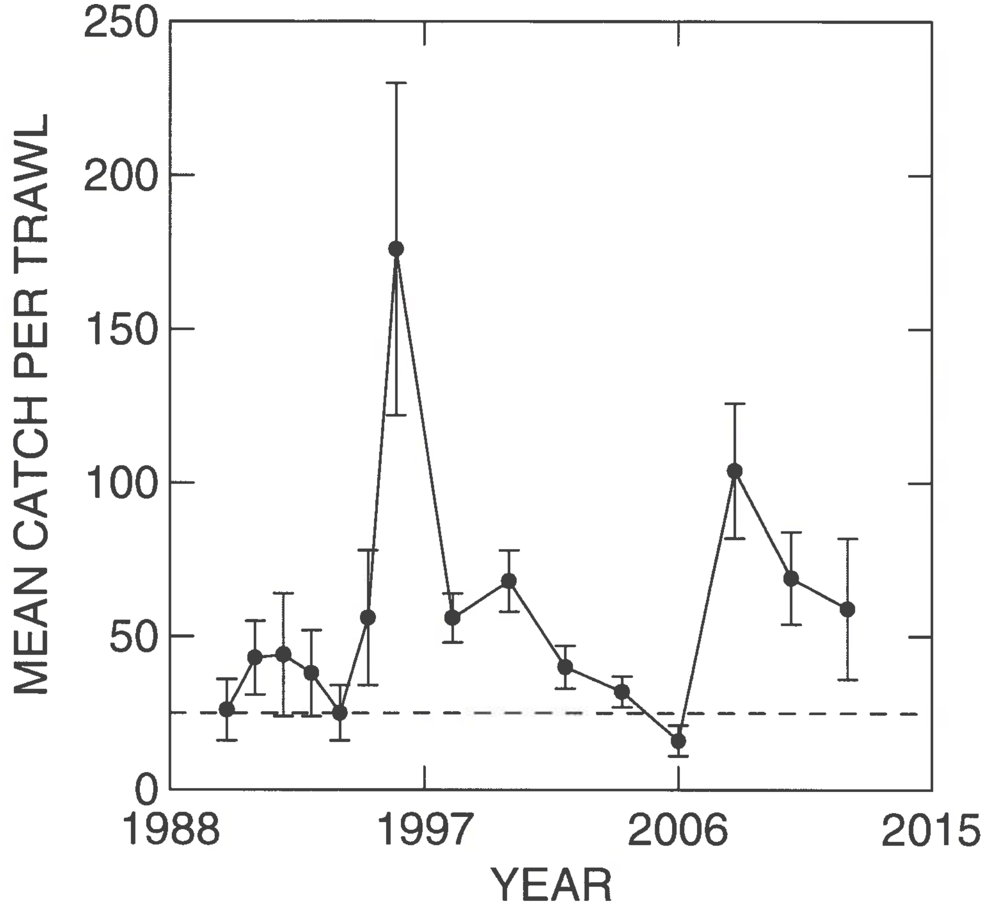

Figure 7. Mean catch (•) and standard error (I) per trawl for Bear Lake Sculpin collected from Bear Lake Idaho/Utah. Each trawl was 20 minutes in duration. The horizontal dashed line represents the minimum acceptable Bear Lake sculpin population of 1 million as defined in the Bear Lake Management Plan (Tolentino and Teuscher, 2010).

Devils Creek Reservoir

Introduction and Methods

Devils Creek Reservoir is located in Oneida County and is used primarily for irrigation storage and flood control. The Malad Valley Irrigation Company regulates the dam and reservoir. At full capacity, the reservoir is at 1,568 m elevation, covers 58 ha and contains 5,550,000 m^3 of water. Refilling begins in October and continues through early spring. Irrigation use generally begins in June with drawdown beginning as irrigation demand exceeds inflow.

Devils Creek Reservoir is currently managed as a rainbow trout *Oncorhynchus mykiss* fishery using both catchable and fingerling plants. Kokanee *O. nerka* are also stocked there to provide additional angling opportunities. The reservoir's close proximity to Interstate 15, ease of access, and permanent camping facilities combine to produce heavy summer fishing pressure.

Kokanee were sampled from Devils Creek Reservoir each using a combination of experimental gill nets and net curtains. Experimental gill nets measured 48 m long by 1.8 m deep and were comprised of six panels of 19, 25, 32, 38, 51 and 64 mm bar mesh, placed in random order when manufactured. Experimental net curtains in two different sizes were used. The “small” mesh net curtains measured 55 m long by 6 m deep and were composed of panels of 19, 25, 32, 38, 51, and 64 mm bar mesh monofilament. “Large” mesh net curtains measured 55 m long by 6 m deep and were composed of panels of 76, 102, 127 mm bar mesh monofilament. Sampling in 2009 was conducted using only “large” mesh net curtains to target only larger, older kokanee. Nets were set overnight for a minimum of 8 hr. Gill nets and net curtains were either set floating on the surface or suspended along the thermocline. Kokanee were sampled in 2006, 2007, 2008, 2009 and 2012 between May and July. All kokanee captured were measured for total length to the nearest mm and weighed to the nearest g.

Results and Discussion

Kokanee stocked into Devils Creek Reservoir persist for about four years. During the first two years after kokanee are stocked, they provide little angling opportunity. During their third year and beyond, kokanee reach a size appealing to anglers (>305 mm; Figure 8). Kokanee collected from Devils Creek Reservoir were in excellent condition. Relative weight (Wr) of Kokanee ranged from a low of 94% in 2006 to a high of 103% in 2009. Kokanee Wr in this range suggest our stocking program (≈ 125/ha) is appropriate. With the exception of 2006, adequate numbers and kokanee of desired size were available to provide angling opportunities. However, angler exploitation remains low.

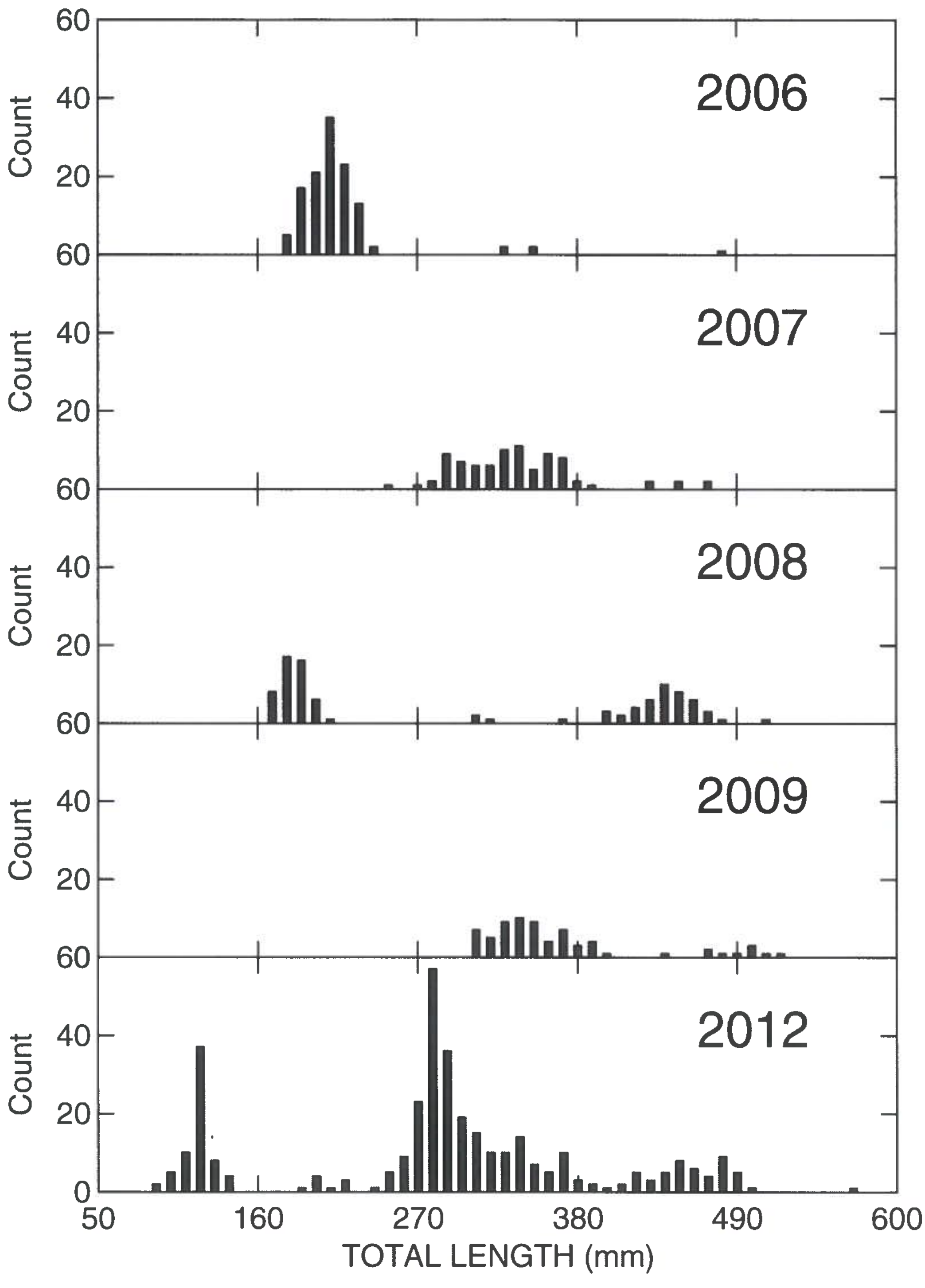

Figure 8. Length frequencies of kokanee collected from Devils Creek Reservoir, Idaho, during the summers of 2006-2009 and again in 2012. Sample sizes were 121, 84, 96, 69 and 182 for 2006, 2007, 2008, 2009 and 2012, respectively.

Edson Fichter Pond

Introduction and Methods

The Edson Fichter Nature Area (EFNA) is a 14 ha parcel of land along the Portneuf River on the southern edge of Pocatello. The land was purchased in 1993 with Idaho Department of Fish and Game license funds to provide public fishing access to the river and a public outdoor educational area. The outdoor educational component consists of a ½ mile interpretive trail with signage that educates readers about wildlife habitat, successional stages and water quality. Additionally, the area provides a working demonstration of water quality projects that can be implemented to improve the water quality of the Portneuf River.

A 1.2 ha (3 acre) fishing pond was added to the EFNA in 2011. Pond construction began in July and was completed in September. The total cost of pond construction was about $270,000. Of the $270,000, $70,000 came from private donations and the remainder from a Dingle/Johnson grant. The fishery at the pond is maintained solely with hatchery produced rainbow trout *Oncorhynchus mykiss.*

We used hourly photographs of the pond to estimate angler trips in 2012 (the first full year the pond was open for use). A remote camera was situated overlooking the pond and was set to take hourly photographs. By counting the number of anglers observed in the photographs we were able to estimate angler use. See Brimmer 2011 for complete details.

Results and Discussion

The EFNA pond received heavy angler use in 2012. Overall, 22,000 angler trips were taken to the pond in 2012. Peak angler use occurred during the summer months; June was the busiest month with about 6,000 angler trips recorded. The lowest angler use occurred during the winter months (Figure 9). While pond construction is complete, development of the area is not. In 2013, we plan to construct a new bathroom near the entrance, continue to develop the native plant community that was disturbed during construction, and construct some shaded rest areas along the path that surrounds the pond.

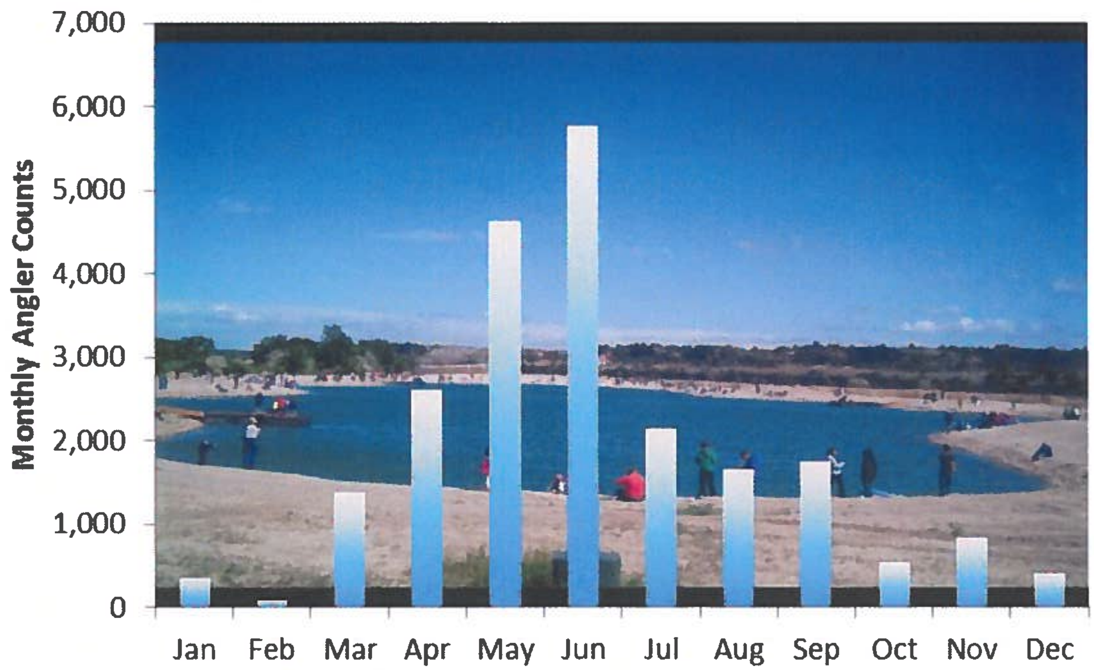

Figure 9. Estimated angler use of Edson Fichter pond during 2012. The pond is located in Pocatello, Idaho.

MANAGEMENT ROCOMMENDATIONS

1. Continue tracking rainbow trout and largemouth bass in Treasureton Reservoir and renovate the reservoir when rainbow trout growth rates decline or when reservoir water level is low.
2. Evaluate the fishery improvement efforts completed at Johnson Reservoir.
3. Continue the American white pelican predation study currently underway.
4. Design and implement a cormorant predation study on the Bear River and surrounding irrigation impoundments.

2012 Southeast Region Annual Fishery Management Report

RIVER AND STREAM INVESTIGATIONS AND SURVEYS

ABSTRACT

We surveyed the Blackfoot, Bear, and Snake River systems via electrofishing in 2012. Using a Maximum Likelihood model, we estimated there were approximately 1,672 Yellowstone cutthroat trout *Oncorhynchus clarkii bouvieri* (YCT) using the Blackfoot Wildlife Management Area in July which was lower than average (3,098). The density estimate of 270 YCT/km was also lower than in previous years. Bonneville cutthroat trout *O. c. utah* (BCT) were sampled from nine streams which included 21 sites within the Nounan and Pegram Management Units of the Bear River drainage. Mean BCT densities were among the highest observed in the Pegram Management Unit over the past three decades. These high densities are correlated to increased precipitation that occurred in 2011. In 2008, the smallmouth bass (SMB) *Micropterus dolomieu* angling regulation changed from 6 bass none under 12" (305 mm) to 2 bass any size on the Snake River below American Falls, Idaho. Smallmouth bass total length, weight, catch-per-unit-effort, and Proportional Stock Density were all higher in 2012 than in 2005 indicating the regulation change had the desired effect.

Yellowstone Cutthroat Trout Monitoring in the Blackfoot River System

Introduction and Methods

There are two long-term monitoring programs in place for Yellowstone cutthroat trout *Oncorhynchus clarkii bouvieri* (YCT) in the upper Blackfoot River. They are adult escapement counts and population estimates within the Blackfoot Wildlife Management Area (BWMA) located about 51 km above the reservoir. The adult escapement counts obtained at the weir have been completed every year since 2001. The population surveys are completed less frequently.

An electric fish migration barrier was installed in the Blackfoot River in 2003. The barrier includes a trap box designed using Smith Root Inc. specifications. The barrier components include four flush mounted electrodes embedded in Insulcrete, four BP-X.X.-POW pulsators, and a computer control and monitoring system. The computer system can be operated remotely, records electrode outputs, and has an alarm system that triggers during power outages. Detailed descriptions of these components and their function can be obtained at www.smith-root.com.

The electric barrier was operated from May 2nd to 23rd – June 11th. Prior to observing fish at the trap, field crews checked the live box several times a week. Once fish began entering the trap, it was checked at least once a day. Fish species and total lengths (mm) and weights (g) were recorded. YCT were visually checked for bird scars. Bird scar monitoring began in 2004. Scar rates were associated with increases in pelicans feeding in the Blackfoot River downriver of the trap. All salmonids handled at the trap were injected with a 32 mm Half Duplex Passive Integrated Transponder (PIT) tag purchased from Oregon RFID (oregonrfid.com). These fish were tagged so they could be included in a pelican predation study currently underway.

In 1994, the Idaho Department of Fish and Game (IDFG), with assistance from the Conservation Fund, purchased the 700 ha ranch and began managing the property as the BWMA. The BWMA straddles the upper Blackfoot River, with an upper boundary at the confluence of Lanes, Diamond, and Spring creeks and a lower boundary at the head of a canyon commonly known as the upper narrows. Approximately 9 km of river meander through the property along with 1.6 km of Angus Creek, which is a historical YCT spawning and rearing stream. Since purchasing the BWMA, IDFG has completed periodic population estimates to monitor native YCT abundance.

We estimated YCT abundance within 5.2 km of the BWMA reach of the Blackfoot River in 2012. The estimate was completed using mark-recapture methods. Fish were sampled with drift boat-mounted electrofishing gear. All YCT captured were injected (marked) with a 23 mm PIT tag (oregonrfid.com). Fish were marked on Aug 22nd and recaptured Aug 31st. Data were analyzed using Fish Analysis + software package (Montana Fish Wildlife and Parks 2004). All YCT caught were measured for total length (mm) and weighed to the nearest g.

Results and Discussion

In 2012, a total of 530 adult YCT were collected at the adult escapement trap. Of these, 421 were females and 100 were males; no sex determination could be made on the remaining 9 fish. Captured females and males had a mean length of 480 and 502 mm, respectively. The bird scarring rate observed in 2012 was 37%, the highest observed since 2006. Scarring rates have varied from no visible scars on fish collected in 2002 to a high of 70% scarred in 2004. Scarring rates may be related to the predation rate by pelicans, but no information is available to determine the relationship. Variation in scarring rates is likely impacted by the overall number of pelicans feeding on the river below the migration trap, water levels and clarity, and hazing efforts exerted on the birds to reduce predation impacts. The hazing efforts were described by Teuscher and Scully (2008). Escapement and bird scar trends are shown in Table 4.

A total of 224 YCT were sampled on the BWMA during the mark and recapture electrofishing surveys (Table 5. The number of YCT caught in 2012 was lowest of the past seven sampling events. We think AWPE predation on BWMA YCT was a contributing factor to the low number of YCT encountered in 2012 (Appendix A).

Table 4. Yellowstone cutthroat trout escapement estimates for the Blackfoot River 2001-2012. No escapement estimates are available in 2011 due to extremely high river discharge during the migration season which resulted in poor tapping efficiency.

Year	Weir Type	YCT Count	Mean Length(mm)	% Bird Scars	Mean May River Discharge (cfs)	Adult Pelican Count
2001	Floating	4,747	486	No data	74	No data
2002	Floating	902	494	0	132	1,352
2003	Electric	427	495	No data	151	1,674
2004	Electric	125	478	70	127	1,748
2005	Electric	16	Na	6	388	2,800
2006	Electric	19	Na	38	453	2,548
2007	Electric	98	445	15	115	3,416
2008	Electric	548	485	10	409	2,390
2009	Electric	865	484	14	568	3,174
2010	Electric	938	468	12	248	1,734
2011	Electric	Na	Na	Na	936	724
2012	Electric	530	483	37	200	3,034

Table 5. Yellowstone cutthroat trout abundance estimates collected from the Wildlife Management Area of the Blackfoot River, Idaho.

Year	Fish Marked	Fish Captured	Fish Recaptured	% Recaptured	Pop. Estimate	Pop. Estimate SD
2005	266	202	20	7.5	3,664	569.1
2006	339	450	57	16.8	3,534	352.3
2008	223	186	28	12.6	2,504	336.5
2009	279	319	44	15.8	2,567	286.5
2010	317	272	11	3.5	12,944	4,131.2
2011	318	147	16	5.0	3,222	411.3
2012	137	99	12	12.1	1,672	421.7
Mean[a]	260	234	30	11.6	2,861	396.2

[a]Excludes 2010.

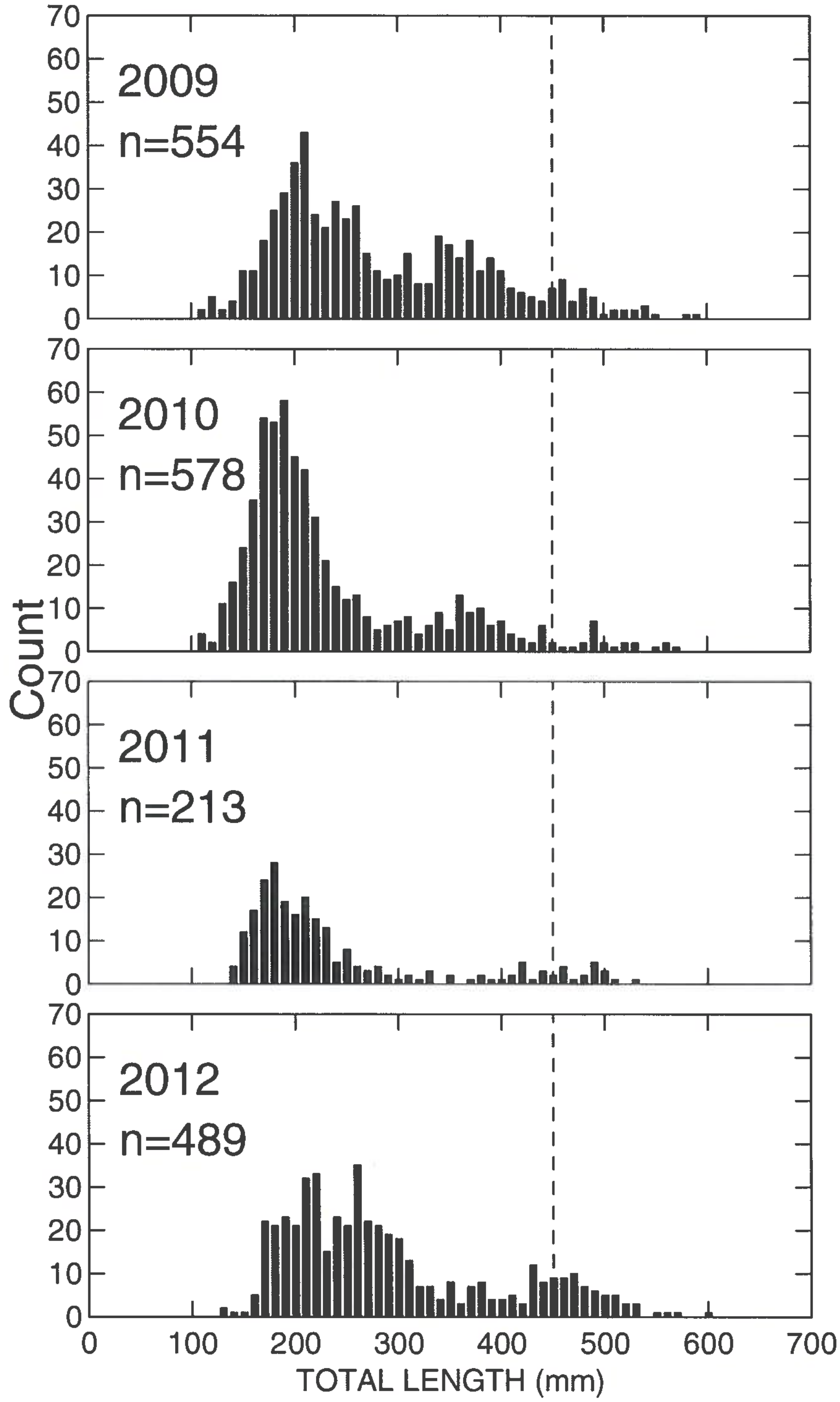

Figure 10. Length frequency distributions of Yellowstone cutthroat trout caught from the Blackfoot Wildlife Management Area of the Blackfoot River, Idaho. The majority of fish located to the right of the vertical dashed lines are likely post spawn adfluvial fish that may return to Blackfoot Reservoir.

In past surveys of the BWMA reach, juveniles (< 300 mm) dominated catch. Thurow (1981) reported that about 80% of the fish caught during population surveys were less than 300 mm total length. Results from 2009, 2010, 2011 and 2012 surveys show similar ratios of juvenile cohorts (Figure 10).

Bonneville Cutthroat Trout Monitoring Program

Introduction and Methods

Bonneville cutthroat trout *Oncorhynchus clarkii utah* (BCT) are one of three native cutthroat trout sub-species in Idaho. The distribution of BCT, in Idaho, is limited to the Bear River Drainage. In the early 1980s, distribution and abundance data for this native trout were deficient. Initially, to better understand BCT population trends and the potential influence of natural and anthropogenic processes, a long-term monitoring program was initiated for three tributary streams of the Thomas Fork Bear River (Preuss, Giraffe, and Dry Creeks). These streams were to be sampled every other year. Although, in 2006, as part of the BCT management plan (Teuscher and Capurso 2007), additional streams were added to the BCT monitoring program to implement a broader representation of BCT population trends from across their historical range in Idaho. These additional monitoring streams included Eightmile, Bailey, Georgetown, Beaver, Whiskey, Montpelier, Maple, Cottonwood, Snow slide, First, Second, and Third creeks, and the Cub River. In 2010, IDFG personnel determined that the monitoring program would be better represented by dropping some sites and streams initiated in 2006, while adding other streams throughout the four BCT management units in the Bear River drainage (Figure 11). Currently, the monitoring program consists of three streams and eight sites in the Pegram Management Unit (PMU), six streams and 14 sites in the Nounan Management Unit (NMU), four streams and nine sites in the Thatcher Management Unit (TMU), four streams and eight sites in the Riverdale Management Unit (RMU), and three streams and six sites in the Malad Management Unit (MMU; Table 6). We will sample half of these streams annually. In addition, the monitoring program will include two segments of the main stem Bear River in each of the management units, excluding the MMU. Main stem Bear River segments in each management unit will be sampled every four years.

There are a number of variables that may be influencing BCT population trends in monitoring streams, which may include annual precipitation, water temperature, irrigation, dams, grazing, etc. Given the sensitive status of BCT and recent petitions to list the species under the Endangered Species Act, it is important to identify and correlate variation in BCT densities that appear to be associated with these and other suspected variables. Therefore in 2011, we collected a suite of habitat variables to begin monitoring potential changes in habitat and stream channel condition. The descriptions of these habitat variables and collection methods are listed in Table 7. In the future, habitat data will be correlated to variation in BCT abundance. Although, analysis of habitat variables require many years of data collection, therefore, no statistical analysis will be reported until sufficient data is collected.

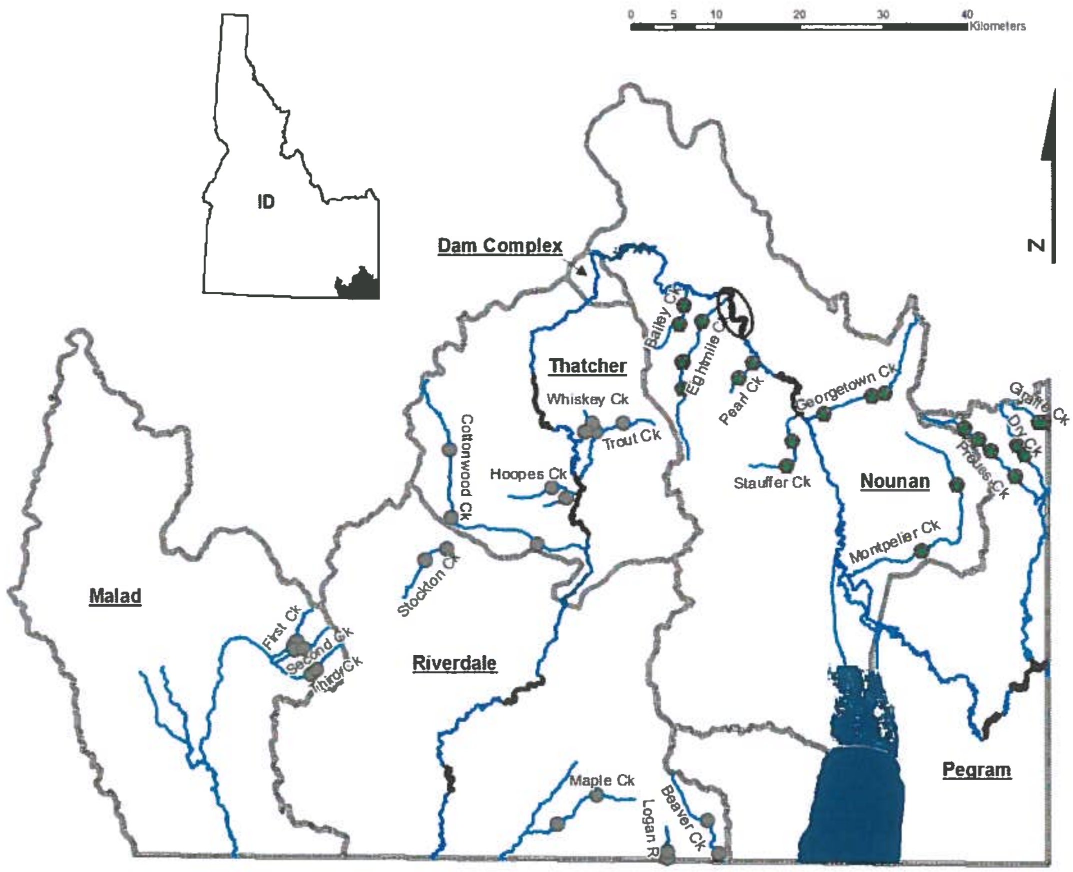

Figure 11. Map of the Bear River watershed in Idaho, including the six Bonneville cutthroat trout management units. The gray circles represent monitoring sites and gray circles with a green star represent sites that were sampled in 2012. The black line segments on the main stem Bear River represent monitoring reaches. Monitoring reaches that are circled were sampled in 2012.

To calculate mean BCT densities, we sampled at least two sites on each stream using multiple pass removal techniques with backpack electro-fishing equipment. At each site, a segment of stream (approximately 100 m) was sampled, which included block nets at the downstream and upstream boundaries. The area (m^2) sampled was calculated using length (m) and average width (m). We calculated a population estimate using Microfish 3.0 software (Microfish Software, Durham, NC, USA). BCT percent composition was calculated by dividing the number of BCT by the total number of all salmonids sampled. Mean densities and percent composition for an entire stream was calculated by averaging the mean values from each site within a stream. Relative weights (W_r) were calculated for individual fish using the equation $Log_{10}W_s = -5.189 + 3.099 \log_{10}TL$, which was obtained from Kruse and Hubert (1997). Mean W_r for each stream was calculated by averaging individual W_r.

Table 6. The 20 monitoring streams and number of sites within the four BCT management units, including the length (km) of stream sampled, total stream length (km), and the percent of stream sampled.

Management Unit	Stream	Sites	Stream Sampled (km)	Stream Length (km)	% Sampled
Pegram	Dry Ck.	2	0.2	13.4	1.5
	Giraffe Ck.	2	0.2	5.7	3.5
	Preuss Ck.	4	0.4	22.0	1.8
	Bear River	2	17.2	61.2	28.1
Nounan	Bailey Ck.	2	0.2	9.9	2.0
	Eightmile Ck.	3	0.3	23.6	1.3
	Georgetown Ck.	3	0.3	21.8	1.4
	Montpelier Ck.	2	0.2	36.0	0.6
	Pearl Ck.	2	0.2	5.3	3.8
	Stauffer Ck.	2	0.2	14.5	1.4
	Bear River	2	18.8	94.5	19.9
Thatcher	Cottonwood Ck.	3	0.3	37.4	0.8
	Hoopes Ck.	2	0.2	13.5	1.5
	Trout Ck.	2	0.2	18.3	1.1
	Whiskey Ck.	2	0.2	5.1	3.9
	Bear River	2	18.0	37.8	47.6
Riverdale	Beaver Ck.	2	0.2	13.7	1.5
	Logan R.	2	0.2	4.7	4.3
	Maple Ck.	3	0.3	16.1	1.9
	Stockton Ck.	2	0.2	9.8	2.0
	Bear River	2	13.6	50.2	27.1
Malad	First Ck.	2	0.2	9.0	2.2
	Second Ck.	2	0.2	8.4	2.4
	Third Ck.	2	0.2	11.2	1.8

Table 7. List of habitat variables, units of measurement and collection methods for habitat characteristics used to explain variation in BCT abundance estimates.

Habitat Variable	Unit of Measurement	Collection Methods
Water Temperature	Celsius	Measured at beginning of survey with handheld thermometer to the nearest ± 0.5 (°C).
Conductivity	µs/cm	Measured at beginning of survey with conductivity meter to the nearest ± 0.1 (µs/cm).
Discharge	ft^3/sec	Measured stream discharge with Rickly discharge meter in a uniform stream segment, using methods proposed by Harrelson et al. (1994)
Gradient	Percent	Gradient was calculated using aerial imagery by calculating the difference in water elevation from an upstream location to a downstream location that was greater than 50 meters apart.
Stream Width	Meters	Measure the wetted width (± 0.1 m) of the stream at ten (10) equally spaced transects within the survey reach and then calculate the mean reach width.
Stream Depth	Centimeters	At ten (10) equally spaced transects, measure and sum the depth (± 1 cm) of the stream at ¼, ½, and ¾ distance across the channel and divide by four. Use these values to calculate the mean reach depth.
Width/Depth Ratio	Meters	Convert the mean reach depth into meters. Divide the mean reach width by the mean reach depth.
Percent Stable Banks	Percent	At the ten (10) equally spaced transects, determine and circle if the bank on the left and right are stable using the following definition. Streambank is stable if they DO NOT show indications of alteration such as breakdown, erosion, tension cracking, shearing, or slumping (Burton 1991).
Total Cover	Percent	Followed instructions from the streambank cover form in Bain and Stevenson (1999).
Canopy	Percent	Used a spherical densiometer and followed the methods of Platts (1987).

Results and Discussion

In 2012, nine streams and the main stem Bear River were sampled which included 15 sites within the NMU and six within the PMU (Figure 11). Mean BCT density estimates were recorded as some of the highest, due to increased precipitation that occurred in 2011. Overall, mean BCT densities were 11.9 BCT/100 m^2 (±3.8; range 0.0 – 28.2). The highest BCT densities was observed in Preuss Creek (28.2 BCT/100 m^2) and the lowest in Georgetown Creek (0.0 BCT/100m^2) (Table 8). The percent composition of BCT in relationship to other salmonids sampled was variable between streams. Georgetown Creek had the lowest composition of BCT with 0.0% and several streams had 100% BCT composition (Table 8).

In the NMU, BCT population estimates in the tributaries remained below 2.2 BCT/100m^2 in all streams except for Pearl and Stauffer Creeks (Table 8). In comparison to historical sampling efforts the estimates for these streams were near or exceeded past data. In Pearl and Stauffer Creeks, population estimates were much higher at 11.8 and 22.9 BCT/100m^2, respectively. Historical population estimates for these two streams is limited to 2007.

Only one of the two main stem Bear River segments was sampled in 2012. On October 4th 2012, IDFG personnel used an electrofishing unit mounted to a drift boat to sample the lower of the two segments in the NMU. A single pass of 9.6 km of river was sampled. The VVP sampling time for the total segment was 5,150 s. There was a total of 22 BCT sampled. This resulted in 2.3 BCT/km or 15.6 BCT/h of sampling. BCT made up 71% of the salmonids species sampled and had an average W_r of 79.3. The quantity and species of fish sampled besides BCT, are as follows; 262 common carp (*Cyprinus carpio*), 58 suckers (*Catostomus sp.*) eight brown trout (*Salmo trutta*), three mountain whitefish (*Prosopium williamsoni*), one rainbow trout (*O. mykiss*) and one channel catfish (*Ictalurus punctatus*).

In the PMU, BCT population estimates have been on-going since the early 1980's and is the largest historical dataset we have for BCT (Table 9). The estimates collected in 2012 are among the highest calculated for Preuss, Giraffe and Dry Creeks over the last three decades (Table 9). During the water year of 2011, there was an abundant amount of precipitation. This corresponded to an increase in age-1 BCT sampled in 2012. The average size of the BCT collected during the population estimates of 2012 was 127 mm. Regression analysis showed the cause-and-effect relationship that the previous year's annual precipitation has on the current year's abundance estimate for BCT. For instance, we used ten years of BCT abundance data collected on Dry Creek between the years of 1987 and 2012. We then identified the annual precipitation (in.) based off of the previous year's water year (Oct. 1-Sept. 30) from the Giveout Snotel site. This data shows that 89% of the variation in BCT abundance estimates is accounted for from the previous year's annual precipitation (Figure 12). It also illustrates that when annual precipitation is less than 10 inches (254 mm), the next year's abundance estimate declines markedly (< 1 BCT/100m^2).

Table 8. Descriptive values of Bonneville cutthroat trout population trends for the Nounan Management Unit.

Management Unit	Stream	Year	Sites	BCT / 100 m² Mean	BCT / 100 m² (+/-) 1 SE	% Comp	BCT Avg. Rel. Wt. (W_r)
Nounan	Bailey Ck.	2001	1	0.0	N/A	0	
		2006	1	0.0	N/A	0	
		2008	1	5.0	N/A	12	109.5
		2010	1	0.0	N/A	0	
		2012	2	0.3	0.3	2	
	Eightmile Ck.	1993	4	1.0	0.4	3	
		1994	4	0.7	0.3	6	
		2001	4	0.1	0.1	1	
		2006	1	0.3	N/A	4	
		2007	3	2.4	0.7	25	93.3
		2008	1	2.8	N/A	12	87.1
		2010	3	0.9	0.3	4	79.5
		2012	3	2.2	1.9	5	89.9
	Georgetown Ck.	1994	4	0.0	N/A	0	
		2000	3	0.0	N/A	0	
		2006	3	0.0	N/A	0	
		2007	4	0.0	N/A	0	
		2008	2	0.0	N/A	0	
		2012	3	0.0	0.0	0	
	Montpelier Ck.	2000	3	1.1	0.3	32	
		2006	3	1.6	0.6	20	82.3
		2008	2	1.8	1.1	42	96.5
		2012	2	2.1	1.9	15	73.2
	Pearl Ck.	2007	1	35.0	N/A	72	75.5
		2012	2	11.8	8.8	76	105.9
	Stauffer Ck.	2007	5	7.7	4.7	100	81.2
		2012	2	22.9	20.0	100	78

Table 9. Descriptive values of Bonneville cutthroat trout population trends for the Pegram Management Unit.

Management Unit	Stream	Year	Sites	BCT / 100 m² Mean	BCT / 100 m² (+/-) 1 SE	% Comp	BCT Avg. Rel. Wt. (W_r)
Pegram	Dry Ck.	1987	1	13.8	N/A	100	61.4
		1990		4.3		100	
		1993		0.0		100	
		1998	3	13.8	0.8	100	
		2000		24.9		100	
		2002		0.6		100	
		2004		0.0		100	
		2006	3	3.1		100	78.3
		2008	2	0.5	0.2	100	106.3
		2010	2	2.0	0.1	100	
		2012	2	14.9	0.1	100	81.6
	Giraffe Ck.	1981		2.2		100	
		1986	1	20.3	N/A	100	61.3
		1987	2	36.0	4.5	100	78.2
		1989	1	26.5	N/A	100	
		1990	1	9.8	N/A	100	
		1993	2	0.3	0.3	100	
		1995	3	3.9	0.7	100	
		1998	4	15.7	4.7	100	
		2000		16.9		100	
		2002	1	4.0	N/A	100	
		2004		4.0		100	
		2006	3	4.2		100	
		2008	4	5.0		100	92.4
		2012	2	25.1	2.9	100	89.9
	Preuss Ck.	1981	1	21.5	N/A	100	
		1985	2	24.1	9.7	100	78.3
		1986	2	15.7	1.1	100	58.2
		1987	3	10.7	2.8	100	71.3
		1988		22.0		100	
		1989	2	2.6	2.0	100	
		1990	3	2.8	0.1	100	
		1991	4	3.2	1.2	100	
		1993	5	5.1	2.6	100	90.0
		1995	6	3.1	0.7	100	
		1997		8.8		100	
		1998		3.2		100	
		2000		7.9		100	
		2002	2	5.0	1.7	100	
		2004	11	9.1		100	
		2006	7	6.0		100	76.5
		2008	7	4.0		100	86.7
		2010	2	2.7	0.3	100	87.1
		2012	2	28.2	15.6	100	81.9

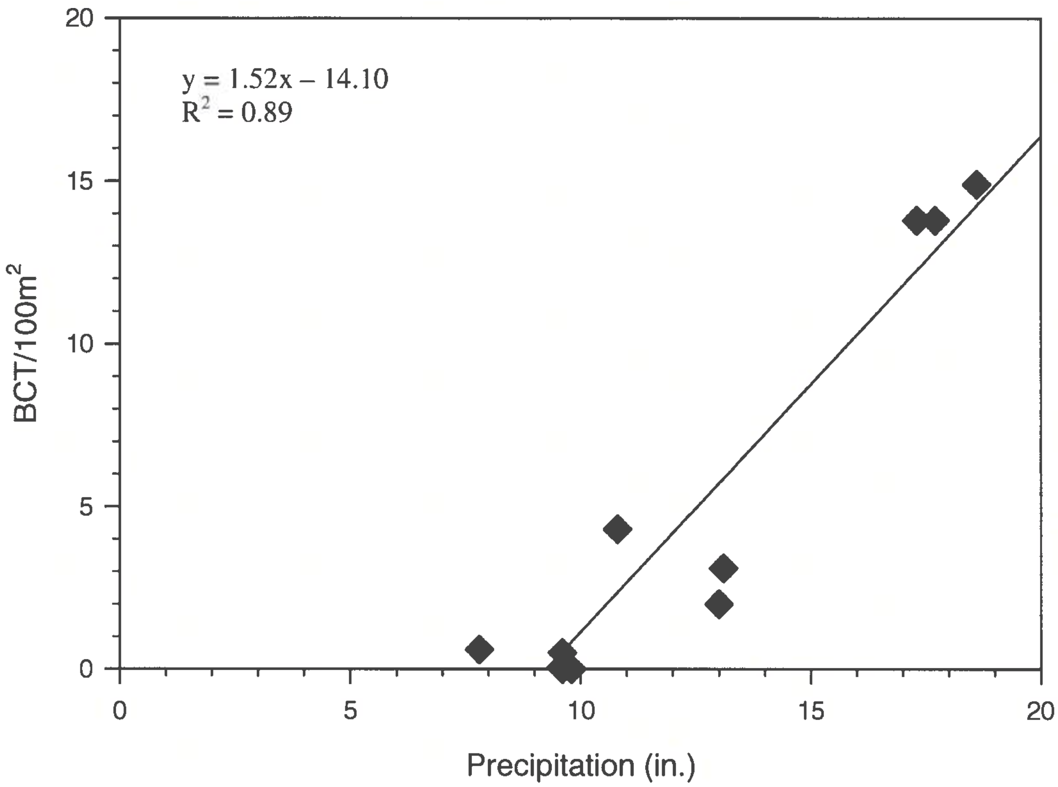

Figure 12. Relationship between annual precipitation (in.) and abundance of BCT (BCT/100m^2) in Dry Creek for 10 years of data between 1987 and 2012.

Smallmouth Bass Investigations

Introduction and Methods

In the late 1980s, smallmouth bass *Micropterus dolomieu* were introduced into the upper Snake River system. Stocking locations included Gem Lake, Lake Walcott, and American Falls Reservoir. The initial stocking events resulted in natural reproducing populations, which expanded rapidly during the 1990s. The success of the smallmouth bass population introduction enhanced fishing opportunities in the Snake River system.

Anglers quickly responded to the new smallmouth bass fishery. In American Falls Reservoir, smallmouth bass increased from 0% of total catch in 1993 to 28% in 2000. The same trend was observed in the Snake River below American Falls Dam. Smallmouth bass started contributing to river creels in the late 1990s and currently make up a significant component of effort and total catch. Perhaps the best indicator of angler response is growth in tournament angling. The first tournament on the river was held at the Massacre Rocks State Park boat launch in 2001. The number of tournaments increased to four in 2004 and six in 2005.

The U.S. Fish and Wildlife Service manages a wildlife refuge that includes 40 km of the Snake River between American Falls and Minidoka dams. The primary function of the refuge is to preserve breeding grounds for water birds. To facilitate that goal, about 60% of the refuge is closed to boating. Since the primary method of fishing for smallmouth bass is by boat and shore access is extremely limited, the closed boating sections are largely unexploited by anglers.

Angler opinions regarding future management of the fishery vary. Local bass club members prefer restrictive harvest regulations. Other users support the general regulation to harvest six smallmouth bass over 305 mm (12 inches). In 2003, results of a random survey of 1,000 anglers showed more support for general bass regulations (41%) compared to those that favored a change to more restrictive harvest (28%). In addition to interest in harvest regulations, anglers are requesting more fishing access for sections of the Snake River that are currently closed to boats.

In 2005, the Idaho Department Fish and Game began investigating the smallmouth bass (SMB) fishery in the Snake River from the tailrace of American Falls Dam downriver to Minidoka Dam. The primary goals of the work were to estimate angler exploitation and determine how the closed boating zones affect angling impacts on smallmouth bass populations. The boating closure provided a unique opportunity to compare SMB populations from open (exploited) and closed (unexploited) areas. Specific questions included: 1) are SMB mortality rates different between open and closed boating zones; and 2) has the quality of smallmouth bass being caught in the open boating zones declined with increases in angling pressure. The results of this research indicated that the exploitation rate of SMB in areas accessible to anglers was nearly 50%. These results clearly showed that under the then current general bass regulations, the quality of this fishery could not be maintained. In response to these findings, the Department implemented a 2-bass any size regulation on the reach of the Snake River that runs from American Falls Dam to the closed boating zone below Gifford Springs. This regulation change took effect in 2008. See Teuscher and Scully 2008 for details. The purpose of our current work was to evaluate the regulation change implemented four years ago.

Smallmouth bass were collected using night-time shoreline electrofishing. The area sampled was between Gifford Springs and the upper end of Massacre Rocks State Park (areas open to boating; Figure 13). Samples were collected with boat-mounted electrofishing equipment. All electrofishing effort was completed between 2100 and 0400 hr.. Lengths (total; mm) and weights (g) were recorded for each fish. We pooled the catch data (as was done in 2005) then used SMB length and weight, catch-per-unit-effort (CPUE) and Proportional Stock Density (PSD) information to assess the efficacy of the angling regulation change mentioned above.

Figure 13. Locations (•) where smallmouth bass were sampled from the Snake River near American Falls, Idaho, in 2005 and 2012.

Results and Discussion

We sampled SMB from the open boating zones of Massacre Rocks and Gifford Springs on July 17th and 18th. In all we captured 202 SMB ranging in size from 90 mm to 481 mm. Mean length and weight of SMB collected were 251 mm and 384 g, respectively. The SMB collected in 2012 were significantly greater in length and heavier than fish collected in 2005 (Wilks' Lambda = 0.894; df = 2, 558; P = 0.000). The PSD of 49 and CPUE of 95 SMB/hour were also greater than what was observed in 2005 (Table 10). Analysis of the length-frequency distribution suggests that anglers harvested SMB as soon as the fish recruited to legal size (305 mm) prior to the regulation change (Figure 14). However, in 2012 more bass were recruited to the larger size classes even though bass of any size could have been harvested. In conclusion, the wholesale increases described above suggest that the regulation change implemented in 2008 has benefitted the Snake River SMB population.

Table 10. Catch-per-unit-effort (CPUE; Hour), Proportional Stock Density (PSD) and other parameters of interest generated from smallmouth bass captured from the open boating areas of the Snake River below American Falls, Idaho, in 2005 and 2012.

Year	CPUE	PSD	Mean Length (mm)	Mean Weight (g)	Sample Size
2005	52	21	197	202	359
2012	95	49	251	384	202

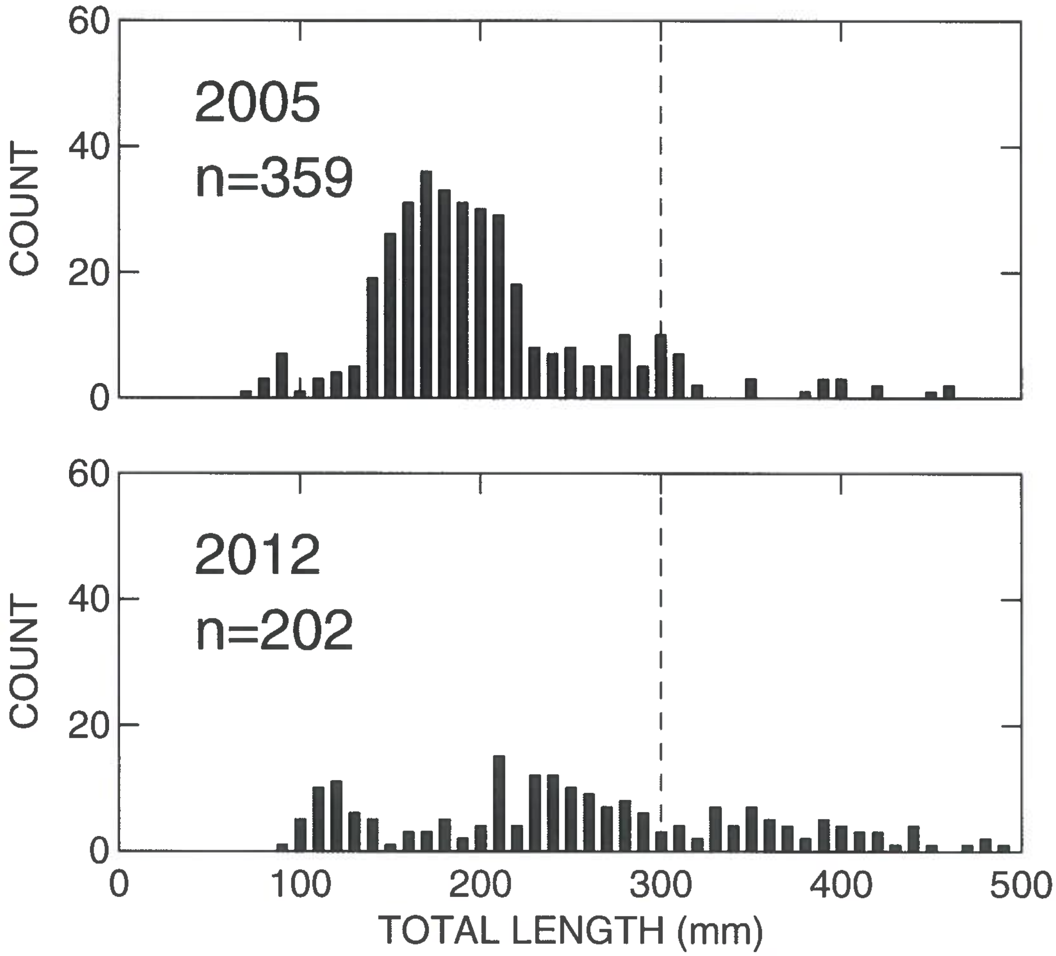

Figure 14. Length-frequency distribution of smallmouth bass collected from the Snake River in the open boating zone below American Falls, Idaho, during the early summers of 2005 and 2012.

MANAGEMENT RECOMMENDATIONS

1. Continue pelican predation work on the Blackfoot River system.
2. Continue Bonneville cutthroat trout monitoring.
3. Implement cormorant predation study on the Bear River system.

APPENDIX A

Estimation of Total Predation Rates for American White Pelicans Foraging on Yellowstone Cutthroat Trout in the Blackfoot River Drainage, Idaho

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ABSTRACT

American white pelican (AWP) *Pelicanus erythrorhynchos* colony growth and associated Yellowstone cutthroat trout (YCT) *Oncorhynchus clarkii bouvieri* declines at Blackfoot Reservoir have generated concerns about the impact of pelican predation on the trout stock. During a 9-year study period, 2,627 wild YCT were tagged using a combination of radio-telemetry and Passive Integrated Transponder (PIT) tags in order to estimate total AWP predation rates. Our two new approaches (live-fish feeding trials of PIT tagged YCT and deployment of multiple fixed site receivers to correct for off-island telemetry tag deposition) appear to be useful methods for estimating total predation rates. Study findings appear to contradict an apparent paradigm in the literature; that AWP do not consume appreciable numbers of salmonids. American white pelicans consumed YCT ranging from 200 mm to 580 mm TL. Total AWP predation rates on YCT >225 mm TL, residing in or migrating through three parts of the drainage, varied from 6.4% to 37.8%. Total predation rates for YCT $\leq$ 255 mm TL ranged from 10.7% to 70.9%. When available for the same tagging location, telemetry and PIT tag methods produced similar predation rate estimates. Off-island telemetry tag deposition by AWP was 47% in 2010 and 50% in 2011. That level of off-island tag deposition applied to earlier telemetry tagging studies (2007) suggests that >60% of the migrating adult adfluvial YCT stock was consumed by AWP. Collectively, study results indicate that over half of the adults and the majority of downstream migrating juveniles supporting the reservoir stock could readily be consumed by AWP in severe drought years. Predation by AWP is likely the most significant cause of the recent collapse of YCT in the upper Blackfoot River drainage. This observation leaves managers with a challenge to find a balanced approach to conserving the Blackfoot YCT population and AWP colony.

INTRODUCTION

The impact of piscivorous birds on commercially and socially important fish stocks has been a broad concern throughout North America and Europe (Harris et al. 2008) and potential negative effects of American white pelican (AWP) populations on such fisheries are no exception (Lovvorn et al. 1999; Glahn and King 2004; King 2005). The number of AWP in North America approximately doubled between 1980 and 2002, increasing by nearly 5% annually during that period (King and Anderson 2005). Keith (2005) reported North American AWP populations increasing from 30,000 in 1933 to about 100,000 birds by 1985, to 400,000 birds by 1995. While most of the continental AWP population breeds east of the Continental Divide, numbers have also increased in many parts of the west and in the western metapopulation collectively (Findholt and Anderson 1995a; King and Anderson 2005; Murphy 2005).

In southern Idaho, growth of AWP nesting colonies since the early 1990s has generated concerns about the effect of their predation on salmonids, especially on YCT in Blackfoot Reservoir and the upper Blackfoot River system (IDFG 2009). Prior to initiating their spawning run, YCT concentrate at the mouth of the Blackfoot River, which lies only 8 km from Gull and Willow islands, the nearest AWP nesting colonies. Nesting AWP on Blackfoot Reservoir have increased from 0 nesting birds in 1992, to 200 nesting birds recorded in 1993, to a peak of 3,418 adult birds in 2007 (Figure 1). Since 2001, the observed abundance of adult adfluvial YCT declined from 4,747 in 2001 to a low of 16 in 2006. Average run size between 2007 and 2012 was 598. Those runs are significantly below the potential of the system. For example, Cuplin (1963) reported that YCT supported angler harvest of over 17,000 and 11,000 YCT in the upper Blackfoot River in 1959 and 1960, respectively.

The potential for AWP to consume biologically meaningful numbers of salmonids appears low, based on some diet studies. Pelicans require shallow water (typically 0.3-0.65 m) or fish that can be reached within 1.3 m of the surface of deep water (Anderson 1991; Ivey and Herziger 2006). In lentic environments, this typically leads to a diet predominantly comprised of nongame fish such as chubs *Gila spp.*, suckers *Catostomus spp.*, and common carp *Cyprinus carpio* (Knopf and Evans 2004; Teuscher 2004). On Pathfinder Reservoir in Wyoming, over 83% of the biomass consumed by AWP was composed of white suckers *C.commersonii*, common carp, and tiger salamanders *Ambystoma tigrinum* (Findholt and Anderson 1995a). At Chase Lake, North Dakota, tiger salamanders comprised the majority of prey items in terms of frequency and volume (Lingle and Sloan 1980).

However, AWP are typically reported in the literature as highly adaptable, opportunistic foragers, readily selecting sites and prey that are most available (Hall 1925; Knopf and Kennedy 1980, 1981; Lingle and Sloan 1980; Flannery 1988; Findholt and Anderson 1995b), a trait that is problematic for some fish spawning aggregations. For example, AWP seek out spawning concentrations of tui chub *Gila bicolor* at Pyramid Lake, particularly when they enter shallow littoral areas and display "quick jerking motions" associated with spawning (Knopf and Kennedy 1980). More recently, AWP have been identified as a hindrance to conservation efforts for Cui-ui *Chasmistes cujus*, an ESA endangered adfluvial sucker that ascends the Truckee River from Pyramid Lake to spawn (Scoppettone and Rissler 2002). Because AWP prey on adult Cui-ui immediately prior to spawning, their impact on this endangered species could be severe (Murphy 2005). Similarly, AWP detect and use adfluvial YCT spawning aggregations in inlet rivers and streams. Davenport (1974) reported that adfluvial YCT were the preferred prey of AWP in a study on Yellowstone Lake, an observation reiterated by Varley and Schullery (1996). In southeast Idaho, increasingly abundant AWP concentrate at the mouths of well-known cutthroat trout spawning tributaries such as the Blackfoot River, St. Charles, and McCoy creeks (IDFG 2009). Because information on impacts by AWP predation on such cutthroat trout populations is lacking, the objective of our study was to directly measure total AWP predation rates on YCT in the upper Blackfoot River system.

STUDY AREA

Blackfoot Reservoir is located in southeast Idaho at an elevation of 1,685 m at full pool and covers 7,284 surface ha (Figure 2). The reservoir is shallow (mean depth < 5 m) and has summer secchi disk readings ranging from 0.5-2.5 m. The reservoir was built for irrigation storage and can undergo summer drawdown of 50% of its capacity. The Blackfoot River is the reservoir's primary tributary and has a mean annual flow of 3.65 m^3/s, and swells to an average of 14.47 m^3/s during spring runoff (IDFG 2009). The fish community is dominated by Utah chub *Gila atraria*, Utah sucker *Catastomus ardens*, yellow perch *Perca flavescens*, and common carp. Yellowstone cutthroat trout and hatchery-produced triploid rainbow trout *Oncorhynchus mykiss* make up less than 20% of the relative species composition in the reservoir.

American white pelicans nest on Gull and Willow islands of Blackfoot Reservoir. The combined surface area of the islands varies with water elevation from 1.5 ha to 8 ha. At full pool, Willow Island is completely inundated. However, inundation of Willow Island has occurred only once in the past 13 years (2011). In addition to AWP, Gull Island supports other colonial nesting species. The most abundant populations are California gull *Larus californicus,* Ring-billed gull *Larus delawarensis*, double-crested cormorants *Phalacrocorax auritus*, snowy egrets *Egretta thula*, black-crowned night herons *Nycticorax nycticorax,* great blue herons *Ardea herodias,* and Caspien terns *Hydroprogne caspia*. American white pelicans are the only ground nesting colonial waterbird species nesting on Willow Island; however snowy egret, great blue heron and black-crowned night-heron nest on the island.

METHODS

To estimate predation rates in the study area, we implanted radio tags and PIT tags in YCT. Both types of tags were used for adult YCT, but only PIT tags were used for juvenile YCT (TL < 225 mm). We use the categories juvenile (< 225 mm TL) and adult (≥ 225 mm TL) to set apart the juvenile fish tagged in-river that were most likely to be migrating downstream to the reservoir during spring (Thurow 1981). We recognize that our "adult" category may have included a combination of immature adfluvial and mature resident YCT (Meyer et al. 2003).

Fish tagging occurred in three locations; Blackfoot Reservoir, an adult YCT escapement trap located up the Blackfoot River about 3.2 km upstream of the reservoir, and an upriver tagging site. The upriver tagging site is surrounded by state land and is managed for wildlife benefits. This tagging site is referred to as the Wildlife Management Area (WMA) and is located about 55 river km above the reservoir (Figure 2).

Each general tagging location noted above documents predation losses that occur over different segments of the adfluvial YCT life cycle. Yellowstone cutthroat trout tagged on the WMA experience exposure to predation in the upper river, during downriver migration, and potential losses in the reservoir during the AWP nesting and chick-rearing period. Fish tagged at the trap (May-June) experience all of the above mentioned exposure and additional predation risk as they migrate upriver from the trap. It is important to note, however, that YCT tagging at the trap excludes predation in the 3.2 km of river located downstream of the trap, the river reach that often receives the most intense AWP foraging pressure, particularly during low to moderate flow years (Figure 3). This river reach below the trap can extend to 6.5 km in drought years due to reservoir drawdown. Yellowstone cutthroat trout tagged in the reservoir experienced predation during up and downriver spawning migrations as well as in-reservoir predation during the summer.

Yellowstone cutthroat trout were collected at the trap in May and June of all study years, anesthetized, measured for TL, tagged, and released in the river immediately above the trap. We captured YCT at the WMA and Blackfoot Reservoir with drift-boat and power-boat mounted electrofishing equipment, respectively, and using typical pulsed DC waveforms. Fish handling procedures were as described above. The WMA tagging occurred during May through July and coincides with the period when most juvenile YCT migrate downriver to the reservoir (Thurow 1981). Reservoir tagging occurred in the fall (62%) and early spring (38%). For reservoir tagging, we targeted YCT that exceeded 400 mm TL and were likely mature by the next spawning season. To evaluate possible prey size selection, we used a Kolmogorov–Smirnov two-tailed distribution test to compare pooled length-frequency histograms of all YCT tagged and those subsequently consumed by AWP. We assumed there was no tagging mortality, and no size-selective tagging mortality. Any tagging mortality (violating the assumption) would result in underestimates of actual AWP predation rates.

Although minimum predation rates of salmonid-eating birds derived using tagged fish have recently been reported (Evens et al. 2012), we sought to estimate total predation rates. To accomplish this end, it was necessary to recover fish tags consumed by AWP and deposited on the nesting islands, but also to account for the number of tags AWP deposited off the nesting islands.

PIT-tag Derived Predation Estimates

For PIT tags, we estimated tag recovery efficiencies in 2010-2012 by feeding live PIT tagged fish to AWP that were actively pursuing fish near the confluence of the Blackfoot River. Fyke nets were used to catch live Utah suckers and Utah chubs. In 2012, live rainbow trout were included in the feeding trials along with suckers and chubs. We PIT tagged and fed 597 fish to AWP from 2010-2012. The number, sizes, and species fed by year are presented in Table 1. Only fish similar in lengths to juvenile and adult migrating YCT were used in PIT-tag feeding trials. The feeding process was completed one fish at a time and efforts were made to ensure that individual feeding pelicans only consumed a single tagged fish. The process included: PIT tagging, injecting air under the skin to keep the fish at the surface, and then releasing the fish close to a group of foraging pelicans. The fish was considered consumed only if it was captured by an AWP and confirmation of ingestion was made by observation of head raising and a swallowing motion sometimes referred to as a head toss (Anderson 1991). We fed PIT tagged fish over a several week period overlapping with the peak adult and juvenile YCT migration to and from the reservoir (May 15 – July 15). That period mirrors peak use by foraging AWP near the confluence of the Blackfoot River (Teuscher and Schill 2010).

After juvenile AWPs fledged, we scanned both of the Blackfoot Reservoir nesting islands for PIT tags. A grid was laid out on the islands and we searched both islands systematically with a backpack PIT tag detector (Oregon RFID). We made a single complete pass over both colony islands to estimate on-island recovery efficiency. To obtain maximum read distance, Half Duplex PIT tags were used for all tagging of fed fish and YCT. Small PIT tags (23 mm) were injected in fish measuring 120-350 mm TL while 32 mm tags were injected into fish greater than 350 mm TL.

Overall PIT tag recovery efficiencies were estimated by dividing the number of island recoveries from live-fed fish by the total number of live-fed fish. For example, if 100 PIT tagged fish were fed to pelicans and 20 of those tags were recovered from the islands, then the PIT tag recovery efficiency was 0.20 (20 / 100). Confidence intervals around this proportion were constructed using the formulas of Fleiss (1981). We assumed that the same proportion of live-fed fish and YCT PIT-tags would go undetected. The estimation of total AWP predation of PIT tagged YCT was calculated as a ratio of two proportions using the following equation:

$PR = x / y$
Where:
PR = AWP predation rate
x = Number of YCT PIT tags found on the Blackfoot Reservoir islands / total number of YCT PIT tags implanted
y = Number of efficiency tags found on the colony / total number of efficiency tags fed to adult AWP

Confidence bounds (90%) were calculated using the approximate formula for the variance of a ratio (McFadden 1961; Yates 1980):

$$S^2\left(\frac{x}{y}\right) = \left(\frac{x}{y}\right)^2 \times \left(\frac{S_x^{\,2}}{x^2} + \frac{S_y^{\,2}}{y^2}\right)$$

Where:
x = Number of YCT tags found on the islands / total number of YCT tagged
y = Number of efficiency tags found on the colony / total number of efficiency tags consumed by AWP
$S_x^{\,2}$ = variance of x (returns of YCT tags)
$S_y^{\,2}$ = variance of y (returns of efficiency tags)

We constructed 90% confidence bounds around AWP predation rates by tagging location, and year using the following:

$$\text{Lower Limit} = \text{Predation rate (PR)} - \sqrt{S^2\left(\frac{x}{y}\right)X\left(\frac{t_\alpha}{2}\right)}$$

$$\text{Upper Limit} = \text{Predation rate (PR)} + \sqrt{S^2\left(\frac{x}{y}\right)X\left(\frac{t_\alpha}{2}\right)}$$

and $t_\alpha/2$ is 1.645.

Radio-tag Derived Predation Estimates

Adult YCT were collected at the trap and from the reservoir via electrofishing as described above. The surgical procedure used to implant the radio transmitters was similar to those described by Ross and Kliener (1982). To decrease surgery times, we used staples rather than sutures to close incisions. Gills were continually irrigated during surgery. Tagged YCT were allowed to recover in an oxygenated live-well and monitored until swimming ability was reestablished. Surgery times averaged 2-min and 44 sec. Upon recovery from anesthesia, fish were released into the river or reservoir near their initial capture location.

Tracking histories were used to estimate off-island telemetry tag deposition rates. Fixed site receivers (ATS model R4500S) were deployed at four locations along the Blackfoot River corridor and one receiver was placed on Gull Island (Figure 2). Those fixed site receiver locations provided tracking histories for fish that exhibited rapid movement consistent with transportation by AWP. Fish tracking histories showed fish traveling from the river receivers to the islands in just a few minutes. Such travel speeds are impossible for fish not being carried by birds. Therefore, telemetry tagged YCT that fit the bird-flight tracking pattern that were subsequently tracked back to the nesting islands, but were not recovered from those islands at the end of the nesting season, were classified as off-island depositions consumed by AWP. The total number of telemetry tagged YCT consumed by AWP was the sum of recovered tags and the number of unrecovered off-island depositions described above. Total predation rates for telemetry tags was the total number of tagged fish consumed divided by the total number of fish originally tagged. Confidence limits for this proportion were calculated as above.

Preliminary telemetry studies were completed in 2004 and 2007. We did not correct for off-island tag deposition for those years. However, during manual tracking of the Blackfoot River and Reservoir, we detected telemetry signals coming from AWP flying over our study area. Those encounters inspired the fixed site receiver methods described above. Although only representing minimum predation rates, the estimates from telemetry tag recoveries in 2004 and 2007 are reported for relative comparison with telemetry tag recoveries from 2010 and 2011.

RESULTS

PIT tag recovery efficiencies varied considerably by year. Of the 597 PIT-tagged fish fed to AWP, we recovered a total of 154 of those tags from Willow and Gull islands on Blackfoot Reservoir during three study years. The associated PIT tag recovery efficiencies were 20.6%, 12.0%, and 48.4% (Table 1). The variation in tag recovery efficiencies followed changes observed in the abundance of breeding AWP. For example, in 2011, we recovered the fewest number of fed fish tags (12.0%) and observed a breeding population of only 724 AWP. In 2012, the breeding bird estimate increased fourfold (3,024 breeding birds) and was the same magnitude of increase observed in our estimated tag recovery efficiencies (i.e., increase from 12.0% to 48.4%). In 2011, all of the established nests on Willow Island were inundated due to increasing water levels during the nesting period. Many of these adult AWP appeared to use their traditional foraging sites but no longer had the connection to the nesting islands and thus deposited a relatively small proportion of tags on them. In contrast, reservoir elevation declined during the 2012 nesting period, which resulted in higher nest success, more feeding of chicks on the islands, and a higher deposition rate of tags on those islands. Therefore, our tag recovery efficiencies include several potential sources of variation that are summarized in the discussion.

Over a three-year period (2010 to 2012), we obtained a wide range of total predation estimates for downstream migrating juvenile YCT collected and tagged in the WMA site. In 2010, we tagged 165 juvenile YCT from which 24 PIT tags were recovered from the nesting islands. The PIT tag recovery efficiency for 2010 noted above (20.6%) expands the nesting island recoveries to a total consumption estimate of 117 (24 / 0.206). The total predation rate estimate for that year and tagging site was 70.9% (total consumed 117 / total tagged 165). Total predation rates on juvenile YCT tagged at the WMA were estimated to be 36.0% and 10.7% in 2011 and 2012, respectively (Table 2).

During the study period, we tagged 2,142 adult YCT (1,993 PIT tags; 149 telemetry tags). The majority of PIT tagged adults (1,424) were collected at the adfluvial trap. Four hundred eighty were tagged at the WMA and 89 were tagged at the reservoir. The distribution for telemetry tagged fish was 55 at the trap and 94 in the reservoir. As described above, the adult fish tagged in the reservoir (telemetry and PIT tags) experience full-river migration exposure to AWP predation. The other two adult tagging sites describe predation rates for directional migration (WMA tagging; downriver only) or partial upriver and complete downriver exposure (adfluvial trap).

Total AWP predation rates on adult YCT tagged at the three locations between 2010 and 2012 ranged from 6.4% to 37.8% (Table 2). In some years, tagging location markedly influenced predation rate. In 2010, adult fish tagged in the reservoir had higher total predation losses (> 32%) compared to fish tagged at the Trap (7.5%) or the WMA (6.4%). Conversely, in 2011, total adult predation rate estimates were similar (range 26.7-32.5%; Table 2).

In addition to the total predation rate estimates above, several other observations are of note. The unexpanded telemetry tag recoveries from adult YCT tagged at the trap in 2004 and 2007 were on par with the highest total predation rates measured in 2010 and 2011. Raw telemetry tag recoveries from this tag location were 14% in 2004 and 33% in 2007. In addition, at the only instance where a direct comparison of the two tag approaches were possible (adult YCT in the reservoir), there were striking similarities between predation rate estimates using telemetry tags compared with PIT tags. Total predation rates for PIT tagged and telemetry tagged adults in the reservoir ranged from 32.2% to 37.8% in 2010 and from 26.7 to 32.7% in 2011 (Table 2).

American white pelicans did not show size-selective predation of tagged YCT, as indicated by the relative-frequency histograms for all of the tagged YCT compared to the lengths of YCT from tags recovered from the nesting islands (Figure 4). There was no significant difference observed between the length-frequencies distributions of tagged compared to consumed YCT ($D_{0.05,26} = 0.259$, $D = 0.0846$, $P > 0.5$).

DISCUSSION

American white pelican predation rates on adfluvial YCT in the upper Blackfoot River System appear to exceed past estimates of colonial waterbird predation on salmonids. In a generalized simulation study, Stapp and Hayward (2002) predicted that 3.5% of stream spawning cutthroat trout could be eaten by piscivorous birds. Trout comprised 1% of AWP diet on the North Platte River in Wyoming prior to stocking and 22% of diet post-stocking (Derby and Lovvorn 1997). A more intensive, multi-year study of piscivorous bird impacts on migrating salmon and steelhead smolts reported minimum predation rates by all species of piscivorous birds consistently below 10% (Evans et al. 2012). That study also reported much lower AWP predation impacts than other piscivorous species (i.e., terns and cormorants). In contrast, based on diet analysis and cormorant counts, Kennedy and Greer (1988) suggested that a minimum of 51-66% of wild Atlantic salmon smolts may have been consumed in an Irish river. In summary, we are unaware of any published or grey literature studies reporting single year predation rates for juvenile salmonids as great as the 70.9% estimated in the present study (Table 2).

Our findings appear to contradict previous studies in the literature that suggest AWP do not consume biologically meaningful proportions of salmonid stocks. This belief appears to be due to estimates of low trout composition in AWP diet samples and the observation that the species only forages on the water surface where trout are typically unavailable due to their deeper depth distribution (Findholt and Anderson 1995b; Derby and Lovvorn 1997). However, migrating salmonids are vulnerable to piscivorous birds (White 1957; Ruggerone 1986; Kennedy and Greer 1988). Adult YCT are especially vulnerable during spawning runs (Davenport 1974) and AWP foraging has been shown to be spatially and temporally associated with YCT spawning-related abundance on the Yellowstone River (Kaeding 2002). These observations are consistent with reports of AWP preying heavily on spawning runs of the Tui Chub *Gila bicolor* (Knopf and Kennedy 1980) and the Cui-ui, (Scoppettone and Rissler 2002; Murphy 2005) in the Pyramid Lake system, Nevada. The apparent focus of AWP on spawning runs of various fishes is likely the result of their widely reported opportunistic nature which results in them readily varying their diet and foraging locations in response to changes in prey vulnerability (e.g. Findholt and Anderson 1995b). We agree with this perspective, and observed tremendous shifts in relative AWP foraging activity across different sites and in different study years that were reflected in the highly variable total predation rates reported (Table 2).

The relatively high AWP predation rates reported for a salmonid in the present study are likely due to this opportunistic nature combined with the following: 1) the YCT spawning river is in close proximity to the nesting islands, 2) the foraging habitat near the confluence of the Blackfoot River is ideal for AWP, and 3) a Utah sucker population concentrates in the lower Blackfoot River to spawn at the same time as YCT, which attracts more AWP to the area than might otherwise be there if only YCT were present. The attraction that Utah suckers pose is especially troubling because it does not appear that their numbers are large enough to swamp out predation impacts on YCT, but their presence keeps AWP coming to the river even at low YCT abundance.

It is also important to note that the high levels of predation documented in the Blackfoot River system occurred during aggressive management actions to reduce that predation. Fisheries biologists began noticing increased aggregations of AWP foraging on the river in 2003. That same year, bird foraging wounds, which are generally obvious on fish (Alexander 1979), began to be commonly observed on adult YCT captured at the adfluvial monitoring trap. By 2004, 70% of migrating YCT arriving at the trap exhibited wounds consistent with AWP attacks (Teuscher and Schill 2010). To reduce potential predation impacts on the declining stock of YCT, non-lethal hazing of AWP began in 2003. The hazing program included: 1) setting wires over about 3 km of the lower reach of the Blackfoot River to prevent AWP access, 2) shooting at birds with non-lethal pyrotechnics, and 3) daily human disturbance through the "gauntlet reach" (Figure 3; IDFG 2009). Hazing results proved largely unsuccessful. Despite a daily human hazing program at the confluence implemented in 2012, adult predation rates remained above 23% (Table 2). In addition to non-lethal hazing, nesting exclusion fences have been constructed on both nesting islands. The exclusion fence has shown some promise in limiting the area used by AWP, although the level of fencing that would be required to reduce population abundance is unknown and has not yet been approached. Finally, American badgers *Taxidea taxus* and striped skunks *Mephitis mephitis* were introduced to Gull Island in 2010 in an attempt to replace those removed from the island in 1990-1992. However, federal restriction on release timing (pre-nesting) resulted in rapid predator departure from the nesting islands and this management approach has been abandoned.

Reservoir storage and river discharge impact AWP predation rates on YCT. During drought conditions, the reservoir is often below 50% of full pool. The drawdown increases the YCT migration distance through a shallow river corridor. Drawdown and (or) below normal spring runoff flows in the river create foraging conditions that attract large flocks of foraging pelicans of up to 300 birds (Figure 3). In their study evaluating AWP use of cui-ui suckers, Scoppettone and Rissler (2002) refer to such an aggregation of AWP feeding on migrating spawners as a "gauntlet", a scenario Murphy (2005) noted could result in severe impacts. Observations of AWP use along the lower reach of the river and the highest rates of predation were measured in 2010 when the reservoir storage in May was 71% of full pool and spring flows were only 49% of average. The next year, AWP predation on juvenile YCT declined markedly (Table 2) when the reservoir filled to capacity and spring flows were 183% of average.

It is unfortunate that total predation rate estimates are unavailable for a number of years between 2002 and 2010 when severe drought conditions occurred. For example, in 2007 the reservoir condition during the onset of nesting and fish migration was 55% of full pool and average May discharge was 22% of normal. That year we recovered 9 out of 27 telemetry tags (33.3%) from the nesting islands that we had implanted in migrating adult YCT at the trap site. If the relatively consistent off-island deposition rates measured for telemetry tags in 2010 and 2011 (47.1% and 50.0%, respectively) approximated the off-island deposition rates for 2007, the total predation rate estimate for adult YCT collected and tagged at the trap would have exceeded 60% that year. Further, such a high predation rate estimate (>60%) would almost certainly have been an underestimate for the spawning run as a whole because the fish radio-tagged at the trap would have already escaped an unusually strong gauntlet of AWP feeding below the trap that year (Figure 3). Because of such potential predation rates, and the observed crash in the Blackfoot River YCT population (Figure 1), we recommend that a follow-up radio-telemetry effort be conducted on adult fish marked in the reservoir below the gauntlet reach during the first future low-flow year.

Although double-crested cormorants and Caspien terns can be effective salmonid predators (Kennedy and Greer 1988; Evans et al. 2012) we do not believe they contribute materially to YCT mortality in the upper Blackfoot River system. Those species nest exclusively on Gull Island. If non-AWP piscivorous birds nesting on Gull Island contributed significantly to YCT predation, then tag recoveries should have been higher on Gull Island than what we observed. About 20% of the AWP population in 2012 nested on Gull Island and the measured proportion of YCT tags recovered from Gull Island was identical. Therefore, while other piscivorous birds may consume YCT, the rate was too low to be detected in this study. Moreover, about 60% of the YCT tagged were larger than 400 mm and could not have been consumed by either double-crested cormorant or Caspien terns (Hatch and Weseloh 1999). Additionally, we have been monitoring use by AWP and other birds on the Blackfoot River in the gauntlet reach using remote photography (Teuscher and Schill 2010). The vast majority of piscivorous birds counted in hourly photographs have been AWP. For example, in all photographs from 2010, we counted 25,770 incidents of AWP using the river compared to only 39 images of double-crested cormorants (0.15%).

Our live-fish feeding and telemetry methods that account for off-island tag deposition appear to comprise useful approaches for estimating total predation rates. In a recent study on the Colombia River, Evans et al. 2012 reported "minimum predation rates" using on-island PIT tag deposition data and noted that off-island deposition of tags was a limitation of their study. The live fish feeding approach accounts for several different types of PIT tag disposition. First, the method accounts for direct off-island tag depositions by AWP. Breeding AWP use many loafing sites around the reservoir and deposit tags in those areas. Non-breeding AWP foraging on the Blackfoot River may deposit all of their consumed tags away from the nesting islands. Our methods account for those types of off-island tag losses. Secondly, tags that pass through the digestive tract may become damaged and no longer detectible by PIT tag readers (Evans et al. 2012). As noted above, our approach accounts for this possible source of error. Thirdly, the method corrects for on-island PIT tag depositions that go undetected during recovery efforts. In the case of the radio-telemetry methods, the fixed site receiver results (flying fish) also account for off-island tag deposition. We suggest that future workers evaluating the impact of piscivorous bird predation on sportfish consider either of the above approaches for estimating total predation rates.

The recently established AWP colony on Blackfoot Reservoir has created a new challenge for resource managers. Past over-exploitation of the YCT stock by anglers was alleviated by implementing no-harvest fishing regulations (Labolle and Schill 1988). As anticipated, the Blackfoot YCT stock expanded rapidly after eliminating the angler-caused mortality (Figure 1). However, the most recent and more significant YCT collapse caused by intense predation pressure by a growing AWP population is not so easily resolved. As Garrott et al. (1993) noted, controlling locally overabundant native species that are negatively affecting other native species is a sensitive issue. The challenge for managers in the Blackfoot River drainage is to find a balanced approach to conserving the YCT population and the AWP nesting colony.

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Table captions. **David Teuscher et al.**

Table 1. Recovery efficiencies for PIT tagged fish fed to American white pelicans. Sample sizes and mean TL are shown. The efficiency estimates account for tag deposition by birds away from the nesting islands, damaged tags, and our ability to detect tags deposited on those islands.

Table 2. Total predation rate estimates on Yellowstone cutthroat trout by American white pelicans in the upper Blackfoot River Drainage, Idaho. Year-specific tagging data and estimated predation rates are shown. See methods for tagging location descriptions. Tag recovery efficiencies were not available for the 2004 and 2007 telemetry tagged fish; thus, total predation rate estimates were not derived for those years.

Figure Captions. **David Teuscher et al.**

Figure 1. Abundance estimates for Yellowstone cutthroat trout and American white pelicans. The trout abundance (bars) represents adult escapement estimates from Blackfoot Reservoir. The adfluvial escapement trap was operated sporadically between 1990 and 2000. Excessive spring river flows prevented tap operation in 2011. The pelican trends (lines) include breeding pelican estimates for the Blackfoot Reservoir colony and results from local pelican surveys. Both breeding bird estimates and the annual pelican surveys are completed the first week in June of each year. The pelican survey includes all age-1 and older pelicans observed in Idaho within 100 km of the Blackfoot nesting colony. The first successful pelican nesting at Blackfoot Reservoir occurred in 1993. Observation of successful nesting occurred between 1993 and 2001, but no nest counts were completed.

Figure 2. Map of study area showing general locations within the Blackfoot River Drainage, Idaho, where Yellowstone cutthroat trout were tagged with Passive Integrated Transponder tags and or radio-telemetry tags, and where telemetry tagged fish were relocated from 2010-2011. American white pelican nesting colonies are located on Gull and Willow islands.

Figure 3. Photograph taken in 2007 showing American white pelicans foraging on the Blackfoot River during the spring Yellowstone cutthroat trout migration. This site is 8.7 km from the nesting colony on Blackfoot Reservoir. This type of concentrated foraging occurs in years with below average spring flow conditions.

Figure 4. Comparison of length-frequency histograms for YCT tagged and recovered (consumed) from the nesting islands on Blackfoot Reservoir. Total lengths from all years tag types, and tagging locations are included.

Table 1. Recovery efficiencies for PIT tagged fish fed to American white pelicans. Sample sizes and mean TL are shown. The efficiency estimates account for tag deposition by birds away from the nesting islands, damaged tags, and our ability to detect tags deposited on those islands.

		Total Length (mm)				95% Confidence Intervals	
Year	Fed	Mean	Range	Recovered	Efficiency (%)	Lower	Upper
2010	180	404	300 - 568	37	20.6	14.5	26.6
2011	233	372	243 – 545	28	12.0	7.8	16.3
2012	184	350	195 - 580	89	48.4	42.0	54.7

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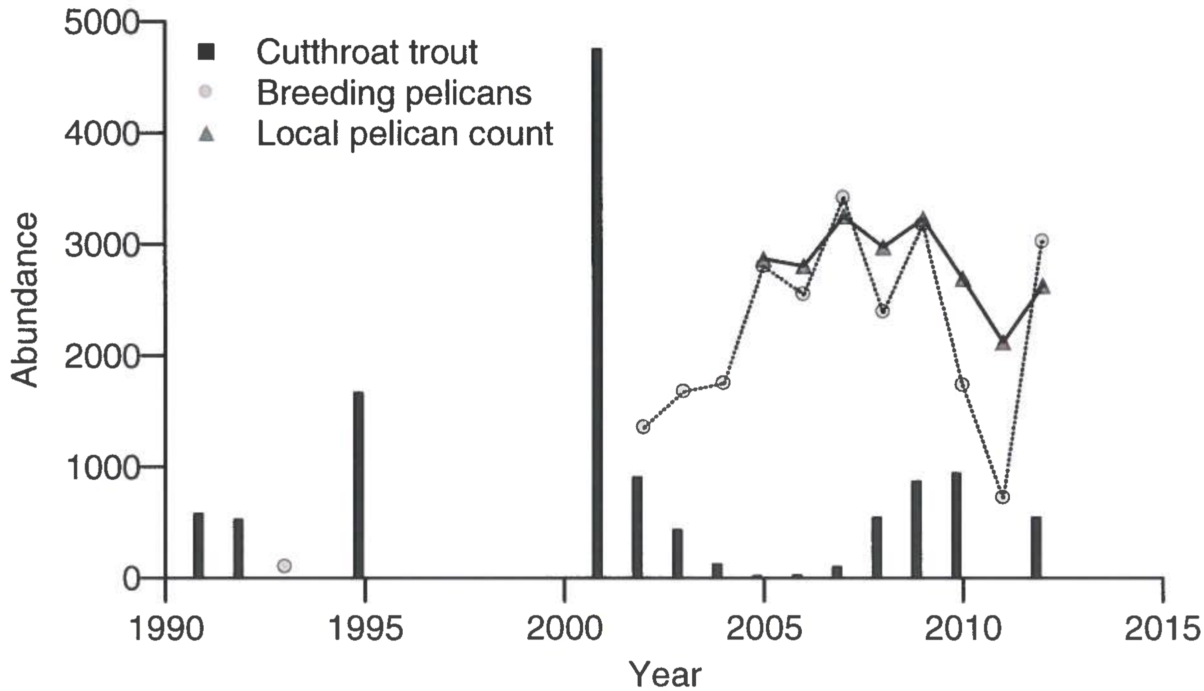
Year	Method	Size class	Tag location	Tagged	Recovered	Recovery efficiency (%)	Total consumed	Predation rate (%)	90% CI Lower	90% CI Upper
2004	Telemetry	Adult	Trap	28	4	NA	NA	NA		
2007	Telemetry	Adult	Trap	27	9	NA	NA	NA		
2010	PIT	Adult	Trap	901	14	20.6	68	7.5	5.5	9.6
2010	PIT	Adult	Reservoir	59	4	20.6	19	32.2	17.1	47.3
2010	Telemetry	Adult	Reservoir	45	8	47.1	17	37.8	23.6	51.9
2010	PIT	Adult	WMA	78	1	20.6	5	6.4	0.7	12.1
2011	PIT	Adult	Trap	11	0	12.0	NA	NA		
2011	PIT	Adult	Reservoir	30	1	12.0	8	26.7	1.5	51.8
2011	Telemetry	Adult	Reservoir	49	8	50.0	16	32.7	19.5	45.8
2011	PIT	Adult	WMA	77	3	12.0	25	32.5	15.0	49.9
2012	PIT	Adult	Trap	512	58	48.4	120	23.4	20.4	26.5
2012	PIT	Adult	WMA	325	38	48.4	79	24.3	20.6	28.0
2010	PIT	Juvenile	WMA	165	24	20.6	117	70.9	55.6	86.2
2011	PIT	Juvenile	WMA	161	7	12.0	58	36.0	22.6	49.5
2012	PIT	Juvenile	WMA	159	8	48.4	17	10.7	7.4	14.0



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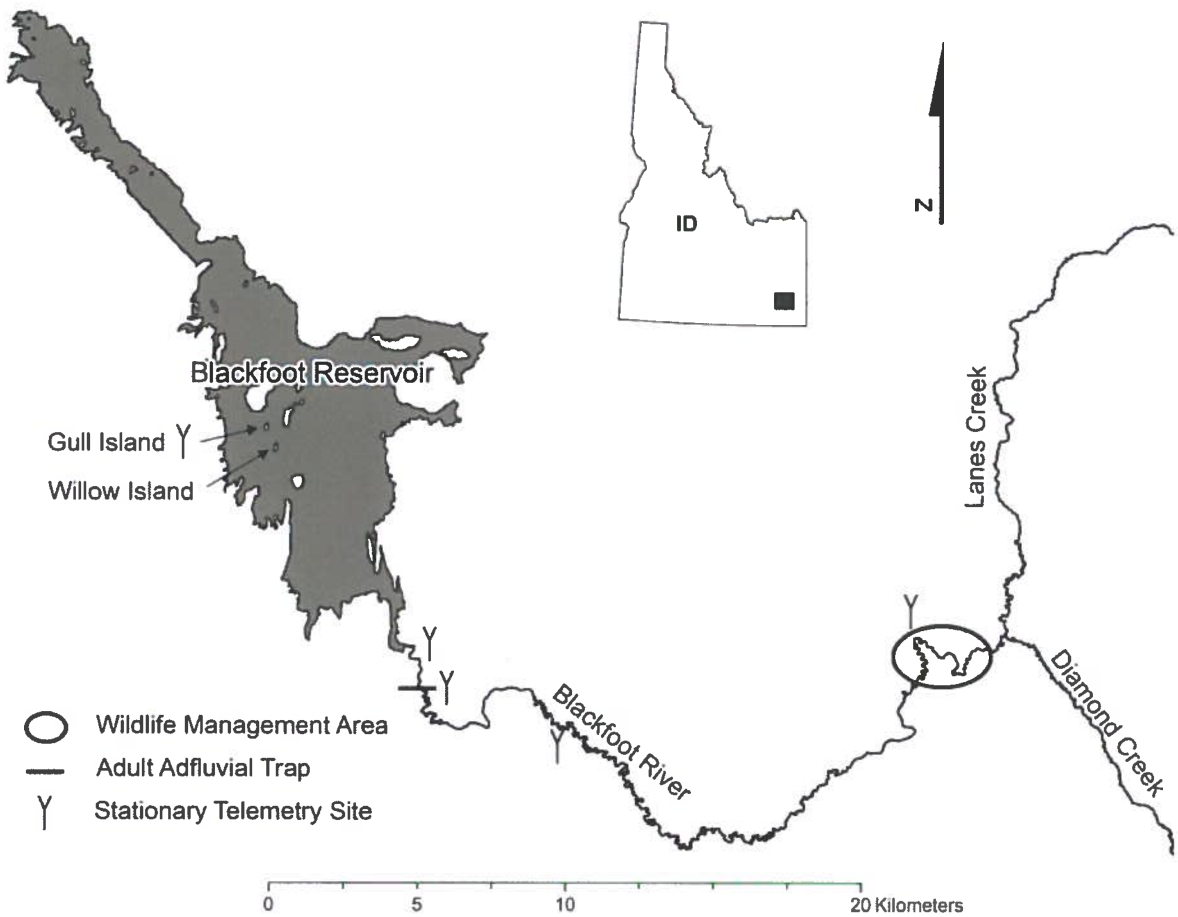

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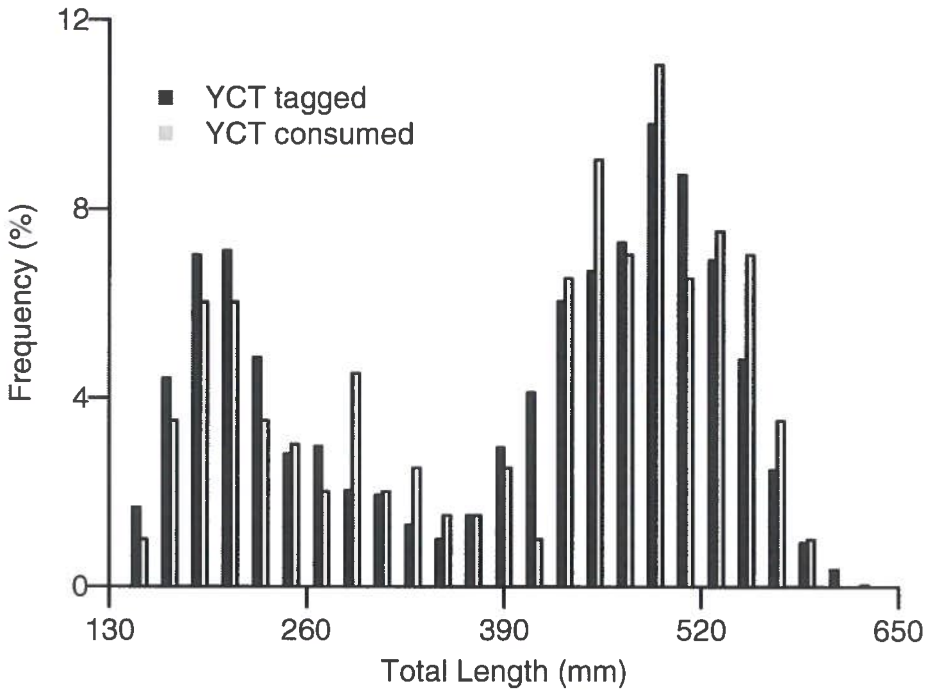

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