

Fisheries Division Federal Aid Job Progress Report

Montana Statewide Fisheries Management

Federal Aid Project Number: F-113

July 1, 2020 – June 30, 2021

Job Title: (3140 Kootenai River Drainage Fisheries Management)

Abstract:

Only 43 catch cards were issued for the Lake Koocanusa recreational bull trout fishery for the 2020 fishing season. The low level of interest was likely due to the elimination of harvest prompted by declining redd counts in Grave Creek and the Wigwam River in 2019. Based on limited information obtained from just 22 respondents, an estimated 26 bull trout were caught by catch card holders.

A review of the history of the Lake Koocanusa bull trout fishery indicated several trends. Angler interest, effort, and bull trout catch and harvest all decreased through time. Reduced novelty of the fishery and more restrictive harvest limits in more recent years likely influenced these declines. Years with no permitted harvest resulted in extremely low numbers of catch cards issued, suggesting harvest is a significant motivation for participation.

The bull trout population in Lake Koocanusa is closely monitored. Catch card data, redd counts, gillnet surveys, and tributary juvenile abundance estimates are reviewed annually and have led to an adaptive management approach where bull trout harvest limits are proactively adjusted based on gathered information. Montana Fish, Wildlife & Parks has managed the Lake Koocanusa bull trout fishery more conservatively than required by USFWS sub permit TE-07753.

Monitoring the bull trout population and fishery will continue. Adaptive harvest management has maintained a limited sport fishery for bull trout in Lake Koocanusa that will persist if monitoring and response efforts remain proactive. The success of this unique fishery enhances the understanding of bull trout while encouraging stakeholder engagement and informational contributions from anglers.

Angler Survey of Experimental Recreational Bull Trout Fishery for Lake Koocanusa, Montana through the 2020 Season.

Brian Stephens, Fisheries Management Biologist Neil Benson, Fisheries Technician

> Montana Fish, Wildlife & Parks 385 Fish Hatchery Road Libby, Montana 59923



December 2021

CONTENTS

CONTENTS	2
LIST OF TABLES	3
LIST OF FIGURES	5
SUMMARY	7
INTRODUCTION	8
BACKGROUND	8
METHODS	9
RESULTS	10
Bull Trout Catch Card/Survey Returns	10
Angler Demographics	10
Fishing Pressure Estimates	10
Harvest and Catch Estimates	12
DISCUSSION	13
Angler Interest	13
Angler Effort	14
Bull Trout Catch	16
Bull Trout Harvest and Take	18
Catch Versus Harvest Length Estimates	20
Bull Trout Redd Counts	21
Juvenile Bull Trout Estimates	24
Koocanusa Spring Gillnet Catch	25
CONCLUSIONS	27
LITERATURE CITED	28
APPENDICIES	29

LIST OF TABLES

Table 1. Bull trout season angling pressure estimates calculated from catch card and survey
results for Lake Koocanusa through the 2020 season11
Table 2. Estimated bull trout harvest (reported harvest) and estimated catch (reported catch)
for Lake Koocanusa through the 2020 season12
Table 1A. Linear regression analysis for number of catch cards issued versus year during the
first seven years of the special fishery (Figure 2)
Table 2A. Single factor ANOVAS of catch cards issued by season harvest limit (Figure 3) 29
Table 3A. Linear regression analysis for angler days versus license year (Figure 4). 30
Table 4A. Single factor ANOVAS of total angler days by season harvest limit (Figure 5)
Table 5A. Single factor ANOVAS of percent of respondents that fished by season harvest limit
(Figure 6)
Table 6A. Linear regression for estimated bull trout catch by license year (Figure 7)
Table 7A. Linear regression for angler effort versus bull trout catch (Figure 8).
Table 8A. Single factor ANOVAS for estimated number of bull trout caught by season harvest
limit (Figure 9)
Table 9A. Linear regression analyses for estimated bull trout harvest and total take by license
year (Figure 10)
Table 10A. Single factor ANOVAS for estimated bull trout harvest and take by season harvest
limit (Figure 11)
Table 11A. Single factor ANOVA for mean length of bull trout by harvest or release (Figure 12).
Table 12A. Linear regressions for Grave Creek bull trout redd counts by harvest management
strategy (Figure 14)
Table 13A. Linear regressions for Wigwam River bull trout redd counts by harvest management
strategy (Figure 15)
Table 14A. Single factor ANOVAS for Grave Creek bull trout redd counts by harvest
management strategy (Figure 16)
Table 15A. Single factor ANOVAS for Wigwam River bull trout redd counts by harvest
management strategy (Figure 17)

Table 16A. Linear regression for Grave Creek juvenile abundance estimate by year (Figure 18	3).
	. 37
Table 17A. Linear regressions for Koocanusa spring gillnet catch of bull trout by year and	
harvest management strategy (Figure 19).	. 38
Table 18A. Single factor ANOVA for Koocanusa spring gillnet catch of bull trout by harvest	
management strategy (Figure 19).	. 39

LIST OF FIGURES

Figure 1. Estimated number of anglers and percent of respondents that fished for bull trout at
Lake Koocanusa, Montana through the 2020 season
Figure 2. Number of Koocanusa bull trout catch cards issued by year and harvest limit
regulation13
Figure 3. Mean number of Koocanusa bull trout catch cards issued by harvest limit regulation.
Error bars represent the 95% CI of the mean14
Figure 4. Estimated effort (total number of angler days) by license year15
Figure 5. Estimated effort (total number of angler days) by harvest limit regulation. Error bars
represent the 95% CI of the mean and categories with the same letter are not significantly
different from one another
Figure 6. Angler participation expressed as the percent of respondents that said they fished
Lake Koocanusa by harvest limit regulation. Error bars represent the 95% CI of the mean and
categories with the same letter are not significantly different from one another
Figure 7. Estimated total bull trout catch by license year17
Figure 8. Relationship between angler effort and number of bull trout caught
Figure 9. Estimated number of bull trout caught by harvest limit regulation. Error bars
represent the 95% CI of the mean and categories with the same letter are not significantly
different from one another
Figure 10. Estimated total bull trout harvest and estimated total bull trout take by license year.
Figure 11. Estimated total bull trout harvest and estimated total bull trout take by harvest limit
regulation. Error bars represent the 95% CI of the mean and categories with the same letter
are not significantly different from one another19
Figure 12. Mean and median length of all reported harvested and released bull trout from Lake
Koocanusa during the permitted fishery. Error bars represent the 95%CI of the mean 20
Figure 13. Length-Frequency of all reported harvested and released bull trout from Lake
Koocanusa during the permitted fishery 21
Figure 14. Number of bull trout redds observed in Grave Creek by year and harvest
management regulation

Figure 15. Number of bull trout redds observed in the Wigwam River by year and harvest	
management regulation.	23
Figure 16. Mean number of bull trout redds observed in Grave Creek by harvest managemen	t
regulation. Error bars represent the 95% CI of the mean and categories with the same letter	
are not significantly different from one another	23
Figure 17. Mean number of bull trout redds observed in the Wigwam River by harvest	
management regulation. Error bars represent the 95% CI of the mean and categories with the	e
same letter are not significantly different from one another	24
Figure 18. Estimated juvenile bull trout abundance in Grave Creek by year.	25
Figure 19. Mean bull trout catch per gillnet in Lake Koocanusa by year and harvest	
management regulation.	26
Figure 20. Mean bull trout catch per gillnet in Lake Koocanusa by harvest management	
regulation. Error bars represent the 95% CI of the mean and categories with the same letter	
are not significantly different from one another	26

SUMMARY

In 2004, the U.S. Fish and Wildlife Service authorized limited sport fishing for bull trout *Salvelinus confluentus* at Lake Koocanusa as requested by Montana Fish, Wildlife & Parks after that fishery was deemed to have reached recovery goals. A portion of the permit conditions called for a bull trout permit and catch card system, an angler survey, and development of educational information pertaining to this new fishery. Over the past 18 years, indices of Lake Koocanusa bull trout abundance have informed adaptive management of this unique fishery resulting in various adjustments of harvest limits.

This was the seventeenth year of the catch card surveys. During the 2020 license year, only 43 anglers obtained bull trout permits/catch cards for Lake Koocanusa. By August 2020, we received 22 catch cards and/or surveys (51% return) from anglers. Most (91%) of all catch card holders were Montana residents. The low number of catch cards issued and catch card/survey returns were likely a result of the catch and release only regulation for the 2020 season. Estimated catch of bull trout was only 26 and likely also limited by the low number of participants.

A review of the history of the Lake Koocanusa bull trout fishery indicated several trends as the program matured. Angler interest, effort, and estimated bull trout catch and harvest all declined through time. This is likely the result of the novelty of the fishery decreasing and more restrictive harvest limits in more recent years, suggesting harvest is a significant motivation for participation.

The bull trout population in Lake Koocanusa is closely monitored. In addition to the catch card information, data from redd counts, gillnet surveys, and tributary juvenile bull trout abundance estimates are reviewed annually. The result has been an adaptive management approach where bull trout harvest limits are proactively adjusted based on gathered information. Through the years, Montana Fish, Wildlife & Parks has managed the Lake Koocanusa bull trout fishery more conservatively than required by the U.S. Fish and Wildlife Service in sub permit TE-07753.

Monitoring the bull trout fishery will continue. By combining indices of bull trout abundance with information regarding angler use, Montana Fish, Wildlife & Parks can continue to evaluate relationships between the fishery and the bull trout population. Adaptive harvest management has maintained a limited bull trout sport fishery that will persist as long as monitoring and response efforts remain proactive. The success of this unique fishery helps enhance the understanding of bull trout and encourages stakeholder engagement and informational contributions by the angling public.

INTRODUCTION

In 2021, Montana Fish, Wildlife & Parks (MFWP) personnel conducted the seventeenth annual angler mail survey for the recreational bull trout (*Salvelinus confluentus*) fishery on Lake Koocanusa. Because bull trout were listed as a "threatened species" under the Endangered Species Act (ESA) in 1998, this fishery was authorized beginning in 2004 under special permit by the U.S. Fish and Wildlife Service (USFWS).

In 2012, Montana Fish Wildlife & Parks decreased bull trout harvest from one per angler per year to catch and release for several reasons: 1) decreasing mean lengths of bull trout caught and harvested; 2) an unstable trend of redd numbers in the Wigwam River (the major spawning tributary in the British Columbia, Canada (BC) portion Lake Koocanusa bull trout) and Grave Creek (the major spawning tributary in the US portion of Lake Koocanusa); 3) unknown amount of angler harvest in the mainstem and tributaries of the BC portion of Lake Koocanusa (Hensler et al. 2015) We believed this was the prudent course of action even though the USFWS sub permit TE-077533 allowed for harvest of 1,140 bull trout. In 2015 MFWP determined that because redd numbers had stabilized then increased and BC further restricted angling regulations for bull trout, a limited (one bull trout/angler/year) harvest would be re-instituted for Lake Koocanusa during the 2016 season. Declining redd numbers in the Wigwam River and Grave Creek in 2019 prompted a return to catch and release angling only beginning in the 2020 season (Stephens and Benson 2020).

BACKGROUND

Bull trout were listed as "threatened" under the Endangered Species Act in 1998. At the time of listing, sport fishing for bull trout had already been discontinued in Montana and was under review, except in Swan Lake which was considered to have a stable population. In 2004, the U.S. Fish and Wildlife Service (USFWS) authorized limited sport fishing for bull trout at Lake Koocanusa as requested by Montana Fish, Wildlife and Parks (MFWP) after the fishery was deemed to have reached recovery goals. The resulting USFWS special permit (TE-077533) included conditions agreed upon by both USFWS and MFWP for authorized take of bull trout in Lake Koocanusa (Hensler and Benson 2005).

One key condition of the USFWS special permit called for development and use of a catch card and angler surveys. The first step in developing a catch card system involved an application process which was available through the Region 1 MFWP office and on MFWP web site. After a completed application was processed, a permit and numbered catch card was issued to each angler. Catch cards requested location, length, and date of each bull trout harvested. Additional supplemental information included total number of days fished, a catch and release log for bull trout, and catch information for rainbow trout.

Anglers were instructed to retain their catch cards until they received a mail survey after the bull trout season. Surveys were mailed to all current catch card holders and in some years, to anglers who had obtained catch cards in previous years. Information gathered from the catch

cards and surveys was used to generate accurate estimates of bull trout catch and harvest from Lake Koocanusa.

Special terms and conditions for FWP's management of the Lake Koocanusa bull trout fishery are found in USFWS permit number: TE077533-1. FWP is authorized to allow individual anglers to intentionally pursue and capture bull trout from Lake Koocanusa with the appropriate permit and catch card. Depending on the status of the bull trout population, FWP may open or close the fishery and adjust harvest limit (maximum 2 per license year – 1 daily). Maximum authorized angler take is 1,140 bull trout from Lake Koocanusa, which includes incidental catch and release mortality calculated as 10 percent of the number of fish caught and released. Anglers may catch and release bull trout year-round, but harvest is restricted to June 1 - through February 28 in years where harvest is allowed.

The level of authorized take is reevaluated annually, and the recovery permit may be amended if bull trout abundance indices, as demonstrated by redd counts, fall below levels that the USFWS considers necessary to ensure local bull trout populations will not be unacceptably impacted. A review of the recovery permit for Lake Koocanusa is triggered when annual redd counts in the index areas of the Kootenai drainage drop below 667 redds in the Wigwam River or 67 redds in Grave Creek.

METHODS

Catch cards and/or surveys were issued to anglers for the Koocanusa bull trout fishery in all years from the 2004 through 2020 fishing seasons. Information obtained from catch card and survey returns was used to estimate fishing pressure, catch, and harvest metrics. To estimate fishing pressure, we used the reported effort from catch cards and surveys and assumed anglers not responding to the survey angled for bull trout with the same effort as respondents. Response rates averaged 72 percent for all years (range 38% - 85%).

For much of the long-term investigation of the Koocanusa bull trout fishery, the 2020 license year was not included due to minimal available information. This lack of data was a result of low numbers of catch cards issued, likely due to no allowable bull trout harvest during this year. Furthermore, this was the only year where surveys were not sent to previous year's catch card holders because prior similar efforts (2012 – 2015) were quite costly and cumbersome. Analyses and figures were generated using Microsoft Excel at a significance level of 0.05 unless otherwise noted. Analyses corresponding to figures are found in the appendices.

RESULTS

Bull Trout Catch Card/Survey Returns

Catch card instructions requested that anglers return catch cards after their license expired with the mail survey. Some anglers returned catch cards but not surveys; some returned both; some returned only surveys. We issued 43 catch cards for the 2020 season and by August 2021, we received 22 catch cards/surveys (51% return rate). The low number of catch cards issued and the lower return rate were likely a result of the catch and release only regulations for the 2020 fishing season.

Angler Demographics

Most anglers that obtained a Lake Koocanusa bull trout catch card for the 2020 season were Montana residents (91%). Anglers from 2 other states and provinces were issued a catch card for Lake Koocanusa. Non-resident anglers were from Idaho and Ohio.

Fishing Pressure Estimates

After the 2020 season, only 5 of the 22 respondents (22.7%) indicated that they did fish for bull trout. The percent of cardholders that fished began an upward trend likely associated with ability to harvest in 2016 (Figure 1) but declined drastically in 2020 with the elimination of harvest. To estimate total number of angler-days of pressure on bull trout, we used the number of days reported from catch cards and surveys. We assumed anglers not responding to the survey angled for bull trout with the same effort as respondents. During the 2020 season, anglers reported fishing 17 days, and the estimate of total angling effort was 33 days (Table 1).



Figure 1. Estimated number of anglers and percent of respondents that fished for bull trout at Lake Koocanusa, Montana through the 2020 season.

Table 1. Bull trout season angling pressure estimates calculated from catch card and survey results for Lake Koocanusa through the 2020 season.

Number Angler-Days Fishing Pressure									
Season	Number of Respondents	Angler- Days from survey	Estimated Angler- Days	Season	Number of Respondents	Angler- Days from survey	Estimated Angler- Days		
2004	897	1,685	3,483	2013	449	1,673	2,370		
2005	774	3,285	4,874	2014	574	1,099	1,842		
2006	590	2,639	3,390	2015	536	874	1,202		
2007	569	2,963	3,595	2016	378	942	1,326		
2008	609	3,917	4,607	2017	319	681	1,008		
2009	691	3,686	4,537	2018	319	703	976		
2010	497	3,154	3,720	2019	327	821	1,165		
2011	598	1,933	2,521	2020	22	17	33		
2012	603	1,456	1,850						

Harvest and Catch Estimates

Since there was no harvest for the 2020 season, only catch estimates were calculated. To estimate total catch at Lake Koocanusa for the 2020 season, we calculated the mean catch rate (0.6 bull trout/angler) for anglers who returned catch cards or surveys. The estimated total catch calculated from all surveyed anglers was 26 bull trout (Table 2).

Season	Bull Trout Harvested	Lower Bound	Upper Bound	Bull Trout Caught	Lower Bound	Upper Bound	Percent Released
2004	650 (259)	259	652	2,399 (698)	*	*	72.1
2005	371 (216)	. (216) 216 373		3,595 (2,171)	2,171	3,611	89.7
2006	180 (140)	140	181	1349 (909)	909	1,353	86.6
2007	267 (220)	220	268	1,484 (997)	997	1,488	82
2008	295 (249)	249	296	1,897 (1,358)	1,358	1,900	84.4
2009	256 (206)	206	257	1,810 (1,247)	1,247	1,815	85.8
2010	163 (138)	138	164	1,568 (1,328)	1,328	1,573	89.6
2011	107 (82)	82	108	1,318 (925)	925	1,323	91.9
2012	No harvest		742 (608)	608	747	100	
2013		No harvest		965 (728)	728	981	100
2014		No harvest		1,250 (746)	746	1,283	100
2015		No Harvest		973 (548)	548	1.019	100
2016	78 (55)	55	79	885 (575)	575	890	91.2
2017	68 (46)	46	69	607 (364)	364	611	87.4
2018	84 (31)	31	85	997 (336)	336	1003	91.6
2019	145 (58)	58	146	1030 (355)	355	1035	83.7
2020		No Harvest		26 (3)	22	29	100

Table 2. Estimated bull trout harvest (reported harvest) and estimated catch (reported catch) for Lake Koocanusa through the 2020 season.

*Point estimate expanded from caught vs. released bull trout from catch cards with no variance calculated

DISCUSSION

Angler Interest

During the first few years, anglers expressed high levels of interest in the Koocanusa bull trout fishery based on the large number of catch cards issued. Through time, the number of catch cards issued decreased, even prior to the first change to the harvest limit in 2011 (Figure 2). The number of catch cards issued annually was positively correlated with the season harvest limit suggesting harvest was a significant motivation for participation. Angler interest was significantly higher when the annual limit was two bull trout per year, and significantly lower under catch and release only regulations (Figure 3).



Figure 2. Number of Koocanusa bull trout catch cards issued by year and harvest limit regulation.





Angler Effort

Similar to interest expressed as the number of catch cards issued, angler effort also decreased through time (Figure 4). Estimated total number of angler days declined from over 4,000 during the first two years to around 1,000 during the most recent catch card surveys. Harvest ability also seemed to affect angler effort. Estimated total angler days were significantly higher in years when the annual harvest limit was two compared to years limited to catch and release only or one bull trout per year (Figure 5). Furthermore, the percent of catch card/survey respondents that did fish Lake Koocanusa was significantly higher when some level of harvest was allowed compared to years of catch and release only (Figure 6).



Figure 4. Estimated effort (total number of angler days) by license year.



Figure 5. Estimated effort (total number of angler days) by harvest limit regulation. Error bars represent the 95% CI of the mean and categories with the same letter are not significantly different from one another.



Figure 6. Angler participation expressed as the percent of respondents that said they fished Lake Koocanusa by harvest limit regulation. Error bars represent the 95% CI of the mean and categories with the same letter are not significantly different from one another.

Bull Trout Catch

Estimated total number of bull trout caught in Koocanusa declined through time (p < 0.001; Figure 7). This could be the result of several factors including novelty of the fishery and changes to harvest regulations. Anglers expressed high levels of interest in the fishery early on, but the number of catch cards issued waned even prior to the first harvest limit modification. A significant positive relationship exists between angler effort and the number of bull trout caught (p < 0.001; Figure 8). There was also a difference in estimated total bull trout catch between seasonal harvest limit regulations. Like the relationship between season harvest limit and angler effort, significantly more bull trout were caught in years when the harvest limit was two compared to years when the harvest limit was one or zero (Figure 9).



Figure 7. Estimated total bull trout catch by license year.



Figure 8. Relationship between angler effort and number of bull trout caught.



Figure 9. Estimated number of bull trout caught by harvest limit regulation. Error bars represent the 95% CI of the mean and categories with the same letter are not significantly different from one another.

Bull Trout Harvest and Take

Estimated bull trout harvest and total take also declined with time (p < 0.01; Figure 10). Estimated total take includes incidental catch and release mortality represented as 10-percent of released bull trout. Like interest, effort, and catch, novelty of the fishery likely contributed to higher levels of harvest and total take that diminished through the years. Season harvest limit clearly influenced indices of take. Years with a two fish limit exhibited significantly higher levels of bull trout take compared to years where the season limit was one or zero (p < 0.02; Figure 11). Years where a single bull trout could be harvested resulted in higher take estimates than years of catch and release only.



Figure 10. Estimated total bull trout harvest and estimated total bull trout take by license year.



Figure 11. Estimated total bull trout harvest and estimated total bull trout take by harvest limit regulation. Error bars represent the 95% CI of the mean and categories with the same letter are not significantly different from one another.

Catch Versus Harvest Length Estimates

Anglers were asked to estimate and record lengths of harvested and released bull trout. Mean length of harvested bull trout was significantly larger than mean length of released bull trout within any given year (e.g., Stephens and Benson 2020; Hensler and Benson 2018). For all years of the Koocanusa bull trout fishery combined, reported mean length of harvested bull trout (26.7"; range 12"-41") was significantly larger than reported mean length of released bull trout (22.5"; range 5"-47") (Figure 12). While anglers caught and released bull trout of all size classes, harvest was targeted at larger bull trout (Figure 13).



Figure 12. Mean and median length of all reported harvested and released bull trout from Lake Koocanusa during the permitted fishery. Error bars represent the 95%CI of the mean.



Figure 13. Length-Frequency of all reported harvested and released bull trout from Lake Koocanusa during the permitted fishery.

Bull Trout Redd Counts

The Koocanusa bull trout population is closely monitored. A primary metric of bull trout abundance is annual fall redd counts. Bull trout redds are counted in index reaches of the Wigwam River and its tributaries annually by BC personnel, and in index reaches of Grave Creek and its tributaries by MFWP personnel (Dunnigan et al. 2019). Provisions of the USFWS sub permit TE-07735 authorized in 2004 for Koocanusa provided for angler take not to exceed 1,140 bull trout per year and that redd counts not drop below 667 for the Wigwam River or below 67 in Grave Creek. Since the experimental fishery, estimated annual total take (estimated harvest + 10% catch and release mortality) has never reached the 1,140-fish take limit and only exceeded 50 percent of this during the first two years (Figure 10).

Redd counts in both Grave Creek and the Wigwam River have exhibited various trends through time and by harvest management strategy (Figures 14 and 15). Prior to reestablishing bull trout harvest in Lake Koocanusa, redd counts displayed a significant increasing trend. Over the first several years of harvest (2 bull trout/year) redd numbers declined, prompting harvest management to become an adaptive response that set the annual individual angler harvest at one or zero depending on the most recent redd trend information. Under the adaptive harvest management in later years, redd numbers fluctuate but remain somewhat stable with mean values that do not differ significantly from mean redd numbers during earlier periods of no harvest (Figures 16 and 17). Wigwam River redd counts from 2005 were not included in the analysis because the value (785) was a significant outlier caused by a landslide that likely prevented many bull trout from reaching the redd count reference reach.



Figure 14. Number of bull trout redds observed in Grave Creek by year and harvest management regulation.



Figure 15. Number of bull trout redds observed in the Wigwam River by year and harvest management regulation.



Figure 16. Mean number of bull trout redds observed in Grave Creek by harvest management regulation. Error bars represent the 95% CI of the mean and categories with the same letter are not significantly different from one another.



Figure 17. Mean number of bull trout redds observed in the Wigwam River by harvest management regulation. Error bars represent the 95% CI of the mean and categories with the same letter are not significantly different from one another.

Juvenile Bull Trout Estimates

Population estimates of juvenile bull trout abundance in Grave Creek have been conducted annually beginning in 1997. Estimates were generated using multiple depletion electrofishing techniques in an approximately 185-meter long reference reach. While estimates vary between years, no trend is apparent through time (Figure 18). Juvenile bull trout abundance in Grave Creek has averaged 11 bull trout per 100m² across all years and ranged from 6 to 18 bull trout per 100m²



Figure 18. Estimated juvenile bull trout abundance in Grave Creek by year.

Koocanusa Spring Gillnet Catch

MFWP has used experimental gillnets to monitor fish population trends in Lake Koocanusa since 1975. Two sections, Rexford and Canada, are currently sampled in the spring with 14 sinking gillnets in each section although historical effort and sections included additional sites (Dunnigan et al 2019). Fish species abundance is expressed as fish/net and used to assess changes through time.

Koocanusa spring bull trout catch in the gillnets has increased through time (Figure 19). Prior to ESA listing and protection in Montana, catch was stable at relatively low levels. Once fishing for bull trout was eliminated beginning in 1994, bull trout catch per gillnet in Lake Koocanusa displayed a significant increasing trend ($R^2 = 0.535$; p < 0.02). Following the reestablishment of a limited fishery that has been adaptively managed, mean annual bull trout catch in gillnets has remained stable at a level not statistically different from the mean during the period of no bull trout fishing (Figure 20).



Figure 19. Mean bull trout catch per gillnet in Lake Koocanusa by year and harvest management regulation.



Figure 20. Mean bull trout catch per gillnet in Lake Koocanusa by harvest management regulation. Error bars represent the 95% CI of the mean and categories with the same letter are not significantly different from one another.

CONCLUSIONS

The Lake Koocanusa bull trout population is quite complex in that most adults rear and mature in the Montana portion of the reservoir while much of the spawning and juvenile rearing occurs in the BC portion of the drainage. Environmental and anthropogenic factors impacting bull trout in such a large system are also complex and poorly understood. MFWP has developed a management strategy for the Lake Koocanusa bull trout recreational fishery that evolved to be more conservative than the limits of the authority statutes set by USFWS sub permit TE-07753. The result has been an adaptive approach where regulations can be modified between years based on the best available knowledge of the bull trout population.

Since the creation of Lake Koocanusa, the bull trout population in this portion of the Kootenai River drainage has become resilient. Likely existing at adult densities much higher than the free-flowing river, the population increased following ESA listing and elimination of targeted angling. Even after limited harvest was established in 2004, indices of bull trout abundance remain stable at levels not different from historic. This stability is a testament to the adaptive management approach where potential impacts of angling pressure are mitigated through harvest regulations, while still allowing a limited recreational fishery for bull trout.

Evaluation of the history of this limited bull trout fishery indicates that angler interest and effort, as well as bull trout catch and take, can be influenced by harvest regulation management. This suggests harvest is a strong motivating factor for anglers participating in the Lake Koocanusa bull trout fishery. By monitoring indices of bull trout abundance through time, harvest regulations can be adjusted to minimize the impacts to the population attributed to the recreational fishery while still allowing opportunity for anglers to target bull trout. The success of this adaptive approach is evident in the persistence and relative stability of the Lake Koocanusa bull trout population and fishery.

Monitoring of the Lake Koocanusa bull trout population will continue. A valuable portion of this monitoring strategy has become the Koocanusa angler survey. By combining standard indices of bull trout abundance with information regarding angler use, MFWP can continue to evaluate the relationship between the fishery and the population. The adaptive harvest management approach employed over the last several years has shown a limited bull trout fishery can persist on Lake Koocanusa as long as monitoring and response efforts remain proactive. The success of this unique fishery not only enhances the understanding of bull trout, but also encourages significant opportunities for stakeholder engagement and informational contributions by the angling public.

LITERATURE CITED

- Dunnigan J, J. DeShazer, T. Ostrowski, M. Benner, J. Lampton, L. Garrow, and M. Boyer. 2019. Mitigation For The Construction and Operation of Libby Dam, 1/1/2018 – 12/31/18 Annual Report, 1995-004-00, {259 pages}.
- Hensler, M. and N. Benson. 2005. Angler Survey of Experimental Recreational Bull Trout Fishery in Lake Koocanusa, Montana 2004. Montana Fish, Wildlife & Parks. Kalispell, MT.
- Hensler, M., J. Dunnigan and N. Benson. 2015. Angler Survey of Experimental Recreational Bull Trout Fishery for Lake Koocanusa, Montana 2014 Season. Montana Fish, Wildlife & Parks, Libby, Montana. December 2015.
- Hensler, M. and N. Benson. 2018. Angler Survey of Experimental Recreational Bull Trout
 Fishery for Lake Koocanusa, Montana 2016 Season. Montana Fish, Wildlife & Parks,
 Libby, Montana. March 2018.
- Stephens, B. and N. Benson. 2020. Angler Survey of Experimental Recreational Bull Trout
 Fishery for Lake Koocanusa, Montana through the 2019 Season. Montana Fish, Wildlife
 & Parks, Libby, Montana. August 2020.

APPENDICIES

Table 1A.	Linear regression	analysis for number	of catch	cards issued	versus year	during the
first sever	vears of the spec	ial fishery (Figure 2).				

Regression Stat	ANOVA						
Multiple R	0.972475		df	SS	MS	F	Significance F
R Square	0.945707	Regression	1	1340719	1340718.893	87.094	0.000237871
Adjusted R Square	0.934849	Residual	5	76969.96	15393.99286		
Standard Error	124.0725	Total	6	1417689			
Observations	7						

Table 2A. Single factor ANOVAS of catch cards issued by season harvest limit (Figure 3).

Groups	Count	Sum	Average	Variance		
Limit 2	7	12076	1725.143	236281.5		
Limit 1	5	2690	538	19401.5		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	4110482	1	4110482	27.48944	0.000377	4.964603
Within Groups	1495295	10	149529.5			
Groups	Count	Sum	Average	Variance		
Limit 1	5	2690	538	19401.5		
Limit 0	5	373	74.6	667.3		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	536848.9	1	536848.9	53.50085	8.27E-05	5.317655
Within Groups	80275.2	8	10034.4		_	
Groups	Count	Sum	Average	Variance		
Limit 0	5	373	74.6	667.3		
Limit 2	7	12076	1725.143	236281.5		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	7945851	1	7945851	55.94259	2.11E-05	4.964603
Within Groups	1420358	10	142035.8			

Regression Sta	ANOVA						
Multiple R	0.914608		df	SS	MS	F	Significance F
R Square	0.836509	Regression	1	26542977	26542977	71.63145	7.06618E-07
Adjusted R Square	0.824831	Residual	14	5187689	370549.2		
Standard Error	608.7276	Total	15	31730667			
Observations	16						

Table 3A. Linear regression analysis for angler days versus license year (Figure 4).

Table 4A. Single factor ANOVAS of total angler days by season harvest limit (Figure 5).

Groups	Count	Sum	Average	Variance		
Limit 1	5	6995.939	1399.188	412894.8		
Limit 0	5	6953.853	1390.771	801285.4		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	177.1216	1	177.1216	0.000292	0.98679	5.317655
Within Groups	4856721	8	607090.1			
Groups	Count	Sum	Average	Variance		
Limit 2	7	29128.48	4161.211	335030.8		
Limit 1	5	6995.939	1399.188	412894.8		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	22250590	1	22250590	60.76467	1.48E-05	4.964603
Within Groups	3661764	10	366176.4			
Groups	Count	Sum	Average	Variance		
Limit 0	5	6953.853	1390.771	801285.4		
Limit 2	7	29128.48	4161.211	335030.8		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	22386412	1	22386412	42.92427	6.46E-05	4.964603
Within Groups	5215327	10	521532.7			

Groups	Count	Sum	Average	Variance		
Limit 1	5	255.88	51.17601	14.41028		
Limit 0	5	154.8823	30.97647	50.1085		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	1020.054	1	1020.054	31.62036	0.000497	5.317655
Within Groups	258.0751	8	32.25939			
Groups	Count	Sum	Average	Variance		
Limit 2	7	325.1253	46.44647	78.09694		
Limit 1	5	255.88	51.17601	14.41028		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	65.24154	1	65.24154	1.239808	0.291556	4.964603
Within Groups	526.2228	10	52.62228			
Groups	Count	Sum	Average	Variance		
Limit 0	5	154.8823	30.97647	50.1085		
Limit 2	7	325.1253	46.44647	78.09694		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	698.0196	1	698.0196	10.43353	0.009019	4.964603
Within Groups	669.0156	10	66.90156			

Table 5A. Single factor ANOVAS of percent of respondents that fished by season harvest limit (Figure 6).

Table 6A. Linear regression for estimated bull trout catch by license year (Figure 7).

Regression Sta	ANOVA							
Multiple R	0.750993		df	SS	MS	F	Significance F	
R Square	0.563991	Regression	1	4722957	4722957	18.10943	0.000799544	
Adjusted R Square	0.532847	Residual	14	3651214	260801			
Standard Error	510.6868	Total	15	8374171				
Observations	16							

Table 7A. Linear regression for angler effort versus bull trout catch (Figure 8).

Regression Sta	ANOVA							
Multiple R	0.963154		df	SS	MS	F	Significance F	
R Square	0.927665	Regression	1	38330085	38330085	192.3676	1.42834E-09	
Adjusted R Square	0.860998	Residual	15	2988816	199254.4			
Standard Error	446.3792	Total	16	41318901				
Observations	16							

Groups	Count	Sum	Average	Variance		
Limit 2	7	14192	2027.429	601818.3		
Limit 1	5	4837	967.4	66098.3		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	3277343	1	3277343	8.456999	0.015616	4.964603
Within Groups	3875303	10	387530.3			
Groups	Count	Sum	Average	Variance		
Limit 1	5	4837	967.4	66098.3		
Limit 0	4	3930	982.5	43264.33		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	506.6889	1	506.6889	0.008998	0.927087	5.591448
Within Groups	394186.2	7	56312.31			
Groups	Count	Sum	Average	Variance		
Limit 0	4	3930	982.5	43264.33		
Limit 2	7	14192	2027.429	601818.3		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	2779320	1	2779320	6.686947	0.02941	5.117355
Within Groups	3740703	9	415633.6			

Table 8A. Single factor ANOVAS for estimated number of bull trout caught by season harvest limit (Figure 9).

Table 9A. Linear regression analyses for estimated bull trout harvest and total take by license year (Figure 10).

Estimated Bull Trout Harvest											
Regression Stati	stics		ANOVA								
Multiple R	0.735354		df	SS	MS	F	Significance F				
R Square	0.540745	Regression	1	243148.9	243148.9	16.48414	0.001169979				
Adjusted R Square	0.507941	Residual	14	206506.6	14750.47						
Standard Error	121.4515	Total	15	449655.5							
Observations	16										
		Estimated	d Total E	Bull Trout Ta	ke						
Regression Stati	stics		ANOVA								
Multiple R	0.779936		df	SS	MS	F	Significance F				
R Square	0.6083	Regression	1	434816.9	434816.9	21.74161	0.000366096				
Adjusted R Square	0.580321	Residual	14	279990.2	19999.3						
Standard Error	141.4189	Total	15	714807.1							
Observations	16										

Table 10A. Single factor ANOVAS for estimated bull trout harvest and take by season harvest limit (Figure 11).

		Estimated B	ull Trout Tal	ke		
Groups	Count	Sum	Average	Variance		
Limit 2	7	3374	482	40467.02		
Limit 1	5	917.2194	183.4439	2234.5		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	259979.3	1	259979.3	10.32729	0.009275	4.964603
Within Groups	251740.1	10	25174.01			
Groups	Count	Sum	Average	Variance		
Limit 1	5	917.2194	183.4439	2234.5		
Limit 0	4	393	98.25	432.6433		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	16128.88	1	16128.88	11.02999	0.012745	5.591448
Within Groups	10235.93	7	1462.275			
Groups	Count	Sum	Average	Variance		
Limit 0	4	393	98.25	432.6433		
Limit 2	7	3374	482	40467.02		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	374854	1	374854	13.82091	0.004788	5.117355
Within Groups	244100.1	9	27122.23			
	Es	timated Bul	l Trout Harv	vest		
Groups	Count	Sum	Average	Variance		
Limit 2	7	2182	311.7143	27133.24		
Limit 1	5	481.6882	96.33763	935.742		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	135295.7	1	135295.7	8.1238	0.017243	4.964603
Within Groups	166542.4	10	16654.24			
Groups	Count	Sum	Average	Variance		
Limit 1	5	481.6882	96.33763	935.742		
Limit 0	4	0	0	0		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	20624.31	1	20624.31	38.57104	0.000441	5.591448
Within Groups	3742.968	7	534.7097			

Groups	Count	Sum	Average	Variance		
Harvested	1779	47578	26.74424	16.22624		
Released	7813	175554.3	22.46952	27.13859		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	26478.93	1	26478.93	1054.289	1.6161E-219	3.842429
Within Groups	240856.9	9590	25.11543			

Table 11A. Single factor ANOVA for mean length of bull trout by harvest or release (Figure 12).

Table 12A. Linear regressions for Grave Creek bull trout redd counts by harvest management strategy (Figure 14).

			Protected	d (0/yr)						
Regression Sta	tistics				ANOVA					
Multiple R	0.961127		df	SS	MS	F	Significance F			
R Square	0.923766	Regression	1	37321.52	37321.52	72.70483	0.000142601			
Adjusted R Square	0.91106	Residual	6	3079.976	513.3294					
Standard Error	22.65677	Total	7	40401.5						
Observations	8									
Harvest (2/yr)										
Regression Sta	tistics				ANOVA					
Multiple R	0.266555		df	SS	MS	F	Significance F			
R Square	0.071051	Regression	1	603.5714	603.5714	0.382429	0.563385914			
Adjusted R Square	-0.11474	Residual	5	7891.286	1578.257					
Standard Error	39.72728	Total	6	8494.857						
Observations	7									
		A	daptive	(0-1/yr)						
Regression Sta	tistics				ANOVA					
Multiple R	0.257806		df	SS	MS	F	Significance F			
R Square	0.066464	Regression	1	281.6	281.6	0.569565	0.472061518			
Adjusted R Square	-0.05023	Residual	8	3955.3	494.4125					
Standard Error	22.23539	Total	9	4236.9						
Observations	10									

			Protected	(0/yr)					
Regression Stat	tistics			A	NOVA				
Multiple R	0.979215		df	SS	MS	F	Significance F		
R Square	0.958862	Regression	1	3117216	3117216	163.1603	4.17678E-06		
Adjusted R Square	0.952986	Residual	7	133736.6	19105.23				
Standard Error	138.2217	Total	8	3250953					
Observations	9								
			Harvest (2	2/yr)					
Regression Statistics	5		ANOVA						
Multiple R	0.87568		df	SS	MS	F	Significance F		
R Square	0.766815	Regression	1	676601.9	676601.9	13.15377	0.022222544		
Adjusted R Square	0.708519	Residual	4	205751.4	51437.86				
Standard Error	226.7992	Total	5	882353.3					
Observations	6								
			Adaptive (0)-1/yr)					
Regression Statistics	5			А	NOVA				
Multiple R	0.504825		df	SS	MS	F	Significance F		
R Square	0.254848	Regression	1	176240.1	176240.1	3.078079	0.113248567		
Adjusted R Square	0.172054	Residual	9	515308.6	57256.52				
Standard Error	239.2833	Total	10	691548.7					
Observations	11								

Table 13A. Linear regressions for Wigwam River bull trout redd counts by harvest management strategy (Figure 15).

Groups	Count	Sum	Average	Variance		
protected	8	998	124.75	5771.643		
2/yr	7	1149	164.1429	1415.81		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	5793.376	1	5793.376	1.540276	0.236506	4.667193
Within Groups	48896.36	13	3761.258			
Groups	Count	Sum	Average	Variance		
2/yr	7	1149	164.1429	1415.81		
managed	10	831	83.1	470.7667		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	27044.48	1	27044.48	31.86262	4.66E-05	4.543077
Within Groups	12731.76	15	848.7838			
Groups	Count	Sum	Average	Variance		
managed	10	831	83.1	470.7667		
protected	8	998	124.75	5771.643		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	7709.878	1	7709.878	2.763496	0.1159	4.493998
Within Groups	44638.4	16	2789.9			

Table 14A. Single factor ANOVAS for Grave Creek bull trout redd counts by harvest management strategy (Figure 16).

Table 15A. 🗄	Single factor ANOVAS for	Wigwam	River b	ull trout	redd	counts l	by harve	est
managemer	nt strategy (Figure 17).							

Groups	Count	Sum	Average	Variance		
protected	9	9521	1057.889	406369.1		
2/yr	6	10840	1806.667	176470.7		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	2018405	1	2018405	6.348252	0.025625	4.667193
Within Groups	4133306	13	317946.6			
Groups	Count	Sum	Average	Variance		
2/yr	6	10840	1806.667	176470.7		
managed	11	14493	1317.545	69154.87		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	928812.4	1	928812.4	8.852003	0.009437	4.543077
Within Groups	1573902	15	104926.8			
Groups	Count	Sum	Average	Variance		
managed	11	14493	1317.545	69154.87		
protected	9	9521	1057.889	406369.1		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	333736.6	1	333736.6	1.523717	0.232931	4.413873
Within Groups	3942502	18	219027.9			

Table 16A. Linear regression for Grave Creek juvenile abundance estimate by year (Figure 18).

Regression Sta	ANOVA						
Multiple R	0.01671		df	SS	MS	F	Significance F
R Square	0.000279	Regression	1	0.052345	0.052345	0.005865	0.939677699
Adjusted R Square	-0.04733	Residual	21	187.4095	8.924263		
Standard Error	2.98735	Total	22	187.4619			
Observations	23						

ALL YEARS										
Regression Sta	ANOVA									
Multiple R	0.610158		df	SS	MS	F	Significance F			
R Square	0.372293	Regression	1	41.96187	41.96187	23.72403	1.78595E-05			
Adjusted R Square	0.356601	Residual	40	70.74997	1.768749					
Standard Error	1.329943	Total	41	112.7118						
Observations	42									
			NOT REST	RICTED						
Regression Sta	tistics			A	NOVA					
Multiple R	0.258301		df	SS	MS	F	Significance F			
R Square	0.066719	Regression	1	0.239567	0.239567	0.857868	0.37258891			
Adjusted R Square	-0.011054	Residual	12	3.3511	0.279258					
Standard Error	0.528449	Total	13	3.590667						
Observations	14									
			PROTEC	CTED						
Regression Sta	tistics	ANOVA								
Multiple R	0.731487		df	SS	MS	F	Significance F			
R Square	0.535074	Regression	1	9.909943	9.909943	9.207021	0.016202922			
Adjusted R Square	0.476958	Residual	8	8.61077	1.076346					
Standard Error	1.037471	Total	9	18.52071						
Observations	10									
MANAGED										
Regression Statistics		ANOVA								
Multiple R	0.32871		df	SS	MS	F	Significance F			
R Square	0.10805	Regression	1	2.705153	2.705153	1.938228	0.18291047			
Adjusted R Square	0.052303	Residual	16	22.33094	1.395684					
	0.052505									
Standard Error	1.181391	Total	17	25.0361						

Table 17A. Linear regressions for Koocanusa spring gillnet catch of bull trout by year and harvest management strategy (Figure 19).

Table 18A. Single factor ANOVA for Koocanusa spring gillnet catch of bull trout by harvest management strategy (Figure 19).

Groups	Count	Sum	Average	Variance		
not restricted	14	20.82586	1.487562	0.276205		
protected	10	41.07261	4.107261	2.057857		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	40.03316	1	40.03316	39.83151	2.37E-06	4.30095
Within Groups	22.11138	22	1.005063			
Groups	Count	Sum	Average	Variance		
protected	10	41.07261	4.107261	2.057857		
managed	18	74.78286	4.154603	1.472712		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.014408	1	0.014408	0.0086	0.926822	4.225201
Within Groups	43.55681	26	1.675262			
Groups	Count	Sum	Average	Variance		
managed	18	74.78286	4.154603	1.472712		
not restricted	14	20.82586	1.487562	0.276205		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	56.01575	1	56.01575	58.70285	1.52E-08	4.170877
Within Groups	28.62676	30	0.954225			