# ANALYSIS AND MANAGEMENT IMPLICATIONS OF MULTIPLE DECADES OF FISHERIES DATA FOR GEORGETOWN LAKE, MT

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## Introduction

Georgetown Lake is a high elevation reservoir located in southwestern Montana, about 8 miles south of the town of Philipsburg. It is approximately 2088 surface acres at full pool making it the largest still-water body in the upper Clark Fork River drainage (Berg 2009). The fishery is managed as a put-grow and take fishery for rainbow trout and brook trout and as a wild, self-sustaining kokanee salmon (kokanee) fishery. Georgetown Lake routinely ranks in the top 10 in Montana for angling pressure and is equally important as both a summer and winter ice-fishing destination. This highly productive reservoir is generally known for producing large numbers of quality sized rainbow trout, abundant kokanee, as well as being a premier location for catching trophy brook trout.

The rainbow trout fishery in Georgetown Lake is sustained by annual stocking from Montana Fish, Wildlife and Parks (MFWP) hatcheries. Rainbow trout spawning does occur in Stuart Mill Creek and North Fork Flint Creek, but the amount of recruitment this spawning provides to the population is unknown. Rainbow trout stocking densities and strains have varied over the years but have remained similar over the past eight years (Table 1). Kamloops rainbow trout stocking ended in 2009 due to the brood source being determined to not be an actual Kamloops strain. Brook trout stocking was initiated in 2004 due to a reduction in angler catch rates observed for this species (Table 1). Brook trout have traditionally been an important component of the Georgetown Lake fishery.

Georgetown Lake has been monitored by Montana Fish, Wildlife and Parks (MFWP) for many years due to its importance as a recreational fishery. Unfortunately, monitoring efforts have not always been completed routinely and the techniques used to assess population size and size structure have also varied. The most common technique used to assess the fishery in Georgetown Lake in the past several decades is winter creel survey. More recently, gill netting has been initiated as an additional method to better monitor this important fishery. This report provides a summary of recent and long term data available on Georgetown Lake for both winter creel surveys and gill net surveys and provides an assessment of the current state of the fishery.

## Methods

### Gill netting

Gill netting was initiated on Georgetown Lake in 2004 to supplement historic winter creel survey data collection efforts. Gill netting is a standard monitoring tool that is used widely throughout Montana and the western United States to monitor and assess lake fisheries. As such, the information is useful for comparing fish populations between years and between water bodies. Gill nets are effective at capturing many different species and size classes of fish making them useful for monitoring sport fish populations and for assessing entire fish communities. Gill netting was also initiated on Georgetown Lake to better assess the status of undesirable fishes in the reservoir including lake trout (which have been previously sampled in the reservoir) and other species that could potentially be introduced in to the reservoir (i.e. northern pike, etc…) (Berg 2009).

Table 1. Total number and strains of trout stocked in Georgetown Lake from 2004 through 2011.

| Year | Species | Strain | Number stocked |
|---|---|---|---|
| 2004 | Rainbow trout | Arlee | 70,208 |
| 2004 | Rainbow trout | Eagle Lake | 116,183 |
| 2004 | Rainbow trout | Kamloops | 39,186 |
| 2004 | Brook trout | | 10,360 |
| 2005 | Rainbow trout | Arlee | 194,681 |
| 2005 | Rainbow trout | Eagle Lake | 10,215 |
| 2005 | Rainbow trout | Kamloops | 35,077 |
| 2005 | Brook trout | | 52,954 |
| 2006 | Rainbow trout | Arlee | 76,274 |
| 2006 | Rainbow trout | Eagle Lake | 80,100 |
| 2006 | Rainbow trout | Kamloops | 36,955 |
| 2007 | Rainbow trout | Arlee | 67,796 |
| 2007 | Rainbow trout | Eagle Lake | 80,035 |
| 2007 | Rainbow trout | Kamloops | 32,580 |
| 2007 | Brook trout | | 59,290 |
| 2008 | Rainbow trout | Arlee | 104,779 |
| 2008 | Rainbow trout | Eagle Lake | 131,670 |
| 2008 | Rainbow trout | Kamloops | 24,244 |
| 2008 | Brook trout | | 47,520 |
| 2009 | Rainbow trout | Arlee | 74,397 |
| 2009 | Rainbow trout | Eagle Lake | 108,598 |
| 2009 | Brook trout | | 40,339 |
| 2010 | Rainbow trout | Arlee | 66,875 |
| 2010 | Rainbow trout | Eagle Lake | 93,696 |
| 2010 | Brook trout | | 48,488 |
| 2011 | Rainbow trout | Arlee | 75,455 |
| 2011 | Rainbow trout | Eagle Lake | 100,680 |
| 2011 | Brook trout | | 58,643 |

Gill netting efforts completed on Georgetown Lake have followed the methods outlined in Berg (2009). Gill netting was initiated on Georgetown Lake in 2004 and was conducted every year though 2006 to provide a baseline data set for the fishery. Gill netting was completed subsequently in 2008, 2010, and 2011, with the goal of sampling at least every two years. In 2004, a total of 15 gill nets were set at various locations throughout the lake. The number of nets

set was increased in 2005 to 18 nets to provide additional coverage of the lake and all 18 sites have been sampled in subsequent years through 2011. The gill nets used are the standard Montana Fish, Wildlife and Parks experimental gill nets which are 1.8 m (6 feet) deep and 38 m (125 feet) long. These experimental nets are constructed of monofilament and consist of five panels of various mesh sizes including 1.9 cm (3/4 inch), 2.5 cm (1 inch), 3.2 cm (1 ¼ inch), 3.8 cm (1 ½ inch) and 5.1 cm (2 inch) square mesh panels. Both sinking and floating gill nets were used in order to better assess the entire fish community, with a total of 13 floating nets and five sinking nets deployed. Gill nets were deployed in mid-September each year and identical netting locations were used in attempt to standardize the sampling efforts from year to year, except for net 16 which was set at different locations some years (Figure 1). The locations of the gill nets were marked on USGS maps and GPS locations were recorded.

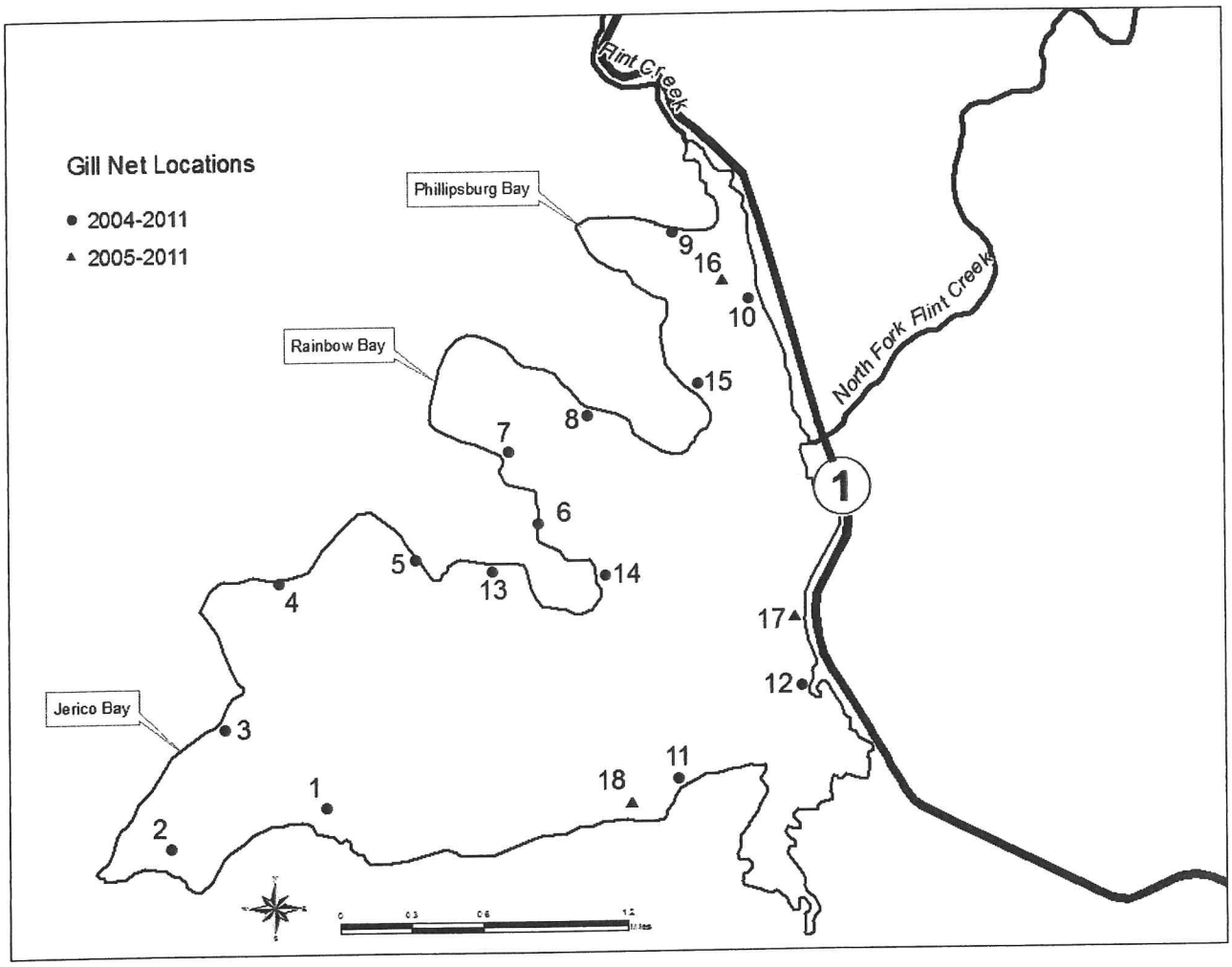
Due to the discrepancy in the number of nets set in 2004 (15 nets set) versus 2005-2011 (18 nets set), gill net catch rates were calculated two ways. The first data set includes catch rates for all years using only the 15 net sets completed in 2004. The second data set included all 18 net sets completed from 2005-2011, but did not include 2004 when only 15 nets were set. A comparison of these two data sets allows for analysis of the effect the additional three net sets had on catch rates for each species.

**Winter Creel Survey**

Winter creel surveys were used to monitor angler catch rates and average length of harvested fish including rainbow trout, brook trout and kokanee. Georgetown Lake provides excellent ice fishing opportunities and thus receives substantial pressure during the winter season, which allows for a relatively large number of anglers to be surveyed. Winter creel survey is believed to be advantageous at Georgetown Lake compared to creel surveys conducted during other seasons, as all the salmonids commonly targeted by anglers are harvested during this time period, including rainbow trout, kokanee and brook trout. Summer/fall creel surveys, on the other hand, may only provide limited catch rates for kokanee due to the difficulty associated with catching kokanee during these months in Georgetown Lake. This is due extensive weed growth limiting anglers from trolling for kokanee which is a very effective method for catching this species during summer and fall months. Also, fall salmon snagging is not allowed at Georgetown Lake, despite this type of angling being allowed at many other regional lakes.

The methods of winter creel surveys previously conducted for Georgetown Lake are relatively simple and do not follow typical creel survey methodologies (Malvestuto 1996). However, this data is the longest term data set and provides a historical perspective of the fishery. These surveys have typically been completed during January. This is a reliable time of year to collect creel survey data as the ice is completely formed and angling pressure appears to be consistent. Over the years, winter creel surveys have been completed at various points throughout the month of January with no specific dates being targeted. The surveys were completed in attempt to reach a minimum number of rainbow trout (appx. 100) to provide sufficient sample size to analyze the size structure of this population. During some years, the total number of anglers interviewed in a party was recorded along with the total number of each species caught by the angler and the total number of angler hours spent fishing up to the point of the interview. The total length of observed fish was commonly measured, although not all fish were measured and length measurements were not completed every sample year. Some demographic information was also recorded in some years including the city and state where the angler resided. The locations of angler interviews were not recorded in the historic data (pre-2010), although it is

Figure 1. Gill net locations for Georgetown Lake including the 15 net set locations completed in 2004 and the 18 net set locations completed from 2005-2011.




assumed that interviews were conducted around most of the reservoir due to its relatively small size.

Angler catch rates were calculated for each species based on the means-of-ratios methodology (Malvestuto 1996). Angler catch rates were calculated using the total number of fish captured per day divided by the total number of angler hours exerted on that day. The means-of-ratios were then calculated by taking the average of these daily catch rates for the entire sample period (month of January). Summary statistics were calculated using typical parametric procedures to calculate variance and 95% confidence intervals for independent observations (Malvestuto 1996).

In 2010 and 2012, the creel surveys were initiated relatively early in the morning (8:00-9:00 am) to ensure an adequate sample size of anglers and to allow time to interview anglers around the lake. The creel clerk drove around the entire lake and interviewed all anglers observed that were within walking distance from the lake shore at accessible sites. These surveys began in the

morning at Flint Creek Dam and continued down the west side of the lake (Sunnyside and Comer's Point). The creel clerk would then drive around to the south side of the lake (Denton's Point) and finally up the east side of the lake (Grassy Point, Pump House and Red Bridge) with the entire lake typically being covered each survey day. Both weekdays and weekends were surveyed in 2010 and 2012 with both being surveyed in proportion to the number of these days in a given week (2 weekend days for every 5 weekdays). Additional data was collected in 2010 and 2012 that was not collected in previous years including where the angler was fishing, what species the angler was targeting and their opinion on the quality of the fishing.

## Results

### Gill netting

Fish species captured in Georgetown Lake during gill netting surveys completed between 2004 and 2011 include rainbow trout, kokanee, brook trout, lake trout, largescale suckers, longnose suckers, redside shiners and northern pikeminnow. Lake trout, redside shiners, and northern pikeminnow were captured in very low abundance. Only two lake trout were sampled between 2004 and 2011 including one 718 mm lake trout captured in 2005 and another 801 mm lake trout captured in 2010. Only one northern pikeminnow and two redside shiners were captured between 2004 and 2011. Rainbow trout made up the largest portion of the species composition in all sample years while kokanee were typically the second most abundant species sampled (Tables 2 and 3). Longnose suckers were the most abundant native non-game species captured comprising 24.2% of the total number of fish sampled from 2004-2011 (Table 2).

Table 2. Species composition for gill netting completed on Georgetown Lake from 2004-2011 with all years combined.

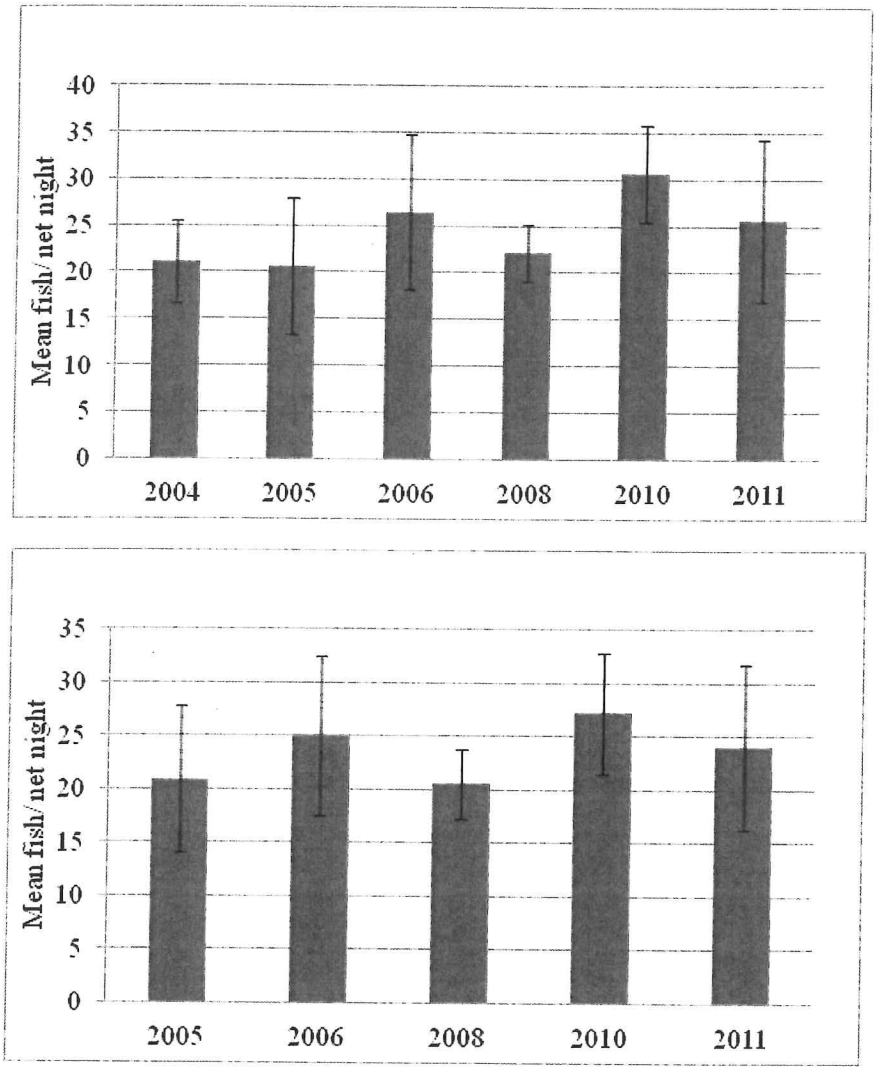
| Species | *n* | Percent of catch |
|---|---|---|
| Brook trout | 301 | 5.3 |
| Kokanee | 1478 | 26.2 |
| Rainbow trout | 2431 | 43.1 |
| Longnose sucker | 1365 | 24.2 |
| Largescale sucker | 58 | 1.0 |
| Lake trout | 2 | 0.04 |
| Redside shiner | 2 | 0.04 |
| Northern pikeminnow | 1 | 0.02 |

Catch rates for rainbow trout appear to have been steady from 2004 through 2011 (Figure 2). The lowest catch rates observed during this period were about 20 fish per net night while catch rates increased to as high as 27 fish per net night in 2010. Mean catch rates appear to be trending slightly upward over the 8 year period of sampling. A comparison of catch rates calculated using the 15 net data set versus the 18 net data set does not appear to show any substantial difference in catch rates for rainbow trout, indicating that the 15 net data set from 2004 can likely be compared directly to the 18 net data set from 2005-2011 for rainbow trout (Figure 2).

Table 3. Species composition by year for gill netting completed on Georgetown Lake from 2004-2011.

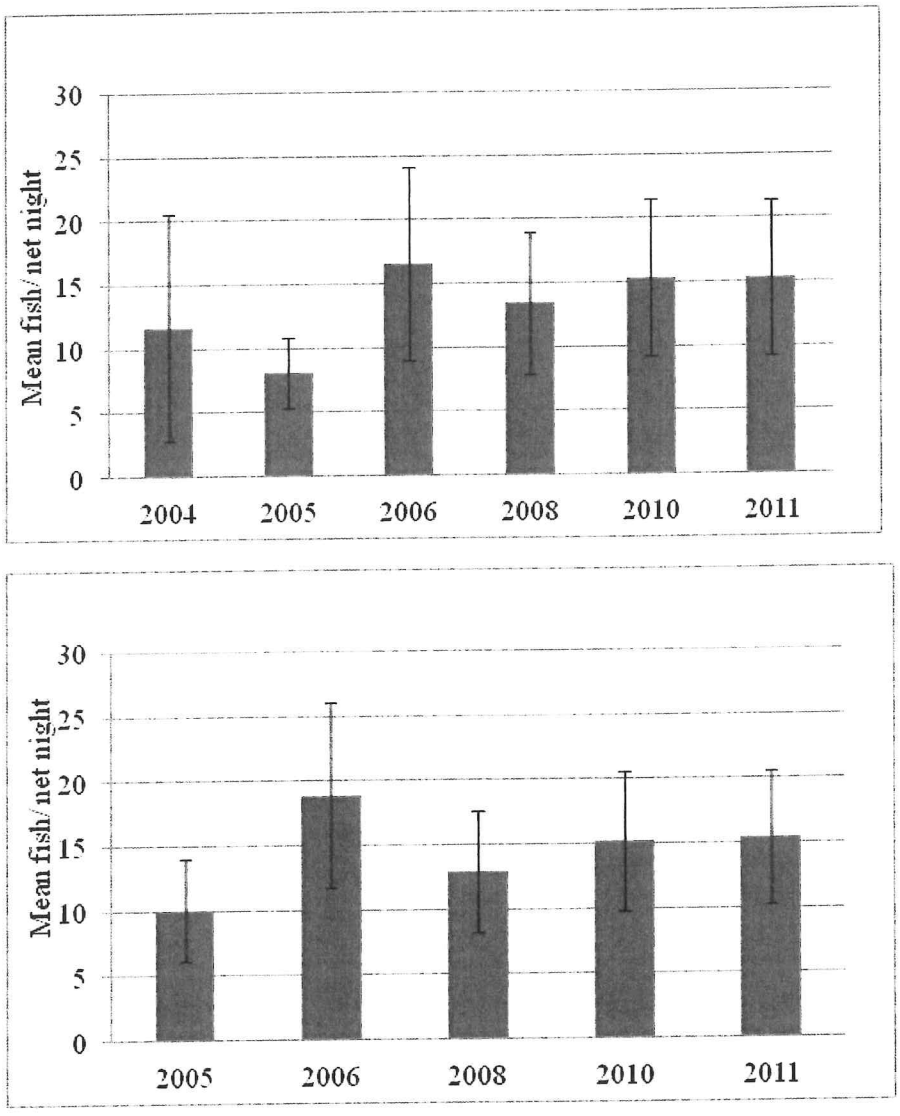
| Species | Year | *n* | Percent of catch |
|---|---|---|---|
| Brook trout | 2004 | 4 | 0.6 |
| | 2005 | 9 | 1.1 |
| | 2006 | 43 | 3.7 |
| | 2008 | 54 | 6.6 |
| | 2010 | 111 | 10.1 |
| | 2011 | 80 | 7.4 |
| Kokanee | 2004 | 175 | 27.1 |
| | 2005 | 181 | 21.8 |
| | 2006 | 340 | 29.1 |
| | 2008 | 232 | 28.5 |
| | 2010 | 273 | 24.8 |
| | 2011 | 277 | 25.6 |
| Rainbow trout | 2004 | 316 | 48.9 |
| | 2005 | 376 | 45.3 |
| | 2006 | 449 | 38.5 |
| | 2008 | 369 | 45.4 |
| | 2010 | 489 | 44.5 |
| | 2011 | 432 | 39.9 |
| Longnose sucker | 2004 | 145 | 22.5 |
| | 2005 | 259 | 31.2 |
| | 2006 | 325 | 27.9 |
| | 2008 | 144 | 17.7 |
| | 2010 | 216 | 19.6 |
| | 2011 | 276 | 25.5 |
| Largescale sucker | 2004 | 6 | 0.9 |
| | 2005 | 4 | 0.5 |
| | 2006 | 9 | 0.8 |
| | 2008 | 13 | 1.6 |
| | 2010 | 10 | 0.9 |
| | 2011 | 16 | 1.5 |
| Lake trout | 2005 | 1 | 0.1 |
| | 2010 | 1 | 0.1 |
| Redside shiner | 2006 | 1 | 0.1 |
| | 2011 | 1 | 0.1 |
| Northern pikeminnow | 2008 | 1 | 0.1 |

Figure 2. Rainbow trout catch rates (95% confidence intervals) for Georgetown Lake gill netting completed from 2004-2011 using 15 gill nets (upper graph) versus 18 gill nets (lower graph).




Gill net catch rates for kokanee also appear to have been stable in Georgetown Lake from 2004 through 2011 (Figure 3). Kokanee catch rates were lowest in 2004 and 2005 and were approximately 10 fish per net night but increased substantially in 2006 to nearly 19 fish per net night. Gill net catch rates dropped in 2008 to 13 fish per net night and were quite similar in 2010 and 2011 at approximately 15 fish per net night. Overall, catch rates for kokanee appear to have been consistent from 2006-2011, which were higher than were observed in 2004 and 2005. Similar to rainbow trout, a comparison of catch rates calculated using the 15 net data set versus the 18 net data set does not appear to show any substantial difference in catch rates for kokanee, indicating that the 15 net data set from 2004 can likely be compared directly to the 18 net data set from 2005-2011 for kokanee (Figure 3).

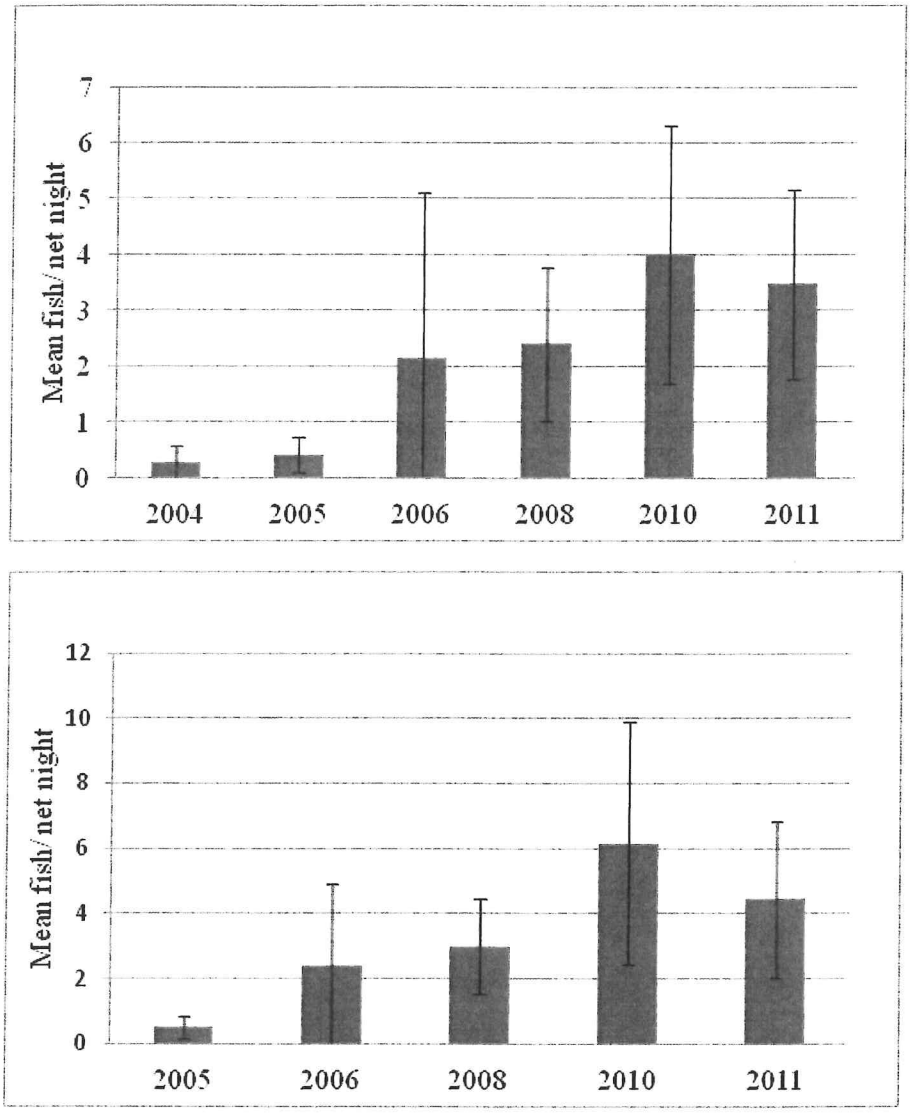
Figure 3. Kokanee catch rates (95% confidence intervals) for Georgetown Lake gill netting completed from 2004-2011 using 15 gill nets (upper graph) versus 18 gill nets (lower graph).




A comparison of gill net catch rates for brook trout using the data set of 15 nets versus 18 nets shows that catch rates varied substantially between these data sets (Figure 4). Comparison of these two data sets indicates that catch rates were much higher using the 18 net versus the 15 net data set. Thus, it is not appropriate to compare the gill net catch rates from 2004 with other sample years, unless only the original 15 net sets are compared (Figure 4).

Gill net catch rates for brook trout have changed substantially for Georgetown Lake from 2004 through 2011. Brook trout catch rates in 2004 and 2005 averaged only 0.3 and 0.4 fish per net night while catch rates increased to 2.1 and 2.4 fish per net night in 2006 and 2008. These catch rates increased even further in 2010 and 2011, averaging 4.0 and 3.5 fish per net night, respectively. A comparison of brook trout catch rates and 95% confidence intervals indicates

Figure 4. Brook trout catch rates (95% confidence intervals) for Georgetown Lake gill netting completed from 2004-2011 using 15 gill nets (upper graph) versus 18 gill nets (lower graph).

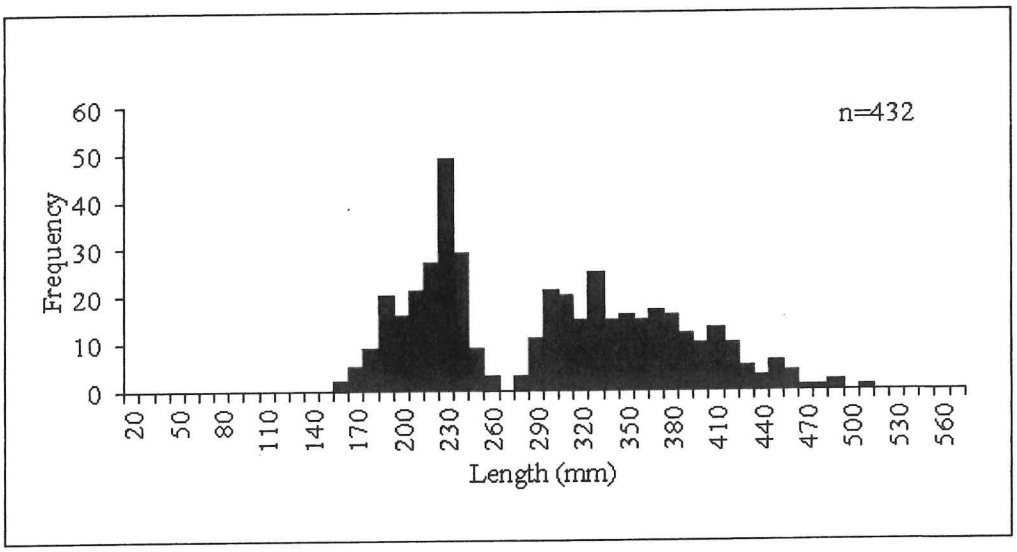



that the catch rates observed in 2008 through 2011 were significantly higher than those observed in 2004 and 2005 (Figure 4).

**Size structure**

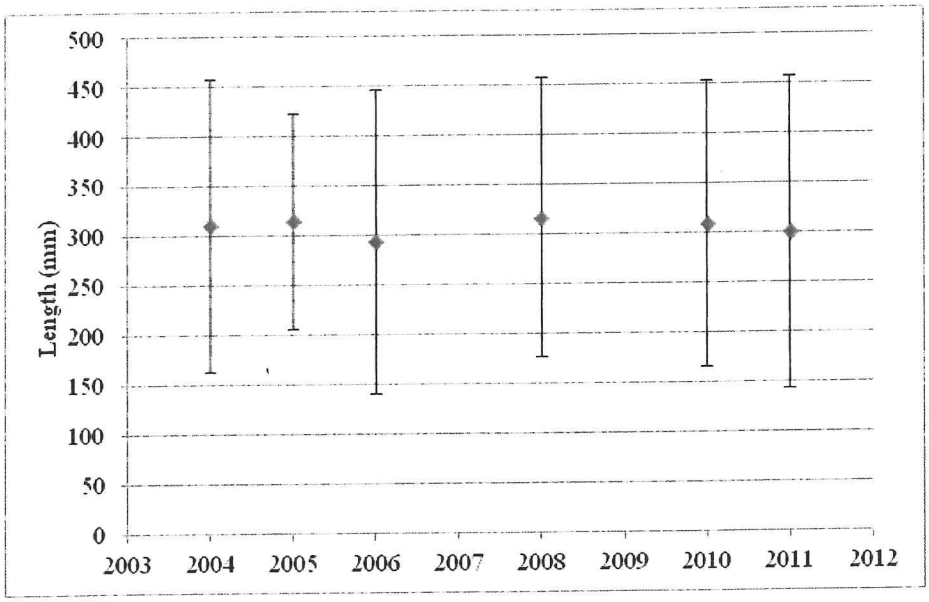
A comparison of average length data was completed for the three main recreational species sought by anglers in Georgetown Lake to assess potential changes in the size structure of these populations. Length frequency histograms were also constructed for each year of sampling, but will not be presented in this report unless significant changes in size structure were observed, due to the large number of graphs. The length frequency histogram for rainbow trout sampled in 2011 demonstrates the basic size structure of the population (Figure 5). This size structure did not change substantially between 2004 and 2011. Similarly, average length of rainbow trout

Figure 5. Length frequency histogram for rainbow trout captured during 2011 gill netting on Georgetown Lake.



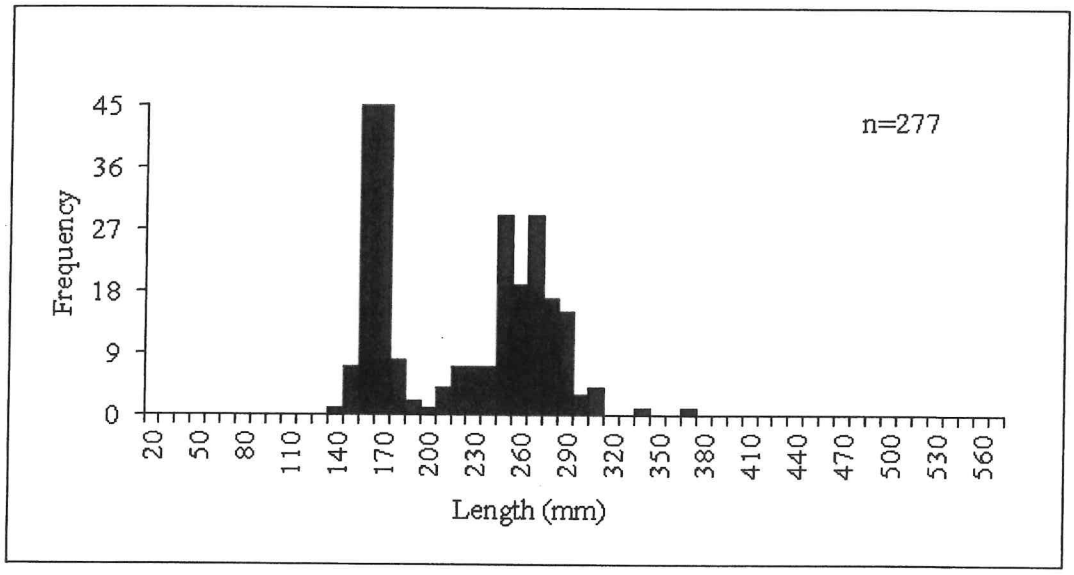

varied minimally from 2004 through 2011. Figure 6 shows that rainbow trout in Georgetown Lake generally averaged approximately 300 mm in length with the lowest average length observed in 2006 of 293 mm and the highest average length observed in 2008 of 316 mm.

Figure 6. Average lengths and 95% confidence intervals for rainbow trout captured during gill net surveys on Georgetown Lake from 2004-2011.



The length frequency histogram for kokanee sampled in 2011 demonstrates the basic size structure of the population (Figure 7). A comparison of length frequency histograms from 2004 through 2011did not demonstrate any substantial changes in the size structure of this population other than a potential reduction in average length . Figure 8 compares average lengths for kokanee captured in Georgetown Lake from 2004 through 2011 and indicates that their average size may have decreased over this time period. In 2004, kokanee averaged 300 mm in length which declined through 2006 to 238 mm. The kokanee average length increased somewhat in 2008 and 2010 to average lengths of 243 and 253 mm and then declined substantially again in 2011 to 221 mm.

Figure 7. Length frequency histogram for kokanee captured during 2011 gill netting on Georgetown Lake.




Due to the relatively large amount of variation observed in average lengths for kokanee, an additional graph of average length greater than 200 mm was also constructed (Figure 9). The 200 mm length delineation was used for this analysis based on an apparent gap between age classes of kokanee at this length in most years in constructed length frequency histograms (Figure 7). A similar trend of declining kokanee length were observed for fish greater than 200 mm with average length being highest in 2004 and 2005 and declining during subsequent years, although the reduction in length was less apparent in 2008 and 2010 (Figure 9).

Figure 8. Average lengths and 95% confidence intervals for kokanee captured during gill net surveys on Georgetown Lake from 2004-2011.

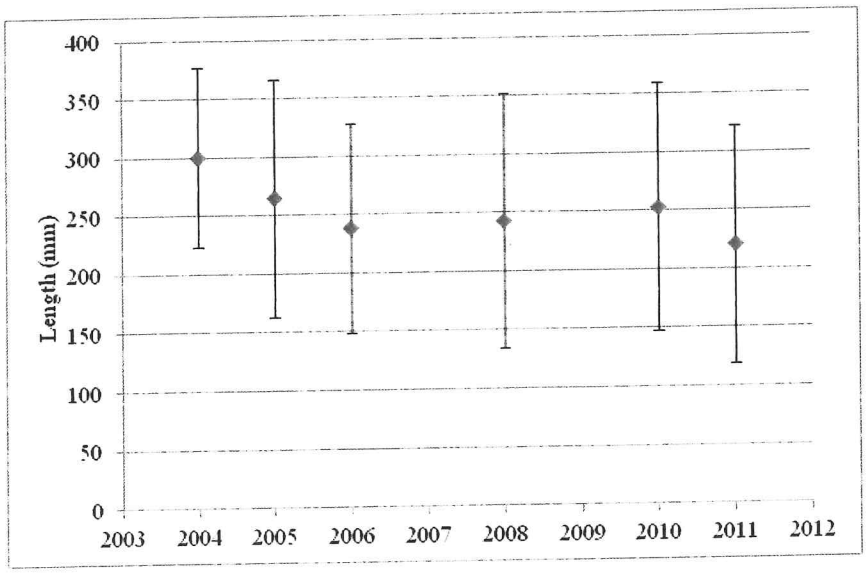
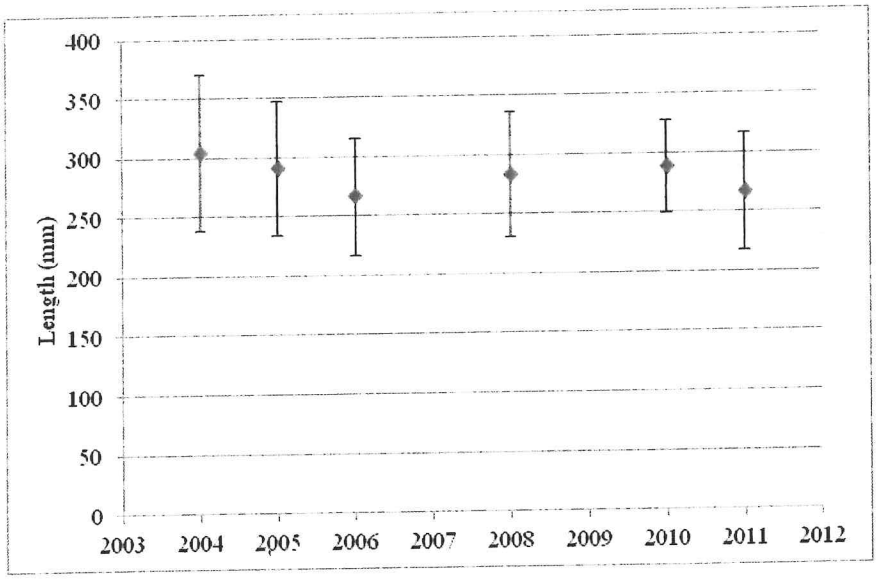
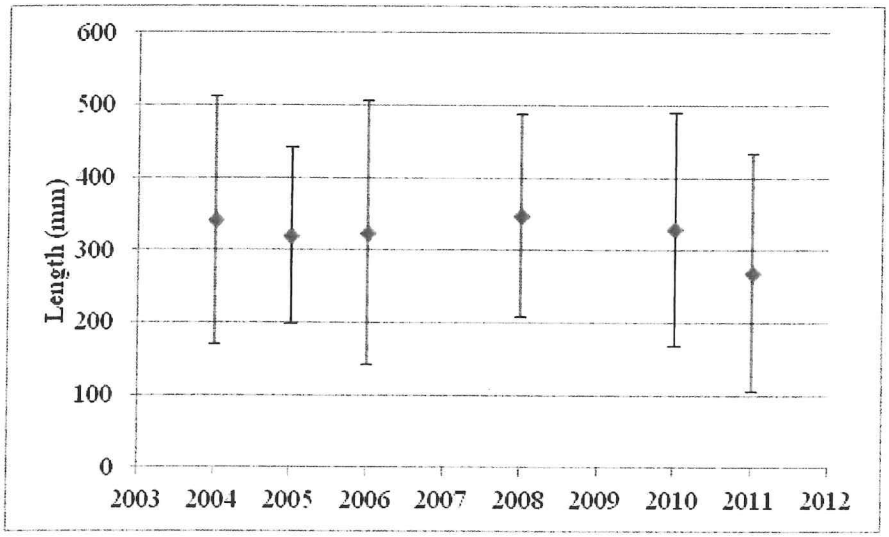



Figure 9. Average lengths and 95% confidence intervals for kokanee greater than 200 mm captured during gill net surveys on Georgetown Lake from 2004-2011.




Very few brook trout were captured during gill netting in 2004 and 2005 with a total of four captured in 2004 and nine in 2005. These low catch rates are likely due to hatchery brook trout being too small during this time period to be captured by gill nets due to brook trout stocking being initiated in 2004. The brook trout that were caught were likely larger wild fish. Winter creel survey data indicates that wild brook trout comprised only a small portion of the fishery prior to these stocking efforts. The shift in the number of hatchery brook trout captured should be kept in mind when comparing the size structure of this population from 2004 through 2011 (Figure 10).

Figure 10. Average lengths and 95% confidence intervals for brook trout captured during gill net surveys on Georgetown Lake from 2004-2011.




Brook trout averaged between 322 and 341 mm in length from 2004 to 2006 when the sample likely consisted of mainly wild and non-mature hatchery fish (Figure 10). Interestingly, the average length of brook trout in the following sampling years of 2008 and 2010 were relatively similar with these fish averaging 349 mm and 330 mm, respectively. A substantial decline in average length was observed in 2011 when the average length of brook trout sampled was 270 mm. A comparison of length frequency histograms for brook trout from 2008-2011 indicate the reduction in average size in 2011 appears to be due to the loss of larger sized fish (Figure 11). The loss of larger fish is particularly evident when comparing the number brook trout captured that were greater than 400 mm in 2008 and 2010 versus 2011 (Figure 11).

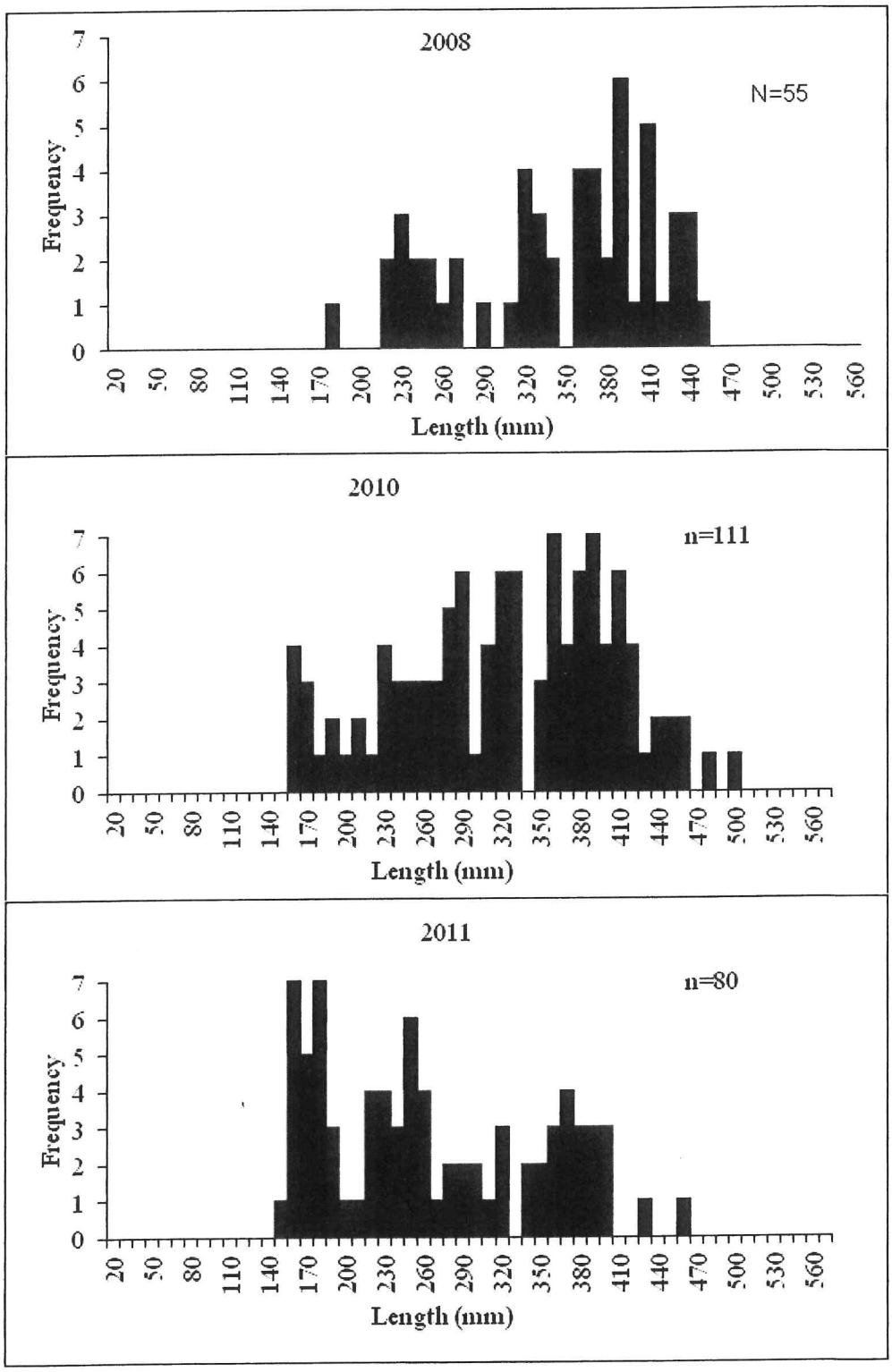
**Winter Creel Survey**

***2010 Results***

A winter creel survey was completed at Georgetown Lake in January 2010 with interviews being conducted between January 20th and January 31st. Eight creel survey days were completed in this time period including six weekdays and two weekend days. A total of 307 angler interviews were completed accounting for approximately 1042.3 angler hours on Georgetown Lake. Of the 307 angler interviews completed, 98.4% of the interviews were completed on anglers residing in Montana.

During this survey, both rainbow trout and kokanee were measured and a subsample weighed, to assess size structure and growth of these species. Brook trout were not measured or weighed as the 2010 fishing regulations required that anglers release brook trout. Thus, no length or weight data is available through the 2010 winter creel for this species. A total of 301 rainbow trout were observed and measured by the creel clerk. These fish averaged 349 mm (st. dev. = 51.9) in length and a length frequency histogram that demonstrates the size structure is presented in Figure 12. A subsample of rainbow trout were also weighed and these fish averaged 430 g

Figure 11. Length frequency histograms for brook trout captured during gill netting from 2008 through 2011 on Georgetown Lake.



(st. dev. = 173 g). A comparison of current data to historical data is provided for rainbow trout, kokanee, and brook trout in the *historical results* section.

A total of 583 kokanee were captured by anglers interviewed in 2010 and a sub-sample of 537 of these were measured. These fish averaged 238 mm (st. dev. = 27.6) and a length frequency histogram which demonstrates the size structure of the population is presented in Figure 13. A slightly smaller subsample of 419 kokanee were weighed and these fish averaged 129 g (st. dev. = 40.9).

Catch rates calculated for rainbow trout, kokanee, and brook trout captured by anglers during the winter creel survey conducted in 2010. Kokanee were the most routinely captured fish with 0.71 fish caught per angler hour (Table 1). Rainbow trout catch rates were only slightly lower at 0.63 fish caught per angler hour. Brook trout were caught at a much lower rate than rainbow trout and kokanee with approximately 0.03 fish caught per angler hour. All species demonstrated substantial variability in catch rates with relatively large standard deviations and wide 95% confidence intervals for angler catch rates (Table 1).

Figure 12. Length frequency histogram of rainbow trout measured during a winter creel survey conducted in 2010.

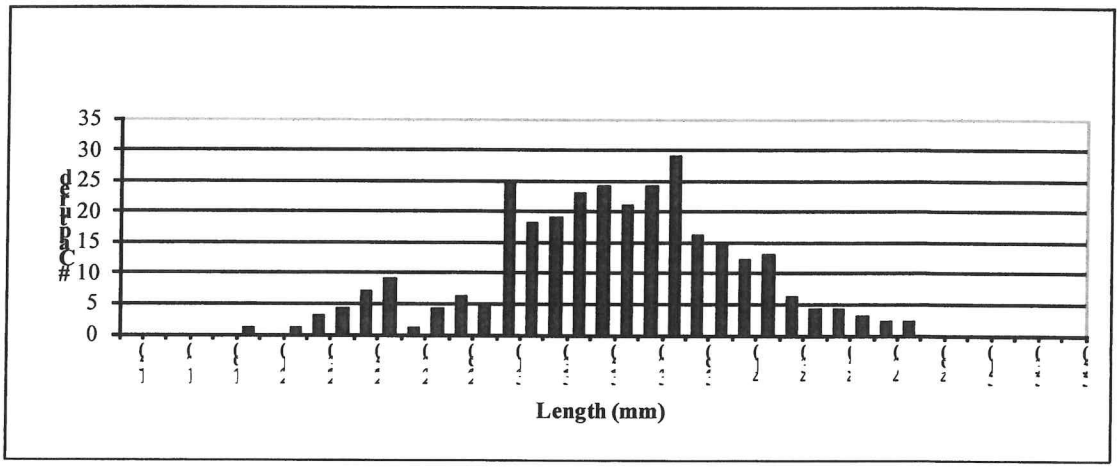


Figure 13. Length frequency histogram of kokanee measured during a winter creel survey conducted in 2010.

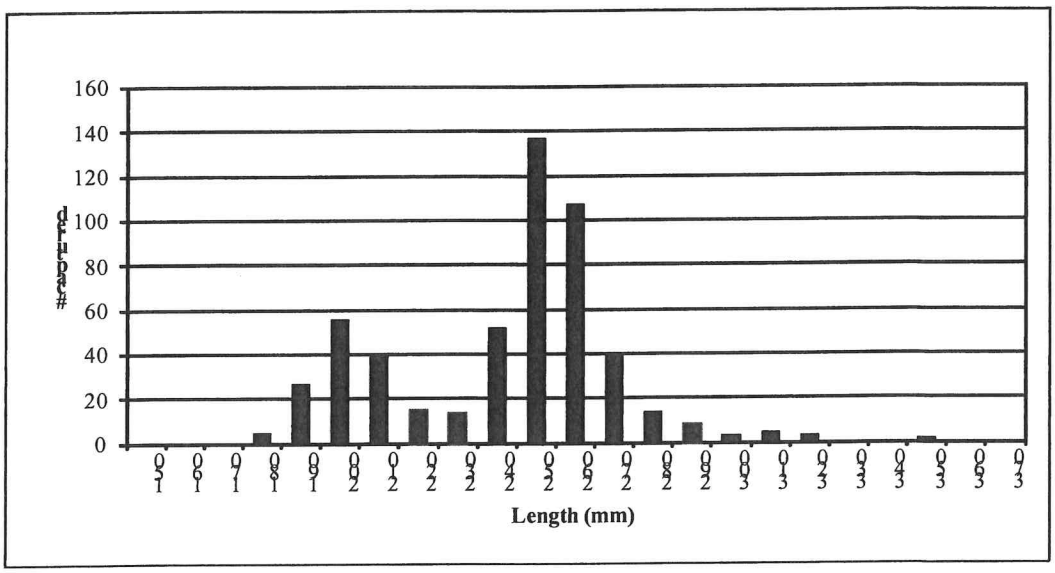



Table 3. Angler catch rate and associated summary statistics from the 2010 winter creel survey for the three main game species sought after by anglers at Georgetown Lake.

| Species | Total Caught | Catch rate (# caught per hr) | Standard Deviation | 95% Confidence Interval |
|---|---|---|---|---|
| Rainbow trout | 574 | 0.63 | 0.31 | 0.03 - 1.23 |
| Kokanee | 583 | 0.71 | 0.45 | 0 - 1.59 |
| Brook trout | 31 | 0.03 | 0.02 | 0 - 0.06 |

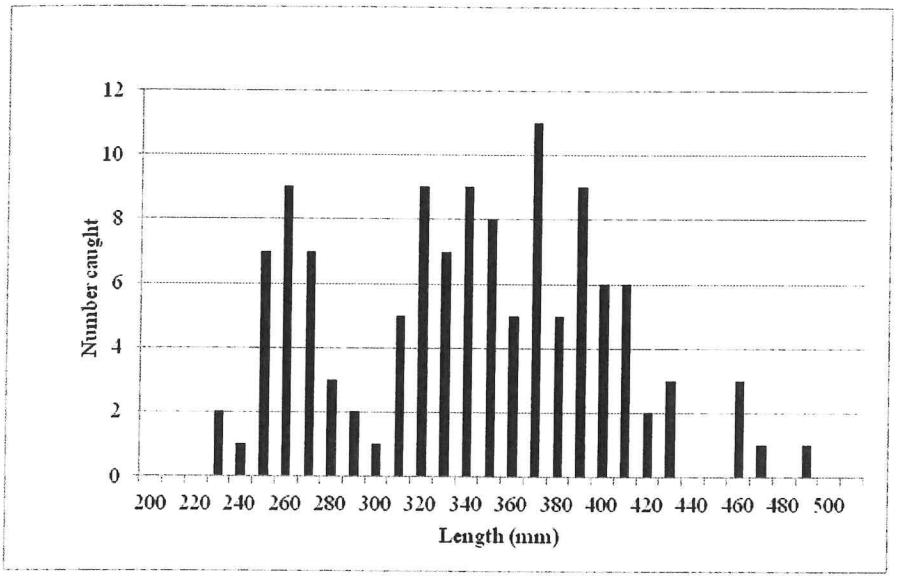
***2012 Results***

A winter creel survey was completed at Georgetown Lake in January 2012 with interviews being conducted between January 22nd and January 31st. Seven survey days were completed in this time period including five weekdays and two weekend days. A total of 177 angler interviews were completed accounting for about 590.5 angler hours. Of the 177 angler interviews completed, 98.9% were residents of Montana.

During this survey, rainbow trout, kokanee and brook trout were measured and a subsample weighed, to assess size structure and growth of the population. A total of 122 rainbow trout were observed and measured. These fish averaged 345 mm (st. dev. = 59.5) in length and a length frequency histogram which demonstrates the size structure of the population is presented in

Figure 14. A subsample of rainbow trout were also weighed and these fish averaged 436 g (st. dev. = 231). A comparison of current data to historical data for rainbow trout, kokanee and brook trout is provided in the following *historical results* section.

Figure 14. Length frequency histogram of rainbow trout measured during a winter creel survey conducted in 2012.




A total of 368 kokanee were observed and measured in 2012. These fish averaged 230 mm in length (st. dev. = 26.8) and a length frequency histogram which demonstrates the size structure of the population is presented in Figure 15. A subsample of 285 kokanee were weighed and these fish averaged 112 g (st. dev. = 33.3). A total of only 17 brook trout were observed and measured in 2012. Brook trout were able to be measured in 2012 due to a regulation change in 2011 that allowed anglers to harvest two brook trout as part of their five fish limit. These fish averaged 346 mm in length (st. dev. = 58.4). A subsample of 16 brook trout were weighed and these fish averaged 458 g (st. dev. = 260.3).

Angler catch rates were calculated for rainbow trout, kokanee and brook trout observed during the winter creel survey conducted in 2012. In 2012, rainbow trout were the most routinely captured fish at 0.71 fish caught per angler hour (Table 2). Kokanee catch rates were only slightly lower at 0.61, fish caught per angler hour. Brook trout exhibited substantially lower catch rates than rainbow trout and kokanee with approximately 0.04 fish caught per angler hour. All species demonstrated substantial variability in catch rates with relatively large standard deviations and wide 95% confidence intervals (Table 2).

Figure 15. Length frequency histogram of kokanee salmon measured during a winter creel survey conducted in 2012.

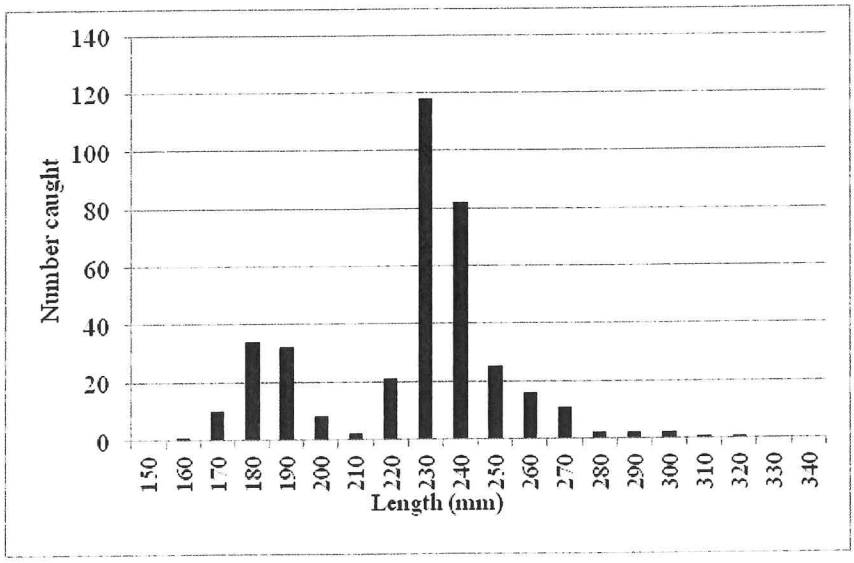



Figure 16. Length frequency histogram of brook trout measured during a winter creel survey conducted in 2012.

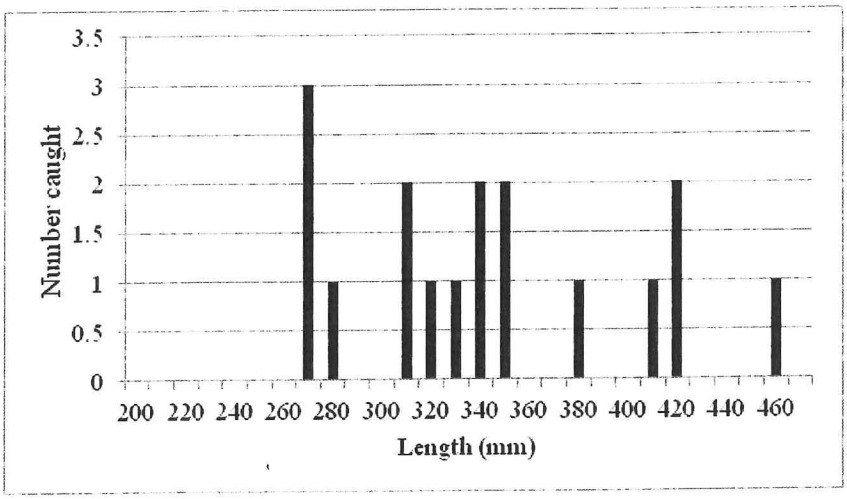


Table 4. Angler catch rates and associated summary statistics from the 2012 winter creel survey for the three main game species sought by anglers at Georgetown Lake.

| Species | Total Caught | Catch rates (# caught/hr) | Standard Deviation | 95% Confidence Interval |
|---|---|---|---|---|
| Rainbow trout | 279 | 0.71 | 0.59 | 0 - 1.87 |
| Kokanee | 414 | 0.61 | 0.42 | 0 - 1.43 |
| Brook trout | 27 | 0.04 | 0.02 | 0 - 0.08 |

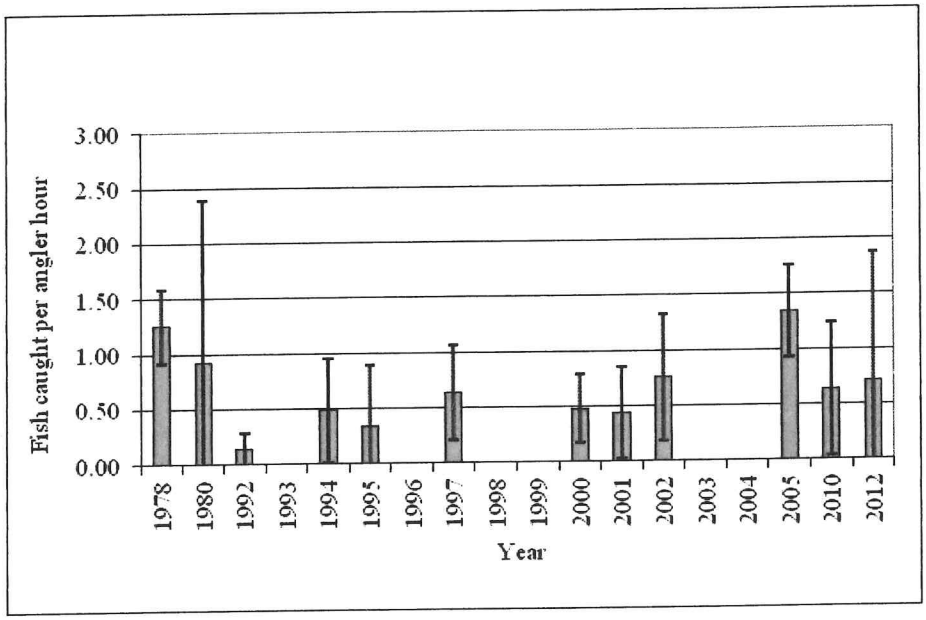
***Historical results and comparison***

Winter creel survey data have been collected for many years on Georgetown Lake. Winter creel data from 1976 to 2012 are analyzed and presented in this report representing trends over a 36 year period for this fishery. Both angler catch rates and length data are summarized in this section to provide a basic assessment of the fishery over this time period and to assess possible changes in this fishery. As stated in the methods, the amount and type of data collected varied by year preventing some analyses from being completed for certain years (i.e. length data not available for some years and angler catch rates not available for others).

*Rainbow trout*

Angler catch rates of rainbow trout appear to have varied substantially based on winter creel surveys completed during the past 34 years (Figure 17). Rainbow trout catch rates have generally been between 0.5 and 1.0 fish per hour, but have been observed as low as 0.14 fish per hour in the 1992 and as high as 1.34 fish per hour in 2005 (Figure 17). Catch rates calculated for 2005 through 2012 are relatively high compared to previous years, suggesting that rainbow trout abundance was high during these years. However, a significant amount of variability is present in this data set through all time periods. Figure 17 includes 95% confidence intervals around rainbow trout catch rates calculated during the winter creel surveys and these confidence intervals are quite wide.

Figure 17. Angler catch rates and 95% confidence intervals for rainbow trout in Georgetown Lake from 1978 through 2012. Years with no data represent years when no winter creel surveys were completed.




Mean lengths of rainbow trout observed during winter creel surveys from the late 1970's through 2012 are provided in Figure 18. Comparison of mean length suggests that it has oscillated over the period of record with mean length being as low as 248 mm in 1978 and as high as 376 mm in 2003. Mean lengths were relatively high during the 2000's (higher than any of the two previous decades) with the 2010 and 2012 mean length estimates being in the upper range of mean lengths observed since the mid 1980's (Figure 18). Rainbow trout average lengths appear to be particularly low in the late 1970's and early 1980's.

*Kokanee*

Similar to rainbow trout, kokanee catch rates have also varied considerably from 1978 to 2012 based on winter creel survey data. Kokanee catch rates have generally been between one and four fish per angler hour and have ranged from as low as 0.61 fish per hour in 2012 to as high as 4.71 fish per hour in 2005 (Figure 19). Catch rates appeared to increase during the early 2000's compared to previous years and subsequently dropped in the 2010 and 2012 to substantially lower values than observed in previous years. Significantly more data variability was observed for kokanee catch rates than even rainbow trout, with 95% confidence intervals being proportionally wider than observed for rainbow trout (Figure 19).

Figure 18. Mean length and 95% confidence intervals for rainbow trout measured during winter creel surveys completed on Georgetown Lake from 1976 to 2012.

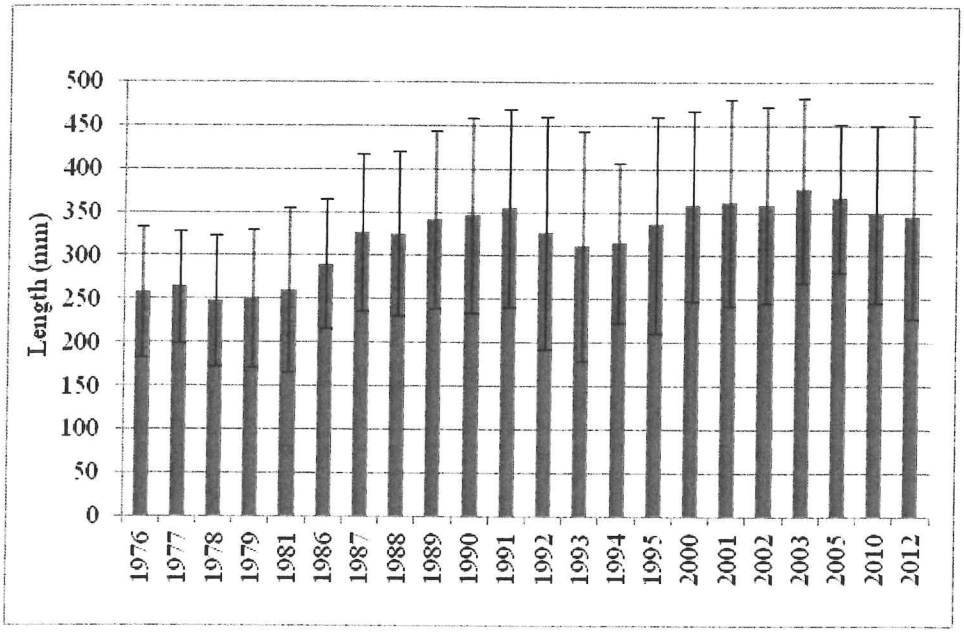
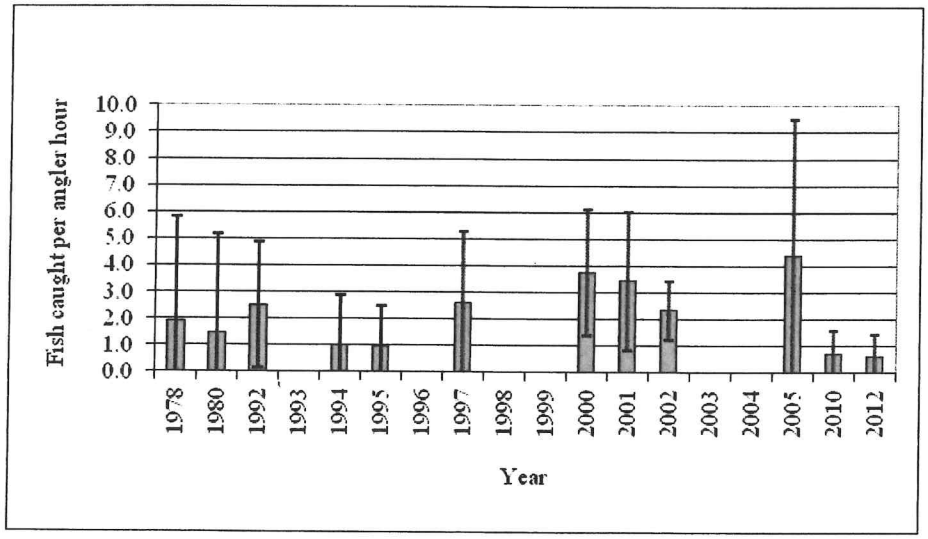
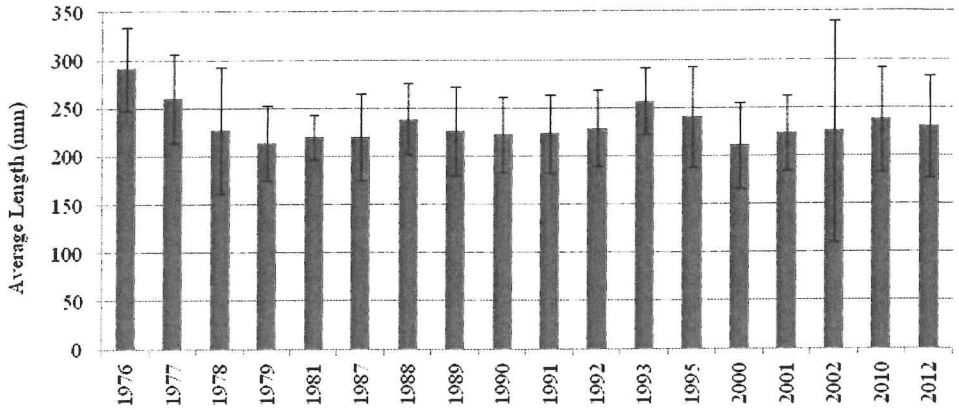



Figure 19. Angler catch rates and 95% confidence intervals for kokanee salmon in Georgetown Lake from 1978 through 2012. Years with no data represent years when no winter creel surveys were completed.




Length data has also been collected for kokanee throughout the period of record for winter creel survey and comparison of average lengths collected during this period are provided in Figure 20. A comparison of average lengths from 1978 to 2010 indicates that it has varied throughout this period with the lowest being measured in 2000 at 211 mm and the highest in 1978 at 291 mm.

Figure 20. Mean length and 95% confidence intervals for kokanee salmon measured during winter creel surveys completed on Georgetown Lake from 1976 to 2012.




Average lengths for kokanee caught appear to generally range from 210 to 250 mm. The average length of kokanee caught by anglers in 2010 and 2012 was 238 and 230 mm respectively, which is within the range typically observed for this population since the late 1970's (Figure 20).

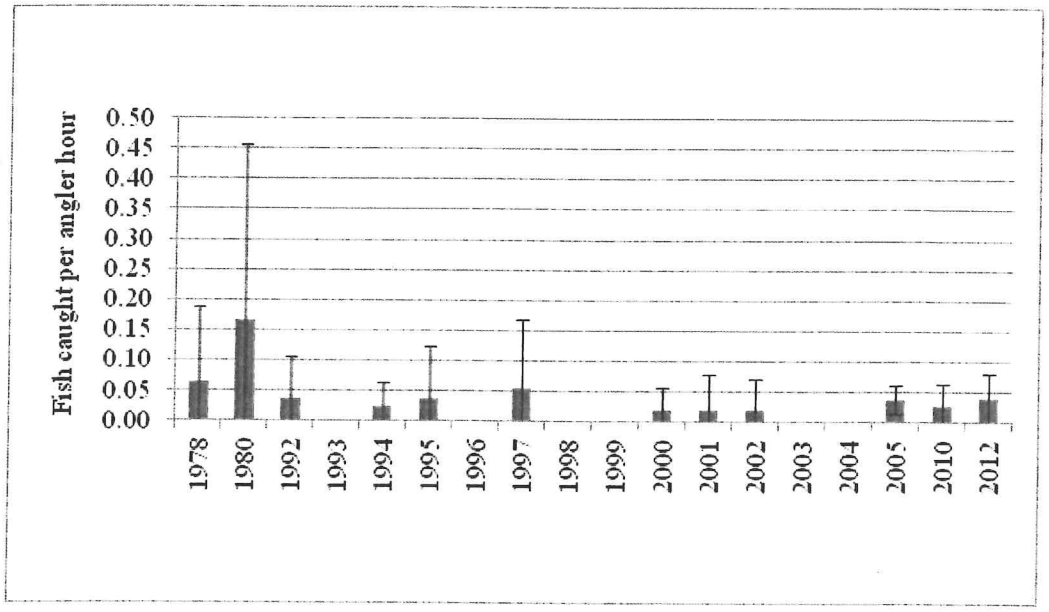
*Brook trout*

Brook trout represent a historically important component of the Georgetown Lake fishery. Brook trout catch rates observed during the winter creel survey have been low at Georgetown Lake with catch rates typically being below 0.05 fish per angler hour (1 fish caught for every twenty hours of angling; Figure 21). Catch rates were higher from 1978 through 1997 and declined in the early 2000's. Catch rates observed in 2005 through 2012 were about twice as high as observed in the early 2000's, which is likely due to increased brook trout abundance from the hatchery supplementation program initiated in 2004. However, the catch rates observed in 2010 and 2012 did not increase proportionally to the increases observed in gill net catch rates (Figures 4 and 21). Winter creel catch rates for brook trout again demonstrated very high variability with the 95% confidence intervals being quite wide (Figure 21). This variability in catch rates appeared to be proportionally greater than was observed for both rainbow trout and kokanee.

## Discussion

Gill netting completed on Georgetown Lake from 2004 through 2011 has provided a basis for consistently monitoring this important fishery over time to ensure that a quality fishery is maintained in this system for years to come. The results of this work provide a basic understanding of the overall fish community including species composition and general abundance of native non-game species. This work also provides additional data for monitoring the three primary game species in the system: rainbow trout, kokanee, and brook trout. Winter creel survey data has been collected on Georgetown Lake for many years and will likely serve as a tool for managing the fishery in the future. Creel surveys measure the success of anglers, the ultimate goal of management. However, analysis of the Georgetown Lake winter creel survey

Figure 21. Angler catch rates and 95% confidence intervals for brook trout in Georgetown Lake from 1978 through 2012. Years with no data represent years when no winter creel surveys were completed.




data indicates that catch rates for individual species has a large amount of variability. Creel survey data is also affected by the bias of angler preference and the susceptibility of various species and sizes of fish to angling. Fortunately, gill netting is not affected by these biases. The comparison of size structure based on the creel survey data does appear to provide insights into the fishery particularly over a long period of time.

Both gill net and winter creel survey data demonstrate positive stable trends in the rainbow trout fishery in Georgetown Lake. Gill net catch rates have been consistent from 2004 through 2011 suggesting that rainbow trout abundance has remained relatively constant over the last decade, with their abundance potentially improving in recent years. Gill net catch rates for rainbow trout ranged from 20 to 29 fish per net night which is at or above gill net catch rates for other regionally important rainbow trout fisheries including Clark Canyon Reservoir, Browns Lake, and Canyon Ferry Reservoir (before the illegal introduction of walleye into Canyon Ferry Reservoir) (Roberts et al. 2011, M Jaeger, pers. comm., L. Knotek, pers. comm.). These reasonably good catch rates at Georgetown Lake in comparison to other regional fisheries suggests that rainbow trout abundance is high enough in Georgetown Lake to provide an excellent rainbow trout fishery. Similarly, winter creel survey catch rates have been quite stable throughout the last three decades. The size structure comparisons for rainbow trout using both gill net and winter creel survey data also indicate that the size structure has changed very little from those observed over the past 20 years. Based on these results, it appears that no changes in fisheries management (stocking rates, fishing regulations, etc…) are necessary for rainbow trout in Georgetown Lake at this time.

Interestingly, a change in size structure of rainbow trout in the mid 1980's does suggest that changes in fish management during this time period may have significantly affected the size

structure of this population. Average lengths for rainbow trout did appear to be particularly low in the early to mid 1980's and was likely due to more liberal harvest regulations that were in place during that time period. The limit on rainbow trout before 1986 was "10 fish up to 10 pounds" which included other trout (i.e. brook trout). During the 1986 fishing season, the regulation became 5 trout of any size including both rainbow and brook trout. This regulation change significantly limited harvest on trout in Georgetown Lake and appeared to improve the average size of rainbow trout. It is suspected that the reduced harvest improved survival of older age classes of rainbow trout which in turn increased the average size of this population.

Gill netting data from 2004-2011 indicate that kokanee abundance has fluctuated throughout this time period with a general trend of increasing abundance. Winter creel survey data is relatively sparse from 2001 through 2012, but based on the years when data was collected (2010 and 2012), catch rates were much lower than were observed during previous years. Due to the size selectivity of angling particularly for kokanee (Rieman and Maeolie 1995), and the high variability associated with the winter creel survey data, it is suspected that the gill netting data more accurately reflects trends in kokanee abundance in Georgetown Lake.

One possible explanation for the reduced angler catch rates observed for kokanee in Georgetown Lake is the reduced size of kokanee in the population. Rieman and Maeolie (1995) found that kokanee catch rates for anglers in several Idaho and Oregon lakes was based on the size structure of the population. They found that as the average size of the population declined, angler catch rates also declined. This reduction in catchability could explain why fewer kokanee have been caught by winter anglers at Georgetown Lake in the past several years. A comparison of the average length of kokanee captured during gill netting indicates that the average size of kokanee has declined, with particularly small fish observed in 2011. The average length of kokanee captured during winter creel surveys in 2010 and 2012 was not proportionally as low as was observed in the gill netting data, but this may be expected due to bias of angling towards catching larger kokanee, making this method less reliable for assessing size structure of kokanee (Rieman and Maeolie 1995). The use of experimental gill nets with multiple mesh sizes limits the bias associated with the size structure of fish caught during gill netting on Georgetown Lake. Further data collection efforts on angler catch rates and the size structure of the kokanee population in Georgetown Lake will be necessary to better understand the interaction of these two variables and its effect on the fishery.

One possible explanation for the reduced size of kokanee in Georgetown Lake may be a reduced number of larger zooplankton in the system. Stafford (2013- attached report) completed plankton tows in Georgetown Lake and compared zooplankton densities to those observed in a previous study. It was found that densities of large copepods and cladocerans were much lower in July of 2010 and 2011 than were observed in 1974. This disparity in zooplankton densities was not as apparent during other summer and fall months, however. Nonetheless, reduced densities of large zooplankton during July could negatively affect kokanee growth, particularly since large zooplankton typically make up a considerable portion of a kokanee's diet (Rieman and Meyers 1992). Further investigation into zooplankton densities in Georgetown Lake may provide a better understanding of why average lengths of kokanee are declining.

Gill net catch rates indicate that brook trout abundance has no doubt improved in Georgetown Lake since 2004. A majority of this improvement is likely due to the hatchery supplementation of brook trout since 2004, which consists of stocking approximately 50,000 brook trout annually.

into the system (Table 1). Significant increases in gill net catch rates were observed in 2006. This coincides with the time period when the 2004 year-class of stocked brook trout were large enough to be effectively captured by gill nets. Further increases in catch rates were observed in 2008, 2010 and 2011, providing further evidence that the fishery is well established. Unfortunately, winter creel survey data is the only long term data set available to assess changes in the abundance of brook trout over the last 30 years. Based on this data, brook trout appear to be returning to similar numbers observed in the late 1970's and 1980's, but did not appear to demonstrate the magnitude of increase observed in the gill netting data.

Due to the decline in the number of brook trout caught by anglers in Georgetown Lake during the 1990's and early 2000's, a catch and release regulation was implemented in 2004 in attempt to improve this population. This action was implemented concurrently with the initiation of hatchery supplementation of this population. Based on their numbers improving, the catch and release regulation for brook trout in Georgetown Lake was removed in spring 2011 to allow anglers to harvest some brook trout. The regulation change that was proposed and ultimately accepted allows anglers to keep two brook trout of any size as part of their five fish limit. The increase in brook trout harvest was evident during the 2012 winter creel survey when several anglers were observed keeping brook trout. A slight decrease in gill net catch rates was observed for brook trout in 2011 with catch rates dropping to 4.4 fish per net night from the 6.2 fish per net night observed in 2010 (Figure 4). Comparisons of length frequency histograms for brook trout from 2008 and 2010, to those from 2011 also show a reduction in the number of brook trout captured greater than 400 mm (Figure 11). These changes in gill net catch rates and alterations of size structure may be due to additional harvest that occurred on this population due to this regulation change, but is unclear at this time due to the limited amount of data that is available. Brook trout in Georgetown Lake do provide a trophy fishery that is not available in many lakes or reservoirs in Montana or the western United States. Thus, providing trophy brook trout (>400 mm (16")) should be a management goal for this fishery. If this fishery continues to show reduced numbers of fish greater than 400 mm, regulation changes should be considered that maintain a trophy size structure for this population. Further data collection will be necessary to assess whether these changes in size structure and abundance are truly occurring.

Gill netting in Georgetown Lake was also initiated to monitor the expansion of lake trout and to detect potential illegal introductions into the system. Fortunately, no new illegal introductions have been observed in Georgetown Lake since netting began in 2004. Lake trout have been sampled in the lake with one being captured in 2005 and another in 2010. Both of these fish were large mature adults (718 and 801 mm) with no smaller juvenile fish being observed, suggesting that natural reproduction of lake trout is likely not occurring in Georgetown Lake at this time. It is suspected that the occurrence of lake trout in Georgetown Lake is due to its seasonal connectivity to Silver Lake via Hardtla Ditch. Silver Lake does support an abundant population of lake trout (Berg 2009). Fortunately, the lack of summer thermal stratification and the apparent lack of lake trout spawning habitat likely limits the potential for lake trout expansion in Georgetown Lake. The only other species captured in Georgetown Lake of concern was the one northern pikeminnow captured in 2008. While northern pikeminnow are native to the Flint Creek drainage, it is unlikely that they were native to the upper portion of the drainage at the current location of Georgetown Lake. Their absence in this portion of the drainage is likely due to the presence of a historic barrier falls located just downstream of Flint Creek Dam. Northern pikeminnow are abundant in other reservoirs in western Montana and can maintain a

large proportion of the biomass in these systems (Liermann and Tholl 2004). The impact they would have on the biomass of other species should they become abundant in Georgetown Lake is unknown, but their status should be monitored and assessed via future gill netting.

Analysis and comparison of gill netting data in this report indicates that this technique will be quite valuable for monitoring Georgetown Lake into the future. Gill netting provides a relatively un-biased sampling method that allows for a more accurate assessment of fish abundance and also size structure of these populations. The variability associated with catch rates was also much lower than was observed for winter creel surveys which will allow for earlier detection of changes in this fishery and higher confidence in the monitoring results. While gill netting has only been completed on Georgetown Lake since 2004, a solid baseline is now established that will allow for assessment of these populations in the future.

Future gill netting efforts should follow the same methods that were completed from 2005-2011. Analysis of the gill netting data indicates that the current number of nets provides a sufficient sample size for accurate assessment of both abundance and the size structure of these populations. The three additional nets added in 2005 did increase brook trout catch substantially and should be continued into the future to monitor this population. The current schedule of netting every two years appears adequate, unless substantial changes in a population are observed that need to be assessed.

Analysis of winter creel data in this report indicates that this method has some benefits and some short comings. The primary benefit of monitoring via the winter creel survey is that there is a significant long term data set available. This report summarizes creel survey data from as early as 1976 and includes data collected through 2012, providing a long period of record by which to assess the fishery. Creel surveys also monitor the most important component of a recreational fishery- anglers catching and harvesting fish. One of the short comings of this data is large amounts of variability in angler catch rates which makes assessing trends in fish abundance difficult. Creel surveys also have bias associated with selectivity of angling in terms of the size and species of fish caught. Nonetheless, winter creel surveys will likely play a role in managing Georgetown Lake at least in the near term due to the extensive data set that is available versus the relatively short term data set available for gill netting.

One possible improvement that could be made to the winter creel survey at Georgetown Lake is the determination of species that individual anglers are targeting. In general, trout anglers and salmon anglers tend to fish in different locations and also different habitats in Georgetown Lake. Ice fishermen targeting trout commonly fish shallower waters near shore while anglers targeting salmon commonly fish deeper waters, further from shore. By stratifying the data based on species preference of the anglers, the variability in catch rates may be able to be reduced. One difficulty with this method is that many anglers do fish for both species and an additional category of "general trout and salmon" anglers would need to be included. Unfortunately, the historic winter creel survey data collected at Georgetown Lake does not include species targeted as part of the angler interviews and thus cannot be stratified in this manner. Anglers were asked which species they were targeting during the 2010 and 2012 creel surveys. Another possible improvement that should be investigated for the winter creel survey is increasing the number of interviews. Increasing the number of interviews would increase the sample size which may reduce the variability associated with the data. Unfortunately, increasing the number of interviews enough to reduce the variability in this data set will require a significantly larger

effort than has been exerted in the past. This amount of effort may not be possible due to the time and labor needed to sample additional days.

**Future Management Recommendations**

*Rainbow trout*- The rainbow trout population and angler catch rates have been stable through the years at Georgetown Lake providing a quality, harvest oriented fishery. The management recommendation is to maintain current stocking rates and harvest limits on this population.

*Kokanee*- Gill netting data indicates that kokanee abundance has increased from 2006 to present in comparison to catch rates observed in 2004 and 2005. The average size of kokanee based on gill netting data appears to have dropped concurrent with the increase in abundance observed from 2006-2011 which is consistent with density dependent growth patterns that are commonly exhibited by kokanee (Rieman and Meyers 1992). Comparison of winter creel survey trends over a longer period of time indicate that angler catch rates have dropped in recent years whereas average length has remained relatively stable. However, average length comparisons derived from creel survey data are likely biased due to size related catchablility observed for kokanee (Rieman and Maeolie 1995). Increased kokanee abundance, reduced size, and reduced catch rates by anglers all suggest an overabundance of kokanee in the lake. There is currently a no limit regulation on kokanee to encourage their harvest and improve the size of kokanee in Georgetown Lake. This regulation was implemented many years ago and will likely only maintain the current condition of this population. Other management options are to allow the population to cycle naturally or to pursue a reduction program via either increased predation or mechanical removal. Increasing brook trout abundance may provide additional predation on kokanee in Georgetown Lake particularly as this population continues to expand. Further assessment of kokanee predation by brook trout is needed, but it is recommended that the brook trout population be managed in a way that increases the abundance of large brook trout that could potentially exert additional predation pressure on kokanee. This will include further assessment of the size structure of the brook trout population to ensure that adequate numbers of 400 mm and larger brook trout are present in the system and also assessment of current stocking rates to determine whether increased stocking rates can improve brook trout abundance without reducing growth rates of this population.

*Brook trout*- Both gill netting and winter creel survey data indicate that hatchery supplementation of brook trout has been successful at restoring the brook trout fishery in Georgetown Lake. Recent gill netting data suggest that the size structure of this population may be changing after the implementation of a more liberal harvest regulation with reduced numbers of large fish being observed. Additional monitoring will be necessary to further investigate whether this change in size structure is occurring. If future work suggests that larger brook trout are being removed from the population, more restrictive regulations should be considered to serve the dual purpose of providing a trophy brook trout fishery and exerting additional predation pressure on the kokanee population. Stocking rates should also be assessed to determine whether increased stocking rates could improve densities without reducing the number of large brook trout in the population. Brook trout predation on kokanee should be investigated to determine whether this predation is truly occurring.

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