Lake Granby

Fishery Management Report

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Introduction

Lake Granby, approximately 7,250 surface acres when full, is one of the largest coldwater reservoirs in the state. It is the main storage reservoir in the west slope portion of the Colorado-Big Thompson Project which supplies water to the northern Front Range through the Adams Tunnel at Grand Lake. It is a focal point of the Grand County tourism economy and offers many amenities. Recreational access is managed by the U.S. Forest Service as part of the Arapaho National Recreation Area.

The recreational fishery of Granby is dominated by Lake Trout (aka Mackinaw) and hosts the highest density of the species that has been documented in Colorado. Kokanee Salmon have been stocked in Granby since 1951 to provide recreational opportunity, a prey base to produce trophy Lake Trout, and spawning adult Kokanee are captured annually to provide eggs for restocking. Rainbow Trout of various sizes are also stocked and there is a moderate density of self-sustaining Brown Trout. Suckers and Mottled Sculpin are also present.

Lake Granby also contains a dense population of Mysis shrimp, which are an excellent prey source for smaller (<24”) Lake Trout. The high density of Lake Trout is a result of the availability of this prey base. However, the Mysis compete with Kokanee salmon and small trout for their prey base of zooplankton, making the lake less productive for those species. Therefore, the dominant challenge to managing the recreational fishery at Granby is to maintain enough prey to produce quality- and trophy-sized Lake Trout while at the same time maintaining angling opportunity for other species.

Figure 1. Lake Granby

Angling Regulations

a. The bag and possession limit for Lake Trout is four fish.
b. From January 1 through August 31, the bag and possession limit for trout (except Lake Trout) and Kokanee salmon is four fish, singly or in aggregate.
c. From September 1 through December 31, the bag and possession limit for trout (except lake trout) is four fish, singly or in aggregate.
d. From September 1 through December 31, the bag and possession limit for Kokanee salmon is 10 fish.
e. Snagging of Kokanee salmon is permitted in Lake Granby only from September 1 through December 31 except snagging is prohibited in Columbine Bay from the inlet of Twin Creek upstream.
f. Gaffs and tail snares are prohibited.
g. Ice fishing shelters must be portable.
h. In Columbine Bay from the inlet of Twin Creek upstream, fishing is prohibited from October 15 through November 30.

The purpose of regulation (a) above is to encourage harvest of Lake Trout, allowing for four to be harvested separate from the aggregate bag limit of other species. Due to reasons described above, the Lake Trout fishery in Lake Granby is healthiest when a generous amount of harvest is occurring.

The purpose of regulations (b) - (e) is to allow for a Kokanee snagging season and to increase the bag limit for Kokanee during that time. In recent years those regulations have had limited usefulness due to the poor Kokanee population (discussed below). The purpose of regulation (h) is to protect spawning Kokanee that run up the Colorado River inlet toward Shadow Mountain dam, where CPW harvests eggs annually.

Table 1. Five-year stocking history

	Catchable Rainbow (10")	Fingerling Rainbow (3-5")	Kokanee
2017	59,100	503,000	1,000,000
2018	58,400	506,500	1,100,000
2019	74,500	500,000	1,060,000
2020	70,700	432,000	1,070,000
2021	77,100	500,200	889,000

Stocking

All stocking occurring in Lake Granby is accomplished by the CPW State Fish Hatchery system in coordination with the local biologist.

Rainbow Trout and Kokanee are stocked annually (Table 1). Both catchable-sized and fingerling Rainbows are stocked. Catchable Rainbows are stocked off of the boat ramps several times throughout the season. Prior to 2016, fingerling Rainbows were also stocked from the boat ramps, but beginning in 2016, the stocking location moved to the Colorado River upstream of the reservoir, immediately downstream of Shadow Mountain Dam. The reason for this change was that there appeared to be very little recruitment of fingerling Rainbows stocked by the traditional method at the boat ramps. We hoped that by stocking Rainbows in the river above the reservoir, they would have more time in the river to become acclimated to their surroundings, work their way downstream into the lake at a slower rate, possibly avoid predation in the main body of the lake, and have a better chance at recruiting into the recreational fishery. After six years of pursuing this strategy, evidence of obvious benefits of this practice to the Lake Granby fishery is not strong (discussed below). In addition, the timing of availability of this large of a number of Rainbow eggs to produce fish of the desired size at the ideal time is problematic. In 2022 this number will be reduced to 100,000 while we assess further and explore new and different stocking strategies for subcatchable-sized Rainbows in the future.

Kokanee are stocked in late spring annually into the river below Shadow Mountain Dam, typically during runoff stage. We stock a smaller number in the Dike 3 area of the lake in hopes that some spawning adults will return there, contributing to the recreational fishery in the fall.

Table 2. Dates, lake level, and water temperature at the time of gillnet surveys. Temperature was recorded at the surface when nets were set in the morning.

Year	Dates	Avg. lake elevation	Avg. surface temperature
2011	5/25, 27, 31, 6/1	8253	43.3
2012	5/21 — 24	8263	50.1
2013	5/28, 29, 6/3, 4	8237	50.2
2014	5/27 — 30	8254	50.4
2015	5/18, 20, 22, 26	8274	46.9
2016	5/19, 23, 24, 25	8262	45.5
2017	5/22, 23, 24, 26	8264	47.7
2018	5/21, 22, 23, 29, 30	8271	51.6
2019	5/20, 22, 24, 29, 31	8254	44.6
2020	5/19, 20, 26, 27, 28	8269	50.8
2021	5/20, 21, 25, 27	8256	47.8

Fish Population Gillnet Surveys

In 2011, we adopted a gillnet survey strategy with the goal of producing a relatively thorough picture of Lake Trout population dynamics in Granby. We set nets for six hours apiece at randomly located sites throughout the lake (Figure 3). In 2011 and 2012 we netted 30 locations and beginning in 2013 we increased the number to 32 nets across four days. The survey has occurred annually around the third or fourth week in May. The reason for this timing is that the period after ice-off but before thermal stratification seems to be a part of the year in which Lake Trout are relatively evenly distributed throughout the lake. Also, when water temperatures are cool and the lake is not stratified, incidental mortality from gillnet capture is lower. This approach provides satisfactory statistical power to

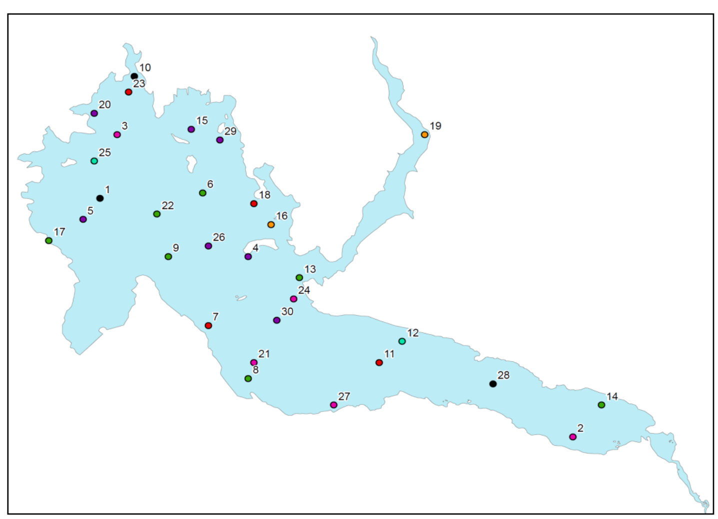

Figure 3. Some of the 32 gillnet locations used in the survey.

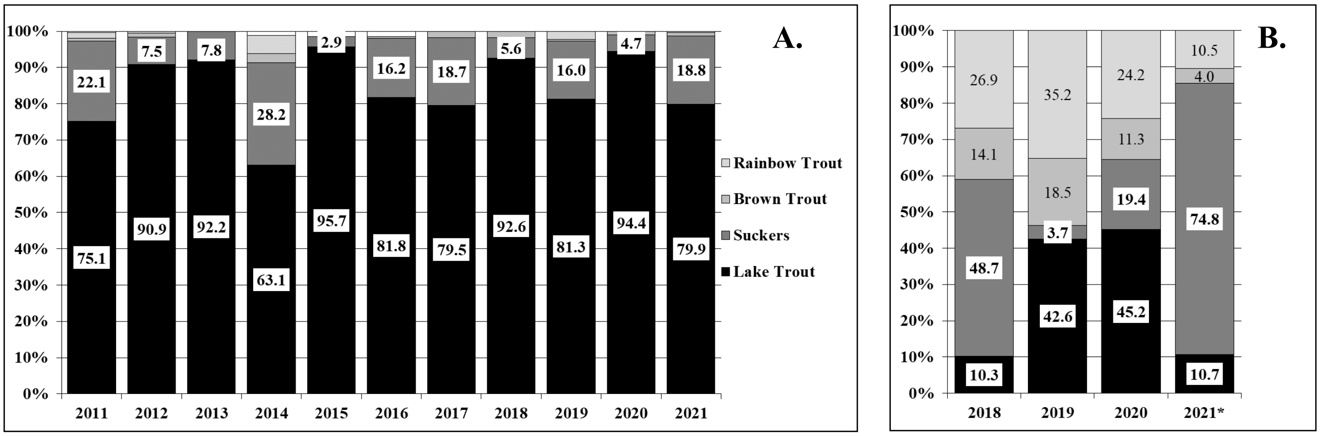

Figure 3. Species composition in gillnet surveys, Lake Granby 2011-2021. (A) at left are the in-lake net locations designed to monitor the Lake Trout population. (B) at right are the 8 shoreline net locations that were established in an attempt to more closely monitor Rainbow Trout stocking success. In 2018-2020, those 8 nets were fished for six hours during the day simultaneous with the main survey. *In 2021, the 8 shoreline nets were fished overnight in an attempt to increase sample size of Rainbow and Brown Trout.

detect changes in the Lake Trout population over time. In 2018, we added eight net sets along the shoreline, roughly evenly distributed around the lake, to attempt to monitor the success or failure of fingerling Rainbow Trout stocking and to better observe trends in the Brown Trout and sucker populations. Results of those shoreline net sets are analyzed separately from the 32 original nets that are focused on Lake Trout monitoring.

Lake Trout are the overwhelmingly dominant species caught in the 32 traditional nets, averaging 84% of the total catch across the 11 years of surveys (Figure 3A). The majority of variation in sucker catch is explained by catch rates in a single net (R20, near the Stillwater Creek inlet) which has varied in its sucker catch between 4 and 41 fish.

The difference in species composition in the 8 shoreline nets suggests that Brown and Rainbow Trout and suckers are confined to a narrow band of habitat close to the shorelines at the time these surveys are conducted (Figure 3B). This is typical of these species and expected, but appears to be more pronounced in Granby than other lakes (for example, see CPW Fishery Management Reports for Williams Fork and Green Mountain Reservoirs). This is probably due to the very high density of Lake Trout in the lake. The high variability in species composition of these shoreline nets give them limited utility.

Kokanee are notoriously difficult to capture in gillnets, and are only incidentally captured in these surveys. We conduct annual SONAR surveys to monitor trends in the Kokanee population.

The size distribution of Rainbow Trout captured in these surveys is typically narrow and the vast majority of fish captured are obviously hatchery-origin catchable-sized fish stocked that year. Evidence of recruitment of the stocked fingerlings is scarce (Figure 4). Therefore, we plan to explore different stocking strategies for subcatchable fish in the future.

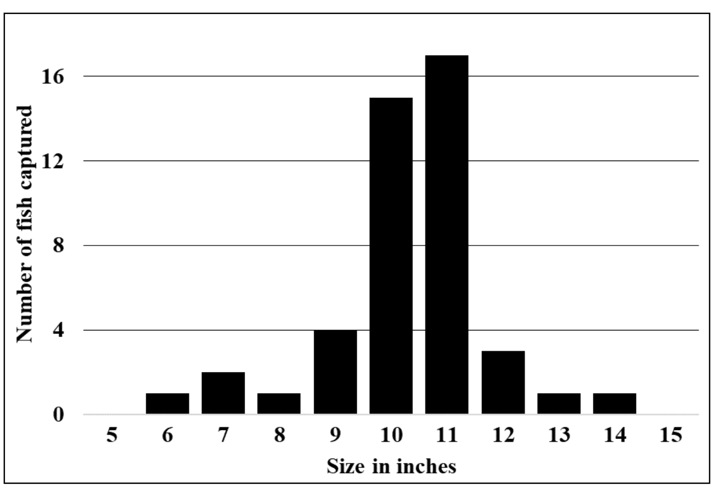

Figure 4. Size distribution of Rainbow Trout captured in overnight shoreline gillnets, Lake Granby 2021.

Figure 5. The largest lake trout from 2014. 39.7” long, 27.8 lbs.

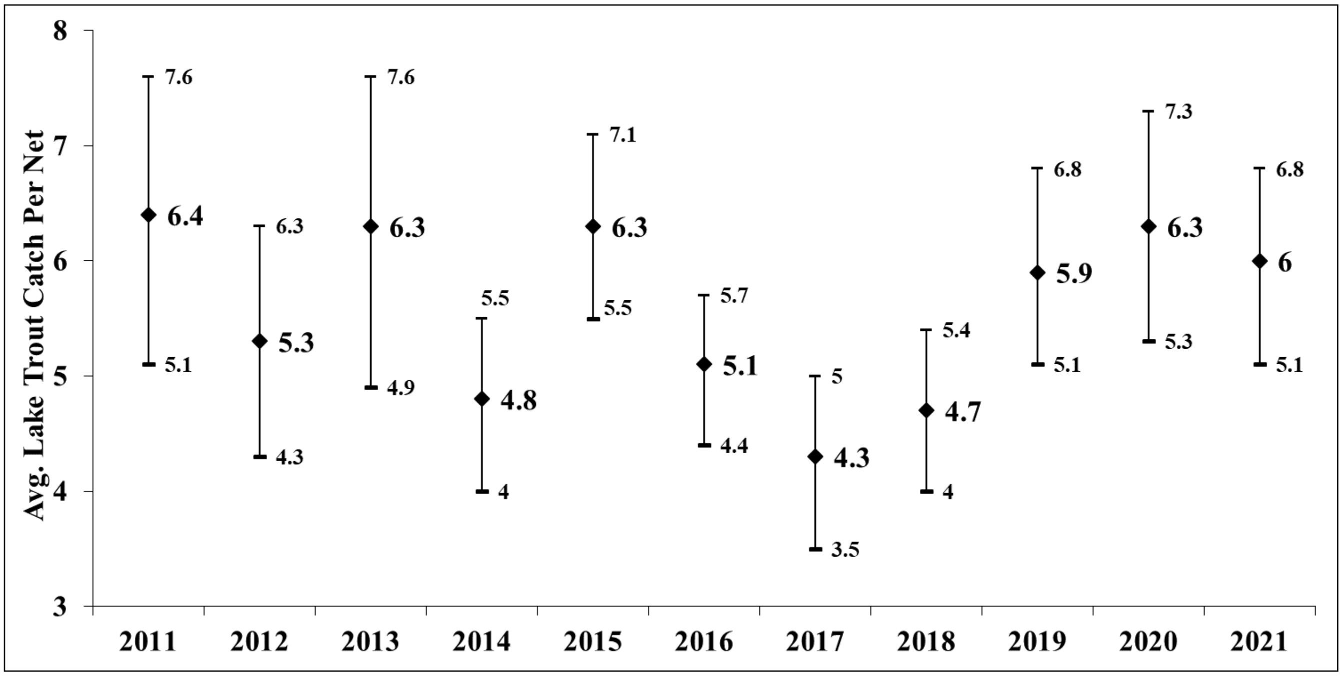

Figure 6. Average Lake Trout catch per 6-hour net set, Lake Granby 2011-2021. N = 30 nets for 2011 and 2012. N = 32 for all other years exept for 2019, when 31 nets were set due to equipment problems. Error bars represent 80% confidence intervals.

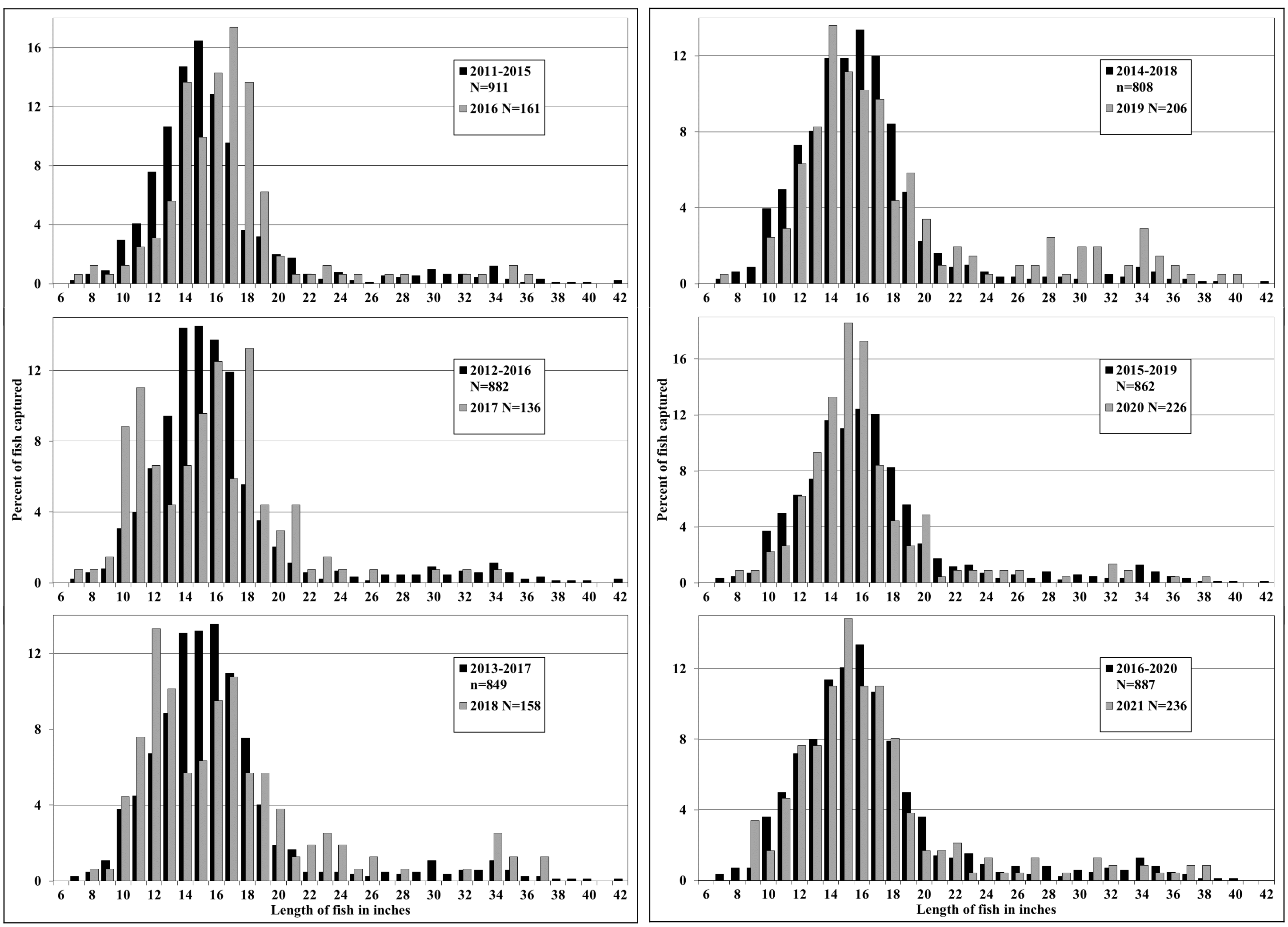

Figure 7. Size distribution of Lake Trout captured in Lake Granby gillnet surveys, 2016-2021. All Lake Trout sampled in the previous five years (black bars) are pooled to represent the "normal" or "expected" size distribution, and the current year's catch is overlaid in order to assess differences or trends in size distribution.

This survey is carefully designed to yield an index of Lake Trout density in the lake, meaning that if catch declines, it is at least in part because their density in the lake has declined. Over the long term, our catch rates in these surveys have remained essentially flat, suggesting no major trend in Lake Trout densities. The most notable apparent change that we observed is a three-year period of reduced catch rates in 2016-2018, with a full recovery by 2020 (Figure 6, previous page). Interestingly, this period of reduced catch corresponded with an apparent gap in recruitment which we observed in the size structure during those same years (Figure 7, previous page). This gap in recruitment first appeared in 2016 in reduced catch rates of fish in the 10-13" size range. Over the subsequent four years, this gap can be followed through the 13-15", 14-16", 15-18", 17-19" size ranges. By 2021, the gap is still visible but minimized, in the 19-20" size classes. Because catch rates had fully recovered by 2020 and 2021, it appears that the effect of this recruitment gap on the density of Lake Trout has passed.

Lake Granby experiences some amount of drawdown during all winters as water is pumped out of the lake and through the Adams Tunnel. During drought periods the drawdown tends to be greater. The greatest winter drawdown that occurred in this study period was during the winter of 2012-2013.(Figure 9).

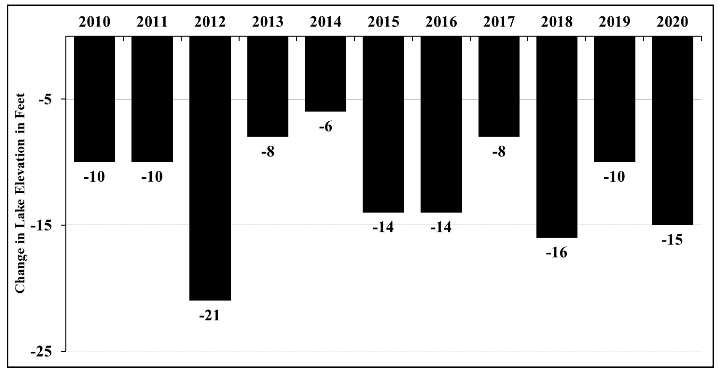

Figure 9. Change in Lake Granby surface elevation from October 1 of listed year to March 1 of following year. This is the portion of the year in which Lake Trout spawning (October) and egg incubation occur.

Figure 8. This lake trout in 2017 had recently eaten a kokanee.

Lake Trout spawn in the fall (typically October), and so any eggs deposited are incubating during the period of winter drawdown. Aging studies conducted at Granby and other waters in the state have shown that typically Lake Trout in the 13-16" range are 3-4 years old. This is the size group that was missing in 2017 (Figure 7). It is possible that this recruitment gap that we have observed was a result of reduced egg survival to hatching due to the drawdown during the winter of 2012-2013.

When considering the results of this type of index-based survey, it's important to assess whether or not other variables are affecting catch rates in a way that has the potential to lead to erroneous conclusions about the population trend. We tested for correlations between Lake Trout catch and lake elevation, lake volume, and water temperature (Table 3). We found a significant relationship between our catches of large (>24") Lake Trout and lake surface elevation and lake volume. The correlation with elevation was slightly stronger, and suggests that lake elevation explains 66% of the variation in catch rate of fish >24". Granby undergoes multi-year high– and low-water cycles based on water availability and demand. Therefore, the elevation and volume of the reservoir has varied wide-

Table 3. Regression analysis to test the relationships between Lake Trout catch rates and physical conditions of the reservoir. Values in bold indicate significant correlations.

	Lake Trout <24"avg.	>24" average
Lake elevation	R^2 = 0.00 P = 0.94	**R^2 = 0.66 P = 0.002**
Lake volume	R^2 = 0.00 P = 0.90	**R^2 = 0.63 P = 0.004**
Water temperature	R^2 = 0.11 P = 0.32	R^2 = 0.01 P = 0.82

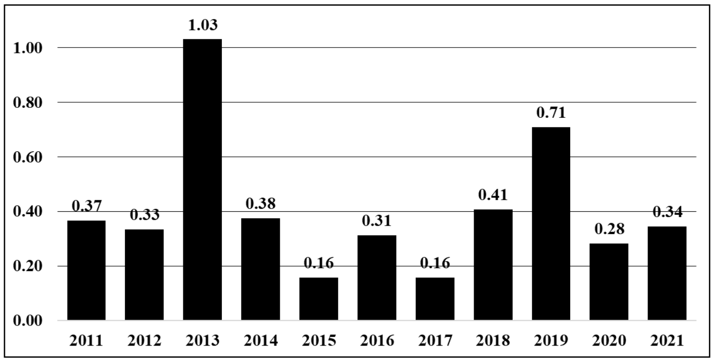

Figure 10. Catch rate per net of large (>24”) Lake Trout in Lake Granby gillnet surveys, 2011-2021

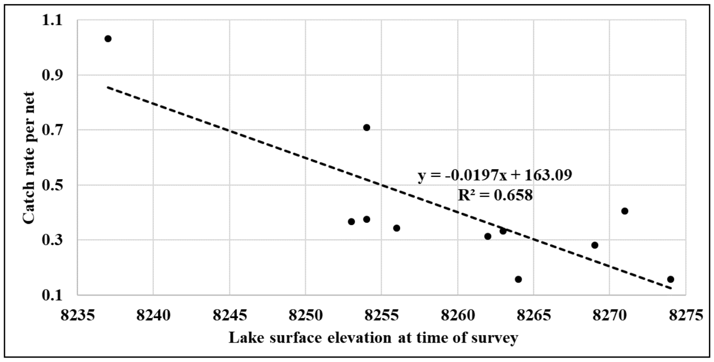

Figure 11. Relationship of catch rate of large (>24”) Lake Trout and lake elevation in Lake Granby gillnet surveys, 2011-2021.

ly during our surveys even though the dates correspond closely from year to year (Table 2). It is important to note that this relationship is driven largely by the high catch rate in 2013 when the lake was at the lowest elevation of all of the surveys to date (Figure 11). When we performed an analysis of this relationship excluding 2013, the correlation value dropped to 0.31 and it was less statistically significant ($P = 0.10$). Our assessment of this relationship will be greatly strengthened if in future years the survey is conducted between surface elevations of 8240 and 8250, in order to fill in the “gap” in this data set.

There is no relationship between any of these parameters and catch rate of Lake Trout <24” (Table 3). This may be because smaller fish are more likely to stay in close association with certain habitat features, while large predatory fish likely have to cover more area in order to find adequate prey. While the reservoir is drawn down, it would follow that the rate of encounter with large fish would increase due to the smaller volume of the lake. If this pattern holds, in future years we will consider using a correction factor to account for differences in lake elevation when assessing the trend in the density of Lake Trout >24” in the lake.

Figure 12. The largest Lake Trout captured in the 2020 survey, measuring 38.6” and weighing 23.9 pounds for a relative weight of 89.8.

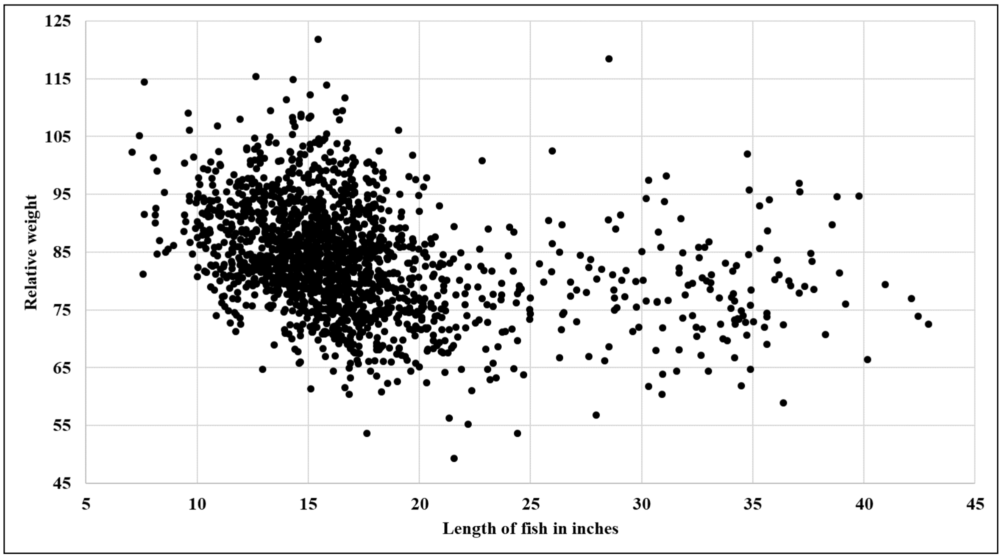

Figure 13. Lake Trout body condition by size, Lake Granby 2011-2021. N=1,869

Lake Trout body condition

In many ways, Lake Trout populations exhibit properties of two different populations, one of fish smaller than 24” and one of fish larger than 24”. This is the approximate size at which Lake Trout must switch to primarily vertebrate prey in order to continue growing. In Granby, fish larger than 24” have consistently had poorer body condition than smaller fish (Figure 13, Table 4). On average, Lake Trout >24” have a relative weight that is 6% lower than smaller fish. In comparison, two other nearby Lake Trout fisheries, Williams Fork and Green Mountain reservoirs, do not exhibit this decline in large Lake Trout body condition. With some caveats, in those waters, body condition of large Lake Trout is better than small Lake Trout (see Williams Fork and Green Mountain Fishery Management Reports).

Lake Trout smaller than 24” prey heavily on the dense Mysis population and it appears that this is a very high quality prey base for these fish. It is probably the dominant factor in Granby’s ability to sustain high densities of smaller Lake Trout. Larger fish continue to consume Mysis, but this food source alone does not appear to provide enough nutrition for the fish to grow to trophy size. In order to continue growing to trophy sizes, Lake Trout in Granby must have a robust vertebrate prey base available. Kokanee salmon are the most valuable prey to accomplish this, and the kokanee population in Granby has struggled in recent history (discussed below.

In 2021, the body condition of the Lake Trout >24” that we captured was the highest that we have observed in the course of this study, and also had the smallest decline in body condition compared to fish <24” that we have observed. The most likely explanation is presented in Table 5 (below). Due to changes in the timing of fish availability in CPW’s hatchery system, in 2021 we had stocked the largest number of catchable rainbows in recent history prior to our May survey. Given the current lack of Kokanee to provide the prey base, it is obvious that we are subsidizing the diet of large Lake Trout with catchable rainbows. This is not a cost-effective or desirable way to manage a trophy Lake Trout fishery, which is one reason why a recovery in the Kokanee population is important.

Table 4. Body condition as expressed by relative weight of Lake Trout captured in Lake Granby gillnet surveys, 2011-2021.

Year	<24”	>24”	Diff.	Year	<24”	>24”	Diff.
2011	83.3	79.6	-3.7	2017	85.7	81.3	-4.4
2012	79.9	80.8	+0.9	2018	86.3	79.9	-6.4
2013	81.8	73.5	-8.3	2019	85.4	79.4	-6.0
2014	83.5	79.4	-4.1	2020	87.6	77.5	-10.1
2015	84.7	81.8	-2.9	2021	85.9	85.6	-0.3
2016	87.2	78.1	-9.1	**AVG**	**84.6**	**78.6**	**-6.0**

Table 5. Number of catchable (10”) Rainbow Trout stocked into Lake Granby by month, January through July, 2017-2021.

	2017	2018	2019	2020	2021
Jan					33,487
Feb					
Mar				18,008	
Apr	11,240				11,002
May	12,000	29,940	13,672	5,000	
Jun	16,529	9,505	19,240	27,449	15,822
Jul	19,355	9,952	24,674	9,320	16,771

Status of Kokanee Salmon

Kokanee Salmon were first introduced to Lake Granby in 1951, and it is home to Colorado's longest-running Kokanee egg harvesting effort. There is not enough successful natural reproduction of Kokanee to sustain the population, so eggs are manually harvested and raised in CPW hatcheries. 1 million Kokanee fry are stocked annually into the Colorado River upstream of the lake. CPW's management goal for the species in Granby is to sustain a spawning run that produces at least 1.2 million eggs, which is the number needed for this population to sustain itself. Historically, Granby produced enough eggs to not only restock Granby itself, but also to stock many other reservoirs. Kokanee numbers have dwindled in recent years, and 2021 marked the tenth consecutive year that Granby has not provided enough eggs to support itself.

CPW research crews monitor the density of Mysis shrimp in the reservoir (Figure 15). Because Mysis eat the same zooplankton that Kokanee do, they are a highly efficient competitor and can create difficult conditions for Kokanee growth and survival. Mysis densities in Granby have proven to be highly variable over the years. They follow the general pattern of declines during drought periods followed by population explosions to extremely high densities when the reservoir refills. These high densities do not appear to be sustainable over time, and so the population seems to undergo a boom-and-bust oscillation.

The productive period for Kokanee in Granby from 2004-2011 appears to be a response to the low-water period of 2001-2008. Mysis densities were low for much of that time, which reduced competition for zooplankton. Lake Trout predation was also likely suppressed during this time due to stratified thermal conditions which caused Lake Trout to remain at depth for the majority of the growing season. The minor recovery in the Kokanee run that occurred in 2016 was likely a result of similar, but more brief low water conditions in 2012-2013.

We believe that the current failure of Kokanee in Granby is the result of two persistent unfavorable and related conditions: Granby hosts the highest known density of Lake Trout in the state, and this has likely resulted in a "predator trap" which prevents recovery of the prey base. Consistently high water levels foster high densities of Mysis, reducing zooplankton prey available for Kokanee. Importantly, the gill lice parasite which has decimated Kokanee populations in other waters of the state has not been found to date in Granby. CPW plans to pursue liberalization of the Lake Trout bag limit in the near future; however we believe that the most likely way for Kokanee to make a recovery in Granby is for the lake to undergo multiple consecutive years in which the average surface elevation during summer remains below 8,260 feet.

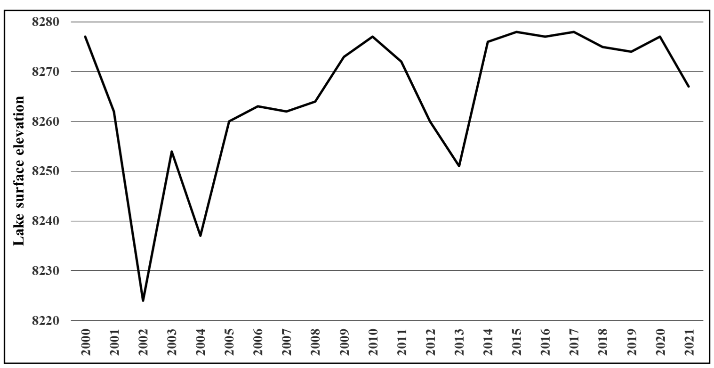

Figure 14. Average surface elevation of Lake Granby during the months of June, July, and August, 2000-2021.

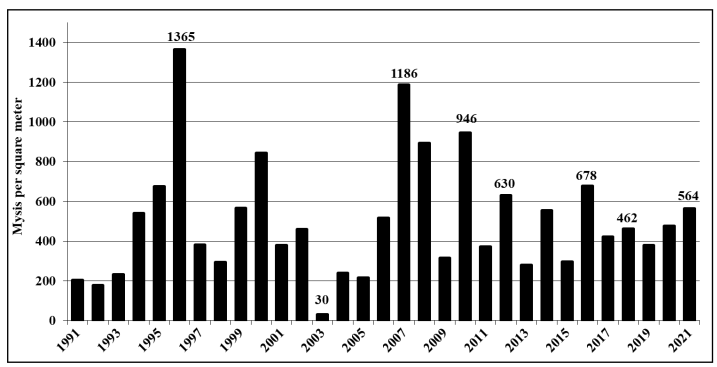

Figure 15. Estimates of Mysis density per square meter of surface area, Lake Granby 1991-2021.

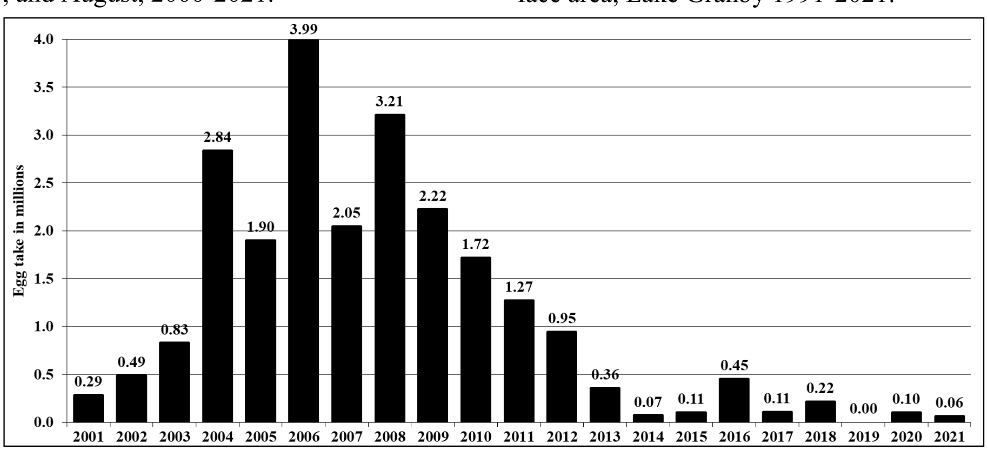

Figure 16. Annual Kokanee Salmon egg harvest at Lake Granby in millions of eggs, 2001-2021.