Green Mountain Reservoir

Fishery Management Report

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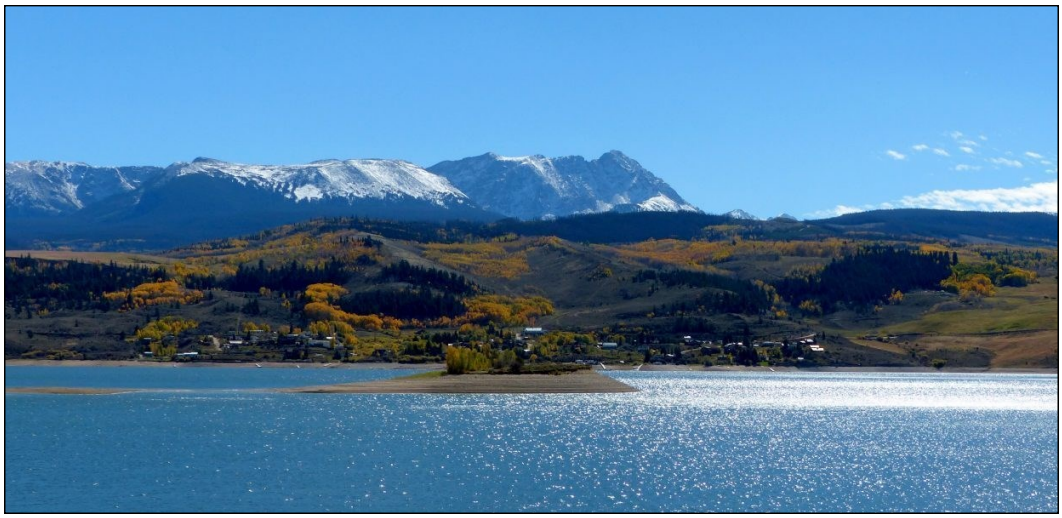

Figure 1. Green Mountain Reservoir and Town of Heeney, Summit County.

Introduction

Green Mountain Reservoir (GMR), a 2,125- acre storage reservoir approximately 13 miles south of Kremmling, is operated by the U.S. Bureau of Reclamation as part of the Colorado-Big Thompson (C-BT) project. It provides good fishing for Lake Trout, Rainbow, Brown Trout, and Kokanee Salmon. Colorado Highway 9 runs along the east side of the reservoir, making for easy direct access. Recreational access is managed by the U.S. Forest Service, Dillon Ranger District. For more information, visit: http://www.dillonrangerdistrict.com/index.htm.

Because of its function to provide replacement water for the C-BT project to points downstream, GMR experiences the widest annual fluctuations in elevation of any of the large reservoirs in the headwaters of the Colorado River (Figure 2, right). The average annual low point of elevation over the six water years displayed in Figure 2 is 7,892 feet, which is 58 vertical feet below GMR's full-pool elevation of 7,950 feet. This extreme amount of fluctuation presents unique challenges to fisheries management as this is a highly unnatural situation and most fish and other aquatic organisms are not well adapted to cope with such dynamic conditions.

In August 2017, Quagga Mussel veligers (larvae) were detected and confirmed in GMR during routine sampling for aquatic nuisance species. Despite intensive sampling since then this positive result has not been replicated. Therefore GMR is currently considered a "suspect" water.

Two challenges in particular have had a major effect on the management of the fishery in GMR in recent years. An illegal introduction of Northern Pike was discovered in 2012, which has greatly affected the management of the fishery. Beginning in 2016, CPW instituted an angler harvest incentive for this species. Any angler who catches a Northern Pike can present the freshly-caught fish at Heeney Marina during business hours and receive a $20 harvest incentive payment for each fish turned in.

In approximately 2008, gill lice parasites started appearing on Rainbow Trout and Kokanee Salmon in Green Mountain. Despite maintenance of consistent stocking rates, the Kokanee fishery began declining and was ultimately decimated. CPW has seen other Kokanee fisheries in the state severely impacted by heavy infestations of this parasite.

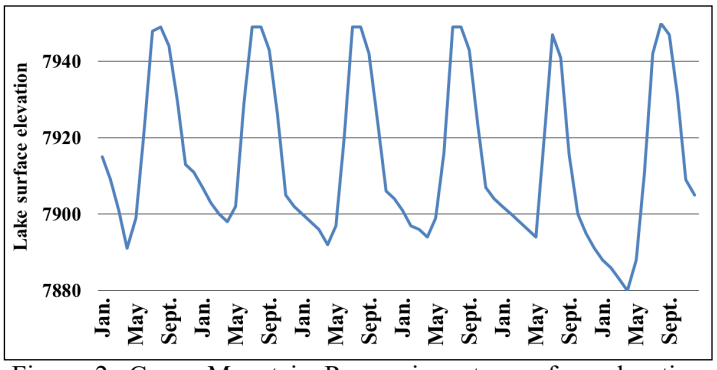

Figure 2. Green Mountain Reservoir water surface elevation recorded on the first day of each month, January 2014-December 2019.

Fishing Regulations

The Lake Trout bag and possession limit is 8 fish, in addition to the aggregate bag limit of 4 fish for other trout species. The purpose of this regulation is to encourage harvest of the large population of relatively small Lake Trout. Maintaining harvest pressure on this species helps produce a higher-quality fishery in a water with a relatively limited prey base.

Snagging for Kokanee Salmon is allowed from September 1—December 31in GMR and the Blue River from the inlet upstream to the Highway 9 bridge closest to the reservoir. The purpose of this regulation is to allow for efficient harvest of Kokanee that are attempting to migrate out of GMR up the Blue River to spawn. The Blue River does not have the conditions necessary for Kokanee to spawn in numbers that would maintain their population. The inlet area of GMR has historically been a very popular location for snagging with high rates of success, however this has drastically declined in more recent years with the decline in the Kokanee fishery due to gill lice.

All other standard statewide fishing regulations apply.

Stocking

When we confirmed the presence of Northern Pike in GMR in 2015, we made the decision to cease all stocking temporarily (Table 1, below). The reason for this decision was to attempt to address the two principal management challenges we faced at GMR—the Northern Pike invasion and a gill lice infestation. Gill lice only infect Rainbows and Kokanee. A cessation of stocking deprived the pike of an easy prey base in the form of these two species, while at the same time we believed that the only plausible way to reduce the infestation of gill lice was to temporarily deprive the parasite of its hosts. We reduced Kokanee stocking in 2013 and 2014 as a response to gill lice, however we believe that the only way to truly reduce the parasite is to create as complete a gap as possible in the susceptible fish population. GMR is the only large reservoir in Colorado with a gill lice infestation where we have responded in this way. The Brown Trout and Lake Trout fisheries are self-sustaining through natural reproduction and have continued to provide recreational angling opportunity during this time.

In 2019 we stocked Brown Trout and Snake River Cutthroat, which were the first fish that we had stocked since 2015. Both of these species appear to be either resistant or immune to infection by gill lice. Although Brown Trout are self-sustaining, they are currently the main species providing recreational opportunity for shoreline anglers and bolstering their numbers should be helpful. The contribution of Snake River Cutthroat to the GMR fishery, despite consistent stocking in the past, appears minimal. We have never captured this species in our gillnet surveys and they are rarely reported by anglers.

Based on the results of our 2019 gillnet surveys (discussed below), we will stock 200,000 Kokanee in 2020. We do not have any plans to stock Rainbows in 2020. Restoration of the Kokanee fishery is our highest priority for stocking, and we want to be as careful as possible in attempting to avoid a renewed explosion of gill lice infestation. Resuming both Kokanee and Rainbow stocking at the same time would increase the likelihood of this occurring. Future stocking decisions will depend on developments in the fishery.

	Rainbow (10”)	Rainbow (3-5”)	Brown Trout (2.5”)	Snake River Cutthroat (5”)	Kokanee (1.5”)
2012	28,734	100,000		20,000	300,043
2013	37,307	50,000		19,147	100,415
2014	20,000	100,000		22,698	100,000
2015	17,520	100,000			
2016	No fish stocked				
2017	No fish stocked				
2018	No fish stocked				
2019			24,070	23,053	

Table 1. CPW stocking in Green Mountain Reservoir 2012-2019.

Fishery Surveys

Beginning in 2011, we adopted a randomized gillnet survey protocol on GMR as well as Granby, Williams Fork, Shadow Mountain, and Dillon reservoirs. Gillnets are set for six hours apiece (Figure 3), as close to the same dates as possible. From 2011-2014 we set 24 gillnets over three days annually. Analysis of this data suggested that increasing our sample size to 40 net sets over five days every other year would increase the statistical power of these surveys, so in 2015, 2017, and 2019 we switched to this approach. All survey work has occurred between the dates of May 29 and June 21, and when surface water temperatures were between 50 and 55 degrees F.

Rainbow Trout catch has declined in the years since stocking ceased (Table 2). In 2019 we captured two and we did not observe any gill lice on either of these fish. This led to our decision to resume stocking of Kokanee in 2020. Kokanee Salmon are known to be difficult to capture and monitor with gillnet surveys, and are therefore likely underrepresented in this data.

Large, predatory Lake Trout preferentially choose Kokanee and Rainbow Trout as prey when they are available. One apparent effect of the lack of stocking has been to force these fish to increase their reliance on suckers as a prey base, resulting in a decline in the percent contribution of suckers in the catch of these surveys (Table 2, below). We have also anecdotally captured more large Lake Trout with freshly eaten suckers in their stomachs (Figure 5). This has the potential to provide a benefit to the fishery, as nonnative suckers, an undesirable invasive species in our reservoirs, compete with sportfish due to overlapping habitats and prey.

We liberalized the Lake Trout harvest regulation in 2011 (see discussion on page 2). Aside from a single year of reduced catch rates in 2014, these surveys have not produced any evidence that Lake Trout densities have declined as a result of the liberalized bag limit. (Figure 4). This corresponds with evidence that we have seen at other

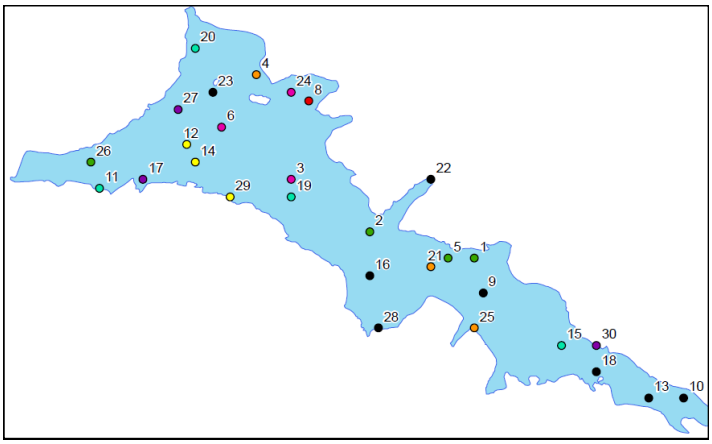

Figure 3. 30 randomized gillnet locations on GMR.

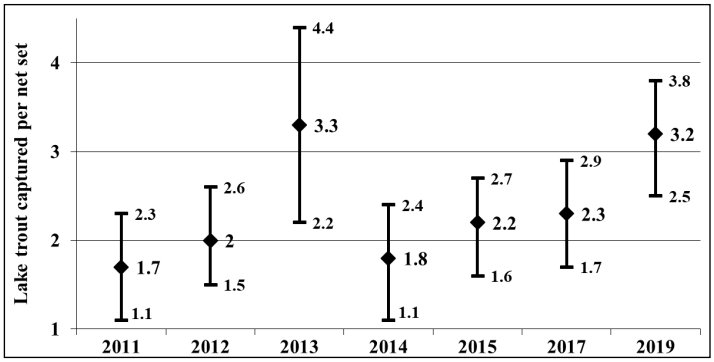

Figure 4. Average catch of Lake Trout per 6-hour gillnet set with 80% confidence intervals displayed, GMR 2011-2019.

Figure 5. This large Lake Trout in 2017 had recently eaten a White Sucker.

	2011	2012	2013	2014	2015	2017	2019
Northern Pike	0%	1%	2%	1%	5%	2%	6%
Rainbow Trout	3	3	5	3	3	2	1
Brown Trout	4	7	4	6	5	13	10
Lake Trout	15	25	33	21	26	36	39
Suckers	78	65	57	70	62	48	44

Table 2. Percent composition of catch by species in GMR randomized gillnet surveys, 2011-2019.

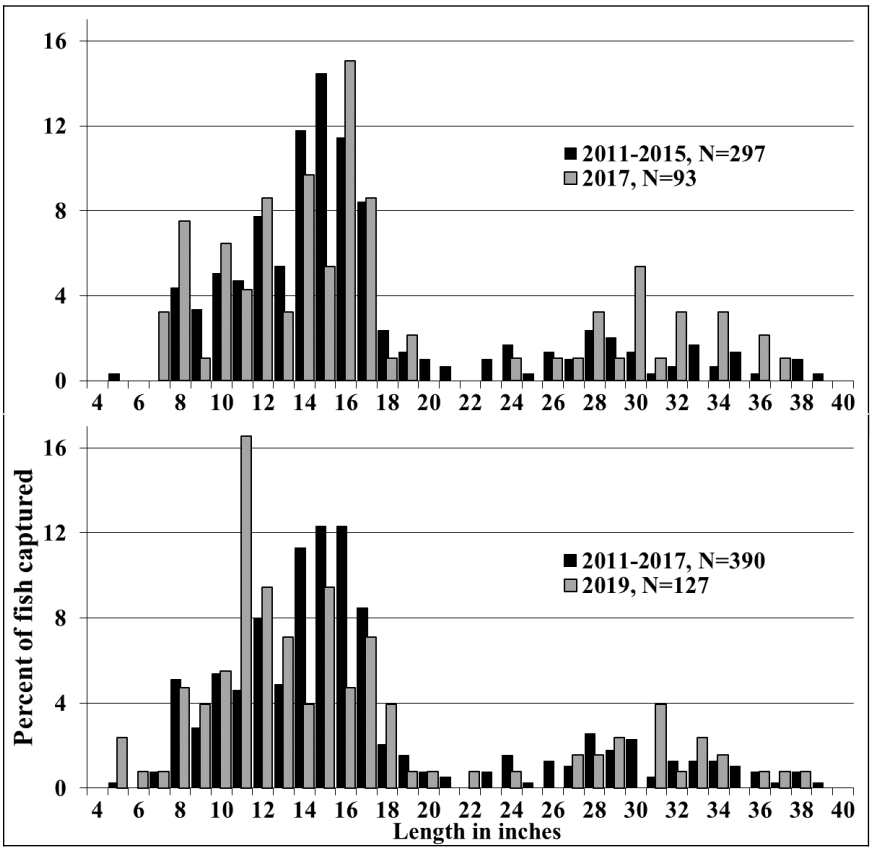

Figure 6. Size distribution of Lake Trout captured in gillnet surveys of GMR. Black bars are all Lake Trout captured prior to the given year pooled, by percent. Gray bars are Lake Trout captured in 2017 (top) and in 2019 (bottom) by percent.

reservoirs in the state that self-sustaining Lake Trout populations can withstand high levels of harvest pressure, particularly among fish less than 24" long.

The most common size of Lake Trout that we have captured throughout the history of these surveys is 14-17" (Figure 6). The purpose of pooling all Lake Trout captures prior to 2017 (top) and 2019 (bottom) in Figure 6 is to display what is "expected" or "normal" over the long term. Overlaying an individual year's catch highlights any apparent changes or trends in the size distribution during the period of no stocking. In 2017 we captured fewer fish in the 13-15" range, while we captured far more large (28-37") fish. In 2019 the small fish "gap" had moved to the 14-17" range, while we captured far more 11-13" fish than normal, and again captured more large fish than expected.

At GMR and other reservoirs with Lake Trout fisheries, it is helpful to view Lake Trout as essentially two separate but related populations with different characteristics and behavior. The size distributions in Figure 6 as well as the relative weight plots in Figure 7 (next page) demonstrate that the dividing line between these two populations is 22-24". This is the size at which this species becomes highly predatory on other fish. Only a small percentage of Lake Trout less than 22" successfully make this switch. Aging studies of Lake Trout in other locations have found 20" Lake Trout to be anywhere from 6 to 30 years of age, and larger fish cover similar age ranges. We do not know the mechanism by which some of these fish grow to large sizes quickly and some simply stop growing without ever making the full prey switch.

It is particularly interesting to note that in a period of no stocking, our catch rates of large fish have increased significantly. There are two possible reasons for an increase in catch rates: 1.) There were suddenly more large Lake Trout in GMR in these years; 2.) Higher catch rates are actually reflective of a behavioral change caused by the cessation of stocking, in which large Lake Trout have to move more frequently over longer distances to find prey, making them more susceptible to capture in our nets.

Conditions in the lake (decline in prey base, liberalized regulation with no size protection) do not provide any reason to believe that the overall number of large Lake Trout should have suddenly increased. In fact, if the increased bag limit was having its intended effect, this is the opposite result of what would be expected. Also, it does not make sense biologically for the population of large fish to quickly increase without having observed a large cohort of smaller fish in previous surveys. The second possibility listed above is the most likely, and is also supported by our observations of Lake Trout body condition (Figure 7).

At the same time that catch rates of large fish increased, the body condition of large fish has also declined significantly (Figure 7). We have also received increased reports from anglers of fish in poor body condition (Figure 9) which was rare prior to 2015. Average body condition for large Lake Trout in our samples declined by 16.9 points from 2015-2017. There was no significant difference between body condition of large fish and small fish in the 2017 and 2019 surveys, when this had never been the case in GMR prior to 2015—larger fish had always had higher average body condition.

While the decline in body condition was expected when we ceased stocking, an unexpected result has been the variation in body condition in fish >24" that we observed in 2017 and 2019 (Figure 10). The standard deviation in relative weight among these fish was 8.7 for the stocking period and 13.0, or a 49% increase, for the period with no stocking. Therefore it appears that for reasons un-

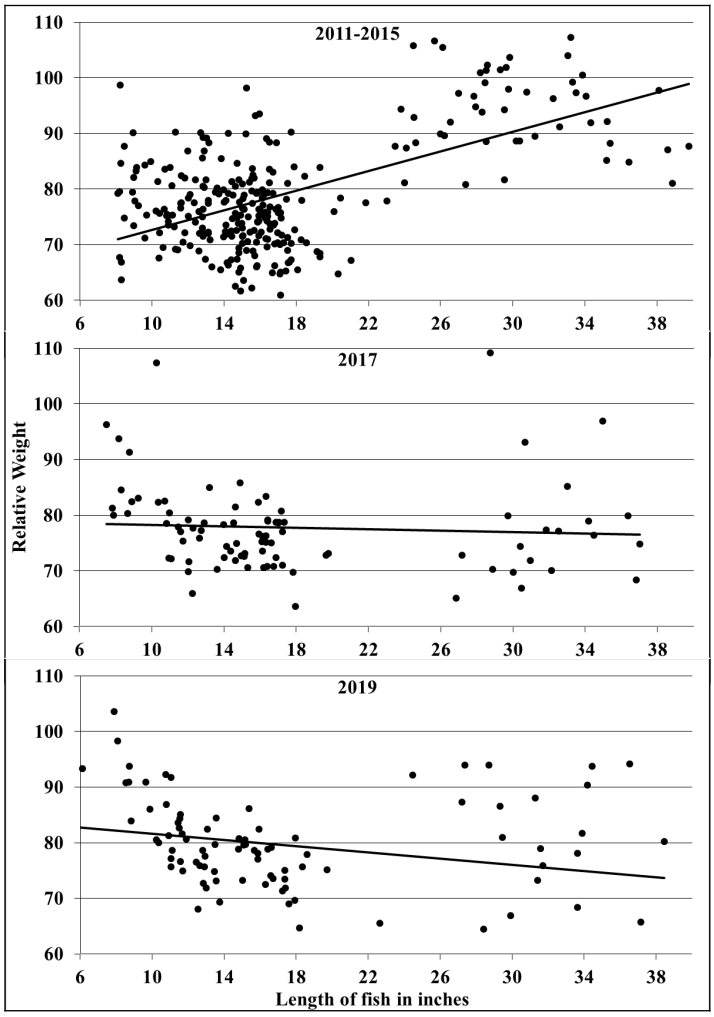

Figure 7. Relationship between Lake Trout size and relative weight ("plumpness"), GMR. Lines are least-squares regression. Stocking of Rainbow Trout and Kokanee was occurring in 2011 -2015 (top). 2017 (middle) and 2019 (bottom) samples were collected during the period of no stocking.

Figure 8. The largest lake trout captured in 2019, measuring 37" and 21.0 lbs. Relative weight = 90.

Figure 9. An angler in 2018 with a Lake Trout in extremely poor body condition. Photo courtesy Roger Harris.

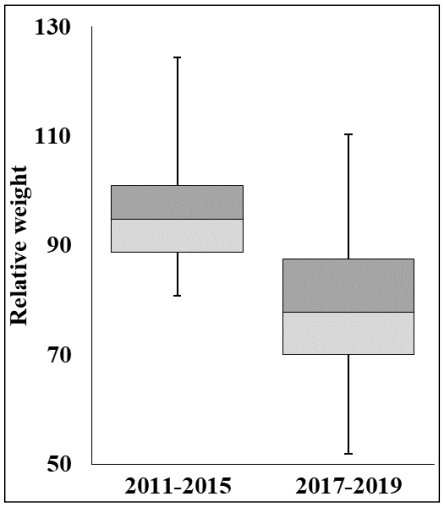

Figure 10. Box and whisker plot of relative weights of Lake Trout larger than 24" in GMR during a period of Rainbow and Kokanee stocking (2011-2015, N = 49, median 94.7) and no stocking (2017-2019, N = 44, median 77.7).

known to us, a small portion of the large fish we captured are adapting to the change in prey availability effectively (Figure 8, previous page), while most of the fish have lost a significant amount of weight. Three of the 44 fish >24" captured in 2017 and 2019 had relative weights greater than the 2011-2015 median of 94.7.

When fish are in poor body condition, growth will slow or stop and egg production will inevitably decline. These observations provide strong evidence to refute the notion that large Lake Trout can persist indefinitely and maintain a high quality fishery on a forage base of suckers and smaller Lake Trout alone. All state records for Lake Trout in Colorado have been caught from waters with healthy Kokanee populations at the time. Kokanee and Rainbow Trout contain more calories per pound of flesh than suckers. Despite their recent decline in relative abundance, suckers are still the most numerous fish in GMR. Forcing the large Lake Trout to prey nearly exclusively on them has resulted in a major decline in body condition.

Anglers have turned in 228 Northern Pike since the angler harvest incentive program was introduced in 2016. Despite this, we captured 18 Northern Pike in our 2019 survey, which was the most we have captured to date (Figure 11). More concerning than the number of Northern Pike that we captured was their distribution and behavior at the time of the survey. Spring 2019 was particularly cool and wet, and this delayed the timing of runoff and filling of GMR. As a result, there was far more spring weed growth on the lake bed than we have observed in the past (Figure 12). When these weeds were then inundated as the reservoir rose, this created what appeared to be excellent Northern Pike spawning habitat, which is normally lacking in GMR. The majority of the pike we captured were in these areas, and both males and females appeared to be actively spawning and were freely expressing eggs and milt. As a result, we expect to find a robust year class that was born in 2019, and are gravely concerned that Northern Pike numbers are in danger of growing out of control. We plan to expend extra effort in spring 2020 with Northern Pike trapping and removal.

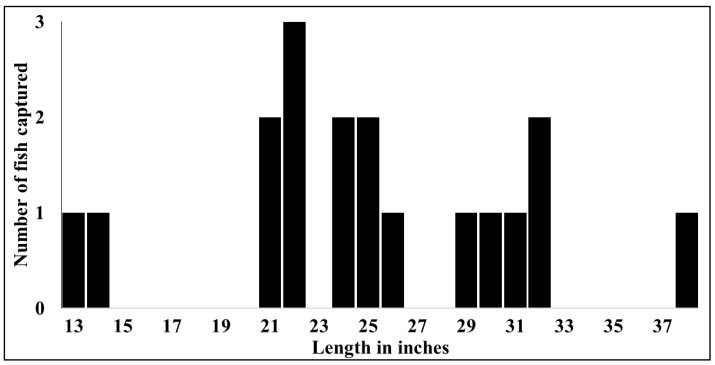

Figure 11. Size distribution of Northern Pike captured in standard gillnet survey of GMR, 2019.


Figure 12. Extensive weed growth on the lake bed of GMR in spring 2019 (left). Inundation of the weeds as the lake level rose (right) created excellent Northern Pike spawning habitat.