Blue River

Fishery management report

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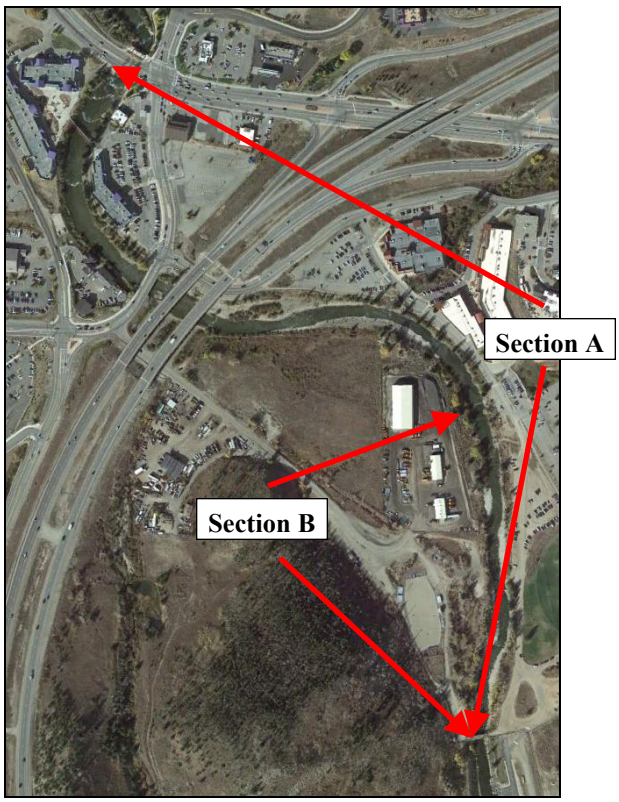
The information contained in this report summarizes surveys conducted annually from 2010-2017 on the Blue River tailwater reach downstream from Dillon dam. In 2010, 2011, and 2015-17 we surveyed a 0.7-mile long reach of river immediately below the dam in the town of Silverthorne (below, Section A) by raft. In 2012, 2013, and 2014 there was not enough flow in the river to float a raft, so we surveyed a shorter reach of river, approximately 1,300 feet, from the USGS gauge concrete sill upstream to the power plant bridge (below, Section B). This was done by wade electrofishing. The reach surveyed in those years represents roughly the upstream 1/3 of the reach that was surveyed by raft. Mark-recapture survey methodology was used in all surveys. All fish that are captured are measured, weighed, marked, and released. At a later date, the same reach of river is surveyed again. The proportion of marked fish captured on the second day provides the statistics needed to estimate fish population parameters.

Wade electrofishing



Survey dates	
8/24 & 26/2010	8/25 & 28/2104
8/22 & 25/2011	8/17 & 20/2015
8/13 & 16/2012	8/15 & 18/2016
8/16 & 19/2013	8/28 & 30/2017

Raft electrofishing. This type of electrofishing is accomplished using a thrown electrode (right). There are two netters on the bow of the boat, and a thrower in the middle. There is a fourth person on the back of the boat who positions the boat in the water to maximize fish capture. The target flow to be able to accomplish this is 150-300 CFS during the second half of August.

Rainbow trout stocking in the Blue River tailwater

2010			2011			2012			2013		
Date	Size	Number	Date	Size	Number	Date	Size	Number	Date	Size	Number
3/25	14	161	1/05	17	500[A]	4/5	17	825[C]	5/15	18	560[D]
6/30	10	1,333	3/01	17	500[A]	8/23	4	53,300[B]	5/16	18	320[D]
8/11	10	4,192	9/14	4	50,000[B]						
8/26	3	45,000[B]									

2014			2015			2016			2017		
Date	Size	Number	Date	Size	Number	Date	Size	Number	Date	Size	Number
2/26	19	376[E]	1/8	19	363	4/13[F]	14	692	4/13	18	600[G]
4/16	19	647[E]	4/8	16	640						
			12/3[F]	14	765						

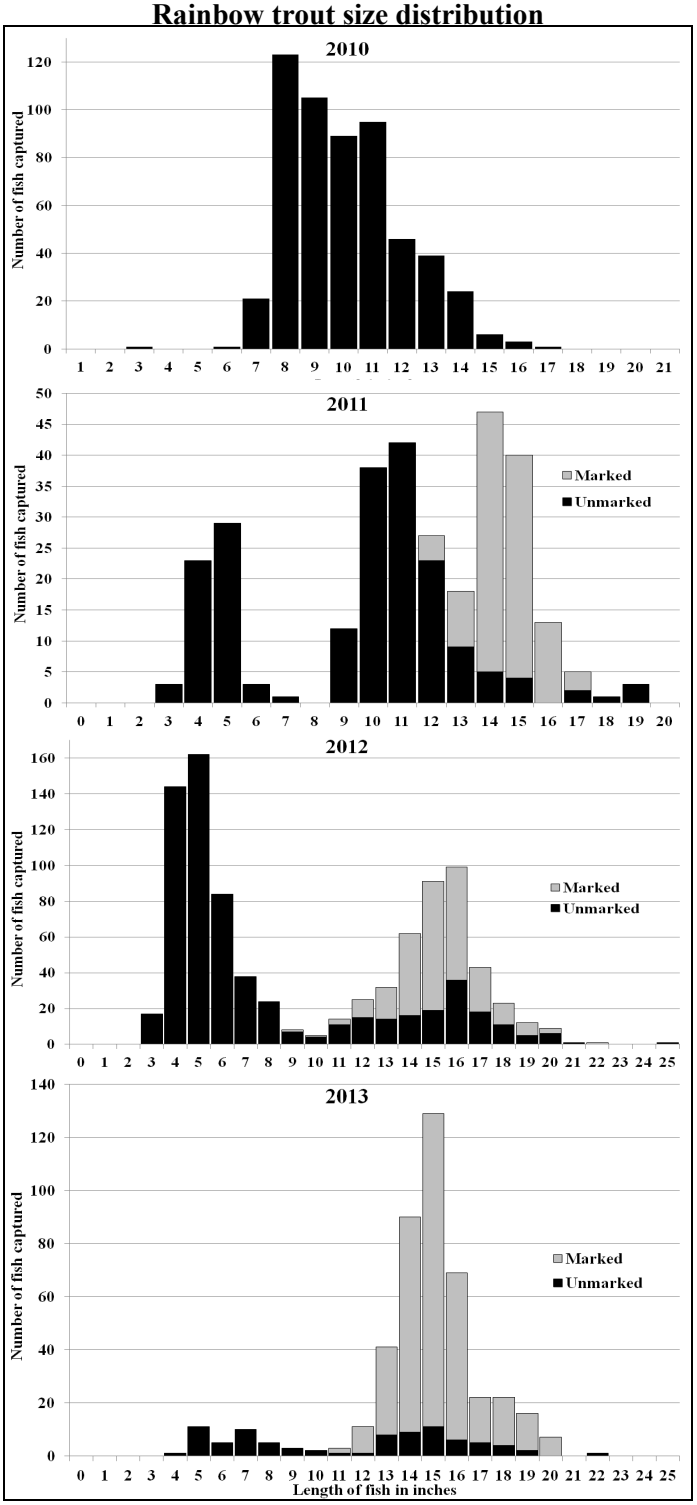
(A) The 2011 brood cull plant were marked with an adipose clip.
(B) 2010, 2011, and 2012 fingerling plants all took place AFTER that year's electrofishing surveys.
(C) 493 of the 2012 brood cull plant were marked with orange Alpha-VIE tags behind the eye. All 2012 brood culls (tagged and untagged) were marked with an adipose clip. Tags began with the letters P, R, S, T, and U.
(D) 496 of the 2013 brood cull plant were marked with orange Alpha-VIE tags beginning with letters V, W, X, Y, and Z. These and all other 2013 brood culls were also marked with an adipose clip.
(E) 2014 brood cull plants were adipose-clipped but not individually tagged.
(F) December 2015 and April 2016 brood plants from Crystal River were not marked in any way.
(G) 2017 brood plant from Crystal River were left pelvic clipped.

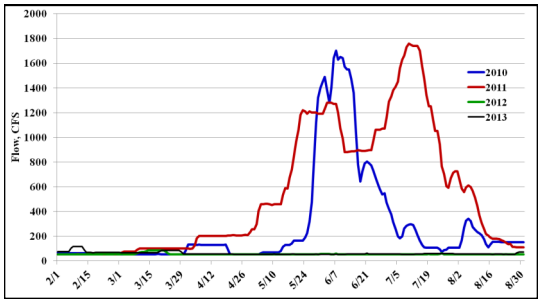
The recent rainbow trout stocking history for the Blue tailwater is above. Reported sizes of fish are an average; there is always some variation within batches of stocked fish. Through April 2015, the small batches of large fish were brood culls from the Glenwood Springs State Fish Hatchery. Beginning in 2011 we marked the brood cull plant with clipped adipose fins, and until the plant of 12/3/15 which came from Crystal River State Fish Hatchery, all brood fish stocked into the river were adipose-clipped. From the 12/15 plant onward, all fish have been Crystal River Hatchery brood culls. The purpose for marking stocked fish is to monitor the success of stocking rainbows at smaller sizes—either fingerlings or 10" catchables. Identifying the ideal stocking strategy for this reach has always been a challenge. Marking the large fish that are stocked allows us to detect whether or not any growth and/or recruitment takes place from batches of smaller fish that are stocked.

Population Estimates

	Section A surveys					Section B surveys		
	2010	**2011**	**2015**	**2016**	**2017**	**2012**	**2013**	**2014**
Rainbows: # > 6"/mile	830	606	420	385	356	1,632	1,071	702
# >14"/surface acre	5	24	36	17	29	188	167	119
Biomass (lbs./acre)	40	63	64	38	57	395	305	248
Avg. body condition	73.6	82.9	77.7	75.1	74.0	86.1	86.1	85.6
Browns:# > 6"/mile	934	1,128	1,059	799	996	1,042	666	434
#>14"/surface acre	8	7	3	2	5	37	20	7
Biomass (lbs./acre)	43	48	42	37	40	138	68	52
Avg. body condition	75.2	87.4	89.6	92.5	90.6	91.2	82.7	95.7

Rainbow trout size distribution





Flows 2010-2013. 2012 and 2013 were drought years in which Dillon releases remained near minimum all year.

Population estimates (previous page) derived from Section B in drought years are drastically different from the Section A estimates in non-drought years. It is difficult to ascertain the reasons for this. Nearly the entire difference in these estimates is accounted for by the stocked brood rainbows. When brood fish are stocked during base flow conditions, our anecdotal observations are that they don't disperse throughout the river. They appear to remain in, or close to, the locations that they were stocked for the entire season. This may artificially inflate the population estimates in those years. It is also possible that fish densities in the upper 1/3 of Section A, which is what Section B encompasses, are always much higher. We will attempt to answer these questions in future surveys.

The length-frequency histograms for the rainbow trout captured the past eight years appear here and on page 4. It is important to keep in mind that for each of the years discussed when fingerlings were stocked, the stocking took place after the electrofishing survey, so we did not observe the success (or lack thereof) of the fingerling plants until nearly a full year after they had been stocked. The 2011 survey revealed size groups of rainbows that correspond very closely with the three sizes of rainbows that had been stocked over the previous 12 months. It was encouraging to see the 2010 fingerling plant still present in 2011, especially considering the high runoff year they had endured. However, slow growth was evident, with the fish gaining approximately 2" of length after being in the river a full year. The fish stocked at 10" in 2010 appear in the 2011 sample in the 10-12" size range (also apparently accomplishing little to no growth since being stocked). Also, 2011 was the first year that we were able to observe the contribution of the brood fish to the large-fish portion of the population. At the time of the survey, these fish had been in the river either 32 or 24 weeks. The brood cull plant accounted for 34% of all rainbow trout, and 88% of the rainbow population >14". Without the brood cull plant, this reach of river would not have met the gold medal standard for density of quality fish (12 fish/acre >14").

Also beginning in 2011, we ceased stocking 10" rainbows in order to ascertain whether or not the fingerlings were contributing to the adult population. The result of this change appears in the 2012 sample. The group of fingerlings that we observed in 2011 at 5" had not advanced in size to any measurable degree. Instead, there was a void in the 9-12" size range that had been occupied in 2011 by the 2010 10" plant. We observed a large number of fingerling-sized fish in the river, which was the result of both the 2010 and 2011 fingerling plants "stacking" on top of each other and failing to grow. Because of this, we omitted fingerling plants in 2013 and 2014 ostensibly to allow the larger number of fingerlings present time to grow without more competition from additional plants. The 2012 brood plant were adipose-clipped also, and so in 2012 the combination of brood plants from 2011 and 2012 (all the marked fish in the river)accounted for 63% of all rainbows >14".

In the 2013 survey (page 3), we were perplexed to find an almost complete absence of the large fingerling group that had been present a year earlier. Fingerlings were stocked in 2012 after our survey and even these fish were absent. Rather than growing and contributing to the catchable-sized portion of the population, all of the previous three years' fingerlings had simply disappeared. 2012 and 2013 was a dry period, and flows from Dillon Dam were nearly identical for both of those years, at minimum release for nearly the entire period. There had not been a high-flow period between the 2012 and 2013 surveys to "flush" small fish downstream or trigger emigration. Marked rainbows in 2013 accounted for 76% of the total rainbow trout population and 87% of all rainbows larger than 14".

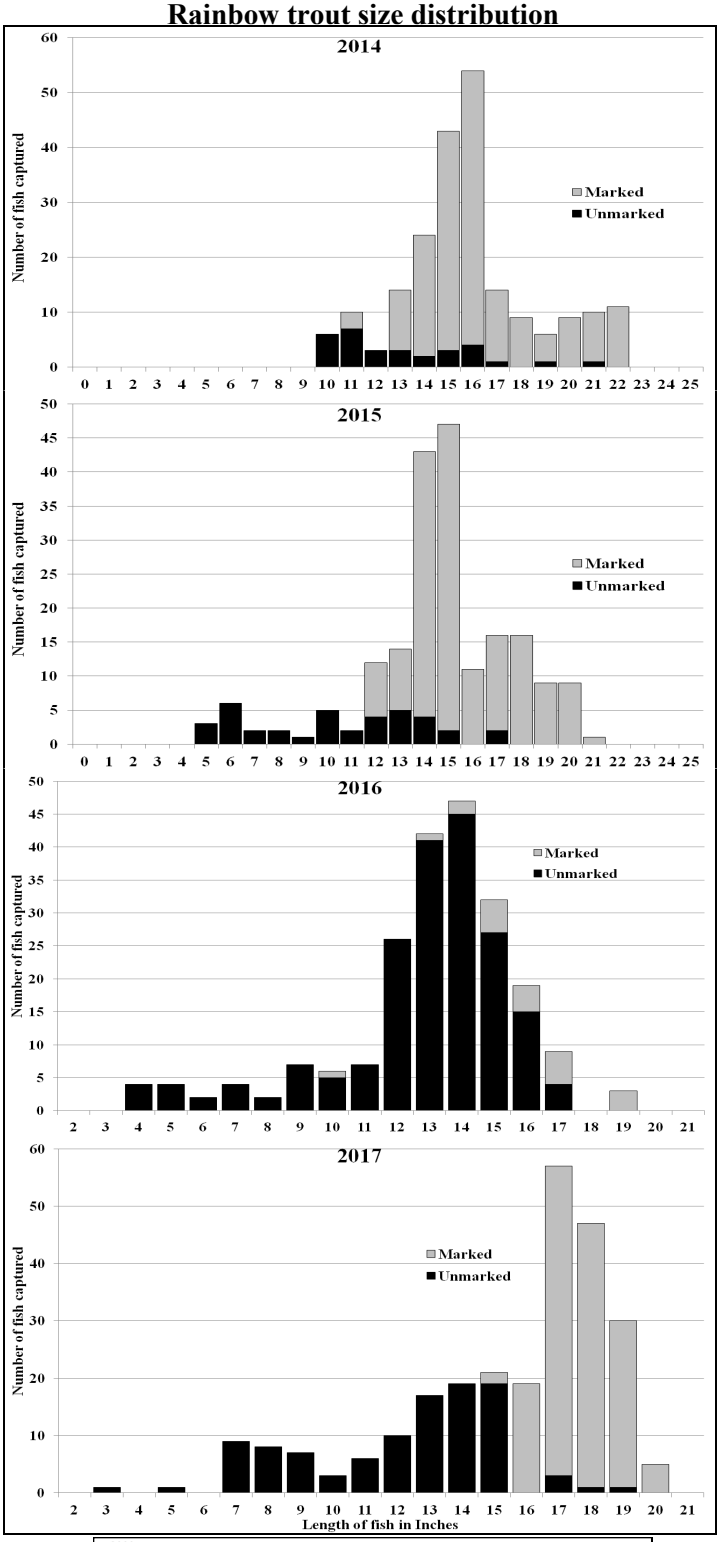
The 2014 and 2015 surveys yielded results very similar to 2013, with an overwhelming majority of the rainbows having originated from brood plants. Brood culls are the only fish that have been stocked since the 2012 fingerling plant, and the figures demonstrate that the recreational fishery is being maintained through those plants only.

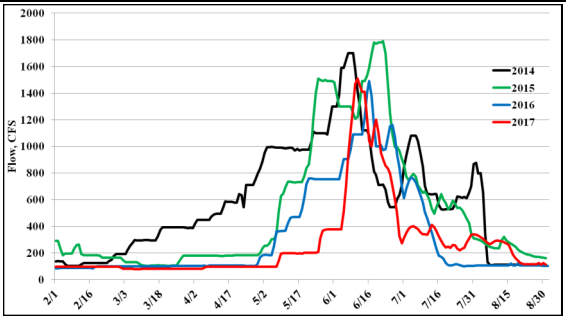
The December 2015 and April 2016 plants of brood culls from Crystal River hatchery were the first groups of brood fish to be stocked since 2011 with no clips or marks. These fish appear in the 2016 sample as unmarked fish.

The 2017 brood cull plant was marked with a left pelvic clip. The exercise of switching between unmarked and marked fish during 2016-2017 and observing the contribution of those groups to the population provides further evidence that this rainbow trout fishery is maintained nearly exclusively with these brood plants.

Flows released from Dillon Dam over the past eight years are also displayed here and on page 3. A drought cycle in 2012 and 2013 saw flows remain at minimum or near-minimum releases for the entire growing season and there was no runoff peak. All water that was released in 2014 came from the release structure at the bottom of the dam—there was no surface spill. In 2010, 2011, and 2015-17, Dillon experienced "traditional" fill-and-spill hydrology, in which the peak flow in those years was a controlled release (to prevent flooding) of approximately 1,800 CFS released through the gates at the bottom of the reservoir. This was followed in each of those years by a surface spill which came after the peak controlled release. These release patterns are important to consider because mysis entrainment through the dam is presumably one of the most important food sources to fish in the tailwater. When the reservoir is in surface spill, mysis are not available because they do not occupy the surface of the lake. Also, when the dam is releasing the minimum flow of 50 CFS, this flow likely does not produce enough velocity to entrain mysis into the tailwater — however, this is supposition and has not been verified with direct observation in the field.

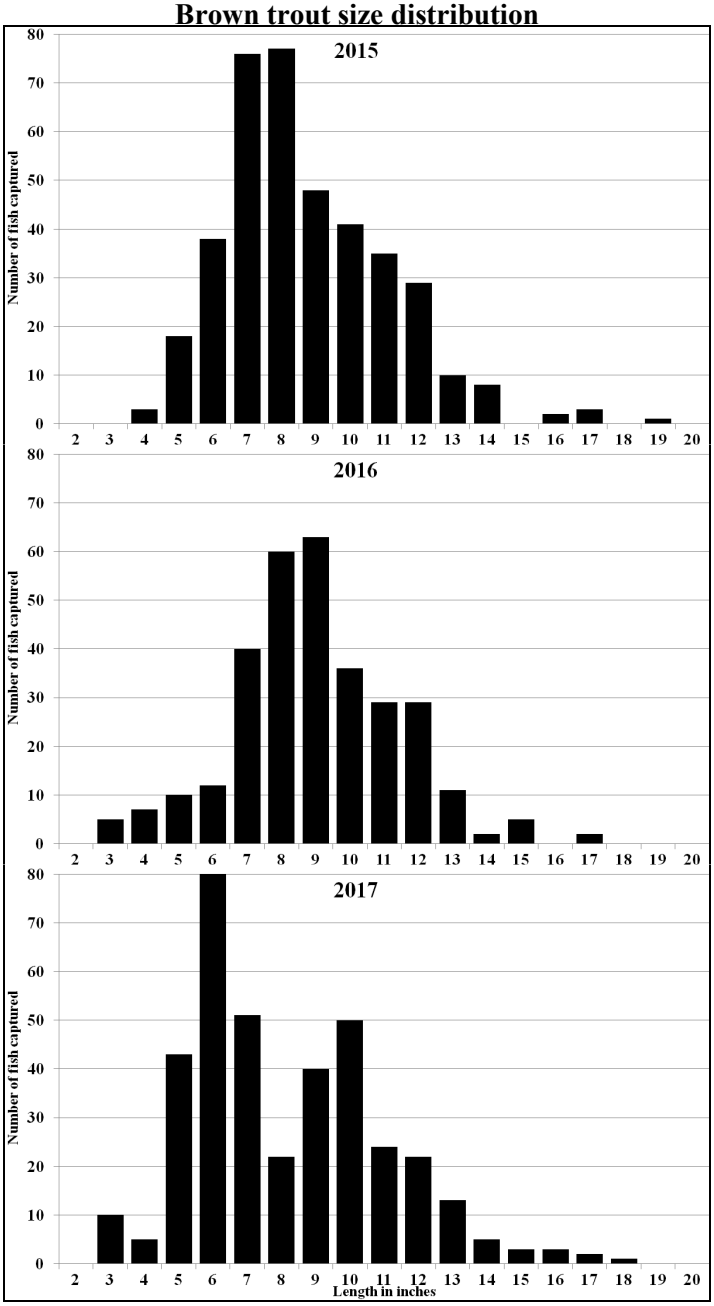
Rainbow trout size distribution





Flows 2014-2017

Brown trout size distribution



The largest fish captured in 2014. 23", 4.2 pounds. Interestingly, this fish appeared to be of hatchery origin but was not marked.

The size distribution of brown trout from the past three years' surveys is shown at left. The lack of separation between year classes is an indicator of slow growth in this reach of river. The size structure of the brown trout population has been relatively low quality, and fish larger than 14" have been rare. In 2012, a larger number of quality-sized (>14") brown trout were captured (see table on page 2), yielding much higher population estimates that year. It appears that due to the dense accumulation of rainbow fingerlings that took place in 2012, this section of river was probably the recipient of immigrating larger brown trout that were attracted to the prolific —but temporary— forage base. Due to the lack of growth and recruitment, rainbow fingerlings have not been stocked since 2012. Subsequently, the density of brown trout >14" has fallen back to levels observed prior to 2012.

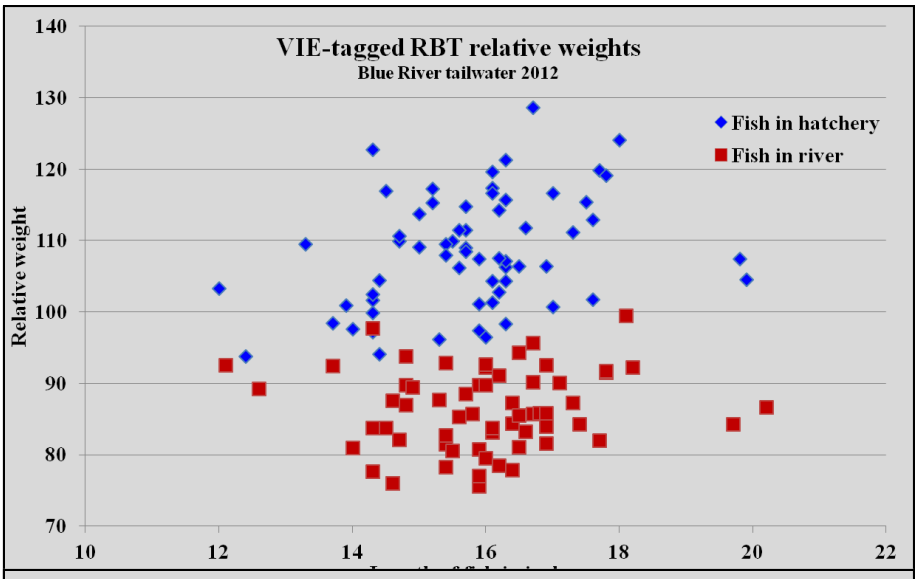
Conclusions

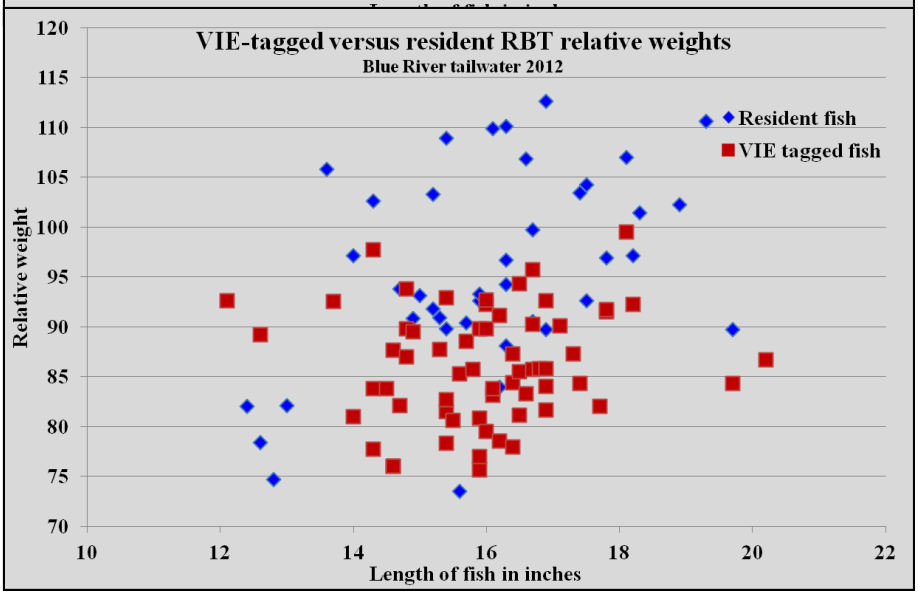
Changes in the rainbow population during recent years reflect the experimental changes in stocking strategies described in this report. Essentially, what we have found is that the only rainbows making a large contribution to the fishery are the annual brood cull plants. All other sizes of rainbows stocked have been ultimately unsuccessful, except as providing an artificial forage base for brown trout.

There are many aspects of this information which suggest that this fishery does not benefit from a constant supply of mysis from Dillon Dam, but rather realizes occasional benefits based on operational patterns. In years such as 2014 when a large volume of water is released from depth rather than surface spill, we have seen generally better body condition and growth. In years such as 2010 when the runoff period consisted mostly of surface spill water, we have seen remarkably poor body condition. We are aware that the invertebrate population on this reach of river is sparse, thus the entire fishery is apparently heavily dependent upon the input of mysis from dam releases. There is a tradeoff however, because the abnormally low temperatures that result from the bottom releases appear to have a negative impact on the productivity of the river and may have a detrimental effect on invertebrate production. We have maintained the density of large rainbows by stocking only brood culls, and intend to continue with that strategy indefinitely. This section of river would benefit from larger-scale improvement efforts, which may consist of operational changes at Dillon dam or other innovative enhancement efforts such as artificial augmentation of organic material or nutrients to attempt to enhance aquatic insect production within the reach.

VIE Tag Study

In order to assess individual growth in the brood cull plants and thus gain some further insight into growth rates, in 2012 and 2013 we placed Alpha-VIE tags (pictured at right) into a portion of the brood culls that were stocked. These tags allow individual fish to be identified with a unique alpha-numeric code. Time constraints prevented the entire batch from being tagged. In 2012, 493 (61%) of the 825 total fish stocked were tagged, and in 2013 496 (56%) of the 880 tootal fish stocked were tagged. The fish were tagged at the Glenwood Springs hatchery prior to stocking, and at that time lengths and weights for the tagged fish were recorded.





Results

2012

70 individually tagged fish were captured in the survey, 61 of which were weighed. From the time of tagging, these 70 fish gained an average of 5 mm in length, with the fastest-growing individual gaining 17 mm. Much more revealing is the change in weight that occurred, displayed in the graph at left. This depicts the body condition of 61 fish at the time of tagging in the hatchery, and the same fish 18 weeks later in the river. On average, these fish lost 18% of their body weight. At the time of tagging the average relative weight (a measure of body condition or "plumpness") for these 61 fish was 108.4. At the time of the survey, their relative weights had dropped to 86.2.

The second graph (left) compares the 61 tagged and weighed fish in the sample with "resident" rainbow trout in the same size range. These were fish captured in the sample that were not tagged or adipose-clipped, indicating that they have been in the river since sometime prior to 2011. Average body condition of the resident fish was 95.6. So, the 2012 brood culls went into the river in significantly better body condition than the resident fish, and by mid-August had lost enough weight that they were in significantly worse body condition than the resident fish. One question that will be answered in 2013 is whether or not these brood cull plants eventually become accustomed to the conditions and improve their body condition after another year in the river.

2013

In 2013, we captured 57 tagged fish. Five of those had been tagged in 2012, and the remaining 52 were tagged in 2013. The fish that were tagged in 2012 had been in the river for approximately 16 months. Those five fish had a body condition factor of 74.5. The 52 fish that had been tagged in 2013 had an average body condition factor of 87.6. This suggests that the weight loss that we observed in 2012 for fish that had been in the river for 18 weeks after stocking continued for the 16 months that the 2012 fish had been in the river. However, the sample size for the 2012 fish was quite small (five fish), and probably doesn't allow for generalizations.

Growth in length for the five 2012 fish averaged 19 mm from the time they were stocked. Average growth for the 52 fish stocked in 2013 was 4 mm. Both of these values represent very slow annual growth.

2014

The fish that were stocked in 2014 were not individually tagged. There were a total of 19 tagged fish captured. 16 had been tagged in 2013 and three had been tagged in 2012. The three fish from 2012 had grown an average of 57 mm while in the river. The 2013 fish had grown an average of 26 mm. The complete records for these 19 fish are shown in the table below. Cells for which there is no observation contain a dash. There are multiple interesting observations that can be made from this table. The most common scenario that we have observed is slow growth and a loss of body condition, and sometimes even gross weight, every time a tagged fish is recaptured. A few fish appear to have lost weight and body condition in the year after they were stocked but recovered in 2014, with 6 fish actually surpassing their hatchery weight, but not their hatchery body condition. No fish have maintained their hatchery body condition after being stocked. Improvements in growth and/or body condition in some of the fish in 2014 is probably explained by the release regime (previous page). Because of work taking place on the dam, all of the water, even during the high flow period, was released from the gates at the bottom of the dam and no water spilled off the surface of the reservoir. Therefore, in 2014 the fish probably had a supply of mysis shrimp from the deep-water releases for the first time since 2011. 2012 and 2013 flows were most likely too low to entrain mysis in the reservoir and release them through the dam.

Tagged fish captured in 2014

Tag ID	Year tagged	Length in hatchery	Weight in hatchery (Wr)*	2013 length	2013 weight (Wr)	2014 length	2014 weight (Wr)
T44	2012	284 mm	250 g (91.3)	319	301 (77.7)	358	470 (85.9)
U22	2012	409	950 (116.6)	-	-	437	-
U94	2012	386	700 (102.1)	-	-	456	1092 (96.8)
V02	2013	409	778 (95.5)	421	773 (87)	434	-
V40	2013	383	698 (104.3)	-	-	390	590 (83.5)
V68	2013	371	632 (103.8)	-	-	393	-
W09	2013	410	789 (96.1)	419	723 (82.6)	439	886 (88.0)
W57	2013	383	619 (92.5)	-	-	416	-
W70	2013	384	683 (101.2)	387	588 (85.1)	394	495 (67.9)
X00	2013	411	919 (111.2)	413	769 (91.7)	413	732 (87.9)
X01	2013	403	824 (105.7)	-	-	411	720 (87.1)
X08	2013	367	611 (103.7)	-	-	368	413 (69.5)
X33	2013	470	1318 (106.7)	-	-	523	1765 (103.9)
Y70	2013	442	1040 (101.2)	-	-	489	1269 (91.3)
Y99	2013	357	458 (101)	-	-	381	305 (46.3)
Z02	2013	404	858 (109.2)	-	-	427	850 (91.7)
Z69	2013	401	800 (104.2)	405	726 (91.8)	427	882 (95.2)
Z75	2013	389	754 (107.5)	-	-	421	-
Z96	2013	373	653 (105.6)	377	590 (92.4)	446	-

*Wr = relative weight, a measure of the fish's body condition on a scale of 100.

Forest Service Station

On August 15, 2013, we conducted an electrofishing survey of a reach behind the Forest Service office in Silverthorne (see map at right). This is a site that has been surveyed repeatedly in the past but not since 2008. The surveyed reach is 630 feet long and encompasses multiple riffle-pool-run complexes.

Results for surveys dating back to 2004 are displayed below. The 2013 survey was significantly earlier in the year, so comparisons should be made with caution. However, it is interesting to note how consistent brown trout biomass has been on all four occasions. Rainbow estimates have been more variable; however the differences can be directly attributed to stocking strategies in effect at the time. For instance, in 2008 brood fish were stocked in this location, but in more recent years all the brood fish have been stocked upstream of I-70 because of the tagging study. It is obvious that if they were not stocked regularly, rainbow trout would comprise a relatively small portion of the fishery in this location.

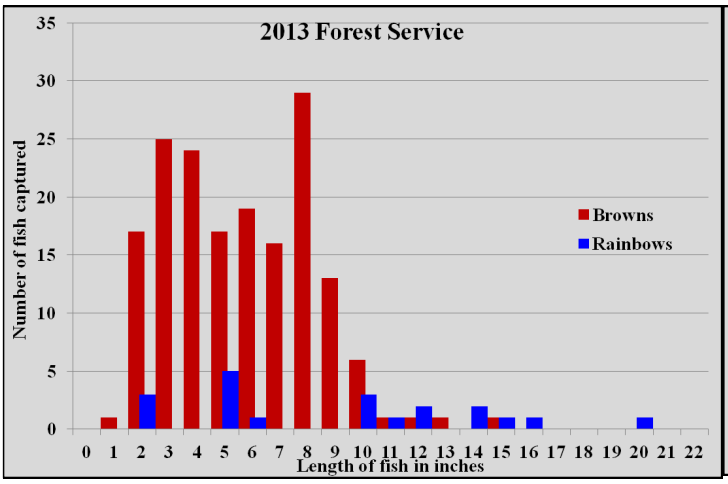
The graph below left displays the size distribution of brown and rainbow trout captured in 2013. All five rainbows >14" were adipose -clipped, indicating that they were brood fish that had moved downstream into this reach from their original stocking location.

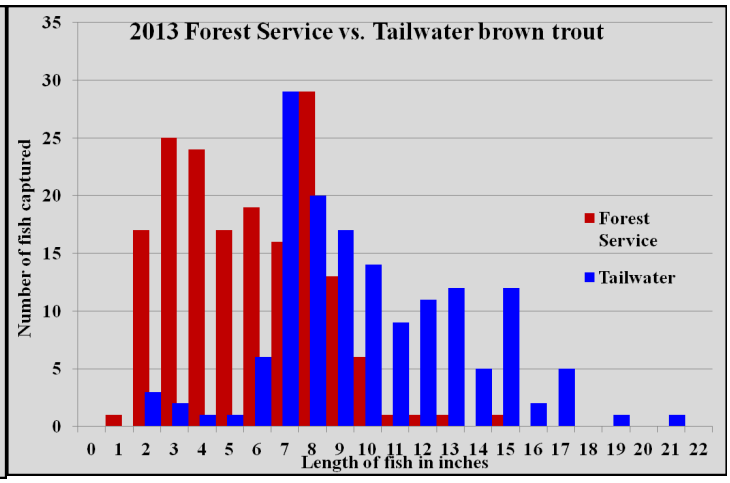
The graph below right displays the size distribution of brown trout captured at this site and at the tailwater site in 2013. The population at the Forest Service site was skewed toward small fish more than the tailwater site, and very few brown trout greater than 10" were found. It is possible that as brown trout in this area reach greater sizes, they tend to move closer to the dam in search of a better food supply.

Interestingly, the years with the highest densities of brown trout per mile (2004 and 2013) were also the years with the lowest rainbow trout densities. It is possible that the stocking of large rainbow trout at high densities suppresses brown trout numbers here.

In 2013 this section did not meet the criteria for Gold Medal designation (60 lbs./acre biomass AND at least 12 fish greater than 14"). The same is true for 2004. Without the input of rainbow stocking, it is likely that none of the four surveys would have met those criteria.

	2004	2005	2008	2013
Date of survey	10/22	10/27	10/24	8/15
Rainbows: # > 6"/mile	313	429	461	101
# >14"/mile (surface acre)	11 (1)	84 (15)	314 (56)	42 (8)
Biomass (lbs./acre)	5	59	110	18
Browns:# > 6"/mile	1,185	477	235	897
#>14"/mile (surface acre)	45 (4)	59 (11)	59 (11)	8 (2)
Biomass (lbs./acre)	37	39	30	39





Campground Station

	2011	2015	2017
Date of survey	8/17 & 19	5/5 & 7	5/9 & 11
Rainbows: # > 6”/mile	90	27	44
# >14”/mile (surface acre)	19 (2)	15(1)	93(9)
Biomass (lbs./acre)	8	4	6
Browns:# > 6”/mile	521	231	415
#>14”/mile (surface acre)	43(4)	51(5)	26 (2)
Biomass (lbs./acre)	25	18	31
#days in previous 3 years flows <100 CFS	446	493	224

The largest rainbow from this reach in 2017, 23.3”

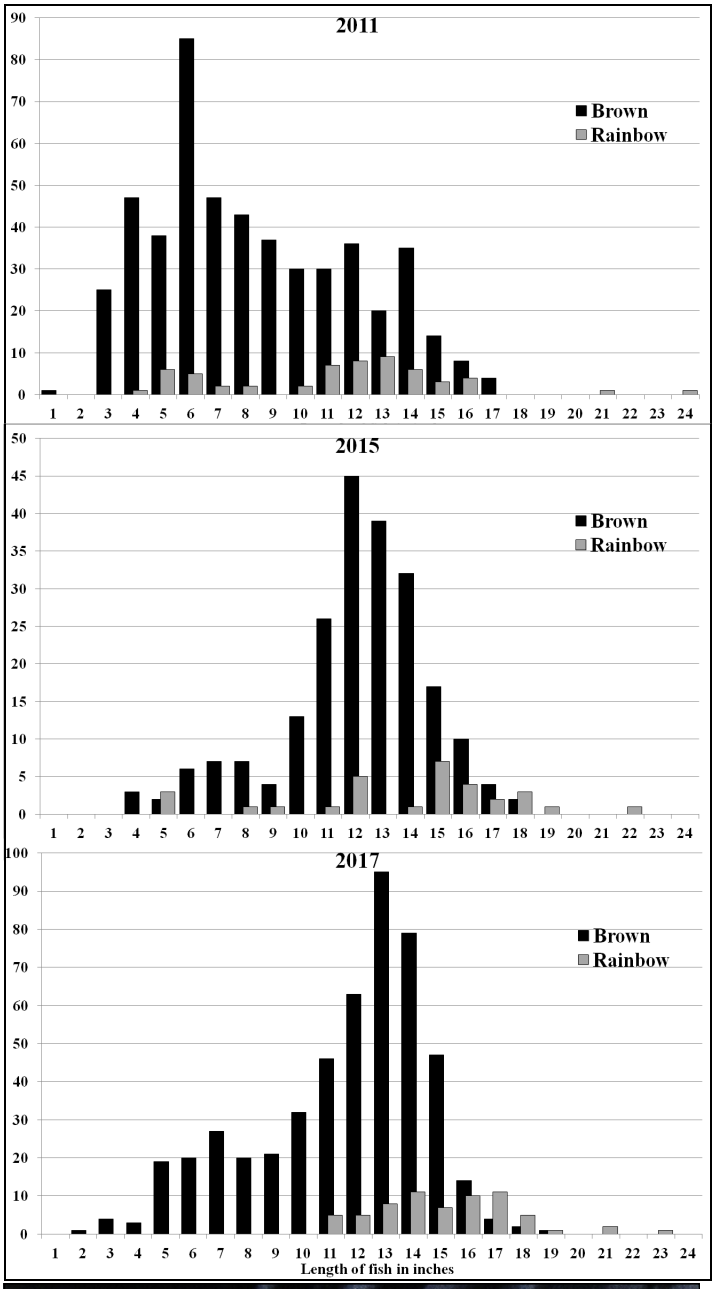
The section of the Blue River adjacent to the USFS Blue River Campground has been surveyed multiple times over the past decade. In 2011, 2015, and 2017 we surveyed the two-mile section of river shown in the photo at left by raft electrofishing. The 2011 survey was conducted in August, and the 2015 and 2017 surveys took place in May. The date was moved to May because the minimum flow for us to float this section (200 CFS) is more reliably available at that time.

Population estimates from these surveys is shown in the table at left. These results, along with information from other past surveys, is what led CPW to remove Gold Medal designation from this reach in 2016. The minimum biological criteria for the designation is “Any river, stream segment, or standing water which is producing a standing stock of at least 60 pounds per acre and at least 12 trout 14 inches or longer per acre on a sustained basis.” (CPW administrative directive W-14) None of the three estimates since 2011 have met that standard.

Reasons for the lack of productivity on this reach of the Blue are not fully understood. There are some areas with obvious physical habitat shortcomings (particularly when Dillon releases are less than 100 CFS) but we do not believe this to be the only limiting factor, because another characteristic of this reach is extremely slow trout growth. This suggests food or biological productivity limitations.

Some flow information is included at the bottom of the table. We have anecdotally observed that Dillon releases less than 100 CFS appear to negatively impact physical habitat availability on this reach. Therefore, it’s interesting to note that many of the population parameters in both 2011 and 2017 were better than in 2015, which had the highest number of days in the previous three years when Dillon releases were below 100.

During our spring surveys, Dillon releases have not yet increased to high levels but the tributary streams are in early runoff mode. As a result, we often find brown trout gorging on earthworms near tributary confluences.



The white tips and excellent condition of the dorsal and anal fins on this 2017 rainbow suggest that it was not raised in a hatchery.

The size distribution of brown and rainbow trout that we captured on the campground reach is shown at left. Note the different scales of the x-axis. There was a much greater representation of juvenile brown trout (4-8") in the 2011 sample than in 2015 and 2017. This is not unusual when comparing fall vs. spring samples. In the spring, fewer juvenile brown trout are present because winter mortality is high for small fish, and fish born that year have not yet emerged.

The only year with a significant number of juvenile rainbow trout was 2011. We had stocked 3" fingerlings the year before in Silverthorne (see page 2), and it is possible that the 4-8" rainbows that we captured in 2011 were the result of this stocking.

We were surprised to capture a higher number of good quality rainbows in 2017. Some of these fish are pictured below. Because we have not surveyed this reach annually and have not been able to track individual year classes, their origins are a mystery. We know that there is some private stocking that occurs upstream of this reach. However, the condition of these rainbows was excellent and they did not appear to be of hatchery origin (see photos). It is possible that these fish are the same large group of fingerlings that were present in Silverthorne in 2012 but had disappeared by 2013. The slow growth rates that we have observed on the Blue correspond with this theory. Because of these findings, we plan to stock 50,000 3" rainbow fingerlings on the campground reach in 2018. This will be the first time we have stocked fingerling rainbows on the Blue since 2012.

The tail fin of this larger rainbow captured in 2017 is in excellent condition, with straight fin rays coming to clean points. Fish raised to adult sizes in hatcheries rarely have fins this clean, suggesting that the origin of this fish is likely a past fingerling plant.