BONNEVILLE CUTTHROAT TROUT RESTORATION IN THE MAMMOTH CREEK DRAINAGE: 2021 ACTIVITIES

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Introduction

Native Bonneville cutthroat trout (BCT) were confirmed 98% pure in Mammoth Creek in 2012. The Mammoth Creek BCT Restoration Project was subsequently formulated with the goal of removing nonnative trout – primarily brook trout – from the Mammoth Creek drainage upstream of Mammoth Spring (Figure 1). Description of the drainage, history of fish management, details of the project, and progress through 2020 can be found in Hadley, et al. 2015, Hadley and Golden 2016a and b, Hadley and Golden 2019, Hadley and Golden 2020, and Hadley and Golden 2021.

Activities during 2015-2019 focused on nonnative trout removal in Mammoth Creek's tributaries. In 2020, the final phase of the project was commenced with nonnative removal in main stem Mammoth Creek and the Meadow Lake system. Salvage of remnant BCT was conducted during the 2020 treatment to maintain the genetic representation of the Mammoth Creek population. Drought-related complications experienced during rotenone application were mitigated by experienced crew. Coordination with private landowners presented a challenge to treatment logistics, but those efforts resulted in valuable cooperative relationships that facilitated BCT conservation. The final treatments of the main stem and Meadow Lake drainage were conducted in 2021, followed by introduction of BCT throughout the drainage. This report details those activities conducted in 2021.

Pathogen Surveys

Brook trout collected in Meadow Lake Creek upstream of the lake prior to rotenone treatment in 2020 were tested for infection by *Myxobolus cerebralis*, the parasite that causes whirling disease, at the Fisheries Experiment Station (FES) in Logan. (This testing was intended to continue documentation of the spread of whirling disease throughout the Mammoth Creek drainage.) Results received in 2021 showed that the pathogen has infected the Meadow Lake system. Testing over the years of the project has shown that whirling disease has spread throughout the Mammoth Creek drainage, except in Reed Valley Creek and John L Flat Creek.

BCT Salvage

The infection of Mammoth Creek BCT with whirling disease has made replicating the population difficult. Utah's fish pathologist approved salvage and temporary holding of BCT during rotenone application in 2020. Attempts to collect eggs from remnant fish in the stream – including one final attempt in 2021 – have been unsuccessful. It was determined, following this final attempt, that BCT would be salvaged one more time during the 2021 treatment and that the lower reach of the project area (from Mammoth Spring upstream to the waterfalls above Castle Creek [Fig. 1]) would be repopulated only by the remnant BCT. The rest of the drainage would be stocked with BCT fingerlings produced by the Manning Meadow brood. This would allow the remnant population to be genetically represented in the new population, while allowing for timely reintroduction to satisfy both conservation and recreation needs. On July 12, 2021, crews collected 130 remnant BCT from the Mammoth Creek reach downstream of Castle Creek. The fish were held in a transport tank until rotenone concentration had sufficiently dissipated on July 16, then were returned to the stream in the same vicinity where they were collected (Fig. 2).

Rotenone Treatments

Drought-induced low stream flow and dewatering complicated rotenone application in

2020 (Hadley and Golden 2021). The primary recommended adjustment for repeat treatments in 2021 was to conduct the project in mid-July, about three weeks earlier than in 2020. However, even more severe drought conditions persisted in 2021, resulting in multiple dry stream reaches by early June (Fig. 3). Mammoth Creek was completely dry in two reaches: from just below the Lowder Creek confluence, down to the waterfall gorge above the Castle Creek confluence; and from near the confluence with John L Flat Creek to Mammoth Spring (Fig. 4). These dry reaches totaled nearly 3 miles (4.6 km) of Mammoth Creek. In addition, tributaries Lowder Creek, John L Flat Creek, and Reed Valley Creek also dried up before reaching Mammoth Creek. The drought-induced dewatering prompted project staff to split rotenone application into multiple projects from late May to mid-July, accomplishing each application with fewer personnel and less complicated logistics.

Harber Private Pond

The Harbers' upper private pond was not treated in 2020 because it was unknown during the treatment whether the pond contained brook trout (Fig. 5). In addition, the pond was disconnected from the remainder of the drainage, so treatment – if needed – could be delayed until after the family's fishing season had ended. However, the pond froze over shortly after brook trout were found in the pond in November, postponing treatment until spring 2021. Liquid rotenone was applied to the pond on May 26, 2021, using backpack sprayers and a small water pump-aspirator system. Rotenone (5% active ingredient) was applied at a concentration of 1.5 parts per million (ppm). No water was flowing out of the pond at the time of application. Table 1 lists personnel that participated in the treatments in the Mammoth Creek drainage in 2021, with assigned tasks. 2.5 gal (9.5 L) of rotenone were applied to the upper Harber pond on May 26 (Table 2). No fish were observed on the day of the treatment. Two gill nets were set overnight in the pond one week after the treatment and caught no fish. A noticeable smell of rotenone was still present at the pond one week after application. Based on these results, it was determined that the treatment was successful in removing all fish from the pond. Ten-inch tiger trout were stocked in the pond by Mammoth Creek Hatchery in mid-June, after sufficient time for the rotenone to break down. The fish were provided to the pond owners to replace those lost to the treatment. The Harbers reported that the tiger trout survived well and provided valuable angling opportunity throughout the summer.

Meadow Lake and Tributaries

The extreme upper headwater of Meadow Lake Creek, which was isolated from the remainder of the stream by a reach of subsurface flow in 2020, was sampled by electrofishing in June 2021 and found to be fishless. The combination of lower flows, no fish observed in June 2021, and observations of seemingly high efficacy of rotenone during the 2020 treatment (Hadley and Golden 2021) led to the determination that this reach needed no further treatment in 2021.

Project personnel planned to treat Meadow Lake and its inflow as early as possible in 2021, so that the lake could be restocked early in the summer and provide angling opportunity to local cabin owners. The Martin family (owners of the lake) offered to fit tubes to the lake's outflow culverts, to act as a temporary fish passage barrier in between treatment of the lake and the system below, which was originally anticipated to be up to 1.5 months apart. Because Mammoth Creek dried up within a relatively short distance below Meadow Lake, detox of rotenone below the lake was not necessary as the pesticide would be allowed to carry

downstream to the dry reach. Project staff determined that upstream reinvasion of the lake by nonnative trout in Mammoth Creek was extremely unlikely and a temporary barrier below the lake was not needed.

The Meadow Lake tributaries were treated on June 15-16, 2021. Three 35-gal (7-hr) drip barrels were set near the heads of three spring tributaries at 10:00 pm on June 15, while a fourth was also set just below the confluence of the spring tributaries at the same time (Fig. 6). A fifth was set in another spring tributary at 4:00 am on June 16. (This tributary is ditched from its source through the Meadow Lake subdivision and was previously found to be fishless.) Flow in the spring tributaries was found to be moving more slowly than anticipated during the 2020 treatment, so those drips were set one hour earlier in 2021. The four drips in the spring tributaries were set for a second charge in the morning. Two "micro" drips (32-oz bottles) were also set on seeps in the spring tributaries. Spray crews walked each stream reach and applied rotenone in areas of low mixing. A total of 2.10 gal (7.95 L) of rotenone was applied to Meadow Lake Creek and its tributaries above the lake (Table 3) – 1.34 gal by drip stations and 0.76 gal by sprayers. 2.11 mi (3.40 km) of Meadow Lake Creek were treated on June 15-16 (the lowest reach was treated by outflow from the lake) (Table 3). No fish were observed in the target area.

Fifty gallons (190 L) of liquid rotenone were applied to Meadow Lake on the morning of June 16 (Table 2). The pesticide was spread throughout the lake area using a boat-mounted aspirator system. In addition, liquid rotenone was applied to the shorelines and shallow areas with backpack sprayers. No fish were observed in the lake. Rotenone was allowed to flow out of the lake and treat Meadow Lake Creek and Mammoth Creek down to the dry reach near the Lowder Creek confluence.

Mammoth Creek Headwaters

Liquid rotenone was applied to Mammoth Creek from its headwaters to the upper dry reach on June 29 and 30, 2021. In 2020, crews pulled beaver dams in the headwaters on the day before the treatment in order to improve flow between ponds. Instead, the ponds became isolated with no flow in between. As an adjustment, the beaver ponds were sprayed with 0.9 gal of rotenone on the afternoon of June 29, 2021, and the rotenone was allowed to flow out overnight. Once application to the rest of the stream was completed on June 30, the beaver dams were pulled to flush rotenone downstream out of the ponds. This strategy appeared to work much better than that in 2020.

The remainder of the Mammoth Creek headwaters were treated using five 35-gal (7-hr charge) drip barrels and two 7-gal (4-hr charge) drip barrels. The 35-gal barrels were set at major headwater points as well as locations along streams to act as boosters to the flow (Fig. 7). Most of these started applying rotenone at 11:00 pm on June 29 to facilitate overnight application and achieve coverage of the target area by morning. Some of the drips were set for a second charge on the morning of June 30. Seven-gal barrels were set on tributaries at 6:00 am on June 30 and were run for a single, 4-hr charge. Spray crews were assigned to inspect the entire treatment area for potential refugia and areas of low mixing and applied rotenone to these sites with backpack sprayers. Sentinel fish were set in the stream in buckets upstream of boosters to monitor rotenone arrival from upstream sources. Boosters were pulled when it was observed that rotenone had reached that point.

Complications experienced during rotenone application included a broken drip head on Drip 1 that allowed the rotenone to flow out too fast overnight. Conversely, the drip head on Booster 3 was clogged and drained out only 10 of the gallons overnight. Sentinel fish at Booster

4 indicated that rotenone concentration was still sufficiently lethal in the reach between the boosters. Despite these minor complications, no fish were observed anywhere in the treatment reach, indicating that the 2020 treatment was successful in removing all nonnative trout from the headwater reaches. A total of 4.5 gal (17.2 L) of rotenone was applied to the Mammoth Creek headwater reaches on June 29 and 30 (Table 2) – 2.9 gal by drip stations and 1.6 gal by sprayers.

Mammoth Creek Lower

Liquid rotenone was applied to the lower reach of Mammoth Creek between the dry reaches on July 12 and 13, 2021 (Fig. 3). The chemical was applied using two 35-gal (7-hr charge) drip barrels and three 7-gal (4-hr charge) drip barrels. The 35-gal barrels were set just below the Castle Creek confluence, as well as at the upper fish passage barrier to act as a booster to the flow (Fig. 8-9). These started applying rotenone between 10:00 and 11:00 pm on July 12 to facilitate overnight application and achieve coverage of the target area by morning. Both drips were set for a second charge on the morning of July 13, though the booster was pulled at 8:30 am when sentinel fish indicated that rotenone had reached that point from Drip 1. One of the 7-gal barrels was set in Mammoth Creek at the low end of the dry reach (just below the waterfalls) at 6:00 am on July 13 in order to treat the 0.3 mile reach above Drip 1. The other two barrels were set on two small spring tributaries near the Castle Creek confluence at 7:00 am and were run for 1 to 1.5 hour. Castle Creek was almost dry at the confluence, so flow was treated by spray crew instead of drip barrel. Spray crews were assigned to inspect the entire treatment area for potential refugia and areas of low mixing and applied rotenone to these sites with backpack sprayers. A total of 3.6 gal (13.5 L) of rotenone was applied to the lower Mammoth Creek reaches on July 12 and 13 (Table 2) – 2.9 gal by drip stations and 0.6 gal by sprayers.

The only fish observed during the treatment on July 12 and 13 were a number of BCT that were missed during salvage on July 12. Two brook trout were removed from this reach during qualitative electrofishing the week previous to the treatment, marking the only nonnative fish observed to have persisted through 2020 treatments and 2021 drought conditions. Because Mammoth Creek was dry below the treatment area down to Mammoth Spring, detox operations were not necessary. Approximately 8.82 miles (14.2 km) of Mammoth were treated with rotenone between the two treatments in June and July 2021 (Table 3).

Stocking

Ten-inch tiger trout were stocked in two private waters (Harber Pond, Meadow Lake) to replace fish lost to rotenone treatments and provide cooperative partners with angling opportunity immediately following the treatments. Fingerling (2-inch) BCT produced from the Manning Meadow brood were stocked throughout the upper Mammoth Creek drainage during August and September 2021 (Fig. 10, Table 4). A total of 31,210 BCT were stocked between the two events. BCT were stocked in Lowder Creek because population monitoring discovered that the fish previously stocked there had not successfully established or persisted. Monitoring did find suitable numbers of adult BCT in the Sidney Valley reach of Castle Creek (also restored in previous years), so no more fish were stocked there. BCT stocking was requested for the Castle Valley reach of Castle Creek in October; however, early snowstorms created ice and snow bridges over the stream and the fish could not be stocked.

Discussion

Project activities in 2021 concluded nearly a decade's worth of BCT conservation work in the upper Mammoth Creek drainage. Surveys and rotenone treatments found that 2020 treatment efforts were very successful in removing nonnative trout from the target area, despite complications experienced during application. Stocking efforts will continue for at least two more years to establish a minimum of three BCT cohorts in most of the project area. The lowest reach of the restoration project (Castle Creek confluence downstream to Mammoth Spring) will be populated by the remnant BCT salvaged during the 2020 and 2021 treatments. Efforts will also be made in the coming years to monitor survival and spawning in this reach. When these populations are fully established, the upper Mammoth Creek drainage will provide up to 26 miles (42 km) of habitat for BCT (Table 5).

Literature Cited

Hadley, M. J., M. E. Golden, and J. E. Whelan. 2015. 2014 survey of Bonneville cutthroat trout in the upper Sevier River drainage, Utah. Publication Number 15-04. Utah Department of Natural Resources, Division of Wildlife Resources, Salt Lake City. 32 pp.

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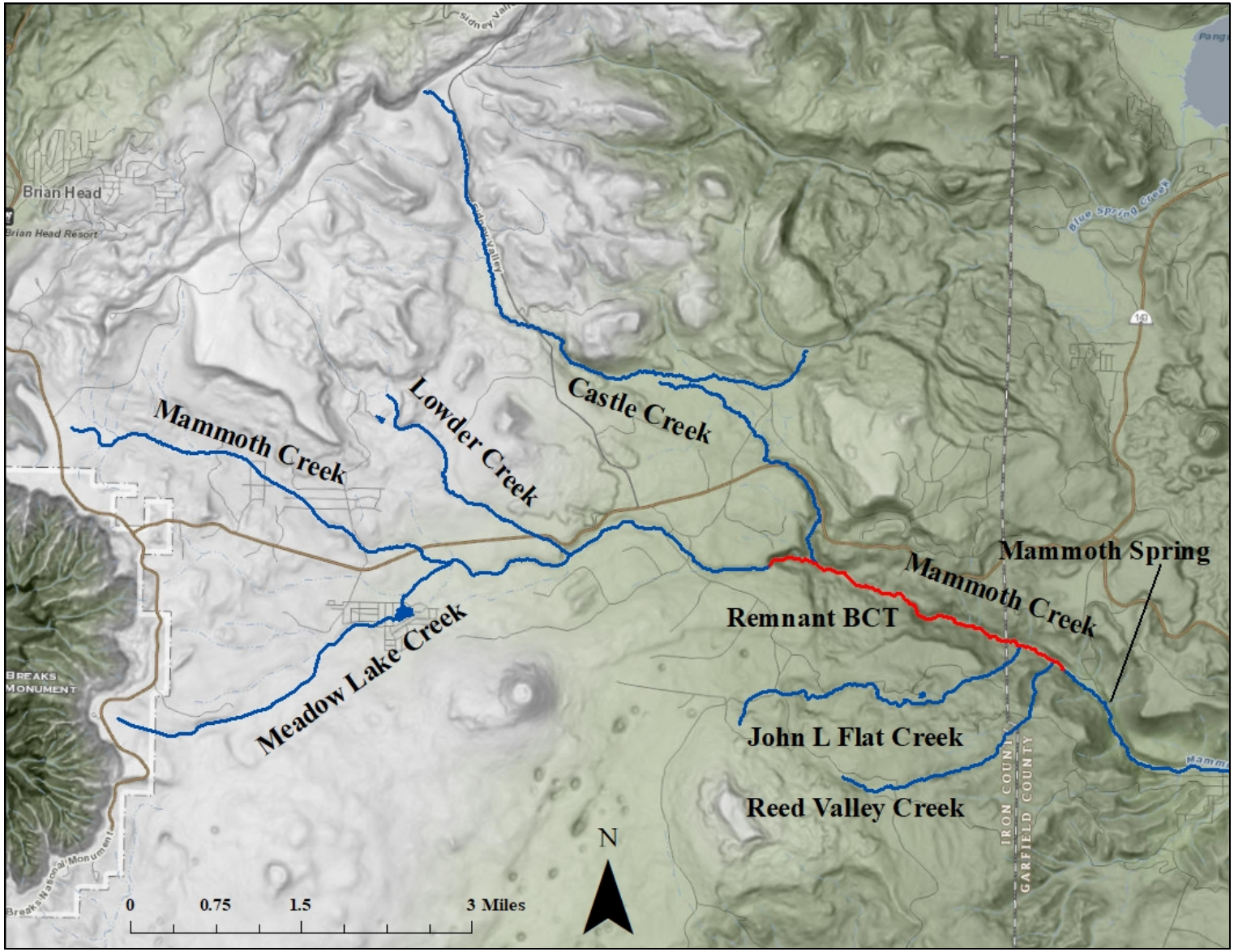

Figure 1. Upper Mammoth Creek drainage, including reach occupied by remnant BCT (highlighted in red).

Figure 2. Salvaged BCT are packed and released into Mammoth Creek.

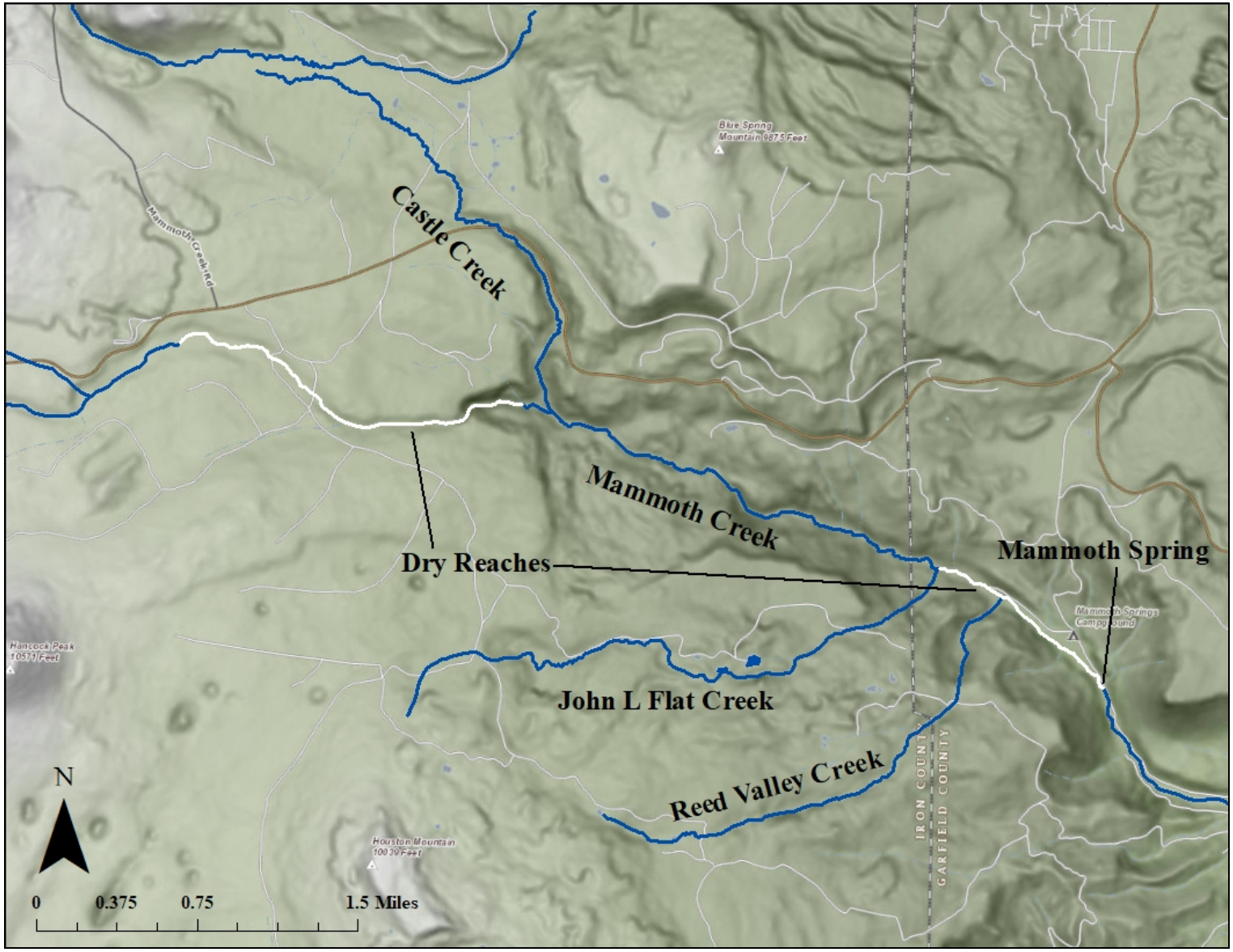

Figure 3. Reaches of Mammoth Creek (highlighted in white) that dried up during summer 2021.

Figure 4. Mammoth Creek, dried up at the lower fish passage barrier, in late June 2021.

Figure 5. Location of the upper Harber private pond.

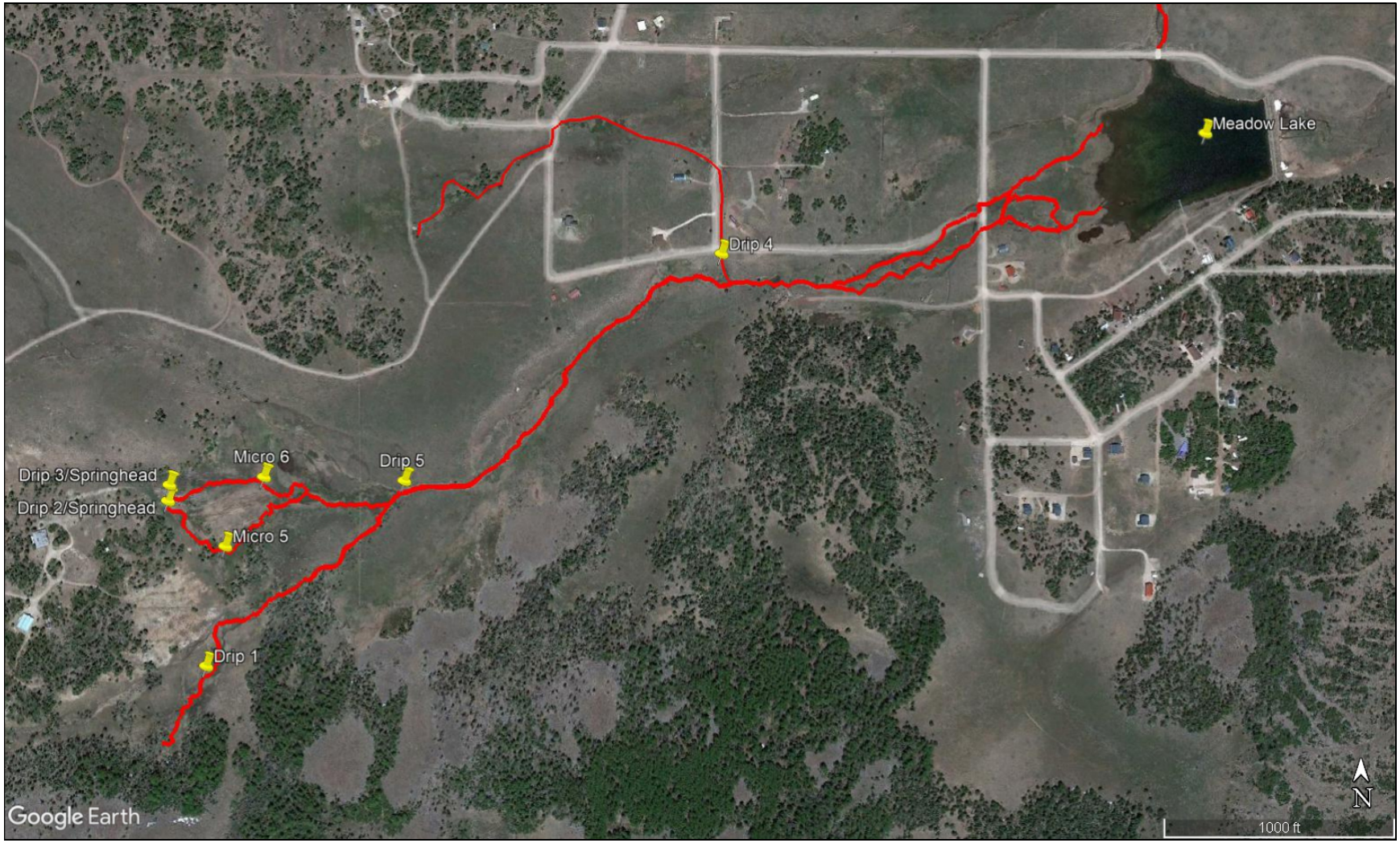

Figure 6. Locations of rotenone drip stations set in the headwaters of Meadow Lake.

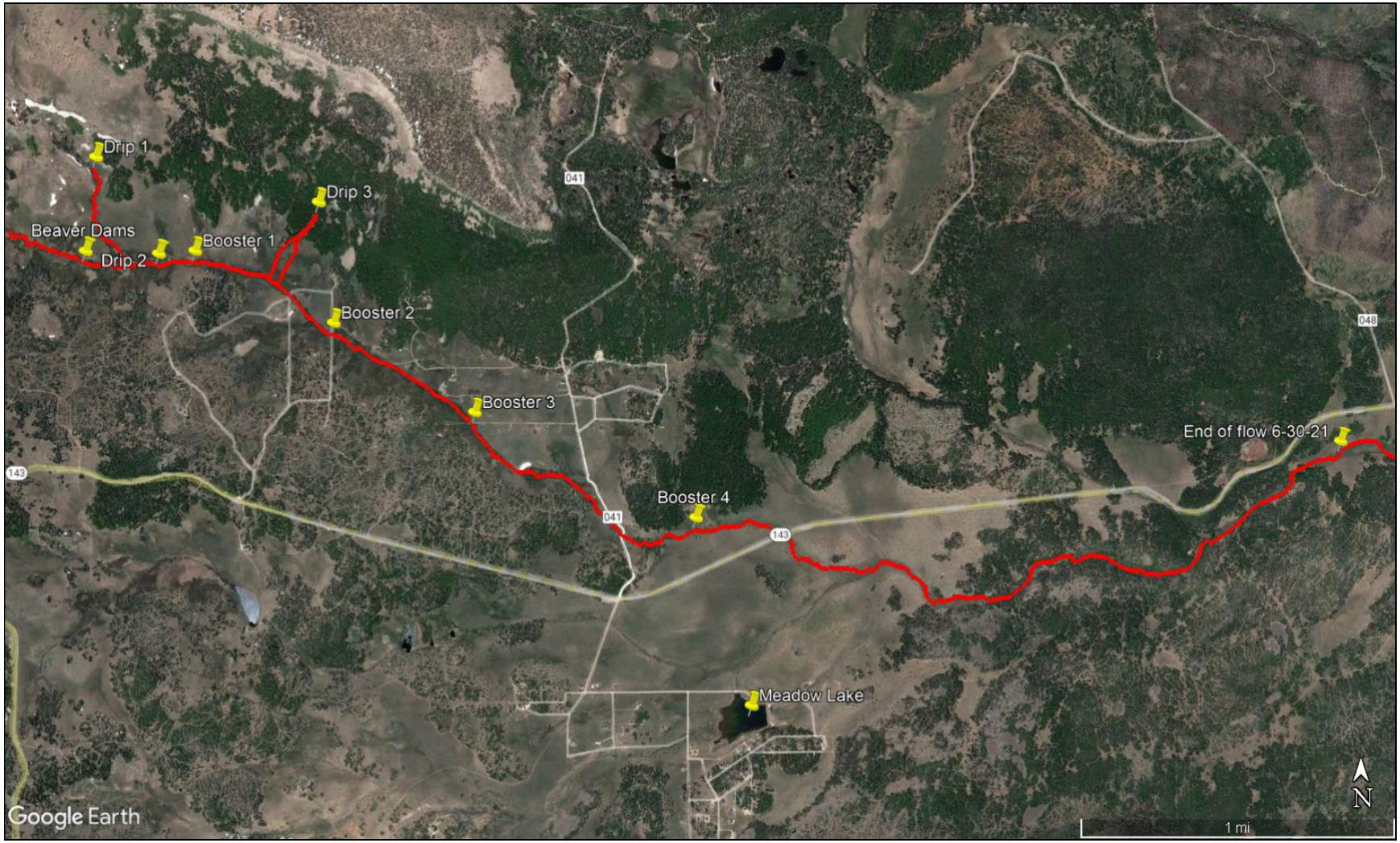

Figure 7. Locations of rotenone drip stations set in the headwaters reaches of Mammoth Creek.

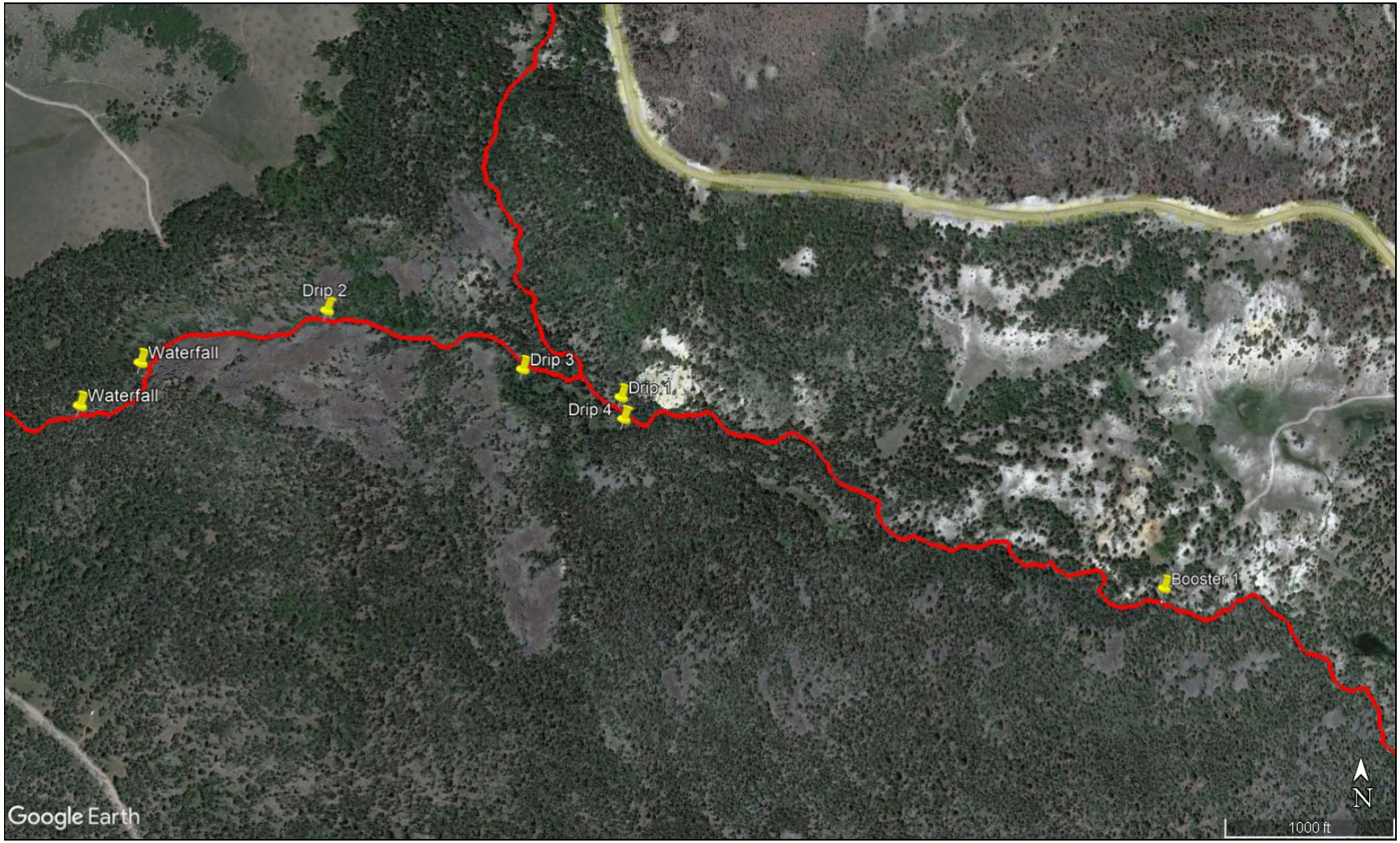

Figure 8. Locations of rotenone drip stations set in Mammoth Creek between the waterfall and upper fish passage barrier.

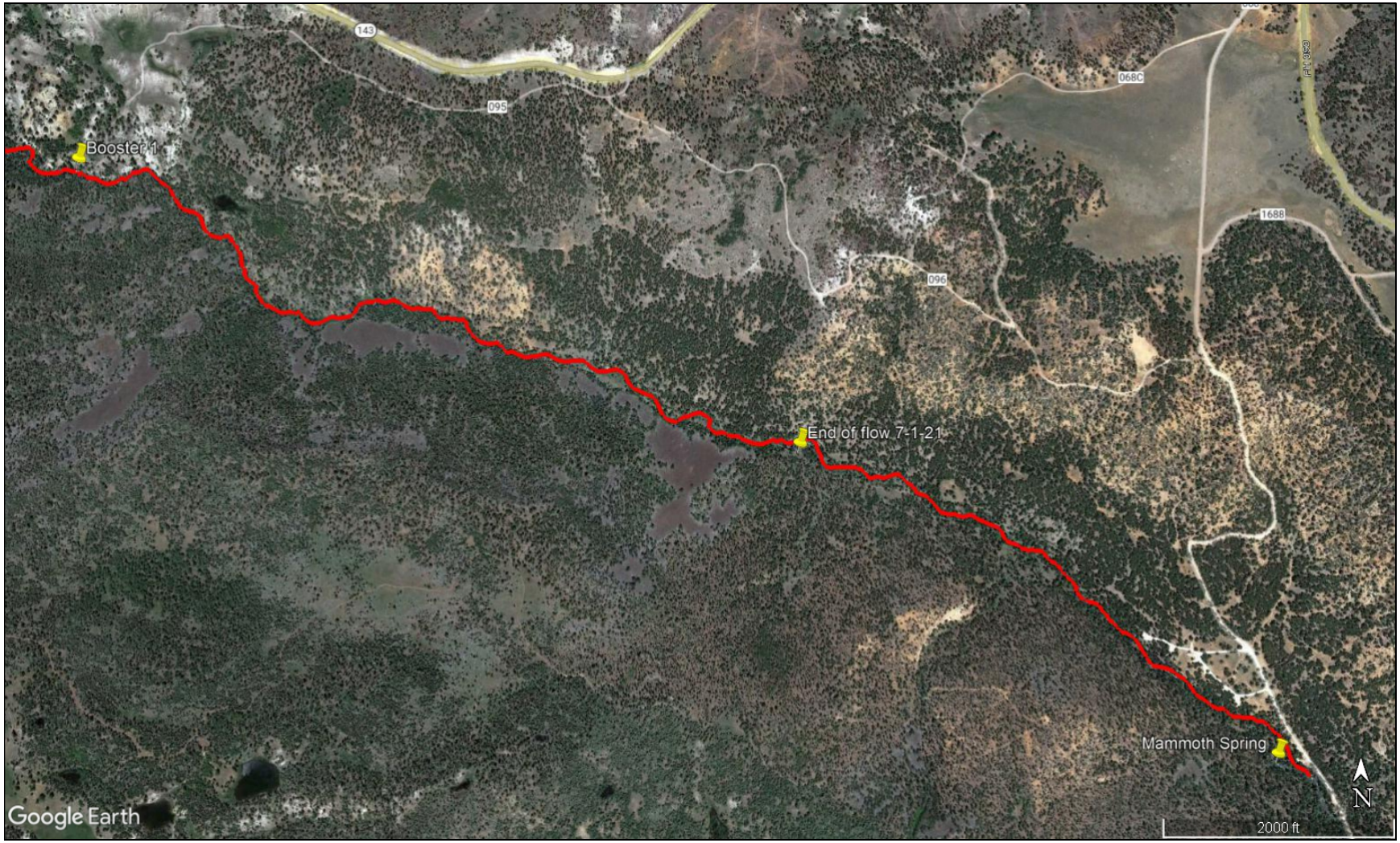

Figure 9. Locations of rotenone drip stations set in Mammoth Creek between the upper fish passage barrier and dry reach.

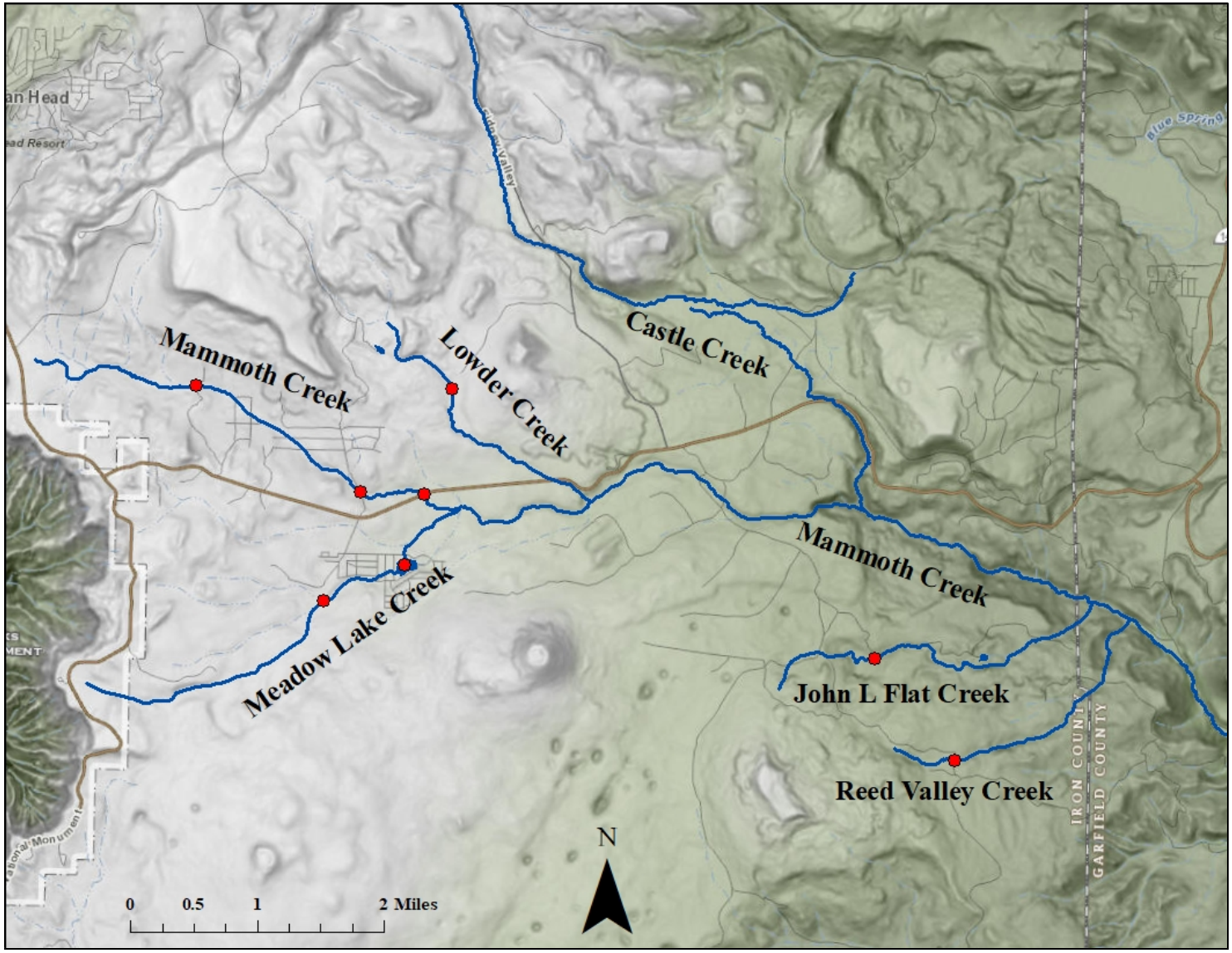

Figure 10. Locations BCT fingerling stocking in the Mammoth Creek drainage during August and September 2021.

Table 1. Project personnel and assignments for chemical treatments in the Mammoth Creek drainage in 2021.

Personnel	Assignment
Upper Harber Pond: May 26, 2021	
Mike Hadley, UDWR SRO	Planning, recon, supervise, pond application (pump)
MaKayla Roundy, UDWR SRO	Pond application (spray)
Trent Utley, UDWR SRO	Pond application (spray)
Meadow Lake and Creek: June 15-16, 2021	
Mike Hadley, UDWR SRO	Planning, recon, supervise, drip, lake application
Richard Hepworth, UDWR SRO	Lake application
MaKayla Roundy, UDWR SRO	Lake application
Trent Utley, UDWR SRO	Lake application
Abby Silva, UDWR SRO	Drips, spray
Jens Swensen, FNF	Drips, spray
Logan Ekker, FNF	Drips, spray
Cat Berrick, DNF	Drips, spray
Ryan Handeland, DNF	Drips, spray
Meghan Krott, BLM	Drips, spray
Jon Hudson, UDWR SRO	Spray
Nathan Dorn, UDWR SRO	Spray
Kevin Wheeler, UDWR WCFO	Lake shoreline spray crew
Tyson Victor, UDWR WCFO	Lake shoreline spray crew
Kathy Liu, UDWR WCFO	Lake shoreline spray crew
Adar Reed, UDWR WCFO	Lake shoreline spray crew
Andrew Hageman, UDWR WCFO	Lake shoreline spray crew
Mammoth Creek headwaters: June 29-30, 2021	
Mike Hadley, UDWR SRO	Planning, recon, supervise, drips
MaKayla Roundy, UDWR SRO	Drips, spray
Abby Silva, UDWR SRO	Drips, spray
Trent Utley, UDWR SRO	Drips, spray
Cat Berrick, DNF	Drips, spray
Ryan Handeland, DNF	Drips, spray
Logan Ekker, FNF	Drips, spray
Jon Hudson, UDWR SRO	Drips, spray
Nathan Dorn, UDWR SRO	Drips, spray
Stan Beckstrom, UDWR SRO	Drips
Mammoth Creek lower: July 12-13, 2021	
Mike Hadley, UDWR SRO	Planning, recon, supervise, drips, salvage
Mike Golden, DNF	Drips, salvage
MaKayla Roundy, UDWR SRO	Drips, spray, salvage
Abby Silva, UDWR SRO	Drips, spray, salvage
Trent Utley, UDWR SRO	Drips, spray, salvage
Logan Ekker, FNF	Drips, spray
Cat Berrick, DNF	Spray, salvage
Danelle Ellington, FNF	Spray
Mike Jensen, UDWR SRO	Salvage

Table 2. Chemical used during 2021 treatments in the Mammoth Creek drainage.

Date and location	Chemical and formulation	Application method	Amount of chemical used	Concentration / rate
May 26, 2021 Upper Harber Pond	Liquid rotenone, 5% active ingredient	Back pack sprayers and pump	2.5 gal (9.5 L)	~1.5 ppm total ingredient
June 15-16, 2021 Meadow Lake Cr	Liquid rotenone, 5% active ingredient	Drip barrels and back pack sprayers	2.1 gal (8.0 L)	~1.5 ppm total ingredient
June 16, 2021 Meadow Lake	Liquid rotenone, 5% active ingredient	Pump and back pack sprayers	50 gal (190 L)	~1.5 ppm total ingredient
June 29-30, 2021 Mammoth Creek	Liquid rotenone, 5% active ingredient	Drip barrels and back pack sprayers	2.16 gal (8.16 L)	~1.5 ppm total ingredient
July 12-13, 2021 Castle Creek	Liquid rotenone, 5% active ingredient	Drip barrels and back pack sprayers	3.6 gal (13.5 L)	~1.5 ppm total ingredient

Table 3. Length of stream and area of lakes treated with rotenone in the Mammoth Creek drainage in 2021.

Stream	Length (mi)	Length (km)
Meadow Lake Creek	2.11	3.40
Mammoth Creek	8.82	14.20
Total	**10.93**	**17.60**
Lake	**Area (ac)**	**Area (ha)**
Meadow Lake	12.00	4.86
Harber Upper Pond	1.20	0.49
Total	**13.20**	**5.35**

Table 4. BCT stocked in the upper Mammoth Creek drainage, fall 2021.

Water Name	Location	No. Stocked Aug 18	No. Stocked Sep 16
Mammoth Creek	Rainbow Meadows Road	5,960	
Mammoth Creek	Little Ireland Road	2,500	
Mammoth Creek	Hwy 143		9,250
Meadow Lake		2,500	2,500
Meadow Lake Creek	Above lake		2,500
Lowder Creek	Big Flat	2,500	2,500
Reed Valley Creek	Reed Valley		2,500
John L Flat Creek	John L Flat		1,000
Total		**10,960**	**20,250**

Table 5. Potential BCT habitat in the upper Mammoth Creek drainage.

Stream	Miles	KM
Mammoth Creek	10.24	16.47
Castle Creek	7.48	12.03
Reed Valley Creek	2.28	3.67
Lowder Creek	2.32	3.73
John L Flat Creek	2.17	3.49
Meadow Lake Creek	1.46	2.35
Total	**25.94**	**41.74**