COLORADO RIVER CUTTHROAT TROUT RESTORATION IN THE NORTH CREEK DRAINAGE: 2022 ACTIVITIES

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Introduction

North Creek is one of the primary tributaries of the Escalante River and drains the southwest slope of Boulder Mountain (Figure 1). North Creek and its tributaries upstream of North Creek Reservoir contain up to 15.5 miles (25 km) of potential trout habitat. This upper drainage is found within the Dixie National Forest (DNF) Escalante Ranger District. Tributaries that are known to sustain trout include White Creek, Twitchell Creek, and the Joe Lay Reservoir outlet stream. North Creek is seasonally dewatered below North Creek Reservoir and surveys by both Utah Division of Wildlife Resources (UDWR) and DNF have found that this reach provides only seasonal or intermittent habitat for trout. Stream temperature and flash floods from side canyons limit trout occupation in lower North Creek, while native speckled dace are abundant. Eleven lakes, reservoirs, and ponds in the headwaters of the basin also sustain trout populations (Fig. 2). Stocking of nonnative trout – including rainbow, cutthroat, and brook trout – was documented as early as the 1940s in the North Creek drainage and likely occurred even earlier. Over time, nonnative trout expanded and replaced native Colorado River cutthroat trout (CRCT) throughout much of the drainage. Stocking of fertile rainbow and brook trout continued in several of the lakes into the mid-2000s.

General plans for CRCT restoration and conservation in Utah were formalized in the late 1990s in the state's conservation agreement and strategy (Lentsch and Converse 1997), followed by a rangewide agreement and strategy in 2006 (CRCT Conservation Team 2006, CRCT Coordination Team 2006). Utah updated its own CRCT conservation strategy in 2020 (Utah CRCT Team 2020). Benefits of and needs for CRCT restoration and conservation in the Escalante River drainage were identified by UDWR in a drainage management plan (Ottenbacher and Hepworth 2003). CRCT conservation efforts in the Lower Colorado River Geographic Management Unit (GMU) – which encompasses the Fremont and Escalante river drainages – are coordinated and completed by a cooperative interagency team, with representatives from UDWR, Fishlake National Forest (FNF), DNF, Bureau of Land Management (BLM), and Trout Unlimited (TU). This team acts as a subset of the range wide CRCT Conservation Team.

Remnant CRCT were first discovered in the Lower Colorado River GMU in the mid-1980s, in East Fork Boulder Creek (Hepworth et al. 2001, 2002). This discovery prompted extensive searches for CRCT throughout the Escalante River drainage, eventually yielding an additional six populations between 1990 and 2011 (Hadley et al. 2014). One of those was discovered in North Creek tributary White Creek in the late 1990s (Hepworth et al. 2001). The White Creek population was isolated from nonnative trout by a natural cascade barrier and was found to be genetically pure (University of Montana unpublished analysis 2001, Evans et al. 2013). Two fish passage barriers were constructed in lower White Creek in 2000 and nonnative trout were removed from the lower 0.3 mile (0.5 km) of stream in 2001. Nonnative trout were discovered in and removed from the reach between the constructed barriers during the mid-2000s, prompting a retrofitting of the lower barrier with a concrete splash pad that removed the plunge pool and prevented reinvasion.

CRCT were transferred from the east and west forks of Boulder Creek to Dougherty Basin Lake in the North Creek drainage from 1997 to 1999 to establish a wild brood population that would support the conservation and restoration of CRCT in southern Utah, as well as provide fish for sport fish stocking. The Boulder Creek populations were identified as pure CRCT by both meristic and genetic analyses (Behnke 1992, Shiozawa and Evans 1994, Hudson

and Davis 2002, Thron and Miller 2002, Shiozawa and Evans 2011). The brood established in Dougherty Basin Lake and the connected Tall Four Reservoir has produced fertilized CRCT eggs since 1999. This two-lake system is isolated from the rest of the North Creek drainage by sinkholes and subsurface flow. Efforts to improve the genetic diversity of the Dougherty Basin brood began in 2014 with the introduction of CRCT from remnant populations in White Creek and Pine Creek, as well as additional transfers from Pine Creek in 2017, 2018, and 2020 (Hadley 2022). Spawning efforts have documented contribution from each of these transferred groups to the brood, though the White Creek population contributed only minimally due to limited numbers of CRCT available for transfer. The Pine Creek remnant was identified as pure CRCT by Toline et al. 1999, Evans and Shiozawa 2005, and Evans et al. 2013.

As a joint effort of the Boulder Mountain Sport Fish Enhancement Project and CRCT conservation, nonnative trout were removed from Twitchell Creek and it headwaters lakes – Long Willow Bottom and Round Willow Bottom reservoirs – in 2001 and 2002 (UDWR 2000, Hadley and Hepworth 2013). One fish barrier was constructed in lower Twitchell Creek to prevent reinvasion from North Creek, while a natural barrier acts as security in the case of passage over the constructed barrier. The reach between the two barriers was treated again in 2006 to remove brook trout that had bypassed the constructed barrier. The barrier was also retrofitted with a concrete splash pad. CRCT produced by the Dougherty Basin brood were introduced to Twitchell Creek after 2002 and are stocked annually – along with sterile tiger trout – in the headwater reservoirs. The stream has maintained a self-sustaining CRCT population for nearly 20 years (Hadley et al. 2021).

A number of CRCT were transferred from White Creek to the headwaters of North Creek in 2014. This reach, isolated from the outlet streams of the Barker reservoirs and Joe Lay Reservoir by natural waterfalls, had been previously observed as fishless. Regular GMU-wide population monitoring conducted in 2020 found that these CRCT had established a population and had spread to 0.5 mi (1.8 km) of upper North Creek (Hadley et al. 2021). The population's primary limitations appeared to be cold stream temperature and additional barriers preventing upstream migration. It was also observed that brook trout occupation extended upstream in North Creek only as far as cascades just upstream of the confluence with the Joe Lay/Barkers combined outlet.

Beginning in the late 2000s, rainbow and brook trout stocking in the North Creek lakes was converted to triploid fish. This change was intended to help facilitate a potential future restoration of CRCT in North Creek, as well as to provide greater security for CRCT brood and conservation populations in the drainage by reducing the opportunity for illegal movement of fertile competing/hybridizing species. Focus on CRCT expansion in the Boulder Creek drainage mostly delayed any further efforts in North Creek for over 10 years, with the exception of the experimental transfer of CRCT from White Creek to the fishless headwater of North Creek. The Boulder Creek project was indefinitely postponed in 2019, however, allowing for a shift in CRCT conservation to other drainages. North Creek was considered a high priority for restoration due to the presence of an assumed barrier (North Creek Reservoir dam), the Dougherty Basin brood, two current CRCT populations, and the previous shift to sterile sport fish stocking. North Creek and its headwaters represent up to 10 mi (15.7 km) of additional CRCT habitat and would provide a location for further combination of CRCT remnants from White Creek, Boulder Creek, and Pine Creek.

Preliminary efforts to restore CRCT in North Creek commenced in 2019 and 2020 and

are summarized in previous reports (Hadley 2020a and b). Efforts in 2021 focused on documenting the presence of diploid (ie. fertile) brook trout in Barker and Joe Lay reservoirs. These lakes are directly connected to North Creek by their outflows and have stream inflow that could support brook trout spawning. Even though brook trout stocking was switched to triploids in the early 2010s, it was deemed plausible that fertile brook trout may still occur in the lakes and pose a threat to CRCT restoration if not removed. Samples of blood were collected from live brook trout caught in both reservoirs in August 2021 and sent to a lab at the University of Washington for ploidy analysis. Of the 42 brook trout collected in Barker Reservoir, all were triploid. Seven of the 34 brook trout (21%) collected in Joe Lay Reservoir were diploid, the rest triploid. While it was not clear whether brook trout were recruiting in Joe Lay Reservoir, or whether these diploid fish were just older fish stocked prior to 2013, it was determined that Joe Lay Reservoir would need to be included in future nonnative fish removal efforts.

Following preliminary project efforts conducted in previous years, the primary phase of CRCT restoration in the North Creek drainage was scheduled to commence in 2022 with removal of nonnative trout (including fertile brook, rainbow, and hybridized cutthroat trout) from North Creek, Joe Lay Reservoir, and North Creek Reservoir. The remainder of this report summarizes those activities.

Coordination

In preparation for the nonnative fish removal efforts set to occur in summer 2022, regional staff consulted the Boulder Mountain Sportfish Advisory Committee in the spring to discuss the situation at Joe Lay Reservoir. The committee was meeting to review and update the Boulder Mountain Sportfish Management Plan. Management in Joe Lay Reservoir focuses on producing trophy brook trout through stocking an appropriate number of triploid fish annually and surveys indicated that this goal was being achieved. The committee was informed of the need to remove fertile brook trout from the lake, as well as a plan to return to the same management strategy (trophy brook trout) as soon as possible following treatments in 2022. The committee members understood the needs of CRCT restoration and were supportive of the treatment plan.

Regional staff also met with shareholders of the New Escalante Irrigation Company in spring 2022 to discuss the project and the potential for coordinating the timing of rotenone treatment for the lowest seasonal water level at North Creek Reservoir. Treating at the lowest level would reduce the amount of rotenone needed to treat the reservoir, as well as negate the need to deactivate rotenone downstream, since the dam outlet would be closed while the reservoir refilled. The shareholders also expressed support for the project but were not able to provide an exact time for the reservoir drawdown. Due to the reservoir's low relative water volume (significant volume has been lost over time due to siltation in the highly erosive sandstone canyon) the reservoir is filled and drawn down multiple times during the year and the exact timing of these events is dictated by snowmelt and summer rainstorms. Regional staff included contingencies for detox effort and maximum reservoir volume in the treatment plan and planned to communicate with irrigators about plans for water level management as the date of the treatment approached.

Rotenone Treatments

Joe Lay Reservoir

Liquid rotenone was applied to Joe Lay Reservoir on the afternoon of July 26, 2022, using backpack sprayers from shore and a raft, and to its tributary spring sources with 7-gal (4-hr charge) drip barrels. The raft was used to treat areas not reached from shore. The grassy portions of the spring inlets and lakeshore were also sprayed. Rotenone (5% active ingredient) was applied at a concentration of 1.5 parts per million (ppm). Piscicide applied by drip stations was subtracted from the total needed to treat the lake volume to avoid elevating concentration over 1.5 ppm. Rotenone was allowed to flow out of Joe Lay Reservoir as part of the North Creek treatment on the following day.

Table 1 lists personnel that participated in the treatments in the North Creek drainage in 2022, with assigned tasks. 6.5 gal (25.1 L) of rotenone were applied to Joe Lay Reservoir and its spring tributary (Table 2). Large brook and tiger trout were observed toward the end of application and ensuing days. No small fish were observed. A gill net was set in the lake on July 28 and allowed to fish overnight. No fish were caught in the net and a noticeable smell of rotenone was still present. Based on these results, it was determined that the treatment was successful in removing all fish from the lake. The requested annual quota of fingerling triploid brook trout was stocked in mid-August by Egan Hatchery.

North Creek

Liquid rotenone was applied to North Creek from its headwaters to North Creek Reservoir on July 26 and 27, 2022, using 35-gal (7-hr charge) drip barrels, 7-gal (4-hr charge) drip barrels, and backpack sprayers. Four-hour drips were set at the Joe Lay Reservoir outlet, upper extent of brook trout in North Creek, identified spring sources that may provide refuge to target fish, and above the migration barrier in Twitchell Creek (Fig. 3-5). Seven-hour drips were set at three locations along North Creek (including above the lower barrier in White Creek) to act as boosters to the flow (Fig. 5-7). Boosters started applying rotenone at 11:00 pm on July 26 to facilitate overnight application and achieve coverage of most of the target area by morning. All three boosters were set for a second, four-hour charge on the morning of July 27. Four-hour drips were set between 6:00 and 7:00 am on July 27 and were run for a single charge. Charges calculated to treat main stream flow (boosters, upper North Creek, Twitchell Creek) were increased above prescribed values in order to account for flows increased by recent rain storms. 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. Travel of rotenone throughout the treatment area was monitored by behavior of resident fish.

The only complications experienced during stream rotenone application occurred in the highest reach of the Joe Lay Reservoir outlet stream, just below the reservoir, and resulted from multiple springs sources, a marsh, and slow travel time. The target area here was small enough that assigned personnel were able to address the issues and achieve complete pesticide coverage by midday. Extensive treatment experience was also vital in this reach, as it allowed personnel to adjust to conditions and solve potential complications.

A total of 5.4 gal (20.5 L) of rotenone was applied to North Creek and other stream sources on July 26 and 27 (Table 2) – 4.6 gal by drip stations and 0.8 gal by sprayers. Application was completed by midday on July 27. Observations by treatment personnel indicated that the treatment was effective in removing most, if not all, fish from the target area. Due to

personnel being diverted to the reservoir treatment, rotenone arrival was only observed at Booster 2. Therefore, measure of travel time was only made for the reach from Booster 1 to White Creek. Rotenone travelled at a rate of approximately 0.36 mi/hr over 8.75 hrs. This rate was very similar to that estimated by pre-treatment flow tests conducted in the reach.

North Creek Reservoir

Rotenone powder was expected to be applied to North Creek Reservoir by a boat-mounted aspirator system on the morning of July 27. Shortly after launch, however, the water pump malfunctioned, leaking oil and spewing smoke. A backup pump was not brought to the treatment, so personnel applied 440 lbs (200 kg) of powdered rotenone (5.5% active ingredient) (Table 3) by hand-mixing the powder into a slurry in buckets of water. The slurry was spread throughout the lake area by boat. In addition, 0.4 gal (1.5 L) of liquid rotenone was applied to the shorelines and shallow areas with backpack sprayers. Turbidity caused by recent rain made fish observation in the reservoir difficult, though a number of nonnative cutthroat trout were observed dead later in the day. Conversely, no indications of application failure or lack of efficacy were noted.

Detox

We attempted to coordinate timing of rotenone application to a lower water level at North Creek Reservoir, when the dam would be closed and detox operation would be unnecessary. Irrigators typically drain and refill the reservoir multiple times during the irrigation season. Unfortunately, the severe drought conditions of 2022 prompted irrigators to change their strategy by mid-July. They determined to leave the reservoir full and spilling during the hottest, driest portion of the summer, then flush it out quickly in the fall, hoping that more water would be able to get past losing reaches in lower North Creek and make it to the Wide Hollow Reservoir diversion. This meant that the reservoir would require treatment at its full volume and that deactivation of rotenone below the target area would be necessary.

Potassium permanganate ($KMnO_4$) was applied to toxic waters at a constant rate using an auger-hopper system to deactivate the rotenone below the target area. The detox station was set in North Creek below the North Creek Reservoir spillway, with a backup station set up 0.3 mi downstream (Fig. 7). The main detox hopper was set upstream of the confluence with Jake Hollow due to the frequency of flood flows that occur in that drainage during rain events. Sentinel fish (brook trout collected in North Creek on July 26) were placed both upstream (to monitor rotenone arrival) and downstream (to monitor deactivation) of the detox station. Application of $KMnO_4$ began at 6:45 am on July 27. Sentinel fish behavior indicated that rotenone from the reservoir application was reaching detox at stressing levels by 10:30 am and at lethal levels by 1:20 pm. A rain storm hit the North Creek drainage during early afternoon on July 27, increasing flows in North Creek just above the reservoir and in Jake Hollow. The backup detox and all sentinel fish cages below Jake Hollow were removed at 3:00 pm to avoid loss to flood level. Additionally, the application rate of $KMnO_4$ was increased to accommodate increased stream flow. Spillover from the reservoir never increased enough to endanger the main detox hopper while Jake Hollow elevated downstream flow for several hours. As flood flow subsided in the evening, the application rate was again reduced. The backup detox was left out of the channel due to the continued threat of rainstorms, more of which occurred on July 29 and 31. None of these subsequent storms elevated flows to the level of that which was seen on July 27.

Sentinel fish placed below detox experienced stress and mortality throughout the first two

days of detox operation, though this was attributed to effects of $KMnO_4$ with the cages being set too close to detox. Other factors that contributed to stress and mortality of sentinel fish were flood sediments accumulating in the cages and higher water temperature in the detox reach, compared to where the fish came from in upper North Creek. Resident speckled dace were also observed to be stressed near the lower sentinel cage, while no stressed fish were observed just 0.3 mi downstream. Ultimately, sentinel cages were moved downstream below the area where $KMnO_4$ was too high. The sentinel fish in the lower cage (1.1 mi below detox) demonstrated that rotenone was effectively deactivated.

It was hoped that rainstorms would actually help shorten detox effort by diluting rotenone concentration and flushing it out of the target area. Sentinel fish placed in North Creek upstream of the reservoir on July 29 lived for seven hours with no signs of stress, indicating that most of the target area was free of rotenone. Water flowing out of the reservoir was sufficiently lethal, however, to continue detox through August 1. Apparently flood flows were not sufficient to dilute rotenone concentration in the reservoir and the turnover rate was slow enough that the rotenone took five days to flush out. $KMnO_4$ application rate ranged from 40 to 80 g/min, though it was applied at 40-50 g/min for most of the detox operation. A total of 800 lbs (363 kg) of $KMnO_4$ were applied at the detox station (Table 3).

Transfer

In spring 2022, pathogen clearance was completed for White Creek to allow for transfer of more CRCT to the fishless headwaters of North Creek. Later, the highest reach where CRCT were likely to establish a population was identified at the Great Western Trail crossing (UTM 120428274E 4198996N, NAD83). CRCT were collected for transfer on October 6, 2022, beginning at the lower White Creek migration barrier and continuing upstream. Only 39 CRCT were collected, however, due to electrofisher malfunction. Those fish were packed into upper North Creek by horse. Unfortunately, eight small brook trout were also collected in and removed from White Creek in between the barriers. This indicates that brook trout were able to bypass the lower barrier in recent years. Prior to the second rotenone treatment in 2023, electrofishing will be conducted to make sure that brook trout have not bypassed the upper barrier. This will also facilitate salvage of more CRCT that can be transferred to upper North Creek. During the treatment, the drip barrel should be placed at the White Creek upper barrier to ensure removal of any remaining brook trout.

Conclusion

2022 marked the greatest progress toward CRCT restoration in the North Creek drainage with the first efforts to remove fertile nonnative fish from 7.9 miles (12.7 km) of stream and 23 acres (9.3 ha) of lakes. Despite a few complications from springs, equipment malfunction, rain, and extended detox, the removal project was assessed as a likely success. The second treatment of North Creek and North Creek Reservoir scheduled for 2023 will more fully evaluate the success of the 2022 project. If that treatment confirms complete removal of nonnative trout, CRCT introduction will commence in the fall with stocking of fingerings produced by brood operations and transfer of adult fish from Pine Creek. Fingerling stocking will continue for a minimum of three years to ensure establishment of multiple cohorts. Transfers from Pine Creek will be repeated as well if sufficient numbers are found in the source waters. Downstream

movement from established populations in North Creek tributaries will also contribute to establishing a robust, genetically diverse population. The 2022 treatment of Joe Lay Reservoir was deemed successful and restoration of the sterile brook trout fishery was commenced with stocking in August. Rapid recovery of this important sport fishery is vital to gaining and/or maintaining public support for native fish restoration.

While the North Creek project has so far focused on CRCT, other native fish species will also be considered for restoration. Speckled dace are common in North Creek below North Creek Reservoir, despite conditions that limit trout. This population should provide ample fish for transfer upstream of the reservoir. Mottled sculpin may also be restored from the nearby population in Boulder Creek. Disease testing will be requested for those source populations in 2023 or 2024 to facilitate transfer to North Creek.

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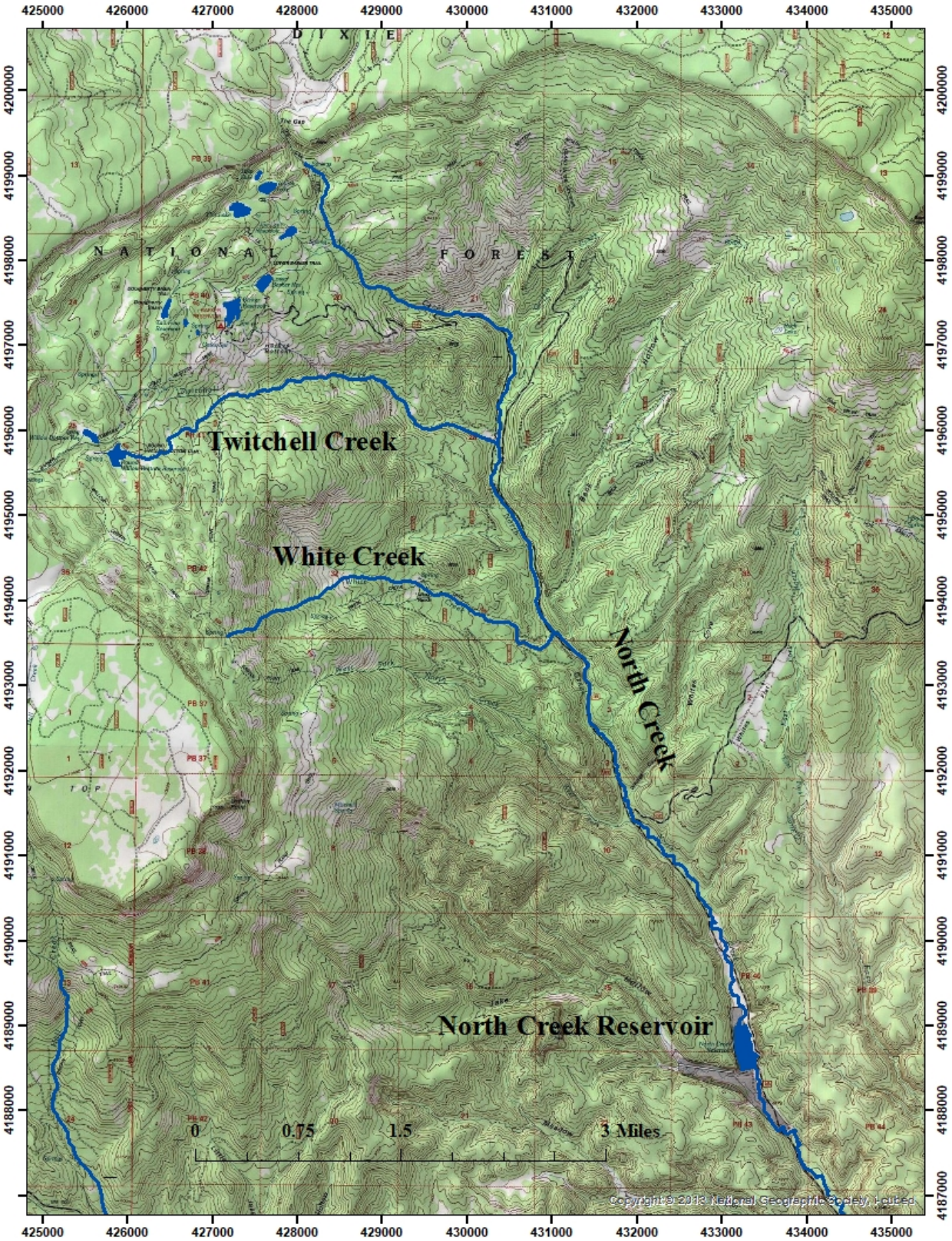

Figure 1. North Creek drainage.

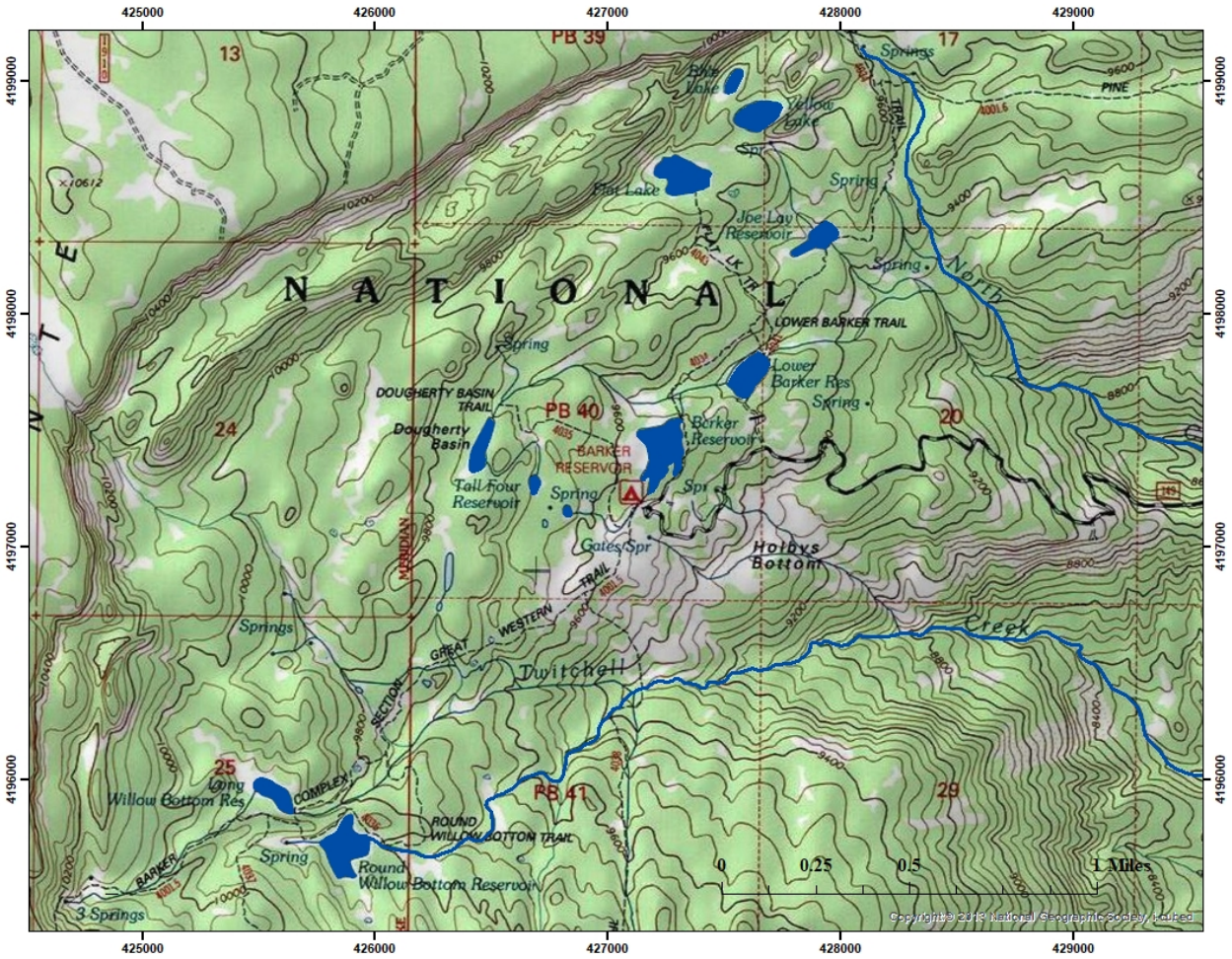

Figure 2. Lakes, reservoirs, and ponds of the North Creek headwaters.

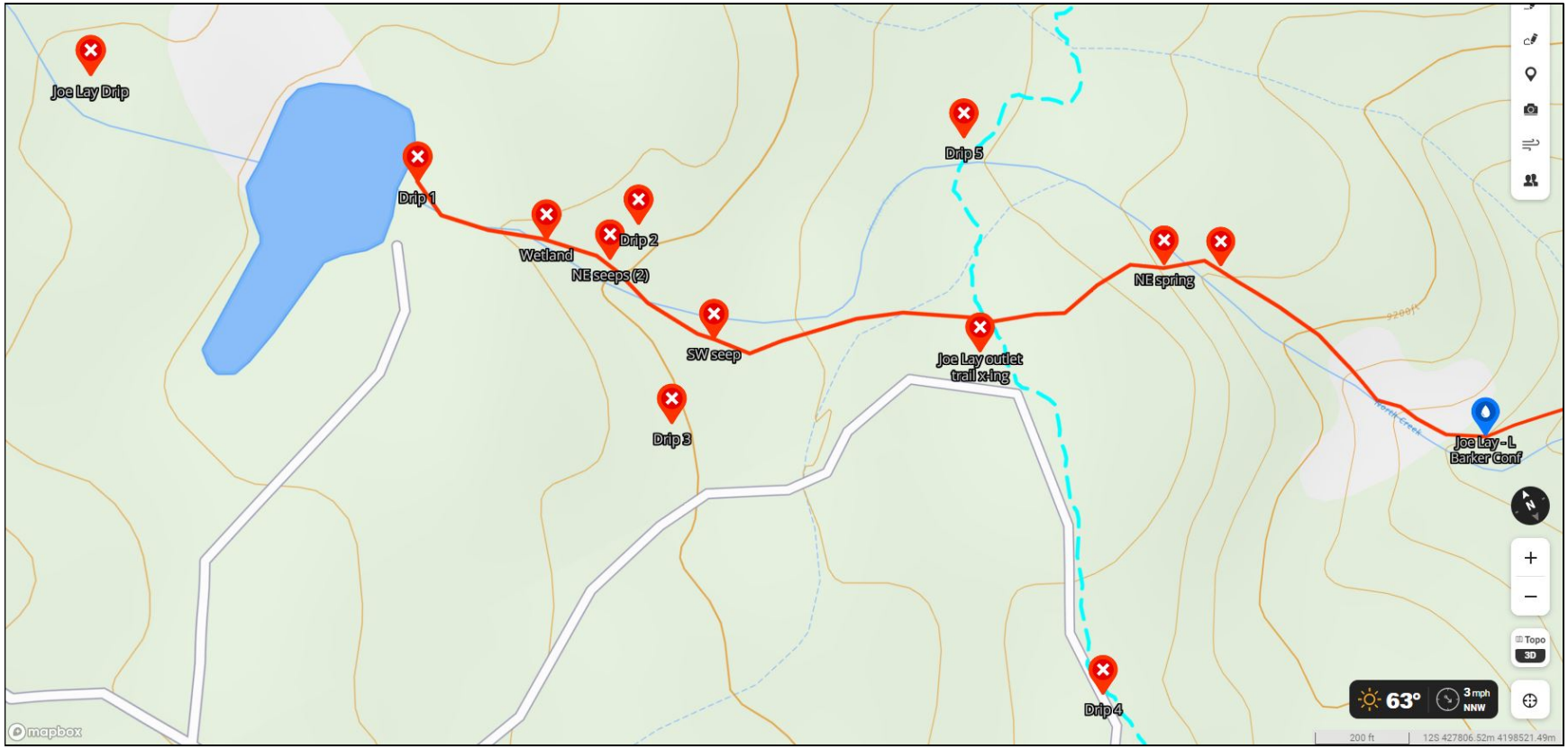

Figure 3. Rotenone treatment plan map for the highest reach – Joe Lay Reservoir and its inlet and outlet streams. The red line more accurately represents the stream location than does the topographic map layer.

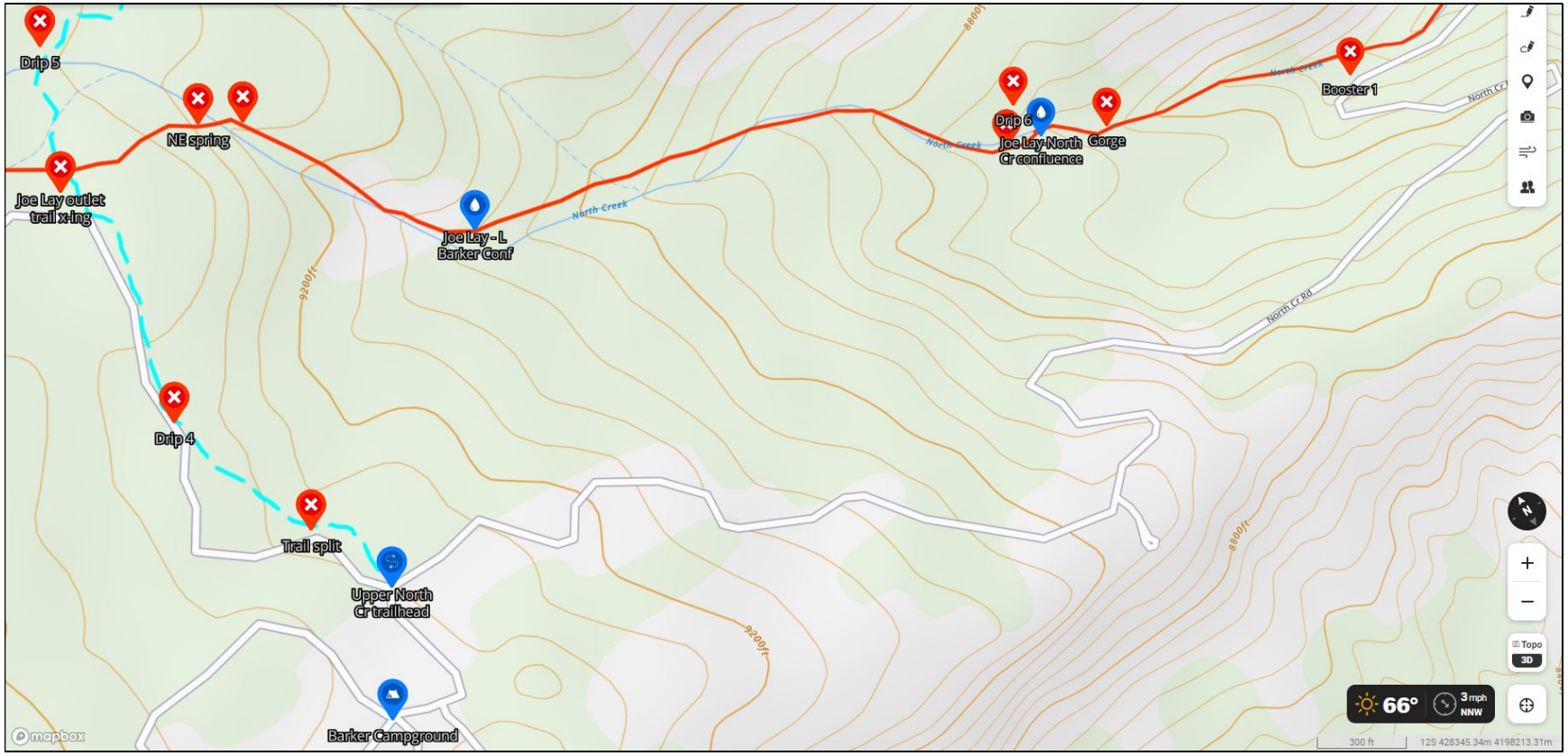

Figure 4. Rotenone treatment plan map for the lower Joe Lay Reservoir outlet reach and upper North Creek reach. The red line more accurately represents the stream location than does the topographic map layer. Other inaccuracies include calling the Joe Lay outlet "North Creek", representing upper North Creek as an intermittent stream (stream entering from the North in the center of the map) and the location of the North Creek-Joe Lay outlet confluence (see pins).

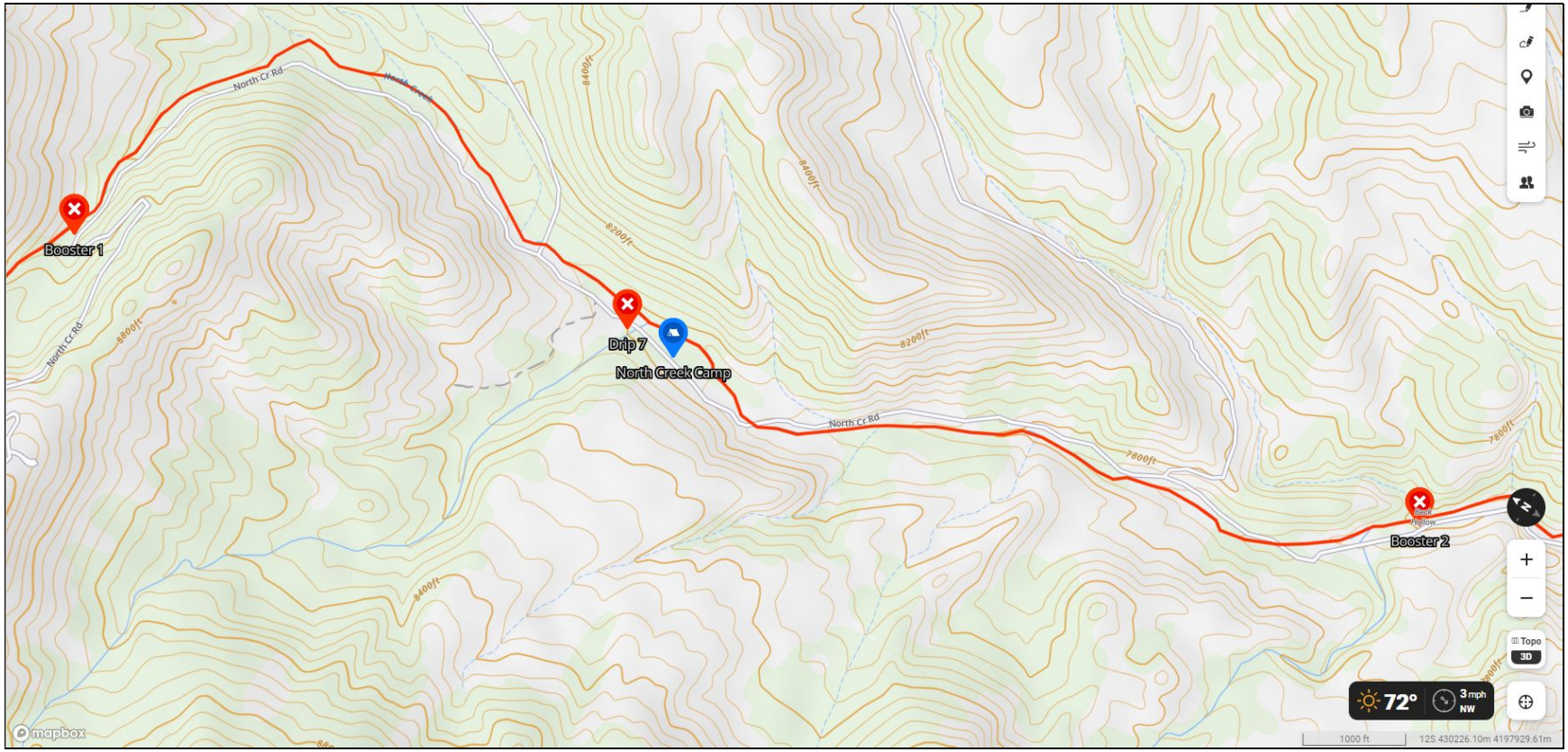

Figure 5. Rotenone treatment plan map for the North Creek reach from Booster 1 to Booster 2.

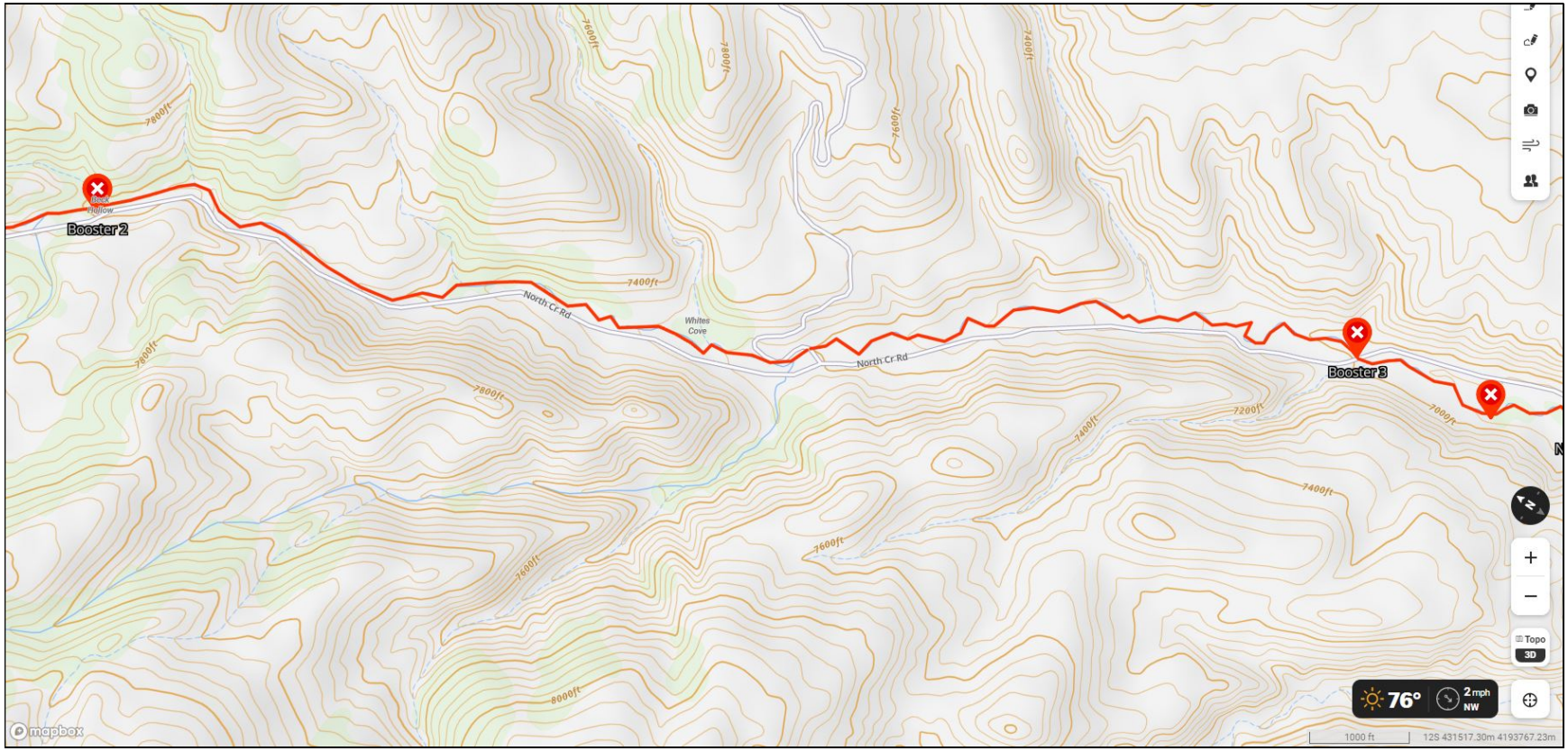

Figure 6. Rotenone treatment plan map for the North Creek reach from Booster 2 to Booster 3.

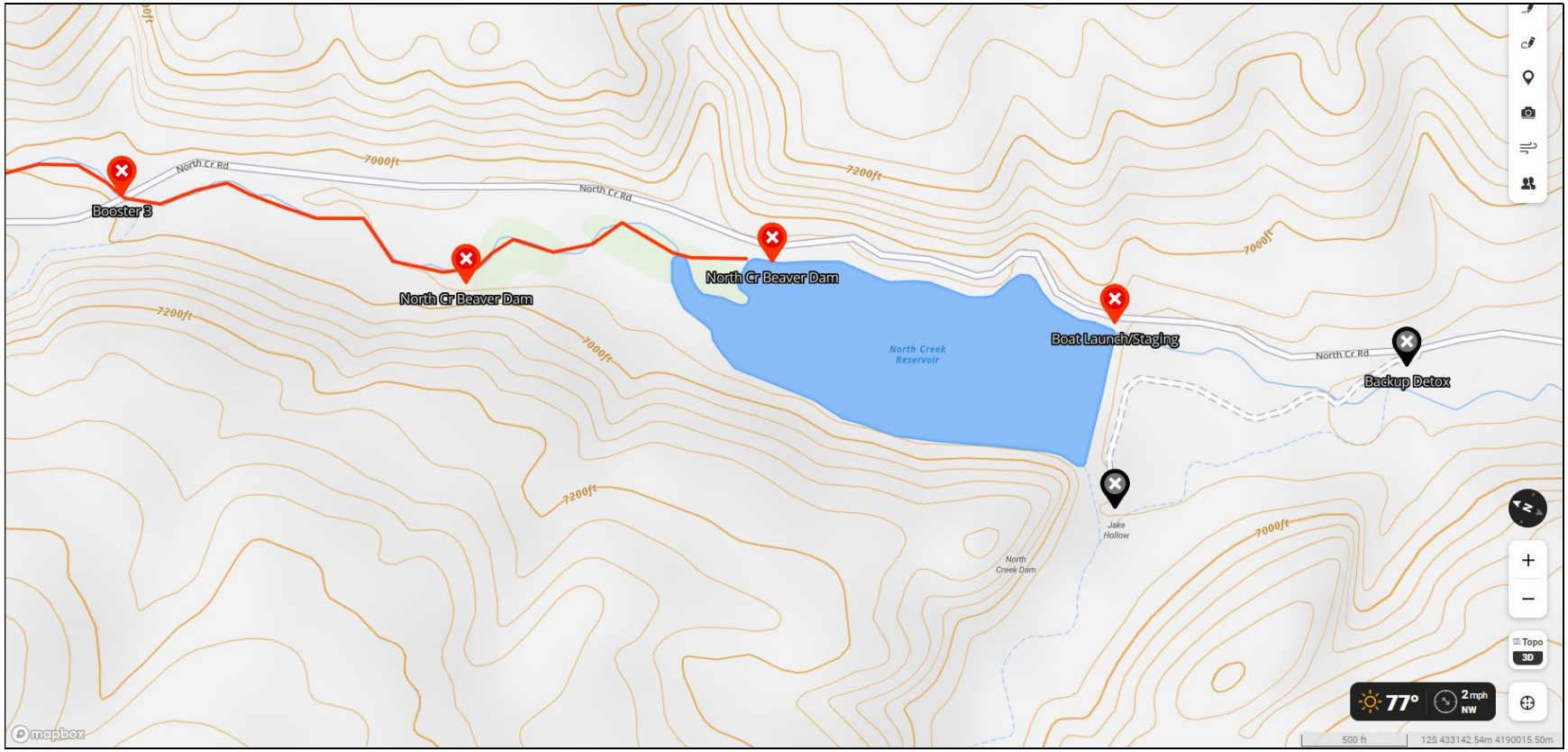

Figure 7. Rotenone treatment plan map for the North Creek reach from Booster 3 to North Creek Reservoir.

Table 1. Project personnel and assignments for chemical treatments in the North Creek drainage in 2022.

Personnel	Assignment
Mike Hadley, UDWR SRO	Planning, recon, supervise
Joe Lay Reservoir: July 26, 2022	
Mike Golden, DNF	Tributary drip, lake application (Spray)
Ashlee Chynoweth, DNF	Lake application (Spray)
Jessica Ellis, DNF	Lake application (Spray)
Nic Braithwaite, UDWR SRO	Lake application (Spray)
Dillon Brown, UDWR SRO	Lake application (Spray)
Teresa Whitesell, UDWR SRO	Lake application (Spray)
MaKaty Thorley, UDWR SRO	Lake application (Spray)
North Creek: July 27, 2022	
Mike Golden, DNF	Drips, spray
Nic Braithwaite, UDWR SRO	Drips, spray
Taylor Shamo, UDWR SRO	Drips, spray
Dillon Brown, UDWR SRO	Spray
MaKayla Roundy, UDWR SRO	Drips, spray
MaKaty Thorley, UDWR SRO	Spray
Mike Hadley, UDWR SRO	Drips
Jens Swensen, FNF	Drips, spray
Paul Stafford, FNF	Spray
Mike Jensen, UDWR SRO	Logistics, food
North Creek Reservoir: July 27, 2022	
Richard Hepworth, UDWR SRO	Powder application
Teresa Whitesell, UDWR SRO	Powder application
Ashlee Chynoweth, DNF	Powder application
Mike Hadley, UDWR SRO	Powder application
Kevin Wheeler, UDWR WCFO	Spray
Luke Matschek, UDWR WCFO	Spray
Jessica Ellis, DNF	Spray
Detox: July 27-Aug 1, 2022	
Chuck Chamberlain, DNF	July 26-28
Mike Hadley, UDWR SRO	July 28-29
Nic Braithwaite, UDWR SRO	July 29-31
Mike Golden, DNF	July 31-Aug 1

Table 2. Chemical used during 2022 treatments in the North Creek drainage.

Date and location	Chemical and formulation	Application method	Amount of chemical used	Concentration / rate
July 26, 2022 Joe Lay Reservoir	Liquid rotenone, 5% active ingredient	Drip barrels and back pack sprayers	6.5 gal (24.6 L)	~1.5 ppm total ingredient
July 26-27, 2022 North Creek	Liquid rotenone, 5% active ingredient	Drip barrels and back pack sprayers	5.4 gal (20.5 L)	~1.5 ppm total ingredient
July 27, 2022 North Creek Res	Liquid rotenone, 5% active ingredient	Back pack sprayers	0.4 gal (1.5 L)	~1.5 ppm total ingredient
July 27, 2022 North Creek Res	Powder rotenone, 5.5% active ingr.	Hand-mixed slurry from boat	440 lbs (200 kg)	~1.5 ppm total ingredient
July 27-Aug 1, 2022 North Creek	Potassium permanganate	Auger	800 lbs (363 kg)	40-85 g/min