McCloud River drainage summary report

June 23-24 and August 10-16, 2011

State of California

Natural Resources Agency

Department of Fish and Game

Heritage and Wild Trout Program

Prepared by Stephanie Hogan and Jeff Weaver

Introduction

The McCloud River, tributary to the Sacramento River, is located approximately 50 miles north of Redding, California in Shasta and Siskiyou counties (Figures 1 and 2). McCloud River redband trout (*Oncorhynchus mykiss stonei; MRRT*) are native to the upper McCloud River and tributaries above Middle Falls and are designated by the California Department of Fish and Game (CDFG) as a Fish Species of Special Concern (Moyle, et al. 1995). In 1994, 1995, and 1997, MRRT were proposed for listing as a federally Threatened species under the Endangered Species Act due to habitat degradation, recreational fishing, and stocking of hatchery fish (USFWS 1994; Rhew 2007). A subsequent conservation agreement was signed by federal, state, and private entities in 1998 which identified threats to the persistence of MRRT, defined conservation actions to prevent listing, including the delineation of a refugium area for MRRT, developing a watershed improvement plan, and implementing a monitoring strategy for grazing and timber practices (USFS 1998). In 1999, due to the protections offered from implementation of the conservation agreement, the U.S. Fish and Wildlife Service ruled to remove the candidate status of MRRT (USFWS 2000).

Recent genetic analysis using mitochondrial and nuclear single nucleotide polymorphisms of *O. mykiss* was conducted throughout this watershed by the CDFG Heritage and Wild Trout Program (HWTP) in conjunction with the University of California Davis (UCD) Genomics Variation Laboratory (GVL). The goal was to quantify hybridization levels between redband and rainbow trout within the system and aid in the development of a conservation strategy (Weaver and Mehalick 2007, 2008). Redband trout populations in Swamp, Edson, Moosehead, and Sheepheaven creeks were not significantly introgressed with rainbow trout, while those in Tate, Raccoon, and McKay creeks and the main-stem McCloud River were highly introgressed (Simmons, et al. 2009). The Sheepheaven Creek population is currently considered one of the most genetically differentiated form of redband trout in California and may, in fact, represent a distinct subspecies (Simmons 2008). Based on the results of these analyses, in 2011 the HWTP conducted population-level monitoring and habitat assessments of putative MRRT populations in Sheepheaven, Edson, Swamp, and Moosehead creeks. The goals and objectives of these surveys were:

- Determine the extent of wetted habitat within each creek.

- Evaluate the population in each creek using single-pass electrofishing to delineate the extent of fish distribution and determine if the population exceeds a minimum population size (N ≥ 100) to justify multiple-pass electrofishing surveys.

- In those creeks where N ≥ 100, conduct population-level fisheries assessments of a minimum of ten percent of the occupied habitat using multiple-pass electrofish to better understand size class structure and relative abundance

of putative MRRT populations in order to estimate the total population within each creek.

- Conduct habitat assessments concurrent with multiple-pass electrofish surveys to document resource condition and gather baseline data on various habitat attributes, including: habitat type(s), substrate, streambank stability, fish cover rating and types, water temperature, streamflow, and other parameters.

Methods

Multiple-pass electrofish methodology was used to generate population-level data including species composition, size and age class structure, and estimates of abundance in upper McKay Creek from Sheepheaven Springs downstream approximately 1.2 miles. This portion of McKay Creek is commonly referred to as "Sheepheaven Creek" and will be referenced as such in this report (the remaining downstream portion will be referred to as McKay Creek). These data can be compared over time to study trends in the population. Multiple-pass electrofish surveys were conducted in Sheepheaven Creek on June 23, 2011 at two locations (Sections 7 and 24). Using Geographic Information System (GIS) software, a point file was created that delineated Sheepheaven Creek into 100 meter segments and each point (with associated geographic coordinates; North America datum 1983) was sequentially numbered. Using a random numbers table, two points were selected. Using Global Positioning System (GPS) equipment, HWTP staff navigated to each randomly selected point and determined survey feasibility. Specific section boundaries were chosen at areas where mesh block nets could effectively be installed and maintained throughout the survey effort with a minimum section length of 300 feet where feasible. If a mesh block net could not be installed at the randomly selected location and/or flows and water depth were not conducive to backpack electrofishing, a new randomly selected location was chosen.

At each section boundary, nylon mesh block nets were installed across the wetted width, effectively closing the population within the section. Both sides of the nets were secured above bankful, heavy rocks were placed side by side along the bottom of the nets, and the nets were secured in such a way as to hold the top of the net out of the water. These nets were routinely monitored and inspected throughout the survey to ensure their integrity and to prevent fish from moving into or out of the section during the course of the survey.

Prior to electrofishing, physical measurements of the stream and environmental conditions were taken, including air and water temperature (ºC) and conductivity (both specific and ambient, in microsiemens). These factors were used to determine appropriate electrofisher settings (Smith Root Model 20B and LR24 backpack units). Due to the low conductivity observed in Sheepheaven Creek, salt was added directly upstream of the upper block net to increase conductivity and, presumably, capture efficiency. Geographic coordinates were recorded for both the upstream and downstream boundaries of the survey. Current weather

conditions were noted and the area was scouted for any species of concern prior to commencing the surveys.

Personnel needs were determined based on stream width, habitat complexity, and water visibility. For each of the surveys, individuals were assigned to shock, net, and tend live cars for the duration of the effort. Surveys were initiated at the lower block net and proceeded in an upstream direction, with netters capturing fish and placing them in live cars (32 gallon plastic trash bins perforated with holes to allow water circulation) to be held until processed. A minimum of three passes were conducted within each section (unless zero fish were captured during the first pass), with fish from each pass stored separately. Over the course of the survey, fish were handled carefully to minimize injury and stress.

Fish were processed separately by pass number. Each fish was identified to species and total length (mm) and weight (g) were measured. Fish were recovered in live cars secured in the stream and released back into the section.

A habitat assessment was conducted in each section to document resource condition by collecting base-line data on habitat types and quality, water conditions, substrate, discharge, bank condition, and other attributes. The HWTP habitat assessment is a pared-down synthesis of Rosgen (1994) and the California Salmonid Stream Habitat Restoration Manual (CSSHRM; Flosi et al 1988). Section length (ft) was measured along the thalweg. The length of the section was then divided into five cells of equal length. Wetted width (ft) measurements were taken at the center of each of the five cells. Across each width transect, five depths were taken (also at the center of five evenly divided cells, in ft) and both widths and depths were averaged for each section.

Stream characteristics, including active erosion (erosion occurring in the present), erosion at bankful and canopy closure were measured as percentages of either the total stream area (canopy cover) or bank area (erosion). Section percentages were defined for each habitat type (riffle, flatwater, and pool) following Level II protocols as defined by the CSSHRM. Using visual observation, substrate size classes and the percentage of each class relative to the total bottom material within the wetted width were quantified. A rating (between poor and excellent) was given to the instream cover available to fish and cover types were identified and defined as percentages of total instream cover. The change in water surface elevation (section gradient, %) and streamflow (cubic feet per second; cfs) were measured. Representative photographs of the section were taken.

Fish measurements were entered into the DFG Fisheries Information Sharing Host (FISH) database and were extracted into MicroFish (MicroFish Software). Based on the capture rate (number of fish captured per pass) and probability of capture, a population estimate was determined for each species in each section. MicroFish also calculated the average weight of each species by section. These

data were used to determine biomass (pounds per acre; lbs/ac) and density (fish per mile; fish/mi) of each species.

Sheepheaven Creek Section 7 resulted in the capture of zero trout. Based on these results, the HWTP conducted single-pass electrofishing in Sheepheaven Creek and a portion of McKay Creek on June 24, 2011 to determine fish distribution in this system. To increase survey efficiency and geographic scope of sampling during the single-pass effort, all captured fish were identified to species and total length was measured (mm); fish weights were not measured.

GPS equipment was used to record the geographic coordinates (North American Datum 1983) of fish capture sites including the downstream- and upstream-most capture locations. These coordinates were imported into ArcGIS software and the length of the populated reach was calculated (miles).

The results of the Sheepheaven Creek surveys were used to further define the sample design and survey strategy for Edson, Swamp, and Moosehead creeks. Due to the intermittent nature of this drainage, the HWTP conducted field reconnaissance in each stream system in August, 2011 to determine the extent and location of wetted habitat versus dry stream segments; coordinates were recorded to mark locations where changes in streamflow occurred (i.e. locations where streamflow became subterranean).

Single-pass electrofishing was used to delineate the upstream- and downstream-extent of fish distribution in each creek. Coordinates were recorded at fish capture locations and the total length of each populated reach was calculated using GIS software. Surveyors verified continuous wetted habitat throughout this reach but did not electroshock all wetted habitat to confirm fish presence in all habitat types.

To minimize potential harm from multiple-pass electrofishing to small and isolated putative MRRT populations, the HWTP established a minimum population threshold of 100 individuals in each creek to determine whether multiple-pass survey methodology should be utilized. Using GIS software, a point file was created that delineated the populated reaches in Edson, Swamp, and Moosehead creeks (the portion of each creek between the downstream- and upstream-most trout capture locations) into 100 meter segments and single-pass electrofishing was used to sub-sample a maximum of ten percent of the populated reach using a systematic stratified approach. Using a conservative capture efficiency of 50% (based on a capture efficiency of 64% from Sheepheaven Creek Section 24), the HWTP sub-sampled the population via single-pass electrofishing to determine whether the minimum population threshold was met. If it was perceived that a population had greater than 100 individuals (excluding 0+ age class fish), the single-pass electrofish surveys were terminated and multiple-pass electrofishing was initiated using a random sample design. If it was perceived that a population contained less than 100 adult redband trout, multiple-pass removal was not conducted in that creek.

Multiple-pass electrofish surveys and habitat analyses were conducted between August 12-16, 2011 in Edson (Sections 425 and 454), Swamp (Sections 139, 195, and 240), and Moosehead creeks (Sections 26, 40, and 49) by HWTP staff (from Headquarters and Northern Region), DFG staff (Northern and North Central regions), and volunteers. All multiple-pass electrofish sections were newly established in 2011 and were selected at random from within the populated reaches identified during the single-pass electrofish effort. The number of sections per creek was determined using a minimum sample size of ten percent of the populated reach. Surveys were conducted following the protocol outlined above for Sheepheaven Creek. Due to time constraints, not all habitat attributes were measured in Swamp Creek Section 139.

Results

Sheepheaven Creek

Sheepheaven Creek originates at the confluence of numerous springs and is located on private timber land. During high flows, it is tributary to McKay Creek (Bacon et al. 1980). On June 24, 2011 Sheepheaven Creek had continuous flow from Sheepheaven Springs downstream approximately 1.2 miles (Figure 3). The single-pass electrofish effort captured MRRT in 41.7% (0.5 miles) of the available wetted habitat in the vicinity of Sheepheaven Springs. In addition, 0.25 miles of McKay Creek was surveyed via single-pass electrofishing downstream of the confluence with Sheepheaven Creek; this entire section was wetted and zero fish were captured. The remaining lower portion of McKay Creek was not surveyed or visually examined by the HWTP in 2011 for wetted flow or fish presence/absence. Sheepheaven Creek ranged from lower-gradient meadow habitat near the headwaters to medium-gradient forested habitat (Figures 4 and 5). Water temperature was measured at 7º C in both sections, average wetted width was 7.7 ft, and average water depth was less than one foot. Streamflow was approximately four cubic feet per second. Habitat consisted predominantly of flatwater and riffle; pools were generally absent (Table 1). Evidence of erosion was higher in the meadow although sand, silts/fines, and organic substrate were more prevalent in the higher-gradient forested habitat (Table 2). Fish cover was rated as excellent throughout and included a diversity of water turbulence, overhanging vegetation, large woody debris, boulders, and undercut banks (Table 3). Gravel and cobble formed the dominant substrate types throughout. Two multiple-pass electrofish sections were randomly selected from within the wetted habitat with a total survey length of 1049.6 feet (this differs from the methods employed in Edson, Swamp, and Moosehead creeks where the sampling frame was limited to areas where fish where captured during single-pass electrofishing). Seven MRRT were captured in Section 24 (meadow habitat in the vicinity of Sheepheaven Springs) and zero fish were captured in Section 7 (forested habitat near the confluence with McKay Creek; Tables 4 and 5). Numerous MRRT captured in Sheepheaven Creek had frayed dorsal fins and inflamed vents (Figure 5). No other fish species were captured. MRRT abundance in Section 24 was estimated at 85.8 trout/mi and 12.27 lbs/ac. Based

on fish occupancy observed in 0.5 miles of stream habitat, the HWTP estimated approximately 43 MRRT in Sheepheaven Creek in 2011. Approximately 17% of the total wetted habitat in Sheepheaven Creek was surveyed via multiple-pass electrofishing in 2011 (both sections). Of the presumed occupied habitat, 16% was surveyed via multiple-pass electrofishing (Section 24).

Edson Creek

The headwaters of Edson Creek flow through private timber land and the remaining lower portion is located on the Shasta-Trinity National Forest. The majority of Edson Creek was dry during the survey effort (7.7 miles); wetted habitat was limited to 4.9 miles in the upper portion of the watershed (Figure 6). Edson Creek is tributary to Ash Creek only during periods of heavy runoff (Bacon et al. 1980); during the survey effort, the two were not connected via surface flow. The single-pass electrofish effort captured MRRT in approximately 16% (0.8 miles) of the available wetted habitat. Two multiple-pass electrofish sections were selected at random within the 0.8 miles of occupied habitat (15% of the sampling frame) with a total survey length of 649.8 feet. Streamflow was approximately one cubic foot per second, the average wetted width was eight feet and average water depth was 0.4 ft. Habitat was predominantly low-gradient flatwater; pools and riffles were mostly absent (Figures 7 and 8). The average water temperature was 7º C. Fish cover was rated from good to excellent and was dominated by large woody debris, overhanging vegetation, and undercut banks. Canopy closure ranged from 20% to 55%. Gravel and cobble comprised the majority of substrate; sand and silt/fines were present in areas with low streambank stability. The multiple-pass electrofish effort yielded a capture of 96 MRRT in 649.8 feet of stream habitat, with an estimated average abundance of 804.9 trout/mi and 23.16 lbs/ac. No other fish species were captured. An expansion of the density estimate over 0.8 miles of occupied habitat yielded a total estimated population of approximately 644 MRRT in Edson Creek in 2011.

Swamp Creek

Swamp Creek flows predominantly through private timber holdings with small stream segments on national forest land. In August, 2011 Swamp Creek had 5.3 miles of wetted habitat in the upper and middle portions of the watershed; the lower two miles were dry and not connected to any other water body by surface flow (Figure 9). First-order headwater tributaries were extensively logged and there was often no defined stream channel. The single-pass electrofish effort identified MRRT in 43% (2.3 miles) of the available wetted habitat. The wetted portion of Swamp Creek was dominated by medium-gradient forested habitat; riffle, flatwater, and pool habitats were present throughout (Figures 10-12). Streamflow was, on average, two cubic feet per second, average wetted width was 11.8 ft, and average water depth was 0.6 ft. Canopy closure ranged from 10% to 70%. Instream fish cover was rated good to excellent and the dominant cover types were: boulders, water depth, large woody debris, and water turbulence. Substrate was predominantly cobble and gravel with some boulder.

There was evidence of severe erosion in a large portion of the watershed. Some areas adjacent to the stream have been logged and large woody debris and windfalls were prevalent. The multiple-pass electrofish effort yielded a capture of 166 MRRT in 1190.0 feet of stream habitat (three sections; 10% of the sampling frame). No other fish species were captured. Estimated abundance of MRRT was 788.8 trout/mi and 32.43 lbs/ac. An expansion of the average density estimate over 2.3 miles of occupied habitat yielded a total estimated population of approximately 1814 MRRT in Swamp Creek in 2011.

Moosehead Creek

Moosehead Creek flows predominantly through national forest land and includes meadow habitat in the upper reach, higher-gradient forested habitat in the middle reach, and low-gradient brush-meadow habitat in the lower reach. In August, 2011, Moosehead Creek had contiguous flow from the headwaters to the confluence with the McCloud River (4.2 miles of wetted habitat; Figure 13). A fish barrier consisting of a concrete apron located at the USFS Road 39N05 crossing separates the creek into two segments; approximately 1.4 miles of habitat downstream of the barrier is occupied by rainbow trout of mixed origin (*Oncorhynchus mykiss* spp.) and brook trout (*Salvelinus fontinalis*) and had connectivity to the main-stem McCloud River. This segment was sampled via single-pass electrofishing in 2011 to verify the presence of brook trout (three rainbow, five brook, and one unknown trout were captured) and was excluded from the multiple-pass electrofish sample frame. The portion of stream above the barrier is occupied by MRRT (based on genetic sampling conducted in 2007 and 2008). In August, 2011, the single-pass electrofish effort captured MRRT from the bridge crossing upstream 1.9 miles. Zero fish were captured in the remaining 0.9 miles of wetted habitat in the headwaters of the system (based on single-pass spot shocking at accessible locations). This presumably fishless habitat consisted of medium- to high-gradient first order tributaries with dense riparian vegetation and limited spawning gravels.

The multiple-pass electrofishing sample frame included habitat from the USFS Road 39N05 road crossing upstream 1.9 miles and three sections were randomly selected, encompassing a total of 1080.0 feet of stream habitat (11% of the sample frame). Water temperatures ranged from 6º C to 10º C and canopy closure ranged from 15% (forested habitat) to 95% (meadow habitat with dense riparian *Salix* spp.). Streamflow averaged 3.8 cfs, average wetted width was 12.9 ft, and average water depth was 0.5 ft. Habitat was dominated by flatwater (step runs) with some riffles and pools (Figures 14-16). Overall instream fish cover was rated good to excellent. Within higher-gradient forested habitat, fish cover was provided predominantly by boulders, water turbulence, and water depth. In lower-gradient meadow habitat, overhanging vegetation, water turbulence, and large woody debris were the dominant cover types. Substrate was mostly cobble, boulder, and gravel throughout the system. Streambank stability was generally good with minimum evidence of erosion, except for the lower-gradient reach directly upstream of the USFS Road 39N05 crossing. The multiple-pass

electrofish effort yielded a capture of 93 MRRT in 1080.0 feet of stream habitat with an estimated abundance of 557.2 trout/mi and 16.72lbs/ac. No other fish species were captured. An expansion of the average MRRT density over 1.9 miles of occupied habitat yielded a total estimated population of approximately 1059 MRRT in Moosehead Creek in 2011.

Discussion

Based on recent genetic analysis conducted at the UCD GVL, putative MRRT populations in Sheepheaven, Edson, Swamp, and Moosehead creeks are not significantly introgressed with rainbow trout (Simmons 2009) and, based on relatively small population sizes, should be managed collectively (Stephens 2011). In addition, preliminary analysis suggests Edson and Sheepheaven Creek populations have low allelic richness and Sheepheaven Creek appears to have significant signs of bottleneck and inbreeding depression (Stephens 2011). Future genetic analysis of tissue samples from other upper McCloud River tributaries is pending and may reveal additional populations of putative MRRT within this drainage.

The HWTP 2011 fisheries and habitat assessments of known putative MRRT populations in Sheepheaven, Edson, Swamp, and Moosehead creeks estimated a total population of 3560 MRRT occupying 5.5 miles of stream habitat. Sheepheaven, Edson, and Swamp creeks are south flowing tributaries to the upper McCloud River and, during low flow years, are typically isolated due to insufficient flow barriers (due to porous volcanic substrates). In 2011, Edson and Swamp creeks were isolated due to subterranean flow; however, Sheepheaven Creek had connectivity to McKay Creek. The downstream extent of surface flow in McKay Creek was not assessed in 2011. Genetic analysis of fish captured in lower McKay Creek showed high introgression rates with rainbow trout (Simmons et al. 2009).

Conclusion

The HWTP is currently updating the Redband Trout Conservation Agreement and this document should guide future monitoring, conservation, and management of MRRT within the upper McCloud River drainage. Conservation measures needed for the MRRT focus on the following objectives:

- Establish a McCloud redband refugium
- Conserve, protect, and enhance habitat
- Maintain and preserve genetic integrity
- Create contingency plans
- Monitor habitat and trout populations

Based on these recent surveys and related data, the HWTP recommends conducting a translocation/reintroduction feasibility assessment. Determining factors justifying this effort include, but are not limited to:

- Low estimated population size in Sheepheaven Creek (<100 individuals)
- Good quality habitat is available in sufficient amounts but not occupied
- Nearby donor stocks have no connectivity and cannot naturally recolonize
- Suitable donor stocks are available and can likely withstand extraction of individuals
- Genetic analysis of the Sheepheaven population indicates low genetic diversity
- Historic flow conditions in Sheepheaven Creek during drought years can reduce the available habitat to a few isolated pools
- Extant population is not evenly distributed throughout or across available habitats
- Representative age and size classes appear limited

References

Bacon, M., P. Brouha, M. Rode, and C. Staley. 1980. Redband trout comprehensive management plan. U.S. Forest Service. Shasta-Trinity National Forest, California.

Flosi, G., S. Downie, J. Hopelain, M. Bird, R. Coey and B. Collins. 1998. California Salmonid Stream Habitat Restoration Manual. 3rd Edition. Vol. 1. State of California Resources Agency. Department of Fish and Game. Inland Fisheries Division.

Moyle, P. B., R. M. Yoshiyama, J. E. Williams, and E. D. Wikramanayake. 1995. Fish species of special concern in California, 2nd edition. Prepared for the California Department of Fish and Game, Rancho Cordova.

Rhew, R. 2007. Redband trout and the Endangered Species Act. Redband trout: resilience and challenge in a changing landscape. American Fisheries Society, Oregon Chapter.

Rosgen, D.L., 1994. A Classification of Natural Rivers. Catena Vol. 22 169-199.

Stephens, M., R. Simmons, M. Finger, and B. May. 2011. Genetic analysis of California native trout (phase 3). Final report to the California Department of Fish and Game (draft). Genomic Variation Laboratory, University of California, Davis.

Simmons, R. and B. May. 2008. Redband Trout Genetics Report. Genomic Variation Laboratory, University of California, Davis.

Simmons, R., P. Lavretsky, and B. May. 2009. Introgressive hybridization of redband trout in the upper McCloud River watershed. Department of Animal Sciences. University of California-Davis. Davis, CA.

U.S. Fish and Wildlife Service. 1994. Endangered and threatened wildlife and plants: animal candidate review for listing as endangered or threatened species. Federal register 219: (15 November 1994): 58985.

U.S. Fish and Wildlife Service. 2000. Endangered and threatened wildlife and plants: notice of reclassification of nine candidate taxa. Federal register 65 (204): (20 March 2000):63044-63045.

U.S. Forest Service. 1998. Redband trout conservation agreement. Shasta-Trinity National Forest. Redding, California.

U.S. Forest Service. 1998. Redband trout conservation agreement. Shasta-Trinity National Forest. Redding, California.

Weaver, J. and S. Mehalick. 2007. Genetic sampling of *Oncorhynchus mykiss* in the upper McCloud River drainage. State of California Resources Agency. Department of Fish and Game. Heritage and Wild Trout Program. Rancho Cordova, CA.

Weaver, J. and S. Mehalick. 2008. Genetic sampling of *Oncorhynchus mykiss* in the upper McCloud River drainage. State of California Resources Agency. Department of Fish and Game. Heritage and Wild Trout Program. Rancho Cordova, CA.

Figure 1. Vicinity map of McCloud River drainage 2011 survey location

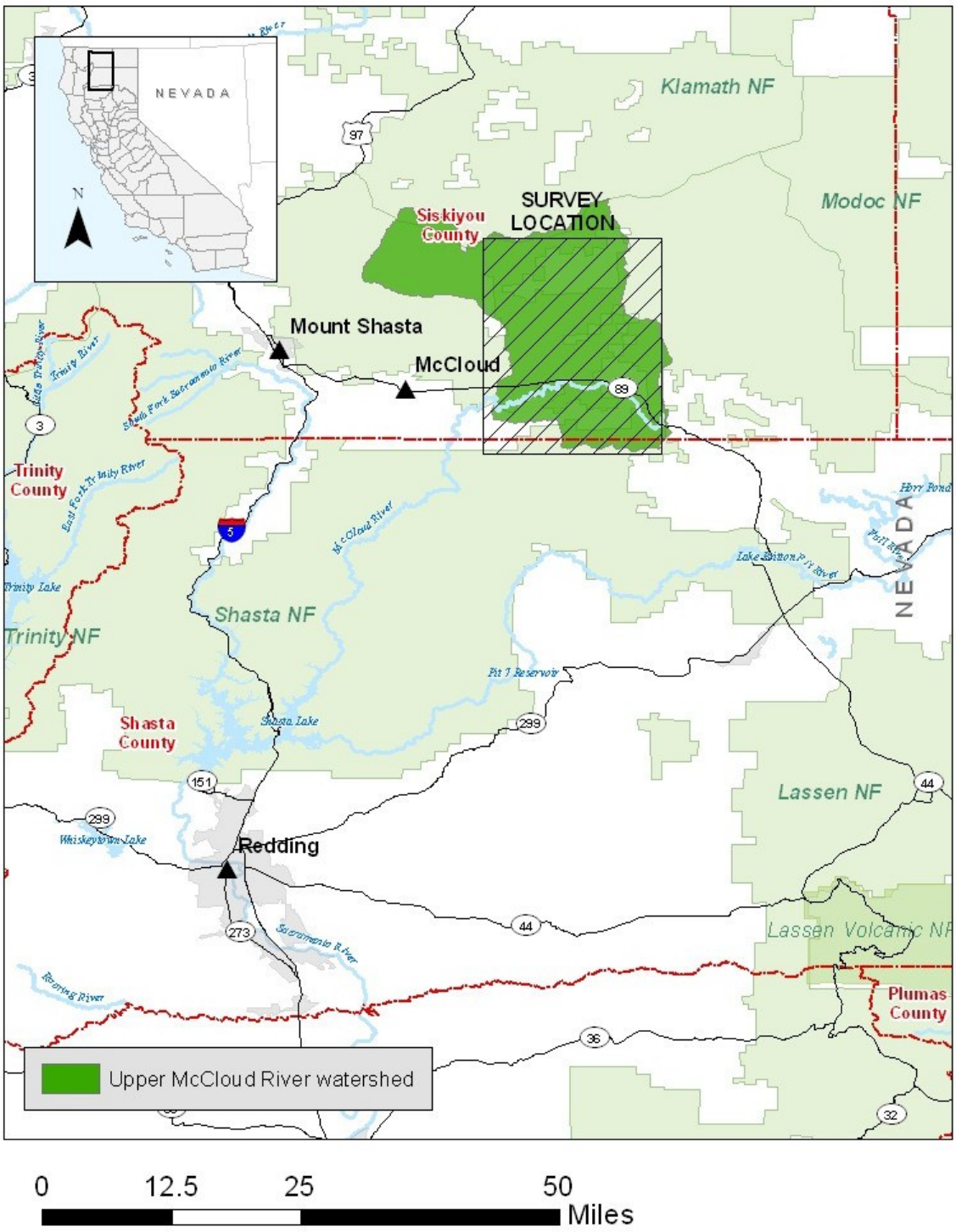

Figure 2. Watershed-level map of the upper McCloud River above Middle Falls including tributaries

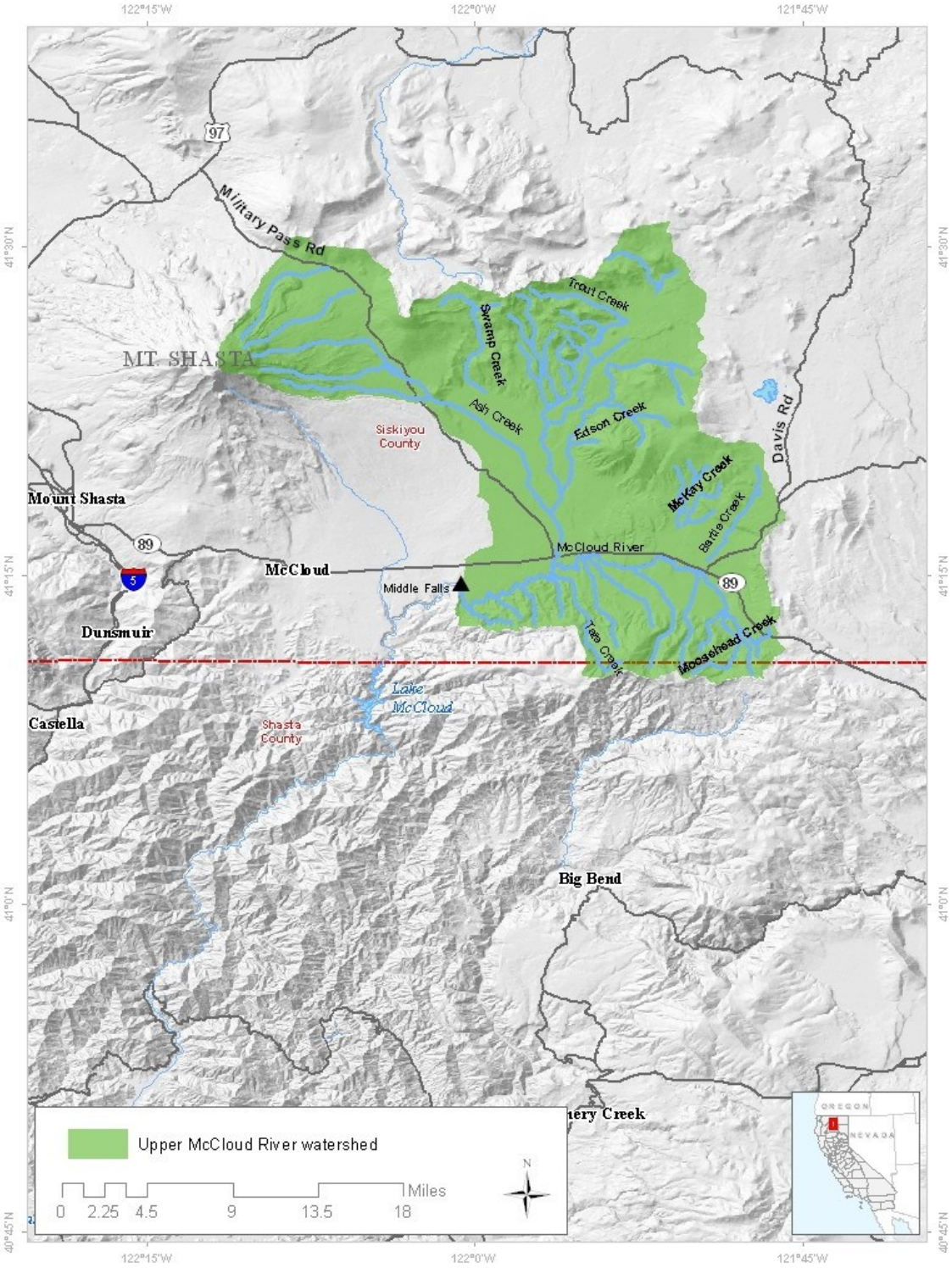

Figure 3. Map of Sheepheaven Creek 2011 survey section locations

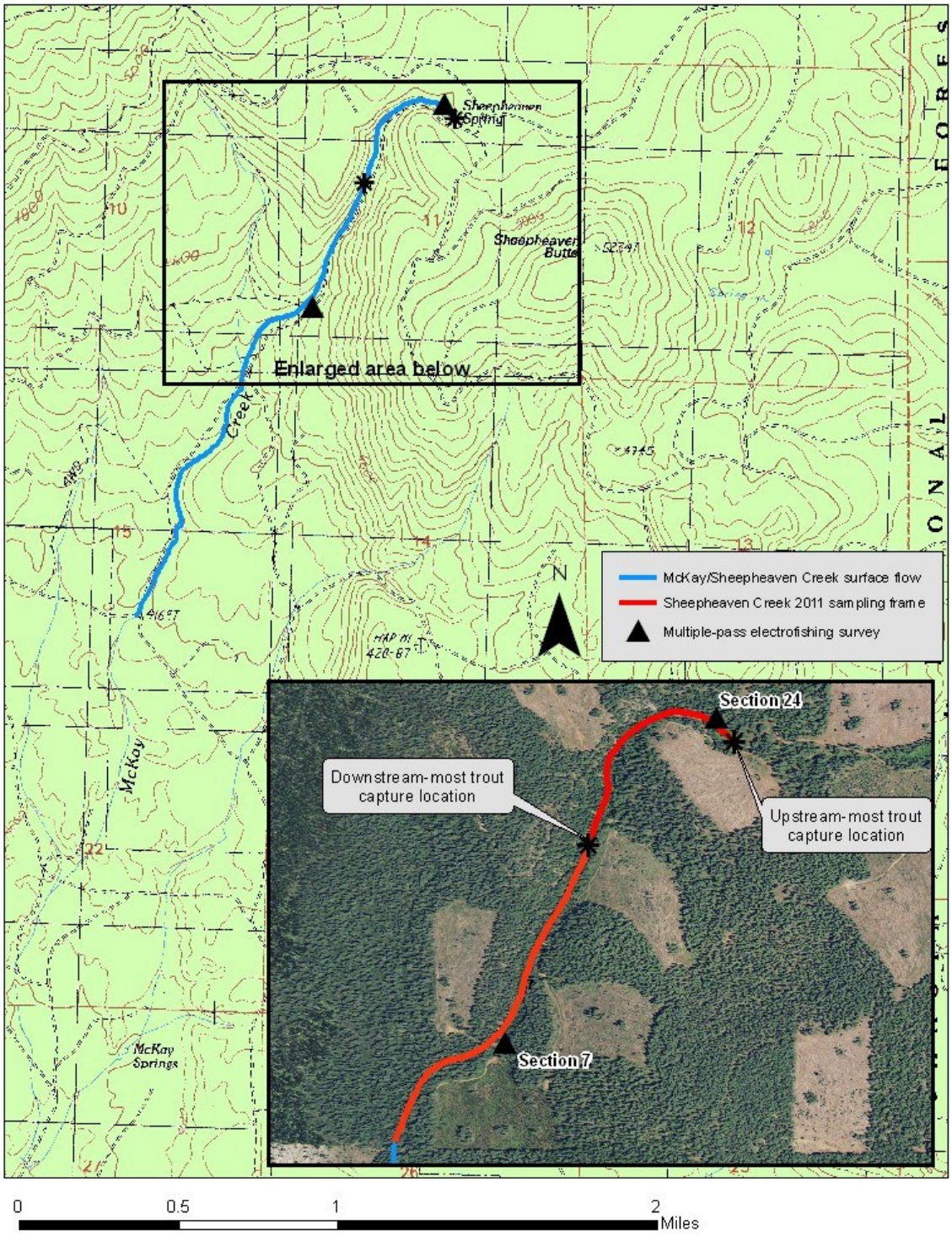

Figure 4. Representative photographs of Sheepheaven Creek Section 7 in 2011

Figure 5. Representative photographs of Sheepheaven Creek Section 24 in 2011

Figure 6. Map of Edson Creek 2011 survey section locations

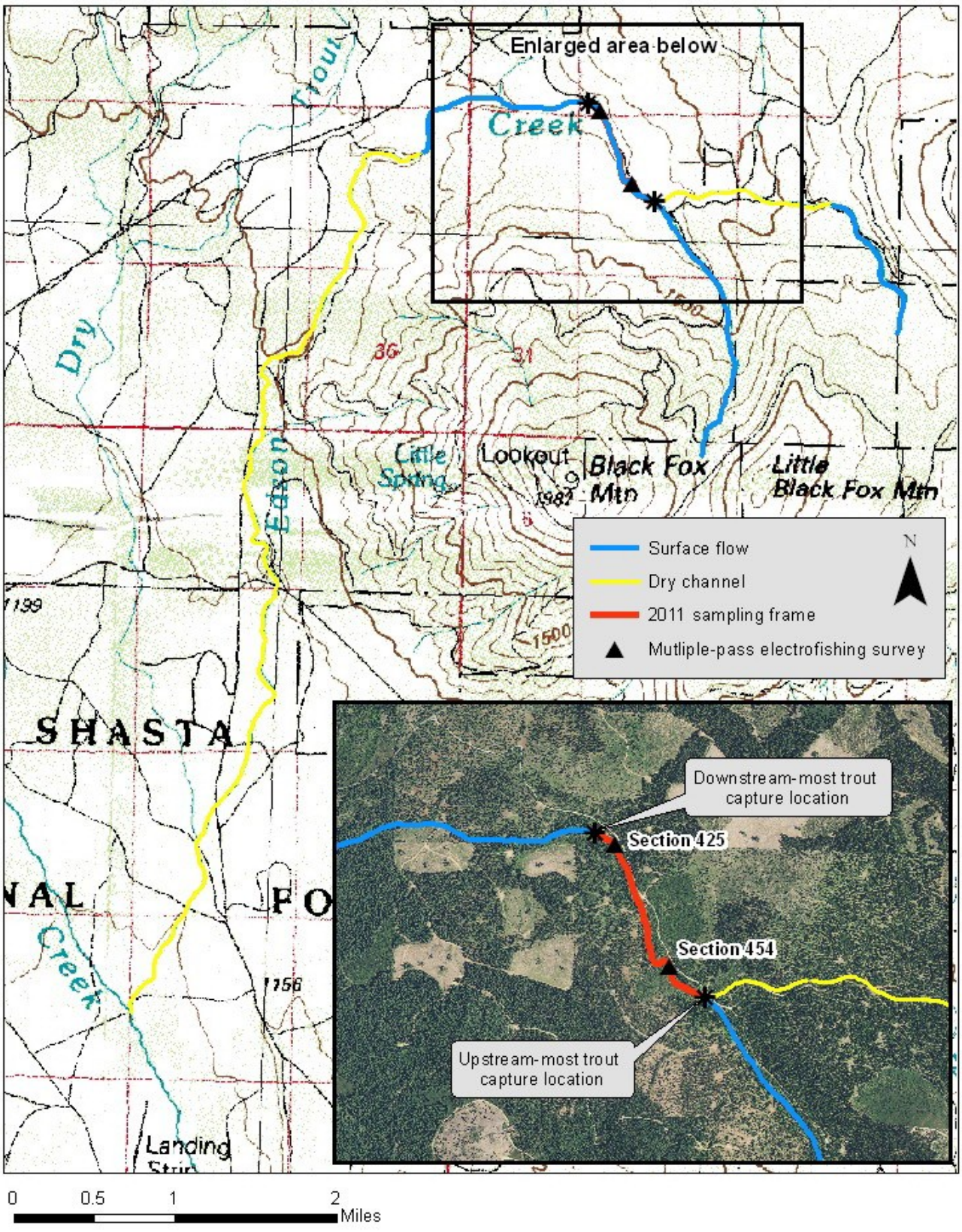

Figure 7. Representative photographs of Edson Creek Section 425 in 2011

Figure 8. Representative photographs of Edson Creek Section 454 in 2011

Figure 9. Map of Swamp Creek 2011 survey section locations

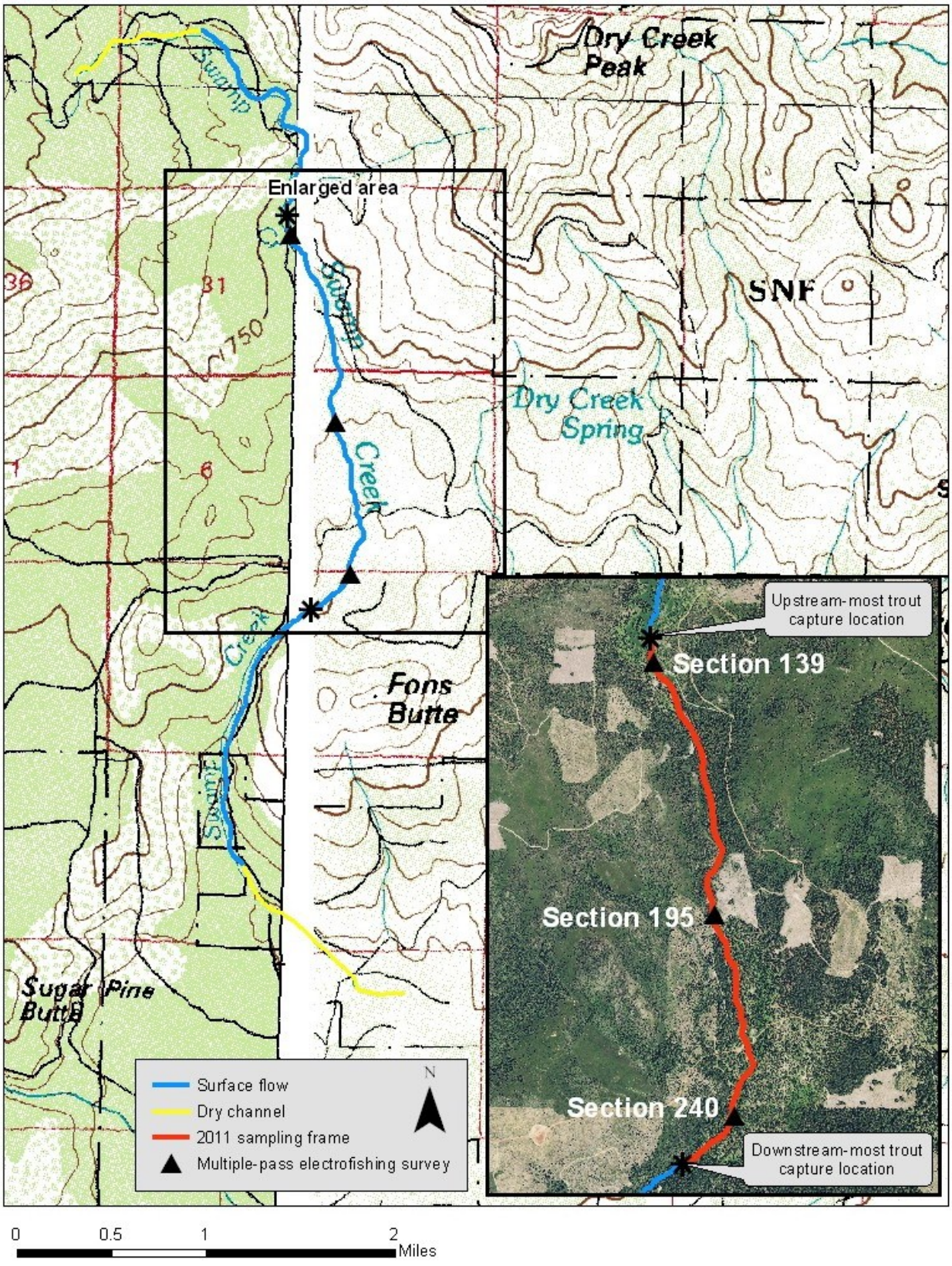

Figure 10. Representative photographs of Swamp Creek Section 139 in 2011

Figure 11. Representative photographs of Swamp Creek Section 195 in 2011

Figure 12. Representative photographs of Swamp Creek Section 240 in 2011

Figure 13. Map of Moosehead Creek 2011 survey section locations

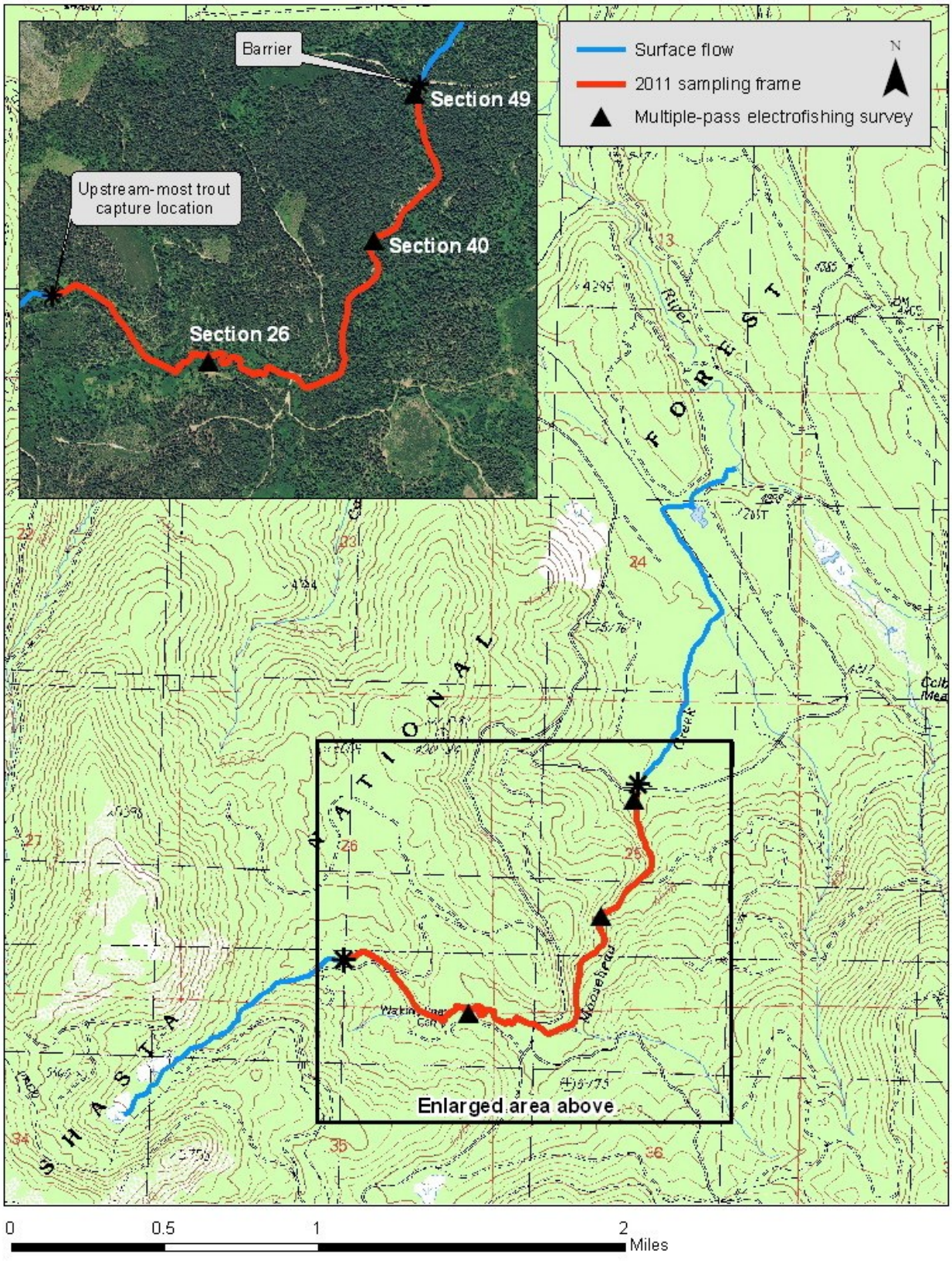

Figure 14. Representative photographs of Moosehead Creek Section 26 in 2011

Figure 15. Representative photographs of Moosehead Creek Section 40 in 2011

Figure 16. Representative photographs of Moosehead Creek Section 49 in 2011

Table 1. McCloud River drainage 2011 habitat data by water and section

Water	Section	Habitat type			Water temperature (ºC)	Overall instream cover rating	Streamflow (cfs)	Gradient (%)	Bankful erosion (%)	Active erosion (%)	Canopy closure (%)
		Riffle (%)	Flatwater (%)	Pool (%)							
Sheepheaven Creek	7	78	20	2	7	Excellent	4.55	5.6	5	5	85
	23	97	0	3	7	Excellent	3.03	3.4	60	40	30
Edson Creek	425	0	95	5	7	Excellent	0.98	1.8	30	5	55
	454	10	85	5	8	Good	6.7	2.1	60	0	20
Swamp Creek	139	5	80	15	6	Excellent	2.01	-	5	1	70
	195	5	56	39	10	Excellent	2.53	5.1	95	5	50
	240	75	25	0	11	Good	1.72	4	25	7	10
Moosehead Creek	26	8	92	0	6	Excellent	2.89	-	0	0	95
	40	25	55	20	9	Excellent	4.64	7.3	5	3	15
	49	25	75	0	10	Good	3.84	3.5	40	0	55

Table 2. McCloud River drainage 2011 substrate type percentages by water and section

Water	Section	Substrate type percentages						
		Bedrock	Boulder (>10")	Cobble (2.5"-10")	Gravel (0.8"-2.5")	Sand (<0.8")	Silt/fines	Organic
Sheepheaven Creek	7	0	0	0	0	0	0	0
	23	0	25	20	40	5	5	5
Edson Creek	425	0	3	10	60	7	10	10
	454	0	10	20	31	12	20	7
Swamp Creek	139	-	-	-	-	-	-	-
	195	2	15	30	40	2	7	4
	240	0	25	50	20	2	2	1
Moosehead Creek	26	0	15	25	30	10	15	5
	40	0	33	34	33	0	0	0
	49	0	30	40	25	4	1	0

Table 3. McCloud River drainage 2011 instream fish cover types by water and section

Water	Section	Instream cover type percentages						
		Aquatic vegetation	Boulders	Large woody debris	Water turbulence	Overhanging vegetation	Undercut banks	Water depth
Sheepheaven Creek	7	3	7	15	50	20	0	5
	23	5	10	30	3	15	35	2
Edson Creek	425	0	3	30	0	50	12	5
	454	0	5	20	5	35	30	5
Swamp Creek	139	-	-	-	-	-	-	-
	195	1	20	20	20	3	11	25
	240	6	35	5	10	7	7	30
Moosehead Creek	26	5	2	15	25	40	8	5
	40	0	30	3	30	10	0	27
	49	0	70	4	10	6	0	10

Table 4. McCloud River drainage 2011 multiple-pass electrofish data by water and section

Water	Section	Section length (ft)	McCloud River redband trout					
			Total number captured	Estimated section population	Confidence interval (+/-)	Estimated density (fish/mi)	Estimated biomass (lbs/acre)	Capture probability
Sheepheaven Creek	7	618.6	0	0	-----	0	0.00	-----
	23	431.0	7	7	28.6%	85.8	12.27	63.6%
			Average			**n/a**	**n/a**	
Edson Creek	425	337.8	73	77	9.1%	1203.6	32.98	61.3%
	454	312.0	23	24	16.7%	406.2	19.28	62.2%
			Average			**804.9**	**26.13**	
Swamp Creek	139	422.5	17	17	0.0%	212.4	31.21	89.5%
	195	410.0	72	80	13.8%	1030.2	41.20	52.9%
	240	366.5	77	78	3.8%	1123.7	24.87	74.8%
			Average			**788.8**	**32.43**	
Moosehead Creek	26	371.0	17	17	11.8%	241.9	17.78	70.8%
	40	354.0	40	42	11.9%	626.4	23.45	61.5%
	49	355.0	36	54	66.7%	803.2	8.92	23.7%
			Average			**557.2**	**16.72**	

Table 5. McCloud River drainage 2011 MRRT length and weight data by water and section

Water	Section	McCloud River redband trout						
		Total number captured	Min total length (mm)	Max total length (mm)	Mean total length (mm)	Min weight (g)	Max weight (g)	Mean weight (g)
Sheepheaven Creek	7	0	-	-	-	-	-	-
	24	7	156	187	171.7	38.6	68.8	48.0
Edson Creek	425	73	39	175	97.9	0.3	39.4	11.6
	454	23	65	184	122.8	2.8	63.9	21.4
	Total	96	39	184	103.9	0.3	63.9	14.0
Swamp Creek	139	17	167	243	196.1	42.9	136	72.7
	195	72	49	201	134.7	2	96.4	29.9
	240	77	37	203	102.9	1.1	88.9	15.7
	Total	166	37	243	126.2	1.1	136	27.7
Moosehead Creek	26	17	76	206	146.2	4.6	99.8	40.4
	40	40	46	217	126.0	0.8	111.3	28.3
	49	36	41	147	83.1	0.8	35.8	9.1
	Total	93	41	217	113.1	0.8	111.3	23.1