Mt. Hood Scott's Apatanian Caddisfly Completion Study

Final Report

Prepared for USDA Forest Service – Region 6 and DOI Bureau of Land Management Interagency Special Status/Sensitive Species Program (ISSSSP) Coordinator

By Greg Wanner

USDA Forest Service, Mt. Hood National Forest – Zigzag Ranger District, Zigzag, Oregon 97049

Photo Credit: G. Wanner, 2016; Scott's apatanian larval case collected at the headwaters of Camp Creek, Mt. Hood National Forest

January 2018

Introduction

Considerable development related to road building, trail construction, and vegetation clearing associated with ski area operations, timber thinning, and wildfire suppression activities have occurred adjacent to and upslope of the headwater tributaries of Mt. Hood, Oregon. These activities have increased fine sediment inputs to stream channels from the highly erodible volcanic soils (Crandell 1980) and resulted in negative impacts to streams. Anthropogenic increases in sediment to streams is one of the most important causes of lotic system degradation (USEPA 1990). Fine sediment inputs from human activities and natural disturbances may eventually cause sufficient habitat alteration to adversely impact caddisfly populations (Lemly 1982; Waters 1995) that are present in streams around Mt. Hood.

Scott's apatanian caddisfly *Allomyia scotti*, is a rare species and is endemic only to Mt. Hood, Oregon (Wiggins 1973; Wanner 2016). This caddisfly species is a glacial relict, surviving the latest glaciation period (Wisseman 2010). The distributions of this species was relatively unknown (Wisseman 2010) until 2013 and 2014 larval caddisfly surveys were conducted around Mt. Hood in perennial 1st through 3rd order clear water (non-glacial) steams (Wanner and Arendt 2015). Those larval surveys covered over 62 streams each year with a total of 485 samples sites. As a result of that survey and past records (Wiggins 1973; Wisseman 2010), *A. scotti* populations have been documented in eight separate streams. This species has a patchy distribution in approximately 4.6 linear miles of seeps, springs, and 1st through 3rd order streams at elevations from 3,494 to 5,722 feet around Mt. Hood (Wanner and Arendt 2015).

The Little Zigzag River and Sand Canyon Creek appear to be the stronghold habitat for this species (Wanner and Arendt 2015). These two streams accounted for 69% of their entire known range. These two streams have stable discharge mostly originating from springs. The population range in Still Creek and West Fork Salmon River are believed to only occur in the headwater springs of these streams. *A. scotti* habitat in South Fork Iron Creek and tributaries to McGee Creek, and Muddy Fork Sandy River are much less known due to the steepness of terrain and lack of sampling that has occurred in these streams; however, these streams do have the required spring fed, cold water with dense mats of moss (Wanner and Arendt 2015). Much of the *A. scotti* populations are protected from anthropomorphic disturbances (with the exception fires or climate change) due to their location within the congressionally designated Mt. Hood Wilderness. The populations of *A. scotti* in Still Creek, West Fork Salmon River, and a tributary to East Fork Hood River are more susceptible to human disturbance as they are located within ski permit areas with associated roads and trails and appear to be occupying limited ranges within those areas.

Caddisflies are continuously under threat of intensive recreational development resulting in among other things, human-induced fine sediments entering their narrow range of habitat. The 2013 and 2014 study delivered a baseline for the distribution and relative abundance of larval caddisfly species. However, we now have a better understanding of how truly rare *A. scotti* is and that 38% of the entire known population found in the world are susceptible to anthropogenic disturbance. Thus, the objective of this study was to complete a comprehensive survey for Scott's apatanian caddisfly in Forest Service managed areas in the Mt. Hood Meadows, Timberline, Upper Sandy and Hood River watersheds, Government Camp, Oregon, and the associated roads and trails in these areas. This study will also identify key areas for protection and restoration for this critically rare species.

Another objective of this study was to obtain a better understanding of the adult caddisfly population around Mt. Hood. In 2015, an adult caddisfly survey was conducted around Mt. Hood. However, few specimens were captured and a relatively limited amount of information was gained about sensitive caddisfly species around Mt. Hood (Ikeda and Wanner 2015). It was hypothesized that the record lack of snow pack during the spring of 2015 and record warm temperatures across Oregon in 2015 (NOAA 2016) resulted in few adult captures that year.

Methods

Larval and adult caddisflies were sampled in six areas that could be impacted by direct Forest Service management activities. These areas included the Upper Sandy River (Clear Fork tributaries), Upper West Fork Hood River (McGee, Marco, and Stump tributaries), Upper East Fork Hood River (East Fork Hood River, Mitchell Creek, and Clark Creek), Upper White River (North and South Forks of Iron Creek), Still Creek (Still Creek tributaries), and Zigzag Canyon (Camp Creek tributaries). Larval and adult caddisfly surveys were conducted from May through July 2016. Additional larval surveys were conducted September and October 2016. This survey targeted seeps, springs, and streams with dense mats of wiry mosses, which has been documented as a key environmental attribute needed for *A. scotti* (Wanner and Arendt 2015).

Extreme care was taken to avoid disrupting stream banks and vegetation while larval caddisfly sampling. A D-frame kick-net was used to acquire multi-habitat kick net samples from a 50-ft stream reach with a minimum of three sub-samples at each collection site. The D-net had a heavy cotton and polyester bag with non-rotting thread secured to 12 inch wide D-rim by hog rings with a nylon mesh bottom 8 inches below rim. The cotton and polyester bag extended 4 inches to protect the mesh from snags and wear. The D-net was equipped with a 5-foot hardwood handle. The D-frame net had a mesh size fine enough to retain small larvae (0.5 mm). A standard kick-net technique was applied by holding the net vertically with the opening facing upstream and the flat side pressed tightly against the bottom substrate, so that water flows neither under nor over the net. Large rocks and wood substrate immediately upstream of the net and up to 5 feet upstream were disturbed with hands, feet, or a stick while the current carried the uncovered and dislodged caddisflies and material into the net. A standardized sample area was 5 ft^2 for each sub-sample. The stream bottom was disturbed to a depth of 4 – 6 cm (1.2 – 2 in.) for about 30 to 60 seconds, following which the net was removed from the water for specimen retrieval. The bottom of the frame was swept forward in a scooping motion to prevent caddisflies from escaping when the net was removed from the stream. Net contents were then rinsed into a shallow white tray to search for larvae more easily, as they are often quite cryptic and can be difficult to see if they are not moving. Samples were placed in white tubs and repeatedly elutriated with stream water to separate organic material and invertebrates from mineral substrates. Mineral substrates were checked for the presence of cased caddisfly larva. Organic material was then refloated with stream water and all identified caddisflies were removed with tweezers and preserved in 95% alcohol. All individual larval caddisflies were identified to the group, genus, and when possible, down to species level.

Adult caddisflies surveys were conducted for a period of 10 minutes at each site. Samples were collected using a 15” diameter circular butterfly net with a 3’ long wooden handle. One to two surveyors would walk for 10 minutes, sweeping the net through the riparian area, paying particular attention to vegetation and woody debris where adult caddisflies may land. The nets were checked periodically, and if adult caddisflies were present, they were removed with tweezers and preserved in 95% alcohol. Vouchered specimens were sent to an expert to be identified. All individual adult caddisflies were identified to the genus and when possible, down to species level.

Water temperature, depth, wetted width were measured at each sub-sample site. A Garmin Montana 600 was used to collect UTM coordinates and elevation. Additionally, qualitative habitat data was acquired at each sub-sample location, which included: visual estimation of percent sand, gravel, cobble, and boulder, instream vegetation, and over-story vegetation.

Results and Discussion

A total of 128 larval sub-samples were taken with a D-frame kick net in 24 streams. A total of 39 adult caddisfly sub-samples were taken at 22 streams. The adult caddisfly samples were taken prior to and in the same general areas of the three larval sub-samples at each site. Samples were taken from elevations as low as 2,647 feet in a tributary to McGee Creek to 5,991 feet in a tributary to East Fork Hood River (Figure 1).

Habitat at sample sites

The sampling in 2016 concentrated in streams that were fed by springs and seeps. Water temperature at the sample sites ranged from 1.8 °C in a headwater spring of Camp Creek at an elevation of 4,400 feet to 10.5 °C in a tributary to the East Fork Hood River at an elevation of 5,226 feet. Overall, the average temperature at all sample sites was 6.3 °C (Table 1). Streams sampled ranged from 2 to 45 cm (average = 13 cm) in depth, which was nearly identical to depths sampled in 2013 and 2014 (Wanner and Arendt 2015). Stream widths sampled ranged from 5 to 530 cm (average = 125 cm). Many of the sample sites had mixed substrate; however, over 42% of the sites had sand (< 2 mm) as the dominant (≥ 50%) substrate type, 16% of the sites were dominated by gravel (2 – 64 mm), while only 9% of the sites were dominated by cobble (64– 256 mm) (Table 1). In the past caddisfly surveys around Mt. Hood, gravel was the dominate substrate sampled (71% in 2013 and 42% in 2014). This change in substrates sampled were due to the fact that this study focused primarily on sampling springs and streams with dense wiry moss while the previous studies focused on collecting a wide range of sensitive caddisfly species (Wanner and Arendt 2015).

Nearly 70% of the streams sampled in 2016 had moss as the dominant instream vegetation (54% in 2013 and 50% in 2014; Wanner and Arendt 2015), while detritus (2013 = 27%; 2014 = 30%; 2016 = 13%) and no vegetation (2013 = 19%; 2014 = 20%; 2016 = 18%) at the sample sites were less common. The over-story vegetation cover was dominated by Pacific silver fir plant association community in the 4,000 to 5,500 feet elevation band around Mt. Hood. In 2016, 45% of the streams sampled were in small tree (9”- 21” dbh) stands, 25% in shrubs (1”- 5” dbh), and 15% in large tree (21”- 32” dbh).

Larval caddisflies collected

In 2016, larval caddisflies were collected in 95% of the kick net samples. Larval caddisflies were identified to species when possible; otherwise they were identified to genus or group. A total 1,224 larval caddisflies were collected from 11 families (Table 2).

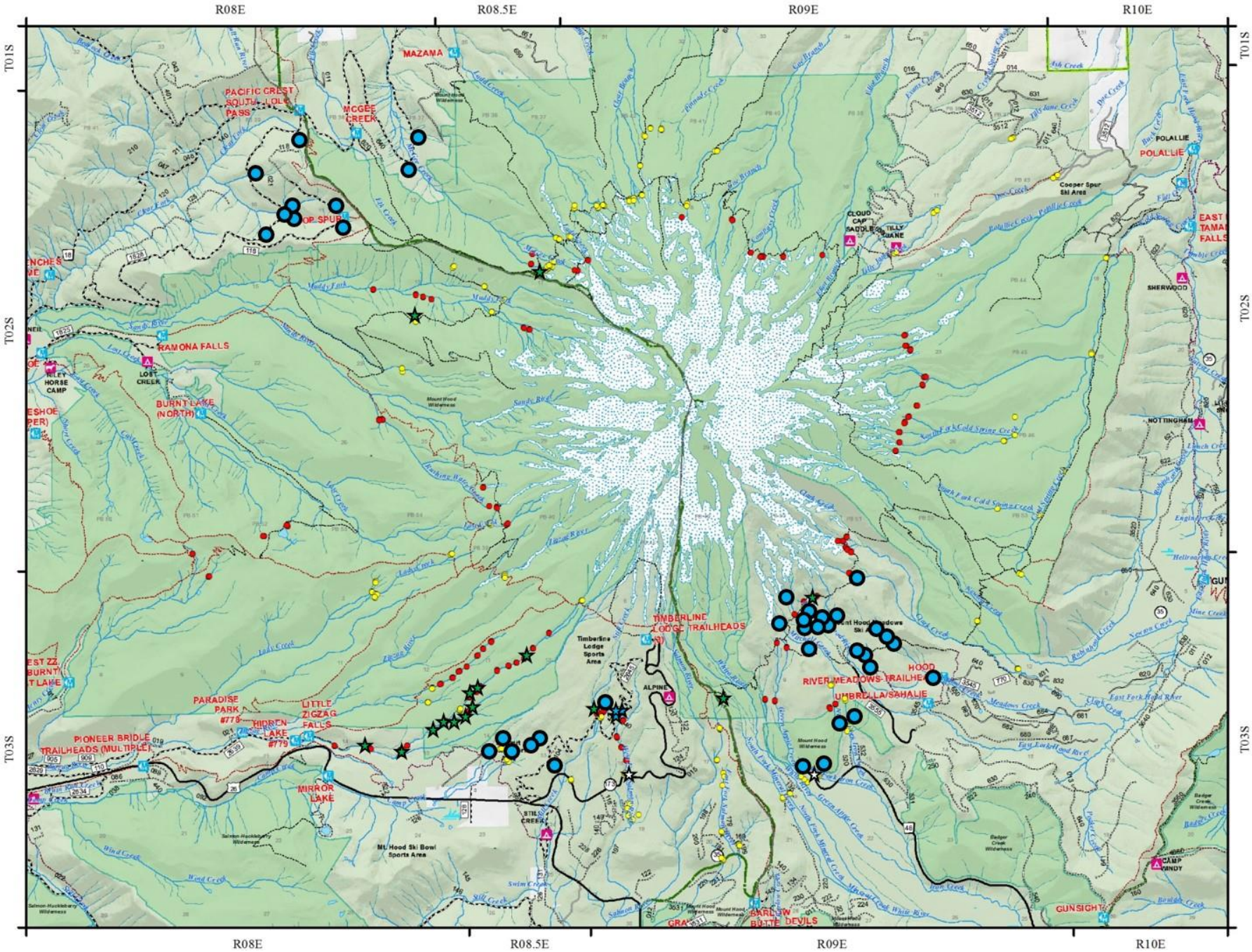

Figure 1. Blue circles indicate the 2016 larval and adult caddisfly survey sites. Yellow circles were larval sample sites in 2013 and red circles were sample sites in 2014 illustrating the range of recent larval caddisfly surveys (Wanner and Arendt 2015). White stars indicate where *A. scotti* were collected in 1964 and 1966 (Wiggins 1973), blue stars are 2010 *A. scotti* collections (Wisseman 2010), and green stars are *A. scotti* collections in 2013 and 2014 (Wanner and Arendt 2015). Dark green shade on map indicates congressionally designated wilderness around Mt. Hood.

Table 1. Average elevation, water temperature, depth, wetted width, visual estimation of percent sand, gravel, cobble, and boulder at the survey sites for streams sampled in each 6th field watershed around Mt. Hood in May through July and September through October 2016.

Stream	Elev. (ft.)	Water temp. (°C)	Depth (cm)	Wetted width (cm)	% Sand	% Gravel	% Cobble	% Boulder
			Still Creek					
Still Creek	4254	5.0	17	270	40	27	20	13
Still Creek Trib	4939	4.7	12	84	85	6	8	1
			Zigzag Canyon					
Camp Creek Trib1	4202	5.0	9	87	57	17	20	7
Camp Creek Trib2	4247	4.4	7	103	47	33	20	0
Camp Creek Trib3	4341	5.5	12	157	47	27	13	13
Camp Creek Trib4	4057	7.0	7	83	37	37	23	3
Camp Creek Headwater Springs	4420	2.1	6	101	68	33	0	0
			Upper Sandy River					
Clear Fork	3445	5.0	7	71	25	40	32	3
Clear Fork Trib	3500	5.7	7	135	23	47	25	3
			Upper West Fork Hood River					
Marco Creek Trib	2859	5.0	12	210	0	25	65	10
McGee Creek Trib1	3060	6.0	8	102	22	65	13	0
McGee Creek Trib2	2844	10.0	6	140	22	6	44	28
Stump Creek	4209	7.2	14	165	0	30	35	35
			Upper East Fork Hood River					
E. Fork Hood River Headwater Springs	5641	4.9	38	44	96	4	0	0
Mitchell Creek	5580	6.0	19	147	30	15	30	25
Mitchell Creek Trib	5885	9.0	11	40	63	2	5	30
Clark Creek Trib	5684	7.0	10	157	42	20	27	12
East Fork Hood River Trib	5452	7.9	18	168	45	17	14	23
Meadows Creek Trib	4998	7.0	8	67	56	26	10	10
			Upper White River					
North Fork Iron Creek	4422	8.0	14	337	37	13	37	13
North Fork Iron Creek Trib	4461	7.2	9	78	17	58	20	5
South Fork Iron Creek	4270	5.1	27	100	40	13	33	13
South Fork Iron Creek Trib	4248	5.0	17	63	27	20	20	33

Table 2. Total number of larval caddisflies collected in each 6th field watershed around Mt. Hood from May through October 2016.

Taxa	Still Creek	Upper East Fork Hood River	Upper Sandy River	Upper West Fork Hood River	Upper White River	Zigzag Canyon	Grand Total
Apataniidae							
Allomyia sp.	3	91					94
Allomyia scotti					1	4	5
Allomyia scotti cases						12	12
Apatania sp.		1		1	1		3
Brachycentridae							
Eobrachycentrus gelidae					3	2	5
Micrasema sp.		11	2	8	3		24
Glossosomatidae							
Anagapetus sp.	1		3	1			5
Goeridae							
Goeracea genota			3	5			8
Hydropsychidae							
Parapsyche turbinata	2	3	6			4	15
Parapsyche elsis	11	48	32	8	14	25	138
Lepidostomatidae							
Lepidostoma (early instars)				2			2
Lepidostoma hoodi group	6	22	14	31	10	3	86
Lepidostoma (panel case group)			3				3
Lepidostoma (spiral case)			7				7
Limnephilidae							
Limnephilidae pupae/early instars		9					9
Allocosmoecus partitus			1				1
Chyranda centralis	1	7	4		1	1	14
Cryptochia sp.	5	5	4	6	1	1	22
Desmona sp.							
Dicosmoecus (early instars)		5	1				6
Ecclisocosmoecus scylla	9	14	1	6		2	32
Ecclisomyia sp.		9	2				11
Eocosmoecus frontalis	2	43	18	4	3	7	77
Homophylax sp.	1	1	3		1		6
Onocosmoecus unicolor			1				1
Philocasca sp.		9	2	12			23
Psychoglypha sp.	20	45	14	1	11	3	94
Philopotamidae							
Dolophilodes sp.							
Dolophilodes pallidipes	1		23	2	1	6	33
Wormaldia sp.			1			1	2

Table 2 continued.

Taxa	Still Creek	Upper East Fork Hood River	Upper Sandy River	Upper West Fork Hood River	Upper White River	Zigzag Canyon	Grand Total
Polycentropodidae							
Polycentropus sp.			1				1
Rhyacophilidae							
Rhyacophila (pupae/early instar)			1				1
Rhyacophila alberta group		2					2
Rhyacophila angelita group			1				1
Rhyacophila betteni group	2	20	22	5	1	2	49
Rhyacophila perda				1			1
Rhyacophila brunnea/vemna group	1	14	2	7	4	5	33
Rhyacophila vemna						1	1
Rhyacophila grandis		4	3	1			8
Rhyacophila rotunda group		6					6
Rhyacophila sibirica group (Vetina complex)	1	8			2	2	13
Uenoidae							
Farula sp.	16	46			108	28	198
Neophylax splendens		2	12		2		16
Neothremma sp.		71	4	2	2	2	81
Oligophlebodes sp.		24					24

Scott's apatanian caddisfly

There are now nine known populations of *A. scotti* in the world. In 2016, a new population of *A. scotti* was discovered in the headwater springs of Camp Creek (Figure 2). Four live specimens and 12 empty *A. scotti* cases were collected from four separate springs at elevations of 4,400 to 4,435 feet in 1.8 to 2.5 °C water temperature. At 1.8 °C, this is the coldest temperature this species has been documented in. Previous known temperature range was 2.8 to 6.8 °C. The Camp Creek headwater springs are similar to the ones where this rare species have been documented in West Fork Salmon River (Wisseman 2010) and Still Creek (Wanner and Arendt 2015) where multiple springs and stream threads, covered in dense mats of wiry moss, come out of the mountain in a narrow band around Mt. Hood. Among the five springs and seeps that originate as the headwaters of Camp Creek, we estimated that there is approximately 1,600 linear feet of stream habitat for this rare species. The Camp Creek spring also serves as the water source for the city of Government Camp, Oregon (Figure 3). Two other populations of *A. scotti* are found at developed springs for drinking water such as the one in the headwater springs in the West Fork Salmon River that serves for Timberline Lodge and the headwater springs for the East Fork Hood River for Mt. Hood Meadows Ski Area (Wanner 2016). All three developed springs provide a consistent volume of cold, clear water, which are the same criteria for *A. scotti*.

We also re-discovered an *A. scotti* population in a tributary to South Fork Iron Creek, which was last recorded in 1966 (Wiggins 1973). This site was immediately adjacent to Oregon Highway 35 and near the junction of the Forest Service Road 48. At an elevation of 4,253 feet, the spring emerged from a steep gradient gravel slide covered in a dense mat of wiry moss. Water temperature in this tributary to South Fork Iron Creek was 5 °C.

Figure 2. Headwater spring of Camp Creek is six feet wide with down woody debris and nearly covered with 4 to 8 inch deep mats of moss at this site. Two live larval specimens and four empty cases of *A. scotti* were collected in a 5 ft^2 sampling area here on 13 September 2016.

Figure 3. Main overflow culvert from Government Camp water supply spring box in the headwaters of Camp Creek. Photo illustrates where four empty *A. scotti* cases were collected immediately downstream of culvert under 8 inch dense mats of moss on 13 September 2016.

Other larval sensitive, strategic, and species of interest collected

No larval caddisfly *Namamyia plutonis* (strategic species) or caddisfly *Moselyana comosa* (strategic species) were collected during this study or in the other recent surveys around Mt. Hood (Wanner and Arendt 2015; Ikeda and Wanner 2016). *Namanyia plutonis* was documented nearby in Cabin Creek in the Columbia River National Scenic Area in 2015 (Fallon et al. 2016). It was surprising that we did not collect the caddisfly *Namamyia plutonis* as they have been described in the Cascade Range in sand and gravel substrate streams at 4,000 to 5,000 feet elevation (Andrews 2010a). Caddisfly *Moselyana comosa* have been documented on Mt. Hood (Andrews 2010b). This species of caddisfly has been recorded with localized populations in seeps at elevations from 3,000 to 6,000 feet. We sampled relatively few seeps during this study, which may account for none sampled.

No larval Tombstone prairie caddisfly *Oligophlebodes mostbento* (strategic species) were collected in 2016. However, a total of 24 Tombstone prairie caddisfly was collected in a tributary to the Muddy Fork in the Sandy River Basin in 2013 while none were found in 2014 (Wanner and Arendt 2015). This caddisfly was collected near 4,200 feet elevation, in a cold 7.3 °C, wide stream (250 – 300 cm), with no instream vegetation or detritus and a shrub dominated over-story, and dominated by boulder substrate (Table 6).

No larval *Lepania cascada* were collected in 2016. Only two caddisfly *Lepania cascada* (strategic species) were collected in Camp Creek in 2013 while none were found in 2014 (Wanner and Arendt 2015). This caddisfly was collected in one sample at an elevation of 4,183 feet, at 4.8 °C water temperature, in a small stream (10 cm deep and 95 cm wide), with detritus as the dominate instream vegetation, a mature forest canopy in the riparian area, and with 70% gravel as the dominant substrate.

A total of three Mt. Hood primitive brachycentrid caddisfly *Eobrachycentrus gelidae* were collected in South Fork Iron Creek and two more in Still Creek in 2016 (Table 2). A total of one of this species was collected during 2013 and three in 2014 (Wanner and Arendt 2015). This caddisfly species is also a glacial relict such as Scott's apatanian caddisfly. This species currently is not listed as a sensitive or strategic species but was at one time and was a candidate as an endangered or threatened species by the U.S. Fish and Wildlife Service in 1984 (Wisseman 2010). In 2013, we collected this species in a small (15 cm deep and 80 cm wide) tributary to Hidden Lake in the Zigzag Watershed. Sampling at this location was immediately above the lake in a marshy area with high detritus and sand as the dominant substrate. In 2014, we collected this species in a spring/tributary to the North Fork Iron Creek. The technicians that surveyed this site noted in their comments that this sight looked particularly like Scott's apatanian habitat with wiry moss over small loose gravel.

Adult caddisflies collected

In 2016, adult caddisflies were collected in only 14 out of 39 sample sites. A total of 24 adult caddisfly were collected from six families (Table 3). The capture success for adult caddisflies was low again in 2016 and comparable to the total of 20 adults captured over 38 sites in 2015 (Ikeda and Wanner 2016). Adult surveys in 2016 were completed during the appropriate environmental conditions in 2016; however, that did not improve our success compared to the collections during record warm and dry conditions in 2015. In 2016, three male *Lepania cascada*, a strategic species, were collected in the headwaters of the Clear Fork of the Sandy River near the FS Road 1828. Another female of this species was collected in a headwater tributary to the Clear Fork of the Sandy River near the popular Top Spur Trailhead (Trail 785) along FS Road 1828-021. No other sensitive adult caddisflies were collected in 2015 (Ikeda and Wanner 2016) or in 2016.

Table 3. Adult caddisflies collected around Mt. Hood in 2015.

Taxa	Still Creek	Upper East Fork Hood River	Upper Sandy River	Upper West Fork Hood River	Upper White River	Zigzag Canyon
Brachycentridae						
Micrasema sp.		2				
Micrasema bactro					2	
Glossosomatidae						
Anagapetus bernea			2			
Goeridae						
Lepania cascada			4			
Limnephilidae						
Ecclisocosmoecus scylla						2
Ecclisomyia simulata	1	3				
Philopotamidae						
Dolophilodes pallidipes		1				
Dolophilodes novusamericanus					1	
Wormaldia occidea			1			
Rhyacophilidae						
Rhyacophila ecosa			2			
Rhyacophila visor		2			1	

Restoration and protection needs for Scott's apatanian caddisfly

Camp Creek

The Government Camp Water Company, under a Special Use Permit (ZIG024) with the USDA Forest Service (USDA Forest Service 2004), provides potable water to the community of Government Camp. The company holds the Water Right appropriation issued in 1908 that allows for 1.5 cubic feet/second (CFS) or 969,408 gallons of water per day collected from the headwaters of Camp Creek. Facilities located on National Forest lands include the spring source development (buried spring box and PVC water line), headworks access road, 250,000 gallon steel tank, 100,000 redwood storage tank, distribution lines, and two gates. In 1980, the point of diversion was transferred from a stream source along Camp Creek to the existing headwater spring source of Camp Creek. Although not metered, the current spring collection system is estimated to produce 500 gallons/minute or 720,000 gallons/day (USDA Forest Service 2004).

Currently, *A. scotti* appears to be relatively abundant in four of Camp Creek headwater springs based on the four sub-samples collected in September 2016. *A. scotti* were collected directly downstream of the spring collection system indicating that at least since 1980, when the collection system was constructed, this species has maintained or re-populated the stream directly downstream of the spring box. However, some existing infrastructure may be impacting caddisfly populations. There is evidence that the access road is contributing unnatural levels of road related sediment to the headwaters of Camp Creek, directly into *A. scotti* habitat (Figure 4 and 5). I recommend that this access road be maintained with a 6-inch lift of gravel. Additionally, large (3 to 6 inch) round rock should be placed in the road where a wetland overflows and seeps across the existing road. These measures should reduce unnatural sediment delivery from this access road to the headwaters of Camp Creek.

Figure 4. Government Camp headworks access road on 16 September 2016. Water leaving a wetland and crossing the road. Erosion contributing to unnatural levels of fine sediment to *A. scotti* habitat in Camp Creek.

Figure 5. Government Camp headworks access road. Erosion contributing to unnatural levels of fine sediment to *A. scotti* habitat in Camp Creek. Photo taken on 29 August 2016.

West Fork Salmon River in Timberline Ski Permit Area

A. scotti was first documented in the West Fork Salmon River in 1964 where Timberline Highway 173 crosses the stream (Wiggins 1973). Since that time, the range of *A. scotti* is much reduced to only the headwater springs (Wanner and Arendt 2015). This is likely due to the high volume of unnatural road-related sand coming off the Timberline Highway and the Timberline Lodge parking lot, which is directly connected upstream. Since that first discovery of *A. scotti* in 1964, it is likely that nearly 4,000 feet of habitat has been eliminated due to unnatural road sand entering the West Fork Salmon River. The intermittent reach of this stream substrate is nearly all road sand (Figure 6). The Mt. Hood NF and Oregon Department of Transportation (ODOT) are currently looking at techniques to reduce the amount of road-related sand from entering this stream. The collaboration between ODOT and the Forest Service has seen some success in reducing road-related sediment entering Still Creek further down the mountain along US Highway 26 (DeAngelo et al. 2017).

A. scotti were first recorded in the headwater springs of the West Fork Salmon River in 2010 (Wisseman 2010) (Figure 7). This population is so conspicuous that specimens of this species have been collected by hand by simply grabbing one handful of the deep wiry moss and examining the underside in both September 2014 and July 2017 on site visits (Wanner; unpublished data). These headwater springs to the West Fork Salmon River also serve as the water source for Timberline Lodge and ski area on the Mt. Hood. The Mt. Hood National Forest maintains a water right (29948 and T-11180) that provides 0.5 CFS for Timberline Lodge under a special use permit (ZIG139) with RLK and Company (USDA Forest Service 2008). The springs are crossed with perforated pipe (Figure 8) to collect the spring water that is piped into a concrete vault that is then piped to a pump house (Figure 9). FS Road 2645-040 accesses the pump house (Figure 10). Currently the access road delivers unnatural amounts of sediment to the headwater springs of the West Fork Salmon River. It is recommended that this road be maintained with a six inch gravel lift on top of 3 to 6 inch round rock to allow water to pass through the sub-surface of the road. I also recommend only allowing service vehicles to park at the top of the hill above the pump house. The degraded road down the steep gradient to the pump house should be de-compacted and replanted with native vegetation (Figure 10). There are additional native surface roads in the ski area immediately adjacent and uphill of the spring sites for the West Fork Salmon River (Figure 11). These service roads should be de-compacted and restored with native vegetation.

Figure 6. Intermittent reach of the West Fork Salmon River immediately upstream from where the headwater springs enter. Substrate is nearly entirely road sand as this stream is directly connected to the parking lot at Timberline Lodge and the Timberline Highway. Photo taken on 29 August 2016.

Figure 7. West Fork Salmon River headwater springs emerge directly out of the side of Mt. Hood at an elevation ~5,020 feet. Photo taken looking downstream from the intermittent reach. This site is where the West Fork Salmon River becomes a perennial stream. *A. scotti* were first discovered 4,000 feet downstream of this site in 1964 (Wiggins 1973).

Figure 8. Drainage piping crossing the underground springs in the West Fork Salmon River directly in *A. scotti* habitat.

Figure 9. Pump house in headwater springs of West Fork Salmon River. Deteriorated road contributes fine sediment directly into the headwater springs.

Figure 10. FS Road 2645-040 access road to pump house that has three stream crossings in *A. scotti* habitat.

Figure 11. Native surface roads (FS Road 2645030) to access electrical infrastructure near West Fork Salmon River headwater springs.

Still Creek in Timberline Ski Permit Area

The headwater springs of Still Creek, where *A. scotti* have been documented (Wanner and Arendt 2015), are generally protected from recreational users due to the steep terrain and from road related sediment due to the location from the West Leg Road (FSR 2645). However, there is evidence of tree cutting directly over the perennial stream reaches in this area that has either been done as user created trails or through the hazard tree program in the Timberline Ski Permit Area.

The springs of Still Creek emerge from the mountain 600 feet upstream of the Jeff Flood Chairlift Terminal along the West Leg Road. These springs connect to the intermittent reach of Still Creek above where natural and unnatural fine sediment is high (Figure 12). The area uphill and upstream from the springs has numerous ski runs, hiking trails, and ski lift terminal service roads. Prior to 2013, the Glade Trail, approximately 2,500 feet in length, existed as a series of ill-defined user trails that resulted in a road-like condition. This trail was historically used as a downhill ski run, but it was also used by hikers, huckleberry pickers, and snowshoers. The trail also contains utility lines that supply the Timberline Lodge Resort. The Glade Trail was decommissioned in 2013 and 2014, which included grading the surface to match natural topographic contours, topping the area with topsoil or amended local material, and seeded the site with native plant species. Ultimately, the goals of restoring the Glade Trail were to address erosion concerns and unnatural sediment delivery to Still Creek. RLK and Company in cooperation with the Forest Service has been largely successful in restoring the ski runs by decommissioning or improving the maintenance of service roads and trails in the ski area since 2013.

A flood and debris flow event that was the result of about half of an inch of rain falling on May 22, 2015 at higher elevations on Mt. Hood, resulted in an additional 3.5 inches of water equivalent of snowmelt. There was a lack of snow cover during the spring of 2015; however, this debris flow may have been exasperated by the road network further up Mt. Hood that serves the upper Mile and Stormin' Norman chairlift terminals. These roads may have concentrated runoff flows that further increased sediment delivery to Still Creek. RLK and company has done extensive road work in 2015 and 2016 to further disconnect those road from Still Creek. Similar to the West Fork Salmon River, which is only 1,200 feet away, *A. scotti* most likely occurred in Still Creek downstream of Jeff Flood area, but the amount of sediment and the flashiness of this reach may now preclude this rare caddisfly species to exist in this reach today. I do recommend that additional road work is needed to further reduce stream network connectivity of these service roads at the higher elevations above Timberline Lodge and to further reduce road-related sediment delivery.

Figure 12. Still Creek on 2 June 2015 following debris flow event. Notice the pristine looking headwater spring of Still Creek entering the intermittent, flashy and sediment laden channel of Still Creek.

Figure 13. Intermittent reach of Still Creek immediately upstream of where the headwater springs enter and the stream becomes perennial. Debris flow likely negatively impacted caddisfly populations.

East Fork Hood River in the Meadows Ski Permit Area

A. scotti were first reported in a tributary to East Fork Hood River in 2014 within the Mt. Hood Meadows ski permit area (Wanner and Arendt 2015). Mt. Hood Meadows, Oreg., LLC has a special use permit (HOO413702) with the Forest Service for the Ski Permit area and associated infrastructure (USDA Forest Service 1986). This includes a water development in the headwater springs of the East Fork Hood River similar the water developments in Camp Creek and West Fork Salmon River. Currently, Mt. Hood Meadows draws about 5 gallons per minute or around 0.01 CFS from this spring. The system is set up with a spring box that is then piped to a newly constructed 300,000 gallon tank that replaced an open pond in 2017. The amount of water delivered to the tank is adjusted manually, which may affect the amount of water that is delivered from the spring box to the stream (Figure 14). Although no *A. scotti* were recorded in the stream with the spring box in 2016, there is deep wiry moss, little to no stream scour and deposition, and water temperature of 3 °C, which is ideal habitat for *A. scotti*. Although this rare caddisfly was not detected, they are likely present in low abundances in this stream with the spring box. However, it is unknown how much variation in stream flow occurs due to the manual manipulation of water collection at the spring box.

There is evidence in 2016 that the access road to the water tank is contributing road-related sediment downstream of the springs, which is approximately 1,000 feet downstream of the *A. scotti* recorded site (Figure 15). Additionally, there is a culvert in conjunction with the overland flow from the access road that is creating unstable banks in the headwater streams of East Fork Hood River (Figure 16). The increase in fine sediment and the likely increase in discharge with the connections to the road have scoured the deep wiry most away and embedded the gravels (Figure 17) compared to areas directly upstream of this site (Figure 18).

It is recommended that the entire spring and meadow complex uphill from the Mt. Hood Meadows Lodge should be protected for *A. scotti*. Every effort should be made to maintain the current flow regime from the spring box outflow, which supplies water to the new tank. Reduce fine sediment routing into nearby streams from the access road through routine installation and maintenance of drivable dips. Chlorine is highly toxic to aquatic species in the receiving streams, even at concentrations that cannot be detected by field measurements (Tikkanen 2016). Since *A. scotti* are present in these headwater streams, it is critical that chlorinated water is not released into nearby streams either through planned or unplanned events. The State of Oregon regulatory discharge limit of 0.1 mg/l or less when discharging chlorinated water to a stream with flow less than 50 CFS, shall be met (ODEQ 1997).

There is also evidence of dispersed camping near the numerous headwater springs along the Timberline Trail (Figure 19). Dispersed camping tramples vegetation, removes downed wood through campfires, compacts soils, which may increase flow and sediment routing to the surrounding sensitive springs and streams. It is recommended that dispersed camping be discouraged from these sensitive spring areas and the impacted areas should be replanted with native plants.

Figure 14. Spring box in headwaters of East Fork Hood River in the Mt. Hood Meadows ski permit area. This spring and stream is less than 800 feet from a known *A. scotti* population. Notice the persistent wiry moss that is critical to this rare caddisfly species immediately downstream of the spring box.

Figure 15. Access road to water tank in the Mt. Hood Meadows ski permit area. There is evidence that water runoff from this access road is contributing unnatural levels of fine sediment to the headwaters of East Fork Hood River.

Figure 16. Headwaters of East Fork Hood River with a culvert outlet next to water tank area. Evidence of unstable banks and road related sediment enter the stream here.

Figure 17. Headwater stream of the East Fork Hood River immediately downstream of where the culvert and access road for the water tank. There is no evidence of deep wiry moss and the gravels are embedded with fine silt.

Figure 18. Headwater stream of the East Fork Hood River immediately upstream of the culvert and access road for the water tank. Deep wiry moss critical to *A. scotti* and much less fine silt is evident.

Figure 19. Dispersed camping immediately adjacent to *A. scotti* habitat in the headwater springs of East Fork Hood River off of the Timberline Trail within the Mt. Hood Meadows Ski Area.

Conclusion

Humans were drawn to many of the headwater springs around Mt. Hood due to their stable and consistent flows of cold, clean water. These springs were the perfect sources for drinking water to support a small city and recreation areas on Mt. Hood. Those same spring characteristics are the exact and only niche habitat that *A. scotti* are adapted to occupy. For those reasons, it will be critical to maintain those habitats for this rare caddisfly species, while providing for abundant drinking water around Mt. Hood. Particular attention needs to occur between the Forest Service and special use permit holders when reviewing and updating the operation and maintenance plans associated with these water developments. Further, the Forest Service needs to partner with the permit holders to improve the existing infrastructure, particularly the access roads to these facilities. Additionally, there are opportunities for the Forest Service and the Ski Permit Areas to collaborate on restoring native vegetation while providing world class recreation on Mt. Hood.

Acknowledgements

I thank the USDA Forest Service – Region 6 and DOI Bureau of Land Management Interagency Special Status/Sensitive Species (ISSSSP) Program for funding this study. I thank Emi Ikeda, Jacob Sleasman, Haley McDonel, Josh Haslitt, Kevin Perkins, Nicholas Floyd for collecting, sorting, and entering caddisfly data. Kathryn Arendt reviewed early versions of this report. Jon Lee Consulting identified all Trichopteran adults and larvae for this project.

References

Anderson, N.H. 1976. The Distribution and Biology of the Oregon Trichoptera. Technical Bulletin of the Agricultural Research Station, Oregon State University, Corvallis, OR. 152 pp.

Andrews, H. 2010a. Caddisfly *Namamyia plutonis* Fact Sheet. Prepared for USDA Forest Service and DOI Bureau of Land Management Interagency Special Status/Sensitive Species (ISSSSP) Program (www.fs.fed.us/r6/sfpnw/issssp). http://www.fs.fed.us/r6/sfpnw/issssp/species-index/fauna-invertebrates.shtml

Andrews, H. 2010b. Caddisfly *Moselyana comosa* Fact Sheet. Prepared for USDA Forest Service and DOI Bureau of Land Management Interagency Special Status/Sensitive Species (ISSSSP) Program (www.fs.fed.us/r6/sfpnw/issssp). http://www.fs.fed.us/r6/sfpnw/issssp/species-index/fauna-invertebrates.shtml

Cain, C., and N. Diaz. 2002. Field guide to the forested plant associations of the westside central Cascades of northwest Oregon. USDA Forest Service – Pacific Northwest Region. Technical Paper R6-NR-ECOL-TP-02-02.

Crandell, D.R., 1980. Recent eruptive history of Mount Hood, Oregon, and potential hazards from future eruptions: U.S. Geological Survey Bulletin 1492, 81 p.

DeAngelo, M., O. Guthrie, N. Floyd, C. Dillon, and G. Wanner. 2017. Still Creek Watershed Restoration Completion Report. Mt. Hood National Forest – Zigzag Ranger District, Zigzag, Oregon. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd563779.pdf

Fallon, C., E. Blevins, and R. Wisseman. 2016. Surveys to determine the status and distribution of three Columbia River Gorge endemic caddisfly and stonefly species: *Farula constricta*, *Neothremma andersoni*, and *Namomemoura wahkeena*. Final report from the Xerces Society and Aquatic Biology Associates, Inc. to the Interagency Special Status/Sensitive Species Program (ISSSSP) and the Columbia river Gorge National Scenic Area.

Ikeda, E., and G. Wanner. 2016. 2015 Adult Caddisfly Surveys on Mount Hood National Forest. Final Report prepared for USDA Forest Service – Region 6 and DOI Bureau of Land Management Interagency Special Status/Sensitive Species (ISSSSP) Coordinator. USDA Forest Service, Mt. Hood National Forest – Zigzag Ranger District, Zigzag, Oregon.

Kwak, T.J., and J.T. Peterson. 2007**.** Community indices, parameters, and comparisons. Pages 677-763 *in* C.S. Guy and M.L. Brown, editors. Analysis and interpretation of freshwater fisheries data. American Fisheries Society, Bethesda, Maryland.

Lemly, A.D. 1982. Modification of benthic insect communities in polluted streams: combined effects of sedimentation and nutrient enrichment. Hydrobiologia 87: 229-245.

ODEQ, 1997. Oregon Department of Environment Quality Chlorinated Water Discharge Guidance. Retrieved on 10/12/2016 from: http://www.deq.state.or.us/wq/pubs/bmps/chlorwaterdisp.pdf

NOAA (National Oceanic and Atmospheric Administration). 2016. National Overview – Annual 2015. www.ncdc.noaa.gov/sotc/national/201513

Scheuering, E. 2006. One-spot Rhyacophilan Caddisfly Fact Sheet. Prepared for USDA Forest Service and DOI Bureau of Land Management Interagency Special Status/Sensitive Species (ISSSSP) Program (www.fs.fed.us/r6/sfpnw/issssp). http://www.fs.fed.us/r6/sfpnw/issssp/species-index/fauna-invertebrates.shtml

Tikkanen et al, 2016. Guidance Manual for the Disposal of Chlorinated Water. Retrieved on 10/12/2016 from: http://www.vita-d-chlor.com/specs/awwarfdechlorguides.htm

USDA Forest Service. 2004. Authorization ID: ZIG024. U.S. Department of Agriculture Forest Service Amendment for Special Use Authorization. Amendment Number 1. Mt. Hood National Forest – Zigzag Ranger District, Zigzag, Oregon.

USDA Forest Service. 2008. Authorization ID: ZIG139. U.S. Department of Agriculture Forest Service Special Use Authorization. Mt. Hood National Forest – Zigzag Ranger District, Zigzag, Oregon.

USDA Forest Service. 1986. Authorization ID: HOO413702. U.S. Department of Agriculture Forest Service Special Use Authorization. Mt. Hood National Forest – Hood River Ranger District, Parkdale, Oregon.

USEPA (U.S. Environmental Protection Agency). 1990. The quality of our nation's water: a summary of the 1988 National Water Quality Inventory. U.S. Environmental Protection Agency, EPA Report 440/4-90-005, Washington, D.C.

Wanner, G. A., and K. Arendt. 2015. Caddisfly survey around Mt. Hood: search for Scott's apatanian and other sensitive caddisfly species. Final Report prepared for USDA Forest Service – Region 6 and DOI Bureau of Land Management Interagency Special Status/Sensitive Species (ISSSSP) Coordinator. USDA Forest Service, Mt. Hood National Forest – Zigzag Ranger District, Zigzag, Oregon.

Wanner, G. 2016. Scott's Apatanian Caddisfly Fact Sheet (Revised). Prepared for USDA Forest Service and DOI Bureau of Land Management Interagency Special Status/Sensitive Species (ISSSSP) Program (www.fs.fed.us/r6/sfpnw/isssp). U.S. Department Agriculture Forest Service, Mt. Hood National Forest – Zigzag Ranger District, Zigzag, OR. http://www.fs.fed.us/r6/sfpnw/isssp/species-index/fauna-invertebrates.shtml.

Waters. T.F. 1995. Sediment in streams: sources, biological effects and control. American Fisheries Society Monograph 7 Bethesda, Maryland.

Wisseman, R. 2010. Survey for Sensitive Aquatic Invertebrate Species in Tributaries of Still Creek and the West Fork Salmon River in the Vicinity of Proposed Mountain Bike Trails for the Timberline Lodge Winter Sports Area, Mount Hood, Mount Hood National Forest, Oregon, August 9-10, 2010. Prepared for Zigzag Ranger District, Mount Hood National Forest, Zigzag, OR. Aquatic Biology Associates, Inc., Corvallis, OR.

Wiggins, G.B. 1973. Contributions to the Systematics of the Caddisfly Family Limnephilidae (Trichoptera). Life Sciences Contributions Royal Ontario Museum No. 94. 32 pp.