SURVEYS TO DETERMINE THE STATUS OF THE NORTHERN FORESTFLY (*LEDNIA BOREALIS*) AND RAINIER ROACHFLY (*SOLIPERLA FENDERI*) ON THE OKANOGAN-WENATCHEE AND GIFFORD PINCHOT NATIONAL FORESTS OF WASHINGTON

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Alpine creek in Alpine Lakes Wilderness, Okanogan-Wenatchee National Forest

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THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION

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ABSTRACT

The northern forestfly (*Lednia borealis*) and Rainier roachfly (*Soliperla fenderi*) are both rare endemic stonefly species restricted to montane areas of the Pacific Northwest. In August 2015, Xerces Society biologists surveyed potential habitat for these species on the Okanogan Wenatchee and Gifford Pinchot National Forests in Washington state. Habitat identified and surveyed included: mid to high elevation glacial-fed lakes, ponds, and streams; montane seeps and springs; first order rheocrenes; and small streams. Much of this habitat was only accessible by hiking trail, and surveyors spent 140 hours traveling to and surveying sites; this effort included hiking over 40 trail miles and climbing nearly 10,000 feet in elevation. No *Lednia* were collected or observed during the course of this survey effort. Ten *Soliperla* larvae were collected from four sites on the Gifford Pinchot National Forest in the Goat Rocks Wilderness; however, larvae cannot be identified to species, and two species of *Soliperla* are currently known from Washington, including *S. fenderi* (known only from Mt. Rainier NP) and *S. cowlitz* (recently described from several locations in or near the Gifford Pinchot NF). If genetic markers become available, we recommend DNA analysis on these specimens to positively ID them. In addition, surveyors collected a single larva of the caddisfly *Rhyacophila vetina* on the Okanogan Wenatchee National Forest, which is a Forest Service strategic species in Washington. Other specimens of interest include three collections of *Desmona mono*, and three collections of *Allomyia* larvae, both of which are alpine-associated caddisflies.

We achieved all major goals of this project, including:

- Determine criteria for surveying areas for *L. borealis* and *S. fenderi* by mapping potential suitable habitat
- Consult with USFS biologists on the appropriate districts and national forests to identify suitable USFS-owned habitat near the known collection localities in Washington
- Survey suitable habitat on the Okanogan-Wenatchee, Gifford Pinchot, and/or Mt. Baker Snoqualmie NFs
- Record all data including documenting where surveys were conducted
- Write a complete report that includes detailed maps of areas surveyed for these two species

We recommend continued survey efforts for both species in the Okanogan-Wenatchee, Mt. Baker-Snoqualmie, and Gifford Pinchot National Forests. In particular, potential sites just south of the Mt. Rainier National Park boundary and in the SW region of Mt. Adams were not well searched during this survey effort due to accessibility issues and fire complications, and should be prioritized in future visits. We also recommend that sites with verified *Soliperla* collections be revisited earlier in the season to collect adults for positive species identification. Gifford Pinchot and Mt. Baker-Snoqualmie National Forest lands on the west and south sides of Mt. Rainier should be surveyed for *Soliperla fenderi* and *Lednia borealis*. We were unable to search this area due to time and accessibility constraints, as well as smoke hazards from local wildfires. Seep and spring areas on the southwest side of Mt. Adams could be surveyed as well – this region was closed due to fire activity. Finally, we were unable to verify the single *L. borealis* observation at Colchuck Lake in the Okanogan-Wenatchee NF; this site could also be revisited.

INTRODUCTION

The purpose of this project was to identify and survey potential habitat and determine whether two species of rare or potentially rare stoneflies (*Lednia borealis* and *Soliperla fenderi*) occur in suitable habitat within USFS lands in Washington. One or both of these species are suspected to occur on the Gifford Pinchot, Okanogan Wenatchee, and Mt. Baker Snoqualmie National Forests, based on close proximity to known records (Fig. 1). *Lednia borealis* has already been documented from the Mt. Baker Snoqualmie National Forest at Upper Bagley Lake (Baumann & Kondratieff 2010, Jordan 2013a; see Fig. 1) and an unconfirmed observation was recently made at Colchuck Lake in the Okanogan Wenatchee National Forest (Giersch 2015, pers. comm.; see Fig. 1).

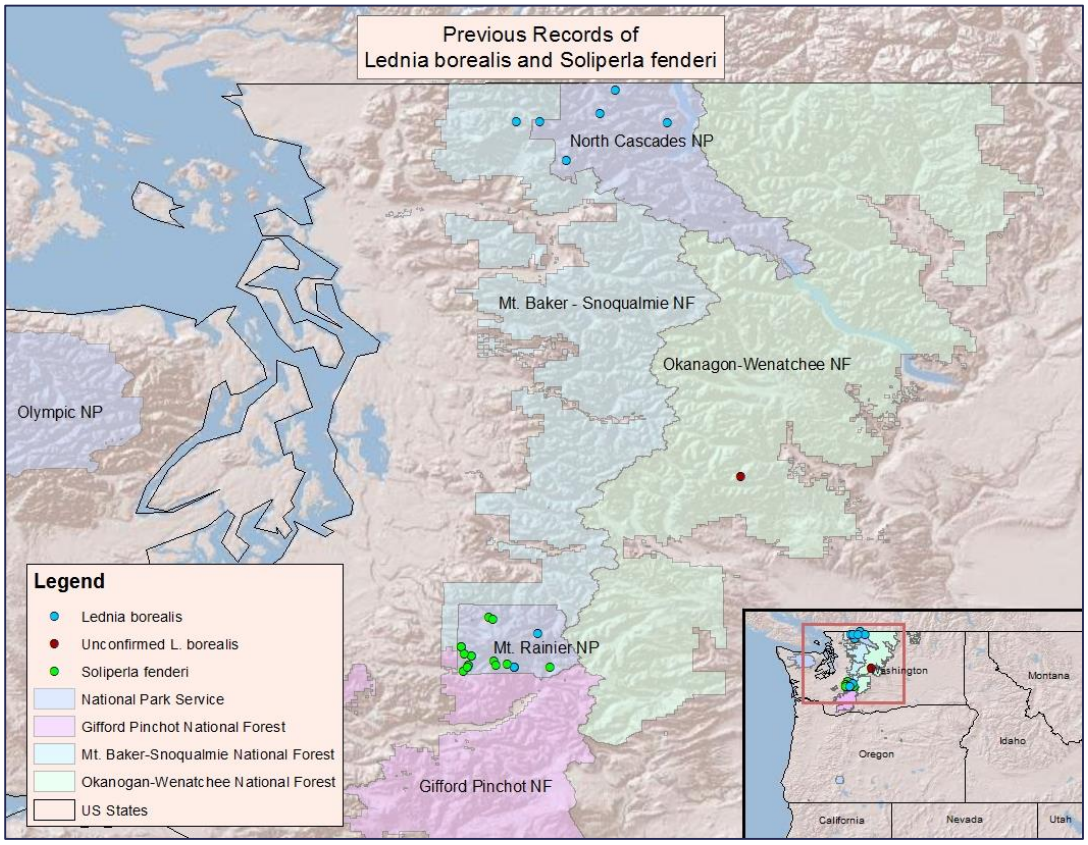

Figure 1: Map of previous known records of *Lednia borealis* and *Soliperla fenderi* in Washington

LEDNIA BOREALIS

The northern forestfly, *Lednia borealis*, is a Washington state endemic known only from high elevation cold water habitat, including lakes, glacial-fed streams, and first order rheocrenes (channelized springs) in the Cascades, including Mt. Rainier and North Cascades National Parks and the Mt. Baker-Snoqualmie National Forest (Jordan 2013a; WDFW 2015). The species was recently described from specimens originally identified as *L. tumana*, which is now only known from Montana (Baumann & Kondratieff 2010). The earliest known record for this species in Washington is from Upper Bagley Lake (Whatcom County) in Mt. Baker National Forest in 1987, and since then it has been described from just seven other sites in three counties: Fryingpan Creek in Pierce County; Redoubt Lake, Nert Lake, No Name Lake, Price Lake, and Middle Tapto Lake in Whatcom County; and Snow Lake in Lewis County (see Appendix I). In addition, the species was recently observed at Colchuck Lake in Chelan County, although no collections were made (Giersch 2015, pers. comm.). Despite seven years of relatively intense stonefly collecting in Mt. Rainier National Park, this species was represented by only one collection in Kondratieff and Lechleitner's 2002 study. It appears to be more widespread in the North Cascades, and Baumann and Kondratieff (2010) believe it could occur in the southern Cascade Range in Oregon and northern California. It is suspected on the Gifford Pinchot and Okanogan-Wenatchee National Forests (Jordan 2013a).

Lednia borealis has not yet been ranked by NatureServe or the Washington Natural Heritage Program; however, it is still listed under its previous name of *L. tumana*, where it is given a state rank of S1 (critically imperiled) and a global rank of G1G2 (note: WNHP gives a state rank of SNA; NatureServe 2015, WNHP 2015). Adults of the northern forestfly are described as 5 to 7.5 mm long with dark brown body color and hyaline wings with darker veins near the cord (Baumann & Kondratieff 2010). Nymphs can reach 4.5 to 6.5 mm and have tiny light colored spines on their legs (Baumann & Kondratieff 2010). A distinguishing characteristic for *Lednia* nymphs is the absence of gills, which makes identification of the genus easy in the field (Baumann & Kondratieff 2010; Giersch 2015, pers. comm.). Past records for *L. borealis* indicate that adults are active from mid-July through mid-September. Little is known about *L. borealis* feeding habits, although most species in the Nemouridae family are shredders or collector-gatherers and use a variety of coarse plant materials (Merritt & Cummins 1996).

SOLIPERLA FENDERI

The Rainier roachfly, *Soliperla fenderi*, was first recorded from St. Andrews Creek, Mt. Rainier National Park, in 1953 and is now known from about 15 occurrences throughout the park in Pierce County, Washington (Jordan 2013b) (see Appendix I). It is suspected to occur on the Mt. Baker-Snoqualmie and Gifford Pinchot National Forests, based on close proximity to these known records. *Soliperla* from the Mt. Adams area were originally thought to be *S. fenderi* but have since been reclassified as a new species, *S. cowlitz* (Stark & Gustafson 2004).

S. fenderi has a global rank of G2 (imperiled) and a S1S2 rank in Washington (WNHP 2014, NatureServe 2015). Adults and nymphs of *Soliperla* are unusual in that they display distinctive pigmentation patterns, with adults typified by a dark mesal pronotal stripe that contrasts sharply with the yellow background, and nymphs having conspicuous white areas on the abdominal terga that contrast with the dark background (Stark 1983). Adults have been collected from mid-June through mid-August (see Appendix I). Data on feeding habits and habitat needs are minimal, but this species is known to occur in spring-fed seeps and streams (rheocrenes) draining mostly on the west side of Mt. Rainier National Park (Jordan 2013b). There is also a single record from a waterfall (Jordan 2013b). In general, most *Soliperla* species utilize specialized habitats such as seeps and splash zones of small streams (Stark & Gustafson 2004).

METHODS

SITE SELECTION

Potential habitat for these stoneflies on USFS lands was first determined by mapping known locations in ArcMap 10.3. Forest Service land ownership boundaries were overlaid with a National Hydrography Dataset (NHD) layer for Washington state. All three layers (known locations, land ownership, and hydrography dataset) were converted to KML files and imported to Google Earth, which was used to select potential sites for surveys. For potential *Lednia borealis* sites, the time lapse Historical Imagery feature on Google Earth was used to determine which areas were most likely to have year-round snow (a method suggested by Joe Giersch). The NHD layer was useful in identifying areas with seeps and springs for *Soliperla* surveys. We also reached out to the following experts and Forest Service biologists to inquire about appropriate habitat and specific site information (note, however, that not all of these contacts responded to our outreach):

1. Joe Giersch, Aquatic Entomologist (Northern Rocky Mountain Science Center)
2. Josh Kubo, Salmon Recovery Scientist (Tulalip Tribes Natural Resources Department)
3. Bob Wisseman, Aquatic Entomologist (Aquatic Biology Associates)
4. Richard Baumann, Emeritus Curator (Brigham Young University)
5. Boris Kondratieff, Entomology Professor (Colorado State University)
6. Baker Holden, Forest Fisheries Program Manager (Gifford Pinchot NF)
7. Ken Wieman, Cowlitz Valley District Fisheries Biologist (Gifford Pinchot NF)
8. Stephanie Caballero, Mt. Adams Ranger District Fisheries Biologist (Gifford Pinchot NF)
9. Richard Vacirca, Forest Fisheries Program Manager (Okanogan Wenatchee NF)
10. Kathy McMillan, Wenatchee River District Fisheries Biologist (Okanogan Wenatchee NF)

Lednia borealis has been observed at sites ranging from 1150-1750 meters elevation and has been collected from springs draining into alpine lakes as well as glacial-fed streams. *Soliperla fenderi* has been observed at sites ranging from 650-1500 meters elevation and is known to occur in spring-fed seeps and streams, including rheocrenes (springs that flow from defined openings into a channel). For *Lednia*, we selected sites that are influenced by year-round snowpack, such as glacial-fed creeks, streams, and lakes. This genus needs permanent, cold water (Giersch 2015, pers. comm.). Seeps and small streams were targeted for *Soliperla*. Overall, our sites ranged from approximately 480 to 2375 meters elevation. Given our limited survey time, we focused our efforts on potential habitat within the Gifford Pinchot National Forest outside of Rainier National Park, where many of the known records for the two species have originated. In addition, based on information from Giersch (2015, pers. comm.) regarding a recent sighting of *L. borealis* at Colchuck Lake on the Okanogan Wenatchee National Forest, we spent two days searching that location and adjacent alpine habitat.

In order to cover a broad geographic range, we surveyed both high elevation sites, where access was difficult, and mid-elevation sites close to the road or along short hiking trails, targeting *Soliperla* (which is known from elevations beginning at 650 meters) but also collecting a representative sample of other stoneflies, caddisflies, and mayflies. In two cases we opted to backpack overnight in order to more efficiently sample a larger number of sites in high elevation backcountry. It should be noted that the intense and widespread wildfire activity this year made selecting and accessing sites particularly challenging, and we had to alter our survey plans several times throughout the week to avoid active fire areas and areas with heavy smoke and limited visibility. Several potential survey areas were closed because of wildfires, particularly on Mt. Adams, including the Riley Creek Trail (#64) and the Riley South Trail (#64A). We were also warned to avoid Island Pond and the small lakes immediately north of it

due to fires (Caballero 2015, pers. comm.). The Divide Camp Trail, which we hiked on our last day under very poor conditions, was officially closed two days later (on August 24, 2015) due to the Cougar Creek Fire. One day later, on August 25, the entire Mt. Adams Wilderness Area was closed to all use due to extremely hazardous fire conditions.

SURVEY PERIOD

At the time of survey planning, all known records of *Lednia borealis* adults were from late July through early September, and *Soliperla fenderi* records were from late June through mid-August. Adults of the closely related *L. tumana* in Montana are thought to emerge in August once temperatures reach 10° C (50° F) (NatureServe 2015). To increase our chances of finding both species at the same time and to minimize exposure to potentially dangerous early-season stream crossings, we planned our surveys for mid-August.

SAMPLING METHODOLOGY

All sites were surveyed by Xerces conservation biologists using standard recommended survey techniques for stoneflies, outlined by Jordan (2011). Stream, lake, and seep habitats were surveyed by overturning rocks, looking through the substrate, and sweep-netting adjacent vegetation (when present). In alpine areas, we also checked snow surfaces for *Lednia* adults (recommended by Giersch 2015, pers. comm.). In addition to target species, we collected a representative sample of all stoneflies, caddisflies, and mayflies present, in order to gather basic distribution data for other species in the region. We spent a minimum of 20 person-minutes searching each site for our target species.

At each site, we recorded the waterbody name, locality information, water temperature, substrate type(s), water depth, stream width, canopy cover, and streamside vegetation. Site coordinates were recorded using a Garmin Rino 120 GPS unit (NAD83). Immature specimens were collected with forceps and placed in plastic screw-cap vials containing 95% ethanol as a preservative. Adults were collected from sweep nets or with forceps and preserved the same way. Surveys began around 8AM each day and continued until approximately 6:30PM. The weather during the survey period was quite variable, with warm sunny days interspersed with cold misty days and days with thick smoke and ash from nearby wildfires. Daytime temperatures ranged from 4 to 32° C (40 to 90° F).

DATA ENTRY AND SPECIES IDENTIFICATION

All data for this project were entered into an Excel spreadsheet and copied onto the Forest Service's Natural Resource Information System (NRIS) data sheets. Elevations were determined from site coordinates using Montana State University's Graphical Locator (http://www.esg.montana.edu/gl/index.html). All material collected for this project was identified by aquatic macroinvertebrate taxa expert Bob Wisseman (Aquatic Biology Associates, Inc.).

RESULTS

One hundred and forty person-hours were spent traveling to and surveying 35 sites (see site maps in Appendix V). No *Lednia* stoneflies were collected during this survey effort. Ten *Soliperla* larvae were collected from four sites in the Goat Rocks Wilderness on the Gifford Pinchot National Forest (Table 1). Larvae of this genus cannot be identified to species. In addition, we collected a single *Rhyacophila vetina* larva from the Okanogan Wenatchee National Forest. This is a USFS Strategic Species in Washington. For a list of all species collected by site, see Appendix III. Habitat descriptions and photos are available in Appendix IV. For a list of all sites surveyed in 2015, see Appendix II.

Table 1: *Soliperla* and *Rhyacophila vetina* collection sites

Date	Species	Site Name	Locality	County	Habitat	Comments
18 Aug 2015	*Rhyacophila vetina*	Colchuck Lake 4	Alpine Lakes Wilderness, Okanogan Wenatchee NF	Chelan	Intermittent creek, likely snow-fed.	WA-STR species, not previously documented on OKW.
20 Aug 2015	*Soliperla* sp.	Goat Rocks 1	Goat Rocks Wilderness, Gifford Pinchot NF	Lewis	Intermittent first order creek.	Potential target species. Need genetic work for ID.
20 Aug 2015	*Soliperla* sp.	Goat Rocks 7	Goat Rocks Wilderness, Gifford Pinchot NF	Lewis	Hillside seep/spring	Potential target species. Need genetic work for ID.
20 Aug 2015	*Soliperla* sp.	Goat Rocks 8	Goat Rocks Wilderness, Gifford Pinchot NF	Lewis	Hillside seep/spring	Potential target species. Need genetic work for ID.
21 Aug 2015	*Soliperla* sp.	Goat Rocks 10	Goat Rocks Wilderness, Gifford Pinchot NF	Lewis	Hillside seep/spring	Potential target species. Need genetic work for ID.

DISCUSSION

SURVEYS

Many of the unique habitats needed by these stoneflies are restricted to high alpine or more remote areas within the National Forests and are not easily accessible, which limits the number of sites that can be surveyed each day, as well as the amount of time spent surveying each site. It is possible that with additional searches and increased survey efforts, the target species may be found. Recommended survey methods are easy, inexpensive, and require little specialized equipment, although confirmation of species identity requires an expert and, in the case of *Soliperla*, also requires collection of adult specimens for positive species identification.

Although we searched for both nymphs and adults at all survey sites, we found very few adults of any aquatic invertebrates in general. This may be due to the limited snowpack this year and a warmer than average summer, which could have caused adults to emerge prior to our survey period. We recommend continued survey efforts for both species in the Okanogan-Wenatchee, Mt. Baker-Snoqualmie, and Gifford Pinchot National Forests. In particular, potential sites just south of the Mt. Rainier National Park boundary and in the SW region of Mt. Adams were not well searched during this survey effort due to accessibility issues and fire complications, and should be prioritized in future visits. Further documentation of these species' ranges and habitats is especially critical for advancing understanding of their status and needs and taking the appropriate conservation measures. Alpine habitats in particular are generally under-surveyed, and given their vulnerability to climate change and other threats, may be of particular conservation concern. If future surveys take place for these two species in Washington, we recommend the following:

1. Revisit sites with verified *Soliperla* collections earlier in the season and attempt to catch adults for positive identification. Based on prior records, adults may be present as early as mid-June.
2. Survey Gifford Pinchot and Mount Baker-Snoqualmie National Forest lands on the west and south sides of Mt. Rainier (see black circle, Figure 2) for *Soliperla fenderi* and *Lednia borealis*. We were unable to search this area due to time and accessibility constraints as well as smoke hazards, but the majority of known *S.*

fenderi records are from the west side of Mt. Rainier National Park, so seeps and splash zones of small streams in this area would be a survey priority.

3. Survey additional seep/spring areas on Mt. Adams, which appear to be relatively abundant in the SW region of the mountain, and which were off-limits during this survey effort due to fire activity and trail closures. Future surveyors will need to identify areas that were not lost or negatively impacted by the burns.
4. Revisit Colchuck Lake (OKW) and attempt to verify the *Lednia borealis* observation shared with us by Giersch (2015, pers. comm.).

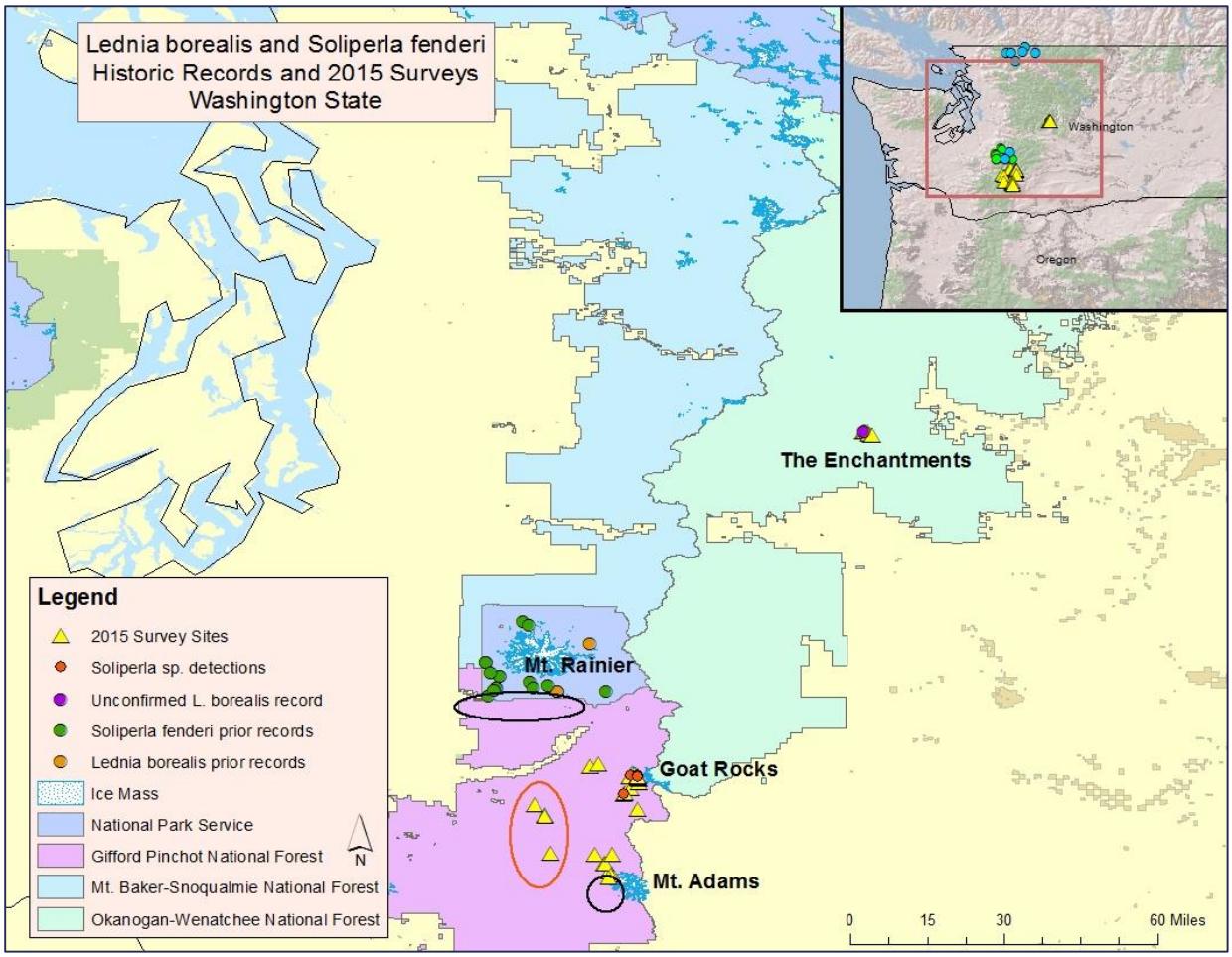

Figure 2: Prior species records and 2015 survey locations. Survey sites inside the red circle indicate opportunistic surveys along roads. The areas within the black circles indicate priority areas for future surveys.

GENETIC ANALYSES

A total of ten *Soliperla* larvae were found during the 2015 surveys which could not be identified to species using morphological characters. There are currently two *Soliperla* species described from Washington: *S. fenderi* (known only from Mt. Rainier National Park) and *S. cowlitz* (Stark & Gustafson 2004; Stark 2015, pers. comm.). It is unclear which species our collections may represent, or if they would be a new species altogether (see Fig. 3 for locations of 2015 collections and other *Soliperla* records in the state). *S. cowlitz* has been collected from lower elevation sites ranging from approximately 60-700 meters elevation, whereas *S. fenderi* is mostly known from mid-elevation

sites (most records appear to be within 650-1500 meters elevation). Our *Soliperla* sp. collections come from even higher elevations, ranging from 1430 to over 2000 meters.

These ten specimens should be saved for potential future analyses. They can be analyzed genetically for positive identification, though limited barcoding has been done for this genus as a whole. Stark (2015, pers. comm.) is unaware of any genetic work done on *S. fenderi*, although he notes that the *S. campanula* COI gene was used in a recent outgroup analysis of *Sierraperla* (see Stark et al 2015), and work by other researchers may be forthcoming.

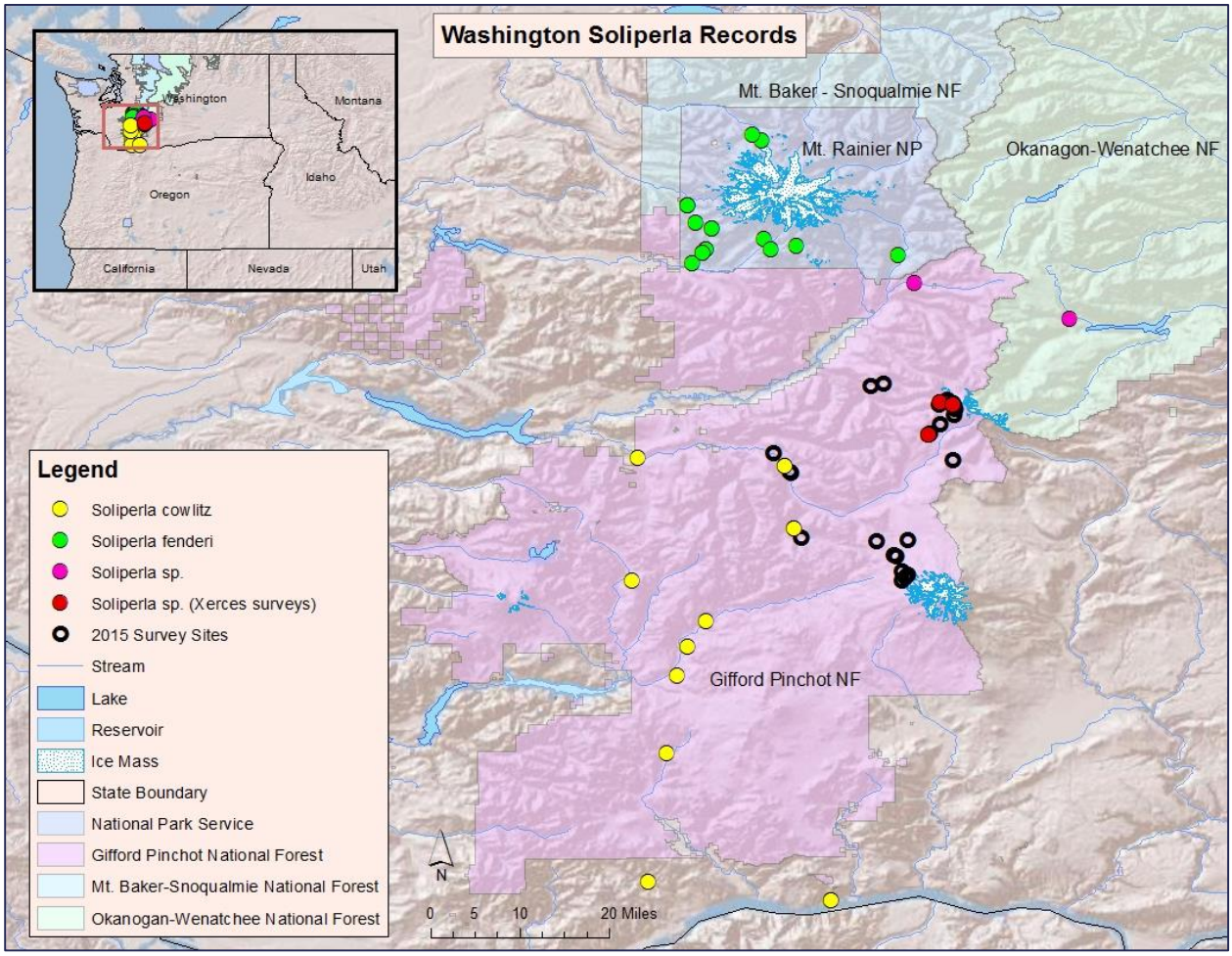

Figure 3: Known *Soliperla* records in Washington state. The red *Soliperla* sp. records are from 2015 Xerces surveys in the Goat Rocks Wilderness.

THREATS

The primary threats to these species are habitat alteration (including sedimentation post-fire and post-logging) and climate change. Alpine species are particularly vulnerable to climate change and can serve as bioindicators of ecosystem function and health. Assessments by the Washington Department of Fish and Wildlife have determined that *Lednia borealis* has a high climate vulnerability ranking, and *S. fenderi* has a ranking of moderate to high (WDFW 2015). Muhlfeld et al. (2011) found that that future projected distribution of another range-restricted endemic stonefly, *L. tumana*, was shown to dramatically contract (losing over 80% of its potential current range) under future glacier and perennial snowfield loss due to projected warming trends. Populations of the rare

endemic stonefly *Zapada glacier* appear to have contracted and declined over the past several decades due to increasing water temperatures and decreasing glacial masses (Giersch et al. 2015). Plecoptera in general have low dispersal abilities (Petersen et al. 1999, Brown et al. 2009) and for alpine species such as *L. borealis*, distributional shifts or dispersal to other suitable habitats is probably unlikely given their location. With glaciers receding and Washington Cascades snowpack levels decreasing in recent years (for example, see Fig. 4), populations of both of these species are likely suffering due to limited suitable habitat. The seep and spring habitats where *Soliperla* are found can also be particularly vulnerable to natural disturbances and warming temperatures and should be monitored.

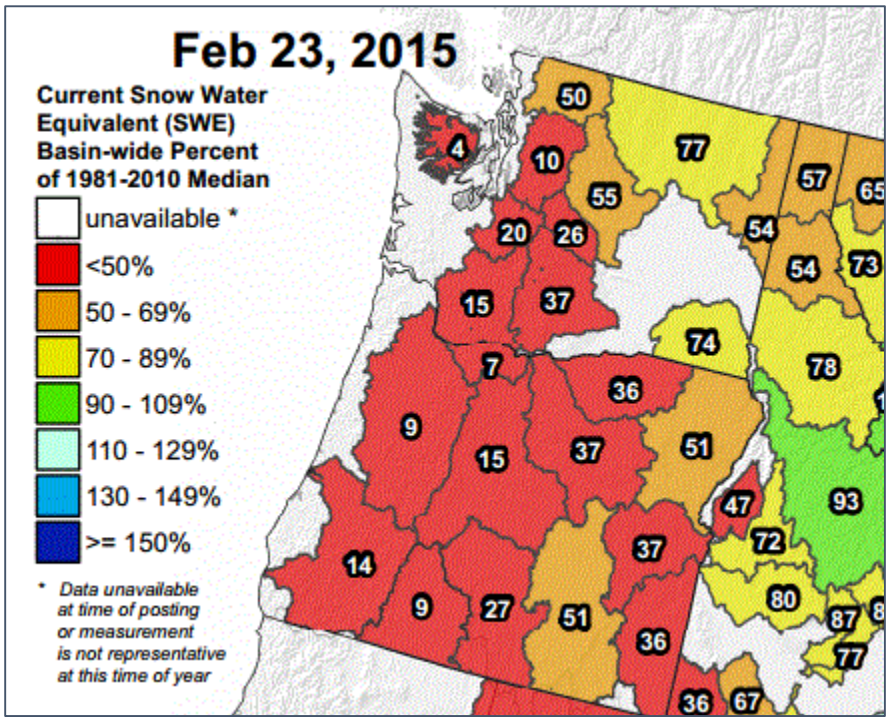

Figure 4: Snow Water Equivalent map depicting snowpack levels as of February 23, 2015 (NRCS 2015)

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APPENDIX I: PRIOR SPECIES RECORDS IN WASHINGTON

LEDNIA BOREALIS

Location	County	State	UTM_E (NAD83)	UTM_N (NAD83)	L_Zone	Loc_Acc	Land_ Owner	BLM_ NF	Elev (m)	Date
Colchuck Lake, Alpine Lakes Wilderness, Okanogan-Wenatchee NF	Chelan	WA	663277.8	5261597.6	10	MAN6	USFS	OKW	1700	2014?
spring source Snow Lake, Snow Lake Basin, Mount Rainier National Park	Lewis	WA	599241.5	5178904.3	10	GPS	NPS		1430	8 Sep 2010
spring source Snow Lake, Snow Lake Basin, Mount Rainier National Park	Lewis	WA	599241.5	5178904.3	10	GPS	NPS		1430	25 Aug 2010
spring source Snow Lake, Snow Lake Basin, Mount Rainier National Park	Lewis	WA	599241.5	5178904.3	10	GPS	NPS		1430	23 Aug 2010
Fryingpan Creek at Sunrise Road Bridge, Mount Rainier National Park	Pierce	WA	605912.7	5193653.3	10	MAN4	NPS		1161	16 Jul 2000
Redoubt Lake, North Cascades National Park	Whatcom	WA	623516.6	5425916.0	10	GPS	NPS		1615	29 Aug 1989
Nert Lake, North Cascades National Park	Whatcom	WA	610241.2	5395731.7	10	GPS	NPS		1389	11 Sep 1989
Middle Tapto Lake, Red Face Mountain Basin, North Cascades National Park	Whatcom	WA	619553.0	5415682.6	10	GPS	NPS		1747	8 Sep 1989
Price Lake, North Cascades National Park	Whatcom	WA	60248.0	5412128.0	10	GPS	NPS		1192	6 Sep 1989
No Name Lake, North Cascades National Park	Whatcom	WA	638436.5	5412528.2	10	GPS	NPS		1171	24 Aug 1989
Upper Bagley Lake, Mount Baker National Forest	Whatcom	WA	596064.4	5412135.3	10	MAN3	USFS	MBS	1295	30 Jul 1987

SOLIPERLA FENDERI

Location	County	State	UTM_E (NAD83)	UTM_N (NAD83)	L_Zone	Loc_Acc	Land_ Owner	BLM_ NF	Elev	Date
Small stream at jct. Westside Road and Hwy 706, Mt. Rainier National Park	Pierce	WA	584315.1	5177037.9	10	MAN4	NPS		652	14 Jul 2003
Small stream 1.5 miles N Westside Road, Mt. Rainier National Park	Pierce	WA	585522.1	5178973.4	10	MAN4	NPS		740	14 Jul 2003
Dick Creek at Wonderland Trail, Mount Rainier National Park	Pierce	WA	592554.8	5199313.9	10	MAN4	NPS		1251	27 Jul 2001
Cataract Creek at Wonderland Trail, Mount Rainier National Park	Pierce	WA	591391.2	5200311.5	10	MAN4	NPS		971	9 Jul 2000
Stream on Westside Road 1.5 miles from Paradise Road, Mount Rainier National Park	Pierce	WA	585522.1	5178973.4	10	MAN4	NPS		740	26 Jun 2000
Boggy stream tributary to Tahoma Creek, Mount Rainier National Park	Pierce	WA	586524.6	5183456.6	10	MAN6	NPS		1089	17 Aug 1999
Small tributary on Westside Road 2 miles N of Paradise Road, Mount Rainier National Park	Pierce	WA	585913.5	5179695.0	10	MAN4	NPS		764	17 Aug 1999
Paradise River, Paradise Valley, Mt. Rainier National Park	Pierce	WA	593939.2	5179777.7	10	MAN6	NPS		1115	16 Aug 1999
Falls Creek at Stevens Canyon Road, Mount Rainier National Park	Pierce	WA	609705.9	5179054.4	10	MAN3	NPS		715	8 Jul 1999
Small tributary on Westside Road 2 miles N of Paradise Road, Mount Rainier National Park	Pierce	WA	585913.5	5179695.0	10	MAN4	NPS		764	8 Jul 1999
Tributary to Tahoma Creek, Mount Rainier National Park	Pierce	WA	586524.6	5183456.6	10	MAN6	NPS		1089	8 Jul 1999
Seeps along Puyallup River, Mount Rainier National Park	Pierce	WA	584584.9	5184431.4	10	MAN6	NPS		1057	29 Jun 1981
Spring seeps along St. Andrews Creek, Mount Rainier National Park	Pierce	WA	583477.8	5187493.5	10	MAN6	NPS		1146	29 Jun 1981
Small stream at Reflection Lake, Mount Rainier National Park	Pierce	WA	597032.8	5180412.9	10	MAN4	NPS		1483	14 Jul 1979

Location	County	State	UTM_E (NAD83)	UTM_N (NAD83)	L_Zone	Loc_Acc	Land_ Owner	BLM_ NF	Elev	Date
Spring seeps along St. Andrews Creek, Mount Rainier National Park	Pierce	WA	583477.8	5187493.5	10	MAN6	NPS		1146	13 Jul 1979
Christina Falls, Mount Rainier National Park	Pierce	WA	593123.1	5181639.4	10	MAN4	NPS		1147	15 Jun 1969
St. Andrews Creek, Mount Rainier National Park	Pierce	WA	583477.8	5187493.5	10	MAN6	NPS		1146	27 Jul 1953

APPENDIX II: SITES SURVEYED IN 2015

Survey Date	Site Name	County	Land Ownership	UTME (NAD83, Zone 10)	UTMN (NAD83, Zone 10)	Loc Acc (ft.)
17 Aug 2015	Colchuck 1	Chelan	USFS - OKW	662928.3	5261749.1	40
17 Aug 2015	Colchuck 2	Chelan	USFS - OKW	663086.0	5261663.4	26
18 Aug 2015	Colchuck 3	Chelan	USFS - OKW	663277.8	5261597.6	65
18 Aug 2015	Enchantments	Chelan	USFS - OKW	664151.4	5260771.2	32
18 Aug 2015	Isolation Lake	Chelan	USFS - OKW	664506.1	5260517.6	11
18 Aug 2015	Perfection Lake	Chelan	USFS - OKW	664721.8	5260515.9	10
19 Aug 2015	Glacier Creek	Lewis	USFS - GIP	606624.3	5155307.4	300
19 Aug 2015	Glacier Lake	Lewis	USFS - GIP	608287.4	5155888.3	20
19 Aug 2015	Walupt Lake	Lewis	USFS - GIP	617188.6	5142198.6	30
20 Aug 2015	Goat Creek 1	Lewis	USFS - GIP	615507.7	5148646.7	15
20 Aug 2015	Goat Creek 2	Lewis	USFS - GIP	616281.6	5153011.0	13
20 Aug 2015	Goat Lake	Lewis	USFS - GIP	616259.4	5153090.6	25
20 Aug 2015	Goat Rocks 1	Lewis	USFS - GIP	614041.3	5146880.5	300
20 Aug 2015	Goat Rocks 2	Lewis	USFS - GIP	614131.6	5147021.1	300
20 Aug 2015	Goat Rocks 3	Lewis	USFS - GIP	617123.7	5150454.0	17
20 Aug 2015	Goat Rocks 4	Lewis	USFS - GIP	617195.8	5151448.0	9
20 Aug 2015	Goat Rocks 5	Lewis	USFS - GIP	617055.5	5151600.9	13
20 Aug 2015	Goat Rocks 6	Lewis	USFS - GIP	617043.9	5151960.8	10
20 Aug 2015	Goat Rocks 7	Lewis	USFS - GIP	616974.3	5152505.2	26
20 Aug 2015	Goat Rocks 8	Lewis	USFS - GIP	617019.1	5152289.3	16
20 Aug 2015	Goat Rocks 9	Lewis	USFS - GIP	617031.8	5152271.8	13
21 Aug 2015	Adams Creek	Skamania	USFS - GIP	610163.4	5124957.5	10
21 Aug 2015	Chain of Lakes	Skamania	USFS - GIP	607952.9	5127551.5	100
21 Aug 2015	Goat Rocks 10	Lewis	USFS - GIP	615386.2	5152567.0	25
21 Aug 2015	Goat Rocks 11	Lewis	USFS - GIP	615185.9	5152244.2	21
21 Aug 2015	Mt. Adams 2	Skamania	USFS - GIP	611824.9	5127700.3	20
21 Aug 2015	Killen Creek	Skamania	USFS - GIP	610367.1	5124805.0	47
22 Aug 2015	Blue Lake Creek	Lewis	USFS - GIP	596925.9	5139903.4	10
22 Aug 2015	Divide Camp	Skamania	USFS - GIP	611120.0	5122187.8	20
22 Aug 2015	E. Canyon Creek	Skamania	USFS - GIP	598487.5	5127980.6	19
22 Aug 2015	Horse Creek	Lewis	USFS - GIP	594839.1	5143147.9	10
22 Aug 2015	Lewis River	Skamania	USFS - GIP	611917.2	5121439.9	11
22 Aug 2015	Mt. Adams 2	Skamania	USFS - GIP	611701.9	5121194.8	9
22 Aug 2015	Mt. Adams 3	Lewis	USFS - GIP	597043.0	5139640.5	10
22 Aug 2015	Mutton Creek	Skamania	USFS - GIP	611210.4	5120438.9	14

APPENDIX III: LIST OF ALL SPECIES COLLECTED BY SITE

Note: Species of interest are highlighted in blue.

Date	Site	Taxa Group	Species	Quantity	Life Stage	Notes
17 Aug 2015	Colchuck Lake 1	Trichoptera	potentially *Ecclisomyia*	1	None	Old case
			Hesperophylax designatus	2	Pupae	Male
	Colchuck Lake 2	Trichoptera	*Mystacides alafimbriata*	1	Adult	Female
			Polycentropus variegatus	1	Adult	Male
18 Aug 2015	Colchuck Lake 3	Ephemeroptera	*Baetis bicaudatus*	3	Larvae	Mid instar
			Baetis tricaudatus	3	Larvae	Late instar
	Enchantments	Trichoptera	*Desmona mono*	6	Larvae	4th instar
			probably *Hesperophylax*	1	None	Old Limnephilid case
	Isolation Lake	Diptera	*Chironomidae*	2	Larvae	
		Ephemeroptera	*Ameletus*	3	Larvae	
		Plecoptera	*Megarcys*	6	Larvae	
		Trichoptera	*Desmona mono*	1	Larva	Probably 4th instar
			Ecclisomyia	10	Larvae	Mid instar
			Rhyacophila rotunda group	2	Larvae	5th instar
	Perfection Lake	Diptera	*Chironomidae*	1	Larva	
		Ephemeroptera	*Ameletus*	6	Larvae	
		Plecoptera	*Capriidae*	5	Larvae	
			Megarcys	5	Larvae	
		Trichoptera	*Allomyia*	2	Larvae	Sealed 5th instar, not in pre-pupal pose.
		Tricladida	*Polycelis*	3	Unknown	
	Colchuck Lake 4	Ephemeroptera	*Baetis bicaudatus*	5	Larvae	Mid to late instar
		Plecoptera	*Soyedina*	2	Larvae	Late instar
			Sweltsa	3	Larvae	Late instar

Date	Site	Taxa Group	Species	Quantity	Life Stage	Notes
			Zapada columbiana	3	Larvae	Mid instar
		Trichoptera	*Desmona mono*	1	Larva	5th instar
			Eocosmoecus ? schmidi	1	Larva	5th instar in mineral case
			Parapsyche elsis	4	Larvae	Late instar
			Rhyacophila vetina	1	Larva	Late instar. FS WA-STR species.
19 Aug 2015	Glacier Lake	Ephemeroptera	*Paraleptophlebia*	6	Larvae	
	Glacier Creek	Ephemeroptera	*Baetis bicaudatus*	1	Larva	
			Baetis tricaudatus	4	Larvae	
			Cinygmula	2	Larvae	
			Drunella doddsii	1	Larva	
			Epeorus deceptivus	1	Larva	
			Rhithrogena	5	Larvae	
		Plecoptera	*Chloroperlidae*	3	Adults	
			Yoraperla	1	Adult	Female
		Trichoptera	*Ecclisomyia*	1	Larva	Mid instar
			Micrasema	1	Larva	~4th instar
			Neophylax occidentalis	1	Pupa	Dead male
			Rhyacophila brunnea-vemna group	1	Larva	
			Rhyacophila vaefes	1	Adult	Male
			Rhyacophila valuma	1	Adult	Male
	Walupt Lake	Trichoptera	*Dicosmoecus giluipes*	1	Larva	5th instar
20 Aug 2015	Goat Rocks 1	Diptera	*Thaumaleidae*	1	Larva	
		Ephemeroptera	*Cinygmula*	6	Larvae	
			Drunella doddsii	1	Larva	
			Epeorus grandis group	2	Larvae	
			Rhithrogena	6	Larvae	
		Plecoptera	*Setvena*	1	Larva	

Date	Site	Taxa Group	Species	Quantity	Life Stage	Notes
			Soliperla	1	Larva	Potential target species.
		Trichoptera	*Anagapetus*	1	Larva	
			Neothremma	~10	Larvae	
			Parapsyche elsis	3	Larvae	
			Rhyacophila betteni group	1	Larva, pupa	Pupa is an immature male.
		Tricladida	*Polycelis*	1		
	Goat Rocks 2	Ephemeroptera	*Baetis tricaudatus*	2	Larvae	
			Cinygma	2	Larvae	
		Plecoptera	*Doroneuria*	1	Larva	
			Sweltsa	1	Larva	
			Zapada oregonensis group	1	Larva	
		Trichoptera	*Lepidostoma hoodi* group	1	Larva	
	Goat Creek 1	Ephemeroptera	*Ameletus*	1	Larva	
			Cinygma	5	Larvae	
			Cinygmula	4	Larvae	
			Drunella doddsii	2	Larvae	
			Epeorus deceptivus	1	Larva	
			Epeorus grandis group	4	Larvae	
			Rhithrogena	4	Larvae	
		Trichoptera	*Apatania*	1	Larva	
			Parapsyche elsis	1	Larva	
	Goat Rocks 3	Ephemeroptera	*Ameletus*	8	Larvae	
			Baetis bicaudatus	2	Larvae	
			Caudatella hystrix	1	Larva	
			Cinygmula	4	Larvae	
			Epeorus grandis group	2	Larvae	
			Rhithrogena	6	Larvae	

Date	Site	Taxa Group	Species	Quantity	Life Stage	Notes
		Plecoptera	*Setvena*	1	Larva	
			Sweltsa	1	Larva	
		Trichoptera	*Allomyia*	1	Larva	
			Psychoglypha	3	Larvae	
			Rhyacophila betteni group	1	Larva	
	Goat Rocks 4	Ephemeroptera	*Ameletus*	3	Larvae	
			Drunella doddsii	5	Larvae	Mid and late instars of 2 cohorts
			Rhithrogena	3	Larvae	
		Plecoptera	*Setvena*	6	Larvae	Mid and late instars of 2 cohorts
		Trichoptera	*Neothremma*	8	Larvae	
	Goat Rocks 5	Diptera	*Tipula*	1	Larva	
		Ephemeroptera	*Baetis bicaudatus*	3	Larvae	
			Drunella doddsii	3	Larvae	
			Rhithrogena	4	Larvae	
		Plecoptera	*Setvena*	6	Larvae	
			Sweltsa	1	Larva	
			Zapada columbiana	3	Larvae	
		Trichoptera	*Neothremma*	3	Larvae	
			Parapsyche elsis	2	Larvae	
			Rhyacophila rotunda group	1	Larva	
	Goat Rocks 6	Ephemeroptera	*Ameletus*	2	Larvae	
			Baetis bicaudatus	15	Larvae	
			Drunella doddsii	10	Larvae	
			Rhithrogena	7	Larvae	
		Plecoptera	*Setvena*	2	Larvae	
			Sweltsa	1	Larva	
		Trichoptera	*Neothremma*	16	Larvae	
			Parapsyche elsis	1	Larva	

Date	Site	Taxa Group	Species	Quantity	Life Stage	Notes
			Psychoglypha	1	Larva	
			Rhyacophila brunnea/vemna group	1	Larva	
	Goat Rocks 7	Ephemeroptera	*Ameletus*	1	Larva	
			Drunella doddsii	1	Larva	
			Paraleptophlebia	1	Larva	
		Plecoptera	*Setvena*	4	Larvae	Probably 2 cohorts
			Soliperla	1	Larva	Mid instar. Potential target species.
		Trichoptera	*Rhyacophila rotunda* group	1	Larva	
	Goat Rocks 8	Plecoptera	*Setvena*	1	Larva	
			Soliperla	7	Larvae	Potential target species.
			Zapada columbiana	1	Larva	
		Trichoptera	*Parapsyche elsis*	1	Larva	
			Rhyacophila betteni group	1	Larva	
	Goat Rocks 9	Ephemeroptera	*Baetis bicaudatus*	1	Larva	
			Rhithrogena	3	Larvae	
		Plecoptera	*Setvena*	5	Larvae	Two cohorts
	Goat Creek 2	Ephemeroptera	*Baetis bicaudatus*	5	Larvae	
		Plecoptera	*Setvena*	1	Larva	
21 Aug 2015	Goat Rocks 10	Ephemeroptera	*Baetis bicaudatus*	4	Larvae	
		Plecoptera	*Setvena*	2	Larvae	Mid and late instar
			Soliperla	1	Larva	Potential target species.
		Trichoptera	*Parapsyche elsis*	2	Larvae	
			Rhyacophila betteni group	1	Larva	
	Goat Rocks 11	Ephemeroptera	*Paraleptophlebia*	3	Larvae	
		Plecoptera	*Setvena*	4	Larvae	
		Trichoptera	*Parapsyche elsis*	1	Larva	
			Psychoglypha	2	Larvae	

Date	Site	Taxa Group	Species	Quantity	Life Stage	Notes
	Adams Creek	Ephemeroptera	*Baetis bicaudatus*	1	Larva	
			Cinygmula	5	Larvae	
			Paraleptophlebia	1	Larva	
		Trichoptera	*Neothremma*	2	Larvae	
	Mt. Adams 1	Ephemeroptera	*Ameletus*	1	Larva	
			Cinygma	2	Larvae	
			Cinygmula	1	Larva	
			Drunella doddsii	2	Larvae	
			Rhithrogena	1	Larva	
		Plecoptera	*Doroneuria*	1	Larva	
			Sweltsa	1	Larva	
		Trichoptera	*Neothremma*	3	Larvae	
			Parapsyche elsis	1	Larva	
			Rhyacophila betteni group	1	Larva	
	Killen Creek	Plecoptera	*Setvena*	1	Larva	
22 Aug 2015	Divide Camp	Diptera	*Pedicia*	1	Larva	
		Ephemeroptera	*Ameletus*	2	Larvae	
			Baetis bicaudatus	1	Larva	
		Plecoptera	*Setvena*	6	Larvae	Mid and late instar, 2 cohorts
			Sweltsa	1	Larva	
		Psectra	Hemerobiidae	1	Adult	
		Trichoptera	*Allomyia*	1	Larva	
			Limnephilidae	?	None	Empty cases
	Lewis River	Plecoptera	*Setvena*	2	Larvae	Mid and late instar, 2 cohorts
	Killen Creek	Plecoptera	*Setvena*	1	Larva	
	East Canyon Creek	Ephemeroptera	*Ameletus*	5	Larvae	
			Baetis tricaudatus	3	Larvae	
			Cinygmula	11	Larvae	

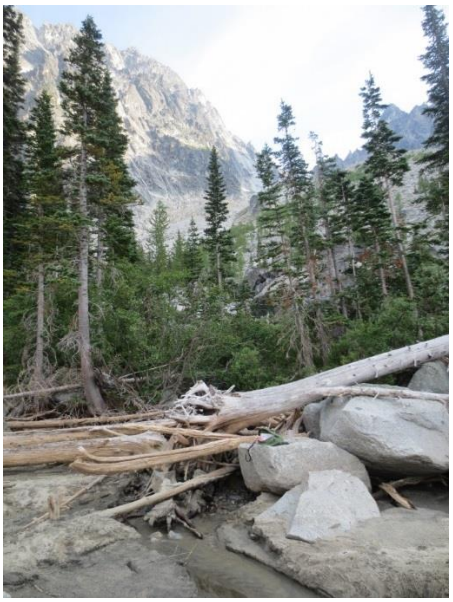
Date	Site	Taxa Group	Species	Quantity	Life Stage	Notes
			Drunella coloradensis	1	Larva	
			Paraleptophlebia	2	Larvae	
			Rhithrogena	1	Larva	
		Plecoptera	*Calineuria californica*	2	Larvae	
			Doroneuria	1	Larva	
			Frisonia picticeps	1	Larva	
			Isoperla	3	Adults	Females
			Megarcys	1	Larva	
			Skwala	2	Larvae	
			Yoraperla mariana	2	Larvae	
		Trichoptera	*Rhyacophila aenaudi*	2	Larvae	
			Rhyacophila betteni group	1	Larva	
			Rhyacophila hyalinata group	1	Larva	
	Mt. Adams 3	Coleoptera	*Lara*	1	Larva	
		Ephemeroptera	*Baetis tricaudatus*	1	Larva	
			Drunella coloradensis	1	Larva	
			Ironodes	4	Larvae	
		Plecoptera	*Pteronarcys princeps*	2	Larvae	
			Sweltsa	4	Larvae	
		Trichoptera	*Neothremma*	3	Larvae	
			Palaeagapetus nearcticus	10	Adults	Males
			Wormaldia occidea	10	Adults	Males
	Blue Lake Creek	Ephemeroptera	*Baetis bicaudatus*	1	Larva	
		Plecoptera	*Doroneuria*	1	Larva	
			Yoraperla mariana	5	Larvae	
			Zapada columbiana	2	Larvae	
		Trichoptera	*Dicosmoecus atripes*	1	Pupa	Female
			Parapsyche elsis	2	Larvae	

Date	Site	Taxa Group	Species	Quantity	Life Stage	Notes
	Horse Creek	Coleoptera	*Lara*	1	Larva	
		Ephemeroptera	*Ironodes*	1	Larva	
		Plecoptera	*Yoraperla nigrosoma/siletz*	1	Larva	
		Trichoptera	*Farula*	5	Larvae	Fatter *malkini* type

APPENDIX IV: HABITAT DESCRIPTIONS

AUGUST 17, 2015: ALPINE LAKES WILDERNESS, OKANOGAN WENATCHEE NF

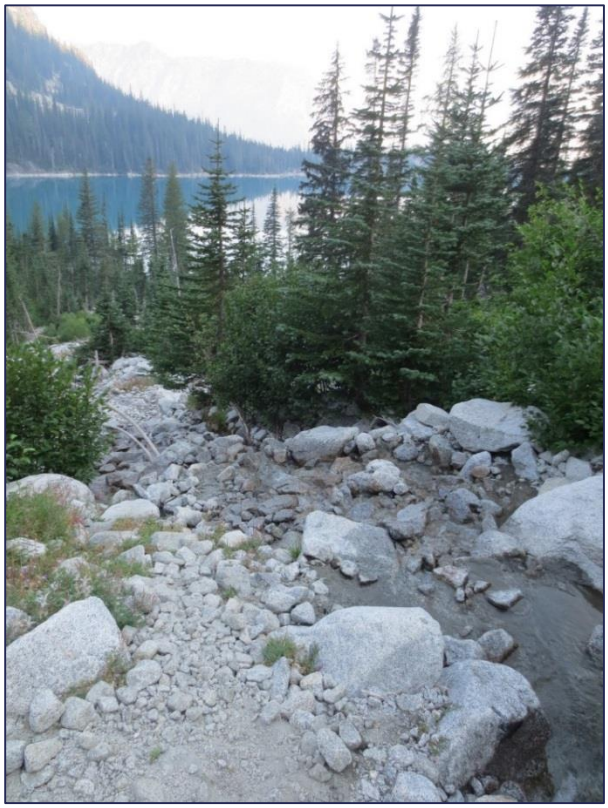
COLCHUCK LAKE 1 & 2

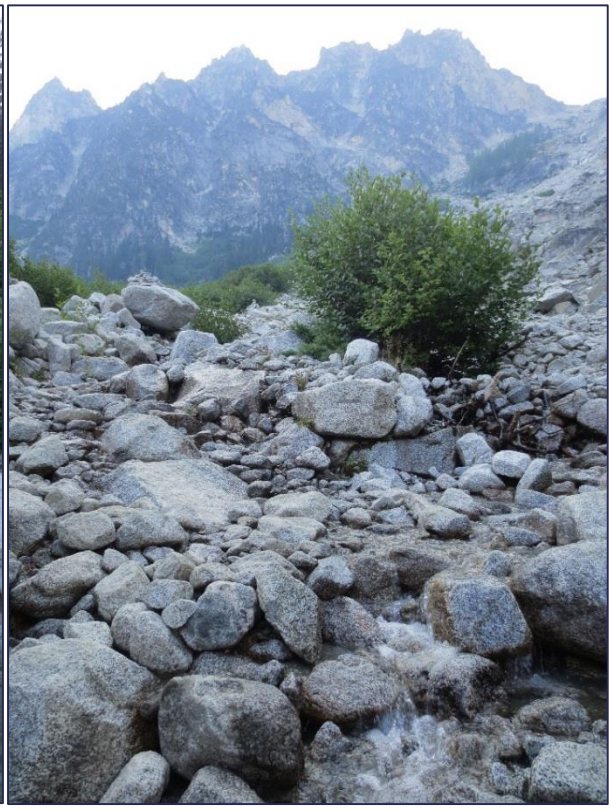


First order intermittent and perennial alpine streams flowing from Colchuck Glacier into Colchuck Lake. Water is mostly subsurface as it flows under enormous boulders and talus. The creeks were primarily accessible to us within 50 feet of the lake shore, where boulders gave way to sandy banks. The sand at these sites was composed of very large granules and made the banks very unstable. Water temperatures ranged from 3 to 7° C. Vegetation along these streams and the lakeshore is primarily willow and alder, with conifers higher up. The lakeshore is popular with recreationalists (camping, fishing). Elevation: 1702 m.

AUGUST 18, 2015: ALPINE LAKES WILDERNESS, OKANOGAN WENATCHEE NF

COLCHUCK LAKE 3





Intermittent alpine stream, likely snow-fed, approximately one to four feet wide. The stream is in full sun with occasional clumps of alder and spruce. A hiking trail up to Aasgard Pass crosses the stream. Slope is quite steep above the sampling site and it is likely that the stream bed shifts frequently in response to rock falls. Substrate is composed of boulders, cobble, gravel, and sand. Water temperature 7° C. Smoke from the nearby Chelan Lake wildfire made for hazy skies. Elevation: 1719 m.

Small perennial alpine pond with sandy bottom and scattered cobbles and boulders. Full sun with no vegetation. Water temperature 13° C. Elevation: 2376 m.

ISOLATION LAKE

Second order perennial alpine stream flowing from Isolation Lake, approximately 7 feet wide and 6 inches deep. Vegetation composed primarily of grasses and mosses. Exposed site in full sun. This site is located in the Core Zone of the Enchantments, which is popular with backpackers. Broad valley. Water temperature 12° C. Elevation: 2347 m.

PERFECTION LAKE

Second order perennial alpine stream connecting the two segments of Perfection Lake. Water temperature 13.5° C. Stream ranges from five to ten feet wide and up to 8 inches deep. Grasses dominant along streambanks with abundant filamentous algae in water. Elevation: 2303 m.

COLCHUCK LAKE 4

Intermittent creek (likely snow-fed) flowing through hanging gardens from below Aasgard Pass. This site is very steep with a lush plant community composed of stunted alder, corn lily, monkey flower, mosses, and grasses. Water temperature 11.5° C. A single larva of the caddisfly *Rhyacophila vetina* (WA-STR) was collected at this site. Elevation: 1971 m.

AUGUST 19, 2015: GLACIER AND WALUPT LAKES, GIFFORD PINCHOT NF

GLACIER LAKE

Mid-elevation lake with very low water levels, approximately 40 feet below vegetation line. Lake was formed by large boulders damming Glacier Creek during a landslide that likely occurred hundreds of years ago. Huge downed logs have congregated in the dammed area. Shoreline is very marshy with high amounts of muck and very few rocks. We briefly surveyed the lake shore by the rock dam; however, this site is not appropriate for our target species. Water temperature 20° C. Elevation: 891 m.

GLACIER CREEK

Fourth order perennial creek at bottom of heavily timbered steep slope, up to 5 feet wide and to 2.5 feet deep in pools. Old growth forest with lush streamside vegetation including hemlock, yew, devil's club, salmonberry, and Douglas-fir. This site is well-shaded with an apparently shifting stream bed. Abundant downed logs and conifer/deciduous inputs. Some boulders in creek but primarily cobble substrate. Water temperature 11° C. Elevation: 704 m.

WALUPT LAKE AND CREEK

Large lake and perennial fourth order stream by the same name. High recreation use (camping, stock use, fishing, boating, and swimming). This site was briefly surveyed due to its location directly adjacent to our campsite, however it did not look appropriate for our target species. Elevation: 1193 m.

AUGUST 20, 2015: GOAT LAKES WILDERNESS, GIFFORD PINCHOT NF

GOAT ROCKS 1

Small perennial creek, 2-3 feet wide and up to 4 inches deep. Fully shaded with a cedar and Douglas-fir overstory. Snowgrass Flat Trail #96 runs through the creek. This site has a lot of blowdown and looks like it could have heavy flows in winter. High slope steepness in a narrow stream valley. Stream bed composed of steep and shifting boulders, cobble, and silt. A single *Soliperla* larva and a tailed frog (*Ascaphus truei*) was found at this site. Water temperature 11° C. Elevation: 1428 m.

GOAT ROCKS 2

Intermittent first order creek approximately one to four feet wide and up to 8 inches deep, draining from vicinity of exposed talus slope. Partially shaded with a fir, cedar, and thimbleberry overstory. Trail runs through the creek. Substrate is composed of boulders, cobble, and silt, with low to medium stability. Downed logs are abundant. This is a very calm creek segment this time of year, with still pools and abundant twig/log/conifer needle input. Forb and shrub coverage is high along the banks. Water temperature 9.5° C. Elevation: 1437 m.

GOAT CREEK 1

Perennial fourth order stream 6-10 feet wide and to one foot deep. Survey site was located at a bridge crossing for trail users. Partially shaded with alder and fir overstory. Substrate composed of bedrock, boulders, cobble, gravel, and sand, with many larger rocks and boulders scattered throughout the creek. Creek bank is lined with shrubs and young firs. Water temperature 9° C. Elevation: 1403 m.

GOAT ROCKS 3

Perennial first order stream in Snowgrass Flats area. Site is in full to partial sun characterized by stunted vegetation, including spruce, hemlock, and many forbs (such as the monkeyflower and corn lilies seen in the photo). Water levels are low, with some areas just a slow trickle into small water pockets. Stream mostly one foot wide or less, to approximately 5 inches deep. Substrate includes boulder, cobble, and gravel. Tiger beetles are abundant on adjacent trail. Numerous tailed frogs and tadpoles (*Ascaphus truei*) observed in creek (see photos below). Also observed a single *Bombus occidentalis* nectaring on *Mimulus lewisii* (see photo). Water temperature 12° C. Elevation: 1814 m.

GOAT ROCKS 4

Perennial third order stream approximately 2 feet wide and up to 5 inches deep, totally exposed to sun. Located in Snowgrass Flat area. Stream margins are lined with grasses, moss, lupine, and sedges. This site is downslope of a large talus field with marmots. The creek becomes narrower and steeper downstream, but not as many species were observed in that area. Stream banks are eroded. Numerous tiger beetles observed at this site and along many of the exposed trails in this area. Substrate composed of boulder, cobble, and sand. Rocks are scoured and angular, providing a good amount of crevices. Some sediment present in stream with a lot of scuz on rock surfaces. Elevation: 1834 m.

GOAT ROCKS 5

Perennial second order stream on very steep gradient. Narrow channel is approximately one foot wide, with water to about 2 inches deep. Water is mostly subsurface, flowing down from a slick weeping wall approximately six feet wide. Talus slope, very unstable, in full sun. Vegetation composed of grasses and forbs, including monkeyflower, yellow asters, and lupine. Some downed wood present. Hiking trail crossing the stream and talus slope. Tailed frogs and tadpoles (*A. truei*) are present. Water temperature 17° C. Elevation: 1827 m.

GOAT ROCKS 6

Small creek through alpine meadow. Full sun, heavy forb growth along margins (*Mimulus*, grasses, heather). Approx. 1' wide and up to 7" deep; braided. Medium gradient, high oxygen. Boulder/cobble/sand, some silt/sediment. Mostly cobble. Broad valley with stunted conifers. *Nostoc* algae prevalent. Water temperature 13° C. Elevation: 1861 m.

GOAT ROCKS 7

Hillside seep on very steep gradient. Loose cobble. Lots of moss, corn lily, *Mimulus*, gentian. Heavily shaded by downstream conifers at time of survey (late afternoon) but probably gets early day sun. Very exposed above. Downed wood in sections. Water flow is a low trickle. This site may dry up some years. Moss is a thick carpet over the rocks. Channel ~1' wide, some water pooling to 2". Seepy areas somewhat more widespread from main channel. A single *Soliperla* larva was collected at this site. Water temperature 12.5° C. Elevation: 1882 m.

GOAT ROCKS 8

Forb-filled alpine hillside completely exposed to the sun. *Mimulus*, corn lily, lupine, gentians, grasses, sedges, and purple asters blanket the slope. Some cobble and sand in the substrate. High gradient, good flow in some areas - totally shaded by forbs. Multiple water channels flowing through this hill, with several different water temperatures recorded at each (4-10° C). Water pools in narrow ditch along trail and then flows downhill into the valley. *Soliperla* relatively abundant in mainstem flows of seeps, especially on mossy rocks and under vegetation. Seven *Soliperla* larvae were collected at this site. Elevation: 1875 m.

GOAT ROCKS 9

Intermittent first order stream located along trail directly south of Goat Rocks 8 site (above), but with a different habitat and warmer water flow. This site is a series of weeping walls covered in thick moss interspersed with small pools filled with boulders, cobbles, and sand. *Mimulus* is dominant. Very steep gradient, full sun. Water temperature 14° C. Elevation: 1877 m.

GOAT CREEK 2

Perennial third order alpine stream draining from Goat Lake, composed of bedrock, boulders, and cobble. The bedrock is covered in moss and rocky pools are very scummy. Water flow is low over bedrock, with a few small riffles into pools and pockets. There is a wide stream bed here, about 10-20’, and a depth to 8”. Very few plants although there are some sedges higher up the bank. This creek settles into a rock bowl before flowing down into the valley below. Several juvenile hoary marmots were observed in the rocks in this creek. Water temperature 15.5° C. Elevation: 1952 m.

GOAT LAKE

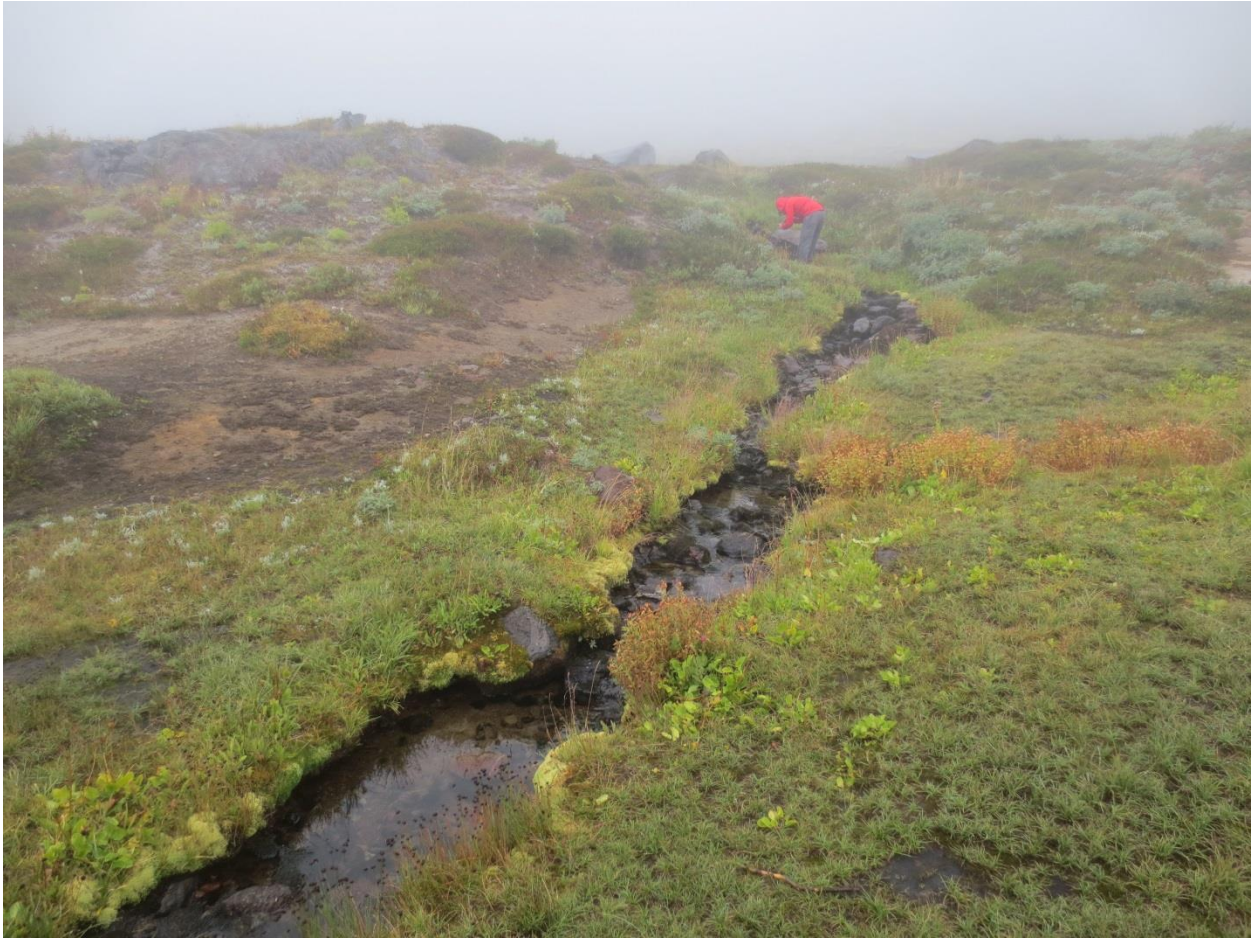
Alpine lake located in a rocky cirque. We did not observe any active inlets to the lake (likely snow-fed) and habitat did not look appropriate for our target species, although we did search the margin of the lake for aquatic activity. No stoneflies or other aquatic invertebrates observed. Elevation: 1882 m.

AUGUST 21, 2015: GOAT LAKES WILDERNESS, GIFFORD PINCHOT NF

GOAT ROCKS 10

Open hillside with widespread seepy areas ~100-125m wide; multiple small channels throughout. Paintbrush, *Mimulus*, grasses, asters, corn lily, and lupine blanket the slopes. Water flow is light, mostly surface, but possibly runs year-round. We sampled several areas along the hillside. This is an alpine area in full sunlight. Water temperature 8° C during our surveys, but it was a cold overcast morning and water may be warmer on sunny days. Moss is thick and abundant on rocks and hillside. Nostoc algae is present. A single *Soliperla* larva was collected at this site. Elevation: 2034 m.

GOAT ROCKS 11



Perennial first order stream with a cobble, sand, and gravel substrate. Very braided meandering creek with abundant moss and forbs/grasses. This is an exposed alpine area in full sun. Flat terrain with low flow. Some very small riffles. Creek is ~6-12" wide and to 5" deep. Low complexity and pore space. Water temperature 6.5° C. Elevation: 1937 m.

CHAIN OF LAKES

Series of small perennial ponds and lakes with marshy wetland habitat and few to no rocks. Lake levels are low and all inlets and outlets observed were dry. Habitat was composed of still, warm waters with mud bottoms and mucky exposed shorelines. Not appropriate habitat for our target species. Elevation: 1330 m.

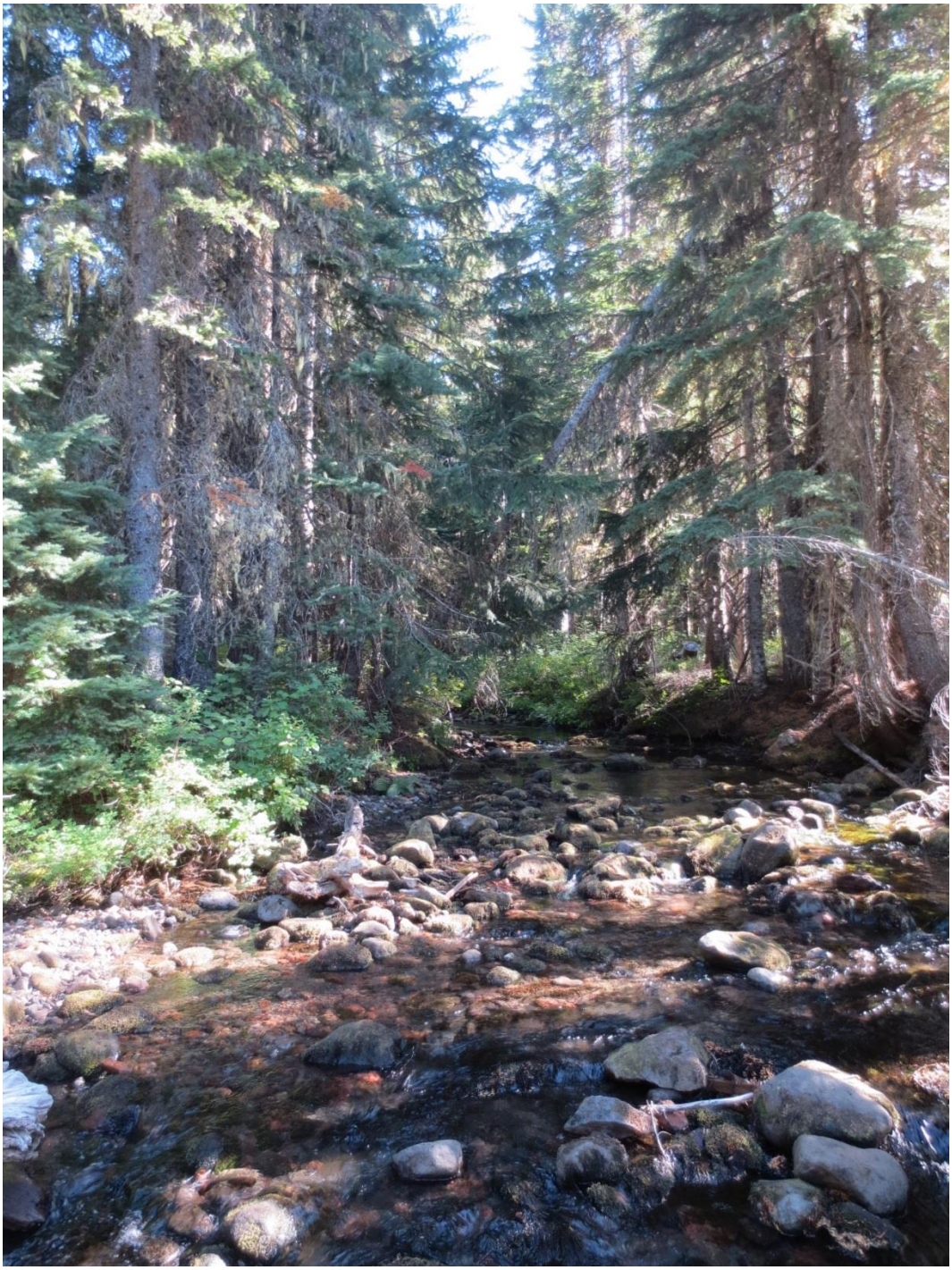
ADAMS CREEK

Perennial third order creek with rushing, torrential flow. Glacial runoff - very silty, milky (turbid) water. Boulders and cobble are heavily embedded in silt at margins. Little habitat complexity. Very strong sulfur smell. No aquatic invertebrate activity observed and sweep netting adjacent rocks and vegetation was unsuccessful. Little interstitial habitat. Water temperature 8° C. Elevation: 1424 m.

MT. ADAMS 1

Perennial second order creek with cobble, boulders, and sand. Gentle gradient. Mostly shaded creek with downed wood and some moss and *Nostoc* algae on rocks. Streamside vegetation includes spirea, sorbose, fir, and other forbs. Stream is approximately one foot wide and up to 6” deep, located just upstream of road crossing. No adult or juvenile activity observed. Water temperature 11° C. Elevation: 1455 m.

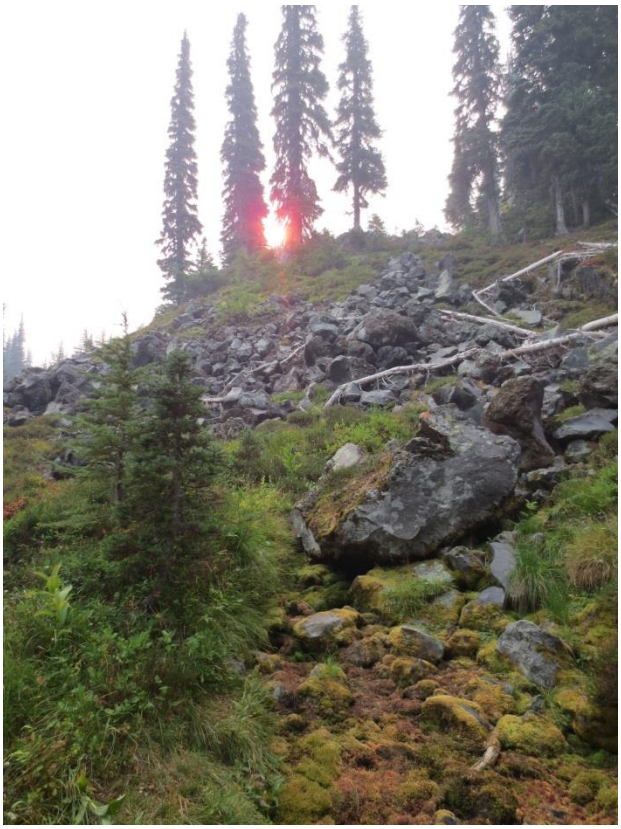
KILLEN CREEK



Perennial second order stream. Shaded creek (except at road crossing/culverts) with cobble, boulder, some bedrock. Moss on rocks. Approx. 6-15" wide, to 6" deep in pockets. Riffles. Medium oxygen. Some downed wood. Conifer overstory with some sorbose and willow at canopy openings. *Nostoc* algae in creek. No adults caught with sweep netting. Tailed frog tadpole observed. Mayfly larvae throughout but little other aquatic invert activity. Water temperature 10.5° C. Elevation: 1359 m.

AUGUST 22, 2015: MT. ADAMS, GIFFORD PINCHOT NF

DIVIDE CAMP



Spring/seep at the base of a lava flow. Thick moss covers the rocks and banks and damper areas of water flow. This is an alpine area mostly open to the sun with some conifer overstory. Grasses, heather, spirea, corn lily, and delphinium make up the ground cover. A cascades frog (*Ranae cascadae*) was observed in the spring. This site is composed of cobble, gravel, and sand, with larger talus and boulders upstream. Liverwort present throughout. The "stream" splits into two channels below the talus, then rejoins. Approximately 2-4' wide to 1-2" deep (mostly less). Water temperature only 2° C. Elevation: 1715 m.

LEWIS RIVER

Perennial second order stream. River channel is approximately 5-8' wide and up to 1' deep in pockets. Riffles and glides are located throughout the boulder, cobble, and silt substrate. Rocks are heavily embedded in silt. This stream segment contains a series of small cascading pools. Medium gradient, medium oxygenation, rocks somewhat eroded. Some downed wood. This is an open site in full sun with just a few spruces on the upper stream banks. *Mimulus* and grasses fill in along the water margins. Water is silty; likely glacial. Dry rocky side channel comes down to meet the river at this trail crossing (just north of river) - looks very unstable and possibly flashy in winter/high rain conditions. Water temperature 6.5° C. Elevation: 1855 m.

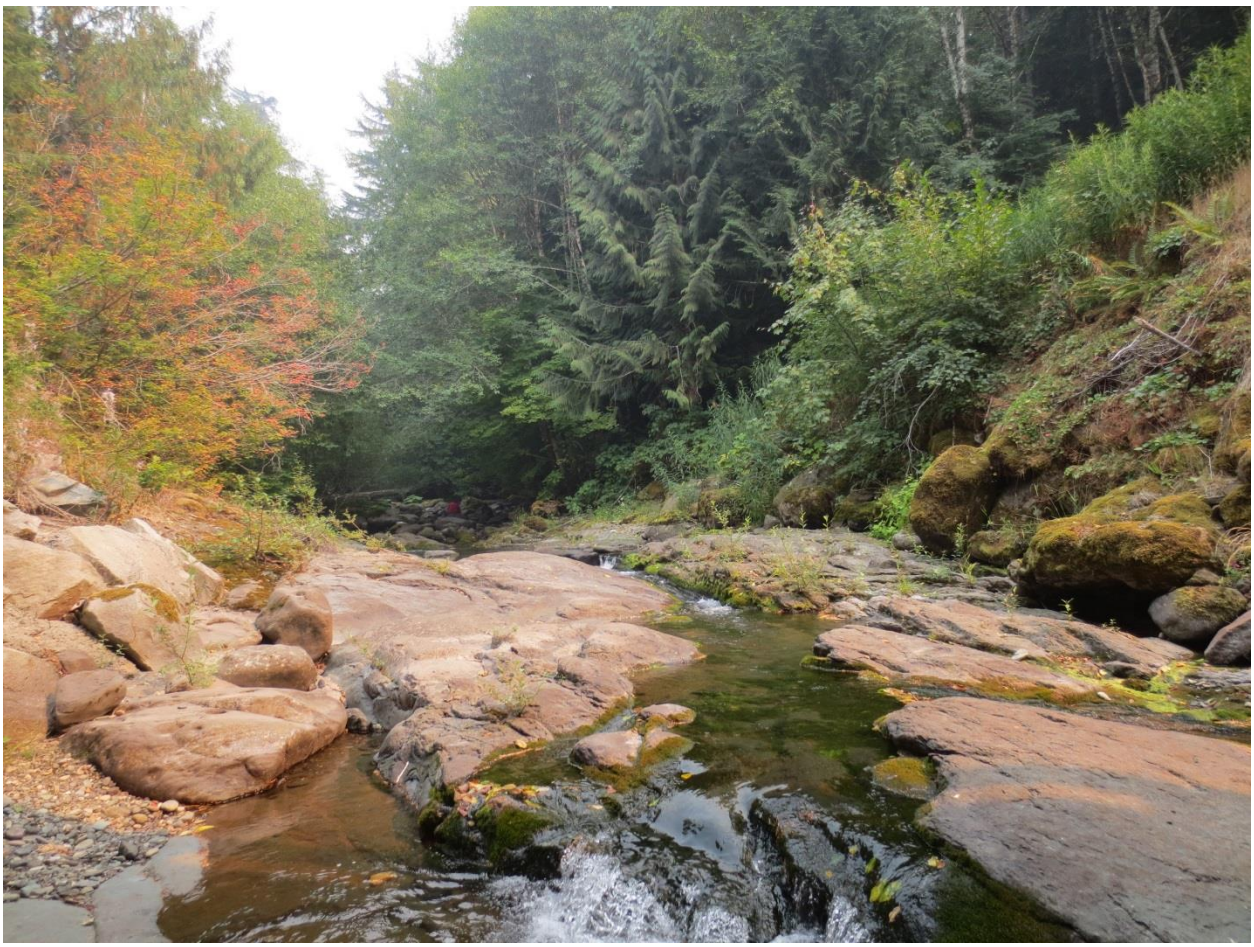
MT. ADAMS 2

Small trickling stream with a boulder, cobble, and sand substrate. Cobble and boulders are heavily embedded in a silt/sand mixture. Pore space is minimal. Stream is approximately 8-12 inches wide and up to 4” deep. Appears perennial but probably gets very low some years and may dry up altogether. Thick forbs and grasses grow on rocks along the bank, including *Mimulus* and lupine. A single *B. occidentalis* was observed visiting *Mimulus* flowers. This meandering stream has a very light flow and is located in a wide open valley that narrows just below the Pacific Crest Trail crossing. Stunted conifers are scattered throughout. Water temperature 10° C. Elevation: 1850 m.

MUTTON CREEK

Perennial first order creek, very low flow, with silty/milky waters. Mostly cobble and silt with some boulders. This site has a high conifer input and is partly shaded by hemlock and fir. Heather, lupine, and huckleberry line the creek bed. Banks are heavily eroded – looks like this creek gets much higher flow. Downed wood and needle debris located throughout the creek. Heavy embedding with sediment on top and rocks cemented into streambed; crevice and pore space is low. Small amounts of moss scattered about. A few small cascades and pools are located just downstream of the trail crossing. This does not look like ideal habitat. No aquatic invertebrates of any species observed. Water temperature 7.5° C. Elevation: 1843.

EAST CANYON CREEK



Perennial fourth order stream with a bedrock, boulder, cobble, and gravel substrate. Some sediment. Stream is party shaded by alder, willow, and fir. Water is very clear with riffles and glides and some deeper pools. Bedrock slides are abundant and coated with thick algae. This site has scoured banks and well-oxygenated water. Medium steepness/gradient. Crevice and pore spaces is medium in rocky pools, but practically nonexistent in bedrock areas. Unusual conglomerated cobble scattered all throughout this site, in colors ranging from red and pink to blue, green, and yellow. There is an abundant and diverse mayfly population in this stream, all different age classes. A single tailed frog tadpole (*Ascaphus truei*) was observed. Water temperature 11.5 C. Elevation: 813 m.

MT. ADAMS 3

Small perennial second order creek cascading over a small rocky fall covered with moss (madicolous). Stream channel is very sandy with cobble throughout. Some sediment exists in the stream, making it cloudy. This site is in full shade with an overstory of bigleaf maple and conifers. Huge sword ferns line the stream banks, lending a tropical look to the site. Large amounts of woody debris and conifer needles in stream. Water flow is routed through a culvert under the road – we only surveyed the upstream side. Cascades frogs (Ranae cascadae) observed in the creek. Channel is approximately 8-12” wide and up to 6” deep in the pool below the falls. Water temperature 11.5° C. Elevation: 549 m.

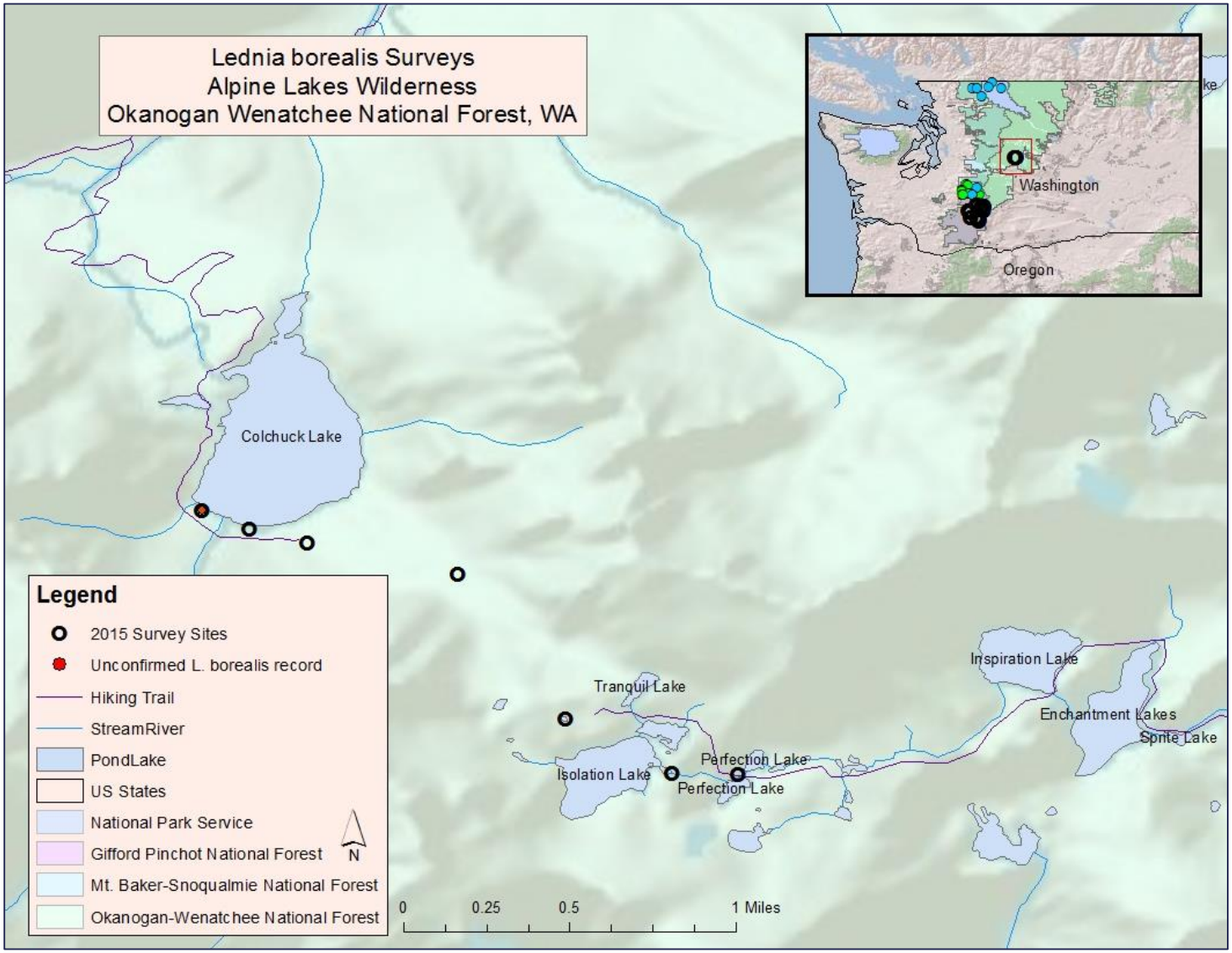
BLUE LAKE CREEK

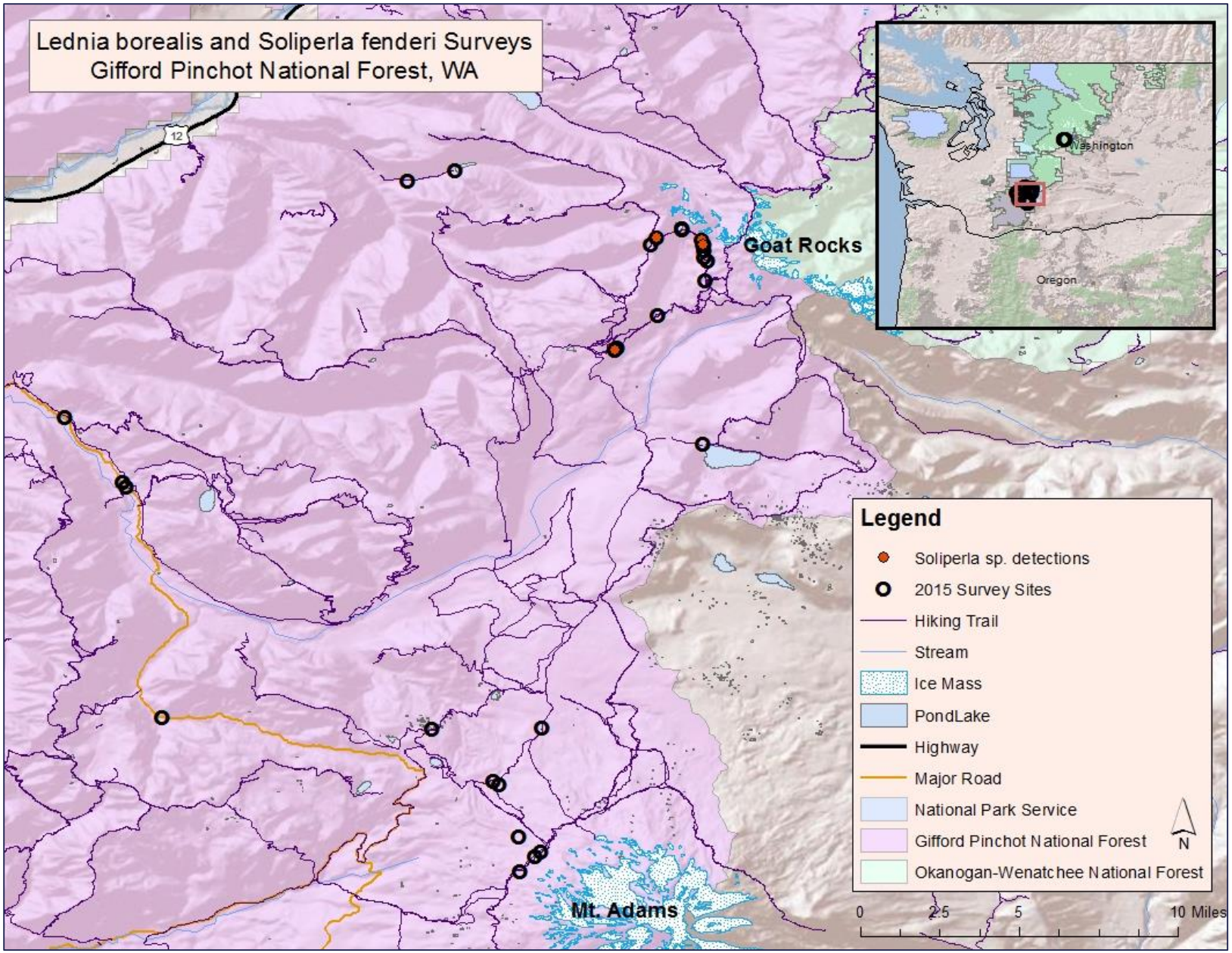
Perennial fourth order creek with cobble and gravel, approximately 6-10 feet wide and up to 8-12” deep. Water flow is strong here on a moderately steep angle, flowing under a huge culvert downstream from survey site. Abundant woody debris and vegetative input from bigleaf maple and alder, with some conifers. Rocks in creek are incredibly slick and covered with moss. Riffles and glides located throughout stream segment. Banks are covered in moss, grasses, sword fern, non-native geraniums, and trailing blackberry. . Perennial mid-sized stream with cobble, gravel. Strong flow on moderately steep angle. Flows under huge culvert. Abundant woody debris and veg input from bigleaf maple and alder canopy (with some conifers). Rocks incredibly slick, with moss. Riffles and glides. Mossy/grassy banks with sword fern, stinky bob, trailing blackberry. Width ~6-10', depth up to 8-12". Water temperature 7.5 C. Elevation: 543 m.

HORSE CREEK

Very small perennial third order creek with steep slopes in narrow valley. Mostly sand and some gravel/cobble substrate. Creek flows through a large culvert under the road – we sampled the upstream segment. Site is fully shaded by an alder overstory with some conifers. Nettle, horsetails, grasses, ferns, and trailing blackberry make up the understory. This is a thickly vegetated stream channel approximately one foot wide and up to a couple inches deep. Very little aquatic invertebrate activity was observed although some adult mayflies were present. Water temperature 12 C. Elevation: 484 m.

APPENDIX V: SITE MAPS




Lednia borealis and Soliperla fenderi Surveys
Gifford Pinchot National Forest, WA
12
Goat Rocks
Mt. Adams
Washington
Oregon
Legend
Soliperla sp. detections
2015 Survey Sites
Hiking Trail
Stream
Ice Mass
PondLake
Highway
Major Road
National Park Service
Gifford Pinchot National Forest
Okanogan-Wenatchee National Forest
N
0
2.5
5
10 Miles