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NORTHWESTERN ENERGY

Mystic Lake Hydroelectric Project

Riparian Vegetation Monitoring Report, 2019

PROJECT NUMBER:
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Riparian Vegetation Monitoring Report, 2019

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ACRONYMS AND ABBREVIATIONS

FERC	Federal Energy Regulatory Commission
FLA	Final License Application
kV	kilovolt
MW	megawatt
NWE	NorthWestern Energy
POWER	Power Engineers, Inc.
Project	Mystic Lake Hydroelectric Facility
USACE	United States Army Corps of Engineers
USFS	United States Forest Service

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1.0 INTRODUCTION

NorthWestern Energy (NWE) owns and operates the Mystic Lake Hydroelectric Facility (Federal Energy Regulatory Commission [FERC] Project No. 2301; hereafter, referred to as the "Project") in the Absaroka Mountains near Fishtail, Montana.

On December 15, 2006, the previous owner of the facility, PPL Montana, submitted the Final License Application (FLA) to the FERC for the Project. The United States Forest Service (USFS) filed Section 4(e) Terms and Conditions on May 3, 2007 and modified these conditions November 30, 2007. FERC approved the FLA and issued an order for the new license on December 17, 2007. The previous license expired December 31, 2009 and the new 40-year license became effective January 1, 2010.

1.1 Project Description

The Project is located on West Rosebud Creek, in Stillwater and Carbon counties, Montana. The FERC boundary for the entire Project (referred to as the "Project boundary") is located on USFS lands within the Custer National Forest and encompasses 673.5 acres of federal lands. Lands within and adjacent to the Project boundary are managed by the Custer Gallatin National Forest.

The Project boundary encompasses: Mystic Lake and the Mystic Lake Dam; West Rosebud Lake and the West Rosebud Lake Dam (Re-regulation Dam); the flowline, surge tank, penstock, and powerhouse; and NWE's Camp that is located adjacent to the powerhouse.

The Project's authorized capacity is 11.25 megawatts (MW). The Project has two reservoirs on West Rosebud Creek—Mystic Lake, which is the Project's storage reservoir; and West Rosebud Lake, which is located downstream from Mystic Lake and is used to moderate peaking flows from the powerhouse.

Water flowing into Mystic Lake is impounded by Mystic Lake Dam, which is a 45-foot-high, 368-foot-long concrete arch-type structure. Mystic Lake has a full pool elevation of 7,673.5 feet above mean sea elevation and a total volume of approximately 47,000 acre-feet. Water from the lake flows through the Project's 2.4-mile-long flowline to the powerhouse, which contains two Pelton turbines with an installed capacity of 11.25 MW. Two 50-kilovolt (kV), 5.38-mile-long transmission lines run from the powerhouse to NWE's Line Creek switchyard.

After exiting the powerhouse, water re-enters West Rosebud Creek and flows approximately one mile to West Rosebud Lake, which is impounded by the Re-regulation Dam. The Re-regulation Dam is a 19-foot-high by 420-foot-long earth-filled structure that modulates peaking flows from the powerhouse.

NWE operates the Project in both base load and peaking modes depending on water availability, electric demands, and license constraints. Mystic Lake is used to store water during heavy runoff months (May through July), which is used to augment flows during the remainder of the year.

1.2 Purpose, Need, and History of Riparian Vegetation Monitoring

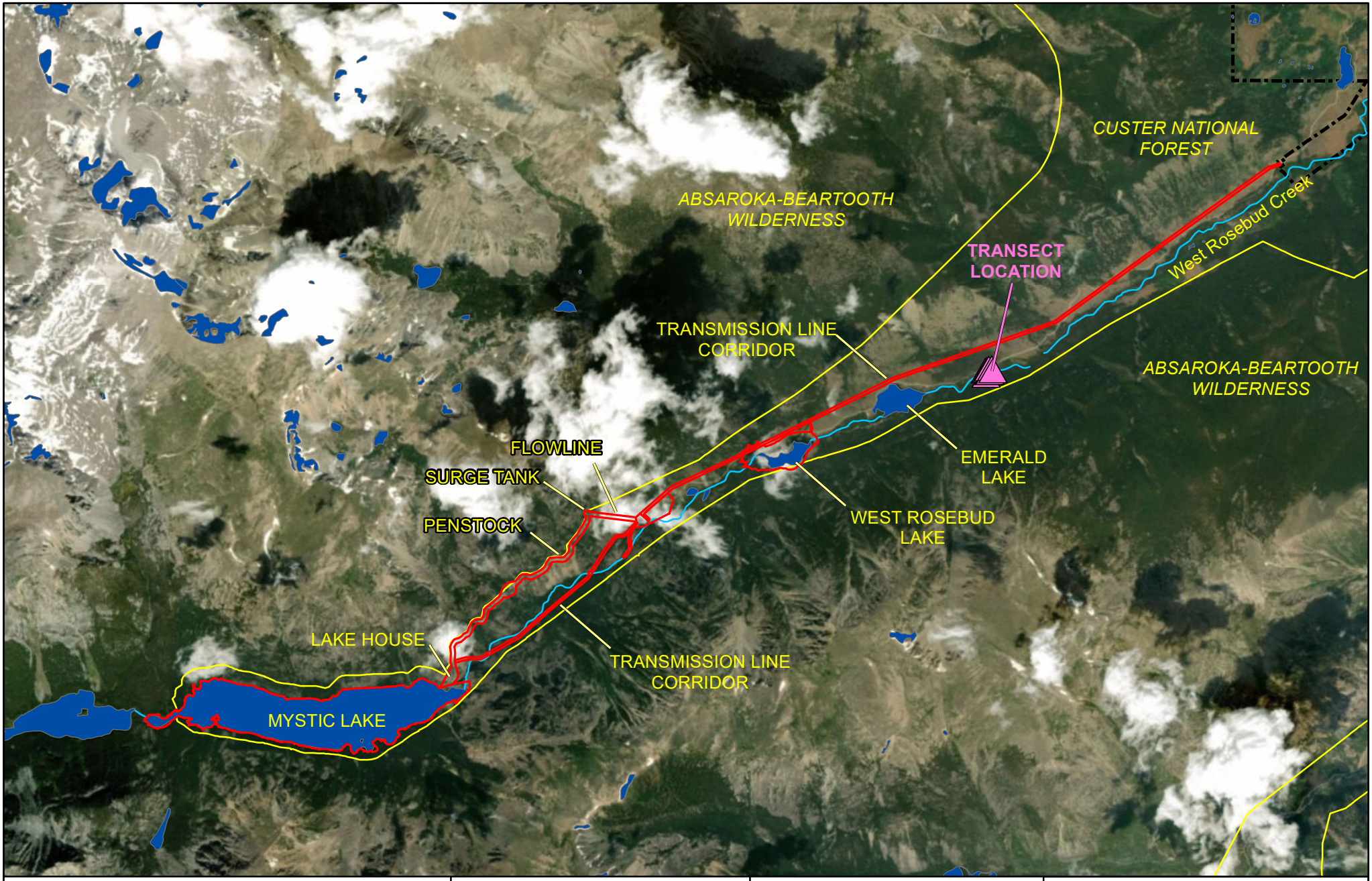
Under Ordering Paragraph E of the FERC license, FERC incorporated the conditions submitted by the USFS under section 4(e) of the FLA into the Mystic license. Condition Number 18 of the USFS 4(e) conditions calls for the operator to file with FERC a riparian vegetation monitoring plan, approved by the USFS. Condition 18 specifies that the riparian monitoring be designed to detect changes in the riparian vegetation, if any, as a result of changes in fluvial processes caused by operation of the Mystic Lake

Hydroelectric Plant for the duration the 40-year license term. PPL Montana, the previous operator, established permanent riparian transects along West Rosebud Creek in order to quantify riparian habitat and monitor trends.

In the summer of 2009, PPL Montana established permanent monitoring transects along West Rosebud Creek in collaboration with USFS staff, and collected baseline vegetation data along the transects (PPL Montana 2009). The Project area and vegetation monitoring transect locations are shown in Figures 1 and 2. Following the baseline data collection in 2009, the permanent transects along West Rosebud Creek were to be monitored and subsequent data would be compared to identify changes in riparian vegetation communities through the term of the license.

Although the new license required future riparian vegetation monitoring efforts following the initial baseline survey completed in 2009 to be completed once every 5 years throughout the duration of the 40-year license, PPL Montana recommended to USFS, and received concurrence, that future monitoring efforts are to be completed once every 10 years based on limitations of physical site characteristics. The 10-year monitoring interval would continue for the duration of the 40-year license with the second monitoring effort to be conducted in 2019.

NWE contracted Power Engineers, Inc. (POWER) to conduct the second (2019) monitoring effort. This survey report describes the methods and results of the 2019 riparian vegetation monitoring and compares the results of the 2009 and 2019 monitoring.



Legend

- Transect Location
- FERC Boundary
- Waterbody
- Absaroka-Beartooth Wilderness Boundary
- Custer National Forest Boundary
- West Rosebud Creek

N

0 255 510 1,020 1,530 2,040 2,550 Meters

0 1,400 2,800 4,200 5,600 7,000 Feet

FIGURE 1
Mystic Lake Hydroelectric Project Overview

1:60,000
UTM 12 North
North American Datum 1983

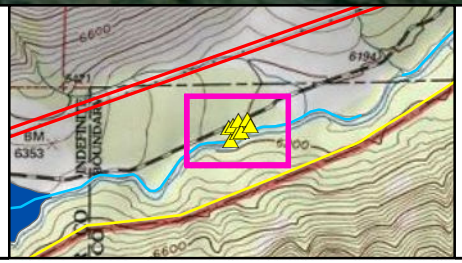
Legend

West Rosebud Creek

Transect Location

North

South



N

0 5 10 20 30 40 50 Meters

0 30 60 90 120 150 Feet

FIGURE 2
Mystic Lake Hydroelectric Project
Riparian Vegetation Monitoring
Transect Locations

1:1,500
UTM 12 North
North American Datum 1983

2.0 METHODS

In 2009, PPL Montana established four permanent riparian monitoring transects and established a monitoring protocol to be conducted in 2009 and all subsequent monitoring efforts (PPL Montana 2009). Vegetation monitoring conducted in 2019 followed the 2009 protocol.

The four monitoring transects are at lengths of 152 feet, 128 feet, 136 feet, and 100 feet, respectively, and were permanently marked at each end with a rebar stake. The endpoint coordinates are provided in Table 1. During sampling, a tape measure is stretched between the two endpoints to mark the transect line. A modified version of the Daubenmire method is used for measuring understory vegetation (below waist height), and the line intercept method is used for measuring canopy cover for trees and tall shrubs—i.e. overstory (above waist height).

TABLE 1 TRANSECT LOCATIONS

TRANSECT	NORTH END COORDINATES[1]		SOUTH END COORDINATES[1]	
	NORTHING	EASTING	NORTHING	EASTING
Transect 1	368172.105	1921722.669	368010.215	1921746.787
Transect 2	368211.641	1921786.871	368107.570	1921840.281
Transect 3	368263.030	1921850.994	368127.547	1921893.801
Transect 4	368282.348	1921963.289	368202.945	1922008.617

[1] Coordinate system is Montana NAD83 2500 State Plane, International Feet and Datum is NAD83.

2.1 Daubenmire Quadrat Data Collection

A 20-centimeter by 50-centimeter quadrat (Daubenmire frame) is placed every four feet (starting at zero) along each transect, and vegetation below waist height is sampled at each quadrat on alternating sides of the tape. Within the quadrat frame, percent cover (absolute cover) is estimated for each species and assigned a canopy cover class (Table 2). The midpoints of each canopy cover class are used to calculate the average canopy cover of each species along the transect.

For each species, at each transect, percent canopy cover was calculated by summing the canopy cover for each quadrat and dividing it by the number of quadrats that were sampled along each transect. Species composition was calculated by dividing the total canopy for each species by the total canopy for all species observed along each transect and multiplying the number by 100. Frequency was calculated by dividing the number of occurrences (total number of quadrats in which each species was observed) by the number of total quadrats sampled along each transect and multiplying the number by 100.

TABLE 2 DAUBENMIRE CANOPY COVER CLASSES

CANOPY COVER CLASS	RANGE OF COVERAGE	MIDPOINT OF RANGE
1	0-5%	2.5%
2	5-25%	15%
3	25-50%	37.5%
4	50-75%	62.5%
5	75-95%	85%
6	95-100%	97.5%

2.2 Line Intercept Data Collection

To measure canopy cover for trees and shrubs greater than waist height, the line intercept method was used. Measurements to the nearest foot are taken of the crown spread of each shrub and tree species that are bisected by the line. In order to determine if taller vegetation is bisected by the line, a densitometer is utilized, holding it directly over the tape. Data collected included the distance of each species intercepting the transect, species, life form (shrub or tree), and whether the vegetation was live or dead.

2.3 Photographic comparison

Photographs were taken in 2009 from the two endpoints at each transect and retaken at the same locations and azimuths in 2019 to visually document changes in the vegetation.

3.0 RESULTS AND DISCUSSION

3.1 2019 Results

On July 25, 2019, POWER conducted vegetation monitoring along the four transects established in 2009. Data collection followed the protocol established in 2009 and included collection of understory vegetation data using a Daubenmire frame, collection of overstory vegetation using a line-intercept method, and creation of a photo-log for comparison with 2009 photos.

3.1.1 Understory Vegetation: Daubenmire Data

The sampling area consists of a mixture of riparian and upland species. For the sake of analysis, each species was assigned a category based upon their typical habitat affiliation—riparian (including wetland species and others primarily associated with floodplains or stream corridors, upland, or intermediate. The assignment was based on professional judgement of the botanists utilizing a combination of three sources: 1) the U.S. Army Corps of Engineers (USACE) National Wetland Plant List wetland ratings (USACE 2019); 2) habitat descriptions in the Manual of Montana Vascular Plants (Lesica 2012); and 3) personal professional experience. Interpretation of USACE wetland ratings was generally as follows. Species rated by USACE as wetland obligate or facultative wetland for the Western Mountains Valleys and Coast region were considered to be riparian species, those rated as facultative were considered to be either riparian or intermediate species (depending on Lesica 2012 and experience), those rated as facultative upland were considered to be either intermediate or upland, and those rated as upland species were considered to be upland or intermediate species. Understory vegetation sampled in 2019 included 65 species, of which 31 were categorized as riparian species, six as upland species, and 28 as intermediate species. The total understory canopy cover was approximately 59 percent, of which approximately 40 percent was riparian vegetation, seven percent was upland vegetation, and 12 percent was intermediate vegetation. The most dominant understory species included tufted hairgrass (*Deschampsia caespitosa*), beaked sedge (*Carex utriculata*), common juniper (*Juniperus communis*), field horsetail (*Equisetum arvense*), prickly rose (*Rosa acicularis*), streambank groundsel (*Senecio pseudaureus*), and Booth willow (*Salix boothii*).

Percent canopy cover (i.e., absolute cover), percent species composition (i.e., relative cover), and percent frequency was calculated for each species at each transect. The typical habitat association (riparian, upland, or intermediate), percent canopy cover, percent species composition, and percent frequency for each understory species, averaged across the four transects, is presented in Table 3. Transect specific

understory data summaries are presented in Appendix A, Tables 7, 8, 9, and 10. The raw Daubenmire frame data is provided in Appendix B, Tables 11, 12, 13, and 14.

TABLE 3 2019 UNDERSTORY VEGETATION: COVER, SPECIES COMPOSITION, AND FREQUENCY, AVERAGED ACROSS ALL TRANSECTS

SPECIES	COMMON NAME	RIPARIAN OR UPLAND	CANOPY COVER[1]	SPECIES COMPOSITION[2]	FREQUENCY[3]
Deschampsia caespitosa	tufted hairgrass	Riparian	11.88	17.81	43.24
Salix spp.	all willows	Riparian	7.00	9.37	35.35
Carex utriculata	beaked sedge	Riparian	6.16	9.29	26.67
Juniperus communis	common juniper	Upland	5.82	10.28	17.74
Equisetum arvense	field horsetail	Riparian	5.58	9.59	48.90
Salix boothii	Booth willow	Riparian	3.41	4.40	14.76
Senecio pseudaureus	streambank groundsel	Riparian	2.78	4.52	29.94
Rosa acicularis	prickly rose	Intermediate	2.74	4.32	39.79
Salix planifolia	diamondleaf willow	Riparian	2.39	3.06	14.12
Symphoricarpos albus	common snowberry	Intermediate	1.76	4.12	19.81
Spirea betulifolia	birch-leaved spirea	Intermediate	1.48	2.49	16.24
Scirpus microcarpus	small-fruit bulrush	Riparian	1.25	2.10	7.69
Arctosaphylos uva-ursi	kinnikinnick	Upland	1.14	2.16	6.34
Picea engelmannii	Engelmann spruce	Intermediate	1.10	2.72	5.45
Salix bebbiana	Bebb willow	Riparian	0.92	1.17	5.03
Arnica mollis	hairy arnica	Riparian	0.82	1.90	3.72
Angelica arguta	white angelica	Riparian	0.80	1.73	12.48
Pyrola asarifolia	pink pyrola	Intermediate	0.76	1.34	20.02
Arnica cordifolia	heart-leaf arnica	Intermediate	0.66	1.28	10.64
Geranium richardsonii	white geranium	Riparian	0.66	1.11	15.16
Cirsium arvense	Canada thistle	Riparian	0.61	1.33	12.83
Galium triflorum	sweet-scented bedstraw	Intermediate	0.50	1.10	16.66
Fragaria virginiana	wild strawberry	Intermediate	0.50	1.11	16.54
Phleum pratense	timothy	Intermediate	0.49	0.63	6.05
Juncus balticus	Baltic rush	Riparian	0.44	0.73	7.87
Heracleum lanatum	cow-parsnip	Riparian	0.42	0.93	6.53
Chamerion angustifolium	fireweed	Intermediate	0.40	0.90	12.62
Shepherdia canadensis	buffaloberry	Upland	0.38	0.61	2.09
Poa palustris	fowl bluegrass	Riparian	0.35	0.72	5.94
Geum macrophyllum	large-leaf avens	Riparian	0.32	0.70	9.36
Glyceria striata	fowl mannagrass	Riparian	0.29	0.49	2.70
Salix eriocephala	yellow willow	Riparian	0.27	0.73	1.44
Ribes lacustre	prickly current	Riparian	0.26	0.56	2.40
Platanthera dilatata	leafy white orchid	Riparian	0.22	0.53	5.64
Antennaria alpina	alpine pussytoes	Intermediate	0.22	0.40	3.84
Dasiphora fruticosa	shrubby cinquefoil	Riparian	0.17	0.28	1.92
Juncus torreyi	Torrey's rush	Riparian	0.12	0.20	4.81
Thalictrum occidentale	western meadow-rue	Intermediate	0.11	0.21	4.49
Solidago canadensis	Canada goldenrod	Intermediate	0.11	0.18	4.27
Prunus virginiana	chokecherry	Intermediate	0.10	0.28	0.66
Achillea millefolium	common yarrow	Intermediate	0.09	0.15	3.77
Galium boreale	northern bedstraw	Intermediate	0.08	0.17	3.24
Epilobium ciliatum	hairy willow-herb	Riparian	0.07	0.10	2.64
Mimulus guttatus	common monkeyflower	Riparian	0.06	0.09	2.28
Rubus idaeus	wild red raspberry	Intermediate	0.06	0.08	2.21
maianthemum stellatum	starry Solomon's seal	Intermediate	0.05	0.11	2.03

SPECIES	COMMON NAME	RIPARIAN OR UPLAND	CANOPY COVER[1]	SPECIES COMPOSITION[2]	FREQUENCY[3]
Hieracium albiflorum	white hawkweed	Intermediate	0.05	0.14	1.97
Osmorhiza berteroi	mountain sweetcicely	Intermediate	0.05	0.14	1.97
Carex geyeri	elk sedge	Upland	0.05	0.14	1.97
Carex interior	inland sedge	Riparian	0.05	0.08	1.92
Senecio triangularis	arrow-leaf groundsel	Riparian	0.05	0.08	1.92
Viola orbiculata	round-leaved yellow violet	Riparian	0.04	0.09	1.62
Elymus glaucus	blue wildrye	Intermediate	0.03	0.09	1.32
Prosartes trachycarpa	wart-berry fairy bells	Intermediate	0.03	0.09	1.32
Dactylis glomerata	orchard grass	Intermediate	0.02	0.04	0.96
Juncus articulatus	jointed rush	Riparian	0.02	0.04	0.96
sedum lanceolatum	spearleaf stonecrop	Upland	0.02	0.03	0.78
Bromus carinatus	mountain brome	Intermediate	0.02	0.02	0.71
Populus tremuloides	quaking aspen	Intermediate	0.02	0.02	0.71
Betula occidentalis	water birch	Riparian	0.02	0.02	0.71
Veronica americana	American speedwell	Riparian	0.02	0.02	0.71
Actaea rubra	baneberry	Intermediate	0.02	0.05	0.66
Orthilia secunda	one-sided wintergreen	Intermediate	0.02	0.05	0.66
taraxacum officinale	dandelion	Intermediate	0.02	0.05	0.66
Mertensia ciliata	streamside bluebells	Riparian	0.02	0.05	0.66
Berberis repens	creeping Oregon grape	Upland	0.02	0.05	0.66

*All values presented are the mean of the four transects: calculated by summing the values from the transects and dividing by four.
[1] Percent canopy cover (i.e., absolute cover): calculated for each transect by taking the total canopy for each species and dividing it by the number of quadrats that were sampled along each transect
[2] Percent species composition (i.e., relative cover): calculated for each transect by dividing the total canopy for each species by the total canopy for all species observed along each transect and multiplying the number by 100
[3] Percent frequency: calculated for each transect by dividing the number of occurrences (total number of quadrats in which each species was observed) by the number of total quadrats sampled along each transect and multiplying the number by 100

3.1.2 Overstory Vegetation: Line Intercept Data

Total canopy cover averaged 54 percent and consisted of a total of nine species. Dominant tree species included Engelmann's spruce (*Picea engelmannii*) and lodgepole pine (*Pinus contorta*), while subalpine fir (*Abies lasiocarpa*) and quaking aspen (*Populus tremuloides*) each contributed less than one percent canopy cover. The most dominant shrub species were diamond-leaf willow (*Salix planifolia*) and Booth willow. Other shrub species included Bebb willow (*Salix bebbiana*), yellow willow (*Salix eriocephala*), and water birch (*Betula occidentalis*). The five shrub species (four willows and water birch) are all typically associated with riparian or wetland areas and contributed a combined 25 percent canopy cover, which was just under half of the total overstory canopy cover. The tree canopy consisted solely of species commonly associated with uplands, and had a total of 30 percent canopy cover. The percent canopy cover for each overstory species, averaged across the four transects, is presented in Table 4. Transect specific overstory data summaries are presented in Appendix C, Tables 15, 16, 17, and 18. The raw line-intercept data is provided in Appendix D, Tables 19, 20, 21, and 22.

TABLE 4 2019 OVERSTORY CANOPY COVER BY SPECIES, AVERAGED ACROSS ALL TRANSECTS

SPECIES	COMMON NAME	FORM	CANOPY COVER[1]
Abies lasiocarpa	subalpine fir	tree	0.83
Betula occidentalis	water birch	shrub	1.88
picea engelmannii	Engelmann's spruce	tree	13.40
Pinus contorta	lodgepole pine	tree	8.63
Populus tremuloides	quaking aspen	Tree	0.19
Salix eriocephala	yellow willow	shrub	1.90
Salix bebbiana	Bebb willow	shrub	2.85
Salix boothii	Booth willow	shrub	8.85
Salix planifolia	diamond-leaf willow	shrub	9.03
Total Salix	-	-	22.63
Total Shrub	-	-	24.53
Total Tree	-	-	29.78
Grand Total	-	-	54.30

[1] Percent canopy cover (i.e., absolute cover)

3.2 Comparison with 2009 Results

3.2.1 Understory Vegetation: Daubenmire Data

The total understory cover estimated at the site was relatively consistent both years—decreasing slightly from 63 percent in 2009 to 59 percent in 2019. The data also suggest similar species diversity, with just a slight increase in species diversity at both the site scale (from 60 species recorded in 2009 to 65 species in 2019), and at the quadrat scale (average frequency of approximately 5 percent in 2009 versus 7 percent in 2019). There were 14 new species observed in 2019 and nine species that were observed in 2009 but not in 2019 (Table 5). Most of the differing species were uncommon in either year. With the exception of western groundsel (*Senecio integerrimus*), Geyer willow (*Salix geyeriana*), and diamond-leaf willow, each of the differing species accounted for less than one percent understory cover in either year. Overall, species composition appeared similar, with percent cover of characteristically upland vegetation remaining constant, cover of characteristically riparian vegetation increasing by approximately eight percent and cover of intermediate vegetation decreasing by approximately 12 percent.

Table 5 shows the change in percent canopy cover, percent species composition, and percent frequency, from 2009 to 2019. Species with the greatest increase in understory canopy cover from 2009 to 2019 were tufted hairgrass (approximately six percent increase) and field horsetail (approximately five percent increase). The only species with a large decrease was the non-native timothy grass (*Phleum pratense*; approximately eight percent decrease). As a group, understory cover (below waist height) of willows (*Salix* spp.) decreased slightly from approximately nine percent to seven percent. Comparisons of individual willow species may not be reliable due to apparent differences in species identification between 2009 and 2019. While willows are readily identified to genus, reliable species-level identification can be difficult, particularly in mid-summer when flowers and fruit are not available.

TABLE 5 CHANGE IN UNDERSTORY COVER, SPECIES COMPOSITION, AND FREQUENCY, 2009 TO 2019, AVERAGED ACROSS ALL TRANSECTS

SPECIES	COMMON NAME	RIPARIAN OR UPLAND SPECIES[1]	Δ CANOPY COVER[2]	Δ **SPECIES** COMPOSITION[3]	Δ FREQUENCY[4]
Deschampsia caespitosa	tufted hairgrass	Riparian	5.73	8.13	18.92
Salix spp.	all willows	Riparian	-2.4	-5.83	-4.78
Carex utriculata	beaked sedge	Riparian	1.96	2.34	6.02
Juniperus communis	common juniper	Upland	0.92	1.90	4.89
Equisetum arvense	field horsetail	Riparian	4.75	7.97	36.65
Salix boothii	Booth willow	Riparian	2.96	3.78	14.04
Senecio pseudaureus	streambank groundsel	Riparian	1.05	1.77	13.09
Rosa acicularis	prickly rose	Intermediate	0.34	0.04	13.59
Salix planifolia[5]	diamond-leaf willow	Riparian	2.39	3.06	14.12
Symphoricarpos albus	common snowberry	Intermediate	-0.09	0.02	3.91
Spirea betulifolia	birch-leaved spirea	Intermediate	-1.14	-2.34	2.31
Scirpus microcarpus	small-fruit bulrush	Riparian	1.10	1.82	6.69
Arctosaphylos uva-ursi	kinnikinnick	Upland	-0.03	-0.04	-0.14
Picea engelmannii	Engelmann spruce	Intermediate	0.67	1.82	2.57
Salix bebbiana[5]	Bebb willow	Riparian	0.92	1.17	5.03
Arnica mollis[5]	hairy arnica	Riparian	0.82	1.90	3.72
Angelica arguta	white angelica	Riparian	-0.57	-0.77	6.58
Pyrola asarifolia	pink pyrola	Intermediate	0.06	0.07	10.04
Arnica cordifolia	heart-leaf arnica	Intermediate	-0.09	-0.32	4.32
Geranium richardsonii	white geranium	Riparian	-0.19	-0.64	7.33
Cirsium arvense	Canada thistle	Riparian	0.34	0.83	5.68
Galium triflorum	sweet-scented bedstraw	Intermediate	0.46	1.03	14.94
Fragaria virginiana	wild strawberry	Intermediate	-0.58	-1.11	2.37
Phleum pratense	timothy	Intermediate	-8.58	-1.90	-1.40
Juncus balticus	Baltic rush	Riparian	-2.31	-4.10	1.52
Heracleum lanatum	cow-parsnip	Riparian	-0.31	-0.39	2.25
Chamerion angustifolium	fireweed	Intermediate	0.03	0.12	9.14
Shepherdia canadensis	buffaloberry	Upland	0.18	0.11	1.44
Poa palustris	fowl bluegrass	Riparian	-0.60	-0.58	2.99
Geum macrophyllum	large-leaf avens	Riparian	-0.18	-0.32	1.14
Glyceria striata	fowl mannagrass	Riparian	0.14	0.24	-0.02
Salix eriocephala	yellow willow	Riparian	-1.43	-1.57	-2.96
Ribes lacustre	prickly current	Riparian	0.11	0.28	1.40
Platanthera dilatata	leafy white orchid	Riparian	0.20	0.45	4.34
Antennaria alpina	alpine pussytoes	Intermediate	0.17	0.33	2.11
Dasiphora fruticosa	shrubby cinquefoil	Riparian	-0.01	-0.02	-0.08
Juncus torreyi	Torrey's rush	Riparian	0.10	0.15	3.81
Thalictrum occidentale	western meadow-rue	Intermediate	-0.08	-0.19	-0.14
Solidago canadensis	Canada goldenrod	Intermediate	0.09	0.16	3.54
Prunus virginiana[5]	chokecherry	Intermediate	0.10	0.28	0.66
Achillea millefolium	common yarrow	Intermediate	0.02	0.05	0.80
Galium boreale	northern bedstraw	Intermediate	-0.39	-0.70	-4.01
Epilobium ciliatum	hairy willow-herb	Riparian	-0.03	-0.05	-0.66
Mimulus guttatus	common monkeyflower	Riparian	-0.34	-0.49	0.78
Rubus idaeus	wild red raspberry	Intermediate	0.03	0.00	0.91
maianthemum stellatum	starry Solomon's seal	Intermediate	-0.32	-0.64	-2.14
Hieracium albiflorum	white hawkweed	Intermediate	-0.38	-0.61	-1.50
Osmorhiza berteroi	mountain sweetcicely	Intermediate	-0.15	-0.36	0.67

SPECIES	COMMON NAME	RIPARIAN OR UPLAND SPECIES[1]	Δ CANOPY COVER[2]	Δ **SPECIES** COMPOSITION[3]	Δ FREQUENCY[4]
Carex geyeri	elk sedge	Upland	-0.08	-0.04	0.50
Carex interior[5]	inland sedge	Riparian	0.05	0.08	1.92
Senecio triangularis	arrow-leaf groundsel	Riparian	-0.03	-0.04	-1.08
Viola orbiculata	round-leaved yellow violet	Riparian	-0.11	-0.19	-4.38
Elymus glaucus[5]	blue wildrye	Intermediate	0.03	0.09	1.32
Prosartes trachycarpa[5]	wart-berry fairy bells	Intermediate	-0.24	-0.58	-2.63
Dactylis glomerata[5]	orchard grass	Intermediate	0.02	0.04	0.96
Juncus articulatus[5]	jointed rush	Riparian	0.02	0.04	0.96
sedum lanceolatum[5]	spearleaf stonecrop	Upland	0.02	0.03	0.78
Bromus carinatus[5]	mountain brome	Intermediate	0.02	0.02	0.71
Populus tremuloides[5]	quaking aspen	Intermediate	0.02	0.02	0.71
Betula occidentalis	water birch	Riparian	-0.60	-1.18	-3.09
Veronica americana	American speedwell	Riparian	0.00	0.00	-0.06
Actaea rubra	baneberry	Intermediate	-0.33	-0.83	-0.64
Orthilia secunda[5]	one-sided wintergreen	Intermediate	0.02	0.05	0.66
taraxacum officinale[5]	dandelion	Intermediate	0.02	0.05	0.66
Mertensia ciliata	streamside bluebells	Riparian	-0.18	-0.35	-0.72
Berberis repens[5]	creeping Oregon grape	Upland	0.02	0.05	0.66
Abies lasiocarpa[6]	subalpine fir	Intermediate	-0.33	-0.58	-3.00
Calamagrostis rubescens[6]	pinegrass	Intermediate	-0.63	-1.10	-6.00
Cynoglossum officinale[6]	houndstongue	Intermediate	-0.03	-0.05	-1.00
Rubus parviflorus[6]	thimbleberry	Intermediate	-0.40	-0.70	-1.58
Symphyotrichum foliaceum[6]	leafy aster	Intermediate	-0.13	-0.20	-0.78
Cirsium foliosum[6]	elk thistle	Riparian	-0.15	-0.23	-2.48
Ribes aureum[6]	golden currant	Riparian	-0.30	-0.50	-0.78
Salix geyeriana[6]	Geyer willow	Riparian	-7.25	-12.28	-35.00
Senecio integerrimus[6]	western groundsel	Upland	-1.24	-2.58	-8.58

[1] Typical habitat association. Professional judgement based on a combination of USACE (2019), Lesica (2012), and personal experience
[2]Change in percent canopy cover (i.e., absolute cover): calculated by subtracting the 2009 value from the 2019 value.
[3] Change in percent species composition (i.e., relative cover): calculated by subtracting the 2009 value from the 2019 value.
[4] Change in percent frequency: calculated by subtracting the 2009 value from the 2019 value.
[5] Not recorded in 2009
[6] Not recorded in 2019

3.2.2 Overstory Vegetation: Line Intercept Data

Overstory cover (greater than waist height), including tall shrubs and trees, did not appear to change dramatically from 2009 to 2019, but minor changes were observed. Total overstory cover decreased from approximately 59 to 54 percent. Tree cover, which was composed of typical upland conifer forest species, declined from approximately 41 to 30 percent, while shrub cover, which was composed of riparian species, increased from approximately 18 to 25 percent. The decline in tree cover was primarily driven by lodgepole pine, which decreased from approximately 26 to nine percent cover. As discussed in Section 3.2.3, photographic comparison revealed a few cases of lodgepole pine trees and saplings that were observed to have died and fallen and/or been removed. As a group, cover of willows increased from approximately 13 to 23 percent. Comparisons of individual willow species may not be reliable due to apparent differences in species identification between 2009 and 2019. While willows are readily identified to genus, reliable species-level identification can be difficult, particularly in mid-summer when flowers and fruit are not available.

TABLE 6 CHANGE IN OVERSTORY CANOPY COVER BY SPECIES, 2009 TO 2019, AVERAGED ACROSS ALL TRANSECTS

SPECIES	COMMON NAME	FORM	Δ CANOPY COVER[1]
Abies lasiocarpa	subalpine fir	tree	0.33
Betula occidentalis	water birch	shrub	-3.38
picea engelmannii	Engelmann's spruce	tree	-0.85
Pinus contorta	lodgepole pine	tree	-17.63
Populus tremuloides	quaking aspen	tree	-0.07
Salix eriocephala	yellow willow	shrub	-3.35
Salix geyeriana	Geyer willow	shrub	-7.25
Salix bebbiana	Bebb willow	shrub	2.85
Salix boothii	Booth willow	shrub	8.60
Salix planifolia	diamond-leaf willow	shrub	9.03
Total Salix	-	-	10.13
Total Shrub	-	-	6.78
Total Tree	-	-	-11.48
Grand Total	-	-	-4.70

[1]Change in percent canopy cover (i.e., absolute cover): calculated by subtracting the 2009 value from the 2019 value

3.3 Photographic comparison

Photographs were taken in 2009 from the two endpoints at each transect and retaken at the same locations and azimuths in 2019 to visually document changes in the vegetation. The 2009 and 2019 comparison photos are provided in Appendix E. Overall, the photographs did not reveal substantial change in the appearance of the vegetation. Isolated changes apparent in the photographs included live trees in 2009 photographs visible as snags or entirely missing in 2019, small trees in 2009 visible as larger trees in 2019, and minor and seemingly random differences in understory vegetation. A few missing lodgepole pine trees occurred at the north end near the road. Since dispersed camping areas are located nearby, these may have been removed for fire wood, which implies that they likely died prior to being cut down. In other cases, missing trees were visible as either snags or downed trees. In most cases, the observed dead or missing trees were lodgepole pines.

3.4 Discussion

The apparent decrease in lodgepole pine and increase in willow shrubs over waist height suggests a possible shift toward wetter conditions at the site. Likewise, the slight increase in understory cover of typical riparian-associated species and slight decrease in understory cover of species deemed intermediate between upland and riparian, may also suggest more available moisture at the site. Inference, is limited however, given the limitations of the study—four transects along an approximately 100-meter-long stretch of stream, sampled in 2009 and 2019. While the spatial extent of the monitoring remains constrained by the same factors discussed in the 2009 report (channel type, land use, influence by other water sources, and transect orientation), additional monitoring may add temporal information to the existing picture. As monitoring is scheduled to occur at ten-year intervals, the next survey will take place in 2029.

4.0 REFERENCES

Lesica, P. 2012. Manual of Montana vascular plants. Distribution of copies by Botanical Research Institute of Texas. http://www.brit.org/brit-press/

PPL Montana. 2009. Mystic Lake Hydroelectric Project riparian vegetation monitoring plan. FERC Project 2301. Prepared by PPL Montana with assistance from Morrison-Maierle, Inc. and GEI Consultants, Inc.

United States Army Corps of Engineers (USACE). 2019. National Wetland Plant List wetland ratings. Available at http://wetland-plants.usace.army.mil/nwpl_static/v33/species/species.html?DET=001100# Accessed August 2019.

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APPENDIX A TRANSECT-SPECIFIC UNDERSTORY DATA TABLES

TABLE 7 UNDERSTORY VEGETATION: COVER, SPECIES COMPOSITION, AND FREQUENCY IN 2019 AND CHANGE FROM 2009—TRANSECT 1

SPECIES	COMMON NAME	2019 CANOPY COVER[1]	2019 SPECIES COMPOSITION[2]	2019 FREQUENCY[3]	Δ **CANOPY** COVER[4]	Δ **SPECIES** COMPOSITION[5]	Δ FREQUENCY[6]
Actaea rubra	baneberry	0.07	0.19	2.63	-1.33	-3.31	-2.57
Angelica arguta	white angelica	1.84	5.22	23.68	0.44	1.72	18.48
Antennaria alpina	alpine pussytoes	0.13	0.37	5.26	0.13	0.37	5.26
Arctosaphylos uva-ursi	kinnikinnick	1.25	3.54	10.53	-0.05	0.34	0.03
Arnica cordifolia	heart-leaf arnica	0.86	2.43	21.05	-0.54	-1.27	2.65
Arnica mollis	hairy arnica	1.78	5.04	7.89	1.78	5.04	7.89
Berberis repens	creeping Oregon grape	0.07	0.19	2.63	0.07	0.19	2.63
Carex geyeri	elk sedge	0.20	0.56	7.89	0.20	0.56	7.89
Chamerion angustifolium	fireweed	0.92	2.61	23.68	0.02	0.41	15.78
Cirsium arvense	Canada thistle	1.12	3.17	18.42	1.02	2.87	13.22
Deschampsia caespitosa	tufted hairgrass	1.12	3.17	7.89	-0.18	-0.03	-2.61
Elymus glaucus	blue wildrye	0.13	0.37	5.26	0.13	0.37	5.26
Equisetum arvense	field horsetail	3.55	10.07	36.84	2.15	6.57	21.04
Fragaria virginiana	wild strawberry	0.99	2.80	26.32	-0.91	-2.00	2.62
Galium boreale	northern bedstraw	0.13	0.37	5.26	-0.57	-1.43	-10.54
Galium triflorum	sweet-scented bedstraw	0.99	2.80	26.32	0.99	2.80	26.32
Geranium richardsonii	white geranium	0.39	1.12	15.79	-1.21	-3.08	12.59
Geum macrophyllum	large-leaf avens	0.59	1.68	10.53	-0.31	-0.52	2.63
Heracleum lanatum	cow-parsnip	0.99	2.80	13.16	0.09	0.60	5.26
Hieracium albiflorum	white hawkweed	0.20	0.56	7.89	0.20	0.56	7.89
Juniperus communis	common juniper	3.16	8.96	13.16	0.16	1.26	5.26
maianthemum stellatum	starry Solomon's seal	0.13	0.37	5.26	-0.77	-1.83	-2.64
Mertensia ciliata	streamside bluebells	0.07	0.19	2.63	-0.33	-0.81	0.03
Orthilia secunda	one-sided wintergreen	0.07	0.19	2.63	0.07	0.19	2.63
Osmorhiza berteroi	mountain sweetcicely	0.20	0.56	7.89	-0.60	-1.44	2.69
Picea engelmannii	Engelmann spruce	3.22	9.14	5.26	2.42	7.14	0.06
Platanthera dilatata	leafy white orchid	0.53	1.49	7.89	0.43	1.19	2.69
Poa palustris	fowl bluegrass	0.46	1.31	5.26	0.46	1.31	5.26
Prosartes trachycarpa	wart-berry fairy bells	0.13	0.37	5.26	0.13	0.37	5.26
Prunus virginiana	chokecherry	0.39	1.12	2.63	0.39	1.12	2.63
Pyrola asarifolia	pink pyrola	0.66	1.87	13.16	-0.44	-0.83	-2.64

SPECIES	COMMON NAME	2019 CANOPY COVER[1]	2019 SPECIES COMPOSITION[2]	2019 FREQUENCY[3]	Δ **CANOPY** COVER[4]	Δ **SPECIES** COMPOSITION[5]	Δ FREQUENCY[6]
Ribes lacustre	prickly current	0.39	1.12	2.63	0.39	1.12	2.63
Rosa acicularis	prickly rose	1.05	2.99	15.79	-0.95	-2.01	-0.01
Salix eriocephala	yellow willow	0.99	2.80	2.63	0.99	2.80	2.63
Senecio pseudaureus	streambank groundsel	0.66	1.87	13.16	-0.14	-0.13	10.56
Shepherdia canadensis	buffaloberry	0.39	1.12	2.63	-0.41	-0.88	0.03
Spirea betulifolia	birch-leaved spirea	0.86	2.43	21.05	-2.54	-6.27	-10.55
Symphoricarpos albus	common snowberry	4.34	12.31	47.37	-0.66	-0.39	2.67
taraxacum officinale	dandelion	0.07	0.19	2.63	0.07	0.19	2.63
Thalictrum occidentale	western meadow-rue	0.13	0.37	5.26	-0.27	-0.63	2.66
Viola orbiculata	round-leaved yellow violet	0.07	0.19	2.63	0.07	0.19	2.63

[1] Percent canopy cover (i.e., absolute cover): calculated for each transect by taking the total canopy for each species and dividing it by the number of quadrats that were sampled along each transect.
[2] Percent species composition (i.e., relative cover): calculated for each transect by dividing the total canopy for each species by the total canopy for all species observed along each transect and multiplying the number by 100.
[3] Percent frequency: calculated for each transect by dividing the number of occurrences (total number of quadrats in which each species was observed) by the number of total quadrats sampled along each transect and multiplying the number by 100.
[4] Change in percent canopy cover (i.e., absolute cover): calculated by subtracting the 2009 value from the 2019 value.
[5] Change in percent species composition (i.e., relative cover): calculated by subtracting the 2009 value from the 2019 value.
[6] Change in percent frequency: calculated by subtracting the 2009 value from the 2019 value.

TABLE 8 UNDERSTORY VEGETATION: COVER, SPECIES COMPOSITION, AND FREQUENCY IN 2019 AND CHANGE FROM 2009—TRANSECT 2

SPECIES	COMMON NAME	2019 CANOPY COVER[1]	2019 SPECIES COMPOSITION[2]	2019 FREQUENCY[3]	Δ **CANOPY** COVER[4]	Δ **SPECIES** COMPOSITION[5]	Δ FREQUENCY[6]
Achillea millefolium	common yarrow	0.23	0.42	9.38	0.15	0.32	6.28
Angelica arguta	white angelica	0.16	0.28	6.25	-2.44	-4.12	-6.25
Antennaria alpina	alpine pussytoes	0.16	0.28	6.25	0.16	0.28	6.25
Arctosaphylos uva-ursi	kinnikinnick	2.03	3.60	6.25	-0.97	-1.40	-6.25
Arnica cordifolia	heart-leaf arnica	0.55	0.97	6.25	0.55	0.97	6.25
Arnica mollis	hairy arnica	0.08	0.14	3.13	0.08	0.14	3.13
Carex utriculata	beaked sedge	4.06	7.20	28.13	-0.34	-0.20	9.33
Chamerion angustifolium	fireweed	0.31	0.55	12.50	-0.19	-0.25	9.40
Cirsium arvense	Canada thistle	0.08	0.14	3.13	-0.62	-1.06	-9.38
Deschampsia caespitosa	tufted hairgrass	17.97	31.86	65.63	10.47	19.16	31.23
Equisetum arvense	field horsetail	6.41	11.36	56.25	5.81	10.26	46.85
Fragaria virginiana	wild strawberry	0.47	0.83	18.75	-1.73	-2.87	-6.25
Geranium richardsonii	white geranium	0.94	1.66	21.88	0.34	0.56	12.48
Glyceria striata	fowl mannagrass	0.47	0.83	3.13	0.47	0.83	3.13

SPECIES	COMMON NAME	2019 CANOPY COVER[1]	2019 SPECIES COMPOSITION[2]	2019 FREQUENCY[3]	Δ **CANOPY** COVER[4]	Δ **SPECIES** COMPOSITION[5]	Δ FREQUENCY[6]
Heracleum lanatum	cow-parsnip	0.16	0.28	6.25	-0.74	-1.32	-0.05
Juncus balticus	Baltic rush	0.23	0.42	9.38	-0.77	-1.28	-0.03
Juniperus communis	common juniper	8.59	15.24	28.13	0.29	1.24	6.23
Mimulus guttatus	common monkeyflower	0.16	0.28	6.25	-0.34	-0.52	3.15
Phleum pratense	timothy	0.39	0.69	15.63	-1.81	-3.01	3.13
Picea engelmannii	Engelmann spruce	0.47	0.83	3.13	-0.43	-0.77	-3.18
Platanthera dilatata	leafy white orchid	0.08	0.14	3.13	0.08	0.14	3.13
Poa palustris	fowl bluegrass	0.08	0.14	3.13	0.08	0.14	3.13
Pyrola asarifolia	pink pyrola	0.86	1.52	34.38	0.66	1.12	24.98
Ribes lacustre	prickly current	0.08	0.14	3.13	0.08	0.14	3.13
Rosa acicularis	prickly rose	2.73	4.85	34.38	1.13	2.25	18.78
Rubus idaeus	wild red raspberry	0.08	0.14	3.13	0.08	0.14	3.13
Salix boothii	Booth willow	1.33	2.35	9.38	1.33	2.35	9.38
Salix eriocephala	yellow willow	0.08	0.14	3.13	0.08	0.14	3.13
sedum lanceolatum	spearleaf stonecrop	0.08	0.14	3.13	0.08	0.14	3.13
Senecio pseudaureus	streambank groundsel	2.58	4.57	28.13	2.08	3.67	21.83
Solidago canadensis	Canada goldenrod	0.23	0.42	9.38	0.23	0.42	9.38
Spirea betulifolia	birch-leaved spirea	2.65	4.70	18.18	-0.15	-0.10	8.78
Symphoricarpos albus	common snowberry	1.56	2.77	15.63	1.06	1.97	12.53
Thalictrum occidentale	western meadow-rue	0.08	0.14	3.13	0.00	0.04	0.02

[1] Percent canopy cover (i.e., absolute cover): calculated for each transect by taking the total canopy for each species and dividing it by the number of quadrats that were sampled along each transect.
[2] Percent species composition (i.e., relative cover): calculated for each transect by dividing the total canopy for each species by the total canopy for all species observed along each transect and multiplying the number by 100.
[3] Percent frequency: calculated for each transect by dividing the number of occurrences (total number of quadrats in which each species was observed) by the number of total quadrats sampled along each transect and multiplying the number by 100.
[4] Change in percent canopy cover (i.e., absolute cover): calculated by subtracting the 2009 value from the 2019 value.
[5] Change in percent species composition (i.e., relative cover): calculated by subtracting the 2009 value from the 2019 value.
[6] Change in percent frequency: calculated by subtracting the 2009 value from the 2019 value.

TABLE 9 UNDERSTORY VEGETATION: COVER, SPECIES COMPOSITION, AND FREQUENCY IN 2019 AND CHANGE FROM 2009—TRANSECT 3

SPECIES	COMMON NAME	2019 CANOPY COVER[1]	2019 SPECIES COMPOSITION[2]	2019 FREQUENCY[3]	Δ **CANOPY** COVER[4]	Δ **SPECIES** COMPOSITION[5]	Δ FREQUENCY[6]
Achillea millefolium	common yarrow	0.14	0.17	5.71	-0.06	-0.13	-3.09
Angelica arguta	white angelica	1.21	1.41	20.00	-0.29	-0.69	14.10
Arctosaphylos uva-ursi	kinnikinnick	1.29	1.49	8.57	0.89	0.89	5.67
Arnica cordifolia	heart-leaf arnica	0.64	0.75	11.43	0.24	0.15	8.53
Betula occidentalis	water birch	0.07	0.08	2.86	-0.33	-0.52	-0.04

SPECIES	COMMON NAME	2019 CANOPY COVER[1]	2019 SPECIES COMPOSITION[2]	2019 FREQUENCY[3]	Δ **CANOPY** COVER[4]	Δ **SPECIES** COMPOSITION[5]	Δ FREQUENCY[6]
Bromus marginatus	mountain brome	0.07	0.08	2.86	0.07	0.08	2.86
Carex utriculata	beaked sedge	8.86	10.28	28.57	5.06	5.08	16.77
Chamerion angustifolium	fireweed	0.36	0.41	14.29	0.29	0.31	11.39
Cirsium arvense	Canada thistle	0.07	0.08	2.86	0.00	-0.02	-0.04
Deschampsia caespitosa	tufted hairgrass	22.29	25.87	57.14	9.89	9.07	24.74
Epilobium ciliatum	hairy willow-herb	0.07	0.08	2.86	0.00	-0.02	-0.04
Equisetum arvense	field horsetail	7.36	8.54	37.14	6.36	7.14	25.34
Fragaria virginiana	wild strawberry	0.14	0.17	5.71	0.14	0.17	5.71
Galium triflorum	sweet-scented bedstraw	0.14	0.17	5.71	0.07	0.07	2.81
Geranium richardsonii	white geranium	1.00	1.16	11.43	-0.10	-0.34	-3.27
Heracleum lanatum	cow-parsnip	0.43	0.50	2.86	-0.67	-1.00	-0.04
Juncus balticus	Baltic rush	0.07	0.08	2.86	0.07	0.08	2.86
Juniperus communis	common juniper	4.71	5.47	14.29	-2.09	-3.73	-3.31
maianthemum stellatum	starry Solomon's seal	0.07	0.08	2.86	-0.53	-0.72	-5.94
Mimulus guttatus	common monkeyflower	0.07	0.08	2.86	-1.03	-1.42	-0.04
Phleum pratense	timothy	1.57	1.82	8.57	-32.43	-4.38	-6.13
Picea engelmannii	Engelmann spruce	0.50	0.58	5.71	0.50	0.58	5.71
Populus tremuloides	quaking aspen	0.07	0.08	2.86	0.07	0.08	2.86
Pyrola asarifolia	pink pyrola	1.14	1.33	17.14	-0.36	-0.67	2.44
Rosa acicularis	prickly rose	5.07	5.89	62.86	2.17	1.89	33.46
Rubus idaeus	wild red raspberry	0.14	0.17	5.71	0.14	0.17	5.71
Salix bebbiana	Bebb willow	2.93	3.40	8.57	2.93	3.40	8.57
Salix boothii	Booth willow	10.50	12.19	34.29	8.70	9.69	31.39
Salix planifolia	diamond-leaf willow	7.36	8.54	25.71	7.36	8.54	25.71
Senecio pseudaureus	streambank groundsel	3.07	3.57	40.00	-1.23	-2.23	13.50
Shepherdia canadensis	buffaloberry	1.14	1.33	5.71	1.14	1.33	5.71
Spirea betulifolia	birch-leaved spirea	2.43	2.82	25.71	-1.87	-2.98	11.01
Symphoricarpos albus	common snowberry	0.93	1.08	8.57	-0.37	-0.72	-3.23
Thalictrum occidentale	western meadow-rue	0.14	0.17	5.71	-0.06	-0.13	-3.09
Veronica americana	American speedwell	0.07	0.08	2.86	0.07	0.08	2.86

[1] Percent canopy cover (i.e., absolute cover): calculated for each transect by taking the total canopy for each species and dividing it by the number of quadrats that were sampled along each transect.
[2] Percent species composition (i.e., relative cover): calculated for each transect by dividing the total canopy for each species by the total canopy for all species observed along each transect and multiplying the number by 100.
[3] Percent frequency: calculated for each transect by dividing the number of occurrences (total number of quadrats in which each species was observed) by the number of total quadrats sampled along each transect and multiplying the number by 100.
[4] Change in percent canopy cover (i.e., absolute cover): calculated by subtracting the 2009 value from the 2019 value.
[5] Change in percent species composition (i.e., relative cover): calculated by subtracting the 2009 value from the 2019 value.
[6] Change in percent frequency: calculated by subtracting the 2009 value from the 2019 value.

TABLE 10 UNDERSTORY VEGETATION: COVER, SPECIES COMPOSITION, AND FREQUENCY IN 2019 AND CHANGE FROM 2009—TRANSECT 4

SPECIES	COMMON NAME	2019 CANOPY COVER[1]	2019 SPECIES COMPOSITION[2]	2019 FREQUENCY[3]	Δ **CANOPY** COVER[4]	Δ **SPECIES** COMPOSITION[5]	Δ FREQUENCY[6]
Antennaria alpina	alpine pussytoes	0.58	0.97	3.85	0.48	0.77	-0.15
Arnica cordifolia	heart-leaf arnica	0.58	0.97	3.85	-0.62	-1.13	-0.15
Arnica mollis	hairy arnica	1.44	2.42	3.85	1.44	2.42	3.85
Carex interior	inland sedge	0.19	0.32	7.69	0.19	0.32	7.69
Carex utriculata	beaked sedge	11.73	19.68	50.00	3.13	4.48	-2.00
Cirsium arvense	Canada thistle	1.15	1.94	26.92	0.95	1.54	18.92
Dactylus glomerata	orchard grass	0.10	0.16	3.85	0.10	0.16	3.85
Dasiphora fruticosa	shrubby cinquefoil	0.67	1.13	7.69	-0.03	-0.07	-0.31
Deschampsia caespitosa	tufted hairgrass	6.15	10.32	42.31	2.75	4.32	22.31
Epilobium ciliatum	hairy willow-herb	0.19	0.32	7.69	0.09	0.12	3.69
Equisetum arvense	field horsetail	5.00	8.39	65.38	4.70	7.89	53.38
Fragaria virginiana	wild strawberry	0.38	0.65	15.38	0.18	0.25	7.38
Galium boreale	northern bedstraw	0.19	0.32	7.69	0.09	0.12	3.69
Galium triflorum	sweet-scented bedstraw	0.87	1.45	34.62	0.77	1.25	30.62
Geranium richardsonii	white geranium	0.29	0.48	11.54	0.19	0.28	7.54
Geum macrophyllum	large-leaf avens	0.67	1.13	26.92	-0.23	-0.47	10.92
Glyceria striata	fowl mannagrass	0.67	1.13	7.69	0.47	0.73	-0.31
Heracleum lanatum	cow-parsnip	0.10	0.16	3.85	0.10	0.16	3.85
Juncus articulatus	jointed rush	0.10	0.16	3.85	0.10	0.16	3.85
Juncus balticus	Baltic rush	1.44	2.42	19.23	-8.56	-15.18	3.23
Juncus torreyi	Torrey's rush	0.48	0.81	19.23	0.38	0.61	15.23
Juniperus communis	common juniper	6.83	11.45	15.38	5.33	8.85	11.38
Picea engelmannii	Engelmann spruce	0.19	0.32	7.69	0.19	0.32	7.69
Platanthera dilatata	leafy white orchid	0.29	0.48	11.54	0.29	0.48	11.54
Poa palustris	fowl bluegrass	0.87	1.45	15.38	0.87	1.45	15.38
Pyrola asarifolia	pink pyrola	0.38	0.65	15.38	0.38	0.65	15.38
Ribes lacustre	prickly current	0.58	0.97	3.85	-0.02	-0.13	-0.15
Rosa acicularis	prickly rose	2.12	3.55	46.15	-0.98	-1.95	2.15
Salix bebbiana	Bebb willow	0.77	1.29	11.54	0.77	1.29	11.54
Salix boothii	Booth willow	1.83	3.06	15.38	1.83	3.06	15.38
Salix planifolia	diamond-leaf willow	2.21	3.71	30.77	2.21	3.71	30.77
Scirpus microcarpus	small-fruit bulrush	5.00	8.39	30.77	4.40	7.29	26.77
Senecio pseudaureus	streambank groundsel	4.81	8.06	38.46	3.51	5.76	6.46
Senecio triangularis	arrow-leaf groundsel	0.19	0.32	7.69	-0.11	-0.18	-4.31

SPECIES	COMMON NAME	2019 CANOPY COVER[1]	2019 SPECIES COMPOSITION[2]	2019 FREQUENCY[3]	Δ **CANOPY** COVER[4]	Δ **SPECIES** COMPOSITION[5]	Δ FREQUENCY[6]
Solidago canadensis	Canada goldenrod	0.19	0.32	7.69	0.19	0.32	7.69
Symphoricarpos albus	common snowberry	0.19	0.32	7.69	-0.41	-0.78	3.69
Thalictrum occidentale	western meadow-rue	0.10	0.16	3.85	0.00	-0.04	-0.15
Viola orbiculata	round-leaved yellow violet	0.10	0.16	3.85	-0.50	-0.94	-20.15

[1] Percent canopy cover (i.e., absolute cover): calculated for each transect by taking the total canopy for each species and dividing it by the number of quadrats that were sampled along each transect.
[2] Percent species composition (i.e., relative cover): calculated for each transect by dividing the total canopy for each species by the total canopy for all species observed along each transect and multiplying the number by 100.
[3] Percent frequency: calculated for each transect by dividing the number of occurrences (total number of quadrats in which each species was observed) by the number of total quadrats sampled along each transect and multiplying the number by 100.
[4] Change in percent canopy cover (i.e., absolute cover): calculated by subtracting the 2009 value from the 2019 value.
[5] Change in percent species composition (i.e., relative cover): calculated by subtracting the 2009 value from the 2019 value.
[6] Change in percent frequency: calculated by subtracting the 2009 value from the 2019 value.

APPENDIX B RAW DAUBENMIRE UNDERSTORY DATA

TABLE 11 2019 UNDERSTORY VEGETATION: RAW DATA—TRANSECT 1

SPECIES	COMMON NAME	QUADRATS[1]																																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
Actaea rubra	baneberry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0
Angelica arguta	white angelica	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	2.5	15	2.5	0	2.5	37.5	0	0	0	2.5	0	2.5	0	2.5	0	0	0	0	0
Antennaria alpina	alpine pussytoes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	2.5	0
Arctosaphylos uva-ursi	kinnikinnick	0	0	0	0	0	2.5	15	15	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arnica cordifolia	heart-leaf arnica	0	0	0	0	0	0	0	2.5	15	2.5	2.5	0	0	2.5	0	0	0	0	0	2.5	2.5	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arnica mollis	hairy arnica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	15	37.5	0	0	0	0	0	0	0	0
Berberis repens	creeping Oregon grape	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex geyeri	elk sedge	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0
Chamerion angustifolium	fireweed	2.5	0	0	0	0	2.5	2.5	0	0	2.5	2.5	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	2.5	0	0	0	0	0	0	2.5	15	0	0	0
Cirsium arvense	Canada thistle	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	2.5	2.5	0	2.5	15	0	0	2.5	2.5	0	0	0	0	0
Deschampsia cespitosa	tufted hairgrass	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	2.5	37.5	0	0	0	0	0
Elymus glaucus	blue wildrye	0	2.5	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Equisetum arvense	field horsetail	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	2.5	15	15	2.5	0	15	15	2.5	0	15	15	15	0	15	2.5	2.5	0	0	0
Fragaria virginiana	wild strawberry	0	2.5	15	2.5	0	2.5	0	2.5	2.5	0	0	0	0	0	2.5	0	0	2.5	0	0	0	0	2.5	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0
Galium boreale	northern bedstraw	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0
Galium triflorum	sweet-scented bedstraw	0	0	2.5	0	0	0	0	0	0	2.5	0	0	0	0	0	2.5	0	0	0	2.5	0	2.5	2.5	0	2.5	15	2.5	0	0	0	0	2.5	0	0	0	0	0	0
Geranium richardsonii	white geranium	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	2.5	0	0	0	2.5	0	0	0	2.5	2.5	0	0	0	0
Geum macrophyllum	large-leaf avens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	2.5	15	0	2.5	0	0	0	0	0	0	0	0
Heracleum lanatum	cow-parsnip	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	2.5	2.5	0	0	0	15	0	0	15	0	0	0	0
Hieracium albiflorum	white hawkweed	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5
Juniperus communis	common juniper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	15	0	85	2.5
maianthemum stellatum	starry Solomon's seal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mertensia ciliata	streamside bluebells	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0
Orthilia secunda	one-sided wintergreen	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Osmorhiza berteroi	mountain sweetcicely	0	0	2.5	2.5	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Picea engelmannii	Engelmann spruce	0	0	0	0	0	85	0	0	0	37.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Platanthera dilatata	leafy white orchid	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	2.5	0	2.5	0	0	0	0	0	0	0
Poa palustris	fowl bluegrass	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0
Prosartes trachycarpa	wart-berry fairy bells	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prunus virginiana	chokecherry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0
Pyrola asarifolia	pink pyrola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	2.5	0	0	0	0	0	0	2.5	2.5	15	0	0	0	0	0
Ribes lacustre	prickly current	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rosa acicularis	prickly rose	15	2.5	2.5	2.5	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0
Salix eriocephala	yellow willow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37.5	0	0	0	0	0	0
Senecio pseudaureus	streambank groundsel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	2.5	2.5	0	2.5	15	0	0	0	0	0	0	0
Shepherdia canadensis	buffaloberry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15
Spirea betulifolia	birch-leaved spirea	15	2.5	0	0	2.5	0	0	0	0	0	0	0	0	2.5	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	2.5	2.5
Symphoricarpos albus	common snowberry	2.5	0	2.5	0	2.5	0	15	2.5	2.5	2.5	15	0	0	2.5	15	0	2.5	15	0	2.5	0	0	37.5	37.5	0	0	2.5	0	0	0	0	0	0	2.5	0	2.5	0	0
taraxacum officinale	dandelion	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thalictrum occidentale	western meadow-rue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	2.5	0	0
Viola orbiculata	round-leaved yellow violet	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

[1] Values presented represent the midpoint, in percent cover, of the assigned cover class.

TABLE 12 2019 UNDERSTORY VEGETATION: RAW DATA—TRANSECT 2

SPECIES	COMMON NAME	QUADRATS[1]																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Achillea millefolium	common yarrow	0	0	2.5	2.5	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Angelica arguta	white angelica	0	0	0	2.5	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Antennaria alpina	alpine pussytoes	2.5	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctosaphylos uva-ursi	kinnikinnick	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	62.5
Arnica cordifolia	heart-leaf arnica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	2.5	0	0	0	0
Arnica mollis	hairy arnica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex utriculata	beaked sedge	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	15	2.5	15	37.5	15	0	2.5	37.5	0	0	0	0	2.5	0	0	0	0	0
Chamerion angustifolium	fireweed	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	2.5	2.5	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0
Cirsium arvense	Canada thistle	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deschampsia caespitosa	tufted hairgrass	0	0	0	0	2.5	2.5	37.5	62.5	37.5	62.5	37.5	37.5	37.5	62.5	37.5	2.5	37.5	15	15	0	0	2.5	2.5	15	15	37.5	15	0	0	0	0	0
Equisetum arvense	field horsetail	0	0	0	2.5	15	0	2.5	0	0	0	15	15	15	37.5	15	0	2.5	0	15	2.5	0	15	2.5	15	15	2.5	15	2.5	0	0	0	0
Fragaria virginiana	wild strawberry	0	0	2.5	0	2.5	2.5	2.5	0	0	0	0	2.5	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0
Geranium richardsonii	white geranium	0	0	0	0	0	2.5	0	2.5	0	0	0	2.5	0	0	0	0	2.5	0	2.5	0	0	0	0	0	0	2.5	15	0	0	0	0	0
Glyceria striata	fowl mannagrass	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heracleum lanatum	cow-parsnip	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus balticus	Baltic rush	0	0	2.5	0	2.5	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juniperus communis	common juniper	2.5	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	62.5	0	0	15	15	15	62.5	37.5	62.5	0
Mimulus guttatus	common monkeyflower	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	2.5	0	0	0	0	0	0	0	0	0	0	0	0
Phleum pratense	timothy	2.5	2.5	2.5	2.5	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Picea engelmannii	Engelmann spruce	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0
Platanthera dilatata	leafy white orchid	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poa palustris	fowl bluegrass	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pyrola asarifolia	pink pyrola	0	0	0	0	0	0	0	0	0	0	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0	0	2.5	0	0	2.5	0	0	0	0	0	0	0
Ribes lacustre	prickly current	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rosa acicularis	prickly rose	0	62.5	2.5	0	2.5	0	2.5	0	0	2.5	0	0	2.5	2.5	2.5	2.5	2.5	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rubus idaeus	wild red raspberry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Salix boothii	Booth willow	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	2.5	37.5	0	0	0	0	0	0	0
Salix eriocephala	yellow willow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0
sedum lanceolatum	spearleaf stonecrop	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Senecio pseudaureus	streambank groundsel	0	0	0	15	37.5	15	2.5	2.5	0	0	2.5	0	0	0	0	2.5	0	2.5	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0
Solidago canadensis	Canada goldenrod	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0
Spirea betulifolia	birch-leaved spirea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	15	2.5	15	15
Symphoricarpos albus	common snowberry	0	0	2.5	15	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	2.5	0	0	0
Thalictrum occidentale	western meadow-rue	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

[1] Values presented represent the midpoint, in percent cover, of the assigned cover class.

TABLE 13 2019 UNDERSTORY VEGETATION: RAW DATA—TRANSECT 3

SPECIES	COMMON NAME	QUADRATS[1]																																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Achillea millefolium	common yarrow	0	0	0	0	0	0	0	2.5	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Angelica arguta	white angelica	0	0	2.5	15	2.5	2.5	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	2.5	0	0	0	0
Arctosaphylos uva-ursi	kinnikinnick	15	15	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arnica cordifolia	heart-leaf arnica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	15	2.5	2.5
Betula occidentalis	water birch	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bromus marginatus	mountain brome	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0
Carex utriculata	beaked sedge	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	15	0	0	0	0	15	15	37.5	37.5	62.5	85	37.5	0	0	0	2.5	0	0	0	0	0
Chamerion angustifolium	fireweed	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	2.5	2.5	2.5	0	0	0	0	0	0
Cirsium arvense	Canada thistle	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0
Deschampsia caespitosa	tufted hairgrass	0	0	0	0	15	0	15	15	15	15	37.5	37.5	37.5	62.5	62.5	62.5	62.5	62.5	62.5	37.5	62.5	37.5	0	0	0	0	0	15	62.5	2.5	0	0	0	0	0
Epilobium ciliatum	hairy willow-herb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0
Equisetum arvense	field horsetail	37.5	37.5	15	0	0	0	0	0	37.5	15	0	2.5	0	0	2.5	0	15	0	0	0	0	15	0	0	0	0	37.5	2.5	37.5	2.5	0	0	0	0	0
Fragaria virginiana	wild strawberry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	2.5	0	0	0
Galium triflorum	sweet-scented bedstraw	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0
Geranium richardsonii	white geranium	0	0	2.5	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	2.5	0	0	0	0	0	0
Heracleum lanatum	cow-parsnip	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0
Juncus balticus	Baltic rush	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0
Juniperus communis	common juniper	37.5	37.5	0	0	0	0	37.5	0	0	37.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0
maianthemum stellatum	starry Solomon's seal	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mimulus guttatus	common monkeyflower	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0
Phleum pratense	timothy	0	0	15	37.5	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Picea engelmannii	Engelmann spruce	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0
Populus tremuloides	quaking aspen	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pyrola asarifolia	pink pyrola	0	0	0	0	0	2.5	0	0	0	2.5	0	0	2.5	0	0	0	0	2.5	15	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rosa acicularis	prickly rose	2.5	2.5	0	0	2.5	0	15	15	2.5	2.5	15	0	2.5	2.5	0	2.5	15	2.5	2.5	2.5	0	2.5	0	0	0	0	2.5	15	15	2.5	37.5	15	0	0	0
Rubus idaeus	wild red raspberry	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Salix bebbiana	Bebb willow	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37.5	62.5	0	0	0	0	0	0	0
Salix boothii	Booth willow	0	0	0	0	0	0	0	62.5	0	0	0	2.5	0	62.5	62.5	15	0	15	15	2.5	62.5	15	0	0	37.5	15	0	0	0	0	0	0	0	0	0
Salix planifolia	diamond-leaf willow	0	0	0	0	0	0	0	0	0	37.5	0	0	0	0	2.5	2.5	2.5	0	0	85	37.5	37.5	15	37.5	0	0	0	0	0	0	0	0	0	0	0
Senecio pseudaureus	streambank groundsel	0	0	0	2.5	0	0	0	0	0	0	2.5	2.5	2.5	2.5	2.5	2.5	0	0	0	37.5	0	15	2.5	15	15	0	2.5	2.5	0	0	0	0	0	0	0
Shepherdia canadensis	buffaloberry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37.5	2.5	0	0	0	0
Spirea betulifolia	birch-leaved spirea	0	0	0	0	0	2.5	15	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	2.5	15	15	0	15	15
Symphoricarpos albus	common snowberry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	15	15	
Thalictrum occidentale	western meadow-rue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0
Veronica americana	American speedwell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0

[1] Values presented represent the midpoint, in percent cover, of the assigned cover class.

TABLE 14 2019 UNDERSTORY VEGETATION: RAW DATA—TRANSECT 4

SPECIES	COMMON NAME	QUADRATS[1]																									
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Antennaria alpina	alpine pussytoes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15
Arnica cordifolia	heart-leaf arnica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0
Arnica mollis	hairy arnica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37.5	0	0	0	0
Carex interior	inland sedge	0	2.5	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex utriculata	beaked sedge	2.5	0	0	15	2.5	2.5	15	37.5	37.5	37.5	62.5	37.5	37.5	0	0	15	0	0	0	0	2.5	0	0	0	0	0
Cirsium arvense	Canada thistle	0	0	0	0	0	0	2.5	0	0	0	0	0	0	2.5	0	0	0	2.5	0	2.5	2.5	15	2.5	0	0	0
Dactylus glomerata	orchard grass	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dasiphora fruticosa	shrubby cinquefoil	15	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deschampsia caespitosa	tufted hairgrass	0	0	15	0	37.5	0	15	0	15	0	0	0	15	0	0	0	0	0	2.5	37.5	15	2.5	2.5	2.5	0	0
Epilobium ciliatum	hairy willow-herb	0	0	0	0	0	0	0	2.5	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Equisetum arvense	field horsetail	2.5	15	15	2.5	15	15	15	2.5	15	0	2.5	2.5	2.5	15	2.5	0	0	2.5	2.5	0	0	2.5	0	0	0	0
Fragaria virginiana	wild strawberry	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	2.5	2.5	0	0	0	0
Galium boreale	northern bedstraw	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0
Galium triflorum	sweet-scented bedstraw	0	0	2.5	0	2.5	0	2.5	0	0	2.5	2.5	2.5	0	2.5	0	0	2.5	2.5	0	0	0	0	0	0	0	0
Geranium richardsonii	white geranium	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	2.5	0	0	2.5	0	0	0	0	0	0	0
Geum macrophyllum	large-leaf avens	0	0	2.5	2.5	0	0	0	0	2.5	0	0	0	0	2.5	0	0	2.5	2.5	0	2.5	0	0	0	0	0	0
Glyceria striata	fowl mannagrass	0	0	0	0	0	15	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heracleum lanatum	cow-parsnip	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0
Juncus articulatus	jointed rush	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0
Juncus balticus	Baltic rush	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	2.5	15	15	2.5	0	0	0	0
Juncus torreyi	Torrey's rush	0	0	2.5	2.5	2.5	0	0	0	0	2.5	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0
Juniperus communis	common juniper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	62.5	62.5	15	37.5
Picea engelmannii	Engelmann spruce	0	0	0	2.5	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Platanthera dilatata	leafy white orchid	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	2.5	2.5	0	0	0	0	0	0	0	0	0	0
Poa palustris	fowl bluegrass	2.5	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	2.5	0
Pyrola asarifolia	pink pyrola	0	0	0	0	2.5	0	0	0	0	0	0	0	2.5	0	2.5	0	0	0	2.5	0	0	0	0	0	0	0
Ribes lacustre	prickly current	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0
Rosa acicularis	prickly rose	0	2.5	0	0	0	0	0	0	0	0	0	0	2.5	2.5	2.5	2.5	2.5	15	2.5	2.5	2.5	15	0	2.5	0	0
Salix bebbiana	Bebb willow	0	0	15	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0
Salix boothii	Booth willow	0	0	0	0	0	0	0	0	0	0	15	15	0	15	2.5	0	0	0	0	0	0	0	0	0	0	0
Salix planifolia	diamond-leaf willow	2.5	0	0	15	2.5	2.5	2.5	0	15	15	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scirpus microcarpus	small-fruit bulrush	0	0	0	0	0	0	0	0	0	0	0	0	15	15	15	15	37.5	15	15	2.5	0	0	0	0	0	0
Senecio pseudaureus	streambank groundsel	0	2.5	0	0	0	0	2.5	0	0	0	0	0	15	15	15	15	15	15	0	15	15	0	0	0	0	0
Senecio triangularis	arrow-leaf groundsel	0	0	0	0	0	0	2.5	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Solidago canadensis	Canada goldenrod	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	2.5	0	0	0	0	0
Symphoricarpos albus	common snowberry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.5	0	2.5	0
Thalictrum occidentale	western meadow-rue	0	0	0	0	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viola orbiculata	round-leaved yellow violet	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Values presented represent the midpoint, in percent cover, of the assigned cover class.

APPENDIX C TRANSECT-SPECIFIC OVERSTORY DATA TABLES

TABLE 15 OVERSTORY CANOPY COVER BY SPECIES IN 2019 AND CHANGE FROM 2009—TRANSECT 1

SPECIES	COMMON NAME	FORM	CANOPY COVER[1]	∆ **CANOPY COVER**[1]
Abies lasiocarpa	subalpine fir	tree	3.30	1.30
Betula occidentalis	water birch	shrub	4.60	-6.40
picea engelmannii	Engelmann's spruce	tree	37.50	2.50
Pinus contorta	lodgepole pine	tree	13.20	-7.80
Salix eriocephala	yellow willow	shrub	5.30	5.30
Salix geyeriana	Geyer willow	shrub	0.00	-3.00
Salix boothii	Booth willow	shrub	0.00	-1.00
Total Salix	-	-	5.30	2.30
Total Shrub	-	-	9.90	-4.10
Total Tree	-	-	53.90	-4.10
Grand Total	-	-	63.80	-8.20

[1]Change in percent canopy cover (i.e., absolute cover): calculated by subtracting the 2009 value from the 2019 value.

TABLE 16 OVERSTORY CANOPY COVER BY SPECIES IN 2019 AND CHANGE FROM 2009—TRANSECT 2

SPECIES	COMMON NAME	FORM	CANOPY COVER[1]	∆ **CANOPY COVER**[1]
Betula occidentalis	water birch	shrub	0.00	-5.00
picea engelmannii	Engelmann's spruce	tree	14.10	10.10
Pinus contorta	lodgepole pine	tree	6.30	-20.70
Salix eriocephala	yellow willow	shrub	2.30	2.30
Salix geyeriana	Geyer willow	shrub	0.00	-2.00
Salix bebbiana	Bebb willow	shrub	1.60	1.60
Salix boothii	Booth willow	shrub	1.60	1.60
Total Salix	-	-	5.50	3.50
Total Shrub	-	-	5.50	-1.50
Total Tree	-	-	20.30	-10.70
Grand Total	-	-	25.80	-12.20

[1]Change in percent canopy cover (i.e., absolute cover): calculated by subtracting the 2009 value from the 2019 value.

TABLE 17 OVERSTORY CANOPY COVER BY SPECIES IN 2019 AND CHANGE FROM 2009—TRANSECT 3

SPECIES	COMMON NAME	FORM	CANOPY COVER[1]	∆ **CANOPY COVER**[1]
Betula occidentalis	water birch	shrub	2.90	0.90
picea engelmannii	Engelmann's spruce	tree	0.00	-13.00
Pinus contorta	lodgepole pine	tree	0.00	-35.00
Populus tremuloides	quaking aspen	Tree	0.00	-1.00
Salix eriocephala	yellow willow	shrub	0.00	-9.00
Salix geyeriana	Geyer willow	shrub	0.00	-10.00
Salix bebbiana	Bebb willow	shrub	8.80	8.80
Salix boothii	Booth willow	shrub	8.80	8.80
Salix planifolia	diamond-leaf willow	shrub	8.10	8.10
Total Salix	-	-	25.70	6.70
Total Shrub	-	-	28.70	7.70
Total Tree	-	-	27.90	-21.10
Grand Total	-	-	56.60	-13.40

[1]Change in percent canopy cover (i.e., absolute cover): calculated by subtracting the 2009 value from the 2019 value.

TABLE 18 OVERSTORY CANOPY COVER BY SPECIES IN 2019 AND CHANGE FROM 2009—TRANSECT 4

SPECIES	COMMON NAME	FORM	CANOPY COVER[1]	∆ CANOPY COVER[1]
Betula occidentalis	water birch	shrub	0.00	-3.00
Picea engelmannii	Engelmann's spruce	tree	2.00	-3.00
Pinus contorta	lodgepole pine	tree	15.00	-7.00
Salix eriocephala	yellow willow	shrub	0.00	-12.00
Salix geyeriana	Geyer willow	shrub	0.00	-14.00
Salix bebbiana	Bebb willow	shrub	1.00	1.00
Salix boothii	Booth willow	shrub	25.00	25.00
Salix planifolia	diamond-leaf willow	shrub	28.00	28.00
Total Salix	-	-	54.00	28.00
Total Shrub	-	-	54.00	25.00
Total Tree	-	-	17.00	-10.00
Grand Total	-	-	71.00	15.00

[1]Change in percent canopy cover (i.e., absolute cover): calculated by subtracting the 2009 value from the 2019 value.

APPENDIX D RAW LINE TRANSECT OVERSTORY DATA

TABLE 19 2019 OVERSTORY VEGETATION: RAW DATA—TRANSECT 1

START[1]	STOP[1]	INTERCEPT[3]	SPECIES	COMMON NAME	LIVE/DEAD	FORM
0	7	7	*Picea engelmannii*	Engelmann's spruce	Live	Tree
0	15	15	*Pinus contorta*	lodgepole pine	Live	Tree
16	18	2	*Picea engelmannii*	Engelmann's spruce	Live	Tree
27	28	1	*Salix eriocephala*	yellow willow	Live	Shrub
28	29	1	*Picea engelmannii*	Engelmann's spruce	Live	Tree
38	39	1	*Betula occidentalis*	water birch	Live	Shrub
40	55	15	*Picea engelmannii*	Engelmann's spruce	Live	Tree
53	58	5	*Abies lasiocarpa*	subalpine fir	Live	Tree
60	61	1	*Picea engelmannii*	Engelmann's spruce	Live	Tree
64	69	5	*Pinus contorta*	lodgepole pine	Dead	Tree
70	76	6	*Picea engelmannii*	Engelmann's spruce	Dead	Tree
80	81	1	*Betula occidentalis*	water birch	Live	Shrub
81	85	4	*Picea engelmannii*	Engelmann's spruce	Dead	Tree
86	104	18	*Picea engelmannii*	Engelmann's spruce	Live	Tree
115	117	2	*Betula occidentalis*	water birch	Live	Shrub
115	117	2	*Salix eriocephala*	yellow willow	Live	Shrub
118	123	5	*Salix eriocephala*	yellow willow	Live	Shrub
120	121	1	*Betula occidentalis*	water birch	Live	Shrub
129	132	3	*Picea engelmannii*	Engelmann's spruce	Live	Tree
131	133	2	*Betula occidentalis*	water birch	Live	Shrub

[1] Starting and stopping point (in feet) of species canopy cover as it crosses the transect line.
[2] Total length (in feet) of species canopy cover as it crosses the transect line.

TABLE 20 2019 OVERSTORY VEGETATION: RAW DATA—TRANSECT 2

START[1]	STOP[1]	INTERCEPT[3]	SPECIES	COMMON NAME	LIVE/DEAD	FORM
28	30	2	*Salix leriocephala*	yellow willow	Live	Shrub
30	32	2	*Salix bebbiana*	Bebb willow	Live	Shrub
31	37	6	*Picea engelmannii*	Engelmann's spruce	Live	Tree
36	37	1	*Salix eriocephala*	yellow willow	Live	Shrub
39	40	1	*Salix boothii*	Booth willow	Live	Shrub
39	40	1	*Picea engelmannii*	Engelmann's spruce	Live	Tree
42	44	2	*Picea engelmannii*	Engelmann's spruce	Live	Tree
45	48	3	*Picea engelmannii*	Engelmann's spruce	Live	Tree
57	59	2	*Picea engelmannii*	Engelmann's spruce	Live	Tree
89	93	4	*Picea engelmannii*	Engelmann's spruce	Live	Tree
95	96	1	*Salix boothii*	Booth willow	Live	Shrub
109	117	8	*Pinus contorta*	lodgepole pine	Live	Tree

[1] Starting and stopping point (in feet) of species canopy cover as it crosses the transect line.
[2] Total length (in feet) of species canopy cover as it crosses the transect line.

TABLE 21 2019 OVERSTORY VEGETATION: RAW DATA—TRANSECT 3

START[1]	STOP[1]	INTERCEPT[3]	SPECIES	COMMON NAME	LIVE/DEAD	FORM
0	3	3	*Betula occidentalis*	water birch	Live	Shrub
4	5	1	*Populus tremuloides*	quaking aspen	Live	Tree
4	6	2	*Picea engelmannii*	Engelmann's spruce	Live	Tree
14	20	6	*Salix bebbiana*	Bebb willow	Live	Shrub
17	19	2	*Salix boothii*	Booth willow	Live	Shrub
16	18	2	*Pinus contorta*	lodgepole pine	Dead	Tree
28	37	9	*Pinus contorta*	lodgepole pine	Dead	Tree
39	40	1	*Betula occidentalis*	water birch	Live	Shrub
46	47	1	*Picea engelmannii*	Engelmann's spruce	Live	Tree
51	52	1	*Picea engelmannii*	Engelmann's spruce	Live	Tree
53	54	1	*Salix boothii*	Booth willow	Live	Shrub
61	70	9	*Picea engelmannii*	Engelmann's spruce	Live	Tree
72	73	1	*Salix planifolia*	diamond-leaf willow	Live	Shrub
75	76	1	*Salix boothii*	Booth willow	Live	Shrub
76	78	2	*Salix planifolia*	diamond-leaf willow	Live	Shrub
79	80	1	*Salix boothii*	Booth willow	Live	Shrub
86	87	1	*Salix boothii*	Booth willow	Live	Shrub
87	94	7	*Salix planifolia*	diamond-leaf willow	Live	Shrub
95	101	6	*Salix boothii*	Booth willow	Live	Shrub
103	104	1	*Salix planifolia*	diamond-leaf willow	Live	Shrub
104	108	4	*Salix bebbiana*	Bebb willow	Live	Shrub
107	116	9	*Pinus contorta*	lodgepole pine	Live	Tree
109	111	2	*Salix bebbiana*	Bebb willow	Live	Shrub
126	130	4	*Pinus contorta*	lodgepole pine	Live	Tree

[1] Starting and stopping point (in feet) of species canopy cover as it crosses the transect line.
[2] Total length (in feet) of species canopy cover as it crosses the transect line.

TABLE 22 2019 OVERSTORY VEGETATION: RAW DATA—TRANSECT 4

START[1]	STOP[1]	INTERCEPT[3]	SPECIES	COMMON NAME	LIVE/DEAD	FORM
4	10	6	*Salix planifolia*	diamond-leaf willow	Live	Shrub
8	9	1	*Salix bebbiana*	Bebb willow	Live	Shrub
14	16	2	*Salix planifolia*	diamond-leaf willow	Live	Shrub
13	15	2	*Picea engelmannii*	Engelmann's spruce	Live	Tree
17	19	2	*Salix planifolia*	diamond-leaf willow	Live	Shrub
19	21	2	*Salix boothii*	Booth willow	Live	Shrub
25	27	2	*Salix planifolia*	diamond-leaf willow	Live	Shrub
29	32	3	*Salix planifolia*	diamond-leaf willow	Live	Shrub
34	35	1	*Salix planifolia*	diamond-leaf willow	Live	Shrub
36	37	1	*Salix planifolia*	diamond-leaf willow	Live	Shrub
38	40	2	*Salix planifolia*	diamond-leaf willow	Live	Shrub
41	47	6	*Salix planifolia*	diamond-leaf willow	Live	Shrub
51	59	8	*Salix boothii*	Booth willow	Live	Shrub
56	57	1	*Salix planifolia*	diamond-leaf willow	Live	Shrub
57	60	3	*Salix boothii*	Booth willow	Live	Shrub
61	70	9	*Salix boothii*	Booth willow	Live	Shrub
71	73	2	*Salix planifolia*	diamond-leaf willow	Live	Shrub
72	75	3	*Salix boothii*	Booth willow	Live	Shrub
80	94	14	*Pinus contorta*	lodgepole pine	Live	Tree
98	99	1	*Pinus contorta*	lodgepole pine	Live	Tree

[1] Starting and stopping point (in feet) of species canopy cover as it crosses the transect line.
[2] Total length (in feet) of species canopy cover as it crosses the transect line.

APPENDIX E PHOTOS

APPENDIX E PHOTOS

PHOTO 1 2009 VIEW OF TRANSECT 1 FROM THE SOUTHERN ENDPOINT; BEARING 350 DEGREES.

pHOTO 2 2019 view of Transect 1 from the southern endpoint; bearing 350 degrees.

PHOTO 3 2009 view of Transect 1 from the Northern endpoint; bearing 170 degrees.

PHOTO 4 2019 view of Transect 1 from the Northern endpoint; bearing 170 degrees.

PHOTO 5 2009 view of Transect 2 from the southern endpoint; bearing 330 degrees.

PHOTO 6 2019 view of Transect 2 from the southern endpoint; bearing 330 degrees.

PHOTO 7 2009 VIEW OF TRANSECT 2 FROM THE NORTHERN ENDPOINT; BEARING 150 DEGREES.

PHOTO 8 2019 VIEW OF TRANSECT 2 FROM THE NORTHERN ENDPOINT; BEARING 150 DEGREES.

PHOTO 9 2009 VIEW OF TRANSECT 3 FROM THE SOUTHERN ENDPOINT; BEARING 330 DEGREES.

PHOTO 10 2019 VIEW OF TRANSECT 3 FROM THE SOUTHERN ENDPOINT; BEARING 330 DEGREES.

PHOTO 11 2009 VIEW OF TRANSECT 3 FROM THE NORTHERN ENDPOINT; BEARING 150 DEGREES.

PHOTO 12 2019 VIEW OF TRANSECT 3 FROM THE NORTHERN ENDPOINT; BEARING 150 DEGREES.

PHOTO 13 2009 VIEW OF TRANSECT 4 FROM THE SOUTHERN ENDPOINT; BEARING 334 DEGREES.

PHOTO 14 2019 VIEW OF TRANSECT 4 FROM THE SOUTHERN ENDPOINT; BEARING 334 DEGREES.

PHOTO 15 2009 VIEW OF TRANSECT 4 FROM THE NORTHERN ENDPOINT; BEARING 154 DEGREES.

PHOTO 16 2019 VIEW OF TRANSECT 4 FROM THE NORTHERN ENDPOINT; BEARING 154 DEGREES.