2016

Blackfoot-Swan Landscape Restoration Project

LANDSCAPE ASSESSMENT FOR TERRESTRIAL FOREST ECOSYSTEMS – EXECUTIVE SUMMARY

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INTRODUCTION

The Blackfoot Swan Landscape Restoration Project (BSLRP) is a restoration intitiative with the primary objective of reducing uncharacteristic wildfire risk and conserving terrestrial and aquatic biodiversity, while also considering future climate change. Primary outputs from this effort will include the identification and prioritization of forest restoration treatments at a landscape scale as a component of the Southwest Crown of the Continent (SWCC) Collaborative Forest Landscape Restoration Project (CFLRP). A terrestrial landscape assessment was conducted and the results are summarized here to provide the background and technical analysis for characterizing upland forest ecosystem diversity in the project area for both historical and current conditions, as well as to evaluate species of concern in relation to cumulative changes in ecosystem diversity. This assessment is the product of the Ecosystem Management Research Institute and does not necessarily represent U.S. Forest Service BSLRP or Forest Plan Revision Interdisciplinary Teams' analysis or review, and has not included a public input process.

CONSERVATION STRATEGY

To effectively conserve biodiversity, a conservation strategy should be selected using two criteria; 1) evidence of a strong scientific foundation to conserve biodiversity over the long-term, and 2) the ability to conduct land management such that it is compatible with the strategy. Inconsistent, partially applied, or generalized approaches to implementing the strategy may compromise or even undermine the scientific foundation, thereby reducing the likelihood of achieving the long term objectives. The U.S. Forest Service has recently updated and described its primary conservation strategy for biodiversity. This strategy and its scientific foundation are presented in the ecological sustainability objectives of the 2012 USFS Forest Planning Rule and is further supported by the 2016 USFS Ecosystem Restoration Policy. Both of these directives focus on historical ecosystem diversity as the foundation for the conservation strategy and defining restoration, as well as the basis for identifying desired restoration conditions of forests and grasslands. Future management decisions that deviate from the desired restoration conditions should be identified based on other social or economic objectives, or because achieving or maintaining historical ecosystem diversity is deemed unfeasible or unsustainable. The Ecosystem Restoration Policy stated: "Ecological restoration focuses on reestablishing the composition, structure, pattern, and ecological processes necessary to facilitate terrestrial and aquatic ecosystem sustainability, resilience, and health under current and future conditions….The desired future condition of an ecosystem should be informed by an assessment of spatial and temportal variation in ecosystem characteristics under historical disturbance processes during a specified reference period." This landscape assessment is based on the conservation strategy for ecological sustainability as described in the Forest Planning Rule and the Ecological Restoration Policy of the Forest Service. The strategy requires a sufficiently rigorous classification and analysis of ecosystem diversity at appropriate scales to identify the range of native ecosystem conditions that function as the foundation for the conservation strategy and the scientific basis for future restoration goals. The terrestrial landscape assessment emphasized developing an appropriate classification of upland forest ecosystem diversity, quantifying and characterizing the ecosystem diversity for historical conditions, comparing these conditions to current conditions to identify cumulative changes, describing historical reference conditions to aid in determining desired future conditions, and assessing the implications of changes in habitat conditions for selected terrestrial wildlife species.

ECOSYSTEM DIVERSITY ASSESSMENT

Ecoregion Classification

Developing an appropriate classification of ecosystem diversity begins at the landscape level. The SWCC CFLRP landscape was evaluated to determine the best boundaries to function in this regard and selected the section-level apply an analysis of ecosystem diversity. Figure 1 presents the final ecoregion boundaries used as the landscape-level classification for the BSLRP landscape assessment. The SWCC CFLRP project area was divided into 3 ecoregions - the Northern Rockies Ecoregion (M333C) and the Northern Rockies and Bitterroot Valley West and East Ecoregions (M332B-West and M332B-East). Separate analyses of ecosystem diversity were conducted in each of the ecogions.

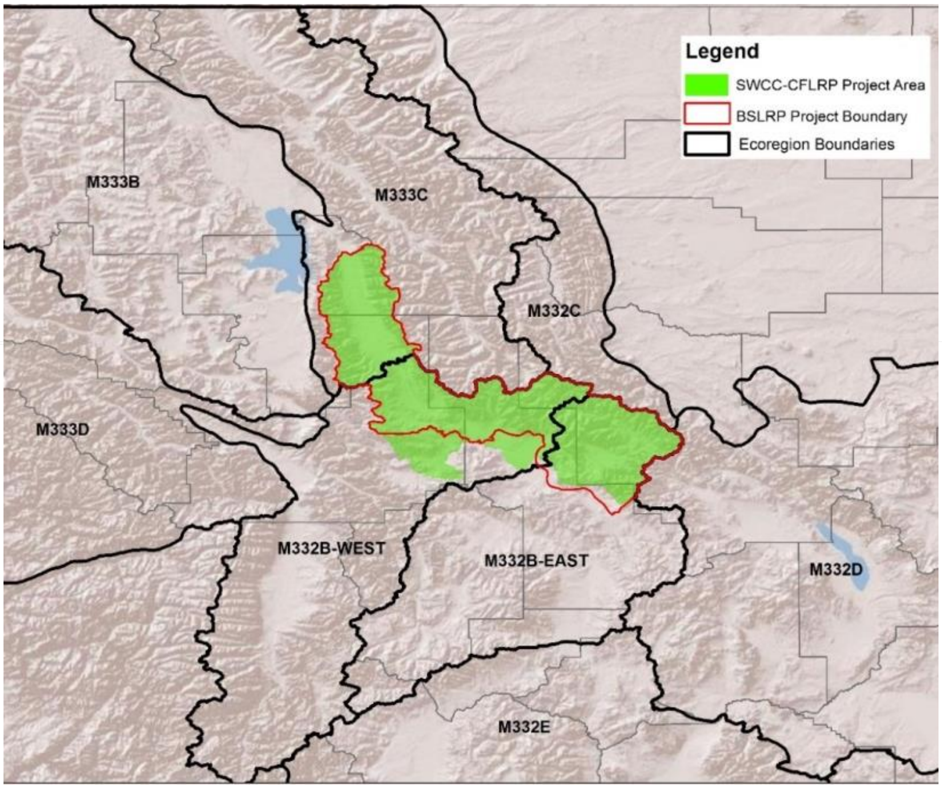


Figure 1. Map of final ecoregions (M333C, M332B-West, M332B-East) used in the landscape assessment.

Ecosystem Classification

Ecological Site - Abiotic Setting

Each ecoregion was evaluated for classification and mapping of the different abiotic settings influencing upland forest ecosystem diversity. Groupings of habitat types as used by Region 1 of the U.S. Forest Service and more generally labeled ecological sites in this landscape assessment, were identified and mapped for each of the ecoregions. Figure 2 presents the map of the 10 forest ecological sites occurring across the 3 ecoregions as well as a general typing of grass-shrub and riparian ecological sites that were not further classified into finer categories. It should be noted that the individual habitat types included within an ecological site for a specific ecoregion can differ, as each ecoregion has a unique classification of ecosystem diversity including the classification of the abiotic environment. Figure 3 presents the amounts of each ecological site occurring within each of the 3 ecoregions.

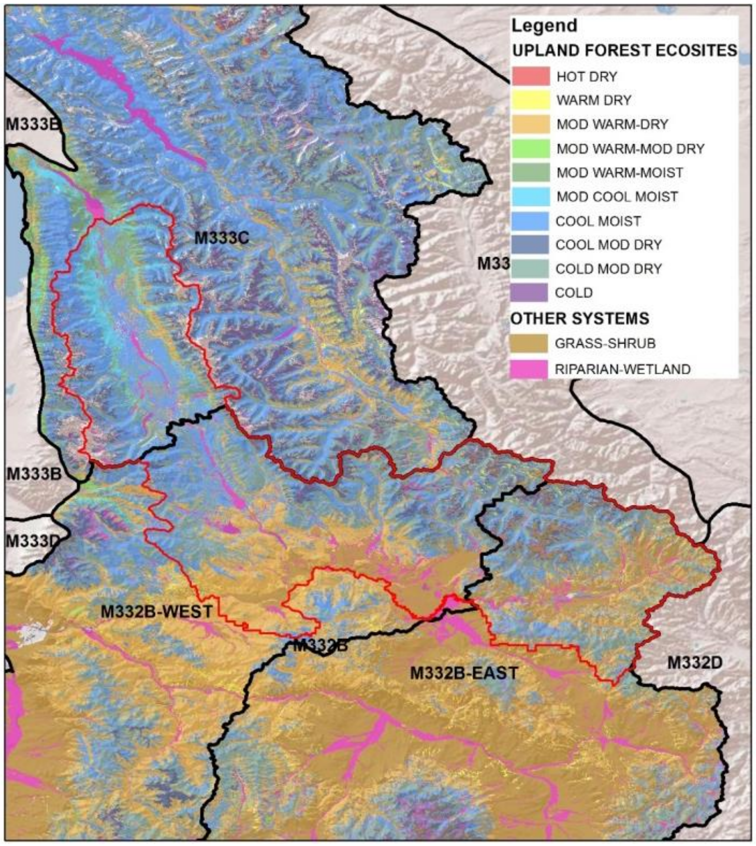


Figure 2. The distribution of 10 upland forest ecological sites as well as a single grouping each of grass-shrub and riparian-wetland ecological sites, within the project area and its delineated ecoregions.

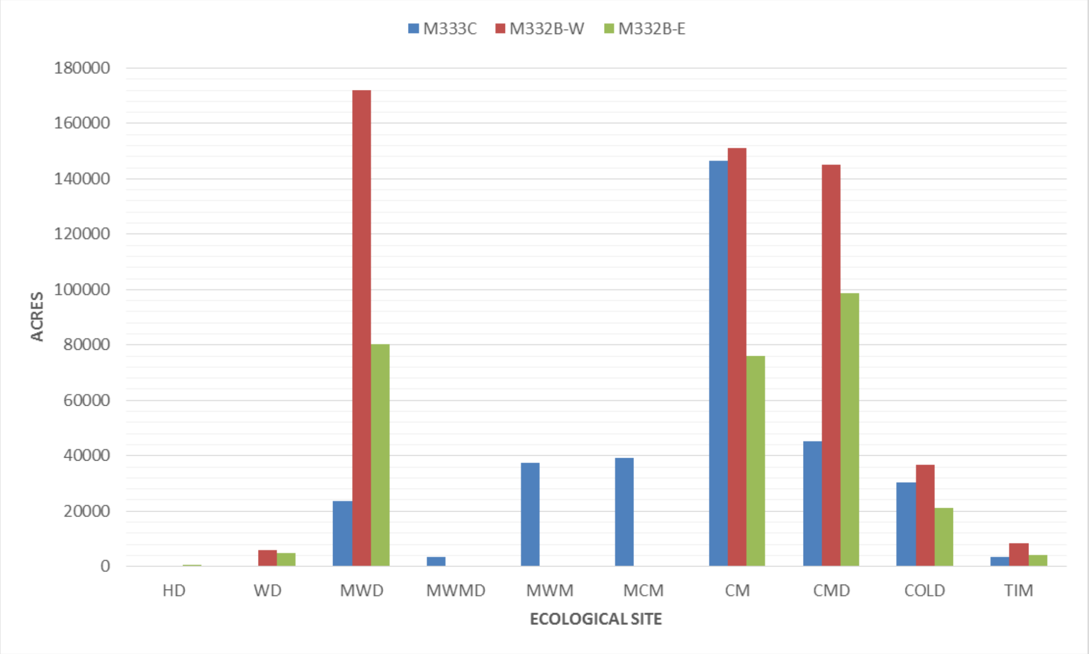


Figure 3. The distribution of ecological sites and the number of acres occurring across each of the 3 Ecoregions. HD is the hot and dry ecological site, WD is warm and dry, MWD is moderately warm and dry, MWMD is moderately warm and moderately dry, MWM is moderately warm and moist, MCM is moderately cool and moist, CM is cool and moist, CMD is cool and moderately dry, Cold is cold, and TIM is timberline.

Disturbance State

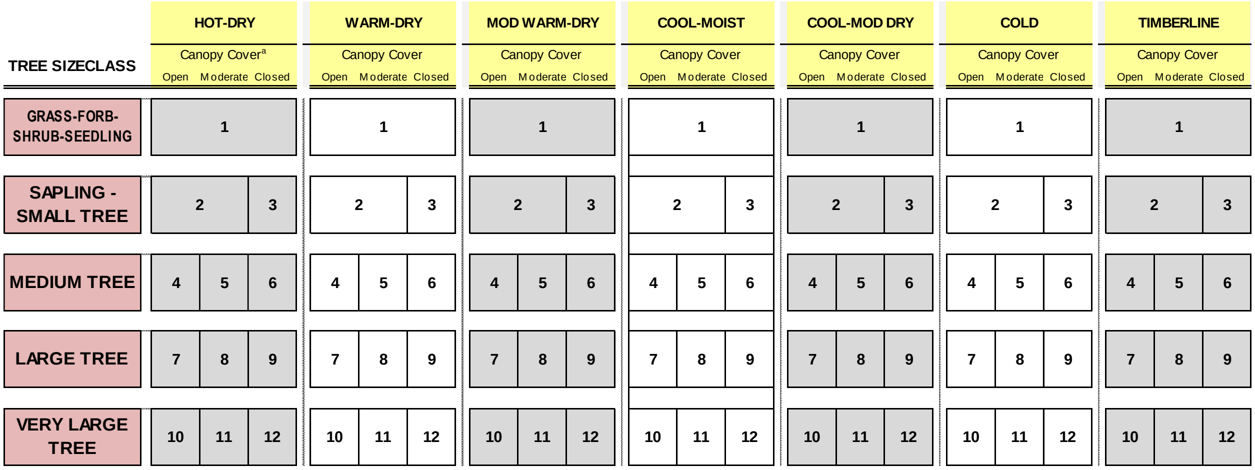
The plant community occurring at a specific location on an ecological site at any point in time is the result of successional progression, or a disruption to normal succession in response to disturbance processes. State and transition models were used to classify plant communities responding to these dynamic processes. For each ecological site, 12 possible disturbance states were identified to occur under historical conditions and at sufficient resolution to achieve the classification objectives for the conservation strategy. Each disturbance state was classified using overstory canopy cover and the presence of a sufficient number of trees in a specific diameter range or size class. Each disturbance state is considered to be an ecosystem such that we define a forest ecosystem as a grouping of similar plant communities occurring on a specific ecological site in response to successional and disturbance processes. An ecosystem is then characterized by its species composition, structure, and processes. Table 1 lists the classification criteria used to categorize ecosystem diversity (disturbance states) within each ecological site. The canopy cover classes and tree size classes were selected to conform to classification breaks currently being used by U.S. Forest Service, Region 1.

Table 1. Structural characteristics used to define successional progression, (e.g., GRASS-FORB-SHRUB-SEEDLING, SAPLING-SMALL TREE, etc.) and disturbance influences on canopy cover (e.g., OPEN, MODERATELY OPEN, CLOSED) and species composition (fire adapted vs. fire intolerant) used in the state and transition model. DS refers to disturbance state.

SIZE CLASS (BASED ON LARGEST COHORT)			Canopy Cover Class (Tree Component Only)		
			OPEN (10-39%)	MODERATELY OPEN (40-59%)	CLOSED (≥60%)
GRASS-FORB-SHRUB-SEEDLING			**DS 1**		
	DBH Range	<1.0”			
	Avg. Age	<15 yrs.			
SAPLING-SMALL TREE			**DS2**		**DS3**
	DBH Range	1.0”– 4.9”			
	Avg. Age	40 to 60 yrs.			
MEDIUM TREE			**DS4**	**DS5**	**DS6**
	DBH Range	5.0” – 14.9”			
	Avg. Age	80 to 100 yrs.			
LARGE TREE			**DS7**	**DS8**	**DS9**
	DBH Range	15.0” – 19.9”			
	Avg. Age	120 to 180 yrs.			
VERY LARGE TREE			**DS10**	**DS11**	**DS12**
	DBH Range	≥20.0”			
	Avg. Age	>200 yrs.			

Ecosystem Diversity Framework

Ecosystem diversity is classified for the purposes of this landscape assessment using the combination of ecological sites and disturbance states, and is presented in a tool termed the ecosystem diversity framework. Three separate ecosystem diversity frameworks are required to present the results of each of three ecoregions. As an example, Figure 4 represents the ecosystem diversity framework for ecoregion M332B-East.



TREE SIZECLASS	HOT-DRY			WARM-DRY			MOD WARM-DRY			COOL-MOIST			COOL-MOD DRY			COLD			TIMBERLINE		
	Canopy Cover[a]			Canopy Cover			Canopy Cover			Canopy Cover			Canopy Cover			Canopy Cover			Canopy Cover		
	Open	Moderate	Closed	Open	Moderate	Closed	Open	Moderate	Closed	Open	Moderate	Closed	Open	Moderate	Closed	Open	Moderate	Closed	Open	Moderate	Closed
GRASS-FORB-SHRUB-SEEDLING	1			1			1			1			1			1			1		
SAPLING - SMALL TREE	2		3	2		3	2		3	2		3	2		3	2		3	2		3
MEDIUM TREE	4	5	6	4	5	6	4	5	6	4	5	6	4	5	6	4	5	6	4	5	6
LARGE TREE	7	8	9	7	8	9	7	8	9	7	8	9	7	8	9	7	8	9	7	8	9
VERY LARGE TREE	10	11	12	10	11	12	10	11	12	10	11	12	10	11	12	10	11	12	10	11	12

Figure 4. An example of the upland forested ecosystem diversity framework in ecoregion M332B-East. Columns represent the 7 ecological sites occurring in this ecoregion and the “cells” represent the 12 disturbance states for each ecological site as delineated using forest structural characteristics for size class and canopy cover. All 84 ecological site x disturbance state combinations represent upland forest ecosystem diversity occurring in ecoregion M332B-East, with each cell considered an individual ecosystem.

Reference Conditions

Ecosystem Diversity

Each ecosystem in the ecosystem diversity framework was described in terms of its historical characteristics; specifically, species composition in terms of trees and understory vegetation, structure in terms of numbers of different sized live and dead trees, downed woody material, and basal area, and primary disturbance processes in terms of fire return intervals and insect and disease infestations. This information was derived from review of historical analyses of ecosystem conditions such as fire scar and stand reconstruction analyses, historical reports or observations, and historical photographs. It also included analysis of Forest Inventory Analysis (FIA) plot data, while recognizing these data are from current conditions and some variables will not apply to historical reference conditions. A database was produced to help quantify reference conditions. Table 2 provides empirical information on historical fire return intervals for the project area derived from fire analysis studies. Figures 5-7 present the dominant tree species for each ecosystem in each of the 3 ecoregions along with the distribution of tree species across ecological sites. Table 3 provides an example of ecosystem characteristics derived from plot data.

Box 1 provides an example of a description of the historical reference conditions for the very large tree, open canopy ecosystem in the moderately warm dry ecological site for the M332B-West ecoregion. Similar descriptions could be developed for all ecosystems identified for the BSLRP project area, and should be developed and used in setting desired conditions for planning specific silvicultural treatments for ecosystem restoration for specific locations in the project area.

Box 1. Example reference conditions for the moderately warm and dry ecological site - ecoregion M332B-West, to help guide restoration actions.

This ecological site occurs most commonly at low to mid-elevations and on dry southerly aspects, in particular, where it is often transitional to grass-shrub ecoystems. Soils are of moderate depth and frequently droughty, with low to moderate productivity. It is primarily influenced by the non-lethal fire regime at less than 25 year fire return intervals but is also sometimes influenced by mixed-severity fire regimes on moister inclusions of this site. Forest conditions resulting from these less severe disturbances were characterized by an open overstory (<40% canopy cover) comprised primarily of ponderosa pine but with some Douglas-fir. Very large trees (>20" dbh) were the most common size class averaging 13 trees per acre within a range of 8 to 18, but may also have included 11 large trees (15 to 20" dbh) within a range of 0 to 35. Trees were often scattered and sometimes clumpy. All age classes were present but smaller trees were low in numbers. Understory plants included antelope bitterbrush, common snowberry, snowbush ceonothus, bluebunch wheatgrass, rough fescue, arrowleaf balsamroot, common gallardia, fireweed, silky lupine, and woodland strawberry. Very large and large snags were not common averaging only 1 each per acre within a range of 0 to 7 and 0 to 18, respectively. Basal area weighted diameter averaged 19 within a range of 15 to 27.

Historical Range of Variability

Historical range of variability was modeled for terrestrial ecosystems of the BSLRP project area using the spatially explicit landscape model SIMPPLLE (SIMulating Patterns and Processes at Landscape scales). SIMPPLLE was used to simulate ecosystem dynamics as a result of primary historical disturbance events (e.g., fire, insects, and disease), climate, and spatially explicit landscape elements such as natural fire breaks. SIMPPLLE was used to simulate the interaction of historical disturbance regimes and vegetation dynamics over a 1000 year period prior to Euro-American settlement of the BSLRP area. Initial model outputs were compared to fire-scar studies conducted in or near the project area (e.g., Table 2) to help calibrate the input information and verify that the model results were consistent with empirical evidence of mean fire return intervals and forest species composition and structure. Figures 8-10 present the results of the historical ecosystem diversity from the 1000 year simulated time frame. Figures 11-13 display example maps of disturbances occurring during varying climate conditions within the 1000 year time frame, showing how amounts of fire severities and other disturbances varied with different climate patterns. Figure 14 displays the amounts of the historical fire regimes occurring on each ecological site across the 3 ecoregions.

Table 2. Mean fire interval (MFI), minimum and maximum MFI, and number of plots summarized by fire regime, ecological site, and ecoregion. Data were summarized from fire history survey data (Barrett 2013, 2012, Barrett and Jones 2001).

	FIRE REGIME		Ecological Site								
			WD	MWD	MWMD	MWM	MCM	CM	CMD	COLD	TIM
ALL ECOREGIONS	NL	MFI	11	18	17			20	26		
		MIN-MAX	(9-17)	(6-30)	-			(17-24)	(23-29)		
		#PLOTS	6	51	1			4	2		
	MSA	MFI	30	32	34	44		28	44	32	
		MIN-MAX	(26-36)	(17-45)	(28-38)	(26-60)		(14-35)	(22-66)	(28-35)	
		#PLOTS	6	24	5	6		4	27	4	
	MSB	MFI		48	86	88	78	98	91	97	180
		MIN-MAX		(40-67)	(58-123)	(40-120)	(58-128)	(47-127)	(52-224)	(55-200)	(28-275)
		#PLOTS		16	6	4	5	23	26	7	7
	L	MFI		135	150	97	221	180	193	205	150
		MIN-MAX		(135-135)	-	-	(200-260)	(97-260)	(146-222)	(146-304)	(150-150)
		#PLOTS		2	1	1	6	22	12	15	2
M333C	NL	MFI		21				20			
		MIN-MAX		(15-27)				(17-24)			
		#PLOTS		12				4			
	MSA	MFI		31	34	44		28	48		
		MIN-MAX		(26-36)	(28-38)	(26-60)		(14-35)	(35-66)		
		#PLOTS		9	5	6		4	16		
	MSB	MFI			93	56	98	77	105	78	150
		MIN-MAX			(78-123)	(40-78)	(85-128)	(47-127)	(59-224)	-	(150-150)
		#PLOTS			3	3	4	21	12	1	2
	L	MFI			150	97	221	180	185	184	150
		MIN-MAX			-	-	(200-260)	(97-260)	(146-222)	(146-222)	(150-150)
		#PLOTS			1	1	6	22	11	9	2
M332B-WEST	NL	MFI	11	16					23		
		MIN-MAX	(9-17)	(6-30)					-		
		#PLOTS	5	21					1		
	MSA	MFI		28						32	
		MIN-MAX		(25-30)						(28-35)	
		#PLOTS		3						4	
	MSB	MFI		40				120	80	117	211
		MIN-MAX		(40-40)				(120-120)	(80-80)	(55-200)	(28-275)
		#PLOTS		2				2	5	6	5
	L	MFI		135					200	226	
		MIN-MAX		-					-	(200-304)	
		#PLOTS		1					1	6	
M332B-EAST	NL	MFI	11	15					29		
		MIN-MAX	-	(7-27)					-		
		#PLOTS	1	19					1		
	MSA	MFI		37					40		
		MIN-MAX		(17-45)					(22-45)		
		#PLOTS		12					11		
	MSB	MFI		57					89		
		MIN-MAX		(44-67)					(52-151)		
		#PLOTS		14					9		
	L	MFI		135							
		MIN-MAX		-							
		#PLOTS		1							

TREE SIZECLASS	MOD WARM-DRY			MOD WARM-MOD DRY			MOD WARM-MOIST			MOD COOL-MOIST		
	Canopy Cover[a]			Canopy Cover			Canopy Cover			Canopy Cover		
	Open	Moderate	Closed	Open	Moderate	Closed	Open	Moderate	Closed	Open	Moderate	Closed
GRASS-FORB-SHRUB-SEEDLING	**DS1**			**DS 1**			**DS 1**			**DS 1**		
	PIPO[b], LAOC, PICO			LAOC, PICO, PIPO			PICO, LAOC, PICO, PIMO			PICO, LAOC, PIMO, BEPA, TSHE		
SAPLING - SMALL TREE	**DS2**		**DS3**	**DS2**		**DS3**	**DS2**		**DS3**	**DS2**		**DS3**
	PIPO LAOC PSME PICO		PIPO LAOC PSME PICO	LAOC PICO PIPO PSME		PICO PSME LAOC ABGR	PICO LAOC PSME PIMO		PICO PSME LAOC PIMO	LAOC PIMO PSME PICO		PICO PSME TSHE BEPA
MEDIUM TREE	**DS4**	**DS5**	**DS6**	**DS4**	**DS5**	**DS6**	**DS4**	**DS5**	**DS6**	**DS4**	**DS5**	**DS6**
	PIPO LAOC PSME	PIPO LAOC PSME PICO	LAOC PIPO PSME PICO	PIPO PSME LAOC	LAOC PSME PIPO PICO	PICO PSME LAOC ABGR	LAOC PIPO PSME	LAOC PSME PIMO PICO	PICO PSME LAOC PIEN	LAOC PSME	PIMO LAOC PSME PICO	PIMO LAOC PSME PIEN
LARGE TREE	**DS7**	**DS8**	**DS9**	**DS7**	**DS8**	**DS9**	**DS7**	**DS8**	**DS9**	**DS7**	**DS8**	**DS9**
	PIPO LAOC PSME	LAOC PIPO PSME	LAOC PSME PIPO	PIPO LAOC PSME	LAOC PSME PIPO PICO	LAOC ABGR PSME PICO	LAOC PIPO PSME	LAOC PSME PIPO PIMO PICO	LAOC PSME PIEN PIMO PICO	LAOC PSME	PIMO LAOC PSME PICO	PSME LAOC PIMO TSHE THPL
VERY LARGE TREE	**DS10**	**DS11**	**DS12**	**DS10**	**DS11**	**DS12**	**DS10**	**DS11**	**DS12**	**DS10**	**DS11**	**DS12**
	PIPO PSME LAOC	PIPO LAOC PSME	PIPO PSME LAOC	PIPO LAOC PSME	LAOC PSME PIPO	ABGR PSME LAOC	LAOC PIPO PSME	LAOC PSME PIPO PIMO	ABGR PSME PIMO PIEN	LAOC PSME	LAOC PSME PIMO	THPL TSHE PSME ABGR PIEN ABLA

TREE SIZECLASS	COOL-MOIST			COOL-MOD DRY			COLD			TIMBERLINE		
	Canopy Cover			Canopy Cover			Canopy Cover			Canopy Cover		
	Open	Moderate	Closed	Open	Moderate	Closed	Open	Moderate	Closed	Open	Moderate	Closed
GRASS-FORB-SHRUB-SEEDLING	**DS 1**			**DS 1**			**DS1**			**DS1**		
	PICO, LAOC, PIMO, BEPA, PIPO			PICO, LAOC, PIMO			PICO, PIAL			PIAL		
SAPLING - SMALL TREE	**DS2**		**DS3**	**DS2**		**DS3**	**DS2**		**DS3**	**DS2**		**DS3**
	LAOC PIMO PSME PIPO		PICO PSME BEPA PIMO	LAOC PSME PIMO PICO		PICO PIEN PSME PIMO	PIAL PICO PIEN		PICO PIEN	PIAL LALY PIEN		ABLA PIEN
MEDIUM TREE	**DS4**	**DS5**	**DS6**	**DS4**	**DS5**	**DS6**	**DS4**	**DS5**	**DS6**	**DS4**	**DS5**	**DS6**
	LAOC PSME PIPO	LAOC PSME PICO PIMO	LAOC PICO PSME PIMO	LAOC PSME	PICO PSME LAOC PIMO	PICO PIEN PSME PIMO	PIAL LALY	PIAL LALY PICO PIEN	PICO PIEN ABLA TSME	PIAL LALY	PIAL LALY PIEN	ABLA PIEN
LARGE TREE	**DS7**	**DS8**	**DS9**	**DS7**	**DS8**	**DS9**	**DS7**	**DS8**	**DS9**	**DS7**	**DS8**	**DS9**
	LAOC PSME PIPO	LAOC PSME PICO PIMO	LAOC PSME PIMO PIEN PIEN	LAOC PSME	LAOC PSME PICO PIMO	PSME PIEN PICO PIMO ABLA	PIAL LALY	PIAL LALY PICO PIEN	PIEN ABLA TSME PICO	PIAL LALY	PIAL LALY PIEN	ABLA PIEN
VERY LARGE TREE	**DS10**	**DS11**	**DS12**	**DS10**	**DS11**	**DS12**	**DS10**	**DS11**	**DS12**	**DS10**	**DS11**	**DS12**
	LAOC PSME PIPO	LAOC PSME PIMO	ABLA PSME PIMO ABGR PIEN	LAOC PSME	LAOC PSME PIMO	ABLA PIEN PSME PIMO	PIAL LALY	PIAL LALY PIEN	ABLA PIEN TSME	PIAL LALY	PIAL LALY PIEN	ABLA PIEN

[a] OPEN = 10-39% canopy cover
MODERATE = >40-59% canopy
CLOSED = >60% canopy cover

[b] PIPO = *Pinus ponderosa*
PSME = *Psuedotsuga menziesii*
LAOC = *Larix occidentalis*
PICO = *Pinus contorta*
PIEN = *Picea engelmannii*
PIMO = *Pinus monticola*
ABGR = *Abies grandis*
ABLA = *Abies lasiocarpa*
TSHE = *Tsuga heterophylla*
LALY = *Larix lyallii*
PIAL = *Pinus albicaulis*
TSME= *Tsuga mertensia*
BEPA = *Betula papyrifera*

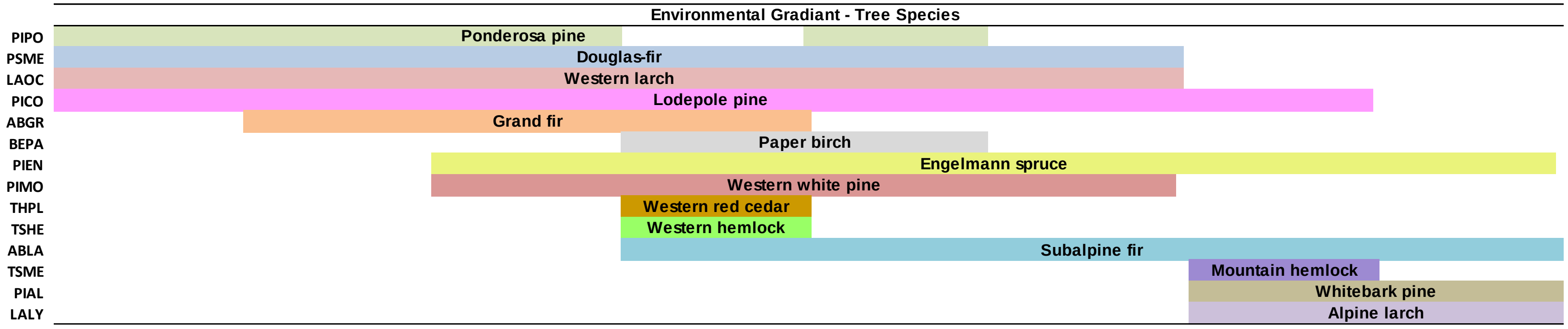
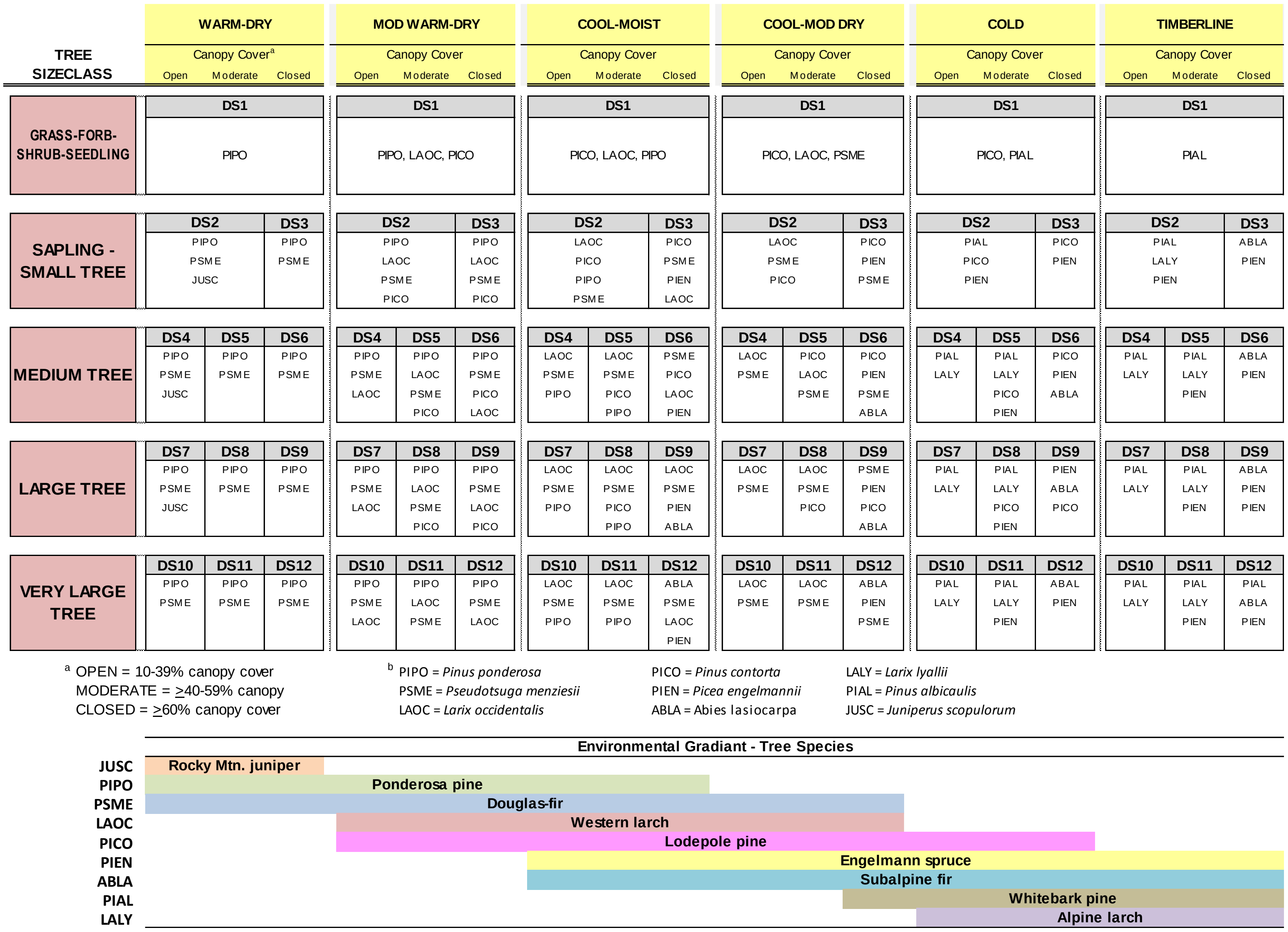


Figure 5. Dominant tree species for each ecosystem and their historical distribution across the ecosystem diversity framework for ecoregion M333C.

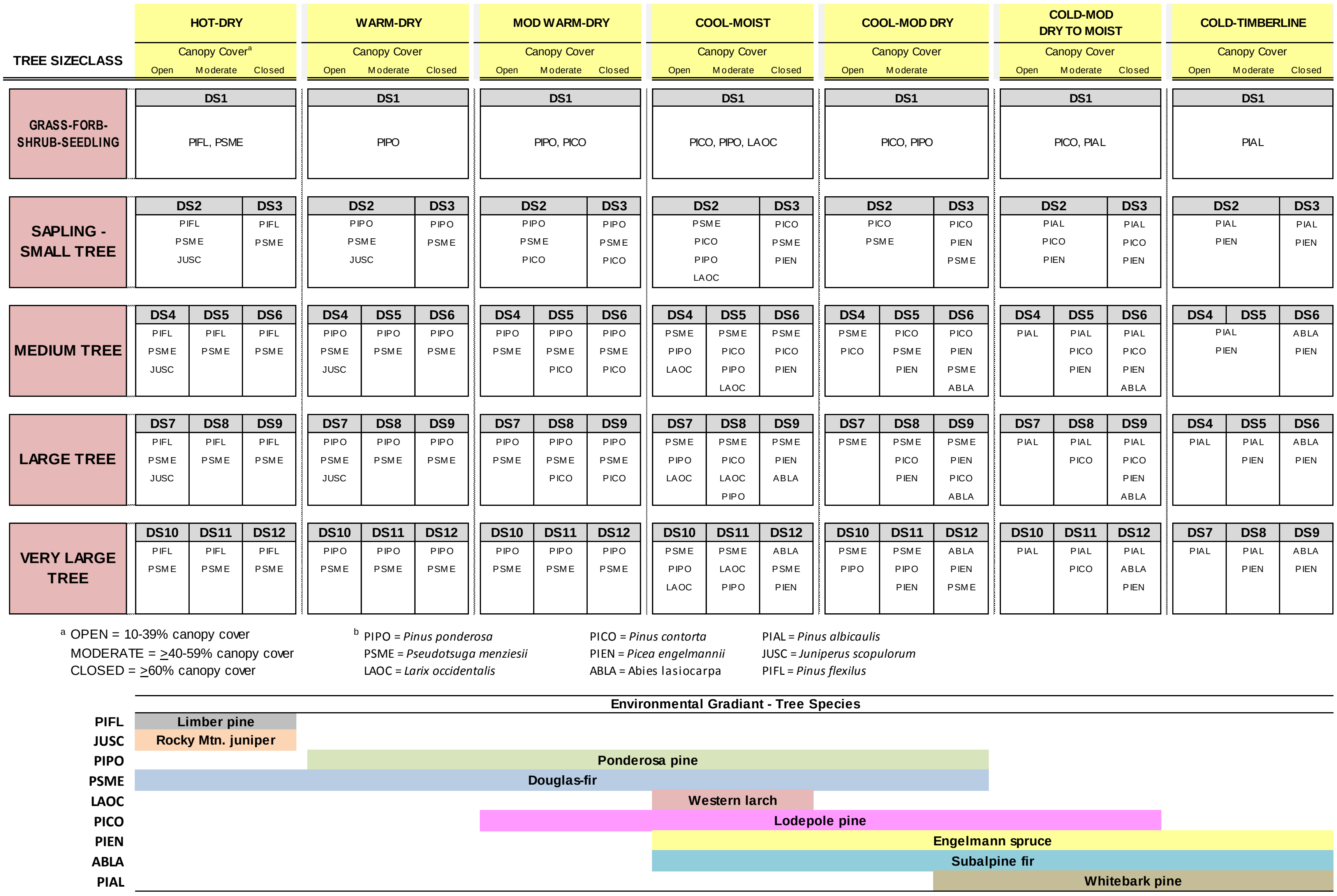


TREE SIZECLASS	WARM-DRY	MOD WARM-DRY	COOL-MOIST	COOL-MOD DRY	COLD	TIMBERLINE
	Canopy Cover[a] Open Moderate Closed	Canopy Cover Open Moderate Closed	Canopy Cover Open Moderate Closed	Canopy Cover Open Moderate Closed	Canopy Cover Open Moderate Closed	Canopy Cover Open Moderate Closed
GRASS-FORB-SHRUB-SEEDLING	DS1: PIPO	DS1: PIPO, LAOC, PICO	DS1: PICO, LAOC, PIPO	DS1: PICO, LAOC, PSME	DS1: PICO, PIAL	DS1: PIAL
SAPLING - SMALL TREE	DS2: PIPO, PSME, JUSC DS3: PIPO, PSME	DS2: PIPO, LAOC, PSME, PICO DS3: PIPO, LAOC, PSME, PICO	DS2: LAOC, PICO, PIPO, PSME DS3: PICO, PSME, PIEN, LAOC	DS2: LAOC, PSME, PICO DS3: PICO, PIEN, PSME	DS2: PIAL, PICO, PIEN DS3: PICO, PIEN	DS2: PIAL, LALY, PIEN DS3: ABLA, PIEN
MEDIUM TREE	DS4: PIPO, PSME, JUSC DS5: PIPO, PSME DS6: PIPO, PSME	DS4: PIPO, PSME, LAOC DS5: PIPO, LAOC, PSME, PICO DS6: PIPO, PSME, PICO, LAOC	DS4: LAOC, PSME, PIPO DS5: LAOC, PSME, PICO, PIPO DS6: PSME, PICO, LAOC, PIEN	DS4: LAOC, PSME DS5: PICO, LAOC, PSME DS6: PICO, PIEN, PSME, ABLA	DS4: PIAL, LALY DS5: PIAL, LALY, PICO, PIEN DS6: PICO, PIEN, ABLA	DS4: PIAL, LALY DS5: PIAL, LALY, PIEN DS6: ABLA, PIEN
LARGE TREE	DS7: PIPO, PSME, JUSC DS8: PIPO, PSME DS9: PIPO, PSME	DS7: PIPO, PSME, LAOC DS8: PIPO, LAOC, PSME, PICO DS9: PIPO, PSME, LAOC, PICO	DS7: LAOC, PSME, PIPO DS8: LAOC, PSME, PICO, PIPO DS9: LAOC, PSME, PIEN, ABLA	DS7: LAOC, PSME DS8: LAOC, PSME, PICO DS9: PSME, PIEN, PICO, ABLA	DS7: PIAL, LALY DS8: PIAL, LALY, PICO, PIEN DS9: PIEN, ABLA, PICO	DS7: PIAL, LALY DS8: PIAL, LALY, PIEN DS9: ABLA, PIEN, PIEN
VERY LARGE TREE	DS10: PIPO, PSME DS11: PIPO, PSME DS12: PIPO, PSME	DS10: PIPO, PSME, LAOC DS11: PIPO, LAOC, PSME DS12: PIPO, PSME, LAOC	DS10: LAOC, PSME, PIPO DS11: LAOC, PSME, PIPO DS12: ABLA, PSME, LAOC, PIEN	DS10: LAOC, PSME DS11: LAOC, PSME DS12: ABLA, PIEN, PSME	DS10: PIAL, LALY DS11: PIAL, LALY, PIEN DS12: ABAL, PIEN	DS10: PIAL, LALY DS11: PIAL, LALY, PIEN DS12: PIAL, ABLA, PIEN

[a] OPEN = 10-39% canopy cover
MODERATE = >40-59% canopy
CLOSED = >60% canopy cover

[b] PIPO = *Pinus ponderosa*
PSME = *Pseudotsuga menziesii*
LAOC = *Larix occidentalis*
PICO = *Pinus contorta*
PIEN = *Picea engelmannii*
ABLA = Abies lasiocarpa
LALY = *Larix lyallii*
PIAL = *Pinus albicaulis*
JUSC = *Juniperus scopulorum*

Figure 6. Dominant tree species for each ecosystem along with their historical distribution across the ecosystem diversity framework for ecoregion M332B-West.



TREE SIZECLASS	HOT-DRY	WARM-DRY	MOD WARM-DRY	COOL-MOIST	COOL-MOD DRY	COLD-MOD DRY TO MOIST	COLD-TIMBERLINE
	Canopy Cover[a] Open Moderate Closed	Canopy Cover Open Moderate Closed	Canopy Cover Open Moderate Closed	Canopy Cover Open Moderate Closed	Canopy Cover Open Moderate	Canopy Cover Open Moderate Closed	Canopy Cover Open Moderate Closed
GRASS-FORB-SHRUB-SEEDLING	DS1: PIFL, PSME	DS1: PIPO	DS1: PIPO, PICO	DS1: PICO, PIPO, LAOC	DS1: PICO, PIPO	DS1: PICO, PIAL	DS1: PIAL
SAPLING - SMALL TREE	DS2: PIFL, PSME, JUSC DS3: PIFL, PSME	DS2: PIPO, PSME, JUSC DS3: PIPO, PSME	DS2: PIPO, PSME, PICO DS3: PIPO, PSME, PICO	DS2: PSME, PICO, PIPO, LAOC DS3: PICO, PSME, PIEN	DS2: PICO, PSME DS3: PICO, PIEN, PSME	DS2: PIAL, PICO, PIEN DS3: PIAL, PICO, PIEN	DS2: PIAL, PIEN DS3: PIAL, PIEN
MEDIUM TREE	DS4: PIFL, PSME, JUSC DS5: PIFL, PSME DS6: PIFL, PSME	DS4: PIPO, PSME, JUSC DS5: PIPO, PSME DS6: PIPO, PSME	DS4: PIPO, PSME DS5: PIPO, PSME, PICO DS6: PIPO, PSME, PICO	DS4: PSME, PIPO, LAOC DS5: PSME, PICO, PIPO, LAOC DS6: PSME, PICO, PIEN	DS4: PSME, PICO DS5: PICO, PSME, PIEN DS6: PICO, PIEN, PSME, ABLA	DS4: PIAL DS5: PIAL, PICO, PIEN DS6: PIAL, PICO, PIEN, ABLA	DS4, DS5: PIAL, PIEN DS6: ABLA, PIEN
LARGE TREE	DS7: PIFL, PSME, JUSC DS8: PIFL, PSME DS9: PIFL, PSME	DS7: PIPO, PSME, JUSC DS8: PIPO, PSME DS9: PIPO, PSME	DS7: PIPO, PSME DS8: PIPO, PSME, PICO DS9: PIPO, PSME, PICO	DS7: PSME, PIPO, LAOC DS8: PSME, PICO, LAOC, PIPO DS9: PSME, PIEN, ABLA	DS7: PSME DS8: PSME, PICO, PIEN DS9: PSME, PIEN, PICO, ABLA	DS7: PIAL DS8: PIAL, PICO DS9: PIAL, PICO, PIEN, ABLA	DS4: PIAL DS5: PIAL, PIEN DS6: ABLA, PIEN
VERY LARGE TREE	DS10: PIFL, PSME DS11: PIFL, PSME DS12: PIFL, PSME	DS10: PIPO, PSME DS11: PIPO, PSME DS12: PIPO, PSME	DS10: PIPO, PSME DS11: PIPO, PSME DS12: PIPO, PSME	DS10: PSME, PIPO, LAOC DS11: PSME, LAOC, PIPO DS12: ABLA, PSME, PIEN	DS10: PSME, PIPO DS11: PSME, PIPO, PIEN DS12: ABLA, PIEN, PSME	DS10: PIAL DS11: PIAL, PICO DS12: PIAL, ABLA, PIEN	DS7: PIAL DS8: PIAL, PIEN DS9: ABLA, PIEN

[a] OPEN = 10-39% canopy cover
MODERATE = ≥40-59% canopy cover
CLOSED = ≥60% canopy cover

[b] PIPO = *Pinus ponderosa*
PSME = *Pseudotsuga menziesii*
LAOC = *Larix occidentalis*
PICO = *Pinus contorta*
PIEN = *Picea engelmannii*
ABLA = Abies lasiocarpa
PIAL = *Pinus albicaulis*
JUSC = *Juniperus scopulorum*
PIFL = *Pinus flexilus*

Figure 7. Dominant tree species for each ecosystem along with their historical distribution across the ecosystem diversity framework for ecoregion M332-East.

Table 3. Example reference conditions listing live trees by size class for the moderately warm and dry ecological site for the M332B-West ecoregion. Red values represent numbers from current conditions that are not expected to have occurred historically.

SIZE-CLASS	DBH RANGE	OPEN (<40% Canopy Cover)		MODERATE (40-60% Canopy Cover)		CLOSED (>60% Canopy Cover)	
GRASS-FORB-SHRUB-SEEDLING		DS1					
		AVG (MIN-MAX)	#PLOTS				
	<1.0"	229 (0 - 1199)	7				
	1.0-4.9"	0 (0 - 0)					
	5.0-14.9"	5 (0 - 12)					
	15.0-19.9"	1 (0 - 3)					
	20.0+"	1 (0 - 3)					
SAPLING/ SMALL		DS2				DS3	
		AVG (MIN-MAX)	#PLOTS			AVG (MIN-MAX)	#PLOTS
	<1.0"	915 (75 - 1860)	4			NA	0
	1.0-4.9"	247 (75 - 540)					
	5.0-14.9"	3 (0 - 6)					
	15.0-19.9"	1 (0 - 5)					
	20.0+"	2 (0 - 6)					
MEDIUM		DS4		DS5		DS6	
		AVG (MIN-MAX)	#PLOTS	AVG (MIN-MAX)	#PLOTS	AVG (MIN-MAX)	#PLOTS
	<1.0"	433 (0 - 5772)	89	680 (0 - 5847)	25	220 (0 - 1260)	15
	1.0-4.9"	121 (0 - 900)		306 (0 - 1140)		838 (180 - 4100)	
	5.0-14.9"	80 (12 - 252)		198 (102 - 371)		399 (238 - 638)	
	15.0-19.9"	2 (0 - 9)		3 (0 - 9)		2 (0 - 8)	
	20.0+"	0 (0 - 6)		1 (0 - 4)		0 (0 - 5)	
LARGE		DS7		DS8		DS9	
	<1.0"	659 (0 - 5940)	46	845 (0 - 9820)	30	733 (0 - 4920)	14
	1.0-4.9"	51 (0 - 500)		143 (0 - 750)		206 (0 - 600)	
	5.0-14.9"	52 (0 - 120)		146 (60 - 271)		270 (60 - 527)	
	15.0-19.9"	14 (4 - 24)		22 (6 - 38)		24 (10 - 78)	
	20.0+"	3 (0 - 7)		2 (0 - 7)		2 (0 - 7)	
VERY LARGE		DS10		DS11		DS12	
	<1.0"	236 (0 - 2100)	22	417 (0 - 3420)	20	660 (0 - 2100)	6
	1.0-4.9"	64 (0 - 420)		86 (0 - 540)		309 (0 - 840)	
	5.0-14.9"	33 (0 - 84)		73 (12 - 189)		115 (37 - 205)	
	15.0-19.9"	11 (0 - 35)		18 (0 - 43)		39 (14 - 62)	
	20.0+"	13 (8 - 18)		16 (9 - 25)		17 (9 - 28)	

TREE SIZECLASS		MOD WARM-DRY Canopy Cover[a] Open Moderate Closed	MOD WARM-MOD DRY Canopy Cover Open Moderate Closed	MOD WARM-MOIST Canopy Cover Open Moderate Closed	MOD COOL-MOIST Canopy Cover Open Moderate Closed	COOL-MOIST Canopy Cover Open Moderate Closed	COOL-MOD DRY Canopy Cover Open Moderate Closed	COLD Canopy Cover Open Moderate Closed	TIMBERLINE Canopy Cover Open Moderate Closed
GRASS-FORB-SHRUB-SEEDLING (<1.0" DBH)	DS1	0.3 (0-0.7)	2.1 (1.1-3.1)	2.7 (1.5-3.8)	1.9 (1.1-2.7)	16.7 (13.8-19.7)	13.4 (11.1-15.7)	3.9 (3.3-4.5)	4.6 (3.8-5.5)
SAPLING-SMALL (1.0"-4.9" DBH)	DS2	0.5 (0.1-0.9)	1.5 (0.6-2.3)	1.8 (0.8-2.7)	1.2 (0.6-1.9)	11.3 (8.9-13.8)	9.0 (7.1-10.9)	3.1 (2.5-3.7)	3.8 (2.9-4.8)
	DS3	0.0 (0-0)	0.1 (0-0.1)	0.1 (0-0.3)	0.1 (0-0.3)	0.9 (0.4-1.4)	0.6 (0.3-1)	0.0 (0-0)	0.0 (0-0)
MEDIUM (5.0"-14.9" DBH)	DS4	0.5 (0.1-0.9)	0.9 (0.4-1.4)	1.0 (0.4-1.6)	0.7 (0.3-1.1)	5.4 (4.1-6.8)	4.6 (3.5-5.7)	3.8 (3.1-4.5)	5.2 (4.1-6.3)
	DS5	0.1 (0-0.2)	0.9 (0.4-1.5)	1.2 (0.6-1.8)	0.8 (0.4-1.2)	6.6 (5.1-8.1)	5.1 (3.9-6.3)	2.4 (1.9-2.8)	2.7 (2-3.4)
	DS6	0.0 (0-0)	0.3 (0.1-0.5)	0.5 (0.3-0.7)	0.4 (0.2-0.6)	3.5 (2.3-4.6)	2.6 (17-10)	0.5 (0.4-0.7)	0.3 (0.2-0.5)
LARGE (15.0"-19.9" DBH)	DS7	0.6 (0.2-1)	1.3 (0.5-2.1)	1.4 (0.6-2.2)	1.2 (0.6-1.7)	4.9 (3.3-6.6)	8.4 (6.8-10)	31.0 (27-35)	29.5 (26-33)
	DS8	0.1 (0.1-0.2)	0.6 (0.4-0.9)	0.9 (0.6-1.3)	0.9 (0.7-1.2)	4.9 (4-5.9)	7.1 (6.2-8.1)	27.0 (25-30)	23.1 (21-25)
	DS9	0.0 (0-0)	0.2 (0.1-0.3)	0.4 (0.2-0.6)	0.6 (0.4-0.8)	3.4 (2.3-4.5)	4.0 (3.1-5)	11.8 (9.5-14)	9.8 (8.2-11.5)
VERY LARGE (≥20.0" DBH)	DS10	70.4 (65-76)	38.5 (33-44)	35.0 (29-41)	32.1 (26-38)	14.9 (12-18)	22.2 (19-25)	10.0 (8-12)	11.7 (10-14)
	DS11	24.7 (20-29)	33.5 (29-38)	32.4 (28-37)	33.9 (30-38)	14.3 (12-17)	15.0 (13-17)	4.1 (3-6)	5.1 (4-7)
	DS12	2.6 (1-4)	20.1 (15-25)	22.6 (17-28)	26.2 (20-32)	13.1 (10-16)	8.0 (6-10)	2.4 (1-3)	4.0 (3-5)
ACRES		23,609	3,404	37,270	39,153	146,600	45,242	30,277	3,275

[a] Open = 10-39%, Moderate = 40-60%, Closed = >60%

Figure 8. M333C Ecoregion - historical range of variability for ecosystem diversity. Numbers represent the mean percentage of each disturbance state by ecological site. Numbers in parenthesis represent the 95% confidence interval around the mean.

TREE SIZECLASS	WARM-DRY			MOD WARM-DRY			COOL-MOIST			COOL-MOD DRY			COLD			TIMBERLINE		
	Canopy Cover[a]			Canopy Cover			Canopy Cover			Canopy Cover			Canopy Cover			Canopy Cover		
	Open	Moderate	Closed	Open	Moderate	Closed	Open	Moderate	Closed	Open	Moderate	Closed	Open	Moderate	Closed	Open	Moderate	Closed
GRASS-FORB-SHRUB-SEEDLING (<1.0" DBH)	**DS1**			**DS1**			**DS1**			**DS1**			**DS1**			**DS1**		
	0.2 (0.1-0.3)			**0.2** (0-0.3)			**15.3** (12.7-17.9)			**17.6** (14.8-20.3)			**5.1** (4.3-5.9)			**8.1** (6.8-9.4)		
SAPLING-SMALL (1.0"-4.9" DBH)	**DS2**		**DS3**	**DS2**		**DS3**	**DS2**		**DS3**	**DS2**		**DS3**	**DS2**		**DS3**	**DS2**		**DS3**
	0.2 (0.1-0.3)		**0.0** (0-0)	**0.3** (0.1-0.4)		**0.0** (0-0)	**10.6** (8.5-12.8)		**0.7** (0.3-1.1)	**12.2** (9.9-14.5)		**0.9** (0.4-1.3)	**4.0** (3.2-4.8)		**0.0** (0-0)	**6.1** (4.9-7.3)		**0.0** (0-0)
MEDIUM (5.0"-14.9" DBH)	**DS4**	**DS5**	**DS6**	**DS4**	**DS5**	**DS6**	**DS4**	**DS5**	**DS6**	**DS4**	**DS5**	**DS6**	**DS4**	**DS5**	**DS6**	**DS4**	**DS5**	**DS6**
	0.3 (0.2-0.4)	**0.1** (0.1-0.2)	**0.0** (0-0)	**0.3** (0.2-0.5)	**0.1** (0.1-0.2)	**0.0** (0-0)	**5.5** (4.2-6.8)	**6.1** (4.6-7.6)	**2.5** (1.7-3.4)	**6.0** (4.7-7.4)	**6.8** (0-8.4)	**3.3** (2.3-4.3)	**5.0** (4.1-6)	**3.1** (2.4-3.7)	**0.7** (0.5-0.9)	**6.5** (5.4-7.6)	**5.1** (4.2-6)	**1.7** (1.2-2.1)
LARGE (15.0"-19.9" DBH)	**DS7**	**DS8**	**DS9**	**DS7**	**DS8**	**DS9**	**DS7**	**DS8**	**DS9**	**DS7**	**DS8**	**DS9**	**DS7**	**DS8**	**DS9**	**DS7**	**DS8**	**DS9**
	0.3 (0.2-0)	**0.1** (0-0.1)	**0.0** (0-0)	**0.4** (0.2-0.6)	**0.1** (0.1-0.2)	**0.0** (0-0)	**4.9** (3.3-6.4)	**4.5** (3.7-5.3)	**3.1** (2-4.2)	**5.7** (4.2-7.2)	**5.7** (4.8-6.6)	**3.0** (2-3.9)	**31.7** (28-36)	**23.9** (21-26)	**7.9** (6.2-9.6)	**26.8** (23-30)	**22.2** (20-24)	**8.6** (7-10)
VERY LARGE (≥20.0" DBH)	**DS10**	**DS11**	**DS12**	**DS10**	**DS11**	**DS12**	**DS10**	**DS11**	**DS12**	**DS10**	**DS11**	**DS12**	**DS10**	**DS11**	**DS12**	**DS10**	**DS11**	**DS12**
	77.0 (73-81)	**20.3** (17-24)	**1.5** (1-2)	**76.5** (72-80)	**19.6** (16-23)	**2.4** (2-3)	**18.3** (15-22)	**15.8** (13-18)	**12.6** (9-16)	**13.9** (11-17)	**12.7** (11-15)	**12.3** (9-15)	**12.1** (10-15)	**4.9** (3-7)	**1.6** (1-2)	**9.2** (7-11)	**4.0** (3-5)	**1.7** (1-2)
ACRES	**6,047**			**172,079**			**151,228**			**144,974**			**36,736**			**8,467**		

[a] Open = 10-39%, Moderate = 40-60%, Closed = >60%

Figure 9. M332B-WEST Ecoregion - historical range of variability for upland forest ecosystem diversity. Numbers represent the mean percentage of each disturbance state by ecological site. Numbers in parenthesis represent the 95% confidence interval around the mean.

TREE SIZECLASS		HOT-DRY Canopy Cover[a] Open Moderate Closed	WARM-DRY Canopy Cover Open Moderate Closed	MOD WARM-DRY Canopy Cover Open Moderate Closed	COOL-MOIST Canopy Cover Open Moderate Closed	COOL-MOD DRY Canopy Cover Open Moderate Closed	COLD Canopy Cover Open Moderate Closed	TIMBERLINE Canopy Cover Open Moderate Closed
GRASS-FORB-SHRUB-SEEDLING (<1.0" DBH)	DS1	**0.1** (0-0.2)	**0.0** (0-0.1)	**0.2** (0-0.3)	**13.6** (10.7-16.5)	**19.7** (16.4-23)	**6.6** (3.4-5.8)	**6.8** (5.4-8.1)
SAPLING-SMALL (1.0"-4.9" DBH)	DS2	**0.0** (0-0)	**0.0** (0-0)	**0.3** (0.1-0.4)	**9.2** (6.8-11.7)	**10.5** (7.9-13.2)	**4.6** (3.4-5.8)	**4.8** (3.6-6)
	DS3	**0.0** (0-0)	**0.0** (0-0)	**0.0** (0-0)	**0.4** (0.1-0.6)	**0.8** (0.3-14)	**0.0** (0-0)	**0.0** (0-0)
MEDIUM (5.0"-14.9" DBH)	DS4	**0.0** (0-0)	**0.0** (0.02-0.07)	**0.4** (0.2-0.5)	**5.9** (4.2-7.6)	**6.1** (4.5-7.7)	**5.9** (4.7-7)	**6.1** (5-7.2)
	DS5	**0.0** (0-0)	**0.0** (0-0.01)	**0.1** (0-0.1)	**4.0** (2.6-5.5)	**4.9** (3.6-6.2)	**3.3** (2.4-4.1)	**3.3** (2.4-4.1)
	DS6	**0.0** (0-0)	**0.0** (0-0)	**0.0** (0-0)	**1.9** (1.1-2.7)	**2.8** (1.8-3.8)	**0.7** (0.4-1)	**0.6** (0.3-0.9)
LARGE (15.0"-19.9" DBH)	DS7	**62.6** (56-70)	**0.0** (0-0.1)	**0.3** (0.1-0.5)	**5.2** (3.5-7)	**6.5** (4.7-8.3)	**38.4** (33.9-42.9)	**38.0** (34-42)
	DS8	**36.8** (30-44)	**0.0** (0-0)	**0.0** (0-0.1)	**2.9** (2.1-3.6)	**3.6** (2.7-4.5)	**16.8** (13.9-19.7)	**16.0** (13-19)
	DS9	**0.3** (0.2-0.5)	**0.0** (0-0)	**0.0** (0-0)	**2.1** (1.1-3)	**1.9** (1.1-2.6)	**4.0** (2.7-5.3)	**4.0** (2.9-5.1)
VERY LARGE (≥20.0" DBH)	DS10	**0.0** (0-0)	**91.8** (90-94)	**83.4** (79-87)	**30.7** (26-35)	**20.8** (17-24)	**13.9** (11-17)	**15.1** (12-18)
	DS11	**0.0** (0-0)	**7.8** (6-10)	**13.7** (10-17)	**14.7** (12-18)	**12.6** (10-15)	**4.3** (3-6)	**4.1** (2-6)
	DS12	**0.1** (0-0)	**0.3** (0.1-0.4)	**1.7** (1-2)	**9.3** (6-13)	**9.8** (7-13)	**1.6** (1-2)	**1.3** (1-2)
ACRES		**668**	**4,919**	**80,110**	**75,932**	**98,562**	**21,025**	**4,157**

[a] Open = 10-39%, Moderate = 40-60%, Closed = >60%

Figure 10. M332B-EAST Ecoregion - historical range of variability for ecosystem diversity. Numbers represent the mean percentage of each disturbance state by ecological site. Numbers in parenthesis represent the 95% confidence interval around the mean.

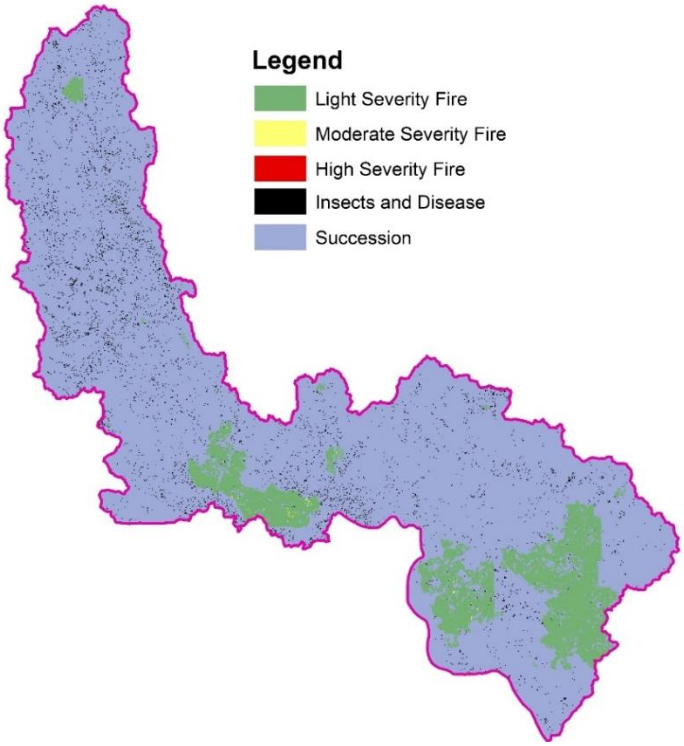


Figure 11. Disturbance processes mapped in SIMPPLLE for a decadal time step occurring during a cool and moist climatic period during the 1000 year simulation for the BSLRP project area.

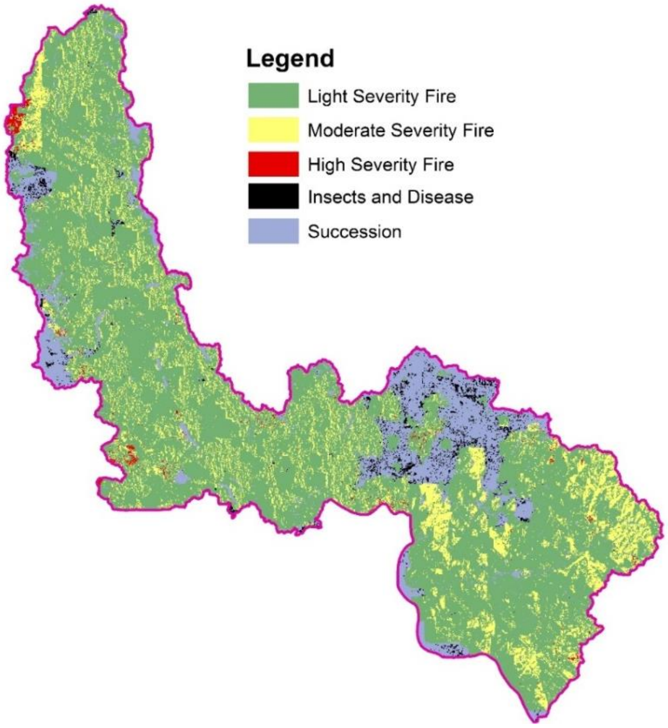


Figure 12. Disturbances processes mapped in SIMPPLLE for a decadal time step occurring during a normal or average climatic period during the 1000 year simulation for the BSLRP project area.

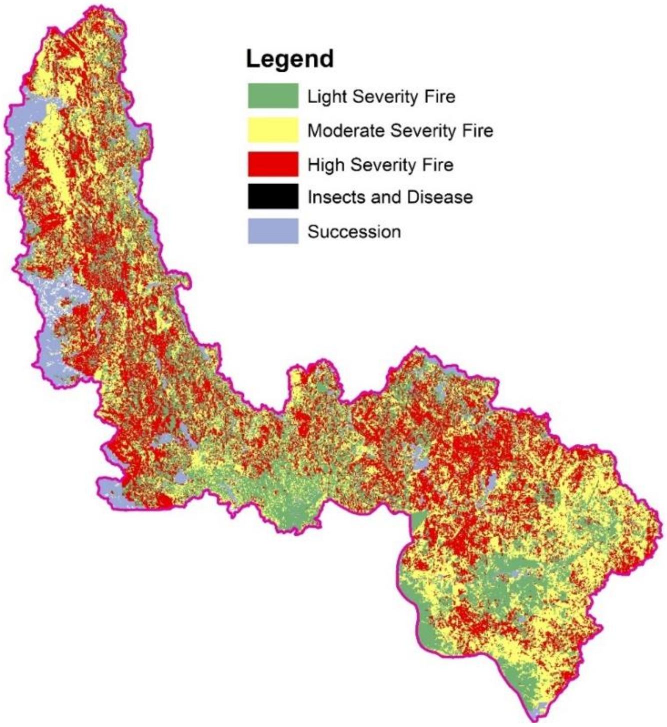


Figure 13. Disturbance processes mapped in SIMPPLLE for a decadal time step occurring during a warm and dry climatic period during the 1000 year simulation for the BSLRP project area.

Current Conditions and Cumulative Changes

Current ecosystem diversity was identified based on the map of ecological sites and a map of current stand conditions developed by the BSLRP team from the U.S. Forest Service, Region 1, using the existing VMAP classification based on remotely-sensed satellite imagery. Figures 15-17 presents the cumulative changes in ecosystem diversity determined by comparing the mean amount of each ecosystem occurring over the 1000 year historical simulation to current conditions. Figure 18 presents the overall changes in canopy cover between historical ecosystem diversity and current conditions. Figure 19 presents a comparison of historical fire regimes to the fire regimes resulting from ecosystem conditions occurring in the project area today.

Direct conversions of forest ecosystems to other land uses has not been a major factor within the BSLRP project area, impacting only about 1% of forest acres. However, significant cumulative changes have occurred to forest ecosystem diversity from other human activities including fire exclusion practices, logging activity, and introduction of exotic insects, diseases, and plants. Currently, forest ecosystems are for the most part no longer influenced by the non-lethal fire regime and the extent and distribution of

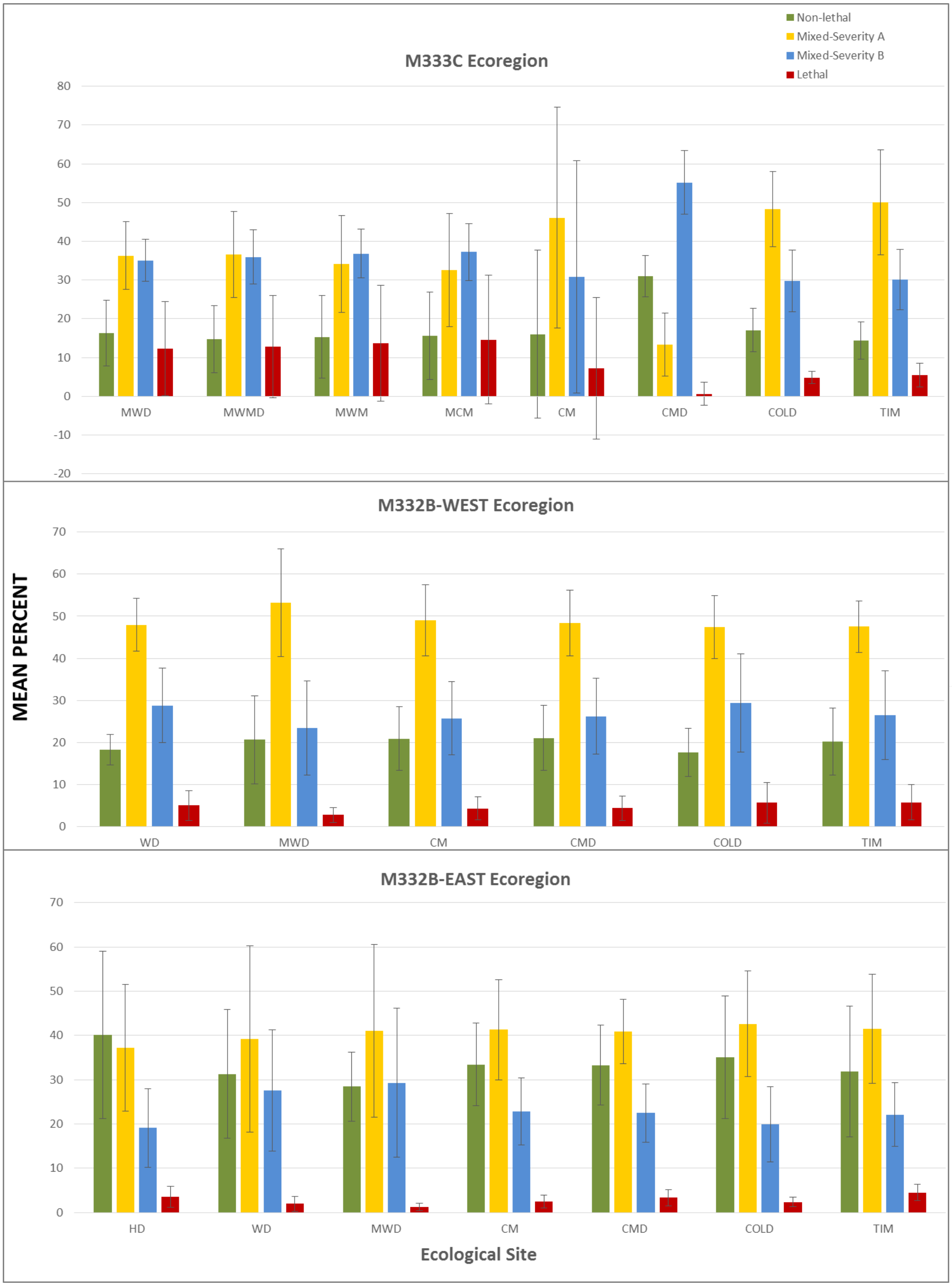
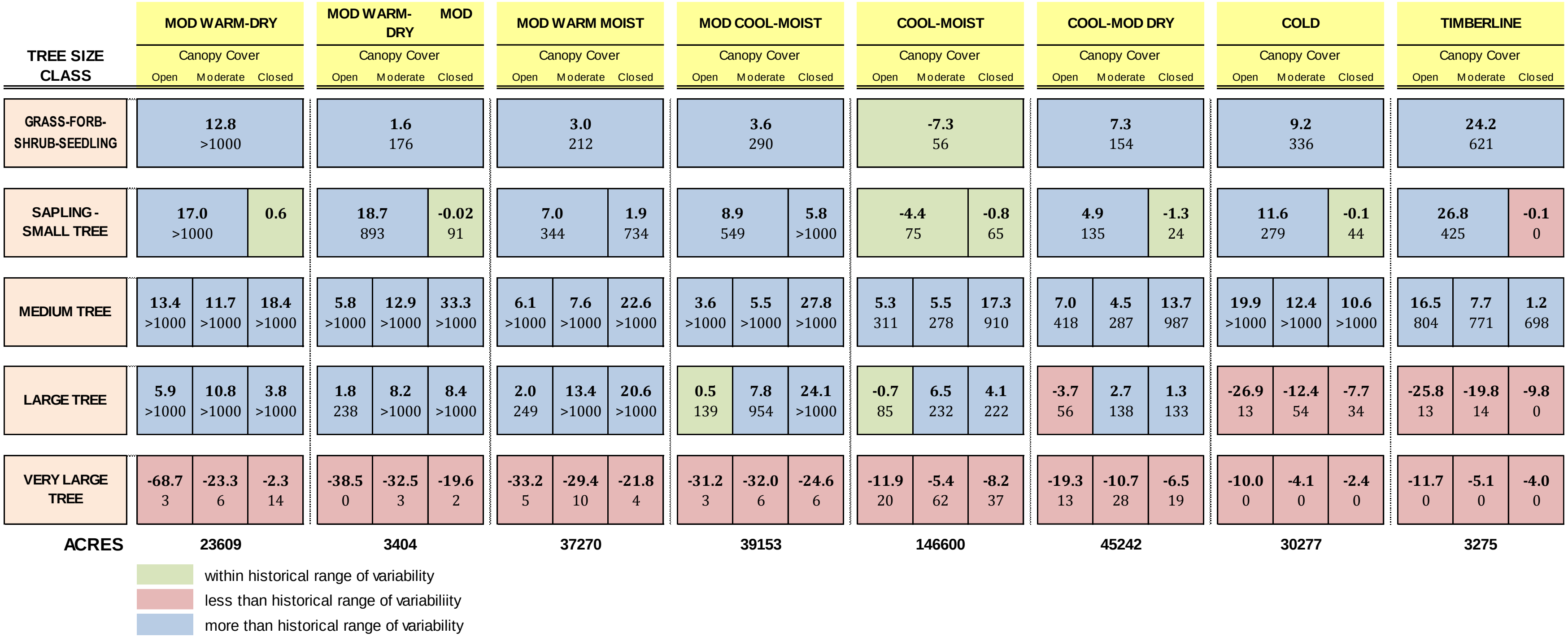


Figure 14. Mean percentage of fire regimes calculated using SIMPPLLE for each ecological site in each ecoregion of the BSLRP project area. Bars represent the 95% confidence interval around the mean value.



TREE SIZE CLASS	MOD WARM-DRY			MOD WARM-MOD DRY			MOD WARM MOIST			MOD COOL-MOIST		
	Canopy Cover			Canopy Cover			Canopy Cover			Canopy Cover		
	Open	Moderate	Closed	Open	Moderate	Closed	Open	Moderate	Closed	Open	Moderate	Closed
GRASS-FORB-SHRUB-SEEDLING	🟦 12.8 >1000			🟦 1.6 176			🟦 3.0 212			🟦 3.6 290		
SAPLING - SMALL TREE	🟦 17.0 >1000		🟩 0.6	🟦 18.7 893		🟩 -0.02 91	🟦 7.0 344		🟦 1.9 734	🟦 8.9 549		🟦 5.8 >1000
MEDIUM TREE	🟦 13.4 >1000	🟦 11.7 >1000	🟦 18.4 >1000	🟦 5.8 >1000	🟦 12.9 >1000	🟦 33.3 >1000	🟦 6.1 >1000	🟦 7.6 >1000	🟦 22.6 >1000	🟦 3.6 >1000	🟦 5.5 >1000	🟦 27.8 >1000
LARGE TREE	🟦 5.9 >1000	🟦 10.8 >1000	🟦 3.8 >1000	🟦 1.8 238	🟦 8.2 >1000	🟦 8.4 >1000	🟦 2.0 249	🟦 13.4 >1000	🟦 20.6 >1000	🟩 0.5 139	🟦 7.8 954	🟦 24.1 >1000
VERY LARGE TREE	🟥 -68.7 3	🟥 -23.3 6	🟥 -2.3 14	🟥 -38.5 0	🟥 -32.5 3	🟥 -19.6 2	🟥 -33.2 5	🟥 -29.4 10	🟥 -21.8 4	🟥 -31.2 3	🟥 -32.0 6	🟥 -24.6 6
ACRES	23609			3404			37270			39153		

TREE SIZE CLASS	COOL-MOIST			COOL-MOD DRY			COLD			TIMBERLINE		
	Canopy Cover			Canopy Cover			Canopy Cover			Canopy Cover		
	Open	Moderate	Closed	Open	Moderate	Closed	Open	Moderate	Closed	Open	Moderate	Closed
GRASS-FORB-SHRUB-SEEDLING	🟩 -7.3 56			🟦 7.3 154			🟦 9.2 336			🟦 24.2 621		
SAPLING - SMALL TREE	🟩 -4.4 75		🟩 -0.8 65	🟦 4.9 135		🟩 -1.3 24	🟦 11.6 279		🟩 -0.1 44	🟦 26.8 425		🟥 -0.1 0
MEDIUM TREE	🟦 5.3 311	🟦 5.5 278	🟦 17.3 910	🟦 7.0 418	🟦 4.5 287	🟦 13.7 987	🟦 19.9 >1000	🟦 12.4 >1000	🟦 10.6 >1000	🟦 16.5 804	🟦 7.7 771	🟦 1.2 698
LARGE TREE	🟩 -0.7 85	🟦 6.5 232	🟦 4.1 222	🟥 -3.7 56	🟦 2.7 138	🟦 1.3 133	🟥 -26.9 13	🟥 -12.4 54	🟥 -7.7 34	🟥 -25.8 13	🟥 -19.8 14	🟥 -9.8 0
VERY LARGE TREE	🟥 -11.9 20	🟥 -5.4 62	🟥 -8.2 37	🟥 -19.3 13	🟥 -10.7 28	🟥 -6.5 19	🟥 -10.0 0	🟥 -4.1 0	🟥 -2.4 0	🟥 -11.7 0	🟥 -5.1 0	🟥 -4.0 0
ACRES	146600			45242			30277			3275		

🟩 within historical range of variability
🟥 less than historical range of variabiliity
🟦 more than historical range of variability

Figure 15. The cumulative change in upland forest ecosystems for the M333C ecoregion. Historical range of variability represents the 95% confidence interval for historical amounts of each ecosystem with the different colors indicating where current conditions are less or more than the 95% confidence interval for historical values. Numbers in the second line represent the current representation of the mean historical amount of each ecosystem as a percentage of historical amounts. Amounts greater than 100 indicate the amount greater than the historical mean while amounts from 0-99 represent the remaining percentage representation of that ecosystem.

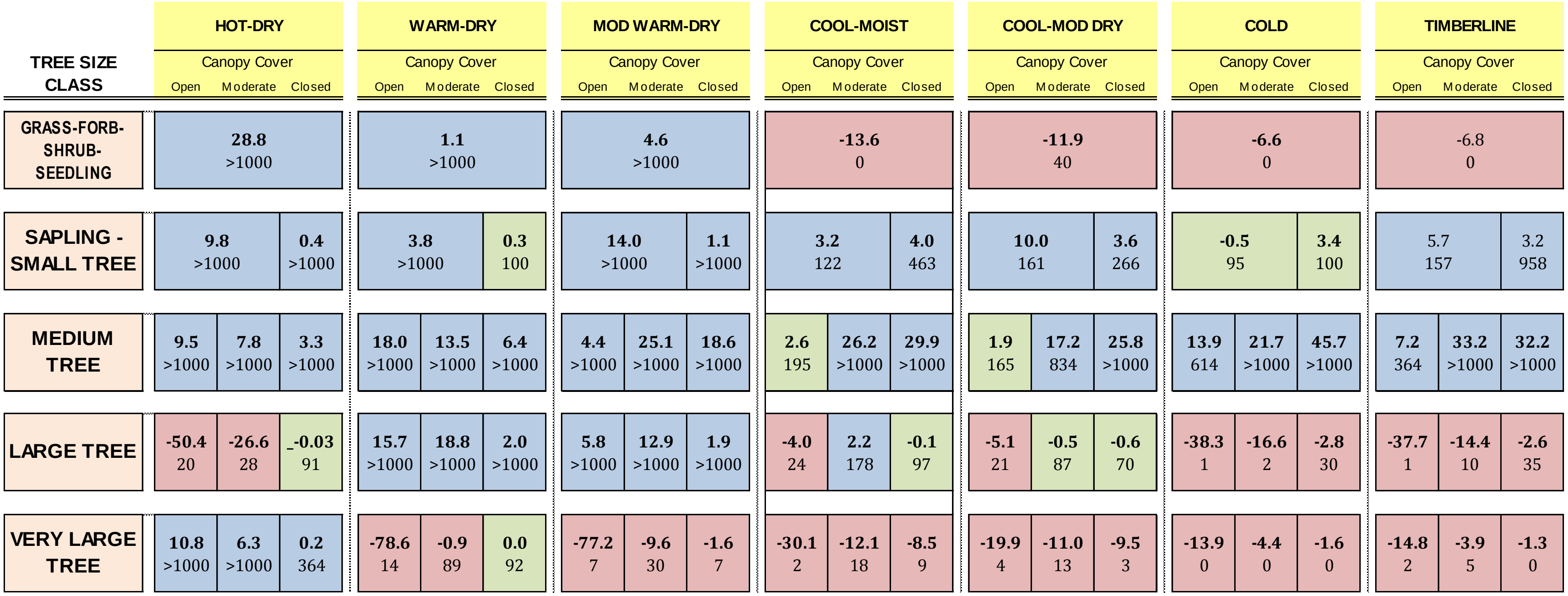
TREE SIZE CLASS	WARM-DRY			MOD WARM-DRY			COOL-MOIST			COOL-MOD DRY			COLD			TIMBERLINE		
	Canopy Cover			Canopy Cover			Canopy Cover			Canopy Cover			Canopy Cover			Canopy Cover		
	Open	Moderate	Closed	Open	Moderate	Closed	Open	Moderate	Closed	Open	Moderate	Closed	Open	Moderate	Closed	Open	Moderate	Closed
GRASS-FORB-SHRUB-SEEDLING	**29.9** >1000			**18.0** >1000			**1.6** 111			**6.3** 136			**11.3** 321			**11.1** 237		
SAPLING - SMALL TREE	**20.9** >1000		**8.1** >1000	**4.4** >1000		**1.6** >1000	**-6.1** 64		**2.1** 227	**-6.0** 68		**1.3** 157	**3.6** 143		**2.1** 884	**4.1** 132		**1.2** 278
MEDIUM TREE	**6.5** >1000	**7.8** >1000	**3.3** >1000	**7.7** >1000	**10.2** >1000	**10.7** >1000	**0.7** 129	**4.5** 256	**17.3** >1000	**0.9** 132	**3.1** 196	**13.9** 806	**9.4** 516	**11.2** 924	**13.5** >1000	**22.9** 886	**10.7** 598	**4.8** 601
LARGE TREE	**3.0** >1000	**6.1** >1000	**1.6** >1000	**0.8** 297	**5.2** >1000	**13.6** >1000	**-1.4** 71	**2.1** 147	**10.2** 428	**-1.9** 66	**-0.3** 95	**7.7** 358	**-26.2** 17	**-10.3** 57	**4.0** 151	**-21.8** 19	**-12.9** 42	**-5.2** 39
VERY LARGE TREE	**-73.6** 4	**-14.2** 30	**0.5** 135	**-71.0** 7	**-4.5** 77	**3.3** 239	**-15.7** 14	**-8.6** 46	**-6.7** 47	**-11.0** 21	**-6.4** 50	**-7.5** 39	**-12.1** 0	**-4.9** 0	**-1.6** 0	**-9.2** 0	**-4.0** 0	**-1.7** 0
ACRES	**6047**			**172079**			**151228**			**144974**			**36736**			**8467**		

🟩 within historical range of variability

🟥 less than historical range of variability

🟦 more than historical range of variability

Figure 16. The cumulative change in upland forest ecosystems for the M332B-West ecoregion. Historical range of variability represents the 95% confidence interval for historical amounts of each ecosystem with the different colors indicating where current conditions are less or more than the 95% confidence interval for historical values. Numbers in the second line represent the current representation of the mean historical amount of each ecosystem as a percentage of historical amounts. Amounts greater than 100 indicate the amount greater than the historical mean while amounts from 0-99 represent the remaining percentage representation of that ecosystem.



TREE SIZE CLASS	HOT-DRY			WARM-DRY			MOD WARM-DRY			COOL-MOIST			COOL-MOD DRY			COLD			TIMBERLINE		
	Canopy Cover			Canopy Cover			Canopy Cover			Canopy Cover			Canopy Cover			Canopy Cover			Canopy Cover		
	Open	Moderate	Closed	Open	Moderate	Closed	Open	Moderate	Closed	Open	Moderate	Closed	Open	Moderate	Closed	Open	Moderate	Closed	Open	Moderate	Closed
GRASS-FORB-SHRUB-SEEDLING	🟦 28.8 >1000			🟦 1.1 >1000			🟦 4.6 >1000			🟥 -13.6 0			🟥 -11.9 40			🟥 -6.6 0			🟥 -6.8 0		
SAPLING - SMALL TREE	🟦 9.8 >1000		🟦 0.4 >1000	🟦 3.8 >1000		🟩 0.3 100	🟦 14.0 >1000		🟦 1.1 >1000	🟦 3.2 122		🟦 4.0 463	🟦 10.0 161		🟦 3.6 266	🟩 -0.5 95		🟩 3.4 100	🟦 5.7 157		🟦 3.2 958
MEDIUM TREE	🟦 9.5 >1000	🟦 7.8 >1000	🟦 3.3 >1000	🟦 18.0 >1000	🟦 13.5 >1000	🟦 6.4 >1000	🟦 4.4 >1000	🟦 25.1 >1000	🟦 18.6 >1000	🟩 2.6 195	🟦 26.2 >1000	🟦 29.9 >1000	🟩 1.9 165	🟦 17.2 834	🟦 25.8 >1000	🟦 13.9 614	🟦 21.7 >1000	🟦 45.7 >1000	🟦 7.2 364	🟦 33.2 >1000	🟦 32.2 >1000
LARGE TREE	🟥 -50.4 20	🟥 -26.6 28	🟩 _-0.03 91	🟦 15.7 >1000	🟦 18.8 >1000	🟦 2.0 >1000	🟦 5.8 >1000	🟦 12.9 >1000	🟦 1.9 >1000	🟥 -4.0 24	🟩 2.2 178	🟩 -0.1 97	🟥 -5.1 21	🟩 -0.5 87	🟩 -0.6 70	🟥 -38.3 1	🟥 -16.6 2	🟥 -2.8 30	🟥 -37.7 1	🟥 -14.4 10	🟥 -2.6 35
VERY LARGE TREE	🟦 10.8 >1000	🟦 6.3 >1000	🟦 0.2 364	🟥 -78.6 14	🟥 -0.9 89	🟩 0.0 92	🟥 -77.2 7	🟥 -9.6 30	🟥 -1.6 7	🟥 -30.1 2	🟥 -12.1 18	🟥 -8.5 9	🟥 -19.9 4	🟥 -11.0 13	🟥 -9.5 3	🟥 -13.9 0	🟥 -4.4 0	🟥 -1.6 0	🟥 -14.8 2	🟥 -3.9 5	🟥 -1.3 0
ACRES	668			4919			80110			75932			98562			21025			4157		

🟩 within historical range of variability

🟥 less than historical range of variability

🟦 more than historical range of variability

Figure 17. The cumulative change in upland forest ecosystems for the M332B-East ecoregion. Historical range of variability represents the 95% confidence interval for historical amounts of each ecosystem with the different colors indicating where current conditions are less or more than the 95% confidence interval for historical values. Numbers in the second line represent the current representation of the mean historical amount of each ecosystem as a percentage of historical amounts. Amounts greater than 100 indicate the amount greater than the historical mean while amounts from 0-99 represent the remaining percentage representation of that ecosystem.

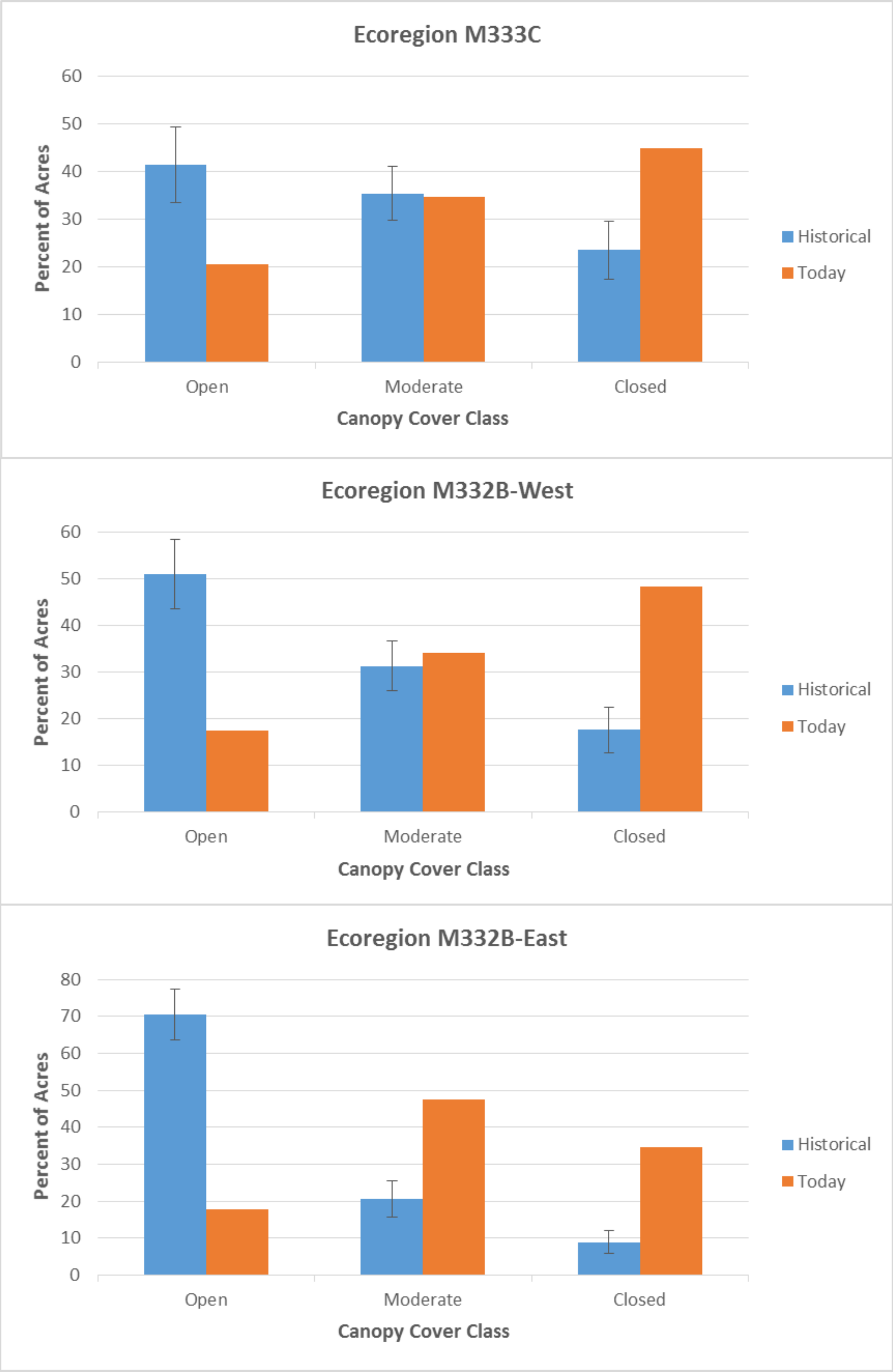


Figure 18. Comparison of percentage of forested area within each ecoregion that was historically in open, moderate, or closed canopy conditions compared to the percentages occurring today.

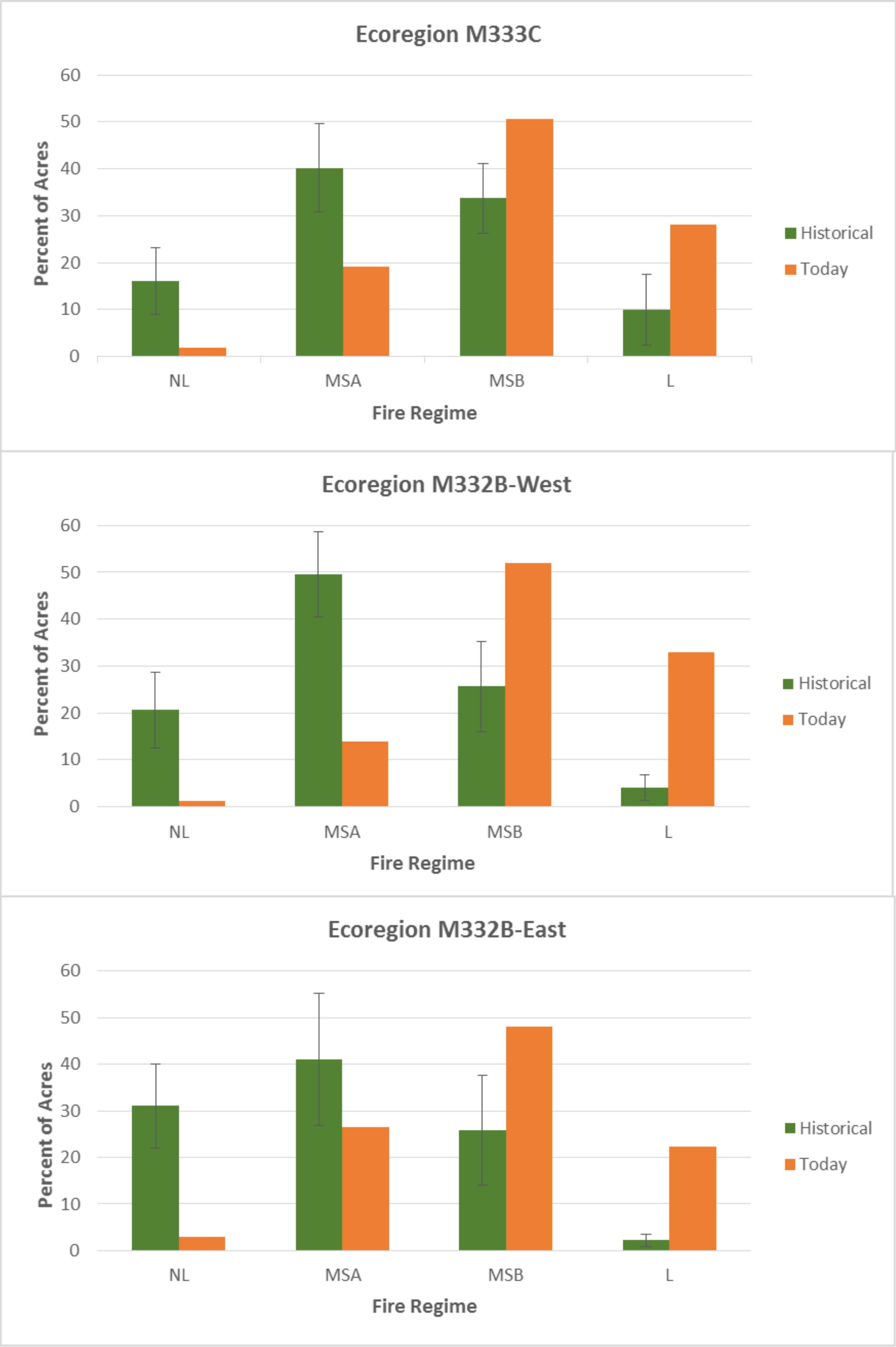


Figure 19. Historical fire regimes based on estimated fire severities of stand conditions within the 3 ecoregions of the BSLRP area compared to current conditions.

the mixed-severity A fire regime has been greatly reduced. This has shifted current forests structures and compositions to conditions with greater potential to burn with high severity, leading to significantly greater amounts of lethal and mixed severity B fire regimes. While this is true for all 3 ecoregions, these effects become greater when moving north to south-southeast in the project area. Analysis of the distribution of disturbance states revealed two significant trends. The first was the increase in forest canopy cover that currently exists compared to historical conditions. This is explained by the reduction in low and moderate severity fire on the landscape that historically kept stands in more open canopies, particularly for the lower elevation warmer and drier ecological sites. Associated with this shift in canopy cover is a shift in the composition of the forest overstory to more shade tolerant species such as Douglas fir, subalpine fir, and Englemann spruce. The second significant trend was the reduction in stands containing very large trees in the project area. This change was identified in both VMAP mapping of tree size classes, as well as an analysis of FIA plot data. Past harvest records and even remaining stumps in the project area confirm that past logging efforts in many ot these mid to low-elevation forests targeted the very large western larch, ponderosa pine, Douglas fir, western white pine, and red cedar.

Analysis of cumulative changes to individual ecosystems showed where the greatest changes have occurred, and where the greatest restoration needs are for restoring the representation of ecosystem diversity required to support biodiversity. In the M333C ecoregion, a number of ecosystems have very low rates of representation compared to their estimated historical amounts. Ecosystems classified as having very large tree structures have the lowest overall level of representation. The moderately warm dry ecological site currently had only 3% representation of the estimated historical amount of the open canopy, very large tree ecosystem, a decline of 69%. The moderate canopy cover very large tree ecosystem for this ecological site only had 6% representation. The moderately warm-moderately dry ecological site had even lower levels of very large tree ecosystems, although this ecological site only occurred across 3404 acres in this ecoregion. The moderately warm moist ecological site, occurred on 37,270 acres and currently had 5%, 10%, and 4% representation of the historical amounts of the open, moderate, and closed canopy very large tree ecosystems respectively, while the moderately cool-moist ecological site had 3%, 6%, and 6% representation of these same disturbance states for this site. The cold and timberline ecological sites were not found to have any representation of the very large tree structures, but for these ecological sites, the large tree structure ecosystems were more abundant historically. The large tree structures were found to be poorly represented as well. This has resulted from the known losses of whitebark pine from the combined effects of fire suppression, white pine blister rust, and bark beetles, and the effects of the reduction in this tree species to these important ecosystems. An additional restoration need is for western white pine. While this did not occupy large areas historically, it was still an important ecosystem in the M333C ecoregion that has been heavily impacted by the combination of past logging and white pine blister rust.

For the M332B-West ecoregion, a major restoration priority is the open canopy, very large tree ecosystem in the moderately warm-dry ecological site, having only an estimated 7% representation of its historical amounts thus experiencing an average reduction of 71% in this ecoregion. The open, very large tree disturbance state in the warm-dry ecological site has only 4% estimated representation of historical conditions, but the relatively small amount of this site in the ecoregion (6,047 acres) reduces the impact of this change compared to the much more abundant moderately warm-dry ecological site. Other needed ecosystems are the open canopy large and very large tree size classes in the cold and timberline ecological sites. As with M333C, these types have been impacted by lack of fire, white pine blister rust, and beetle infestations hitting whitebark pine particularly hard. Very large trees open canopy states are also needed in the cool-moist and cool- moderately dry ecological sites as these have only an estimated representation of 14 and 21% respectively.

The M3332B-East ecoregion has similar conditions as M332B-West, with the open canopy very large tree ecosystems in the warm dry, moderately warm dry, cool moist, and cool-moderately dry having an estimated 14%, 7%, 2%, and 4% representation, respectively. Particularly for the latter three ecological sites, these all have large amounts of acreage in the ecoregion, making these very high priorities for restoration. For all three of these ecological sites, the moderate and closed canopy very large tree ecosystems also had low levels of representation compared to historical amounts. As in both the other two ecoregions, the cold and timberline ecological sites had significant reductions in the open large and very large tree states, and also in the moderate canopy, large tree states. Restoration of these ecosystems, particularly emphasizing whitebark pine, is an additional priority.

Thus, the greatest overall restoration needs are for the open canopy, very large tree ecosystems and in particular those occurring in the moderately warm-dry, cool moist, and cool-moderately dry ecological sites. Restoration of these conditions can occur in two ways. One is to find stands with enough very large tree structure present but in higher canopy cover classes. These stands can be thinned to correspond with reference conditions for the open canopy states. However, the analysis of current conditions indicates an overall lack of very large tree structures across all states, so that finding suitable higher canopy cover stands may not be possible. While more stands with enough very large trees may be present than mapped by VMAP, the lack of very large trees was also supported by the analysis of FIA plot data so that this may not be an option for substantial restoration. One thing that should be examined in the field is the composition of the very large tree component of any existing stands. Where more closed canopy conditions contain very large trees that are dominated by western larch and ponderosa pine, this would indicate conditions favorable for restoration of the open canopy stand conditions which require these trees for their appropriate composition. If the very large tree component is dominated by subalpine fir or Engelmann spruce, then these stands should be left as representative of the very large tree ecosystems for closed canopy states. Stands dominated by very large Douglas fir trees will need to be evaluated for their appropriate canopy closure for restoration. The second option for restoration is to find large tree stands or medium tree stands that can be treated to enhance growth of the desired open canopy species (larch and ponderosa pine), and plan for these stands to grow into the desired reference conditions in the future. While this is a long-term restoration approach, it will be necessary to provide the amounts of representation desired in the future.

SPECIES ASSESSMENT

The species assessment was conducted after the completion of the ecosystem diversity assessment and accomplished several things. First, the range of native ecosystem diversity can be used to assess and evaluate the inherent capability of the landscape to provide historical habitat conditions for a target species. This is an important consideration as some species may have never had high probabilities of persistence or viability in a landscape. Efforts to achieve viable and persistent populations for such species over the long-term may not be feasible in these landscapes, or such efforts may shift ecosystem diversity substantially away from what occurred historically, and ultimately undermine the scientific foundation of the conservation strategy for biodiversity. Thus, understanding the likely historical status of species of concern or interest in a landscape is important information for developing future management decisions. Second, species assessments provide information on the effects of cumulative changes to native ecosystem diversity on a selected species' habitat. While the current status of a species may be influenced by many factors including direct human impacts on populations, comparing historical habitat conditions to today's conditions provides a better understanding of the current status, both in terms of quality and amounts of habitat required by the species. Finally, assessing how changes in ecosystem diversity have affected species of interest can help evaluate planned restoration activities, and ensure that sufficient representation of ecosystem diversity is planned in order to support those species with high probabilities of persistence under historical conditions.

Habitat suitability indices (HSI) were developed for 5 species of interest and included fisher, black-backed woodpecker, flammulated owl, northern goshawk, and pileated woodpecker. The same species HSI model was used to assess both historical and existing conditions. For historical analyses, the ecosystem diversity outputs from the SIMPPLLE model were used. For current conditions, the VMAP layer provided by the BSLRP team was used. The number and quality of potential home ranges were then mapped using a habitat-based species viability approach. SIMPPLLE modeling outputs were evaluated every 200 years of the 1000 year simulation for each species to capture a range of variability for species assessments. Habitat quality over these 5 historical time periods were compared to the current habitat conditions modeled for each species.

Fisher had very low numbers of potential high quality home ranges in all historical time steps included in the analysis. This suggests the project area had a low inherent capability for supporting a population of this species and thereby had low probabilities of long-term persistence. While some fisher habitat was consistently present, the likely small population sizes in the landscape may have received demographic support from nearby landscapes with higher inherent capability. Current habitat quality was slightly lower than historical conditions, likely attributable to the reduction in very large tree ecosystems in the landscape. Restoration of priority ecosystems as discussed previously, particularly the large to very large tree size classes with moderate to closed canopies in the higher elevation and moister ecological sites, should provide higher quality habitat conditions for this species more consistent with historical amounts.

Flammulated owls had very consistent historical habitat quality in the project area. This is not surprising, as the low elevation, warmer and drier ecological sites used by this species were historically maintained in more consistent conditions by frequent low to moderate severity fires. This historical analysis reveals the BSLRP area had good inherent capability for flammulated owls and would be expected to have supported good populations with reasonable probabilities of persistence. Estimates of current conditions reveal an approximate 2/3 reduction in habitat capability for this species. This reduction is easily explained by the loss of very large trees in the lower elevation ecological sites, particularly reductions in large ponderosa pine from early logging. Restoration of open canopy, very large tree ecosystems that have been prioritized for the warmer and drier ecological sites will significantly enhance habitat quality for flammulated owls.

Northern goshawks showed some variability over time in numbers of different quality home ranges, but on average had good amounts of potential habitat. Overall, the analysis showed the BSLRP area supported good habitat for northern goshawks, and the population would be expected to have high probabilities of persistence indicating the landscape's high inherent capability for this species. Current habitat conditions showed a slightly lower number of high quality home ranges than the historical mean, but still well within the historical confidence intervals for both high quality and moderate quality home ranges. n general, these results indicate this species had good habitat conditions in this landscape both historically and under current conditions. The priority restoration goals for ecosystem diversity should maintain this species habitat quality in the landscape.

Black-backed woodpeckers showed the greatest variability in historical habitat quality. High quality home ranges varied considerably, while moderate quality home ranges showed less variation and maintained good amounts. The variation in the habitat for this species is not surprising. High quality habitat is provided by high amounts of high severity fire which was shown to vary widely over time with associated variations in climate conditions. In decades with large amounts of high severity fire, there was an abundance of high quality black-backed woodpecker habitat. In periods following cooler and moister conditions, low amounts of high severity fire occurred, reducing the high quality habitat for this species. However, while there was some variation in the amounts of moderate quality habitat, there was always generally good amounts of this habitat available. This was provided by older high severity burns as well as stands with high tree mortality from disturbances such as insect infestations. While this landscape had good inherent capability for providing black-backed woodpecker habitat, populations would be expected to show substantial fluctuations depending on climate patterns and resulting amounts of high severity fire. Current habitat conditions show lower levels of moderate quality potential home ranges, but still show reasonable amounts of habitat. Due to changes in forest conditions, high severity fire is expected to play a greater future role in the BSLRP landscape. Habitat for this species should be provided by identifying those locations where high severity fire played an important historical role in shaping forest conditions and where this fire regime can be allowed to occur in the future.

Pileated woodpeckers showed relatively low quality habitat both historically and under current conditions, with lower amounts of habitat currently available relative to historical amounts. Historical estimates of high and moderate quality home ranges were low for this species, as were current conditions. The substantial reduction in very large trees could explain the lower habitat conditions occurring today compared to historical. More open canopy conditions historically could also have reduced amounts of high quality habitat for this species based on the habitat suitability model. The model outputs show the landscape had inherent capability to support this species over time, but did not support high numbers of high quality home ranges. Restoration of ecosystem diversity, particularly increasing the very large tree component of the landscape will improve habitat for this species, even with some reduction in canopy cover that could lower habitat quality in some areas.

With the exception of fisher and to a lesser extent pileated woodpecker, the BSLRP landscape had good to excellent inherent capability to support the modeled species. Fisher habitat was present, but may not have been present historically in conditions that would have provided a high probability of viability and persistence.More likely, fisher populations would have been supplemented by better quality surrounding landscapes. Pileated woodpeckers would have had a reasonable probability of persistence, but may not have been present in high numbers. Flammulated owls would have had good habitat conditions in limited portions of the landscape. Black-backed woodpeckers would have had persistent populations but shown considerable variability in numbers in response to climate conditions that temporally increased amounts of high severity fire. Northern goshawk habitat appeared to have had historically good amounts of habitat. Restoration of priority ecosystems are expected to enhance the habitat quality of fisher, flammulated owls, northern goshawks, and pileated woodpeckers. Planning should include consideration of where high severity fire will be allowed to occur, and with this provision, habitat will be provided for black-backed woodpeckers.

KEY FINDINGS AND RECOMMENDATIONS

This landscape assessment is based on the conservation strategy for ecological sustainability as described in the Forest Planning Rule and the Ecological Restoration Policy of the Forest Service. The scientific foundation of this strategy is based on maintaining the diversity of ecosystems occurring historically and that by ensuring adequate representation of these ecosystems, the habitat requirements of all species will be provided where consistent with the inherent capability of a landscape. The Ecosystem Restoration Policy emphasizes restoration should be evaluated within the context of the historical or natural range of variability (NRV), in support of the scientific foundation of the strategy. While adjustments to historical conditions are expected due to current social and economic considerations as well as the challenges of climate change, to maintain the integrity of the conservation strategy, ecosystem restoration founded on a thorough understanding of historical conditions is a primary requirement. The Ecosystem Restoration Policy acknowledges it may not be feasible to restore all ecosystems when it stated: “when an ecosystem has been so degraded such that it is impossible or impractical to return conditions to those within the NRV, then functional restoration may be appropriate to restore ecological processes but achieve the essential functions of the ecosystem with different species compositions and structure than pre-European settlement conditions.” However, the intent of the policy is clear - historical conditions are the restoration goal - while also recognizing forest management must incorporate social and economic considerations.

This landscape assessment has classified and quantified the ecosystem diversity for the BSLRP landscape at both landscape and ecosystem levels. Further, it has provided estimates of historical ecosystem diversity compared to current conditions, and quantified the cumulative changes to this ecosystem diversity due to direct and indirect human effects from recent settlement. The cumulative change analysis highlights those specific ecosystems having low levels of representation today or greatest departure when compared to historical amounts and that should receive high priority for restoration.

The assessment has also provided the data needed to describe and quantify the reference conditions to use as stand level goals for restoration of specific ecosystems in terms of vegetation compositions, structures, and disturbance processes.

Restoration priorities include increasing the amounts of open and moderate canopy cover conditions and increasing the percentage of the landscape containing very large trees. Ecosystems with the greatest departure from historical conditions occur in some of the drier ecological sites, specifically the moderately warm dry type in the M332B-West and M332B-East ecoregions. In addition, whitebark pine ecosystems in the higher elevation cold and timberline ecological sites are a priority for restoration because of the combined effects of fire exclusion, infestation by white pine blister rust, and effects of pine beetles. In the M333C ecoregion, in addition to the need to restore very large tree ecosystems in dry ecological sites, some of the moister sites also have ecosystems that are at very low representation levels. As with the other ecoregions, high elevation whitebark pine is a restoration priority, as well as western white pine ecosystems that have experienced nearly complete loss as functional ecosystems due to past logging, fire exclusion, and the influence of white pine blister rust.

Fire regimes were also assessed and quantified for historical and current conditions. This analysis demonstrated the important role of mixed severity fire regimes in the BSLRP landscape, and also quantified how the amounts of all 4 fire regimes have shifted from historical to current conditions. These shifts were shown to be greater in ecoregions M332B-East and West, as drier ecological sites are a greater proportion of these areas and historically had more low to moderate severity fire.

Restoration efforts should evaluate the existing vegetation patterns in targeted areas, and use interpretation of disturbance processes to guide patterns for restoration. Residual very large trees, especially western larch and ponderosa pine, provide evidence of where low to moderate severity fire occurred historically. In many other locations, residual very large stumps are indicators of where very large tree conditions occurred, particularly on drier ecological sites. In contrast, patches of 100+ year old stands of lodgepole pine are a good indicator of where high severity fire occurred historically, and where early successional conditions may be warranted for restoration.

BSLRP, as with all restoration projects, will have limited budgets and other constraints. To be the most effective in meeting the project objectives, treatments and actions should target those ecosystems with the greatest restoration needs for better representation in the landscape. This assessment has identified the restoration needs at the landscape level for the BSLRP project area, as well as the reference conditions at the ecosystem level to help guide desired conditions for individual stands receiving treatment. While many additional factors will limit the ability and even desirability of restoring historical ecosystem conditions in all locations, the overall restoration goals should emphasize providing key ecosystem conditions that are currently underrepresented in the landscape in order to meet sustainability and biodiversity objectives for the long-term. Deviations from these goals should be identified relative to balancing social and economic needs, or ecological constraints that would interfere with achieving a targeted reference condition.