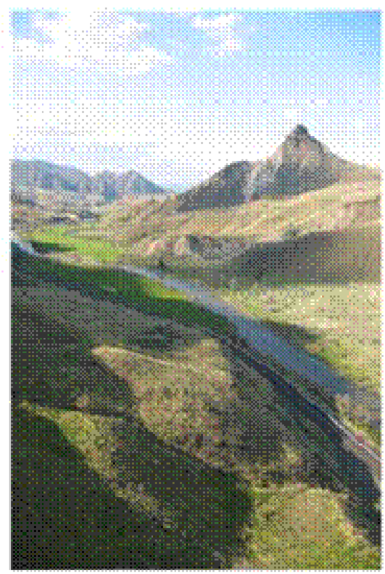
JOHN DAY RIVER BASIN TMDL

APPENDIX C:
ESTIMATE OF NATURAL POTENTIAL VEGETATION IN THE JOHN DAY BASIN
(Preliminary for the Deschutes Basin as well)

Final
November 2010

PREPARED FOR JOHN DAY AND DESCHUTES BASIN TMDLS. THIS REPORT HAS BEEN COMPLETED FOR THE JOHN DAY RIVER BASIN, AND SHOULD BE CONSIDERED IN-DEVELOPMENT FOR THE DESCHUTES BASIN.



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Note: Yellow shading indicates areas where this document should be further modified to more fully address the Deschutes Basin. This report has been completed for the John Day Basin, and should be considered in-development for the Deschutes Basin.

1. INTRODUCTION

Temperature Total Maximum Daily Loads (TMDLs) in the John Day and Deschutes Basins require estimation of the natural vegetation potential in the near-stream environment. Across the basins-wide stream network, the goal is to identify the type and form of vegetation reflecting minimal human-disturbance, in the past or ongoing. Information relating to the following criteria informs this assessment:

- Conditions during the early years of European settlement
- Conditions prior to European settlement (little information available)
- Conditions prior to human disturbance (least information available)
- Existing conditions that are relatively undisturbed
- Potential recovery from human related disturbance (whether recovery is passive, active or combined; what is the long-term full potential?)
- Conditions representing adaptive management targets for assumed or estimated highest ecological status

The aim herein is to best estimate potential natural vegetation conditions, where ‘natural conditions’ are defined (OAR 340-041-002) as “conditions or circumstances affecting the physical, chemical, or biological integrity of a water of the state that are not influenced by past or present anthropogenic activities. Disturbances from wildfire, floods, earthquakes volcanic or geothermal activity, wind, insect infestation, and diseased vegetation are considered natural conditions.”

2. METHOD SUMMARY

The John Day and Deschutes Basins potential natural vegetation estimate is spatially delineated first on fourth level Ecoregion polygons and second, on valley form *sensu* McAllister (2008). In some instances, other differentiating strata are applied to increase spatial resolution. The output of this delineation is a list of Ecoregion-physiographic types (hereafter *EP Types*) that covers all probable EP Types within the landscape. Each EP Type is assigned a vegetation height and density, based on basin-specific historic assessments, plant association studies, observations during TMDL monitoring and, for additional vegetation height information, general botanical literature. Every reach within the landscape can be assigned an explicit EP Type after identifying valley form and ecoregion.

The resultant vegetation assessment is applied to both site-specific temperature models and generalized shade curves of the TMDL. Along the temperature model corridors, EP Types have been specified via Ecoregion and 10-m Geographic Information System (GIS) Digital Elevation Model (DEM) hillshade layers in ArcMap™ software, version 9.3. Regarding generalized shade curves, a representative array of curves will be developed for selected height and density increments, spaced commensurate with uncertainty. It seems likely that five or ten graphs can address the more than sixty identified EP Types in the two Basins.

3. STEPS TAKEN IN ESTIMATING TYPES AND ATTRIBUTES OF NATURAL THERMAL POTENTIAL VEGETATION

1. Conduct literature review

Conduct literature review for basin-specific vegetation information. This step includes review of documents containing historical information (diaries and journals of early explorers and inhabitants, General Land Office Surveys, early 1900s aerial photography, ground level photograph, histories, etc.) and scientific studies and surveys (botanical studies, soil surveys, watershed condition reports, etc.). Critical information includes identification of historic and potential vegetation communities and their location, height and density. An annotated literature review is provided as **Appendix 1**.

2. Focus on key sources of information

Focus on key sources of information with sufficient geographic coverage and relevance. This step narrows down the larger literature review of **Step 1** to the most relevant sources for basin-wide determinations of potential vegetation structure. Some data were available in GIS context and others in conventional literature. The selected sources of information are listed and discussed in **Appendix 2** and summarized in **Table C-9**.

> Land cover information note: in estimation of potential, Level 4 Ecoregions seem ideal for broad-scale information stratification. The Historic GAP GIS coverage (Tobalske, 2002) is tightly-scaled, with entire landscape coverage, but provides minimal detail and is often not riparian specific. The works of Crowe et al. (1997 and 2004) and Wells (2006) are specific to riparian areas. The work of Crowe et al., 1997 and Wells, 2006 are helpful but only addresses the National Forest area comprising the north eastern parts of the John Day Basin. Crowe et al., 2004 addresses much of Eastern Oregon, but the work of Wells (2006) is more specific to dissected canyon and subalpine areas. The Oregon Watershed Enhancement Board (OWEB, 1999) identification of riparian potential is helpful, but lacks the botanical and geomorphic detail of Crowe et al., and Wells. In summary, information sources are mixed in terms of applicability, relevance and detail. Accordingly, the usage and weight of each information source varies substantially across the John Day and Deschutes Basins.

3. Conduct monitoring

During the John Day Basin TMDL intensive monitoring of 2002 and 2004, existing vegetation was described at various flow and morphology monitoring sites. Mature vegetation heights were measured using a LASAR rangefinder. Shade producing species were identified and solar pathfinder measurements were collected at over 100 sites. {Discuss Deschutes Basin}

4. Identify potential vegetation and specify location

a. Assess method to spatially apply information. The most relevant botanical literature for the John Day and Deschutes Basins are keyed by plant associations, not by geographic location. The location resolution varies from Level 3 to 4 Ecoregion to regions aggregating National Forests. Further location specificity is available in that the plant association descriptions are generally accompanied with geographic attributes such as elevation and valley form. A cross-publication spatial key was developed because no single source covered the John Day or Deschutes Basins or contained all the information types needed. Additionally, a uniform key enables comparison of various assessments at similar locations; informing the range and uncertainty of estimates. The spatial key data-stratification method of McAllister (2008) was selected and is expanded upon herein. McAllister stratified data first by Level 4 Ecoregion and then by valley form, invoking 4 valley classes based on cross-valley contour shape and gradient. McAllister addressed four Level 4 Ecoregions in the John Day and Deschutes Basins, identifying eleven Ecoregion-physiographic types (referred to here as ***EP Types***). We expanded that to include all Level 4 Ecoregions present in the two basins.

b. Identify all EP Types present in the Basins. As indicated above, in order to select the applicable EP Type, valley form and Ecoregion must be known. To normalize valley form information in the various botanical source documents, the criteria for valley form of McAllister was modified in this TMDL analysis. The valley floor was considered broad where the potential meander belt is readily accommodated and narrow if the channel appeared constrained, v-shaped or if the channel meander parallels the valley pattern. In order to apply this key to the OWEB (1999) potential vegetation assessment, we broadly assumed that narrow to moderate width valleys fall into their 'constrained' category and otherwise channels were considered unconstrained [refer to further discussion in the following **Section 4c(iv)**]. For application to Crowe et al. (1997, 2004) and Wells (2006), valley form classes were taken from Crowe et al., (1997): broad - greater than 100 m, narrow - 30 m or less and moderate lies in between. These divisions generally held, except in the largest and smallest streams where we delineated valley width based on visual assessment of space available for potential meander. For temperature-modeled corridors, which are larger rivers, a more specific assessment took place as described in **Step 9**.

   There are 25 Level 4 Ecoregions in the combined basin area (**Appendix. 2, Figure C-9**). With 4 valley forms, one hundred EP Types potentially exist. Each Ecoregion was surveyed visually in ArcMap™ (v. 9.3) via a 10-m digital elevation model (USGS) in order to eliminate non-represented EP Types. This narrowed down the number of EP Types to roughly seventy. Most address perennial streams with the presence of large woody vegetation, though riparian tree stands may only occur in patches. A few are specified to address areas without perennial streams. Two were designed to broadly account for meadows. The identified EP Types are listed in **Table C-1**.

Table C-1. Ecoregion-Physiographic Types Identified in the John Day and Deschutes Basins.

Valley Classification (McAllister, 2008)	Gradient (McAllister, 2008)	OWEB Channel Class (OWEB, 1999)	Level 4 Ecoregion - - - - - - - - - - - Level 4 Ecoregion - - - - - - - - - - - Level 4 Ecoregion - - - - - - - - - - - Level 4 Ecoregion - - - - - - - - - - - Level 4 Ecoregion																									any Ecoregion meadow types
			4c	4d	4e	9b	9c	9d	9e	9f	10c	10e	10k	10n	11a	11b	11c	11d	11h	11i	11l	11m	11n	11o	80d	80g	80j	
Broad valley/low gradient; flat or gently sloping floodplain	<1.8%	unconstrained	Type 12			Type 20		Type 27		Type 33	Type 35	Type 39			Type 43.5	Type 8.5	Type 44	Type 47.5			Type 55		Type 3	Type 59	non perennial	non perennial		Type 64
Narrow, V-shaped valleys with high gradient	>4.5%	constrained	Type 13	Type 16	Type 18	Type 21	Type 24	Type 28	Type 31		Type 36				Type 6	Type 9	Type 45	Type 48	Type 50		Type 56	Type 58		Type 60	non perennial	non perennial	Type 63	
Narrow to moderately wide V- or Trough-shaped valleys with moderate gradient	1.8-4.5%	unconstrained	Type 14	Type 17	Type 19	Type 22	Type 25	Type 29	Type 32		Type 37	Type 40	Type 1	Type 42	Type 7	Type 10	Type 46	Type 49	Type 51	Type 53	Type 57		Type 4	Type 61	non perennial	non perennial		
Trough or V-shaped valleys with low gradient	<1.8%	constrained	Type 15			Type 23	Type 26	Type 30		Type 34	Type 38	Type 41	Type 2	Type 43	Type 8	Type 11	Type 47	Type 49.5	Type 52	Type 54	Type 57.5		Type 5	Type 62	non perennial	non perennial		Type 65

Gray shaded cells indicate types identified by McAllister (2008)

c. Assign each EP Type natural potential vegetation types. This was carried out separately for each principal information source, followed by aggregation across sources. Each publication had a different type of key and methods of data stratification. Data stratification for each is summarized in **Appendix 2**, **Table C-11**. The resultant tabulation of vegetation communities associated with the EP Types by author is provided as **Appendix 3**. Methods of source data extraction are as follows, generally in the order of importance, though this varied substantially with spatial applicability:

i. Crowe et al. (2004): In the table of potential vegetation types (**Appendix 3**), there are two columns for Crowe et al., 2004. The first column contains Crowe's general descriptions of the botanical environment by Level 4 Ecoregion. This is often not riparian specific and was of low importance in this assessment. The second Crowe et al., 2004 column provided in the tabulation is riparian specific. Because this information is not organized by Level 4 Ecoregion, elevation was used as a surrogate for Ecoregion. Elevation categories from the Environment Key of Wells (2006) were roughly associated with Ecoregions as shown in **Table C-2**. The Crowe et al. 2004 vegetation community names were organized first by Level 3 Ecoregion (provided for each community type), then into elevation-Ecoregion zones and then finally organized into EP Types with the inclusion of valley floor width and gradient data associated with each community type. This process led to some EP Types exhibiting several vegetation communities, as expected in a natural setting. Generalizations were made during the final synthesis to provide a single height and density attribute to each EP Type. Throughout, communities that do not include tree or willow over-story were generally screened out, to be treated more generally, as described subsequently.

Table C-2. Level 4 Ecoregions Organized Roughly by Elevation

Elevation Range (Wells, 2006)		Elevation Range (Crowe et al., 2004)	Ecoregion 11	Ecoregion 9	Ecoregion 80	Ecoregion 4	Ecoregion 10
<550 m	<1800 ft	Shrub / Willow	11n				10c, 10e, 10k
550-700 m	1800-2300 ft	Willow / Low Elev. Tree	11n	9c			10c, 10k
700-1600 m	2300-5250 ft	Mid Elev. Tree	11i, 11l, 11n, 11o, 11a, 11b, 11d, 11c, 11h	9b, 9c, 9d, 9e, 9f	80d, 80g	4c	10c, 10k, 10n
1600-1900 m	5250-6250 ft	Mid/High Elev. Tree	11l, 11b, 11d, 11h	9e	80j	4c, 4e	
1900-2130 m	6250-7000 ft	High Elev. Tree	11l, 11b, 11d	9e		4c, 4d, 4e	
>2130 m	>7000 ft	High Elev. Tree	11m			4d, 4e	

Note: in Crowe et al., 2004, chapter headings indicate broad tree elevation classes.

ii. Crowe et al. (1997): Potential vegetation communities are applied to this analysis via the Landform Key provided in Crowe et al., 1997.

iii. Wells (2006): Potential vegetation communities are applied to this analysis via the Environment Key provided in Wells, 2006.

iv. OWEB (1999): In this reference, potential vegetation types are organized by Level 4 Ecoregion and further organized by inner and outer zones and via channel morphology - constrained, semi-constrained and unconstrained reaches. Information was excerpted from the inner and outer zone determinations (hence the two OWEB columns in **Table C-12**) and applied to EP Types first by Level 4 Ecoregion and then by associating the level of constraint based on valley width, as described in **Section 4a**. I.e., vegetation in constrained reaches would fall under a different EP Type than for unconstrained reaches. **Table C-1** identifies the association of the constraint categories of OWEB with the valley types of McAllister. The OWEB semi-constrained category was eliminated.

v. Tobalske (2002): This is a state-wide shapefile of estimated historic vegetation types. Level 4 Ecoregions were assigned vegetation types merged from this shapefile. For the final synthesis combining various authors, this source was generally weighted low due to its lack of riparian specificity.

d. Synthesize multi-source information. Up to this step, the output of this effort is a table of natural potential vegetation community types (associations) for each EP Type (**Appendix 3, Table C-12** without the final four columns), provided by various assessments. Note that for some EP Types, the estimates may seem conflictual, but this is generally an artifact of differing scale, differing levels of geographic applicability (though information was screened out where entirely not applicable), different assessment objectives and, in some cases, may be caused by imprecise alignment of Ecoregion and elevation categories or methods of characterizing valley form. In the next steps of identifying height and density for each EP Type, it is necessary to synthesize across the various information sources to identify a single vegetative structure, to assign height and density. This synthesis is based on the relevance of each source as evaluated for each EP Type. These form the basis of the estimates of height and density. The outcome is generally a list of vegetation types for height averaging or a selected community type associated with density or canopy cover data (these are tabulated in the far right columns in **Table C-12**). The outcome is not an assessment of all riparian species and their distribution and variability. The objective here is solely to identify structural attributes influencing solar radiation within the stream corridor. We generally do not address vegetation that does not produce stream shading, though we recognize its importance to the overall fabric of healthy riparian vegetation.

5. Estimate potential vegetation height for each EP Type

For each EP Type, a single height was assigned to the natural potential vegetation communities. This was arrived at through various methods: (1) The most likely over-story species were selected, weighing the geographic relevance and riparian specificity of the various publications, and a simple average of the selected species canopy height was utilized. Prior to averaging, where upper-range individual species heights were given in the literature, these were multiplied by 0.75 to account for a more typical height. Conifers were again multiplied by 0.75 to provide a more typical canopy height, given the serrated nature of their skyline. The resultant individual species heights are listed in **Table C-3** (3^{rd} column from right). Grass/sedge and low shrub communities were only incorporated into the height determination when there were no over-story species (when trees ≥ 3.5 m were not a significant proportion of the vegetation in terms of shading). Grass/sedge/shrub communities were assigned a height of 1.5 m. (2) Where riparian communities were simple, mature and data were available, preference was given to Basin-specific measured values from TMDL field monitoring. For instance, forty-four mature Cottonwoods at their “natural” height were measured (average top of canopy measured with a LASAR rangefinder) along the mainstem and Middle Fork of the John Day River. The 75^{th} percentile of these values was utilized for cottonwood potential in the John Day Basin (**Table C-3**). {add Deschutes Basin information} (3) Basin-specific publications (cited in **Appendix 2**) on natural potential riparian vegetation associations provided, (where cited in **Appendix 3, Table C-12**), composite structure description or in some instances height for complex vegetative structures. (4) McAllister (2008) cited historic reports of willow heights that coincide with modern shrub willow heights in the John Day and Deschutes Basins (**Table C-3**).

Professional judgment was employed to synthesize the various publications, monitoring data and methods described in the preceding paragraph. The selected estimate of natural potential vegetation community typical heights are shown in **Appendix 3**, **Table C-12** (4^{th} column from right) with annotations regarding the source or method of determination. Note that the final height averages in the appendix are the average stand height for the shade-producing species.

Table C-3. Species Heights Used in the Determination of Potential Vegetation Community Height

{add Deschutes Basin information}

	OSU Rangeland Factsheets		Trees to Know in Oregon (EC 1450, OSU & ODF, 1999)			Bever, D. N., 1981. Northwest Conifers, A Photographic Key			
Tree Type	height (m	notes	height (m)	height/note	0.75x adjustment if only extreme value available	height	average height (m)	preliminary selected height (m)	final stand height value in meters (conifers are reduced to 0.75 of individual tree height to account for canopy)
Douglas Fir				may exceed 250 feet (76 m)	57			57.0	42.8
Grand Fir				up to 250 feet (76 m)	57			57.0	42.8
Pacific Silver Fir				up to 180 feet (55 m)	41.3			41.3	30.9
Subalpine Fir				generally less than 100 feet (30.5 m)	22.9	40-100 ft (12-30.5 m)	21.3	21.3	15.9
White Fir				up to 200 feet (61 m)	45.8			45.8	34.3
Mountain Hemlock				up to 100 feet (30.5 m)	22.9	60-100 ft (18-30 m)	24.0	24.0	18.0
Western Hemlock				up to 200 feet (61 m)	45.8	125-200 ft (38-60 m)	49.0	49.0	36.8
Lodgepole Pine				up to 100 feet (30.5 m)	22.9	30-100 ft (9-30 m)	19.5	19.5	14.6
Ponderosa Pine				up to 180 feet (55 m)	41.3	125-180 ft (38-55 m)	46.5	46.5	34.9
Whitebark Pine				generally less than 50 feet (15 m)	11.3	20-50 ft (6-15 m)	10.5	10.5	7.9
Englemann Spruce				up to 120 feet (36.5 m)	27.4	80-120 ft (25-37 m)	31.0	31.0	23.3
Sitka Spruce				up to 180 feet (55 m)	41.3	125-180 ft (38-55 m)	46.5	46.5	34.9
Mountain Alder	2-5	occasionally 12 m (avg 3.5 m)						3.5	3.5
Red Alder				up to 120 feet (36.5 m)	27.4			27.4	27.4
White Alder				up to 80 feet (24 m)	18.0			18.0	18.0
Quaking Aspen				up to 80 feet (24 m)	18.0			18.0	18.0
Water Birch				up to 53 feet (16.2 m)	12.2			12.2	12.2
Narrowleaf Cottonwood				up to 79 feet (24.1 m)	18.1			18.1	18.1
Red-Osier Dogwood	1.4-6	total range (avg 3.7 m)						3.7	3.7
Rocky Mountain Maple				generally under 12 feet (3.7 m)	2.8			2.8	2.8
Oregon White Oak				up to 98 feet (29.9 m)	22.4			22.4	22.4
Geyer's Willow	4-6	total range (avg 5 m)						5.0	5.0
Lemmon's Willow	5	if favorable conditions (assume 4 m)	12	often this tall in Western Oregon				4.0	4.0
Scouler Willow	2-12	occasionally 20 m (avg 7 m)		can get to 12 m in Western Oregon	9.0			7.0	7.0
Yellow Willow	3-7	(avg 5 m)						5.0	5.0
Pacific Willow	5-15	occasionally 20 m (avg 10 m)		40-60 feet (12-18 m)				15.0	15.0

dbutche:
preference was given to average rather than extreme values, when a range is given. Where data was provided only for extremes, the height was adjusted downward to 0.75 to aim toward a more average value (for both conifers and deciduous).

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for conifers with individual tree values for the upper end of the range only, this is the second 0.75 reduction, the first for the difference between extreme and typical and the second for the difference between individual and stand height. This adjustment was not made for deciduous trees, where individual heights and stand heights are more similar.

Table C-3 *(continued)*. Species heights used in the determination of potential vegetation community height.

In-Basin Measured Heights (Average stand height, except cottonwoods measured individually. For cottonwoods and willows, the 75th percentile was selected for potential)		
Mixed conifer at Trout Farm (n=5)	30.5	30.5
Cottonwood on mainstem and Middle Fork (n=44)	27.4	27.4
Large Willow (n=5)	22.9	22.9
Upper N. Fk mixed Larch, Lodgepole, Spruce, Douglas Fir (n=5)	29.0	29.0
Various shrub willows (n=14)	3.5	3.5
Upper N. Fk mixed Lodgepole and Douglas Fir	27.4	27.4
Upper N. Fk mixed Spruce and Douglas Fir	29.6	29.6
McAllister on Willows, Historic Reconstruction		
Historical quote of Willow heights along the North Fork Beaver Ck east of Paulina	3.7	3.7
Crowe et al. Understory Vegetation Heights		
2.5-m Red Osier Dogwood (p. 165), 2.8-m mixed red-osier dogwood, thimbleberry, oceanspray, Rocky Mountain maple and Pacific yew (p. 167); 5-m Rocky Mountain maple (p. 169); 4.7-m black hawthorn (p. 180); 6 to 6.3-m black hawthorn, Lewis' mockorange, serviceberry, Rocky Mountain maple, blue elderberry, oceanspray, and cascara (p. 182, 360); 4-m Mountain alder (p. 193); 5 to 5.3-m mountain alder with red-osier dogwood (p. 195, 199); 15-m western birch (p. 223); 2 to 3.5-m sitka alder (p. 239, 242); 1.5-m dusky willow (p. 247); <6-m dwarf Engelmann spruce and lodge-pole pine (p. 259); 3.4 to 5.5-m geyer willow, booth willow, lemmon willow, bebb willow, and/or (occasionally) bog birch (p. 273, 280); 5.7 to 6.6-m Rocky Mountain maple, Mallow ninebar, common snowberry, baldhip rose, Lewis' mockorange, and western thimbleberry (p. 305, 309); 15-m water birch shrub canopy, but under black cottonwood and white alder (p. 335); 3-m red alder (p. 381).		

Note: For grass/shrub communities, a 1.5 meter height was applied in **Table C-12**. The Crowe et al., (2004) understory heights provided here could be used for site-specific determinations where larger shade producing vegetation is absent, but otherwise was only used as general supportive information.

6. Estimate potential foliage density for each EP Type

For each EP Type, a single density value was assigned to the natural potential vegetation community. Density determination methods ranged from site field observations (plot values of Crowe et al., 1997 & 2004; Wells 2006; and TMDL monitoring) to assumptions regarding typical riparian forests, to a density surrogate from McAllister (2008) where historic record event frequency is employed. The canopy cover (Cov) assessments of Crowe et al., 2004 and Wells, 2006 were used. We recognize that these canopy cover densities are difficult to apply in this context, because data are reported as averages for each species, some with lateral overlap (and therefore can total to more than 100%) and the degree of overlap of various over- and under-story canopies is not provided. Nonetheless, the canopy cover data and descriptions provide substantial information regarding vegetation density. The maximum potential for dense stands was set at 90%. The selected estimates of natural potential vegetation community densities are listed in **Appendix 3** with annotations regarding the source or method of determination.

7. Estimate distribution of vegetation types by percent

Where stands of shade-producing vegetation are intermittent, each vegetation community within that EP Type was assigned a frequency based on the proportion of the stream length it occupies. For example, reaches within EP Type 8 are potentially 80% conifer forest and 20% willow-shrub-grasses, in longitudinal proportions of vegetation occurrence along the stream.

8. Select height and density ranges for generalized shade curves

A limited number of curves have been developed for selected height and density increments (**Chapter 2.1** of the Master TMDL document). Nine curves approximate the range of the more than sixty identified (perennial) EP Types across the two Basins. While treed riverscapes of varying density can be explicitly assessed via EP Type (**Table C-12**), areas of meadow potential cannot, as the EP Type vegetation height estimate is more specifically assessed for trees than low vegetation. Meadow potential is not assessed via the generalized shade curves and should be evaluated on a case-by-case basis by DMA's and DEQ. For temperature model corridors, this process is discussed in **Step 9**.

9. Identify areas of meadow potential

For the purpose herein, the term meadow is used to address relatively flat riparian areas with grasses, shrubbery and wetland plants and lacking in large woody vegetation. Meadows will be invoked in areas where meadow complexes are thought to be the potential – in areas of low valley gradient that were not likely forested and in areas of existing meadows where that is believed to be the natural condition.

a. Locating meadows outside of temperature model corridors. As stated in **Step 8**, meadow potential is not assessed via the generalized shade curves and should be evaluated on a case-by-case basis by DMA's and DEQ.
b. Locating meadows in temperature model corridors. This step commenced with a process of elimination. First, we eliminated v-shaped valleys or valley bottoms with geomorphic slopes that are greater than those of typical riparian meadows. This was completed by reach-scale examination of 10-m DEM inclined illumination graphic displays in ArcMap™ (v. 9.3). Other areas were excluded based on historical information and identification of existing non-meadow reaches that are believed to be nearly at potential, such as the forested upper North fork Wilderness in the Wallowa-Whitman National Forest which resembles the fore-mentioned meadow valley-form criteria. Additionally, meadows were not placed presumptively. Unless there is evidence for meadow potential, larger over-story vegetation is assumed, though of varying density as indicated in **Appendix 3**. Based on this process of elimination reaches of meadow potential were not identified along the model corridors of the mainstem John Day and the North Fork John Day {and

parts of the Deschutes Basin} However, areas of meadow potential were identified along the Middle Fork of the John Day {and areas of the Deschutes Basin}. This is because there are large existing meadow complexes and information indicating that meadows pre-date earliest written or photographic records. For example, **Figure C-2 and Figure C-3** are historic and recent images of one such complex is located 92.9 kilometers upstream from the mouth of the 112.95 km Middle Fork model corridor.

Where not excluded by the process of elimination described previously in this step, meadow potential was evaluated through two criteria, (1) the presence of existing meadows in areas that are believed to have meadow pre-history and (2) areas of exceptionally low stream gradient sustained over substantial distances (0.3%, more than 1.0 km) that are not currently forested and do not exhibit constrained river meander. Gradient was assessed through Ttools (GIS sampling software, 10-m DEM), using a 1.0-kilometer running average (**Figure C-1**), and the presence/absence of forest was viewed with uncompressed half-meter pixel resolution imagery of the National Agriculture Imagery Program (NAIP). Locations of identified meadow potential are shown in **Figure C-1**.

Figure C-1. Locations of identified meadow potential.

Upper Middle Fork gradient (black line) and elevation (blue line) derived from a USGS 10-m DEM sampled at 50-m intervals, from the upper model boundary to a point 50 km downstream. This reach extends approximately from Mill creek to Big Creek. The remaining lower Middle Fork is not considered to have meadow potential.

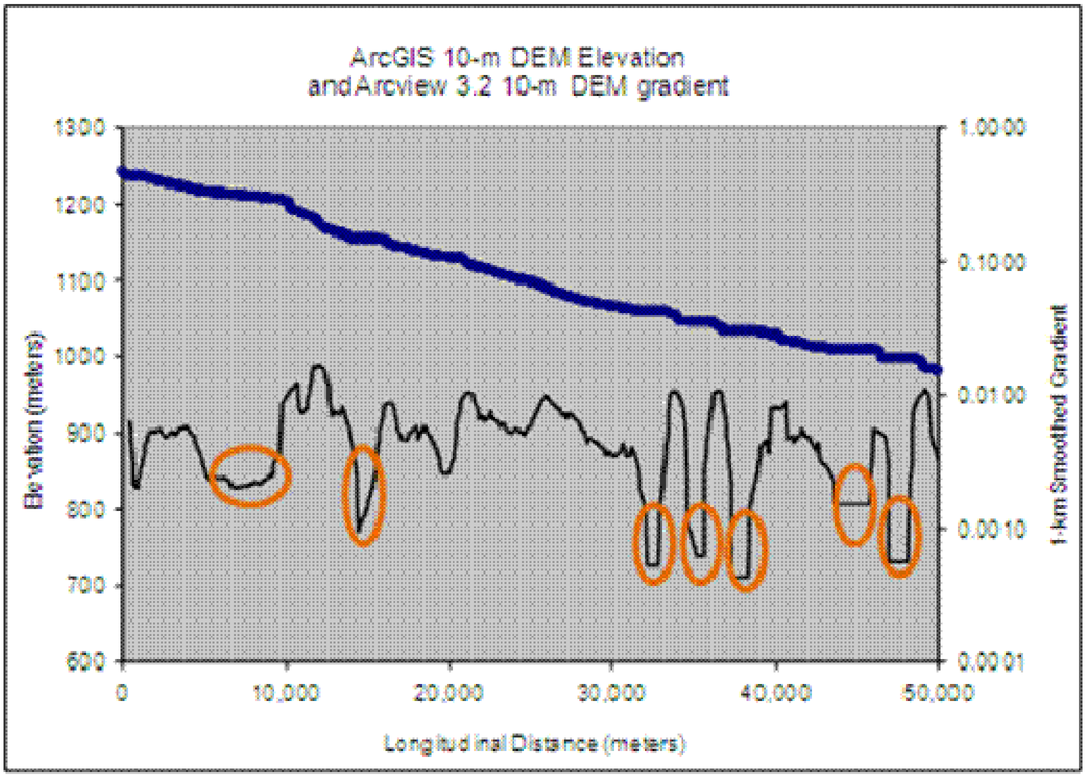


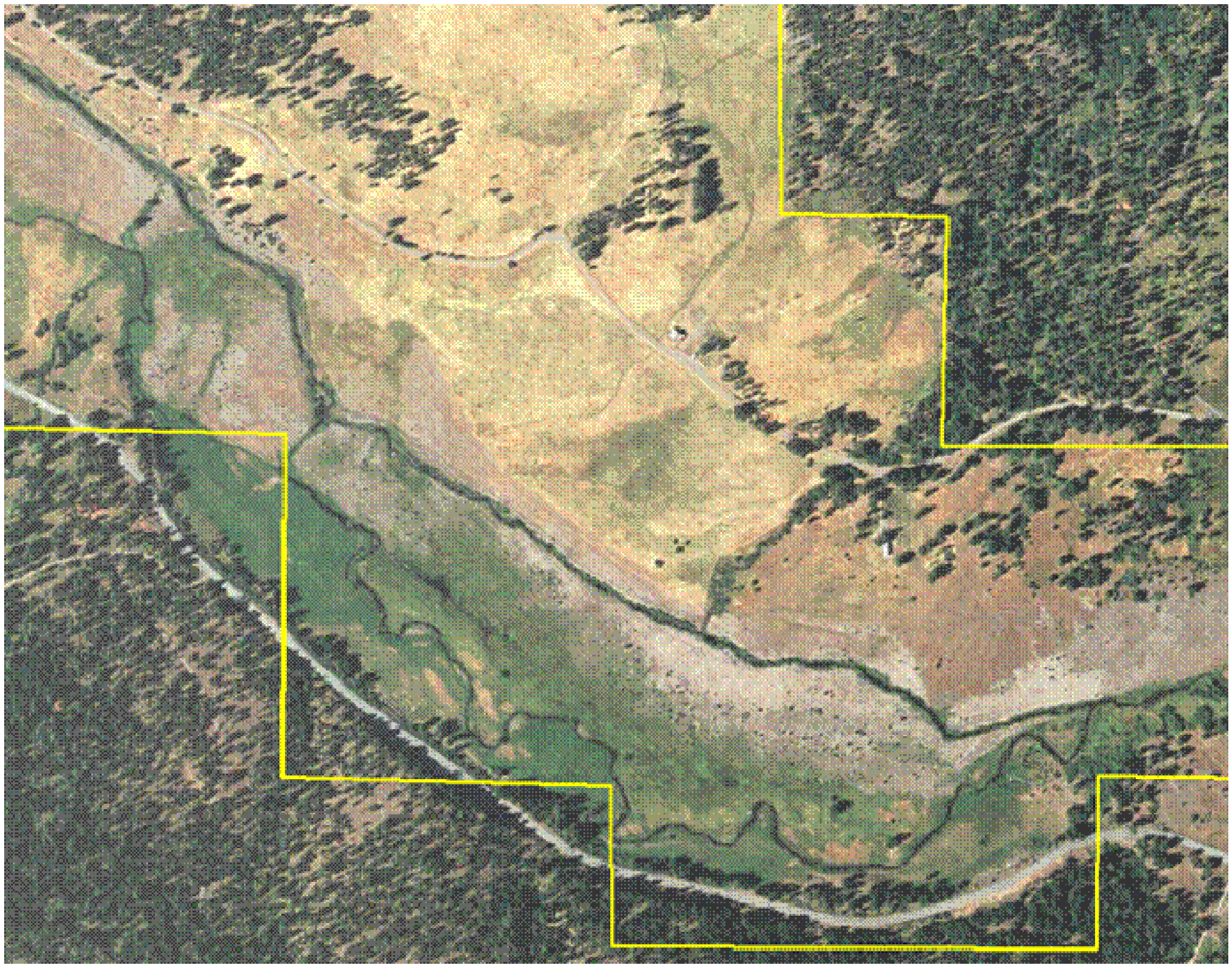
Figure C-2. Meadow complex at confluence of Middle For John Day and Ruby Creek, 1939 and 1956.

Upper Middle Fork historical photos (figure excerpted from USBR, 2008).

Figure 10 – Example of Dredge Mining Impacts on the John Day River and Adjacent Floodplain Reach MF8. The top photograph shows the river conditions in 1939, just prior to the start of dredgi operations in this reach. The bottom photograph was taken in 1956, almost 15 years following the end dredge mining in the basin.

Figure C-3. Upper Middle Fork Meadow complex in 2005.

National Agriculture Imagery Program (NAIP) orthoimage at Ruby Creek confluence. The area between the yellow boundary lines is the Oxbow Conservation area of the Warm Springs Indian Reservation. Note that this image covers the same area as that of Figure C-2.



10. Apply natural potential vegetation estimates to temperature modeling and allocation

a. Make EP Types spatially explicit by identifying Ecoregion and valley form within 100-m digitized buffers along temperature model corridors. For model corridors, EP Types are identified, reach by reach, in ArcMap™ via visual examination of Ecoregion and 10-m DEM hillshade layers. Meadow areas are not located through the preceding steps, as shade-producing vegetation was targeted. Meadows will be assessed separately, as described in the previous step.

b. Apply estimated height and density in the Heat Source temperature model. Model reaches were longitudinally delineated by common valley floor width, gradient, shape and Ecoregion – bracketing EP Types (**Table C-4 and Table C-5** specify valley class criteria for model corridors). Additional breaks were made based on meadow potential. These steps were carried out manually in ArcMap™ based on a 10-m DEM and Ecoregion layer. For the Middle Fork John Day {and areas in the Deschutes Basin} additional breaks were added to delineate large restoration areas. The North Fork John Day delineation includes Wilderness boundaries and restoration areas as well. For each reach in each model corridor, the EP Type was identified. Heat Source 8 model input nodes were associated with the corresponding EP Types. Where EP Types are characterized with both tree and low vegetation heights, these stands were randomly assigned to the potential vegetation input cells, according to the weighted distribution of **Appendix 3 (Table C-12)**.

   Because the assessed riparian corridor is narrow, we assume no transverse variation in potential vegetation height and density, within the distance in which vegetative shade may influence stream temperature. Accordingly, each longitudinal data input node in Heat Source can be consistently coded across all radial subsamples for an EP Type, and this will be varied longitudinally by associating an EP Type with each node. On the John Day mainstem, downstream of Picture Gorge (Reach ID #6-10), the topography suggests deep canyons that will limit the potential riparian width. We assume that on the steep canyon walls and canyon rims, existing vegetation is at its potential height and densities.

   The resultant reach breakdown and associated height and density are provided in **Tables C-6 through C-8**. As well, the reach breaks are illustrated in **Figures C-4 through C-6.** {add tables, figures and callouts for the Deschutes Basin}

Table C-4. Simplified nomenclature (Code A-D) for the various valley classes of McAllister, 2008.

Valley Subtype Code	Valley Classification (McAllister, 2008)	Valley Gradient (McAllister, 2008)
A	Broad valley/low gradient; flat or gently sloping floodplain	< 1.8%
B	Narrow, V-shaped valleys with high gradient	>4.5%
C	Narrow to moderately wide V- or Trough-shaped valleys with moderate gradient	1.8-4.5%
D	Trough or V-shaped valleys with low gradient	<1.8%

Table C-5. Method of determining valley type.

For classifying valley subtypes, for valley gradient < 1.8:
-If valley width < 100 m or potential meander belt width is partly (≥20% valley length) constrained, valley subtype is D
-If valley width is > 100m and potential meander belt width is mostly (>80% of valley length) unconstrained, valley subtype is A
Otherwise, valley types can be distinguished by gradient at breaks of 1.8 and 4.5, as shown in the table above.

Table C-6. Mainstem temperature model reaches with height and density of potential vegetation.

Reach ID #	Upper node	Lower node	Model node range (meters from mouth)		Level 4 Ecoregion	Valley sub-type	Ecoregion-Physiographic Type	Land Cover Height in meters (stream length in %)	Land Cover Density (%)
	Mainstem John Day River, classified into reaches based on ecoregion, valley gradient and subtype breaks								
1	model boundary	bottom of Ecoregion 11l	437000	433750	11l	C	57	29.3 (100)	80
2	top of Ecoregion 11d	conifer forest lower edge	433700	430050	11d	C	49	28.8 (100)	85
3	conifer forest lower edge	Deardorff Creek	430000	424800	11a	D	8	27.4 (80) 2.5 (20)	85 85
4	Deardorff Creek	Prairie City	424750	409600	11a	A	43.5	27.4 (80) 2.5 (20)	85 85
5	Prairie City	top of Picture Gorge	409550	316550	11a	A	43.5	27.4 (80) 2.5 (20)	85 85
6 *	top of Picture Gorge	North Fork	316500	282250	11a	D	8	21 (40) 2.5 (60)	85 85
7 *	North Fork	Service Creek	282200	238200	11a	D	8	21 (40) 2.5 (60)	85 85
8 *	Service Creek	bottom of Ecoregion 11a	238150	135350	11a	D	8	16.3 (25) 2.5 (75)	85 85
9 *	top of Ecoregion 10k	bottom of Ecoregion 10k	135300	17000	10k	D	2	10.8 (50) 2.5 (50)	90 90
10 *	top of Ecoregion 10e	Tumwater Falls	16950	0	10e	D	41	8.4 (50) 1.5 (50)	90 90

* Outside the 50 m riparian buffer was left at "existing" vegetation values.

Figure C-4. Ecoregion map with reach breaks for mainstem John Day River potential vegetation.
Refer to Figure C-9 for Ecoregion legend.

Table C-7. North Fork temperature model reaches with height and density of potential vegetation.

North Fork John Day River, classified into reaches based on ecoregion, valley gradient and subtype breaks									
Reach ID #	Upper node	Lower node	Model node range (meters from mouth)		Level 4 Ecoregion	Valley sub-type	Ecoregion-Physiographic Type	Land Cover Height in meters (stream length in %)	Foliage Density (%)
1	model boundary	bottom of wide valley	172900	166950	11l	A	55	29.9 (100)	53
2	top of narrow valley	immediately above Wilderness	166900	164300	11l	D	57.5	22 (100)	53
3	top of Wilderness	ecoregion transition	164250	151500	11l	C	57	existing	
4	ecoregion transition	ecoregion transition	151450	148750	11d	D	49.5	existing	
5	ecoregion transition	ecoregion transition	148700	143950	11d/11l	D	49.5-57.5	existing	
6	ecoregion transition	ecoregion transition	143900	140500	11d/11l	D	49.5-57.5	existing	
7	ecoregion transition	bottom of Wilderness	140450	120500	11l	D	57.5	existing	
8	immediately below Wilderness	above flat valley bottom, ecoregion transition	120450	112350	11l	D	57.5	existing	
9	top of flat valley bottom	bottom of flat valley bottom	112300	108650	11b	D	11	existing	
10	bottom of flat valley bottom	narrow flat valley bottom	108600	104950	11b	D	11	existing	
11	top of v-shaped valley	bottom of v-shaped valley, bottom of 9 km USFS restoration	104900	91450	11b	D	11	existing	
12	top of flat valley bottom	bottom of flat valley bottom	91400	64450	11b	D	11	21.9 (100)	53
13	top of sinuous valley	bottom of sinuous valley, ecoregion transition	64400	54100	11b	D	11	21.9 (100)	53
14 u/s	ecoregion transition	bottom of narrow valley	54050	32200	11a	D	8	27.4 (80)	57
								2.5 (20)	57
14 d/s	ecoregion transition	bottom of narrow valley	32200	28800	11a	D	8	27.4 (80)	85
								2.5 (20)	85
15	top of wide valley	bottom of wide valley	28750	24400	11a	A	43.5	21 (40)	85
								2.5 (60)	85
16	top of bare rock (Mon. gage)	bottom of bare rock	24350	23500	11a	D	8	21 (40)	85
								2.5 (60)	85
17	top of wide lower valley	mouth	23450	0	11a	A	43.5	21 (40)	85
						A		2.5 (60)	85

green shading indicates areas undergoing broad scale restoration or preservation

Figure C-5. Ecoregion and Wilderness boundary map with reach breaks for North Fork John Day River potential vegetation. Refer to Figure C-9 for Ecoregion legend.

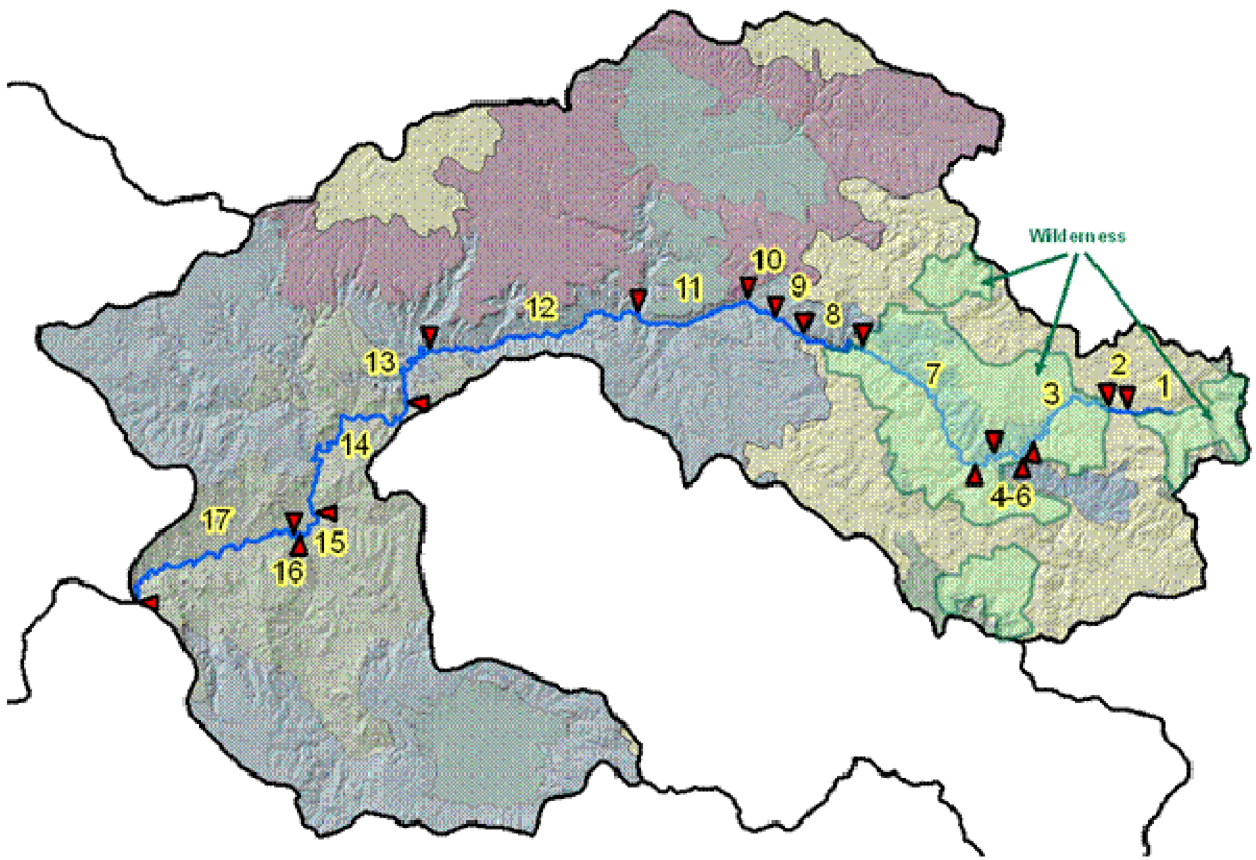


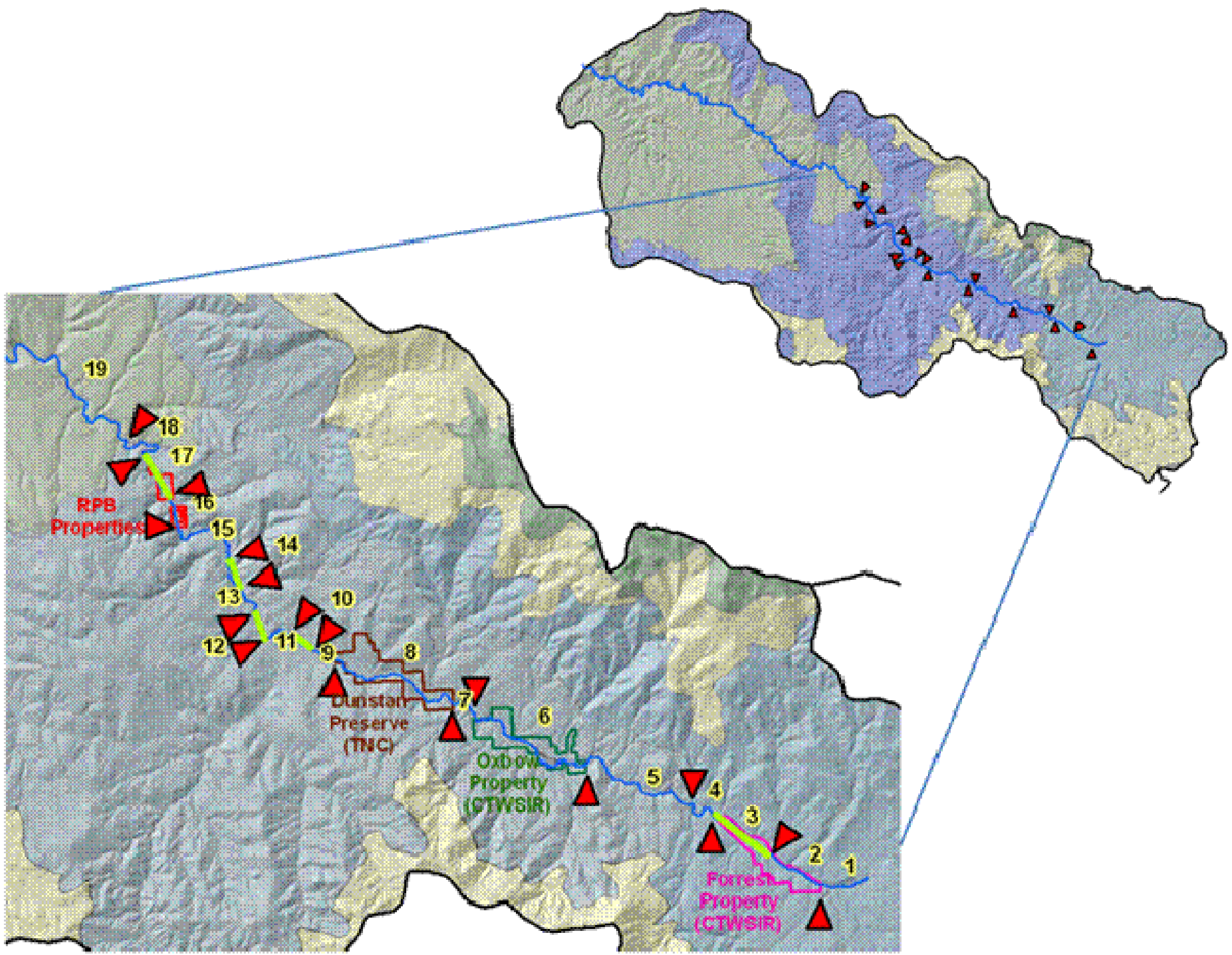
Table C-8. Middle Fork temperature model reaches with height and density of potential vegetation.

Reach ID #	Upper node	Lower node	Model node range (meters from mouth)		Level 4 Ecoregion	Valley sub-type	Ecoregion-Physiographic Type	Land Cover Height in meters (stream length in %)	Foliage Density (%)
	Middle Fork John Day River, classified into reaches based on ecoregion, valley gradient and subtype breaks								
1	model boundary	top of CTWSIR Forrest Property	112950	110650	11d	D	49.5	24.7 (100)	80
2	top of CTWSIR Forrest Property	top of valley gradient <0.3%	110600	107850	11d	A	47.5	16.3 (100)	90
3	top of valley gradient <0.3%	bottom of CTWSIR Forrest Property & bottom of valley gradient < 0.3%	107800	104300	11d	A	64	0.7 (100)	90
4	bottom of CTWSIR Forrest Property & bottom of valley gradient < 0.3%	ecoregion transition	104250	102500	11d	D	49.5	24.7 (100)	80
5	ecoregion transition	top of CTWSIR Oxbow Property	102450	96600	11b	D	11	21.9 (100)	80
6	top of CTWSIR Oxbow Property	bottom of CTWSIR Oxbow Property	96550	89850	11b	A	8.5	13.1 (100)	85
7	bottom of CTWSIR Oxbow Property	top of TNC Dunstan Property	89800	88450	11b	D	11	21.9 (100)	80
8	top of TNC Dunstan Property	bottom of TNC Dunstan Property	88400	82050	11b	A	8.5	13.1 (100)	85
9	bottom of TNC Dunstan Property	top of valley gradient <0.3%	82000	81000	11b	A	8.5	13.1 (100)	85
10	top of valley gradient <0.3%	bottom of valley gradient < 0.3%	80950	79750	11b	A	64	0.7 (100)	90
11	bottom of valley gradient < 0.3%	top of valley gradient <0.3%	79700	78550	11b	D	11	21.9 (100)	80
12	top of valley gradient <0.3%	bottom of valley gradient < 0.3%	78500	77200	11b	D	64	0.7 (100)	90
13	bottom of valley gradient < 0.3%	top of valley gradient <0.3%	77150	75650	11b	D	11	21.9 (100)	80
14	top of valley gradient <0.3%	bottom of valley gradient < 0.3%	75600	74300	11b	A	64	0.7 (100)	90
15	bottom of valley gradient < 0.3%	top of RPB property	74250	70750	11b	D	11	21.9 (100)	80
16	top of RPB property	top of valley gradient <0.3%	70700	69350	11b	A	8.5	13.1 (100)	85
17	top of valley gradient <0.3%	bottom of RPB property, bottom of valley gradient < 0.3%	69300	67100	11b	A	64	0.7 (100)	90
18	bottom of valley gradient < 0.3%	ecoregion transition	67050	64450	11b	D	11	21.9 (100)	80
19	ecoregion transition	mouth	64400	0	11a	D	8	27.4 (80)	85
								2.5 (20)	85

green shading indicates areas undergoing broad scale restoration

Figure C-6. Ecoregion map with reach breaks for Middle Fork John Day River potential vegetation.

Shown at the subbasin scale and as an expanded view in the area where meadows and project sites require fine resolution. Green lines indicate likely meadow reaches based on low valley gradient. Refer to Figure C-9 for Ecoregion legend.



4. REFERENCES

USBR, (2008). Middle Fork and Upper John Day River Tributary Assessments Grant County, Oregon. US Bureau of Reclamation Technical Service Center, Denver, CO and Pacific Northwest Regional Office, Boise, ID. GIS Atlas.

Also, refer to Appendix 2 for additional references cited in this section.

{for Deschutes Basin, add references}

APPENDIX 1: ANNOTATED NATURAL POTENTIAL VEGETATION LITERATURE REVIEW

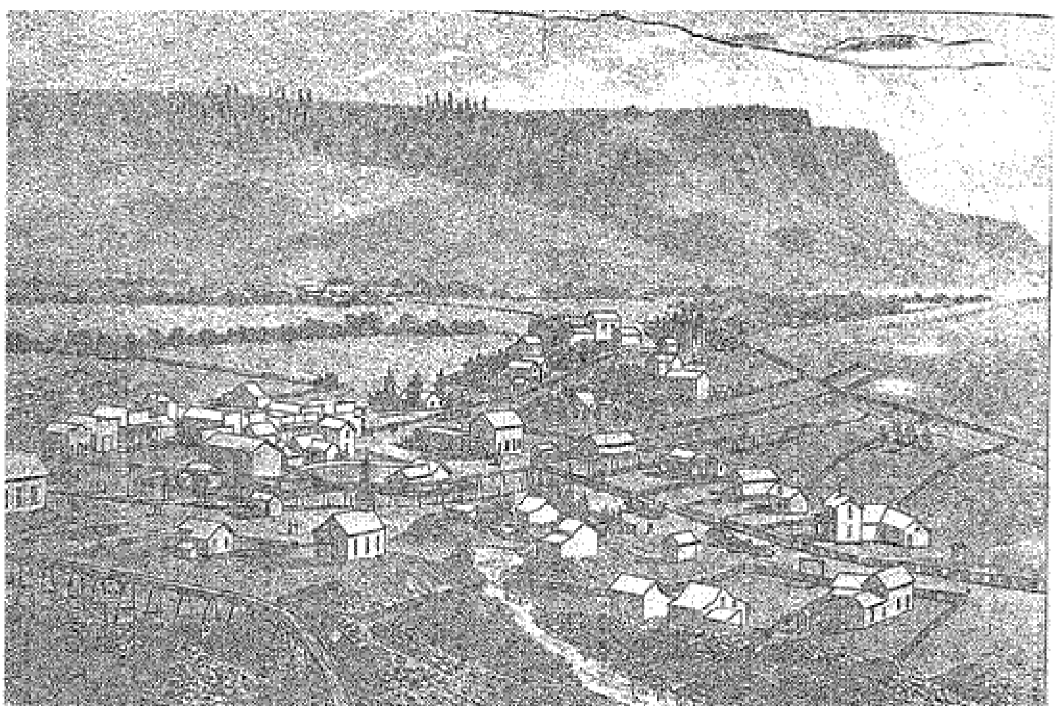
The following literature review targets publications, reports and geographic and historical information that specifically address the John Day and Deschutes Basins, with regard to historic and natural riparian conditions. Bold font annotations below are quotes or description of content that elucidate potential conditions or degree of change. This review focuses primarily on vegetation and may have relevance for morphologic and hydrologic conditions as well, though other TMDL development literature reviews were directed toward those attributes.
{add Deschutes Basin-specific references}

- Beshta, Robert L. and Ripple, William J., 2005, Rapid Assessment of Riparian Cottonwood Recruitment: Middle Fork John Day River, Northeastern Oregon, Ecological Restoration, Vol 23, No. 3, ISSN 1522-4740 E-ISSN 1543-4079, Board of Regents of the University of Wisconsin System. ***Referenced in Beshta and William 2005: Grant, K. 1994. Oregon River Restoration: A Sensitive Management Strategy Boosts Natural Healing. Restoration and Management Notes 12 (2):152-159. Grant "documented a 50-percent decline in tree cover from 1939-92 along some portions of the (Middle Fork) valley."***
- Clarke, S. E. and S. A. Bryce, eds., 1997. Hierarchical subdivisions of the Columbia Plateau and Blue Mountains Ecoregions, Oregon and Washington. General Technical Report, PNW-GTR-395. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. 114 p; ftp://ftp.epa.gov/wed/ecoregions/or/or_eco_lg.pdf ***Oregon Ecoregions.***
- Crowe, E. A. and Clausnitzer, R. R., 1997. Mid-Montane Wetland Plant Associations of the Malheur, Umatilla and Wallowa-Whitman National Forests. United States Department of Agriculture Forest Service, Pacific Northwest Region, Technical Paper R6-NR-ECOL-TP-22-97.
- Crowe, E. A., Kovalchik, B. L. and Kerr, M. J., 2004. Riparian and Wetland Vegetation of Central and Eastern Oregon. Oregon State University, Portland, OR. ***Classification of wetland systems based on Ecoregion, geomorphology, soils and plant associations. The plant association in this classification is the native potential on each fluvial surface. This text describes the expected potential vegetation community (association) for each dominant species type. Once correct associations for an area are identified, available information includes: Level I Ecoregion, elevation, percent soil cover, dominant species and %canopy cover.***
- Fogg, J., 2007. BLM internal memo – John Day River Hydrology Observations for Riparian Assessment. ***"Since most of the unconstrained sections of the river are in agricultural production with constructed berms and terraces, the capability of the system to develop a forested riparian ecosystem is presently very limited. Obviously, restoration of the early Cottonwood-forest riparian condition will require some significant institutional changes."***
- Kagan, J., 1992. {Draft} Manual of Oregon Actual Vegetation. Prepared for the Oregon Gap Analysis Program, directed by the Idaho Cooperative Fish & Wildlife Research Unit, University of Idaho, in cooperation with the Oregon Department of Fish and Wildlife and the Oregon Natural Heritage Program. Edited by Blair Csuti, Oregon Gap Analysis Program Director.
- McAllister, L. S., 2008. Reconstructing Historical Riparian Conditions of Two River Basins in Eastern Oregon, USA. Environmental Management, 42:412-425, DOI 10.1007/s00267-008-9127-1. ***p 413-414 "Although Native Americans had been practicing land management such as burning for thousands of years prior to European arrival (Robbins and Wolf 1994; Meinig 1968), the changes that occurred during western expansion were more significant in their degree and extent (Todd and Elmore 1997; Barker 1996), with a greater focus on extraction of resources and hydrological modifications." "The Lewis and Clark expedition and many of the subsequent explorations of the region did not enter the interior Deschutes and John Day Basins; most of the overland travel… skirted the northern***

boundaries of these basins, near the river mouths. The Northwest and Hudson Bay Companies led fur trapping operations and explorations into the region beginning in 1811. Trapping nearly decimated the beaver by 1847…" "Due to geographic isolation of the area and conflicts between settlers and Native Americans, land in the interior basins was not opened to settlement until 1855 and was not permanently homesteaded until the 1880s (Shaver and others 1905). As the area was rapidly developed, unregulated activities such as mining, livestock grazing, agriculture, logging, railroad building, and, later, road construction and water projects altered the lands in the region (Todd and Elmore 1997; Robbins and Wolf 1994; Grant 1993) and imposed long-term impacts on riparian systems (Wissmar and others 1994; Svejcar 1997). Because of substantial land alterations throughout the study area and the paucity of suitable least-disturbed reference sites for gauging the current condition of streams, historical information can potentially provide data for establishing a more accurate picture of reference conditions for assessing current aquatic health in the region." Data are aggregated by Ecoregion and by valley gradient, width and shape. Primary data sources: written accounts from diaries, journals, scientific explorations and expedition report; GLO survey notes; historic photos. Note that not all Ecoregions are represented.

- National Park Service, 2008. Draft General Management Plan / Environmental Assessment, John Day Fossil Beds National Monument. US Department of Interior, National Park Service. ***p. 137 "In addition to serving as pastures, the lowlands along the John Day River were converted to dryland and irrigated hayfields, which also resulted in the loss of native plant communities, such as Cottonwood galleries." NPS factsheets cited in this document and found online report the historic presence of Cottonwood, Alder and Willow shading Rock and Bridge Creeks and the John Day River and the current presence of "Cottonwood/ Sedge/basin wild rye communities."***
- Oregon Natural Heritage Information Center, 1999. GAP Historical or "Pre-settlement" Land Cover. http://oregonstate.edu/ornhic/or-gap.html ***The Gap Analysis Program includes mapping of historical land cover, attempts to address information gaps regarding change in species diversity, and conditions needed to support basic biodiversity. It is based on GLO and forest and rangeland covers developed by OSU, USFS, Defenders of Wildlife, and others.***
- OSU, 2005. Oregon State University Rangeland Ecology and Management Riparian Plant Fact Sheets. http://oregonstate.edu/dept/range/riparian-plant-fact-sheets ***Reference for riparian vegetation height and density.***
- Oregon Watershed Assessment Manual (1999). developed for the Governor's Watershed Enhancement Board, http://www.oregon.gov/OWEB/docs/pubs/OR_wsassess_manuals.shtml accessed 3/26/2008.
- Potter, M. F., 1995. Oregon's Golden Years, Bonanza of the West. The Caxton Printers, LTD. ***Picture of John Day City with Cottonwood gallery in background. Also in:***
    - Phillips, 2004, John Day – A Brief History. Hutch's Printing Co., John Day, OR.

John Day about 1888. Methodist church in foreground. Possibly a Hazeltine photo.



Drawing of John Day in 1885.

- Taylor, B. and J. Kagan. 1998. Oregon's Living Legacy. Oregon Biodiversity Project. Oregon Natural Heritage Program.
- Thorson, T.D., Bryce, S.A., Lammers, D.A., Woods, A.J., Omernik, J.M., Kagan, J.S., Pater, D.E., and Comstock, J.A., 2003. Ecoregions of Oregon (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,500,000). ***Ecoregion map.***

- Thompson, Gilbert; Johnson, A. J. 1900. Map of the state of Oregon showing the classification of lands and forests. Washington DC: U.S. Department of Interior, Geological Survey. ***Abstract**: **This full-color map was located in the back pocket of a publication entitled "The Forests of Oregon" by Henry Gannett. It shows forested areas within the state of Oregon, as classified using volume per acre, and also provides ancillary information such as the location of harvested areas, burns (forest Fires) and the northern limit of redwood. The map was photographically copied, …. It was also digitized for the Forest's geographic information system (northeast Oregon portion only).*** **http://www.fs.fed.us/r6/uma/publications/history/maps.shtml**

- Tobalske, **Claudine, 2002.** Map of historical ("pre-settlement") vegetation for the state of Oregon, created with Arcview 3.2 by merging digital data from different sources: H. J. Andrews, General Land Office (GLO), Soil Survey Geographic (SSURGO), BLM, Oregon Gap analysis. ***The H. J. Andrews map forms the background into which more detailed coverages were incorporated. OR Natural heritage Program. Scale is 1:100; this updates both the 1992 and 1999 GAP analysis. GAP analysis has two citable related publications; apparently this historical cover is not published. The H. J. Andrews base map was digitized from original surveys of USFS crews headed by H.J. Andrews in the 1930s, presumably from WPA. The original cover was mapped to forest type, with a secondary classification for young forests.***

- US BLM, 1981, 1996 and 2003. Willow Studies, GIS mapping. Prineville District Office, Prineville, OR

- US BLM, 2006. Draft memo of field notes from July 17-20, 2006 Proper Functioning Condition River assessment. **From Picture Gorge to Kimberly: "Vegetation communities would include yellow/booth/coyote willow and/or alder, sedge/rush at potential, with areas of cottonwood. Potential is hundreds of years out from current conditions…" Capability is limited by road encroachment, low supply of large wood and agriculture practices that prevent river meander in wide sections. From Clarno to Butte Creek: "The current river is very different from the shifting sands of 1905 and Charlie Clarno's description of the river. He cut trees from these bars to fuel his boat." Mary Mauer said the cottonwoods from the 1940s were cut to create land for agricultural sue and the channel was straightened. Sorefoot is one example of this." From Butte Creek to Devil's Canyon: "Potential species include scattered cottonwood, torrent sedge, three square bullrush, and various willows (whiplash, yellow, booth, coyote, etc.). The channel has been sized by the 1964 flood."**

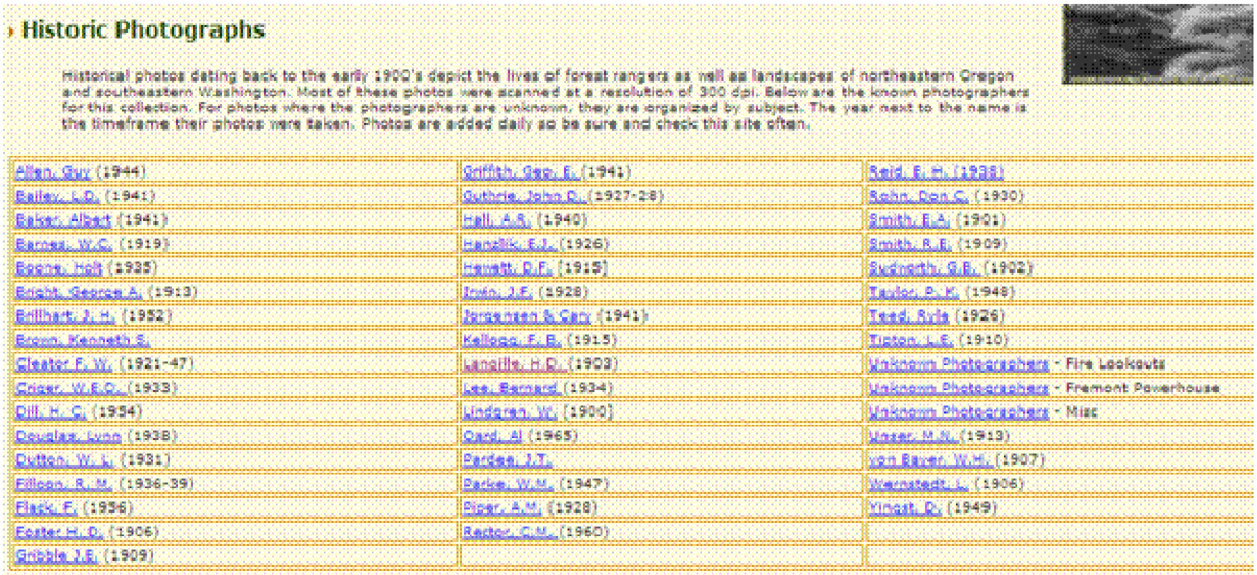
- US FS, 1995. Ecosystem Analysis of the Big Wall, Little Wall, and Skookum Watersheds. Heppner Ranger District, Umatilla National Forest. ***Intro and p 39 "…over 77% (73,372 acres) of the landscape (FS acres only) consisted of Ponderosa Pine or Pine mixture, predominantly in the late/old structure." (based on 1937 map) (p 39 indicates that the remainder were Subalpine, Lodgepole, Juniper, large Doug Fir.) p. 20- "bankfull" width/depth ratios ranged from 2.0 to 35.3… 20 of 48 reaches showed w/d>10.***

- US FS, August 10, 2005. Biological Evaluation, Proposed, Endangered, Threatened, and Sensitive (PETS) Fish and Aquatic Invertebrate Species and Habits, North Fork John Day Ranger District, Umatilla National Forest.

- US FS (Groves, K.), March 26, 2007. Wildcat Vegetative Management Aquatics Report. Umatilla National Forest. ***This report and the citation immediately above, and the associated memo, discuss target wetted w/d ratios of 10-89. The 25th percentile from all the wall creek data = 5.7% and the median is 9.0.***

- US FS, 2007. Memo. PACFISH, INFISH Effectiveness Monitoring Program – trend in Physical Stream Habitat Variables in the Interior Columbia River Basin (2001-2006). ***The Forest Service used 10 as a target for wetted w/d.***

- USFS Historic photo collection website: http://www.fs.fed.us/r6/uma/publications/history/photos_l.shtml



Historic Photographs

Historical photos dating back to the early 1900's depict the lives of forest rangers as well as landscapes of northeastern Oregon and southeastern Washington. Most of these photos were scanned at a resolution of 300 dpi. Below are the known photographers for this collection. For photos where the photographers are unknown, they are organized by subject. The year next to the name is the timeframe their photos were taken. Photos are added daily so be sure and check this site often.

Allen, Guy (1944)	Griffith, Geo. E. (1941)	Reid, E. H. (1938)
Bailey, L.D. (1941)	Guthrie, John D. (1927-28)	Rohn, Don C. (1930)
Baker, Albert (1941)	Hall, A.S. (1940)	Smith, E.A. (1901)
Barnes, W.C. (1919)	Hanzlik, E.J. (1926)	Smith, R.E. (1909)
Boone, Holt (1935)	Hewitt, D.F. (1915)	Sudworth, G.B. (1902)
Bright, George A. (1913)	Irwin, J.F. (1928)	Taylor, P. K. (1948)
Brillhart, J. H. (1952)	Jorgensen & Cary (1941)	Teed, Ryle (1926)
Brown, Kenneth S.	Kellogg, F. B. (1915)	Tipton, L.E. (1910)
Cleator F. W. (1921-47)	Langille, H.D. (1903)	Unknown Photographers - Fire Lookouts
Criger, W.E.O. (1933)	Lee, Bernard (1934)	Unknown Photographers - Fremont Powerhouse
Dill, H. C. (1934)	Lindgren, W. (1900)	Unknown Photographers - Misc
Douglas, Lynn (1938)	Oard, Al (1965)	Unser, M.N. (1913)
Dutton, W. L. (1931)	Pardee, J.T.	von Bayer, W.H. (1907)
Filloon, R. M. (1936-39)	Parke, W.M. (1947)	Wernstedt, L. (1906)
Flack, F. (1936)	Piper, A.M. (1928)	Yingst, D. (1949)
Foster H. D. (1906)	Rector, C.M. (1960)	
Gribble J.E. (1909)		

- Wells, Aaron F., 2006. Deep Canyon and Subalpine Riparian and Wetland Plant Associations of the Malheur, Umatilla, and Wallowa-Whitman National Forests. USFS Pacific Northwest Research Station, General Technical Report PNW-GTR-682. ***This provides potential vegetation community height and canopy percent cover and is more specific to some areas than the work of Crowe et al.***

APPENDIX 2: SELECTED KEY SOURCES OF POTENTIAL VEGETATION INFORMATION

This **Appendix** reflects a narrowing down of the larger literature review to the most relevant sources for basin-wide determinations of potential vegetation structure. Some data were available in GIS context and others in conventional literature.

The following table (**Table C-9**) identifies the primary non-GIS published sources of information used in estimating the types and characteristics of vegetation in the John Day and Deschutes Basin. The key GIS sources of information for this effort are listed in **Table C-10**. Both tables include various attributes regarding applicability and are followed by annotations and/or references. The spatial coverage of each reference is discussed or illustrated as well in figures and text following the tables. In addition, **Table C-11** identifies the method of data stratification by the various authors.

Other resources for potential vegetation characteristics include:

- Oregon DEQ TMDL documents: Malheur Basin draft, Miles Creeks-Eastern Hood, Willow Subbasin, Rogue Basin, Umatilla Basin
- TMDL-specific digital mapping based on color aerial photography (existing conditions for model calibration)
- Assessment of existing areas with minimal disturbance

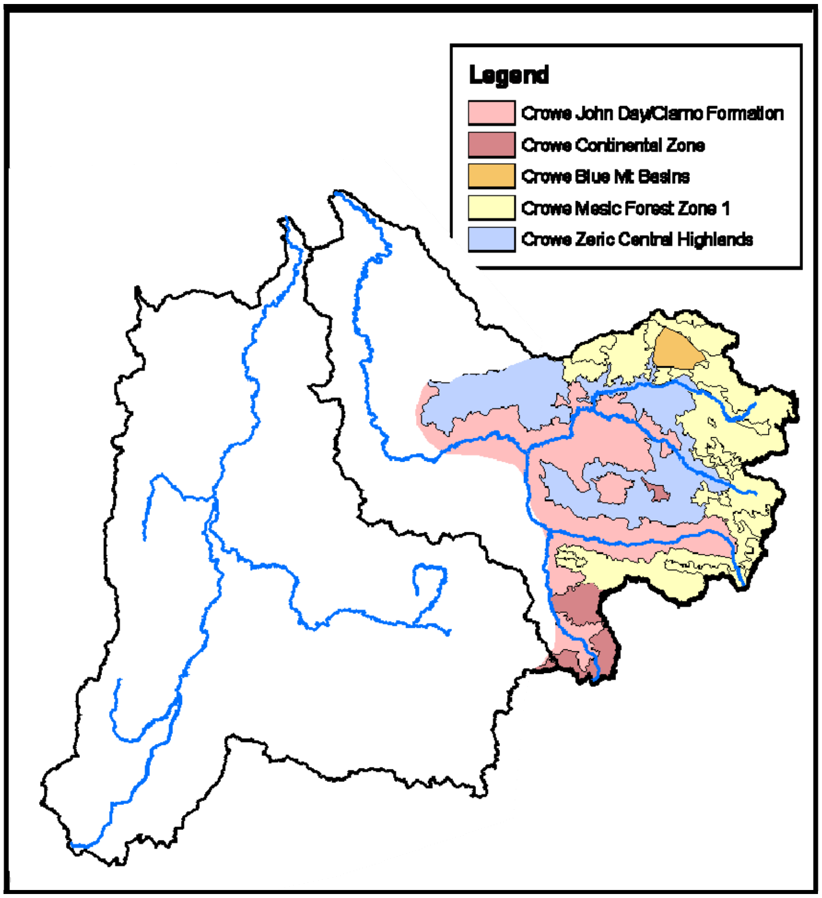
Table C-9. Principle Sources and Attributes of *Literature-derived* Land Cover Information Utilized in Estimation of Natural Thermal Potential

Information Characteristics	Mid-Montane Wetland Plant Associations of the Malheur, Umatilla and Wallowa-Whitman National Forests [1]Crowe et al., 1997	Riparian and Wetland Vegetation of Central and Eastern Oregon [2]Crowe et al., 2004	Reconstructing Historical Riparian Conditions of Two River Basins in Eastern Oregon, USA [4]McAllister, 2008	Watershed Assessment Manual [5]OWEB, 1999	Deep Canyon and Subalpine Riparian and Wetland Plant Associations of the Malheur, Umatilla and Wallowa-Whitman National Forests [9]Wells, 2006
Potential natural vegetation	best seral status, stratified by geomorphology[A1]	best seral status, stratified by geomorphology[A2]		yes, Ecoregion assemblages	associations and species % canopy,
Historic vegetation			yes		
Riparian specificity	yes	yes	yes	yes	yes
Valley or channel type specificity	yes	yes	valley form & gradient	degree of channel constraint	valley gradient and width
Spatially explicit information	Landform Key + coarse est. Level 4 Ecoregion [A1]	limited [A2]	Level 4 Ecoregion + morphology	Level 4 Ecoregion	Environment Key (elevation, soil type, landform)
Spatial resolution	Level 3 Ecoregion scale with finer subtypes (Level 4 potential is broadly described)	Level 3 Ecoregion scale with finer subtypes	Level 4 Ecoregion scale with finer subtypes	Level 4 Ecoregion scale	not scaled to Ecoregion or other spatially explicit source
Covers geographic area	disturbed wetlands in three Eastern Oregon National Forests[B1]	throughout Eastern and Central Oregon	approx. 60% (Ecoregions 10k, 11a, 11b, 11n)	approx. 80% (State-wide, except Ecoregions 10n, 11n, 11o, 80d, 80g, 80j)	deep canyons and Subalpine wetlands of the Blue Mountains Ecoregion[B2]
Land cover height and density	percent canopy	minimal, focus is on herbaceous heights, % canopy.[C]	limited[D]	none	average height of tallest/dominant species, percent canopy
Species Composition	detailed	detailed	limited	yes	detailed

Yellow shading highlights data sources chiefly used for stream temperature modeling.

[A1]Crowe et al., 1997 sub-stratifies a modified Ecoregion map by valley form, stream type, particle size, level of saturation and geomorphic surface. Coverage is illustrated below, addressing primarily the more disturbed wetland areas within the color-coded zones (colored polygons collectively encompass the John Day Basin areas of the Umatilla, Malheur and Wallowa-Whitman National Forests).

Figure C-7. Crowe et al., 1997 Spatial Coverage



[A2]Crowe et al., 2004 sub-stratifies the current Oregon Ecoregion map by valley form, stream type, particle size, level of saturation and geomorphic surface. However, floristic associations, though attributed with Level 3 Ecoregion designations, are not keyed by Ecoregion and generally cross Ecoregion boundaries. Potential vegetation is more broadly described, p 9-18, in the Hierarchy of Physical Environments section, by Level 4 Ecoregion. **Spatial Coverage:** eastern Oregon

[B1] Crowe et al., 1997 **Spatial Coverage:** As indicated by the title, only National Forest lands are addressed, not including National Forests of the Deschutes Basin. The three National Forest areas (Umatilla, Malheur, Wallowa-Whitman) are shown in color in the figure above.[A1]

[B2] Wells, 2006 **Spatial Coverage** The title indicates coverage only in three National Forests[B1], the stated study area is "the deep canyon and mid elevation benches (550–1300 m), and Subalpine (1800–2600 m) riparian and wetland plant associations of the Blue Mountains physiographic province of northeastern Oregon", with emphasis on the John Day, Wallowa and Hells Canyon Basins. Personal Communication with one of the document's collaborators, Jennifer Ferrial, indicated that the document applies primarily within the National Forests and should generally not be extrapolated to the Deschutes or un-sampled areas of the John Day. The study plots in the John Day Basin included these areas (plural sites unless noted): upper most North Fork, mid North Fork (1 site), upper Potamus Creek (1 site), Wall Creek, Strawberry Mountains, South Fork John Day (Murderer's Creek).

[C] With regard to reporting vegetation height, Crowe et al., 2004 focuses on the herbaceous component, with few exceptions. No woody vegetation over-story heights were found.

[D]McAllister 2008 mentions that dense robust Willows along the North Fork Beaver Creek east of Paulina were 12 feet tall; and that in contrast, for the Crooked River SE of Prineville, "banks of river well-lined with Willow, none of great size." Coverage is illustrated below.

Figure C-8. McAllister 2008 Spatial Coverage

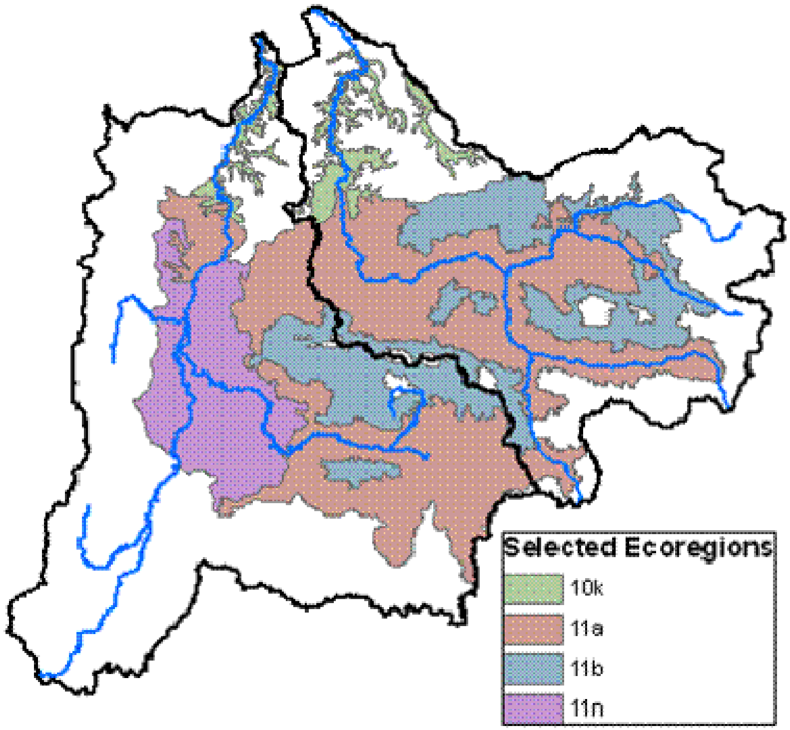


Table C-10. Principle Sources of *GIS* Land Cover Information Utilized in Estimation of Natural Thermal Potential

Information Characteristics	Ecoregions [7]Thorson, et al., 2003	Gap Existing [3, 6]ONHP	Gap Historic [8]Tobalske, 2002
Existing vegetation		yes	
Potential natural vegetation	yes		
Historic Vegetation			yes
Riparian specificity	some	slight	slight
Spatial resolution	coarse	1:100,000	1:100,000
Covers geographic area	yes	yes	yes

Figure C-9. Illustration of Level 3 and 4 Ecoregions for the Deschutes and John Day Basins (1st numeric digits – 4, 9, 10, 11 and 80)

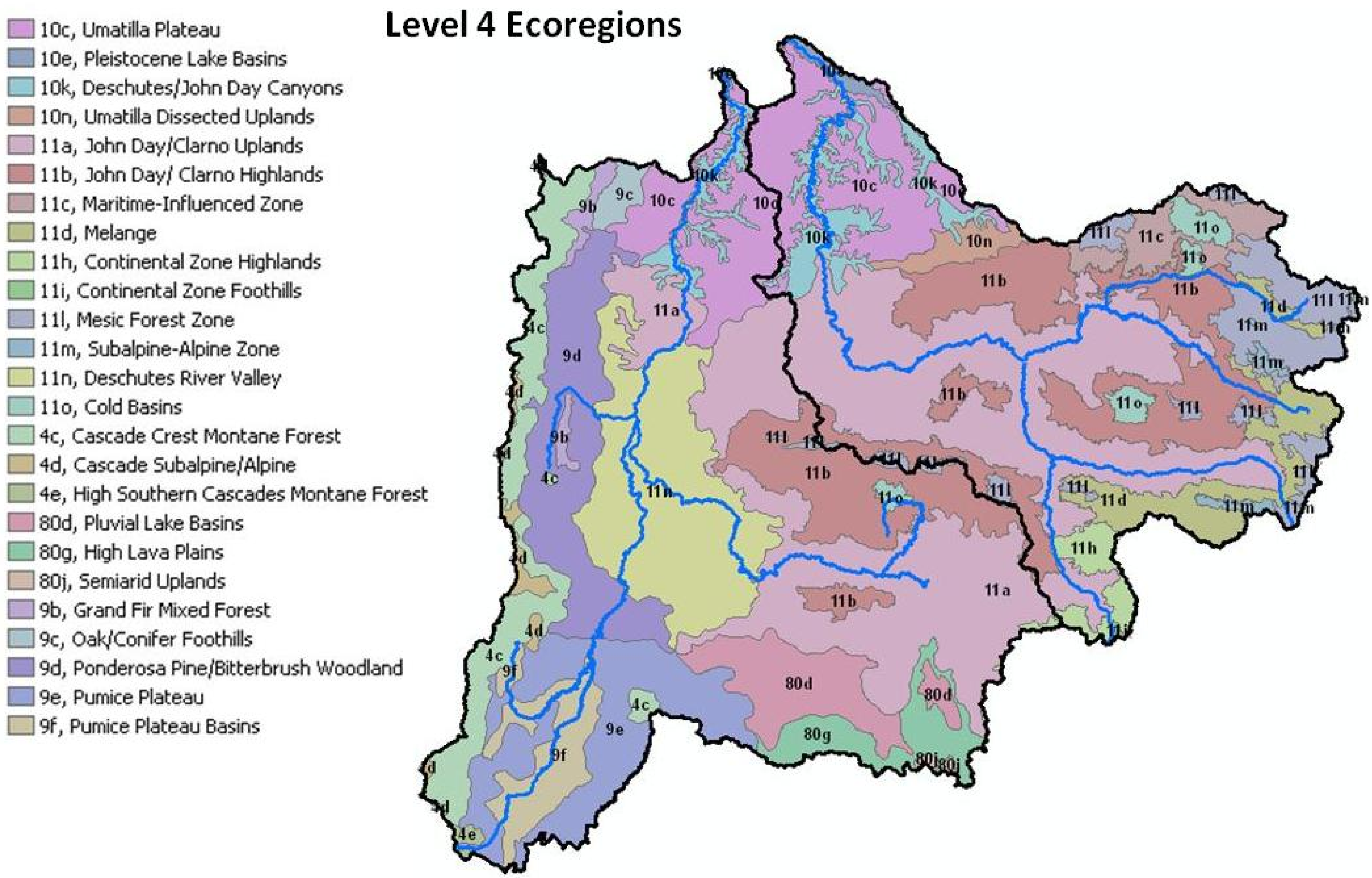


Figure C-10. Illustration of Oregon GAP historic vegetation assessment for the John Day Basin (Tobalske, 2002, Oregon Natural Heritage Program)

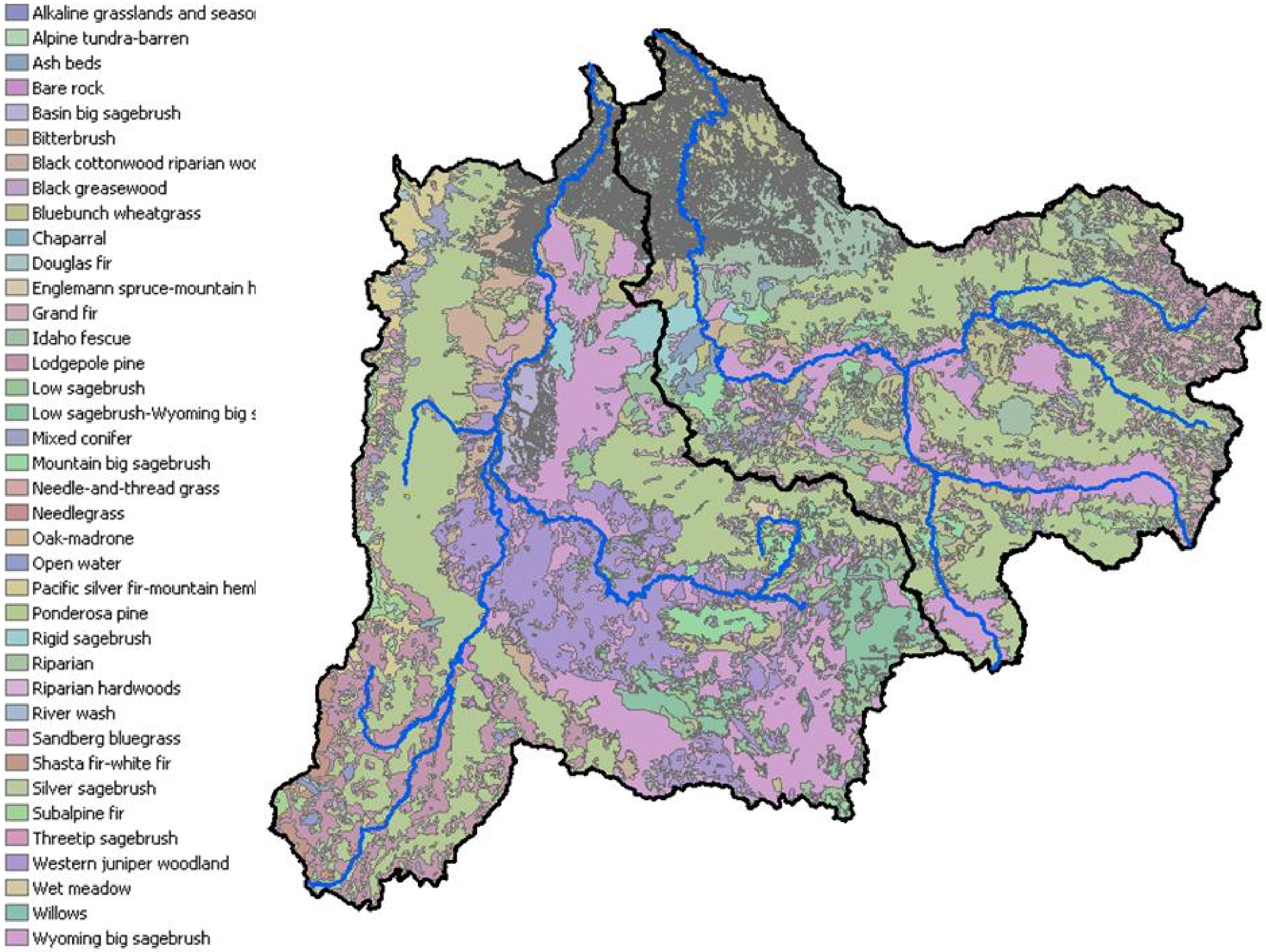


Table C-11. Summary of Vegetation Data Stratification Order and Selected Attributes

McAllister, 2008		Crowe et al., 1997				Wells, 2006			OWEB, 1999		
1st	2nd	1st	2nd	3rd	4th	1st	2nd	3rd	1st	2nd	3rd
Level 4 Ecoregion	Cross-valley contour and gradient	Simplified Level 4 Ecoregion	Valley form	Elevation	Landform	Elevation	Soil texture & valley gradient	Landform	Level 4 Ecoregion	Channel constraint	Distance from stream
10k	broad valley <1.8% grad	Continental zone and Blue Mt. Basins	broad or mod. broad <2% grad.	3k-6k ft	floodplain or overflow channel	<1600 m	valley grad <=3%	floodplain	all zones	constrained	near stream range
11a	narrow V shaped valley >4.5% grad	Xeric Central Highlands and John Day/Clarno Formation	narrow to mod. wide V or trough shaped valleys 2-4% grad (B-type)	4.5k-6.5k ft	alluvial bars	<700 m	valley grad >3%	rocky bars		un-constrained	outer range
11b	narrow to mod. wide V or trough shaped valley 1.9-4.5% grad	Mesic Forest Zone 1	narrow V shaped valleys >4% grad (A-type)	2.5k-4.8k ft	terraces	<550 m		terraces		semi-constrained	
		Mesic Forest Zone 2									
11n	narrow valley <1.8% grad	Columbia Plateau	narrow V shaped valleys 2-4% grad (A & B-type)	4.0k-7.5k ft	headwater basins	>550 m					
			broad or mod. broad <1% grad.	<4.8k ft	streambanks and narrow floodplains	>=1600 m					
				>4.8k ft	streambanks and floodplains	<2130 m					
		Other strata:	Soil saturation, particle size			<1900 m					
						>=1900 m					
						>=2100 m					
		Crowe et al., 2004:	Not keyed to landform or Ecoregion, but for each floristic association, L3 Ecoregion, Valley width and gradient, elevation, and stream type are provided.			Other strata:	Specific regions, landform slope				

Appendix 2: References

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APPENDIX 3: TYPE, HEIGHT AND DENSITY ESTIMATES OF NATURAL POTENTIAL VEGETATION

Table C-12 lists vegetation Ecoregion-physiographic (EP) Types with summaries provided by various authors. The definition and development of EP Types is discussed in the beginning of this report (**Step 4**). The information sources identified in **Table C-12** vary in their spatial relevance and scale, and in their degree of riparian specificity and in the type and amount of information provided. DEQ staff synthesized the information relevant to each EP Type, from the various sources and estimated the vegetation composition sufficient to assess height and density of the natural potential vegetation community. The height and density estimates are tabulated and annotated in the four columns on the right side of the table. Heights and densities are approximated as described previously in **Steps 5** and **6**.

Section 4c includes detailed explanation of the header categories of **Table C-12**. Further discussion of context, definitions and limitations can be found in the main body of this report.

Table C-12. Type, Height and Density Estimates of Natural Potential Vegetation.

This table is many pages and is located on the following pages. Dark gray shading indicates areas where references do not apply. Light gray shading indicates the Ecoregion-physiographic Types of McAllister, 2008.

{the 4 columns to the far right may be modified for the Deschutes Basin, as information from there is incorporated}

		Vegetation Descriptions											
Ecoregion/ Physio-graphic Type	**Ecoregion**	**McAllister, 2008 (historic, focus on riparian, percentages reflect proportion of records)**	**Tobalske, 2002 (historic, not stratified by morphology, GIS layer, focus on uplands)**	**OWEB, 1999 (inner zone, narrow and v/trough valleys with low gradient are assumed constrained)**	**OWEB, 1999 (outer zone, narrow and v/trough valleys with low gradient are assumed constrained)**	**Crowe et al, 1997 (plant associations arranged by Type via Landform Key)**	**Crowe et al, 2004 General overview from Physical Environment Key (each Level 4 Ecoregion is broadly discussed - many entries below are not riparian specific)**	**Crowe et al, 2004 Plant Associations were linked to Level 4 ecoregion (by reported L3 ecoregion and elevation) and then plant associations were assigned a Type based on L4 ecoregion and reported valley width and gradient)**	**Wells, 2006 (First, Level 4 Ecoregions were associated to reported elevation zones, and then plant associations were assigned a Type based on L4 ecoregion and reported valley width and gradient)**	**Height in meters, followed by percent stream length in ()**	**Height basis for shade-dominant stand {if two height entries are present, the lower is shrub-grass (1.5 m), Willow-shrub (3.5 m) or an average of 1.5 and 3.5 m}**	**Density (%)**	**Supportive information for height and density**
Type 12	4 c		Pacific Silver Fir- Mountain Hemlock, Lodgepole, with minor Douglas Fir, Grand Fir and Ponderosa Pine	Hardwoods (Red Alder) and shrubs such as Mountain Alder, and Ovalleaf and Alaska Huckleberry	Conifer (Mountain Hemlock and true Firs)		Extensively forested with Mountain Hemlock and Pacific Silver Fir	no valley morphology for this type in the type ecoregion/elevation		22.7 (100)	Average: Mountain Hemlock, Red Alder, Lodgepole, Silver Fir	90	assumed where riparian forest is predominant
Type 13	4 c		"	Shrubs such as Ovalleaf and Alaska Huckleberry	Conifer (Mountain Hemlock and true Firs)		Extensively forested with Mountain Hemlock and Pacific Silver Fir	no valley morphology for this type in the type ecoregion/elevation		26.9 (100)	Average: Mountain Hemlock and Pacific Silver Fir, Grand Fir, Subalpine Fir	90	assumed where riparian forest is predominant
Type 14	4 c		"	Hardwoods (Red Alder) and shrubs such as Mountain Alder, and Ovalleaf and Alaska Huckleberry	Conifer (Mountain Hemlock and true Firs)		Extensively forested with Mountain Hemlock and Pacific Silver Fir	no valley morphology for this type in the type ecoregion/elevation		25.4 (100)	Average: Pacific Silver Fir, Mountain Hemlock, Red Alder	90	assumed where riparian forest is predominant
Type 15	4 c		"	Shrubs such as Ovalleaf and Alaska Huckleberry	Conifer (Mountain Hemlock and true Firs)		Extensively forested with mountain hemlock and Pacific silver fir	no valley morphology for this type in the type ecoregion/elevation		24.4 (100)	Average: Mountain Hemlock and Pacific Silver Fir	90	assumed where riparian forest is predominant
Type 16	4 d		Alpine Tundra, Subalpine Fir	Usually no woody plants. Occasionally Mountain Alder and Douglas Spiraea.	Not Applicable		Herbaceous and shrubby subalpine meadow vegetation and scattered patches of Mountain Hemlock, Subalpine Fir, and Whitebark Pine	no valley morphology for this type in the type ecoregion/elevation		13.9 (40) 1.5 (60)	Average: Mountain hemlock, subalpine fir, Whitebark Pine	90	p.422, Crowe et al., 2004, tree subdominants

Type	17	4	d		Alpine Tundra, Subalpine Fir	Usually no woody plants. Occasionally Bog Blueberry and Mountain Alder.	Not Applicable		Herbaceous and shrubby subalpine meadow vegetation and scattered patches of Mountain Hemlock, Subalpine Fir, and Whitebark Pine	no valley morphology for this type in the type ecoregion/elevation		17 (40) 1.5 (60)	Average: Mountain hemlock, subalpine fir	90	p.422, Crowe et al., 2004, tree subdominants
Type	18	4	e		Shasta fir - White Fir, with minor Lodgepole, Subalpine Fir and Ponderosa Pine	Shrubs such as Mountain Alder and as Bog Blueberry. Some conifers (Lodgepole Pine, White Fir) may be present.	Conifer (Mountain Hemlock, true Firs and Lodgepole Pine)		Mixed coniferous forest dominated by Mountain Hemlock and Pacific Silver Fir. Grand Fir, White Fir, Shasta Red Fir, and Lodgepole Pine also occur and become more common toward the south and east. More intermittent streams than cascade crest.	no valley morphology for this type in the type ecoregion/elevation		27.7 (70) 2.5 (30)	Average: Mountain Hemlock and Pacific Silver Fir, White Fir	90	p.448, Crowe et al., 2004
Type	19	4	e		"	Shrubs such as Mountain Alder and as Bog Blueberry. Some conifers (Lodgepole Pine, White Fir) may be present.	Conifer (Mountain Hemlock, true Firs and Lodgepole Pine)		Mixed coniferous forest dominated by Mountain Hemlock and Pacific Silver Fir. Grand Fir, White Fir, Shasta Red Fir, and Lodgepole Pine also occur and become more common toward the south and east. More intermittent streams than cascade crest.	no valley morphology for this type in the type ecoregion/elevation		28.1 (70) 2.5 (30)	Average: Mountain Hemlock and Pacific Silver Fir, Grand Fir, White Fir, and Lodgepole Pine	90	p.448, Crowe et al., 2004
Type	20	9	b		Ponderosa Pine, mixed Conifer	Hardwoods and shrubs (such as Vine Maple, Douglas Spiraea, Mountain Alder, Red Osier Dogwood and willows (Geyer and Lemmon). Some conifers (Grand Fir, Western Red Cedar) may be present.	Conifers (Grand Fir, Douglas Fir, and Ponderosa Pine (south))	Black cottonwood – Alluvial bar or Black cottonwood/Common snowberry	Grand Fir, Douglas Fir, and Ponderosa Pine	Lodgepole pine/Bog blueberry or Quaking aspen-lodgepole pine/Douglas' spiraea or Ponderosa dominance		25.9 (100)	Average: Lodgepole, Red Osier Dogwood, Grand Fir, Douglas Fir	90	assumed where riparian forest is predominant

Type	21	9	b		"	Hardwoods and shrubs (such as Vine Maple, Douglas Spiraea, Mountain Alder, Red Osier Dogwood and willows (Geyer and Lemmon). Some conifers (Grand Fir, Western Red Cedar) may be present.	Conifers (Grand Fir, Douglas Fir, and Ponderosa Pine (south))		Grand Fir, Douglas Fir, and Ponderosa Pine	2300-4900 ft: Douglas fir/Rocky Mountain maple-Mallow ninebark, Oceanspray or in the higher range, Engelmann spruce/Ladyfern, or 4300-5300 ft: Quaking aspen/Red-osier dogwood or 4640-6490 ft: Subalpine fir/Arrowleaf groundsel-Brook saxifrage		26.8 (70) 2.5 (30)	Average: Red Osier Dogwood, Grand Fir, Douglas Fir, Quaking Aspen	90	p.420, 439, Crowe et al., 2004
Type	22	9	b		"	Hardwoods and shrubs (such as Vine Maple, Douglas Spiraea, Mountain Alder, Red Osier Dogwood and willows (Geyer and Lemmon). Some conifers (Grand Fir, Western Red Cedar) may be present.	Conifers (Grand Fir, Douglas Fir, and Ponderosa Pine (south))		Grand Fir, Douglas Fir, and Ponderosa Pine	Ponderosa pine/Common snowberry or Red alder/Red-osier dogwood or Red alder/Pacific ninebark or Grand fir/Common snowberry; or Black cottonwood/Mountain alder-Red-osier dogwood or in higher range, Engelmann spruce/Mountain alder-Red-osier dogwood or Lodgepole dominance or Quaking aspen/Woolly sedge		29.8 (75) 2.5 (25)	Average: Red Osier Dogwood, Grand Fir, Douglas Fir	90	p.310, 420, 439, Crowe et al., 2004
Type	23	9	b		"	Hardwoods and shrubs (such as Vine Maple, Douglas Spiraea, Mountain Alder, Red Osier Dogwood and willows (Geyer and Lemmon). Some conifers (Grand Fir, Western Red Cedar) may be present.	Conifers (Grand Fir, Douglas Fir, and Ponderosa Pine (south))		Grand Fir, Douglas Fir, and Ponderosa Pine	Lodgepole pine/Bog blueberry or Quaking aspen-lodgepole pine/Douglas' spiraea or Ponderosa dominance		26.8 (73) 2.5 (27)	Average: Red Osier Dogwood, Grand Fir, Douglas Fir, Quaking Aspen	90	p.322, 390 Crowe et al., 2004
Type	24	9	c		Ponderosa Pine	Hardwoods, and shrubs such as Mountain Alder, Water Birch and Common Snowberry.	Conifer (Douglas Fir (west), Ponderosa Pine (east)), with some Oregon White Oak (east)		Mosaic of vegetation types that includes grasslands, oak woodlands, Douglas-Fir/Ponderosa Pine forests, and Western Hemlock/Douglas-Fir forests	2300-4900 ft: Douglas fir/Rocky Mountain maple-Mallow ninebark, Oceanspray or in the higher range, Engelmann spruce/Ladyfern, or 4300-5300 ft: Quaking aspen/Red-osier dogwood or 4640-6490 ft: Subalpine fir/Arrowleaf groundsel-Brook saxifrage		20.3 (70) 1.5 (30)	Average: White Oak, Willow, Ponderosa Pine	90	oak, willow at 85, with tree frequency reduced for rock/grass/shrub

Type	25	9	c		"	Hardwoods, and shrubs such as Mountain Alder, Water Birch and Common Snowberry.	Conifer (Douglas Fir (west), Ponderosa Pine (east)), with some Oregon White Oak (east)	White alder/Red-osier dogwood or Black cottonwood/Lewis' mockorange or White alder with Black hawthorn or Netleaf hackberry	Mosaic of vegetation types that includes grasslands, oak woodlands, Douglas-Fir/Ponderosa Pine forests, and Western Hemlock/Douglas-Fir forests	Ponderosa pine/Common snowberry or Red alder/Red-osier dogwood or Red alder/Pacific ninebark or Grand fir/Common snowberry; or Black cottonwood/Mountain alder-Red-osier dogwood or in higher range, Engelmann spruce/Mountain alder-Red-osier dogwood or Lodgepole dominance or Quaking aspen/Woolly sedge		20.3 (60) 2.5 (40)	Average: White Oak, Willow, Ponderosa Pine	90	oak, willow at 85, with tree frequency reduced for grassland
Type	26	9	c		"	Hardwoods, and shrubs such as Mountain Alder, Water Birch and Common Snowberry.	Conifer (Douglas Fir (west), Ponderosa Pine (east)), with some Oregon White Oak (east)		Mosaic of vegetation types that includes grasslands, oak woodlands, Douglas-Fir/Ponderosa Pine forests, and Western Hemlock/Douglas-Fir forests	Lodgepole pine/Bog blueberry or Quaking aspen-lodgepole pine/Douglas' spiraea or Ponderosa dominance		13 (60) 2.5 (40)	Average: White Oak, Willow	90	oak, willow at 85, with tree frequency reduced for grassland
Type	27	9	d		"	Hardwoods (including Quaking Aspen) & shrubs such as Mountain Alder, Common Snowberry, & willows (Geyer & Lemmon).	Conifer (Douglas-fir, White Fir, and Ponderosa Pine)	Black cottonwood – Alluvial bar or Black cottonwood/Common snowberry	Nearly homogenous stands of Ponderosa Pine. Bitterbrush grows at lower elevations.	Lodgepole pine/Bog blueberry or Quaking aspen-lodgepole pine/Douglas' spiraea or Ponderosa dominance		31.2 (76) 3.5 (24)	Average: Ponderosa Pine, Black Cottonwood	90	p.322, 329, 374, Crowe et al., 2004
Type	28	9	d		"	Mixed (White Fir, hardwoods) & shrubs such as Douglas Spiraea, & Mountain Alder	Conifer (Douglas-fir, White Fir, and Ponderosa Pine)		Nearly homogenous stands of Ponderosa Pine. Bitterbrush grows at lower elevations.	2300-4900 ft: Douglas fir/Rocky Mountain maple-Mallow ninebark, Oceanspray or in the higher range, Engelmann spruce/Ladyfern, or 4300-5300 ft: Quaking aspen/Red-osier dogwood or 4640-6490 ft: Subalpine fir/Arrowleaf groundsel-Brook saxifrage		34.9 (76) 3.5 (24)	Average: Ponderosa Pine	90	p.322, 329, 374, Crowe et al., 2004
Type	29	9	d		"	Hardwoods (including Quaking Aspen) & shrubs such as Mountain Alder, Common Snowberry, & willows (Geyer & Lemmon).	Conifer (Douglas-fir, White Fir, and Ponderosa Pine)		Nearly homogenous stands of Ponderosa Pine. Bitterbrush grows at lower elevations.	Ponderosa pine/Common snowberry or Red alder/Red-osier dogwood or Red alder/Pacific ninebark or Grand fir/Common snowberry; or Black cottonwood/Mountain alder-Red-osier dogwood or in higher range, Engelmann spruce/Mountain alder-Red-osier dogwood or Lodgepole dominance or Quaking aspen/Woolly sedge		18.8 (76) 3.5 (24)	Average: Ponderosa Pine, White Alder, shrub willow	90	p.322, 329, 374, Crowe et al., 2004

Type	30	9	d		"	Mixed (White Fir, hardwoods) & shrubs such as Douglas Spiraea, & Mountain Alder	Conifer (Douglas-fir, White Fir, and Ponderosa Pine)		search by elevation, valley width, valley gradient	Lodgepole pine/Bog blueberry or Quaking aspen-lodgepole pine/Douglas' spiraea or Ponderosa dominance		31.2 (76) 3.5 (24)	Average: Ponderosa Pine, Black Cottonwood	90	p.322, 329, 374, Crowe et al., 2004
Type	31	9	e		Ponderosa and Lodgepole Pine equally dominant	Conifers (White Fir,) & shrubs (Mountain Alder, Douglas Spiraea with Queencup Beadlily).	See Kovalchik (1987) for more details about specific plant communities and where they occur.		search by elevation, valley width, valley gradient	2300-4900 ft: Douglas fir/Rocky Mountain maple-Mallow ninebark, Oceanspray or in the higher range, Engelmann spruce/Ladyfern, or 4300-5300 ft: Quaking aspen/Red-osier dogwood or 4640-6490 ft: Subalpine fir/Arrowleaf groundsel-Brook saxifrage, 5320-6200 ft: Lodgepole pine-Engelmann spruce/Few-flowered spikerush		26.3 (70) 2.5 (30)	Average: Douglas Fir, Quaking Aspen, Ponderosa Pine, Lodgepole, White Fir, Subalpine Fir, Engelmann Spruce	90	p.310, 424, 396, 420, 445, Crowe et al., 2004
Type	32 and 32.5	9	e		"	Mixed (Lodgepole Pine, Ponderosa Pine, Aspen) with shrubs such as Bearberry, Wax Currant, Bitterbrush, Bog Blueberry, Douglas Spiraea Mountain Alder, Common Snowberry, and willows (Booth, Geyer and Lemmon).	Conifer (Lodgepole Pine primarily; White Fir, Douglas Fir, Mountain Hemlock, and Ponderosa Pine in steeper terrain)		search by elevation, valley width, valley gradient	Ponderosa pine/Common snowberry or Red alder/Red-osier dogwood or Red alder/Pacific ninebark or Grand fir/Common snowberry; or Black cottonwood/Mountain alder-Red-osier dogwood or in higher range, Engelmann spruce/Mountain alder-Red-osier dogwood or Lodgepole dominance or Quaking aspen/Woolly sedge, 5500-7020 ft: Engelmann spruce-Subalpine fir/Bog blueberry/Holm's sedge		Type 32: 26.3 (65) 2.5 (35) Type 32.5: 15.2 (50) 2.5 (50)	Average (Type 32): Douglas Fir, Quaking Aspen, Ponderosa Pine, Lodgepole, White Fir, Subalpine Fir, Engelmann Spruce Average (Type 32.5): Lodgepole, red alder, red-osier dogwood	90	p.310, 424, 396, 445, Crowe et al., 2004
Type	33	9	f		Lodgepole and Ponderosa Pine roughly 65/35%	Shrubs such as Bearberry, Wax Currant, Bitterbrush, Bog Blueberry, and Douglas Spiraea. Willows and wetland vegetation.	Conifer (lodge-pole pine)	Black cottonwood – Alluvial bar or Black cottonwood/Common snowberry	LaPine Basin has high groundwater tables and thick lacustrine deposits	Lodgepole pine/Bog blueberry or Quaking aspen-lodgepole pine/Douglas' spiraea or Ponderosa dominance		3.5 (100)	Willow	90	p.283, Crowe et al., 2004
Type	34	9	f		"	no constrained channels are assumed to exist in this ecoregion	no constrained channels are assumed to exist in this ecoregion		LaPine Basin has high groundwater tables and thick lacustrine deposits	Lodgepole pine/Bog blueberry or Quaking aspen-lodgepole pine/Douglas' spiraea or Ponderosa dominance		9.0 (100)	Average: Lodgepole, shrub willows	90	p.283, Crowe et al., 2004, sum of all tree and willow/shrub average cov.

Type	35	10	c		Grasses and Sages	Shrubs such as Douglas Spiraea, Red Osier Dogwood, willows, Water Birch, and Mountain Alder.	Not Applicable	Black cottonwood – Alluvial bar or Black cottonwood/Common snowberry	search by elevation, valley width, valley gradient	search by elevation, valley width, valley gradient		15.3 (70) 3.5 (30)	Average: cottonwood, shrub willow, large willow	90	field observations
Type	36	10	c		"	Shrubs such as Douglas Spiraea, Red Osier Dogwood, willows, Water Birch, and Mountain Alder.	Not Applicable		search by elevation, valley width, valley gradient	Black cottonwood/Water birch		2.5 (70) 1.5 (30)	Average: shrubs, grasses and shrub willow	90	p.272, 291, 293, Crowe et al., 2004, sum of all willow/shrub average cov.
Type	37	10	c		"	Shrubs such as Douglas Spiraea, Red Osier Dogwood, willows, Water Birch, and Mountain Alder.	Not Applicable	White alder/Red-osier dogwood or Black cottonwood/Lewis' mockorange or White alder with Black hawthorn or Netleaf hackberry	search by elevation, valley width, valley gradient	Black cottonwood-White alder, White alder/Water birch		7.7 (70) 1.5 (30)	Average: shrubs and shrub willow, White Alder	90	p.272, 291, 293, Crowe et al., 2004, sum of all willow/shrub average cov.
Type	38	10	c		"	Shrubs such as Douglas Spiraea, Red Osier Dogwood, willows, Water Birch, and Mountain Alder.	Not Applicable		search by elevation, valley width, valley gradient	no valley morphology for this type in the type ecoregion/elevation		15.3 (40) 2.5 (60)	Average: cottonwood, shrub willow, large willow	90	field observations
Type	39	10	e		"	Shrubs such as Mountain Alder, Red Osier Dogwood and willows. Galleries of Black Cottonwood occurred in areas of perennial streamflow	Not Applicable	Black cottonwood – Alluvial bar or Black cottonwood/Common snowberry	search by elevation, valley width, valley gradient	no valley morphology for this type in the type ecoregion/elevation		16.3 (50) 1.5 (50)	Average: white alder, willow, cottonwood	90	field observations
Type	40	10	e		"	Shrubs such as Mountain Alder, Red Osier Dogwood and willows. Galleries of Black Cottonwood occurred in areas of perennial streamflow	Not Applicable	White alder/Red-osier dogwood or Black cottonwood/Lewis' mockorange or White alder with Black hawthorn or Netleaf hackberry	search by elevation, valley width, valley gradient	Black cottonwood-White alder		10.7 (70) 2.5 (30)	Average: White Alder, shrub willow	90	field observations
Type	41	10	e		"	Shrubs such as Mountain Alder, Red Osier Dogwood and willows.	Not Applicable		search by elevation, valley width, valley gradient	no valley morphology for this type in the type ecoregion/elevation		8.4 (50) 1.5 (50)	Average: White Alder, shrub willow, Red-Osier Dogwood	90	field observations

Type	1	10	k	30% line of Willows and/or Alder shrubs along streambanks; 15% Cottonwood timber scattered and in large riparian forest groves or thickets; 10% well watered landscape, wet meadows and terraces, springs, marshes, swampy bottom lands, seeps; 10% abundant healthy bunchgrasses often on streambanks; 10% scattered juniper throughout landscape including on streambanks; H57	"	Hardwoods (Cottonwood galleries, willow, White Alder) and shrubs such as willow and Red-Osier Dogwood. Infrequent Ponderosa Pine.	Not Applicable	White alder/Red-osier dogwood or Black cottonwood/Lewis' mockorange or White alder with Black hawthorn or Netleaf hackberry	Riparian vegetation in narrow reaches is often limited to a narrow band of White Alder at the water line	White alder/Water birch		16.3 (50) 2.5 (50)	Average: White Alder, shrub willow, Cottonwood	90	field observations
Type	2	10	k	20% boulder lined shores with little vegetation; 20% line of Willows and/or Alder shrubs along streambanks; 15% well watered landscape, wet meadows and terraces, springs, marshes, swampy bottom lands, seeps; 13% abundant healthy bunchgrasses often on streambanks	"	Hardwoods (White Alder, willow) and shrubs such as willow and Red-Osier Dogwood. Infrequent Ponderosa Pine.	Not Applicable		Riparian vegetation in narrow reaches is often limited to a narrow band of White Alder at the water line	no valley morphology for this type in the type ecoregion/elevation		10.8 (50) 2.5 (50)	Average: White Alder, shrub willow	90	field observations
Type	42	10	n		"	not listed	not listed			White alder/Water birch		12.6 (60) 2.5 (40)	Average: White Alder, Water Birch, Shrub	90	field observations
Type	43	10	n		"	not listed	not listed			no valley morphology for this type in the type ecoregion/elevation		11.2 (75) 2.5 (25)	Average: White Alder, Water Birch, Shrub	90	field observations

Type	43.5	11	a	**From McAllister (2008)** **EP Type 8:** 22% line of Willows and/or Alder shrubs along streambanks; 10% abundant healthy bunchgrasses often on streambanks; 13% scattered juniper throughout landscape including on streambanks; 12% well watered landscape, wet meadows and terraces, springs, marshes, swampy bottom lands, seeps; 8% Sage brush and rabbit brush, including along streambanks; 7% Wooded streambanks or extensive streamside forests with large trees	"	Hardwoods (Cottonwood and Alder) and shrubs (willows, Mountain Alder and Douglas Spiraea.) Infrequent Juniper.	Not Applicable	Horsetail, Willow, Sedge and Black Cottonwood/Pacific Willow Associations (p.210, 114, 117, 212, 88); and Mountain Alder, Dogwood, Cottonwood Associations (p.134, 144, 90)	search by elevation, valley width, valley gradient	no valley morphology for this type in the type ecoregion/elevation	Red Alder/Common Snowberry/Dewey Sedge, Mountain Alder/Dewey Sedge, Mountain Alder–Red-Osier Dogwood/Mesic Forb, Mountain Alder–Common Snowberry	<u>John Day</u> General: 16.3 (50) 2.5 (50) Mainstem - Picture Gorge to conif. forest: 27.4 (80), 2.5 (20) Mainstem from Picture Gorge to Service Creek and North Fork below Monument: 21.0 (40) 2.5 (60) Mainstem below Service Creek: 16.3 (25), 2.5 (75)	<u>John Day</u> General- avg Cottonwood, White Alder, shrub Willow. Mainstem - Picture Gorge to conif. forest: Cottonwood gallery. Mainstem Picture Gorge to Service Creek and North Fork below Monument - avg P. Pine, Cottonwood, White Alder, shrub willow. Mainstem below Service Creek - average Cottonwood, White Alder, shrub willow.	85	field observations, McAllister 2008, Crowe et al., 2004
Type	6	11	a	19% scattered juniper throughout landscape including on streambanks; 13% line of Willows and/or Alder shrubs along streambanks; 13% Sagebrush and Rabbitbrush including on streambanks	Ponderosa Pine, Juniper, Low Sagebrush, Grasses	Hardwoods (Cottonwood and Alder) and shrubs (willows, Mountain Alder and Douglas Spiraea.) Infrequent Juniper.	Shrubs (willows).	Mountain Alder, Red-Osier Dogwood, Black Hawthorn, Water Birch, Quaking Aspen, Ponderosa Pine, Douglas Fir Associations (p.134, 152, 154, 164, 80, 72, 66)	search by elevation, valley width, valley gradient	3780-5150 ft: Grand fir/Ladyfern or with Oakfern; 2300-4900 ft: Douglas fir/Rocky Mountain maple-Mallow ninebark, Oceanspray or in the higher range, Engelmann spruce/Ladyfern, or 4300-5300 ft: Quaking aspen/Red-osier dogwood or 4640-6490 ft: Subalpine fir/Arrowleaf groundsel-Brook saxifrage	Red Alder/Common Snowberry/Dewey Sedge, Mountain Alder/Dewey Sedge, Mountain Alder–Red-Osier Dogwood/Mesic Forb, Mountain Alder–Common Snowberry	18.8 (50) 3.5 (50)	Average: Ponderosa Pine, White Alder, shrub Willow	85	field observations, McAllister 2008, Crowe et al., 2004

Type	7	11	a	16% line of Willows and/or Alder shrubs along streambanks; 14% abundant healthy bunchgrasses often on streambanks; 12% scattered juniper throughout landscape including on streambanks; 9% Fir, Tamarack, sometimes Spruce in forests with Pine, often large; 8% Sage brush and rabbit brush, including along streambanks	"	Hardwoods (Cottonwood, Alder and Aspen) and shrubs (willows, Mountain Alder, Douglas Spiraea and Common Snowberry). Infrequent Ponderosa Pine.	Not Applicable	Mountain Alder, Red-Osier Dogwood, Black Hawthorn, Water Birch, Quaking Aspen, Ponderosa Pine, Douglas Fir Associations (p.134, 152, 154, 164, 80, 72, 66)	search by elevation, valley width, valley gradient	White alder/Water birch, Douglas fir/Black hawthorn-Common snowberry, bugbane or Douglas Fir/Water birch or Grand fir/Rocky Mt maple or Black Cottonwood/Rock Mt maple, or Ponderosa pine/Common snowberry or Red alder/Red-osier dogwood or Red alder/Pacific ninebark or Grand fir/Common snowberry; or Black cottonwood/Mountain alder-Red-osier dogwood or in higher range, Engelmann spruce/Mountain alder-Red-osier dogwood or Lodgepole dominance or Quaking aspen/Woolly sedge	Red Alder/Common Snowberry/Dewey Sedge, Mountain Alder/Dewey Sedge, Mountain Alder–Red-Osier Dogwood/Mesic Forb, Mountain Alder–Common Snowberry	John Day General: 18.8 (70) 2.5 (30) Mainstem from Picture Gorge to Service Creek and North Fork below Monument: 18.8 (40) 2.5 (60) Mainstem below Service Creek: 10.8 (25), 2.5 (75)	John Day General- avg White Alder, shrub Willow, Ponderosa pine . Mainstem from Picture Gorge to Service Creek and North Fork below Monument - avg P. Pine, White Alder, shrub willow. Mainstem below Service Creek - average White Alder, shrub willow.	85	field observations, McAllister 2008, Crowe et al., 2004
Type	8	11	a	22% line of Willows and/or Alder shrubs along streambanks; 10% abundant healthy bunchgrasses often on streambanks; 13% scattered juniper throughout landscape including on streambanks; 12% well watered landscape, wet meadows and terraces, springs, marshes, swampy bottom lands, seeps; 8% Sage brush and rabbit brush, including along streambanks; 7% Wooded streambanks or extensive streamside forests with large trees	"	Hardwoods (Cottonwood and Alder) and shrubs (willows, Mountain Alder and Douglas Spiraea.) Infrequent Juniper.	Not Applicable	Horsetail, Willow, Sedge and Black Cottonwood/Pacific Willow Associations (p.210, 114, 117, 212, 88); and Mountain Alder, Dogwood, Cottonwood Associations (p.134, 144, 90)	search by elevation, valley width, valley gradient	no valley morphology for this type in the type ecoregion/elevation	Red Alder/Common Snowberry/Dewey Sedge, Mountain Alder/Dewey Sedge, Mountain Alder–Red-Osier Dogwood/Mesic Forb, Mountain Alder–Common Snowberry	John Day General: 16.3 (50) 2.5 (50) Mainstem - Picture Gorge to conif. forest: 27.4 (80), 2.5 (20) Mainstem from Picture Gorge to Service Creek and North Fork below Monument: 21.0 (40) 2.5 (60) Mainstem below Service Creek: 16.3 (25), 2.5 (75)	John Day General- avg Cottonwood, White Alder, shrub Willow. Mainstem - Picture Gorge to conif. forest: Cottonwood gallery Mainstem Picture Gorge to Service Creek and North Fork below Monument - avg P. Pine, Cottonwood, White Alder, shrub willow. Mainstem below Service Creek - average Cottonwood, White Alder, shrub willow.	57	field observations, McAllister 2008, Crowe et al., 2004

Type	8.5	11	b	**From McAllister (2008) EP Type 11:** 16% abundant healthy bunchgrasses often on streambanks; 12% line of Willows and/or Alder shrubs along streambanks; 12% Cottonwood timber scattered and in large riparian forest groves or thickets; 8% Wooded streambanks or extensive streamside forests with large trees; 8% meandering braided channel, oxbow lakes; 8%Fir, Tamarack, sometimes Spruce in forests with Pine, often large; 8% well watered landscape, wet meadows and terraces, springs, marshes, swampy bottom lands, seeps; 8% rich fertile bottom land soils	"	Hardwoods (Alder & Cottonwood) and shrubs (willows, Sitka Alder, Mountain Alder)	Hardwoods (Alder & Cottonwood) and shrubs (willows, Sitka Alder, Mountain Alder)	Horsetail, Willow, Sedge and Black Cottonwood/Pacific Willow Associations (p.210, 114, 117, 212, 88); and Mountain Alder, Dogwood, Cottonwood Associations (p.134, 144, 90)	search by elevation, valley width, valley gradient	Black cottonwood/Common snowberry, Black cottonwood – Alluvial bar, Black cottonwood/Shining willow		13.1 (100)	Average: Cottonwood, White Alder, Mountain Alder, shrub willow	85	Crowe et al., 2004, e.g., Black Cottonwood - White Alder Association, Black Cottonwood/ Shining Willow
Type	9	11	b	19% Wooded streambanks or extensive streamside forests with large trees; 11% Fir, Tamarack, sometimes Spruce in forests with Pine, often large; 11% abundant healthy bunchgrasses often on streambanks; 7% line of Willows and/or Alder shrubs along streambanks; 7% scattered juniper throughout landscape including on streambanks; 7% riparian shrubs other than willow and alder, often dense and in various associations (currant, mahogany, rose, myrtle, hawthorn...); 7% rich fertile bottom land soils	Ponderosa Pine	Hardwoods (Alder & Cottonwood) and shrubs (willows, Sitka Alder, Mountain Alder)	Hardwoods (Alder & Cottonwood) and shrubs (willows, Sitka Alder, Mountain Alder)	Mountain Alder, Red-Osier Dogwood, Black Hawthorn, Water Birch, Quaking Aspen, Ponderosa Pine, Douglas Fir Associations (p.134, 152, 154, 164, 80, 72, 66)	search by elevation, valley width, valley gradient	3780-5150 ft: Grand fir/Ladyfern or with Oakfern; 2300-4900 ft: Douglas fir/Rocky Mountain maple-Mallow ninebark, Oceanspray or in the higher range, Engelmann spruce/Ladyfern, or 4300-5300 ft: Quaking aspen/Red-osier dogwood or 4640-6490 ft: Subalpine fir/Arrowleaf groundsel-Brook saxifrage	Sitka Alder/Mesic Forb, Sitka Alder/Ladyfern; or if > 1900 m elevation: Engelmann Spruce-Subalpine Fir/Arrowleaf Groundsel, Mountain Alder/Tall Mannagrass [Strawberry Mountain Wilderness], Undergreen Willow/Holm's Rocky Mountain Sedge	19.2 (100)	Average: Ponderosa Pine, Willow	80	field observations

Type	10	11	b	14% riparian shrubs other than willow and alder, often dense and in various associations (currant, mahogany, rose, myrtle, hawthorn...); 12% Fir, Tamarack, sometimes Spruce in forests with Pine, often large; 14% abundant healthy bunchgrasses often on streambanks; 8% well watered landscape, wet meadows and terraces, springs, marshes, swampy bottom lands, seeps; 10% rich fertile bottom land soils	"	Hardwoods (Alder, willow, Cottonwood & aspen) and shrubs (willows, Sitka Alder, Mountain Alder and Common Snowberry, Shrubby Cinquefoil)	Conifers (infrequent true Fir and Ponderosa Pine)	Mountain Alder, Red-Osier Dogwood, Black Hawthorn, Water Birch, Quaking Aspen, Ponderosa Pine, Douglas Fir Associations (p.134, 152, 154, 164, 80, 72, 66)	search by elevation, valley width, valley gradient	White alder/Water birch, Douglas fir/Black hawthorn-Common snowberry, bugbane or Douglas Fir/Water birch or Grand fir/Rocky Mt maple or Black Cottonwood/Rock Mt maple, or Ponderosa pine/Common snowberry or Red alder/Red-osier dogwood or Red alder/Pacific ninebark or Grand fir/Common snowberry; or Black cottonwood/Mountain alder-Red-osier dogwood or in higher range, Engelmann spruce/Mountain alder-Red-osier dogwood or Lodgepole dominance or Quaking aspen/Woolly sedge, 5500-7020 ft: Engelmann spruce-Subalpine fir/Bog blueberry/Holm's sedge	Sitka Alder/Mesic Forb, Sitka Alder/Ladyfern; or if > 1900 m elevation: Engelmann Spruce-Subalpine Fir/Arrowleaf Groundsel, Mountain Alder/Tall Mannagrass [Strawberry Mountain Wilderness], Undergreen Willow/Holm's Rocky Mountain Sedge	18.8 (100)	Average: Ponderosa Pine, Cottonwood, Willow	80	field observations
Type	11	11	b	16% abundant healthy bunchgrasses often on streambanks; 12% line of Willows and/or Alder shrubs along streambanks; 12% Cottonwood timber scattered and in large riparian forest groves or thickets; 8% Wooded streambanks or extensive streamside forests with large trees; 8% meandering braided channel, oxbow lakes; 8%Fir, Tamarack, sometimes Spruce in forests with Pine, often large; 8% well watered landscape, wet meadows and terraces, springs, marshes, swampy bottom lands, seeps; 8% rich fertile bottom land soils	"	Hardwoods (Alder & Cottonwood) and shrubs (willows, Sitka Alder, Mountain Alder)	Hardwoods (Alder & Cottonwood) and shrubs (willows, Sitka Alder, Mountain Alder)	Horsetail, Willow, Sedge and Black Cottonwood/Pacific Willow Associations (p.210, 114, 117, 212, 88); and Mountain Alder, Dogwood, Cottonwood Associations (p.134, 144, 90)	search by elevation, valley width, valley gradient	no valley morphology for this type in the type ecoregion/elevation	Sitka Alder/Mesic Forb, Sitka Alder/Ladyfern; or if > 1900 m elevation: Engelmann Spruce-Subalpine Fir/Arrowleaf Groundsel, Mountain Alder/Tall Mannagrass [Strawberry Mountain Wilderness], Undergreen Willow/Holm's Rocky Mountain Sedge	21.9 (100)	Average: Ponderosa Pine, Cottonwood, shrub willow	53	field observations

Type	44	11	c		"	Hardwoods (Alder, willow, Cottonwood & aspen) and shrubs (willows, Sitka Alder, Mountain Alder and Common Snowberry, Shrubby Cinquefoil)	Conifers (infrequent true Fir and Ponderosa Pine)	Sedge, Horsetail, small Willow, Black Cottonwood/Pacific Willow, Mountain Alder, Red-Osier Dogwood and Quaking Aspen Associations (p.212, 210, 114, 117, 88, 206, 134, 136, 142, 128, 152, 154, 116, 90, 80, 84, 82) and Lodgepole Pine, Grass Associations (p.50, 51)	search by elevation, valley width, valley gradient	Black cottonwood – Alluvial bar or Black cottonwood/Common snowberry, Black cottonwood/Shining willow	Red Alder/Common Snowberry/Dewey Sedge, Mountain Alder/Dewey Sedge, Mountain Alder–Red-Osier Dogwood/Mesic Forb, Mountain Alder–Common Snowberry	27.3 (100)	Average: Lodgepole, Douglas Fir, Quaking Aspen, Grand Fir, White Alder, shrub willow, Cottonwood	85	field observations
Type	45	11	c		"	Hardwoods (Alder & Cottonwood) and shrubs (willows, Sitka Alder, Mountain Alder)	Conifers (infrequent true Fir and Ponderosa Pine)	Maidenhair Fern, Arrowleaf Groundsel, Brook Saxifrage, Currants, Mountain Alder, Subalpine Fir, Engelmann Spruce Associations (p.213, 212, 164, 136, 130, 36, 44)	search by elevation, valley width, valley gradient	3780-5150 ft: Grand fir/Ladyfern or with Oakfern; 2300-4900 ft: Douglas fir/Rocky Mountain maple-Mallow ninebark, Oceanspray or in the higher range, Engelmann spruce/Ladyfern, or 4300-5300 ft: Quaking aspen/Red-osier dogwood or 4640-6490 ft: Subalpine fir/Arrowleaf groundsel-Brook saxifrage	Red Alder/Common Snowberry/Dewey Sedge, Mountain Alder/Dewey Sedge, Mountain Alder–Red-Osier Dogwood/Mesic Forb, Mountain Alder–Common Snowberry	27.2 (100)	Average: Lodgepole, Douglas Fir, Quaking Aspen, Grand Fir, White Alder	85	field observations
Type	46	11	c		"	Hardwoods (Alder, willow, Cottonwood & aspen) and shrubs (willows, Sitka Alder, Mountain Alder and Common Snowberry, Shrubby Cinquefoil)	Conifers (infrequent true Fir and Ponderosa Pine)	Maidenhair Fern, Mountain/Sitka Alder, Dogwood, Horsetail, Rocky Mountain Maple Associations (p.213, 134, 138, 130, 132, 142, 124, 58, 54)	search by elevation, valley width, valley gradient	Douglas fir/Black hawthorn-Common snowberry, bugbane or Douglas Fir/Water birch or Grand fir/Rocky Mt maple or Black Cottonwood/Rock Mt maple, or Ponderosa pine/Common snowberry or Red alder/Red-osier dogwood or Red alder/Pacific ninebark or Grand fir/Common snowberry; or Black cottonwood/Mountain alder-Red-osier dogwood or in higher range, Engelmann spruce/Mountain alder-Red-osier dogwood or Lodgepole dominance or Quaking aspen/Woolly sedge	Red Alder/Common Snowberry/Dewey Sedge, Mountain Alder/Dewey Sedge, Mountain Alder–Red-Osier Dogwood/Mesic Forb, Mountain Alder–Common Snowberry	23.2 (100)	Average: Lodgepole, Douglas Fir, Quaking Aspen, Grand Fir, White Alder, shrub willow	85	field observations
Type	47	11	c		"	Hardwoods (Alder & Cottonwood) and shrubs (willows, Sitka Alder, Mountain Alder)	Conifers (infrequent true Fir and Ponderosa Pine)		search by elevation, valley width, valley gradient	White alder/Water birch	Red Alder/Common Snowberry/Dewey Sedge, Mountain Alder/Dewey Sedge, Mountain Alder–Red-Osier Dogwood/Mesic Forb, Mountain Alder–Common Snowberry	21.9 (100)	Average: Lodgepole, Douglas Fir, White Alder, Water Birch	85	field observations

Type	47.5	11	d		"	Hardwoods (Alder, Cottonwood, willow & Aspen) and shrubs (willows, Sitka Alder, Mountain Alder, and Common Snowberry)	Conifers (Douglas Fir, true Fir, Ponderosa Pine)	Maidenhair Fern, Mountain/Sitka Alder, Dogwood, Horsetail, Rocky Mountain Maple Associations (p.213, 134, 138, 130, 132, 142, 124, 58, 54)	Juniper, Ponderosa Pine, and Douglas Fir - where forested	Black cottonwood/Common snowberry, Black cottonwood – Alluvial bar, Black cottonwood/Shining willow		16.3 (100)	Average: Cottonwood, White Alder, shrub willow	90	Crowe et al., 2004, Black Cottonwood - White Alder Association
Type	48	11	d		"	Hardwoods (Alder & Cottonwood) and shrubs (willows, Sitka Alder, Mountain Alder)	Conifers (Douglas Fir, true Fir, Ponderosa Pine)	Maidenhair Fern, Arrowleaf Groundsel, Brook Saxifrage, Currants, Mountain Alder, Subalpine Fir, Engelmann Spruce Associations (p.213, 212, 164, 136, 130, 36, 44)	Juniper, Ponderosa Pine, and Douglas Fir - where forested	3780-5150 ft: Grand fir/Ladyfern or with Oakfern; 2300-4900 ft: Douglas fir/Rocky Mountain maple-Mallow ninebark, Oceanspray or in the higher range, Engelmann spruce/Ladyfern, or 4300-5300 ft: Quaking aspen/Red-osier dogwood or 4640-6490 ft: Subalpine fir/Arrowleaf groundsel-Brook saxifrage	Sitka Alder/Mesic Forb, Sitka Alder/Ladyfern; or if > 1900 m elevation: Engelmann Spruce-Subalpine Fir/Arrowleaf Groundsel, Mountain Alder/Tall Mannagrass [Strawberry Mountain Wilderness], Undergreen Willow/Holm's Rocky Mountain Sedge	29.1 (100)	Average: Ponderosa Pine, Engelmann Spruce	85	field observations
Type	49	11	d		"	Hardwoods (Alder, Cottonwood, willow & Aspen) and shrubs (willows, Sitka Alder, Mountain Alder, and Common Snowberry)	Conifers (Douglas Fir, true Fir, Ponderosa Pine)	Maidenhair Fern, Mountain/Sitka Alder, Dogwood, Horsetail, Rocky Mountain Maple Associations (p.213, 134, 138, 130, 132, 142, 124, 58, 54)	Juniper, Ponderosa Pine, and Douglas Fir - where forested	White alder/Water birch, Douglas fir/Black hawthorn-Common snowberry, bugbane or Douglas Fir/Water birch or Grand fir/Rocky Mt maple or Black Cottonwood/Rock Mt maple, or Ponderosa pine/Common snowberry or Red alder/Red-osier dogwood or Red alder/Pacific ninebark or Grand fir/Common snowberry; or Black cottonwood/Mountain alder-Red-osier dogwood or in higher range, Engelmann spruce/Mountain alder-Red-osier dogwood or Lodgepole dominance or Quaking aspen/Woolly sedge, 5500-7020 ft: Engelmann spruce-Subalpine fir/Bog blueberry/Holm's sedge	Sitka Alder/Mesic Forb, Sitka Alder/Ladyfern; or if > 1900 m elevation: Engelmann Spruce-Subalpine Fir/Arrowleaf Groundsel, Mountain Alder/Tall Mannagrass [Strawberry Mountain Wilderness], Undergreen Willow/Holm's Rocky Mountain Sedge	28.8 (100)	Average: Ponderosa Pine, Engelmann Spruce, Cottonwood, Subalpine Fir, Douglas Fir	85	field observations
Type	49.5	11	d		"	"	"	"	"	Ponderosa pine-lodgepole pine/Douglas' spiraea-common snowberry		24.7 (100)	average: Ponderosa pine, Lodgepole Pine	80	field observations

Type	50	11	h		"	Mixed (White fir, hardwoods) and shrubs (willows, Mountain Alder).	Conifers (White Fir, Douglas Fir, Lodgepole Pine, and Ponderosa Pine	Mountain Alder Associations (p.136, 132)	No appreciable mesic forest zone in the upper elevations of this ecoregion	3780-5150 ft: Grand fir/Ladyfern or with Oakfern; 2300-4900 ft: Douglas fir/Rocky Mountain maple-Mallow ninebark, Oceanspray or in the higher range, Engelmann spruce/Ladyfern, or 4300-5300 ft: Quaking aspen/Red-osier dogwood or 4640-6490 ft: Subalpine fir/Arrowleaf groundsel-Brook saxifrage	Sitka Alder/Mesic Forb, Sitka Alder/Ladyfern	27.7 (100)	Average: Ponderosa Pine, shrub willow, Engelmann Spruce, White Fir, Douglas Fir	85	assumed where riparian forest is predominant
Type	51	11	h		"	Mixed (White Fir, willows, Black Cottonwood, Alder) and shrubs (Common Snowberry, Mountain Alder).	Conifers (White Fir, Douglas Fir, Lodgepole Pine, and Ponderosa Pine	Various Mountain Alder and Red Osier Dogwood Associations (p.134, 136, 140, 138, 132, 152)	search by elevation, valley width, valley gradient	White alder/Water birch, Douglas fir/Black hawthorn-Common snowberry, bugbane or Douglas Fir/Water birch or Grand fir/Rocky Mt maple or Black Cottonwood/Rock Mt maple, or Ponderosa pine/Common snowberry or Red alder/Red-osier dogwood or Red alder/Pacific ninebark or Grand fir/Common snowberry; or Black cottonwood/Mountain alder-Red-osier dogwood or in higher range, Engelmann spruce/Mountain alder-Red-osier dogwood or Lodgepole dominance or Quaking aspen/Woolly sedge, 5500-7020 ft: Engelmann spruce-Subalpine fir/Bog blueberry/Holm's sedge	Sitka Alder/Mesic Forb, Sitka Alder/Ladyfern	26.1 (100)	Average: Ponderosa Pine, shrub willow, Engelmann Spruce, White Fir, Quaking Aspen, Douglas Fir	85	assumed where riparian forest is predominant
Type	52	11	h		"	Mixed (White fir, hardwoods) and shrubs (willows, Mountain Alder).	Conifers (White Fir, Douglas Fir, Lodgepole Pine, and Ponderosa Pine	Common Horsetail (p.210), Coyote Willow (p.114), Rigid Willow (p.117), Black Cottonwood/ Pacific Willow (p.88), Willow/ Kentucky Bluegrass (p.112), Mountain Alder-Currants/Mesic Forb (p.136), Mountain Alder, Kentucky Bluegrass (p.144), Lodgepole Pine/Kentucky Bluegrass (p.51), Quaking Aspen Associations (p.78, 82, 84)	search by elevation, valley width, valley gradient	no valley morphology for this type in the type ecoregion/elevation	Sitka Alder/Mesic Forb, Sitka Alder/Ladyfern	24.9 (100)	Average: Ponderosa Pine, shrub willow, Engelmann Spruce, White Fir, Quaking Aspen, Douglas Fir, White Alder	85	assumed where riparian forest is predominant

Type	53	11	i		Wyoming Big Sagebrush	Hardwoods (Aspen) and shrubs (Booth, Geyer and Lemmon Willows, Shrubby Cinquefoil, Silver Sage, Big Sage) and Cusick's Bluegrass, Wooly Sedge.	Not Applicable		search by elevation, valley width, valley gradient	White alder/Water birch, Douglas fir/Black hawthorn-Common snowberry, bugbane or Douglas Fir/Water birch or Grand fir/Rocky Mt maple or Black Cottonwood/Rock Mt maple, or Ponderosa pine/Common snowberry or Red alder/Red-osier dogwood or Red alder/Pacific ninebark or Grand fir/Common snowberry; or Black cottonwood/Mountain alder-Red-osier dogwood or in higher range, Engelmann spruce/Mountain alder-Red-osier dogwood or Lodgepole dominance or Quaking aspen/Woolly sedge	Red Alder/Common Snowberry/Dewey Sedge, Mountain Alder/Dewey Sedge, Mountain Alder–Red-Osier Dogwood/Mesic Forb, Mountain Alder–Common Snowberry	13.1 (25) 1.5 (75)	Average: Red Osier Dogwood and shrub willows, Quaking Aspen, Red Alder	25	Field Observation, Low tree density to account for predominance of brush
Type	54	11	i		"	Shrubs (willows).	Not Applicable		search by elevation, valley width, valley gradient	no valley morphology for this type in the type ecoregion/elevation	Red Alder/Common Snowberry/Dewey Sedge, Mountain Alder/Dewey Sedge, Mountain Alder–Red-Osier Dogwood/Mesic Forb, Mountain Alder–Common Snowberry	3.5 (25) 1.5 (75)	Average: shrubs and shrub willows	90	Field Observation, Low tree density to account for predominance of brush
Type	55	11	l		Grand Fir, Lodgepole and Ponderosa Pine, roughly 50/30/20%	Hardwoods and shrubs (willows, Bog Blueberry, Dogwood, Mountain Alder, Pacific Ninebark, Common Snowberry).	Conifers (Engelmann Spruce, Douglas Fir, true Fir, Larch, Lodgepole Pine)	Sedge, Horsetail, small Willow, Black Cottonwood/Pacific Willow, Mountain Alder, Red-Osier Dogwood and Quaking Aspen Associations (p.212, 210, 114, 117, 88, 206, 134, 136, 142, 128, 152, 154, 116, 90, 80, 84, 82) and Lodgepole Pine, Grass Associations (p.50, 51)	search by elevation, valley width, valley gradient	Black cottonwood – Alluvial bar or Black cottonwood/Common snowberry, N62	Sitka Alder/Mesic Forb, Sitka Alder/Ladyfern; or if > 1900 m elevation: Engelmann Spruce-Subalpine Fir/Arrowleaf Groundsel, Mountain Alder/Tall Mannagrass [Strawberry Mountain Wilderness], Undergreen Willow/Holm's Rocky Mountain Sedge	29.9 (100)	Average: Ponderosa Pine, Lodgepole Pine, Cottonwood, Grand Fir	53	Field Observation, mixed densities
Type	56	11	l		"	Hardwoods and shrubs (willows, Bog Blueberry, Dogwood, Mountain Alder)	Conifers (Engelmann Spruce, Douglas Fir, true Fir, Larch, Lodgepole Pine)	Maidenhair Fern, Arrowleaf Groundsel, Brook Saxifrage, Currants, Mountain Alder, Subalpine Fir, Engelmann Spruce Associations (p.213, 212, 164, 136, 130, 36, 44)	search by elevation, valley width, valley gradient	3780-5150 ft: Grand fir/Ladyfern or with Oakfern; 2300-4900 ft: Douglas fir/Rocky Mountain maple-Mallow ninebark, Oceanspray or in the higher range, Engelmann spruce/Ladyfern, or 4300-5300 ft: Quaking aspen/Red-osier dogwood or 4640-6490 ft: Subalpine fir/Arrowleaf groundsel-Brook saxifrage	Sitka Alder/Mesic Forb, Sitka Alder/Ladyfern; or if > 1900 m elevation: Engelmann Spruce-Subalpine Fir/Arrowleaf Groundsel, Mountain Alder/Tall Mannagrass [Strawberry Mountain Wilderness], Undergreen Willow/Holm's Rocky Mountain Sedge	28.7 (100)	Average: Lodgepole Pine, Grand Fir	85	Field Observation, dense forest

Type	57	11	l		"	Hardwoods and shrubs (willows, Bog Blueberry, Dogwood, Mountain Alder, Pacific Ninebark, Common Snowberry).	Conifers (Engelmann Spruce, Douglas Fir, true Fir, Larch, Lodgepole Pine)	Maidenhair Fern, Mountain/Sitka Alder, Dogwood, Horsetail, Rocky Mountain Maple Associations (p.213, 134, 138, 130, 132, 142, 124, 58, 54)	search by elevation, valley width, valley gradient	White alder/Water birch, Douglas fir/Black hawthorn-Common snowberry, bugbane or Douglas Fir/Water birch or Grand fir/Rocky Mt maple or Black Cottonwood/Rock Mt maple, or Ponderosa pine/Common snowberry or Red alder/Red-osier dogwood or Red alder/Pacific ninebark or Grand fir/Common snowberry; or Black cottonwood/Mountain alder-Red-osier dogwood or in higher range, Engelmann spruce/Mountain alder-Red-osier dogwood or Lodgepole dominance or Quaking aspen/Woolly sedge; 5500-7020 ft: Engelmann spruce-Subalpine fir/Bog blueberry/Holm's sedge	Sitka Alder/Mesic Forb, Sitka Alder/Ladyfern; or if > 1900 m elevation: Engelmann Spruce-Subalpine Fir/Arrowleaf Groundsel, Mountain Alder/Tall Mannagrass [Strawberry Mountain Wilderness], Undergreen Willow/Holm's Rocky Mountain Sedge	29.3 (100)	Average: Ponderosa Pine, Grand Fir, Engelmann Spruce, Douglas Fir, White Alder, Subalpine Fir, Black Cottonwood	80	Field measurement e.g., Trout Farm Campground
Type	57.5	11	l		"	"	"	"	search by elevation, valley width, valley gradient	Ponderosa pine/Common snowberry or Red alder/Red-osier dogwood or Red alder/Pacific ninebark or Grand fir/Common snowberry; Black cottonwood/Shining willow		22 (100)	Average: Cottonwood, Ponderosa Pine, Red Osier Dogwood	53	Field Observation
Type	58	11	m		Subalpine Fir, minor amounts of Grand Fir and Lodgepole Pine	Conifers (Subalpine Fir) and shrubs (willows, Mountain Alder, Sitka Alder, Bog Blueberry) with Ladyfern, Arrowleaf Groundsel and Queencup Beadlily.	Conifers (Grand fir, Engelmann Spruce and Subalpine Fir)		>6500 feet: Subalpine Fir, Engelmann Spruce and Whitebark Pine	Subalpine fir-Engelmann spruce/Labrador tea/Holm's sedge	Alpine Laurel/Black Alpine Sedge, Shrubby Cinquefoil–Bog Birch, Willow/Bluejoint Reedgrass, Subalpine Fir-Engelmann Spruce/Labrador Tea, Alpine Laurel/Black Alpine Sedge, Pacific Onion-Holm's Rocky Mountain Sedge, Subalpine Fir/Big Huckleberry	15.7 (50) 1.5 (50)	Average: Subalpine Fir, Whitebark Pine and Grand Fir/Engelmann Spruce	85	Field Observation, Open

Type	3	11	n	31% abundant healthy bunchgrasses often on streambanks; 21% scattered juniper throughout landscape including on streambanks; 15% line of Willows and/or Alder shrubs along streambanks; 13% well watered landscape, wet meadows and terraces, springs, marshes, swampy bottom lands, seeps; 13% wet meadows and terraces, springs, marshes, swampy bottom lands, seeps; 10% rich, fertile bottomland soils	Western Juniper Woodland (~55%), Wyoming Big Sagebrush, Bitter Brush, Basin Big Sagebrush	not listed	not listed		search by elevation, valley width, valley gradient	Black cottonwood – Alluvial bar or Black cottonwood/Common snowberry, Ponderosa pine/Black hawthorn-Common snowberry or Black cottonwood/Shining willow	Black Cottonwood/Mountain Alder–Red-Osier Dogwood, Black Cottonwood/Common Snowberry, Black Cottonwood/Rocky Mountain Maple, Red-Osier Dogwood, White Alder/Blackberry, or if <550 m elevation: Douglas-Fir/Rocky Mountain Maple-Mallow Ninebark	21.6 (70) 2.5 (30)	Average: Cottonwood, Ponderosa Pine, Shrub Willow, Mountain Alder, White Alder, Douglas Fir	90	p.326, 324, 338, Crowe et al., 2004
Type	4	11	n	17% scattered juniper throughout landscape including on streambanks; 14% Sage and Rabbit Brush including along streambanks; 11% Wooded streambanks or extensive streamside forests with large trees; 9% well watered landscape, wet meadows and terraces, springs, marshes, swampy bottom lands, seeps; 9% abundant healthy bunchgrasses often on streambanks; 6% rich fertile bottom land soils	"	not listed	not listed	White alder/Red-osier dogwood or Black cottonwood/Lewis' mockorange or White alder with Black hawthorn or Netleaf hackberry	search by elevation, valley width, valley gradient	Black cottonwood-White alder, White alder/Water birch, Douglas fir/Black hawthorn-Common snowberry, bugbane or Douglas Fir/Water birch or Grand fir/Rocky Mt maple or Black Cottonwood/Rock Mt maple, or Ponderosa pine/Common snowberry or Red alder/Red-osier dogwood or Red alder/Pacific ninebark or Grand fir/Common snowberry; or Black cottonwood/Mountain alder-Red-osier dogwood or in higher range, Engelmann spruce/Mountain alder-Red-osier dogwood or Lodgepole dominance or Quaking aspen/Woolly sedge	Black Cottonwood/Mountain Alder–Red-Osier Dogwood, Black Cottonwood/Common Snowberry, Black Cottonwood/Rocky Mountain Maple, Red-Osier Dogwood, White Alder/Blackberry, or if <550 m elevation: Douglas-Fir/Rocky Mountain Maple-Mallow Ninebark	20.5 (25) 2.5 (75)	Average: Ponderosa Pine, shrub willow, Mountain Alder, White Alder, Douglas Fir	90	p.322, 308, Crowe et al., 2004
Type	5	11	n	17% abundant healthy bunchgrasses often on streambanks; 19% scattered juniper throughout landscape including on streambanks; 20% line of Willows and/or Alder shrubs along streambanks; 12% Sage and Rabbit Brush including along streambanks; 12% boulder lined shores with little vegetation; 5% rich, fertile bottomland soils	"	not listed	not listed		search by elevation, valley width, valley gradient	no valley morphology for this type in the type ecoregion/elevation	Black Cottonwood/Mountain Alder–Red-Osier Dogwood, Black Cottonwood/Common Snowberry, Black Cottonwood/Rocky Mountain Maple, Red-Osier Dogwood, White Alder/Blackberry, or if <550 m elevation: Douglas-Fir/Rocky Mountain Maple-Mallow Ninebark	27 (70) 2.5 (30)	Average: Cottonwood, Ponderosa Pine, shrub willow, Mountain Alder, White Alder, Douglas Fir	90	p.326, 324, 338, Crowe et al., 2004

Type	59	11	o		Idaho Fescue, Ponderosa Pine, Wet Meadow	not listed	not listed	Common Horsetail (p.210), Coyote Willow (p.114), Rigid Willow (p.117), Black Cottonwood/ Pacific Willow (p.88), Willow/ Kentucky Bluegrass (p.112)	search by elevation, valley width, valley gradient	Black cottonwood – Alluvial bar or Black cottonwood/Common snowberry, Black cottonwood/Shining willow	Red Alder/Common Snowberry/Dewey Sedge, Mountain Alder/Dewey Sedge, Mountain Alder–Red-Osier Dogwood/Mesic Forb, Mountain Alder–Common Snowberry	3.5 (15) 1.5 (85)	Average: shrub willows & mountain alder	85	McAllister (2008)
Type	60	11	o		"	not listed	not listed	Mountain Alder Associations (p.136, 132)	search by elevation, valley width, valley gradient	3780-5150 ft: Grand fir/Ladyfern or with Oakfern; 2300-4900 ft: Douglas fir/Rocky Mountain maple-Mallow ninebark, Oceanspray or in the higher range, Engelmann spruce/Ladyfern, or 4300-5300 ft: Quaking aspen/Red-osier dogwood or 4640-6490 ft: Subalpine fir/Arrowleaf groundsel-Brook saxifrage	Red Alder/Common Snowberry/Dewey Sedge, Mountain Alder/Dewey Sedge, Mountain Alder–Red-Osier Dogwood/Mesic Forb, Mountain Alder–Common Snowberry	3.5 (15) 1.5 (85)	Average: shrub willows & mountain alder	85	McAllister (2008)
Type	61	11	o		"	not listed	not listed	Various Mountain Alder and Red Osier Dogwood Associations (p.134, 136, 140, 138, 132, 152)	search by elevation, valley width, valley gradient	White alder/Water birch, Douglas fir/Black hawthorn-Common snowberry, bugbane or Douglas Fir/Water birch or Grand fir/Rocky Mt maple or Black Cottonwood/Rock Mt maple, or Ponderosa pine/Common snowberry or Red alder/Red-osier dogwood or Red alder/Pacific ninebark or Grand fir/Common snowberry; or Black cottonwood/Mountain alder-Red-osier dogwood or in higher range, Engelmann spruce/Mountain alder-Red-osier dogwood or Lodgepole dominance or Quaking aspen/Woolly sedge	Red Alder/Common Snowberry/Dewey Sedge, Mountain Alder/Dewey Sedge, Mountain Alder–Red-Osier Dogwood/Mesic Forb, Mountain Alder–Common Snowberry	3.5 (15) 1.5 (85)	Average: shrub willows & mountain alder	85	McAllister (2008)
Type	62	11	o		"	not listed	not listed		Lodgepole Pine/Bearberry-Mountain Gooseberry Association	no valley morphology for this type in the type ecoregion/elevation	Red Alder/Common Snowberry/Dewey Sedge, Mountain Alder/Dewey Sedge, Mountain Alder–Red-Osier Dogwood/Mesic Forb, Mountain Alder–Common Snowberry	3.5 (15) 1.5 (85)	Average: shrub willows & mountain alder	85	McAllister (2008)
mostly non-perennial, Types 62.1, 62.2, 62.3, 62.4		80	d		Sagebrushes, with minor Western Juniper Woodlands	not listed	not listed		Greasewood, Saltgrass, and Basin Wildrye	if 4780-5000 ft (ecoreg 80) cottonwood/Arroyo willow, or if 4360-5160 ft, Narrowleaf cottonwood/Mountain alder/Western clematis (with Red Osier Dogwood)		16.3 (60) 1.5 (40) except S Fk Crooked: 16.3 (80) 1.5 (20)	Average: Black and Narrowleaf Cottonwood, Mountain Alder	85	p.327,349, Crowe et al., 2004

mostly non-perennial, Types 62.5, 62.6, 62.7, 62.8	80	g		Wyoming Big Sagebrush, Western Juniper Woodland, roughly 65/35%	not listed	not listed		Bluebunch wheatgrass, Wyoming big sagebrush	if 4780-5000 ft (ecoreg 80) cottonwood/Arroyo willow, or if 4360-5160 ft, Narrowleaf cottonwood/Mountain alder/Western clematis (with Red Osier Dogwood)		16.3 (30) 1.5 (70) except S Fk Crooked: 16.3 (80) 1.5 (20)	Average: Black and Narrowleaf Cottonwood, Mountain Alder	85	Similar to ecoregion 80d, but lower tree frequency due to increased grassland
Type 63	80	j		Sagebrushes	not listed	not listed		Western Juniper woodland, sagebrush, Idaho fescue	no valley morphology for this type in the type ecoregion/elevation		5.0 (5) 1.5 (95)	High elevation Juniper (low density so not counted) and Idaho Fescue and shrubs	85	est. based on field observations of open juniper/bunchg rass
Type 64		any		not applicable	not applicable	not applicable	Grasses, sedges, rushes with scattered or continuous shrub/willow communities on banks; near stream trees can be common on terraces and other less frequently saturated ground.	Illustrations: p. 68, 80, 83, 85, 92, 97, 99, 102, 105, 107, 111, 113, 115, 122, 124, 128, 141, 148, 194, 200, 231, 233, 235, 238, 263, 275, 278, 286	<<<<		0.7 (100)	Crowe et al., 2004: p. 167 2.8-m mixed red-osier dogwood, thimbleberry, oceanspray, Rocky Mountain maple and Pacific yew ; mixed with 1.0-m grasses and sedges. Mix shrubs and grasses at 75/25	90	assume that grasses, shrubs and sedges are max density
Type 65		any		not applicable	not applicable	not applicable	"	"	<<<<		1.9 (100)	Crowe et al., 2004: p. 167 2.8-m mixed red-osier dogwood, thimbleberry, oceanspray, Rocky Mountain maple and Pacific yew ; mixed with 1.0-m grasses and sedges. Mix shrubs and grasses at 50/50	90	assume that grasses, shrubs and sedges are max density

Table Notes: Areas where information is not available are shaded gray. Blue shading indicates categories described in McAllister (2008). Green shading indicates final model input.