

Temperature Total Maximum Daily Loads for the John Day River Basin

Technical Support Document Appendix C: Estimation of
Background Vegetation

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Document information

This document was prepared by Victoria Avalos

Oregon Department of Environmental Quality

Water Quality Division

700 NE Multnomah Street, Suite 600

Portland Oregon, 97232

Contact: Steve Mrazik

Phone: 503-229-59830020267

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Front Cover: North Fork John Day River below Sulphur Gulch. Photo by Victoria Avalos.

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1 Introduction

Temperature Total Maximum Daily Loads (TMDLs) in the John Day River Basin requires estimation of the background in the near-stream environment. Across the basin-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 background 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 River Basin background 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 nine graphs can address all the identified EP Types in the basin.

3 Steps taken in estimating types and attributes of background vegetation

3.1 Step 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 background vegetation communities and their location, height and density. An annotated literature review is provided in Section 4.

3.2 Step 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 described in Section 3.1 to the most relevant sources for basin wide determinations of background vegetation structure. Some data were available in GIS context and others in conventional literature. The selected sources of information are listed and discussed in Section 5 and summarized in [Table 5-1](#).

3.2.1 Land Cover information note

In estimation of background, 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 northeastern 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 background conditions 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 River Basin.

3.3 Step 3: Conduct monitoring

During the John Day River 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.

3.4 Step 4: Identify background vegetation and specify location

3.4.1 Assess method to spatially apply information

The most relevant botanical literature for the John Day River Basin 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 River Basin 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.

3.4.2 Identify all EP Types present in the Basin

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) background vegetation assessment, we broadly assumed that narrow to moderate width valleys fall into their 'constrained' category and otherwise channels were considered unconstrained [refer Section 3.4.3(4)]. 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. Valley subtypes were simplified and assigned based on the classification, gradient, and valley width, which are simplified and summarized in [Table 3-1](#). 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 Section 3.9.

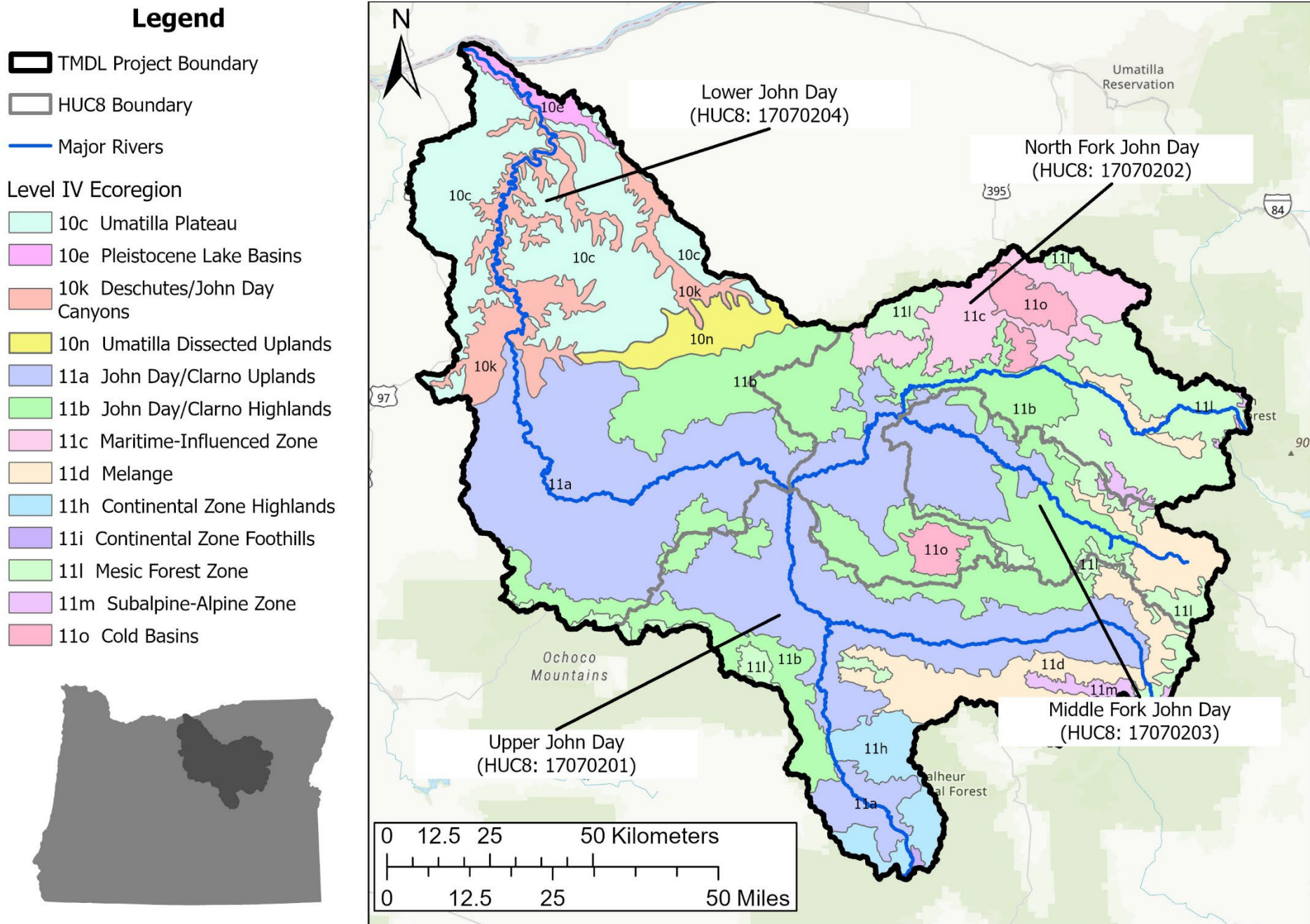


Figure 3-1: Illustration of Level IV Ecoregions for the John Day River Basin.

Temperature TMDLs for the John Day River Basin, TSD Appendix C

There are 13 Level 4 Ecoregions in the John Day River Basin area ([Figure 3-1](#)). With 4 valley forms ([Table 3-1](#)), 52 EP Types potentially exist. Each Ecoregion was surveyed visually in ArcMapTM (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 forty. 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 3-2](#).

Table 3-1: Simplified nomenclature (A-D) for the various valley classes and valley classifications.

Valley Subtype Code	Valey classification (McAllister 2008)	Valley Gradient (McAllister 2008)	OWEB Valley Classification	Valley Width
A	Broad valley/low gradient; flat or gently sloping floodplain	< 1.8%	Unconstrained	< 100m or potential meander belt width is partly ($\geq 20\%$ valley length) constrained
B	Narrow, V-shaped valleys with high gradient	> 4.5%	Constrained	
C	Narrow to moderately wide V- or trough shaded valleys with moderate gradient	1.8 – 4.5%	Unconstrained	
D	Trough or V- shaped valleys with low gradient	< 1.8%	Constrained	> 100m and potential meander belt width is mostly ($>80\%$ of valley length) unconstrained

Table 3-2: Ecoregion-Physiographic types identified in the John Day River Basin.

Level IV Ecoregion	Valley Subtype A	Valley Subtype B	Valley Subtype C	Valley Subtype D
10c	35	36	37	38
10e	39	-	40	41
10k	-	-	1	2
10n	-	-	42	43
11a	43.5	6	7	8
11b	8.5	9	10	11

Level IV Ecoregion	Valley Subtype A	Valley Subtype B	Valley Subtype C	Valley Subtype D
11c	44	45	46	47
11d	47.5	48	49	49.5
11h	-	50	51	52
11i	-	-	53	54
11l	55	56	57	57.5
11m	-	58	-	-
11o	59	60	61	62
Any ecoregion meadow types	64	-	-	65

3.4.3 Assign each EP type background 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 Section 5, [Table 5-3](#). The resultant tabulation of vegetation communities associated with the EP Types by author is provided as Section 6. Methods of source data extraction are as follows, generally in the order of importance, though this varied substantially with spatial applicability:

1. Crowe et al. (2004): In the table of background vegetation types (Section 6), 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 3-3](#). 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.

2. Crowe et al. (1997): Potential vegetation communities are applied to this analysis via the Landform Key provided in Crowe et al (1977).
3. Wells (2006): Potential vegetation communities are applied to this analysis via the Environment Key provided in Wells, 2006.
4. OWEB (1999): In this reference, background 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 6-2](#) through [Table 6-4](#)) 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 3-2](#) identifies the association of the constraint categories of OWEB with the valley types of McAllister. The OWEB semi-constrained category was eliminated.
5. 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.

Table 3-3: Level 4 Ecoregions organized roughly by elevation. (formerly table C-2)

Elevation Range (Wells 2006)	Elevation Range (Crowe et al. 2004)	Ecoregion 11	Ecoregion 10
<550m	Shrub / Willow	11n	10c, 10e, 10k
550–700m	Willow / Low Elevation Tree	11n	10c, 10k
700–1600m	Mid Elev. Tree	11i, 11l, 11n, 11o, 11a, 11b, 11d, 11c, 11h	10c, 10k, 10n
1600–1900m	Mid/High Elev. Tree	11l, 11b, 11d, 11h	
1900–2130m	Mid/High Elev. Tree	11l, 11b, 11d	
>2130m		11m	

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

3.5 Step 5: Estimate background vegetation height for each EP type

For each EP Type, a single height was assigned to the background 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 3-4](#) (3rd 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 75th percentile of these values was utilized for cottonwood potential in the John Day Basin ([Table 3-4](#)). (3) Basin-specific publications (cited in Appendix B) on background riparian vegetation associations provided, (where cited in Section 6), 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 River Basin ([Table 3-4](#)).

Professional judgment was employed to synthesize the various publications, monitoring data and methods described in the preceding paragraph. The selected estimate of background vegetation community typical heights are discussed in Section 6 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 3-4: Species heights used in the determination of background vegetation community height.

	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		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).		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	dbutche: 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.		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

3.6 Step 6: Estimate background foliage density for each EP Type

For each EP Type, a single density value was assigned to the background 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 understory 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 background vegetation community densities are listed in Section 6 with annotations regarding the source or method of determination.

3.7 Step 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 withing EP Type 8 are potentially 80% conifer forest and 20% willow-shrub-grasses, in longitudinal proportions of vegetation occurrence along the stream.

3.8 Step 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 6-1](#) through [Table 6-7](#)), 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.

3.9 Step 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.

3.9.1 Locating meadows outside of temperature model corridors

As stated in Section 3.8, 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.

3.9.2 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 ArcMapTM (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 overstory vegetation is assumed, though of varying density as indicated in Section 6. 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. However, areas of meadow potential were identified along the Middle Fork of John Day. This is because there are large existing meadow complexes and information indicating that meadows predate earliest written or photographic records. For example, [Figure 3-2](#) and [Figure 3-3](#) 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 3-1](#)), 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 3-1](#).

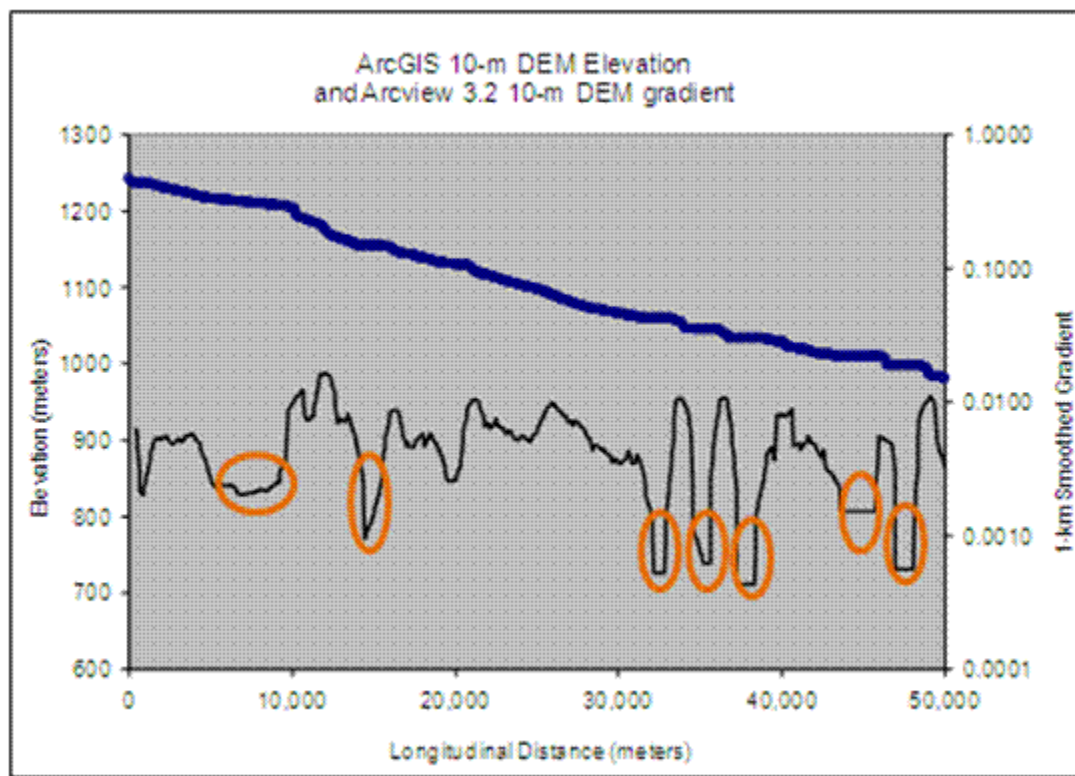


Figure 3-2: Locations of identified meadow potential. Upper Middle Fork gradient (black line) and elevation (blue line) derived from a USGS 10-m DEM sampled at 50-m intervals, from the upper model boundary to a point 50 km downstream. This reach extends approximately from Mill creek to Big Creek. The remaining lower Middle Fork is not considered to have meadow potential.

A



B



Figure 3-3: Meadow complex at confluence of Middle Fork John Day and Ruby Creek, 1939 (A) and 1956 (B). Upper Middle Fork historical photos (figure excerpted from USBR, 2008).

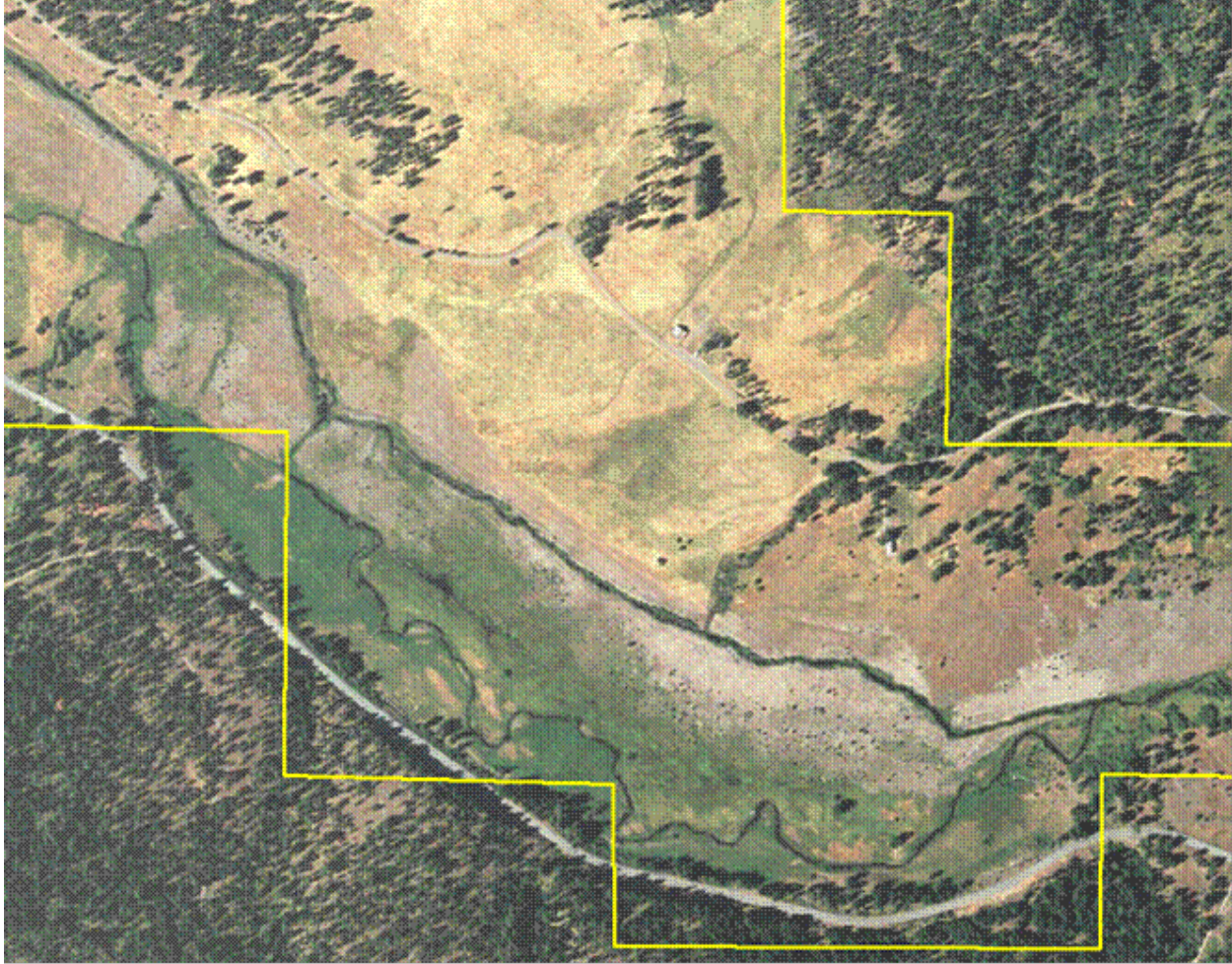


Figure 3-4: Upper Middle Fork Meadow complex in 2005. National Agriculture Imagery Program (NAIP) orthoimage at Ruby Creek confluence. The area between the yellow boundary lines is the Oxbow Conservation area of the Warm Springs Indian Reservation. Note that this image covers the same area as that of Figure 3-2.

3.10 Step 10: Apply background vegetation estimates to temperature model and allocation

3.10.1 Make EP Types explicit

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.

3.10.2 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 3-1](#) specifies valley class criteria for model corridors). Additional breaks were made based on meadow potential. These steps were carried out manually in ArcMapTM 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 Section 6 ([Table 6-1](#)).

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 [Table 3-4](#) through [Table 3-6](#). As well, the reach breaks are illustrated in [Figure 3-5](#) through [Figure 3-7](#).

Table 3-5: Mainstem temperature model reaches with height and density of background vegetation.

Reach ID #	Upper node	Lower node	Model node range (meters from mouth)	Level 4 Ecoregion	Valley Subtype	Ecoregion-Physiographic Type	Land Cover Height in meters (stream length in %)	Land Cover Density (%)
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	8a	27.4 (80) 2.5 (20)	85
4	Deardorff Creek	Prairie City	424750 – 409600	11a	A	43.5	27.4 (80) 2.5 (20)	85
5	Prairie City	top of Picture Gorge	409550 – 316550	11a	A	43.5	27.4 (80) 2.5 (20)	85
6*	top of Picture Gorge	North Fork	316500 – 282250	11a	D	8a	27.4 (80) 2.5 (20)	85
7*	North Fork	Service Creek	282200 – 238200	11a	D	8b	21 (40) 2.5 (60)	85
8*	Service Creek	bottom of Ecoregion 11a	238150 – 135350	11a	D	8c	16.3 (25) 2.5 (75)	85
9*	top of Ecoregion 10k	bottom of Ecoregion 10k	135300 – 17000	10k	D	2	10.8 (50) 2.5 (50)	90
10*	top of Ecoregion 10e	Tumwater Falls	16950 – 0	10e	D	41	8.4 (50) 1.5 (50)	90

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

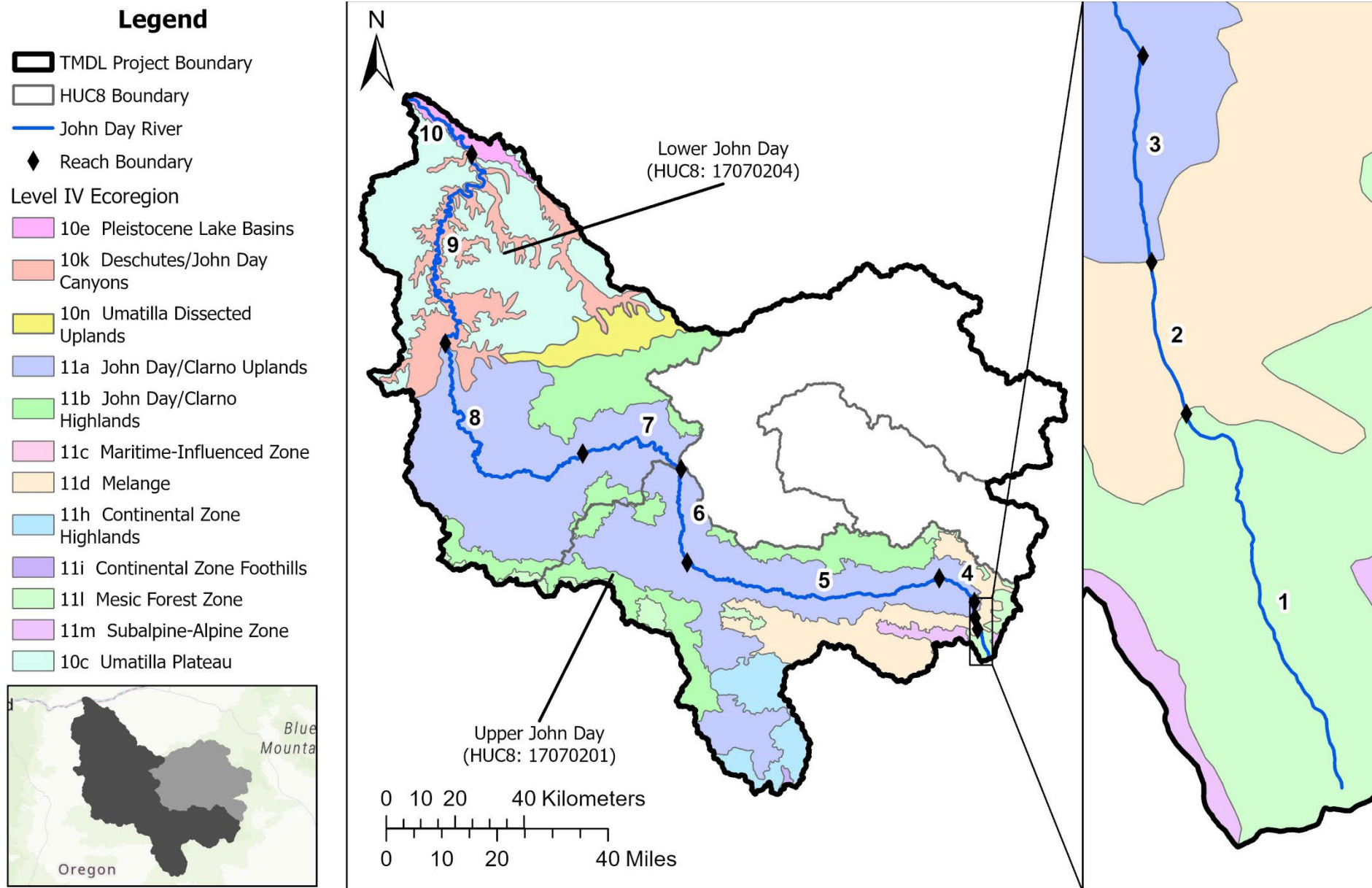


Figure 3-5: Ecoregion map with reach breaks for mainstem John Day River background vegetation.

Table 3-6: North Fork John Day River temperature model reaches with height and density of background vegetation. *Areas undergoing broadscale restoration of preservation.

Reach ID #	Upper node	Lower node	Model node range (meters from mouth)	Level 4 Ecoregion	Valley subtype	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	104900 – 91450	11b	D	11	existing	

Reach ID #	Upper node	Lower node	Model node range (meters from mouth)	Level 4 Ecoregion	Valley subtype	Ecoregion-Physiographic Type	Land Cover Height in meters (stream length in %)	Foliage Density (%)
		km USFS restoration						
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

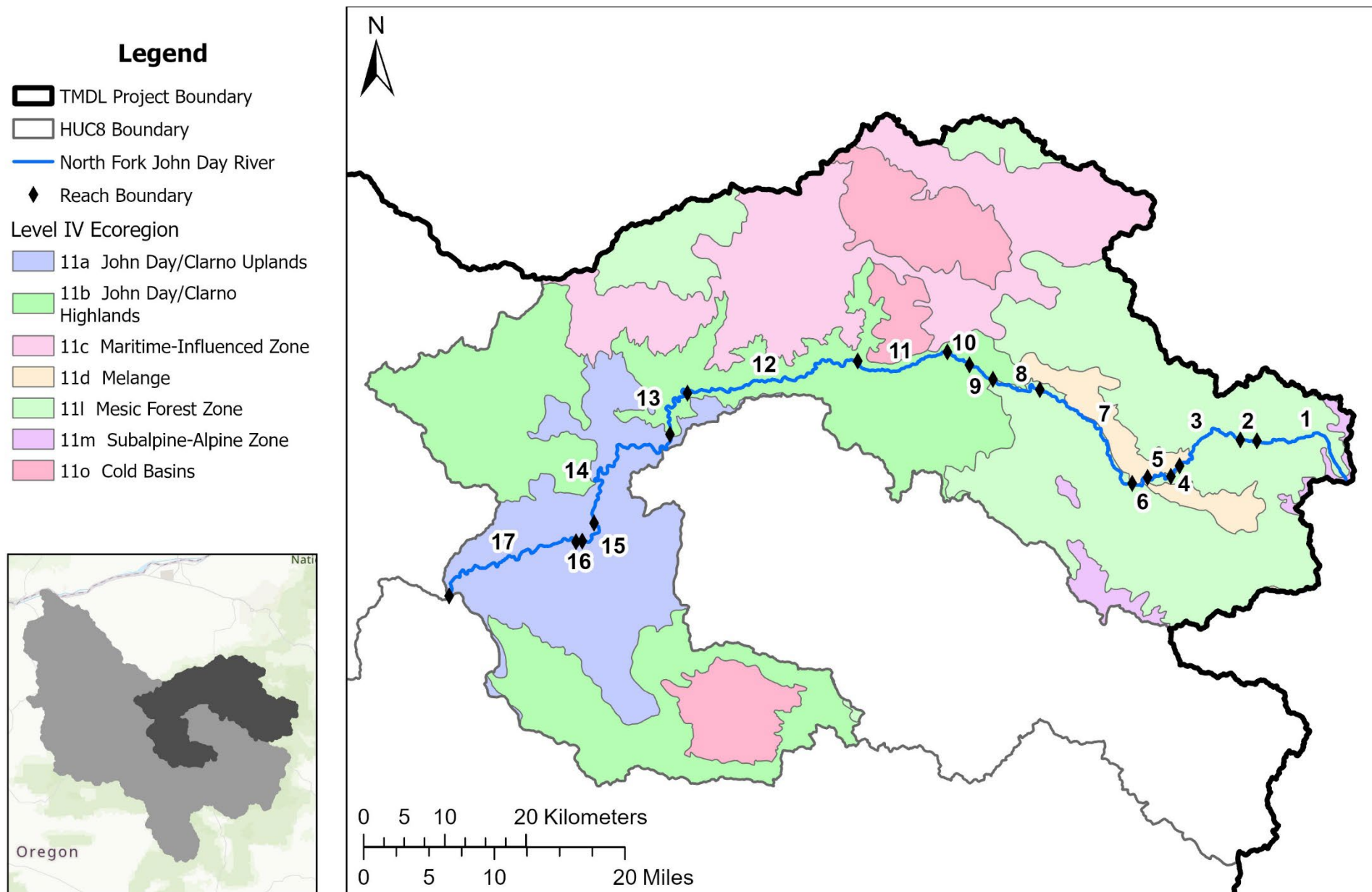


Figure 3-6: Ecoregion and wilderness boundary map with reach breaks for North fork John Day River background vegetation.

Table 3-7: Middle Fork John Day River temperature model reaches with height and density of background vegetation. *Areas undergoing broadscale restoration.

Reach ID #	Upper node	Lower node	Model node range (meters from mouth)	Level 4 Ecoregion	Valley subtype	Ecoregion-Physiographic Type	Land Cover Height in meters (stream length in %)	Foliage Density (%)
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

Reach ID #	Upper node	Lower node	Model node range (meters from mouth)	Level 4 Ecoregion	Valley subtype	Ecoregion-Physiographic Type	Land Cover Height in meters (stream length in %)	Foliage Density (%)
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) 2.5 (20)	85

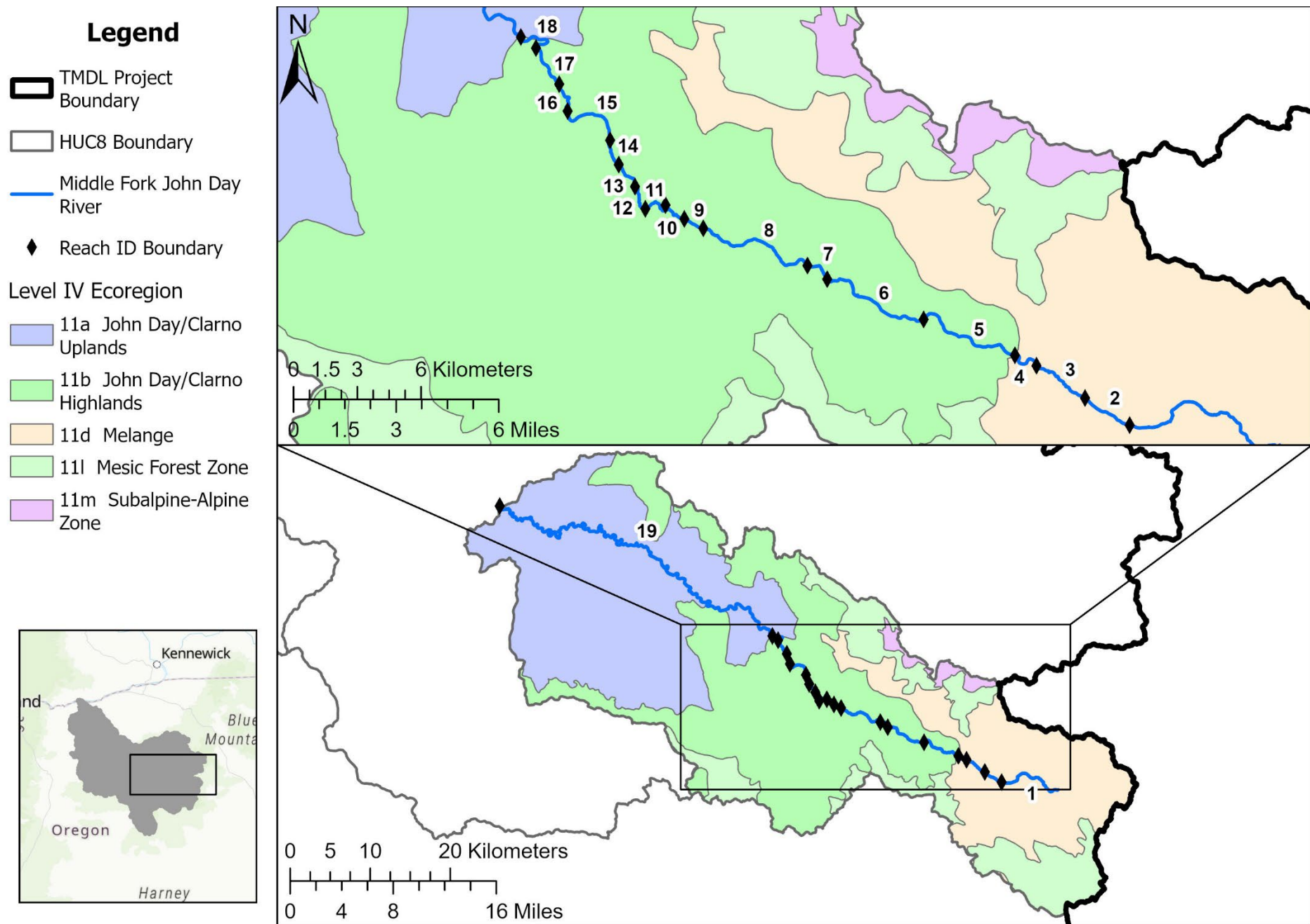


Figure 3-7: Ecoregion and wilderness boundary map with reach breaks for Middle Fork John Day River background vegetation.
 Temperature TMDLs for the John Day River Basin, TSD Appendix C

4 Annotated background vegetation literature review

The literature review targets publications, reports and geographic and historical information that specifically address the John Day River Basin, with regard to historic and natural riparian conditions can be found in [Table 4-1](#). 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. Refer to the references section for the entire list of references cited.

Table 4-1: Annotations, quotes, or description of content that elucidate background conditions or degree of change.

Source	Annotations, quotes or description of content that elucidate background conditions or degree of change
Beshta et al. 2005	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 and Bryce 1997	Oregon Ecoregions
Crowe et al. 2004	Classification of wetland systems based on Ecoregion, geomorphology, soils and plant associations. The plant association in this classification is the native background condition on each fluvial surface. This text describes the expected background 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 2007	“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.”
McAllister 2008	"Although [Indigenous people] 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 [Indigenous people], 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

Source	Annotations, quotes or description of content that elucidate background conditions or degree of change
	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	“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	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	Reference for riparian vegetation height and density.
Potter, 1995	Picture of John Day City with Cottonwood gallery in background
Thorson et al. 2003	Ecoregion
Thompson and Johnson 1900	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).
Tobalske 2002	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.

Source	Annotations, quotes or description of content that elucidate background conditions or degree of change
US BLM 2006	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."
USFS 1995	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.
USFS 2007a	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.
USFS 2007b	The Forest Service used 10 as a target for wetted w/d.
Wells 2006	This provides background vegetation community height and canopy percent cover and is more specific to the certain areas than the work of Crowe et al.

5 Selected key sources of background vegetation information

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

[Table 5-1](#) 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 5-2](#). 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 5-3](#) identifies the method of data stratification by the various authors.

Other resources for background 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 5-1: Principle Sources and Attributes of literature-derived land cover information utilized in estimation of background vegetation.

Information Characteristics	Mid-Montane Wetland Plant Associations of the Malheur, Umatilla and Wallowa-Whitman National Forests (¹Crowe et al., 1997)	Riparian and Wetland Vegetation of Central and Eastern Oregon (²Crowe et al., 2004)	Reconstructing Historical Riparian Conditions of Two River Basins in Eastern Oregon, USA (⁴McAllister, 2008)	Watershed Assessment Manual (⁵OWEB, 1999)	Deep Canyon and Subalpine Riparian and Wetland Plant Associations of the Malheur, Umatilla and Wallowa-Whitman National Forests (⁹Wells, 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

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)
Species Composition	detailed	detailed	limited	yes	detailed

There are five principal literature derived sources used to estimate background vegetation, which are summarized in [Table 5-1](#).

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).

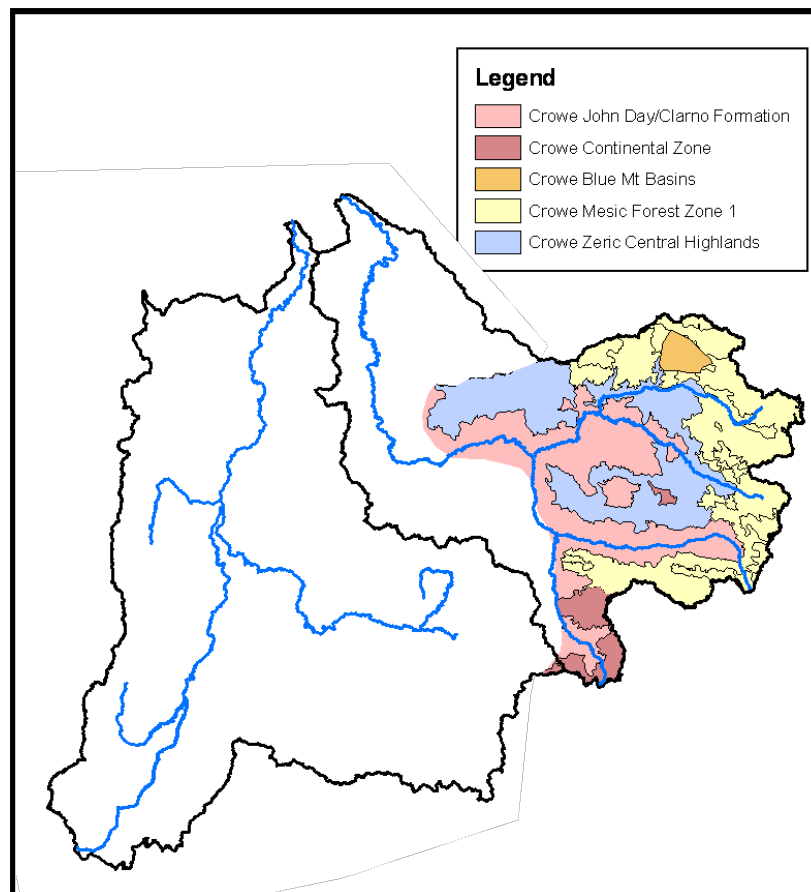


Figure 5-1: Spatial coverage of Crowe et al., 1997.

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. The spatial coverage consists of Eastern Oregon. 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.

Crowe et al., 1997 spatial coverage consists only of National Forest lands. The three National Forest areas (Umatilla, Malheur, Wallowa-Whitman) are shown in color in [Figure 5-1](#).

The spatial coverage described in Wells, 2006 indicates coverage only in three National Forests, 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 unsampled 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).

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 5-2](#)).

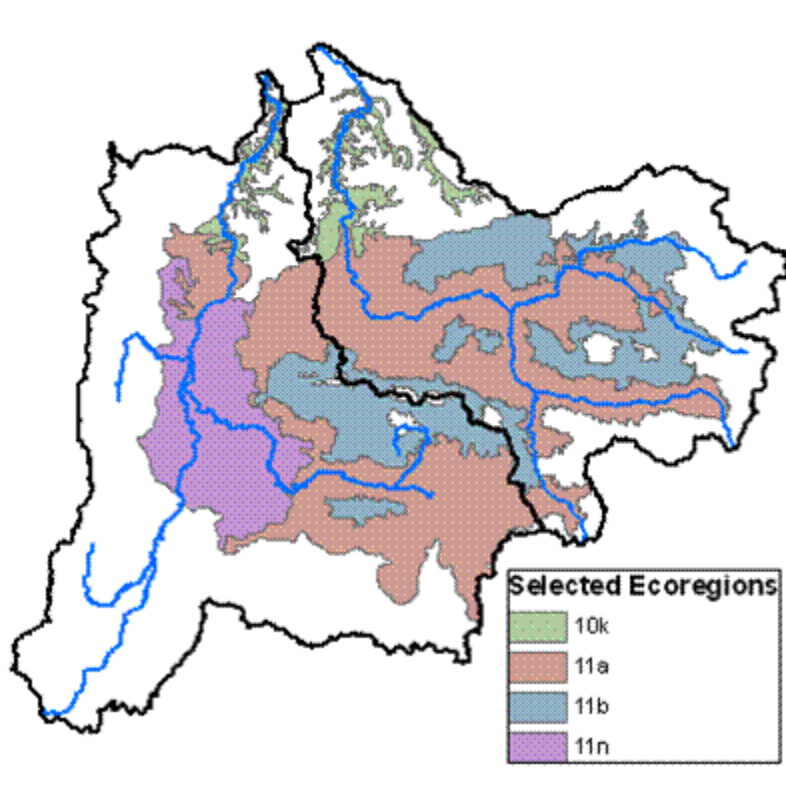


Figure 5-2: Spatial coverage of McAllister, 2008.

Table 5-2: Principle Sources of GIS Land Cover Information Utilized in Estimation of Natural Thermal Potential.

Information Characteristics	Ecoregions	Gap Existing	Gap Historic
Data source	⁷ Thorson, et al., 2003	^{3, 6} ONHP	⁸ Tobalske, 2002
Existing vegetation		yes	

Information Characteristics	Ecoregions	Gap Existing	Gap Historic
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

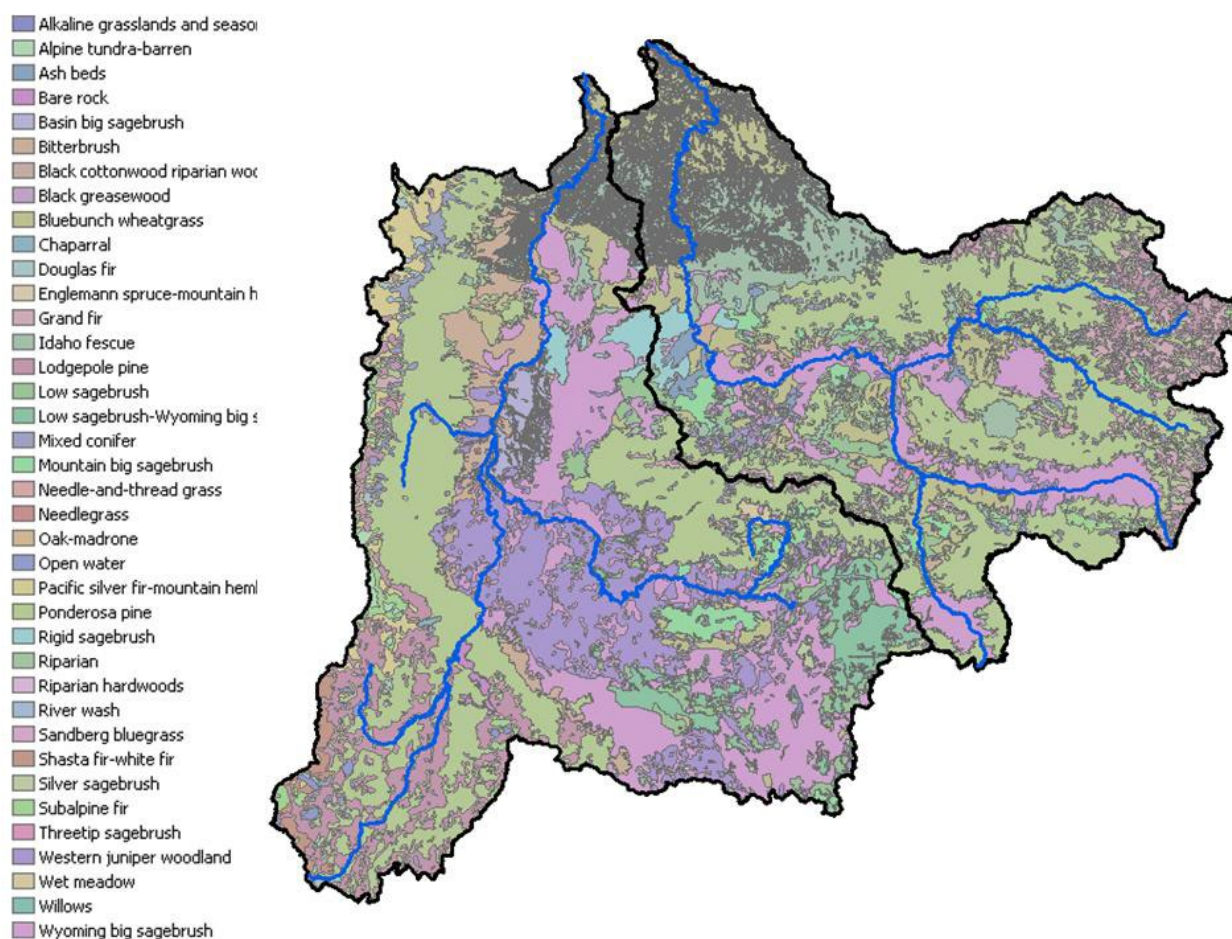


Figure 5-3: Illustration of Oregon GAP historic vegetation assessment for the John Day River Basin (Tobalske 2002).

Table 5-3: Summary of vegetation data stratification order and selected attributes.

McAllister, 2008		Crowe et al., 1997				Wells, 2006			OWEB, 1999		
<u>1st</u>	<u>2nd</u>	<u>1st</u>	<u>2nd</u>	<u>3rd</u>	<u>4th</u>	<u>1st</u>	<u>2nd</u>	<u>3rd</u>	<u>1st</u>	<u>2nd</u>	<u>3rd</u>
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 narrow to mod. wide V or trough shaped valley 1.9- 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) narrow V shaped valleys >4% grad (A- type)	4.5k-6.5k ft	alluvial bars	<700 m	valley grad >3%	rocky bars		un- constrained	outer range
11b		Mesic Forest Zone 1	narrow V shaped valleys	2.5k-4.8k ft	terraces	<550 m		terraces		semi- constrained	
11n	narrow valley <1.8% grad	Mesic Forest Zone 2 Columbia Plateau	2-4% grad (A & B-type) broad or mod. broad <1% grad.	4.0k-7.5k ft	headwater basins streambanks and narrow floodplains streambanks and floodplains	>550 m					
		Other strata: Soil saturation, particle size				>=1600 m					
						<2130 m					
						<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			

6 Type, height, and density estimates of background vegetation

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 [Table 6-1](#). Heights and densities are approximated as described previously in Section 3.5 and Section 3.6.

[Table 6-2](#) to [Table 6-5](#) 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 (Section 3.4). The information sources identified in [Table 6-2](#) to [Table 6-5](#) vary in their spatial relevance and scale, and in their degree of riparian specificity and in the type and amount of information provided.

Section 3.4.3 includes detailed explanation of the header categories of [Table 6-2](#) to [Table 6-5](#). Further discussion of context, definitions and limitations can be found in the main body of this report.

Table 6-1: Type, height and density estimate of background vegetation.

Ecoregion	Ecoregion/ Physiographic Type	Height in meters, (percent stream length)	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
10c	35	15.3 (70) 3.5 (30)	Average: cottonwood, shrub willow, large willow	90	est. 60% riparian forest, %40 treeless
10c	36	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.
10c	37	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.
10c	38	15.3 (40) 2.5 (60)	Average: cottonwood, shrub willow, large willow	90	est. 50% riparian forest, %50 treeless
10e	39	16.3 (50) 1.5 (50)	Average: white alder, willow, cottonwood	90	field observations
10e	40	10.7 (70) 2.5 (30)	Average: White Alder, shrub willow	90	field observations
10e	41	8.4 (50) 1.5 (50)	Average: White Alder, shrub willow, Red-Osier Dogwood	90	field observations
10k	1	16.3 (50) 2.5 (50)	Average: White Alder, shrub willow, Cottonwood	90	field observations
10k	2	10.8 (50) 2.5 (50)	Average: White Alder, shrub willow	90	field observations
10n	42	12.6 (60) 2.5 (40)	Average: White Alder, Water Birch, Shrub	90	field observations
10n	43	11.2 (75) 2.5 (25)	Average: White Alder, Water Birch, Shrub	90	field observations
11a	43.5	General: 16.3 (50) 2.5 (50)	General- avg Cottonwood, White Alder, shrub Willow.	85	field observations, McAllister 2008, Crowe et al., 2004

Ecoregion	Ecoregion/ Physiographic Type	Height in meters, (percent stream length)	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
11a	43.5	Mainstem above Picture Gorge: 27.4 (80) 2.5 (20)	Mainstem above Picture Gorge - Cottonwood gallery.	85	field observations, McAllister 2008, Crowe et al., 2004
11a	43.5	Mainstem from Picture Gorge to Service Creek and North Fork below Monument: 21.0 (40) 2.5 (60)	Mainstem Picture Gorge to Service Creek and North Fork below Monument - avg P. Pine, Cottonwood, White Alder, shrub willow.	85	field observations, McAllister 2008, Crowe et al., 2004
11a	43.5	Mainstem below Service Creek: 16.3 (25) 2.5 (75)	Mainstem below Service Creek - average Cottonwood, White Alder, shrub willow.	85	field observations, McAllister 2008, Crowe et al., 2004
11a	6	18.8 (50) 3.5 (50)	Average: Ponderosa Pine, White Alder, shrub Willow	85	field observations, McAllister 2008, Crowe et al., 2004
11a	7	General: 18.8 (70), 2.5 (30)	General: White Alder, shrub Willow, Ponderosa pine	85	field observations, McAllister 2008, Crowe et al., 2004
11a	7	Mainstem from Picture Gorge to Service Creek and	Mainstem from Picture Gorge to Service Creek and North Fork below Monument - avg P. Pine, White Alder, shrub willow	85	field observations, McAllister 2008, Crowe et al., 2004

Ecoregion	Ecoregion/ Physiographic Type	Height in meters, (percent stream length)	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
		North Fork below Monument: 18.8 (40), 2.5 (60)			
11a	7	Mainstem below Service Creek: 10.8 (25), 2.5 (75)	Mainstem below Service Creek - average White Alder, shrub willow.	85	field observations, McAllister 2008, Crowe et al., 2004
11a	8	General: 16.3 (50) 2.5 (50)	General- avg Cottonwood, White Alder, shrub Willow	85	field observations, McAllister 2008, Crowe et al., 2004
11a	8	Mainstem above Picture Gorge: 27.4 (80) 2.5 (20)	Mainstem above Picture Gorge - Cottonwood gallery	85	field observations, McAllister 2008, Crowe et al., 2004
11a	8	Mainstem from Picture Gorge to Service Creek and North Fork below Monument: 21.0 (40) 2.5 (60)	Mainstem Picture Gorge to Service Creek and North Fork below Monument - avg P. Pine, Cottonwood, White Alder, shrub willow	85	field observations, McAllister 2008, Crowe et al., 2004
11a	8	Mainstem below	Mainstem below Service Creek - average Cottonwood, White Alder, shrub willow.	85	field observations, McAllister 2008, Crowe et al., 2004

Ecoregion	Ecoregion/ Physiographic Type	Height in meters, (percent stream length)	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
		Service Creek: 16.3 (25) 2.5 (75).			
11b	8.5	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
11b	9	19.2 (100)	Average: Ponderosa Pine, Willow	80	field observations
11b	10	18.8 (100)	Average: Ponderosa Pine, Cottonwood, Willow	80	field observations
11b	11	21.9 (100)	Average: Ponderosa Pine, Cottonwood, shrub willow	80	field observations
11c	44	27.3 (100)	Average: Lodgepole, Douglas Fir, Quaking Aspen, Grand Fir, White Alder, shrub willow, Cottonwood	85	field observations
11c	45	27.2 (100)	Average: Lodgepole, Douglas Fir, Quaking Aspen, Grand Fir, White Alder	85	field observations
11c	46	23.2 (100)	Average: Lodgepole, Douglas Fir, Quaking Aspen, Grand Fir, White Alder, shrub willow	85	field observations
11c	47	21.9 (100)	Average: Lodgepole, Douglas Fir, White Alder, Water Birch	85	field observations
11d	47.5	16.3 (100)	Average: Cottonwood, White Alder, shrub willow	90	Crowe et al., 2004, Black Cottonwood - White Alder Association
11d	48	29.1 (100)	Average: Ponderosa Pine, Engelmann Spruce	85	field observations
11d	49	28.8 (100)	Average: Ponderosa Pine, Engelmann Spruce, Cottonwood, Subalpine Fir, Douglas Fir	85	field observations
11d	49.5	24.7 (100)	average: Ponderosa pine, Lodgepole Pine	80	field observations
11h	50	27.7 (100)	Average: Ponderosa Pine, shrub willow, Engelmann Spruce, White Fir, Douglas Fir	85	assumed where riparian forest is predominant
11h	51	26.1 (100)	Average: Ponderosa Pine, shrub willow, Engelmann Spruce, White Fir, Quaking Aspen, Douglas Fir	85	assumed where riparian forest is predominant
11h	52	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

Ecoregion	Ecoregion/ Physiographic Type	Height in meters, (percent stream length)	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
11i	53	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
11i	54	3.5 (25) 1.5 (75)	Average: shrubs and shrub willows	90	Field Observation, Low tree density to account for predominance of brush
11l	55	29.9 (100)	Average: Ponderosa Pine, Lodgepole Pine, Cottonwood, Grand Fir	80	Field Observation, mixed densities
11l	56	28.7 (100)	Average: Lodgepole Pine, Grand Fir	85	Field Observation, dense forest
11l	57	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
11l	57.5	22 (100)	Average: Cottonwood, Ponderosa Pine, Red Osier Dogwood	80	Field Observation
11m	58	15.7 (50) 1.5 (50)	Average: Subalpine Fir, Whitebark Pine and Grand Fir/Engelmann Spruce	85	Field Observation, Open
11o	59	3.5 (15) 1.5 (85)	Average: shrub willows & mountain alder	85	McAllister (2008)
11o	60	3.5 (15) 1.5 (85)	Average: shrub willows & mountain alder	85	McAllister (2008)
11o	61	3.5 (15) 1.5 (85)	Average: shrub willows & mountain alder	85	McAllister (2008)
11o	62	3.5 (15) 1.5 (85)	Average: shrub willows & mountain alder	85	McAllister (2008)
any	64	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
any	65	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 6-2: Vegetation descriptions for Ecoregion 10 based on different literature sources.

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)
10c	35	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
10c	36	Grasses and Sages	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
10c	37	Grasses and Sages	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

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)
10c	38	Grasses and Sages	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
10e	39	Grasses and Sages	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
10e	40	Grasses and Sages	Shrubs such as Mountain Alder, Red Osier Dogwood and willows. Galleries of Black Cottonwood occurred in areas of	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

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)
			perennial streamflow				
10e	41	Grasses and Sages	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
10n	42	Grasses and Sages	not listed	not listed	-	-	White alder/Water birch
10n	43	Grasses and Sages	not listed	not listed	-	-	no valley morphology for this type in the type ecoregion/elevation

Table 6-3: Vegetation descriptions for Ecoregion 11 based on different literature sources.

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)	Wells, 2006
11a	43.5	Grasses and Sages	Hardwoods (Cottonwood and Alder) and shrubs (willows, Mountain Alder and Douglas Spiraea.) Infrequent Juniper.	Not Applicable	Horsetail, Willow, Sedge and Black Cottonwood/Pa cific 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/elev ation	Red Alder/Common Snowberry/Dewey Sedge, Mountain Alder/Dewey Sedge, Mountain Alder– Red-Osier Dogwood/Mesic Forb, Mountain Alder–Common Snowberry
11a	6	Ponderos a Pine, Juniper, Low Sagebrus h, 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/Ladyfer n, or 4300- 5300 ft: Quaking aspen/Red-	Red Alder/Common Snowberry/Dewey Sedge, Mountain Alder/Dewey Sedge, Mountain Alder– Red-Osier Dogwood/Mesic Forb, Mountain Alder–Common Snowberry

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)	Wells, 2006
							osier dogwood or 4640-6490 ft: Subalpine fir/Arrowleaf groundsel- Brook saxifrage	
11a	7	Ponderosa Pine, Juniper, Low Sagebrush, Grasses	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/R ock 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	Red Alder/Common Snowberry/Dewey Sedge, Mountain Alder/Dewey Sedge, Mountain Alder- Red-Osier Dogwood/Mesic Forb, Mountain Alder-Common Snowberry

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)	Wells, 2006
							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	
11a	8	Ponderosa Pine, Juniper, Low Sagebrush, Grasses	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
11b	8.5	Ponderosa Pine, Juniper, Low Sagebrush	Hardwoods (Alder & Cottonwood) and shrubs (willows, Sitka Alder,	Hardwoods (Alder & Cottonwood) and shrubs (willows,	Horsetail, Willow, Sedge and Black Cottonwood/Pacific Willow Associations	search by elevation, valley width, valley gradient	Black cottonwood/Common snowberry, Black cottonwood –	-

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)	Wells, 2006
		h, Grasses	Mountain Alder)	Sitka Alder, Mountain Alder)	(p.210, 114, 117, 212, 88); and Mountain Alder, Dogwood, Cottonwood Associations (p.134, 144, 90)		Alluvial bar, Black cottonwood/Sh ining willow	
11b	9	Ponderos a Pine	Hardwoods (Alder & Cottonwood) and shrubs (willows, Sitka Alder, Mountain Alder)	Hardwood s (Alder & Cottonwo od) 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/Ladyfer n, 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

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)	Wells, 2006
11b	10	Ponderosa Pine	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/R ock 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/Mo untain alder- Red-osier dogwood or in higher range, Engelmann spruce/Mounta in alder-Red-	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

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)	Wells, 2006
							osier dogwood or Lodgpole dominance or Quaking aspen/Woolly sedge, 5500- 7020 ft: Engelmann spruce- Subalpine fir/Bog blueberry/Holm 's sedge	
11b	11	Ponderos a Pine	Hardwoods (Alder & Cottonwood) and shrubs (willows, Sitka Alder, Mountain Alder)	Hardwood s (Alder & Cottonwo od) and shrubs (willows, Sitka Alder, Mountain Alder)	Horsetail, Willow, Sedge and Black Cottonwood/Pa cific 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/elev ation	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
11c	44	Ponderos a Pine	Hardwoods (Alder, willow, Cottonwood	Conifers (infrequen t true Fir and	Sedge, Horsetail, small Willow, Black Cottonwood/Pa	search by elevation, valley width,	Black cottonwood – Alluvial bar or Black	Red Alder/Common Snowberry/Dewey Sedge, Mountain Alder/Dewey Sedge,

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)	Wells, 2006
			& aspen) and shrubs (willows, Sitka Alder, Mountain Alder and Common Snowberry, Shrubby Cinquefoil)	Ponderosa Pine)	cific 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)	valley gradient	cottonwood/Co mmon snowberry, Black cottonwood/Sh ining willow	Mountain Alder– Red-Osier Dogwood/Mesic Forb, Mountain Alder–Common Snowberry
11c	45	Ponderosa Pine	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/Ladyfer n, or 4300- 5300 ft: Quaking	Red Alder/Common Snowberry/Dewey Sedge, Mountain Alder/Dewey Sedge, Mountain Alder– Red-Osier Dogwood/Mesic Forb, Mountain Alder–Common Snowberry

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)	Wells, 2006
							aspen/Red-osier dogwood or 4640-6490 ft: Subalpine fir/Arrowleaf groundsel-Brook saxifrage	
11c	46	Ponderosa Pine	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	Red Alder/Common Snowberry/Dewey Sedge, Mountain Alder/Dewey Sedge, Mountain Alder-Red-Osier Dogwood/Mesic Forb, Mountain Alder-Common Snowberry

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)	Wells, 2006
							Grand fir/Common snowberry; or Black cottonwood/Mo untain alder- Red-osier dogwood or in higher range, Engelmann spruce/Mounta in alder-Red- osier dogwood or Lodgepole dominance or Quaking aspen/Woolly sedge	
11c	47	Ponderos a Pine	Hardwoods (Alder & Cottonwood) and shrubs (willows, Sitka Alder, Mountain Alder)	Conifers (infrequen t true Fir and Ponderos a 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

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)	Wells, 2006
11d	47.5	Ponderosa Pine	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/Co mmon snowberry, Black cottonwood – Alluvial bar, Black cottonwood/Sh ining willow	-
11d	48	Ponderosa Pine	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/Ladyfer n, or 4300- 5300 ft: Quaking aspen/Red- osier dogwood or 4640-6490	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

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)	Wells, 2006
							ft: Subalpine fir/Arrowleaf groundsel- Brook saxifrage	
11d	49	Ponderosa Pine	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/R ock 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/Mo untain alder-	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

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)	Wells, 2006
							Red-osier dogwood or in higher range, Engelmann spruce/Mounta in alder-Red- osier dogwood or Lodgepole dominance or Quaking aspen/Woolly sedge, 5500- 7020 ft: Engelmann spruce- Subalpine fir/Bog blueberry/Holm 's sedge	
11d	49.5	Ponderos a Pine	Hardwoods (Alder, Cottonwood, willow & Aspen) and shrubs (willows, Sitka Alder, Mountain Alder, and Common Snowberry)	Conifers (Douglas Fir, true Fir, Ponderos a 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	Ponderosa pine-lodgepole pine/Douglas' spiraea- common snowberry	-

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)	Wells, 2006
11h	50	Ponderosa Pine	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/Ladyfer n, 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

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)	Wells, 2006
11h	51	Ponderosa Pine	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/R ock 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/Mo untain alder- Red-osier dogwood or in higher range, Engelmann spruce/Mounta in alder-Red-	Sitka Alder/Mesic Forb, Sitka Alder/Ladyfern

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)	Wells, 2006
							osier dogwood or Lodgepole dominance or Quaking aspen/Woolly sedge, 5500- 7020 ft: Engelmann spruce- Subalpine fir/Bog blueberry/Holm 's sedge	
11h	52	Ponderos a Pine	Mixed (White fir, hardwoods) and shrubs (willows, Mountain Alder).	Conifers (White Fir, Douglas Fir, Lodgepole Pine, and Ponderos a 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	search by elevation, valley width, valley gradient	no valley morphology for this type in the type ecoregion/elev ation	Sitka Alder/Mesic Forb, Sitka Alder/Ladyfern

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)	Wells, 2006
					Bluegrass (p.144), Lodgepole Pine/Kentucky Bluegrass (p.51), Quaking Aspen Associations (p.78, 82, 84)			
11i	53	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/R ock Mt maple, or Ponderosa pine/Common snowberry or Red alder/Red- osier dogwood or Red alder/Pacific ninebark or Grand fir/Common	Red Alder/Common Snowberry/Dewey Sedge, Mountain Alder/Dewey Sedge, Mountain Alder- Red-Osier Dogwood/Mesic Forb, Mountain Alder-Common Snowberry

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)	Wells, 2006
							snowberry; or Black cottonwood/Mo untain alder- Red-osier dogwood or in higher range, Engelmann spruce/Mounta in alder-Red- osier dogwood or Lodgepole dominance or Quaking aspen/Woolly sedge	
11i	54	Wyoming Big Sagebrush	Shrubs (willows).	Not Applicable	-	search by elevation, valley width, valley gradient	no valley morphology for this type in the type ecoregion/elev ation	Red Alder/Common Snowberry/Dewey Sedge, Mountain Alder/Dewey Sedge, Mountain Alder- Red-Osier Dogwood/Mesic Forb, Mountain Alder-Common Snowberry
11l	55	Grand Fir, Lodgepole and Ponderosa Pine, roughly 50/30/20%	Hardwoods and shrubs (willows, Bog Blueberry, Dogwood, Mountain Alder, Pacific Ninebark,	Conifers (Engelmann Spruce, Douglas Fir, true Fir, Larch,	Sedge, Horsetail, small Willow, Black Cottonwood/Pa cific Willow, Mountain Alder, Red-Osier Dogwood and	search by elevation, valley width, valley gradient	Black cottonwood – Alluvial bar or Black cottonwood/Co mmon	Sitka Alder/Mesic Forb, Sitka Alder/Ladyfern; or if > 1900 m elevation: Engelmann Spruce- Subalpine Fir/Arrowleaf Groundsel,

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)	Wells, 2006
			Common Snowberry).	Lodgepole Pine)	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)		snowberry, N62	Mountain Alder/Tall Mannagrass [Strawberry Mountain Wilderness], Undergreen Willow/Holm's Rocky Mountain Sedge
111	56	Grand Fir, Lodgepole and Ponderos a Pine, roughly 50/30/20%	Hardwoods and shrubs (willows, Bog Blueberry, Dogwood, Mountain Alder)	Conifers (Engelma nn 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/Ladyfer n, or 4300- 5300 ft: Quaking aspen/Red- osier dogwood or 4640-6490 ft: Subalpine	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

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)	Wells, 2006
							fir/Arrowleaf groundsel- Brook saxifrage	
111	57	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)	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	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

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)	Wells, 2006
							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	
111	57.5	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)	Maidenhair Fern, Mountain/Sitka Alder, Dogwood, Horsetail, Rocky Mountain Maple Associations (p.213, 134, 138, 130, 132,	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;	-

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)	Wells, 2006
					142, 124, 58, 54)		Black cottonwood/Sh ining willow	
11m	58	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, Engelman n Spruce and Subalpine Fir)	-	>6500 feet: Subalpine Fir, Engelmann Spruce and Whitebark Pine	Subalpine fir- Engelmann spruce/Labrad or 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
11o	59	Idaho Fescue, Ponderos a 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/Co mmon snowberry, Black cottonwood/Sh ining willow	Red Alder/Common Snowberry/Dewey Sedge, Mountain Alder/Dewey Sedge, Mountain Alder- Red-Osier Dogwood/Mesic Forb, Mountain Alder-Common Snowberry

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)	Wells, 2006
11o	60	Idaho Fescue, Ponderos a Pine, Wet Meadow	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/Ladyfer n, 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

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)	Wells, 2006
11o	61	Idaho Fescue, Ponderosa Pine, Wet Meadow	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/R ock 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/Mo untain alder- Red-osier dogwood or in higher range, Engelmann spruce/Mounta in alder-Red-	Red Alder/Common Snowberry/Dewey Sedge, Mountain Alder/Dewey Sedge, Mountain Alder- Red-Osier Dogwood/Mesic Forb, Mountain Alder-Common Snowberry

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)	Wells, 2006
							osier dogwood or Lodgepole dominance or Quaking aspen/Woolly sedge	
11o	62	Idaho Fescue, Ponderosa Pine, Wet Meadow	not listed	not listed	-	Lodgepole Pine/Bearber ry-Mountain Gooseberry Association	no valley morphology for this type in the type ecoregion/elev ation	Red Alder/Common Snowberry/Dewey Sedge, Mountain Alder/Dewey Sedge, Mountain Alder– Red-Osier Dogwood/Mesic Forb, Mountain Alder–Common Snowberry

Table 6-4: Vegetation descriptions any Ecoregion based on different literature sources.

Ecoregion	Ecoregion/ Physiographic Type	Tobalske, 2002	OWEB, 1999 (inner zone)	OWEB, 1999 (outer zone)	Crowe et al, 1997 (plant associations)	Crowe et al, 2004 (general overview)	Crowe et al, 2004 (plant associations)
any	64	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	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
any	65	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	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

Table 6-5: Vegetation descriptions based on McAllister, 2008.

Ecoregion	Ecoregion/ Physiographic Type	McAllister, 2008
11a	43.5	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
11a	6	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
11a	7	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,

Ecoregion	Ecoregion/ Physiographic Type	McAllister, 2008
		sometimes Spruce in forests with Pine, often large; 8% Sage brush and rabbit brush, including along streambanks
11a	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
11b	8.5	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
11b	9	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
11b	10	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
11b	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

References

Bever, D. N. (1981). Northwest Conifers, A Photographic Key. Binford and Mort, Publisher; Portland, Oregon.

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.

DEQ. (2009). Draft Malheur temperature TMDL technical appendix.

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.

Oregon Watershed Assessment Manual. (1999). Developed for the Governor's Watershed Enhancement Board (OWEB). Last accessed at [OWEB](#)

Oregon Natural Heritage Information Center. (1999). GAP Historical or "Pre-settlement" Land Cover. Last accessed at [Oregon State University](#)

Oregon State University. (2005). Oregon State University Rangeland Ecology and Management Riparian Plant Fact Sheets. Last Accessed at [Oregon State University](#)

Oregon State University and Oregon Department of Forestry. (1999). Trees to Know in Oregon (EC 1450).

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).

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.

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.

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.