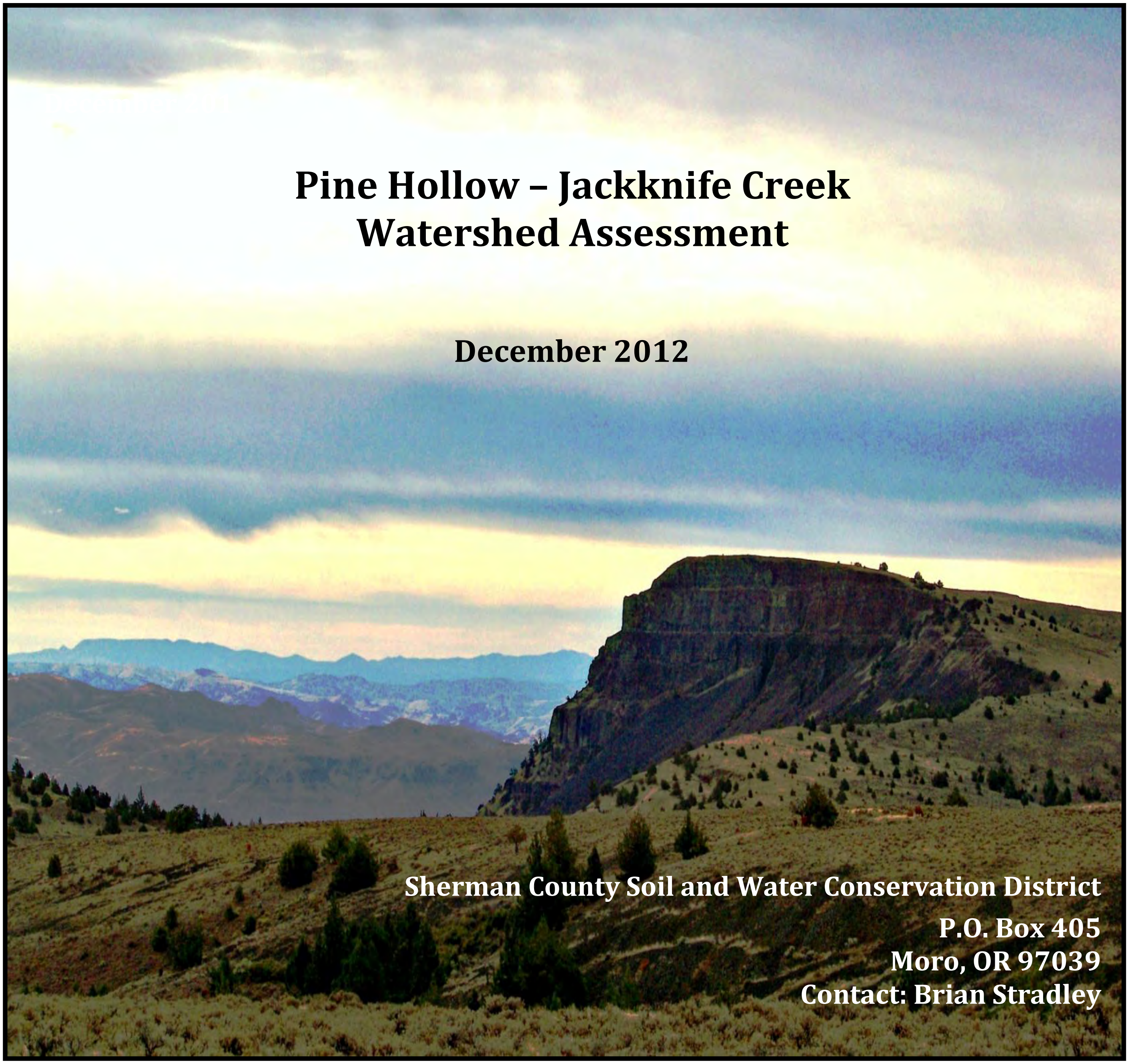

Pine Hollow – Jackknife Creek Watershed Assessment

December 2012

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Citation:
Cascade Environmental Group, LLC. Pine Hollow – Jackknife Creek Watershed Assessment. November 2012. Portland, OR. Prepared for Sherman County Soil and Water Conservation District. Moro, Oregon

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Acronyms and Abbreviations

BLM	Bureau of Land Management
BPA	Bonneville Power Administration
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
ESA	Endangered Species Act
GIS	Geographic Information Systems
GIRAS	Geographic Information Retrieval and Analysis System
GLO	General Land Office
GTN	Gas Transmission Northwest
NMFS	National Marine Fisheries Service
NRCS	Natural Resources Conservation Services
NWI	National Wetland Inventory
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish and Wildlife
OWEB	Oregon Water Enhancement Board
OWRD	Oregon Water Resources Department
RCU	Riparian Condition Units
RM	River Mile
SSURGO	Soil Survey Geographic
SWCD	Soil and Water Conservation District
USDA	United States Department of Agriculture
USGS	United States Geographic Survey
WASCBs	Water and sediment control basins
WSA	Wilderness Study Area

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Chapter Descriptions

Chapter 1. Introduction

This chapter briefly summarizes the purpose and scope of the Pine Hollow – Jackknife Creek Watershed Assessment and outlines the assessment methods.

Chapter 2. Watershed Overview

This chapter introduces and describes the watershed assessment area. Each of the watersheds and subwatersheds are characterized and placed within the context of the larger John Day Basin. Major natural and human-influenced features of the watershed assessment area are described including, the stream network and subwatersheds, land ownership, current land uses, climate, geology, soils, and ecoregions.

Chapter 3. Historical Conditions

This chapter examines the natural and human heritage of the watershed assessment area, including historical vegetation communities, human settlement, and land use.

Chapter 4. Channel Habitat Types and Modification

This chapter evaluates the condition of stream channels in the watershed assessment area. Stream channel features, such as gradient and valley confinement, are identified and the channels are rated by habitat type and potential response to restoration and conservation efforts. The extent of human modifications to the channels is also presented.

Chapter 5. Hydrology and Sediment

This chapter focuses on hydrological conditions within the assessment area. Hydrologic conditions, including flow regimes, flooding, and water use, and juniper impacts are outlined and related to watershed function. The chapter also examines sediment sources and delivery to the stream network.

Chapter 6. Upland Habitat and Wildlife

This chapter characterizes upland vegetation communities, habitat conditions, and key wildlife populations within the watershed assessment area. The chapter includes an overview of how human-related impacts from land-use conversion, alteration of natural fire disturbance patterns, and introduction of exotic animals and invasive plant species have affected the watershed.

Chapter 7. Riparian and Wetland Habitat

This chapter summarizes riparian and wetland habitat conditions within the watershed assessment area. Impacts to riparian areas are examined.

Chapter 8. Water Quality

This chapter examines water quality concerns and patterns within the assessment area, primarily focusing on water temperature.

Chapter 9. Fish Populations and Aquatic Habitat

This chapter provides an overview of fish populations and aquatic habitat conditions throughout the John Day Basin and within the watershed assessment area, with a focus on steelhead and redband trout. Key factors affecting these fish populations are described.

Chapter 10. Watershed Evaluation

This chapter summarizes the findings of the watershed assessment, identifies key factors affecting watershed health and fish populations, and describes opportunities for future restoration and conservation actions. This chapter also identifies key information gaps

Chapter 1. Introduction

Purpose and Scope of the Assessment

This watershed assessment characterizes the historical and current conditions of the Pine Hollow, Jackknife Creek, and Canyon Tributaries watersheds and their subwatersheds—collectively the Pine Hollow – Jackknife Creek watershed assessment area. These watersheds, all of which drain into the Lower John Day River, provide important resources, including habitat for steelhead trout and other fish species. The assessment's emphasis is on streams, associated riparian areas, and the effects of watershed characteristics and management practices on these areas. Uplands are described with a focus on wildlife habitat and the effects of upland areas on streams through key processes such as water runoff and erosion.

There are two main purposes of this watershed assessment. The first is to guide habitat restoration and watershed conservation practices because the watersheds have been affected by land management and other human activities. To this end, the watershed assessment characterizes historical conditions and land-use changes, inventories existing resources, and evaluates the current status of the watersheds' habitats, water quality, and fish and wildlife populations.

The second purpose of this document is to identify the cumulative effects of current and historical management practices and conservation measures within the watershed assessment area. The assessment will aid in identifying opportunities for future restoration and conservation actions and identify key information gaps.

Role of the Watershed Council and Soil and Water Conservation District

The Pine Hollow – Jackknife Watershed Council and its members have been actively engaged in upland and riparian watershed conservation practices throughout the watershed assessment area. The council originated in 1996, focusing on the Pine Hollow watershed. In 1999, a proposal passed to include Jackknife Creek in the watershed council's area. This proposal increased the council to seven board members appointed by the Sherman County Court with representation provided for all interested parties including agricultural operators, residents, and governmental bodies.

The watershed council works in partnership with the Sherman County Soil and Water Conservation District (SWCD). The Sherman County SWCD promotes the conservation of resources not only in Sherman County, but also in all the areas included in the watershed assessment area. Other agencies and private interests that cooperate with the Sherman County SWCD to ensure coordination of efforts across the watershed and the county include Wasco County SWCD, the U.S. Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS), Oregon State University Extension Service, TransCanada Gas Transmission Northwest (GTN), Bureau of Land Management (BLM), Oregon Department of Fish and Wildlife (ODFW), and the Sherman and Wasco County governments.

Methods

This assessment was developed following the general framework described in the Oregon Watershed Assessment Manual (WPN 1999). The assessment relies on existing information and data; no new resource information or field data was gathered. The primary source for this document is the Sherman County SWCD's Draft Pine-Hollow – Jackknife Creek Assessment (Sherman County SWCD 2012). The information presented in the assessment builds on the draft's text and data. Geographic Information Systems (GIS) software was used for analysis and inventory of the watershed assessment area's stream network, habitats, and management practices. Key data sources include digital aerial photography, United States Geological Survey (USGS) digital topographical maps, and regionally- and locally-developed GIS layers from Sherman County SWCD and other state and federal agencies. Many of the methods described in the Watershed Assessment Manual were modified to make use of available information and data. It is important to note that most of the information is from maps, digital aerial photography, and accounts by agency employees and watershed residents, and other sources. The conclusions derived from the assessment of these information sources (for example, the quality of stream habitat and riparian conditions), while based on the best available information, have not been verified on the ground.

Chapter 2. Watershed Overview

Introduction

This chapter provides an overview of the watershed assessment area including stream locations, land ownership, and ecological context. The hydrologic units, or watersheds, are delineated to layer into a multi-level hierarchical drainage system. The watershed assessment area is composed of the Pine Hollow, Jackknife Creek, and Canyon Tributaries watersheds, their associated subwatersheds, and individual tributary streams (Maps 1 and 2).

The assessment area is located in north-central Oregon within the semi-arid Columbia Plateau and the Lower John Day River Basin. The assessment area occupies the southeastern portion of Sherman County and part of the northeastern portion of Wasco County, beginning southeast of the town of Grass Valley and including the towns of Kent and Shaniko. The watershed assessment area is sparsely populated, with an average population density of less than one person per square mile in Sherman County and two per square mile in Wasco County (U.S. Census Bureau 2010).

All of the streams within the Pine Hollow – Jackknife Creek watershed assessment area drain into the Lower John Day River, and the river is the eastern border of the assessment area. The 8,000 square mile John Day Basin is the fourth largest basin in the state. The main stem of the John Day River originates in the Blue Mountains southeast of Prairie City, Oregon, and flows generally westward then northward for approximately 284 miles before discharging into the Columbia River at River Mile (RM) 218, just east of the town of Rufus, Oregon.

The John Day River is the second longest undammed river in the continental United States; only the Yellowstone River is longer. It is primarily fed from high elevation springs and snow melt and typically exhibits extreme variations in seasonal flows and annual discharges, with high-flow events normally occurring in the spring. Some reaches are designated as National Wild and Scenic Rivers or included in the Oregon Scenic Waterways system, and the river provides Essential Fish Habitat for many federally protected and Endangered Species Act (ESA) listed fish species. There are three BLM-designated Wilderness Study Areas (WSAs) within, or partially within, the watershed assessment area: Lower John Day, Thirty Mile, and North Pole Ridge.

The John Day River and its tributaries, including Pine Hollow and Jackknife Creek, support one of the few remaining relatively healthy runs of wild steelhead trout in the Columbia River Basin. Summer steelhead (*Oncorhynchus mykiss*) populations have declined to the point that they are listed under the U.S. ESA. These anadromous fish populations spawn within the John Day system, migrate down the Columbia into the Pacific Ocean, and return to the John Day Basin over the course of their life. Because of this complex life cycle, steelhead trout are vulnerable to a wide range of factors that are negatively affecting the population, both within and outside the John Day Basin. Dams on the Columbia River are an example of one factor outside of the basin that affects steelhead populations. Aquatic limiting factors to steelhead recovery within the John Day Basin include low summer flows due to irrigation-water diversions, elevated water temperatures, and land-use practices which have degraded riparian areas and altered hydrology and sediment patterns (Columbia-Blue Mountain Resource Conservation & Development Area 2005).

Watershed Descriptions

The assessment area is composed of the Pine Hollow, Jackknife Creek, and Canyon Tributaries watersheds and their associated subwatersheds. The combined watersheds encompass a total of 147,421 acres; 84,872 acres in Sherman County and 62,549 acres in Wasco County. Elevations range from 3,911 feet to 704 feet along the John Day River. Table 2-1 describes the land area and elevation ranges for each of the three watersheds and their contributing subwatersheds.

Table 2-1. Watershed and Subwatershed Land Area and Elevation Ranges

Watershed	Subwatershed	Land Area (Acres)	Elevation (ft.)		
			Min	Max	Mean
Pine Hollow	Big Pine Hollow	30,003	2,101	3,911	3,211
	Eakin Canyon	15,128	1,389	2,987	2,537
	Long Hollow	15,659	1,627	3,822	2,911
	Pine Hollow	22,935	991	3,073	2,372
	Total	83,725	991	3,911	2,758
Jackknife Creek	Jackknife Creek	27,586	755	2,732	2,380
Canyon Tributaries	Buckskin Canyon	8,803	853	2,672	2,002
	Chimney Spring Canyon	11,967	1,150	3,823	2,229
	Cow Canyon	5,536	704	2,631	1,642
	Pete Enyart Canyon	9,804	979	3,465	2,053
	Total	36,110	704	3,823	1,982
Watershed Assessment Area Total		147,421	704	3,911	2,371

Pine Hollow Watershed

The Pine Hollow watershed crosses the boundary of Sherman and Wasco Counties in the southwest portion of the assessment area. The watershed drains 83,725 acres (131 square miles) and contains over 143 linear miles of streams within four subwatersheds: Big Pine Hollow, Eakin Canyon, Long Hollow Creek, and Pine Hollow (Map 3). The headwaters of the main stem of Pine Hollow Creek are located near the town of Shaniko in Wasco County. The creek flows mostly north until turning east and flowing into the John Day River at RM 85. The watershed consists of rolling wheat fields, rangeland, and juniper woodlands in the upper portion, dropping steeply into dissected canyons. Elevation ranges from 3,911 feet on the ridge above the headwaters of Brush Canyon to 991 feet at the mouth of the canyon. Secondary tributaries include Hannafin Canyon, Dove Hollow, Brush Canyon, Chapman Hollow, Cramer Creek, Wallace Canyon, and Porter Canyon.

Jackknife Creek Watershed

The Jackknife Creek watershed is located entirely within Sherman County, in the northwest portion of the assessment area (Map 4). This watershed contains 46 miles of streams that drain 27,586 acres (43 square miles); there are no subwatersheds. Jackknife Creek flows north-northeast and converges with the John Day River at RM 59. The watershed features nearly level to rolling topography (much of which is in wheat production) dissected by narrow, steep-walled canyons in the middle and lower drainages. Elevation ranges from 755 feet to 2,732 feet. Major tributaries within the watershed include Armstrong, Kelsay, Hayes, Rutledge, and Marlin Canyons.

Canyon Tributaries Watershed

The Canyon Tributaries watershed is located in the eastern portion of the assessment area, split between Sherman and Wasco Counties (Map 5). The watershed is characterized by a number of relatively short streams that drain directly into the John Day River. The Canyon Tributaries watershed drains 36,110 acres (56 square miles) with over 66 linear miles of stream network. The stream channels are moderate to high gradient and cut through very steep-sided, narrow canyons, rolling hills, and ashbeds. Elevations range from 704 feet to 3,823 feet. The Canyon Tributaries watershed consists of four subwatersheds, all of which are separate and drain into the John Day River: Cow, Buckskin, Pete Enyart, and Chimney Springs Canyons. Other significant tributaries include Duncan Spring, Zigzag, and Combine Canyons.

Land Ownership and Use

Information on land ownership and use was estimated using the USGS 1:250,000-scale Geographic Information Retrieval and Analysis System (GIRAS) for handling land use and land cover data.

Land ownership within the watershed assessment area falls into three categories: private, BLM, and state-administered lands (Map 6 and Table 2-2). The majority of the assessment area is privately owned, primarily consisting of rangeland and wheat fields. The remaining rangelands are administered by the BLM and the State of Oregon. The BLM manages lands primarily along the John Day River in the Canyon Tributaries watershed and the State of Oregon administers a small area of rangeland in the Long Hollow Creek subwatershed.

Table 2-2. Watershed Assessment Area Land Ownership

Watershed	% Privately Owned	% BLM	% State
Pine Hollow	85%	14%	1.0%
Jackknife Creek	87%	13%	0.0%
Canyon Tributaries	50%	49%	1.0%
Watershed Assessment Area Total	77%	21%	2.0%

There are six general land-use categories in the Pine Hollow – Jackknife Creek watershed assessment area: cropland and pasture, mixed rangeland, shrub and brush rangeland, other agricultural land, juniper woodlands, and residential or commercial and services use (Map 7and Table 2-3). Rangelands cover the majority of the assessment area and are used principally for livestock production; cropland is the next most prevalent cover type. The croplands, primarily dryfarmed wheat production, occupy the ridge tops and terraces along the western portion of the watershed assessment area and extend down in elevation until the terrain becomes too steep for tillage, or soil type or depth is unsuitable. Much of the watershed assessment area is territory ceded to the Confederated Tribes of the Umatilla Indian Reservation (Columbia-Blue Mountain Resource Conservation & Development Area 2005).

Approximately 15% of the assessment area is covered by western juniper woodlands. Less than 1% of the assessment area falls within the residential or commercial and services use category; this portion includes the towns of Kent, occupying about 46 acres in the northern portion of the Jackknife Creek watershed in Sherman County, and Shaniko, occupying 47 acres in the western tip of the Big Pine Hollow watershed in Wasco County. The towns' resident populations are 30 and 36 individuals, respectively (U.S. Census Bureau 2010).

Table 2-3. Land Use within the Watershed Assessment Area

Watershed	Crop and Pasture	Mixed Rangeland	Shrub/ Brush Rangeland	Other Ag Land	Juniper Woodlands	Residential/ Commercial and Services
Pine Hollow	13%	56%	7%	<0.1%	23%	<0.1%
Jackknife Creek	52%	3%	45%	<0.1%	0%	<0.1%
Canyon Tributaries	3%	58%	32%	0%	7%	<0.1%
Watershed Assessment Area Total	18%	47%	20%	<1%	15%	<1%

The USDA's Conservation Reserve Program (CRP) and Conservation Reserve Enhancement Program (CREP) have affected agricultural land use within the watershed, resulting in a significant shift from active production to passive conservation. Land enrolled in CRP or CREP is managed for ecological health, water quality improvement, and wildlife habitat. CREP and water quality projects are promoted and coordinated with local landowners through the Sherman County SWCD and the watershed council and are implemented primarily to protect fish and aquatic habitat. Lands enrolled in CREP are exclusively within riparian areas along streams. Conservation practices focus on livestock exclusion and implementation of soil and water conservation practices, such as tree planting. Grazing can still occur outside the riparian area, however fencing requirements can make it more practical in some areas to eliminate grazing altogether. Increasingly, livestock producers are removing cattle from riparian areas within the watershed assessment area.

There are a number of alternative land uses within the watershed assessment area. Some landowners are leasing land to recreational hunting and fishing interests and designating tracts of land as hunting preserves. In 1961, an underground natural gas pipeline was installed by TransCanada Pipeline Company, now GTN, running from Alberta, Canada, to California. The pipeline cuts through north-central Oregon, passing through the Pete Enyart Canyon and Pine Hollow watershed (Map 7). GTN maintains an easement for road access and for the pipeline. Wind turbines for the production of electricity are present in Sherman County north of the watershed assessment area. While there is no wind energy infrastructure currently within the Pine Hollow – Jackknife Creek watershed, a significant area in the south end of the watershed is under contract with various private landowners for potential future development that could include installing wind turbines and associated roads (Brian Stradley, Sherman County SWCD, pers. comm. 2012).

Climate, Geology, and Ecoregions

Climate

The watershed assessment area has a continental climate characterized by low winter and high summer temperatures, low average annual precipitation, and dry summers (WPN 1999). The semi-arid climate is due to the rain-shadow effect of the Cascade Mountains. Winters are cold and receive the bulk of the precipitation, and summers are warm and dry with occasional thunderstorms with heavy precipitation. There is some variation in climate due to elevation differences within the assessment area.

Mean annual precipitation for the assessment area is 11 to 13 inches, which falls mainly in the winter months, as rain in the lower elevations and occasional snow in the higher elevations (Table 2-4; PRISM 2004). Winter snow cover usually does not persist long and deep snowpack rarely develops, particularly in areas below 3,000 feet in elevation (WPN 2001). Most of the land area in the assessment area is below 3,000 feet. Map 8 shows the distribution of mean annual precipitation in the assessment area for the time period of 1981–2010. Areas of potential snow cover, as indicated by an elevation greater than or equal to 3,000 feet, are also overlaid on this map.

The transitory nature of snow and ice events drives runoff in the watershed assessment area. Flood events occur when warm rains fall on frozen soils with a cover of snow, leading to rapid melting and runoff into the stream system. In addition, summer thunderstorms, producing high-intensity rainfall, are also common and lead to high runoff events.

To augment the precipitation and other climate data, climate stations existing within or near the watershed assessment area were also identified. There are no climate stations located within the watershed assessment area; however there is a climate station at the town of Kent, which is very close to the western boundary of Pine Hollow – Jackknife Creek watershed (Map 8). Table 2-5 displays temperature and precipitation data from the National Climatic Data Center's Cooperation Station 354411 in Kent compiled by the Western Regional Climate Center. Data records for the station cover the time period from 1922 through 2004 and are summarized to present both monthly and annual means for minimum and maximum temperature, total precipitation including snowfall, and snow depth. The station is at an elevation of 2,715 feet which is comparable to the mean elevation of the assessment area (2,371 feet).

Table 2-4. Mean Annual Precipitation

Watershed	Subwatershed	Mean Annual Precipitation (inches)
Pine Hollow	Big Pine Hollow	13.35
	Eakin Canyon	12.18
	Long Hollow	12.63
	Pine Hollow	12.18
	Total	12.59
Jackknife Creek	Jackknife Creek	12.23
Canyon Tributaries	Buckskin Canyon	11.83
	Chimney Spring Canyon	11.98
	Cow Canyon	12.18
	Pete Enyart Canyon	11.92
	Total	11.98
Watershed Assessment Area Total		12.26

Source: PRISM 2004

According to the climate station data, air temperature ranges from an average low of 22.9°F in January to an average high of 83.8°F in July. Total average annual precipitation is 11.42 inches, which ranges from an average low of 0.35 inches in July to an average high of 1.48 inches in December. Total cumulative annual snowfall averages 21.3 inches, but snow rarely accumulates for long or for more than a few inches at a time. Snowfall occurs mainly in November through March.

Figure 2-1 displays the average monthly precipitation and snowfall, and average maximum and minimum temperatures over the course of the year, clearly illustrating the characteristic temperature and precipitation curves of an interior, continental climate; however, the extremes of hot and cold temperatures and the dry climate are moderated somewhat by the influence of the Columbia River.

Table 2-5. Monthly Climate Summary for Kent, Oregon

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Average Max. Temperature (°F)	37.5	42.9	50.5	57.8	66.5	74.2	83.8	83.0	74.3	62.4	47.2	39.5	60.0
Average Min. Temperature (°F)	22.9	26.7	30.5	34.1	40.0	46.2	52.2	52.0	45.9	38.0	30.0	25.3	37.0
Average Total Precipitation (in.)	1.40	1.08	1.00	0.93	1.02	0.87	0.35	0.38	0.57	0.87	1.47	1.48	11.42
Average Total Snowfall (in.)	7.0	3.9	2.1	0.7	0.0	0.0	0.0	0.0	0.1	0.2	2.2	5.2	21.3
Average Snow Depth (in.)	2	1	0	0	0	0	0	0	0	0	0	1	0

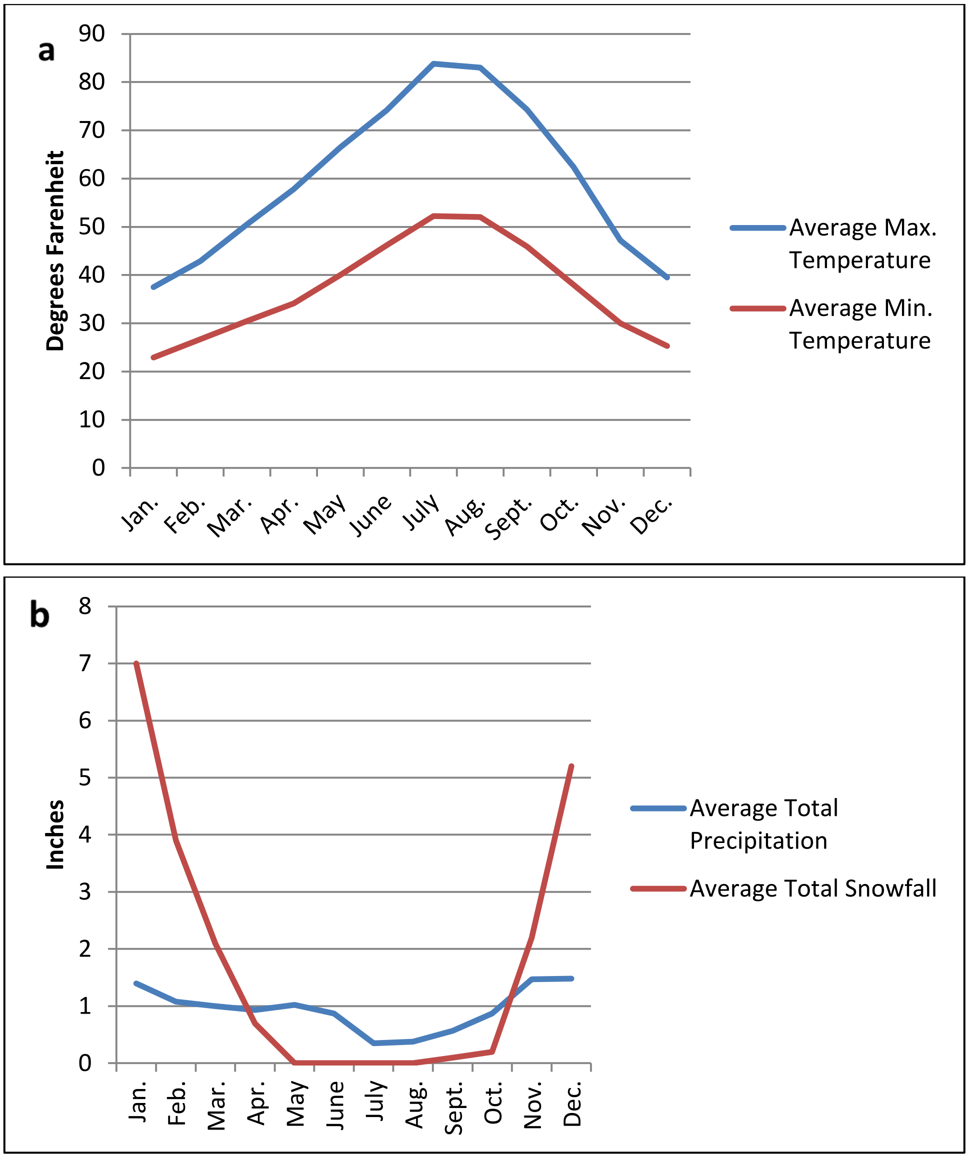
Source: NCDC COOP Station 354411 in Kent, Oregon

Geology and Soils

The watershed assessment area's geology consists primarily of the extensive Grande Ronde Basalt formation of the Columbia River Basalt Group, with areas of other Columbia River Basalt formations including Wanapum and Picture Gorge. The Grande Ronde Basalt was deposited between 16.5 and 15.6 million years ago during the Miocene Epoch and consists of basalt and andesite flows and breccia. The tholeiitic basalts are dark gray, with no olivine and with few crystals visible. Glass, plagioclase, and augite are the most common minerals found.

The soils and landforms in the watershed assessment area were largely formed by wind and water during the Ice Age, or Pleistocene epoch, as the continental glaciers retreated and as loess deposits accumulated over the basalt flows (Straub et al. 2012).

Figure 2-1. Average Monthly Maximum and Minimum Temperatures (a) and Average Monthly Precipitation and Snowfall (b)



According to the Soil Survey Geographic Database, there are 11 primary soil series that occur in the Pine Hollow – Jackknife Creek watershed: Bakeoven, Cantala, Condon, Curant, Endersby, Lickskillet, Simas, Sorf, Tub, Willowdale, and Wrentham (Map 9). In addition, there are very minor occurrences of Day, Hermiston, and Sagemoor soils and xerolls, as well as associated geological formations including alluvial and rough broken soils. Table 2-6 summarizes each soil series' characteristics, distribution, and common land uses and native vegetation patterns.

Table 2-6. Soil Types within the Watershed Assessment Area

Soil Series Name	Characteristics and Geographic Setting	Use and Vegetation
Bakeoven	Very shallow, well drained cobbly-loam formed in mixed slope alluvium, loess, and residuum weathered from basalt. Occurs in uplands on mountains, ridge tops, hill slopes, mesas, and benches at elevations of 1,600 to 3,600 feet with slopes of 2–20%. "Biscuits" or "scabs" are often associated with these soils.	Principal uses are livestock grazing and wildlife habitat. Vegetation includes Sandberg bluegrass and stiff sagebrush.
Cantala	Deep, well drained silt-loam formed in mixed loess and ash over stratified alluvium. Occurs in uplands on mesas at elevations of 1,100 to 3,600 feet with slopes of 1–35% (although typically 1–7%).	Principal use is for production of grain crops. Other uses include production of hay, pasture, and native range. Vegetation includes bluegrasses, forbs, and shrubs.
Condon	Moderately deep, well drained silt-loam formed in loess with appreciable volcanic ash overlying basalt. Occurs in uplands at elevations of 1,100 to 4,000 feet with slopes of 1–7%.	Principal use is for production of grain crops. Other uses include production of hay, pasture, and native range. Vegetation includes bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, and forbs such as yarrow, phlox, and buckwheat.
Curant	Well drained silt-loam formed in loess over mixed medium and moderately coarse textured old alluvium or colluvial material. Occurs in north aspects of moderately steep to very steep slopes at elevations of 2,200 to 3,700 feet with slopes of 8–70%.	Principal use is for livestock grazing. Vegetation includes Idaho fescue, bluebunch wheatgrass, Sandberg bluegrass, yarrow, lupine, arrowleaf balsamroot, rose, and wax currant.
Endersby	Deep, somewhat excessively drained coarse-loam that formed in mixed alluvium. Occurs in nearly level bottomlands at elevations of 200 to 1,500 feet with slopes of 0–3%.	Principal use is for forage crops. Other uses include irrigated and dryfarmed small grains, range, pasture, wildlife, and water supply. Vegetation includes bunchgrasses and forbs.

Soil Series Name	Characteristics and Geographic Setting	Use and Vegetation
Lickskillet	Shallow, well drained very stony-loam that formed in stony colluvium consisting of loess, rock fragments, and residuum weathered from basalt and rhyolite. Occurs on south-facing canyon and mountainside slopes at elevations of 1,000 to 2,800 feet with slopes of 15–70%.	Principal use is for livestock grazing. Other uses include water source, recreation, and wildlife habitat. Vegetation includes bluebunch wheatgrass, Sandberg bluegrass, Thurber needlegrass, western yarrow, and Wyoming big sagebrush.
Simas	Very deep, well drained, very stony clay-loam that formed in loess and colluvium from tuffaceous sediments. Occurs on hills at elevations of 1,300 to 3,000 feet with slopes of 8–70%.	Principal uses are for range, dryfarmed small grains, and wildlife habitat. Vegetation includes bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, and Wyoming and basin big sagebrush.
Sorf	Moderately deep, well drained, very stony loam formed in uplands of mixed loess and fine textured, calcareous colluvium and residuum from sedimentary rock or tuff. Occurs on foothills at elevations of 1,300 to 2,500 feet with slopes of 5–40%.	Principal uses are for range and wildlife habitat. Vegetation includes antelope bitterbrush, bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, and big sagebrush.
Tub	Deep and very deep, well drained gravelly clay loam that formed in uplands from old sediments of volcanic origin. Occurs on hilly uplands at elevations of 2,700 to 4,000 feet with slopes of 1–70%.	Uses are for dryfarmed small grain, hay, pasture, range, wildlife habitat, and water supply. Vegetation includes bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, and related forbs.
Willowdale	Very deep, well drained fine loam that formed recently on bottomlands and mixed alluvium. Occurs on flood plains and alluvial fans at elevations of 1,400 to 3,000 feet with slopes of 0–2%.	Principle uses are for irrigated hay, pasture, dryfarmed small grain, range, wildlife habitat, and water supply. Other uses include irrigated small grain, grass and alfalfa production, and wildlife habitat. Vegetation includes basin wildrye, bluebunch wheatgrass, and bluegrasses.

Soil Series Name	Characteristics and Geographic Setting	Use and Vegetation
Wrentham	Moderately deep, well drained silt-loam that formed in uplands of loess mixed with colluvium weathered from basalt. Occurs on north-facing canyon slopes at elevations of 900 to 3,600 feet with slopes of 35–70%.	Uses are for range, wildlife habitat, and water supply. Vegetation includes Idaho fescue, bluebunch wheatgrass, Sandberg bluegrass, forbs, and shrubs.

Source: Soil Survey Staff, NRCS, USDA, Official Soil Series Descriptions

Ecoregions

The EPA developed a hierarchical ecosystem classification system based on key factors that affect habitat and watershed processes, including soils, vegetation, climate, and geology. Areas are classified into ecoregions using these factors. The watershed assessment area lies within three distinct Level IV ecoregions. These ecoregions and their associated attributes are described below (WPN 1999). Map 10 shows the distribution of the three ecoregions within the watershed assessment area.

Deschutes/John Day Canyons

The Deschutes/John Day Canyons ecoregion covers over 50% of the watershed assessment area, covering most of the Pine Hollow and Canyon Tributary watersheds and a portion of the Jackknife Creek watershed. It is characterized by very steep-sided, deep canyons containing moderate- to high-gradient streams cutting through plateaus. The geology is composed of basalt lava flows. Vegetation supported in this ecoregion includes western juniper (*Juniperus occidentalis*), bluebunch wheatgrass (*Pseudoroegneria spicata*), and Idaho fescue (*Festuca idahoensis).* Dryfarmed wheat production and livestock grazing are common where soil depth and topography are suitable.

Umatilla Plateau

The Umatilla Plateau ecoregion encompasses 40% of the watershed assessment area, covering most of the Jackknife Creek watershed and the western portion of the Pine Hollow watershed. It is a high plateau south of the Columbia River and north of the Blue Mountains. It is characterized by nearly level to rolling treeless hills and plateaus that are dissected by steep-sided canyons. The geology of this ecoregion is loess soil deposits underlain by layers of basalt flows. Vegetation supported here includes bluebunch wheatgrass, Idaho fescue, rose (*Rosa* spp.), hawthorn (*Crataegus douglasii*), and snowberry (*Symphoricarpos* spp.). The non-native cheatgrass (*Bromus tectorum*) dominates broad areas of previously native-dominated grasslands. Agriculture is widespread in this ecoregion: The thick loess deposits are farmed for dryfarmed winter wheat or irrigated alfalfa and barley. Areas where the loess deposits are thinner make up the undulating rangelands that are used extensively for grazing livestock.

John Day/Clarno Uplands

The highly dissected hills, palisades, and ashbeds of the John Day/Clarno Uplands ecoregion covers the smallest portion of the watershed assessment area, covering only the southern part of the Canyon Tributary subwatersheds. This ecoregion is characterized by semi-arid foothills that surround the western side of the Blue Mountains. The geology of this ecoregion consists of ashbeds and remnant mountain chains. Common upland vegetation includes grasslands with bluebunch wheatgrass, basin wildrye, Wyoming big sagebrush, Thurber needlegrass, and Idaho fescue. Juniper woodlands are expanding into these grasslands at a rapid rate.

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Chapter 3. Historical Conditions

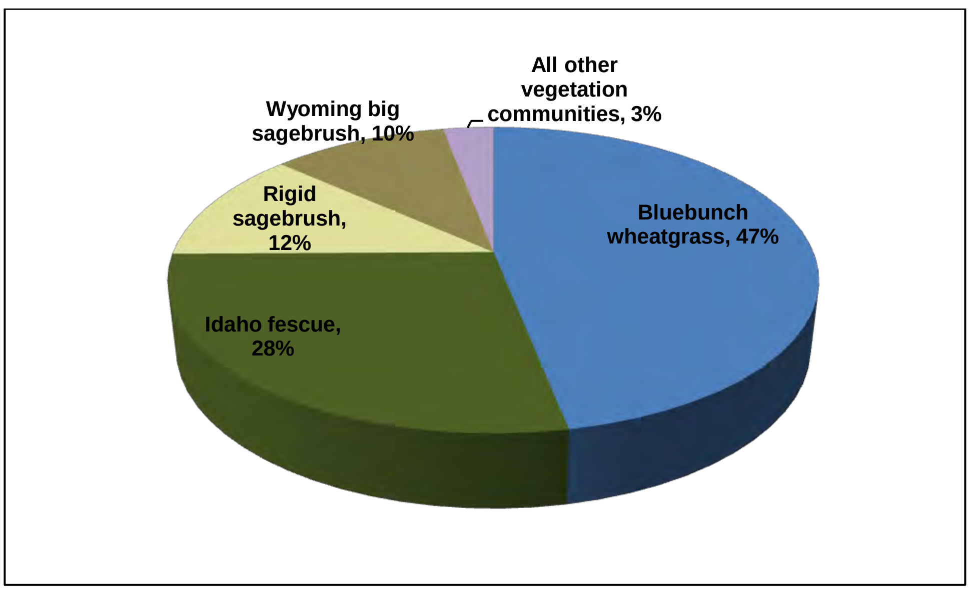
Introduction

This chapter summarizes information on historical vegetation communities, human settlement, and changes in land use within the watershed over the past 200 years. Examining changes in land use and vegetation since the Pine Hollow – Jackknife Creek watershed assessment area was settled by pioneers in the mid-1800s provides clues to how historic management practices have affected the landscape.

Historical Vegetation Communities

Pre-European settlement vegetation and land-cover types for the state of Oregon were derived from General Land Office (GLO), Soil Survey Geographic (SSURGO), BLM, and Oregon Gap analysis data. Map 11and Figure 3-1 depict the historical vegetation distribution patterns and proportion of distribution within the watershed assessment land area.

Figure 3-1. Distribution of Historical Vegetation within the Watershed Assessment Area



GLO notes from the 1880s describe the presence of areas of "good grass," "scattered juniper," with "thick undergrowth" of sage and greasewood. The land was described as being second- or third-rate, good for grazing, and as being "broken and rough." Overall, native vegetation cover originally supported by the soils and climate of the watershed assessment area consisted primarily of grassland communities interspersed with sagebrush shrub and shrub-steppe communities. These plant communities evolved with a frequent, low-severity fire regime that replenished the grasses and maintained shrublands as open and patchy. Bluebunch wheatgrass co-dominating with Idaho fescue formed vast bunchgrass “palouse” prairies with dense canopies, occurring on the canyon slope terrain as well as over the rolling terraces and plateaus where soils are deep and well developed (NatureServe 2012). This historical vegetation community comprised approximately 75% of the assessment area. The drought-tolerant and fire-adapted bunchgrasses are an important food source for many wildlife species. Their extensive root systems stabilize soils and slopes and prevent erosion. This plant community is susceptible to overgrazing by livestock and to alterations in the fire disturbance regime (fire suppression), both of which result in either invasion by exotic annual grass species and other herbaceous weeds or shrub encroachment (Zlatnik 1999, Zouhar 2000).

Rigid sagebrush (*Artemisia rigida)* shrub-steppe communities covered approximately 12% of the watershed assessment area, primarily along the ridge tops and benches of the canyonlands in the north. Rigid sagebrush is associated with harsh, unproductive scablands and occurs on shallow, stony soils over basaltic bedrock or clay subsoils. Its most common plant associate in Oregon is Sandberg bluegrass (*Poa secunda*). Rigid sagebrush is a browse source for ungulates, especially important in early spring when other food sources are scarce (McWilliams 2003).

Wyoming big sagebrush (*Artemisia tridentata* ssp*. wyomingensis)* habitat covered approximately 10% of the watershed assessment area, primarily in the Big Pine Hollow and Long Hollow Creek subwatersheds. This habitat was present on terraces, slopes, and plateaus as well as in valley bottoms, often in association with bluebunch wheatgrass and Idaho fescue. It is long-lived and very drought tolerant. Wyoming big sagebrush provides important wildlife browse and cover and is used heavily by big game species as well as by upland birds such as the sage grouse. Native Americans used Wyoming big sagebrush leaves to make a medicinal tincture and seeds were used as an occasional food source. Wyoming big sagebrush is reliant on fire to renew decadent stands (Howard 1999).

Other historical land cover within the watershed assessment area, comprising 1% or less of the total land area, included basin big sagebrush (*Artemisia tridentata* ssp*. tridentata*) and sparsely vegetated and highly eroded volcanic ashbeds and riverwash formed by alluvial deposition.

Early Settlement and Land Use

Native American Settlement

Native Americans inhabited the region for centuries prior to the European settlement of the watershed area. The Columbia Basin Tenino, also called the Warm Springs Sahaptin, occupied areas within and adjacent to the assessment area. The Tenino were comprised of four local groups that lived, hunted, fished, and traded along the three rivers that border Sherman County, the Columbia, the Deschutes, and the John Day. The tribes migrated throughout the region according to seasonal cycles and food availability (Sherman County SWCD 2012): The Dalles Tenino were near The Dalles on the Columbia River, the Tygh were near the Deschutes River for their summer village and in the Tygh Valley for winters, the Wayam (or Deschutes) had a summer camp on the Columbia River at Celilo Falls and a winter village at the mouth of the Deschutes and the Columbia River, and the John Day (also called Dock-spus or Tukspush) tribe occupied the Lower John Day River Basin. All of these bands split their time between inland winter villages and summer camps near fishing locations. Trail networks along the Columbia, Deschutes, and John Day linked these four bands for trading activities and provided routes to fishing, hunting, and gathering grounds. An important east–west trail located at the southern edge of the Tenino territory provided a route from the John Day to the Tygh Valley and was routed through what is called the "Shaniko Region," near present-day Shaniko (Murdock 1980). Two sites along this trail have been identified as important root-gathering and hunting grounds for the John Day band.

The Tenino people were semi-nomadic; they did not practice agriculture or raise domestic animals for food, although it is noted that they did possess dogs and acquired horses. They subsisted primarily by fishing for salmon, augmenting their diet by hunting and gathering. The men hunted and fished and the women processed the meat and fish. Women did most of the gathering, but records indicate that men assisted with collecting acorn and pine nuts and, to a lesser extent, with picking berries. Other labor was divided by gender as well, men making most of the tools and women being responsible for other domestic matters, including the conduct of trade with other tribal groups.

Regionally important food items included salmon, mule deer, elk, mountain sheep and goats, rabbit, antelope, chokecherries, hawthorn berries, miscellaneous roots, wapato, acorns, hazelnuts, pine nuts, huckleberries, and other miscellaneous berries (Murdock 1980). Animal products and vegetation was also collected and harvested for clothing, tools, hunting utensils, and housing items. Bear skins were used for floor rugs and mattresses and the tanned pelts of wolf, coyote, cougar, lynx, otter, beaver, and raccoon were reportedly used for bedding. Tanned hides of deer, elk, antelope, and mountain sheep were used for clothing. Fibers from plants were combined with animal hair or sinews to sew or weave mats, nets, baskets, and house-building items.

On June 25, 1855 the United States government and the Tenino people entered into a treaty agreement that ceded the Tenino territories and lands of the other tribes in the Confederated Tribes of Warm Spring to the government, and the U.S. Government in turn established the Warm Springs Indian Reservation. According to reservation records, most of the Tenino people had relocated to the reservation by 1858–59 (Murdock 1980).

European American Settlement

European American settlement began in the watershed assessment area in the 1840s with trading posts, inns, and ferry services to facilitate explorers travelling westward along the Oregon Trail. Stockmen soon followed, bringing thousands of cattle, horses, and sheep to range throughout the open hills and prairies and forage on the nutritious bunchgrasses. In the 1880s, the extension of railroad lines into Oregon and through the Columbia Plateau transformed the economy, as the availability of cheaper shipping and more efficient technology drove more economic investment in the area. As a result, hundreds of homesteaders eager for land and opportunity began arriving in the area, building homes and fencing, and plowing the abundant grasslands of the assessment area. Very rapidly, the focus of the local economy began to shift from livestock production to wheat production (Sherman County SWCD 2012).

The open and flat or gently rolling terrain of the region showcased the potential of new agricultural machines. Steam engines began powering wheat harvest and processing operations in the late 1880s. Wheat farming boomed throughout the region and new towns developed with stores, grain warehouses, and saloons to serve the local farm families as well as a growing number of transient farm and ranch laborers(Sherman County SWCD 2012).

Historical Landmarks within and near the Assessment Area

Antelope

The town of Antelope, located in Wasco County just southwest of the assessment area, was established by Henry Maupin in 1863, one and a half miles from its present-day location, as a stage station on The Dalles–Canyon City Road. When the road was re-routed in 1881, the town followed suit. The town boomed briefly as the traffic of freight wagons carrying wool out of the

Antelope, March 1891.
OR Hist. Soc. Research Library, bb007342

region increased and homesteaders poured in. By 1911, the town began to diminish with the establishment of a railroad terminus in the nearby town of Shaniko and a decline in the sheep industry (Ramsey 2012).

In 1981, Bhagwan Shree Rajneesh (1931–1990), a professor of philosophy and spiritual leader from Pune, India, migrated to central Oregon and established an intentional community on the 64,000 acre "Big Muddy Ranch" near Antelope. The ranch was renamed Rajneeshpuram ("City of Rajneesh") and the goal was to build a self-sufficient settlement for his *sannyasins*, or disciples, complete with typical urban infrastructure including an airstrip, sewage system, public transportation, and reservoir. The small, desolate valley twelve miles from Antelope was transformed into a thriving settlement of 2,000 residents. Rajneesh and his aides soon became embroiled in numerous political and legal battles over State of Oregon land use and zoning law violations, and tensions arose between commune members and local residents.

Rajneeshpuram, near Antelope.
The Oregonian, 2012 Oregon Live, LLC

By 1982, the number of Rajneeshees had grown to be sufficient enough to afford them the political influence to incorporate the city of Rajneeshpuram. In 1984, Rajneeshees managed to create a voting majority to amend the city charter of Antelope to rename it "Rajneesh." Continuing conflict involving Rajneeshees resulted in a criminal investigation of commune leaders that uncovered incidents including attempted murder, arson, poisoning, and wiretapping. Rajneesh himself, charged with immigration violations, returned to Pune, India. In 1985, the commune of Rajneeshpuram was dissolved and the city name of Antelope was restored (OregonLive 2011).

Shaniko

European Americans came to the Shaniko area in Wasco County in the southwest portion of the Pine Hollow Creek watershed after the discovery of gold in Canyon City, Oregon, in 1862. Camps were established wherever water could be found. One such camp, Cross Hollow, was located in the present Shaniko city limits. Following complaints by those transporting gold that they feared robbery,

Shaniko train station, 1910
The Shaniko Preservation Guild

the State of Oregon received a grant in 1867 from the United States government to build a military wagon road from The Dalles to Fort Boise, Idaho. The development of this road enabled many more homesteaders to claim land in central Oregon that was previously fairly inaccessible. These homesteaders included August Scherneckau, the founder of Shaniko, who came to the Cross Hollows area in 1874 after the Civil War. The spelling of the town's name reflects local pronunciation of Scherneckau's name. The town was originally called Cross Hollows, and a post office by that name was established in May 1879 with Scherneckau as postmaster; however, Cross Hollows post office closed in 1887, and Shaniko post office opened in 1900 (Rees 1982).

Shaniko experienced its boom when the Columbia Southern Railway, a subsidiary of Union Pacific Railroad, built a rail terminus there. Shaniko soon earned the title as the largest inland wool shipping center in the world and became known as the "Wool Capital of the World" (The Shaniko Preservation Guild 2012).

Imperial Stock Ranch

The Imperial Stock Ranch, located 12 miles southwest of Shaniko, is exemplary of the large stock empires that dominated the West in the early 1900s. During the early 1880s, the sheep industry rapidly increased in importance. Wool and stock became one of Oregon's leading exports and sources of revenue, and 25% of those products originated from northern central Oregon where the semi-arid rangelands were well suited to sheep production. The Imperial Stock Ranch was founded by Richard Roland Hinton in the early 1870s and became the largest individually owned land and stock holdings in the county by 1900. Hinton carefully improved and expanded his flocks, importing breeding stock and cross-breeding meat and wool breeds which eventually led to the creation of the Columbia Sheep. This was an entirely new breed, which was bred for the high desert terrain and yielded more pounds of lamb and excellent wool. Hinton built the Imperial Stock Ranch's strong reputation and established its long-lasting tradition for outstanding lamb, fine grade wool, and high quality beef. James E. Hinton took over for his father in 1915. He earned his own reputation as he

R.R. Hinton and ewes on the Imperial Stock Ranch, 1895.
U.S. Dept. of the Interior, National Park Service, National Register of Historic Places

Sheep shearing shed, built before 1918.
Carver Ranch photo

continued to build the empire. The ranch could move its stock from Shaniko to south of La Pine and never leave land they controlled either through ownership or lease.

George Ward came to work for Jim Hinton in the 1930s and proved himself a hard worker and a good sheep man. In 1945, having no children of his own, Jim Hinton gave George and his wife, Mary, the opportunity to buy a half-interest in the ranch. Upon closing the deal, it became the Hinton-Ward Ranch and remained so until 1967 when the Wards bought the remaining half-interest. In 1988, the ranch passed from the Ward family to the Carver family, who has owned it to the present day (Jeanie Carver 2000).

Kent

Little is documented about the history of Kent, located in Sherman County just west of the watershed assessment area boundary, but it is likely tied to the railroad and agriculture as well, and may date back as far as January 1887, when the post office was allegedly established. It is rumored that a petition was circulated in order to select a name for the town. A number of people wrote their preferences on slips of paper, which were subsequently stirred in a hat. The name drawn, Kent, had been suggested by R.C. Bennett. The only reason R.C. Bennett gave for the selection of the word Kent was that it was "nice and short." The community consisted of dedicated wheat, sheep, and cattle ranchers who benefited from the construction of the railroad (Speck 2011).

The Kent and Shaniko area flourished briefly in wheat and livestock production due to the accessibility provided by the Columbia Southern railroad. The town's production halted when railroad tracks were put in along the Deschutes River in 1908–1911. The new tracks served the distribution needs of grain farmers and livestock ranchers from the south who had been voyaging to Kent and Shaniko to ship their goods. A major fire in Shaniko in 1911 burned most of the business district and led to the slow decline of both towns. People moved away, some taking their homes with them. The railroad stopped service to the Kent–Shaniko area in 1942. The 1964 flood destroyed part of the rail-line, leading to its abandonment and ending railroad service to Kent (The Shaniko Preservation Guild 2012).

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Chapter 4. Channel Habitat Types and Modification

Introduction

Stream habitats are the product of interactions between climate, watershed hydrologic processes, riparian vegetation, and hillslope and channel erosion. Classification of streams into channel habitat types is a useful tool for evaluating the complex interactions between land use and stream habitats. Channel classification provides insights into aquatic habitat conditions and helps direct restoration activities to where the stream is most responsive.

The purpose of the channel habitat type classification is to determine the channel type distribution throughout the assessment area and to identify those portions of the channel network that are most responsive to changes in the delivery of sediment, water, wood, and other factors that shape stream habitat and water quality. The response of stream channels to disturbance is largely dependent on three physical characteristics of terrain: gradient, confinement, and valley form. Natural processes and human influences that modify channel shape, alter flows, or otherwise change natural channels can affect aquatic habitat quality. The type, magnitude, and location of modifications to the channel network are also presented.

This chapter addresses the following questions:

- What are the dominant channel forming processes in the watershed?
- What is the distribution of channel habitat types in the watershed?
- What is the location of channel habitat types most sensitive to changes in the watershed and what are the most likely areas to respond to restoration actions?
- What are the locations and relative magnitude of channel modifications?

Methods

The channel habitat classification is derived from the framework described in the Oregon Water Enhancement Board (OWEB) Watershed Manual (WPN 1999). The methods are largely based on the stream attributes of gradient, confinement, and stream size. Most of the streams within the watershed assessment area, encompassing approximately 231 miles of channel, were included in the channel habitat typing. Classification of channel habitat types involved the following steps:

Step 1. Classification of Stream Segments Based on Gradient

Gradient is defined as the slope of the stream and was determined using GIS and digital topographic maps. Streams were broken into reaches with each segment falling into one of six gradient classifications. Stream segments with a gradient greater than 16% are generally above fish distribution areas and are unresponsive to habitat restoration; for this reason, 16% was chosen as the upper limit of gradient for channels in the network for this assessment.

Step 2. Estimation of Channel Confinement

Channel confinement is defined as the ratio of the bankfull width to the width of the floodplain. Bankfull describes the condition when the stream flow fills the active stream channel; an increase in-stream flow beyond the bankfull level will result in overflow onto the floodplain.

Channel confinement is broken into three classes: confined, moderately confined, and unconfined. Confinement patterns are visible on topographic maps and confinement often follows gradient closely; high gradient streams will be relatively straight and confined due to the steepness of the landscape and low gradient streams are more likely to be unconfined with active floodplains. Within the watershed assessment area, upland confinement is due to natural topography, not channel degradation.

Step 3. Assignment of Initial Channel Habitat Types

Stream segments were assigned to one of nine channel habitat types based on groupings of similar gradient, confinement, stream size, and valley form (Table 4-1).

Table 4-1. Channel Habitat Types and the Associated Channel Attributes

Channel Habitat Type	Gradient	Confinement	Stream Size
FP3 – Low Gradient, Small Floodplain	≤2%	Unconfined	Small to Medium
LM – Low Gradient, Moderately Confined	< 2%	Moderate	Variable
LC – Lower Gradient, Confined	< 2%	Confined	Variable
MM – Moderate Gradient, Moderately Confined	2–4%	Moderate	Variable
MC – Moderate Gradient, Confined	2–4%	Confined	Variable
MH – Moderate Gradient, Headwater	1–6%	Confined	Small

Channel Habitat Type	Gradient	Confinement	Stream Size
MV – Moderately Steep, Narrow Valley	3–10%	Confined	Small to Medium
SV – Steep, Narrow Valley	8–16%	Confined	Small
VH – Very Steep, Headwater	> 16%	Confined	Small

Note: Stream size refers to the Oregon Department of Forestry (ODF) designations based on average annual streamflow. Small streams possess flows ≤2 cubic feet per second (cfs). Medium streams possess flows >2 but <10 cfs. Large streams possess flows of ≥10 cfs. Stream sizes are mapped at 1:24,000 for the entire state, with the exception of the southeast quarter of the state.

Step 4. Improvement of the Mapping

Digital aerial photographs were used on a wide scale to cross-check channel habitat typing. In addition to the aerial photographs, digital elevation models (DEMs) were used as an additional check on channel habitat types. The DEMs display topographical features of the landscape from a three-dimensional perspective and can be displayed in conjunction with the streams.

Step 5. Assignment of a Sensitivity Rating

Channel sensitivity is defined as the potential for a given natural or human process to result in a change in the structure or function of a stream channel. Differences in stream characteristics such as gradient, confinement, and bed morphology have demonstrated that different channel types respond differently to modifications in channel pattern, location, width, depth, sediment storage, and bed roughness (Montgomery and Buffington 1993). These changes in channel characteristics will in turn trigger changes in stream habitat conditions.

Sensitivity ratings are based on the general responsiveness of the channel to alterations in the supply of sediment (fine and course), large wood, and water flows. It is noted in the OWEB manual that large wood plays less of a factor in eastern Oregon systems.

Natural processes and human influences can alter the character of a stream channel by increasing or decreasing sediment loads, peak flows, and large wood in the channel. Landslides are an example of a natural process that increases sediment load in stream channels. Sediment that enters streams from roads and agriculture are examples of human-related increases in sediment. Responsive portions of the stream system are generally characterized as unconfined to moderately confined channels with a low to moderate gradient. These are the portions of the channel that can change form, for example, where sediment deposits lead to widening of the channel. Table 4-2 describes the level of response to adjustment in flow, sediment load, and large wood for the different sensitivity ratings.

Table 4-2. Stream Channel Response Based on Sensitivity Rating

Rating	Large Woody Debris	Fine Sediment	Coarse Sediment	Peak Flows
Low	Not a primary roughness element; often found only along channel margins.	Temporary storage only; most is transported through with little impact.	Temporary storage only; most is transported through with little impact.	Minimal change in channel characteristics; some scour and fill.
Moderate	One of a number of roughness elements present; contributes to pool formation, sediment trapping, and gravel sorting. Interacts with other roughness elements to form habitat features.	Increases result in minor accumulation on stream margins, pool filling, and bed fining.	Slight change in overall morphology; localized widening and adjustments in depth.	Detectable changes in channel form; minor widening, scour, and erosion expected.
High	Critical element in maintenance of channel form, pool formation, gravel trapping/sorting, and bank protection. Linked to stream energy dissipation.	Readily stored; increases result in pool filling and loss of overall complexity of bed form. Create “sand pillows;” gravel interstitial spaces are filled.	A dominant process that alters channel form. Pool filling, channel widening and aggradation, and conversion to plane bed morphology possible.	Nearly all bed material is mobilized; significant widening or deepening of channel expected.

Overview of Channel Characteristics

The channels within the watershed assessment area were classified according to gradient and confinement. These attributes, and the associated channel habitat types, were mapped for all streams channels up to 16% gradient, for a total of approximately 231 miles of classified channels. The channel segments were assigned a sensitivity rating based on a combination of gradient, confinement, valley form, and stream size. The following sections describe the channel habitat types and management implications.

Dominant Channel Forming Processes

The watershed assessment area contains a variety of channel types ranging from steep headwater streams to low gradient, unconfined floodplain channels in the lower portions of the streams. Map 12 shows channel gradient and Map 13 summarizes channel confinement.

The Pine Hollow and Jackknife Creek watersheds have moderately steep to very steep tributaries that flow through narrow canyons into valley bottom areas with moderate to low gradients and moderate confinement, allowing for some floodplain interaction (Tables 4-3 and 4-4). In the Pine Hollow watershed, the majority of the stream channels are higher gradient. There is a significant proportion of the channel network in the Pine Hollow watershed that is low gradient (less than 2% gradient). Unconfined channels occupy 12% of the channel network in Pine Hollow, primarily in the lower end of the stream network. Similarly, the Jackknife Creek watershed stream channels are primarily higher gradient and confined, with low gradient and unconfined areas occupying 18% of the channel network and distributed primarily in the valley bottoms.

The Pine Hollow and Jackknife Creek stream networks transport high flows and move small- and medium-sized sediments through the headwaters and higher gradient stream channels into the valley bottom. It is important to note that there are low gradient stream reaches in the upper portions of both Pine Hollow and Jackknife Creek. The lower gradient reaches flow through the gentler terrain along the watersheds' ridge tops before dropping steeply into the canyons. These headwater streams are potential sources for sediment that can be transported downstream and, as a result, are very sensitive to sediment inputs from land management activities such as roads and agriculture. The lower channels of Jackknife Creek and Pine Hollow Creek act as sediment deposition areas with some channel migration across the valley floor. In some areas, large quantities of channel bedload (sands, gravels, and cobbles) have been deposited.

In contrast to the responsive depositional areas in lower portions of Pine Hollow and Jackknife Creek, the Canyon Tributaries watershed is characterized by channels that are relatively unresponsive to changes in flow or sediment. These relatively short streams flow steeply off a ridge and down confined channels directly into the John Day River. The majority of Canyon Tributaries watershed channels are high gradient and 95% are confined.

Table 4-3. Distribution of Stream Channel Gradient for the Three Watersheds

	Low Gradient (<1%)	Low-Moderate Gradient (1–2%)	Moderate Gradient (2–4%)	Moderate Gradient (4–8%)	Moderate-High Gradient (8–16%)	High Gradient (>16%)
Pine Hollow	0%	18%	34%	23%	23%	2%
Jackknife Creek	1%	21%	28%	24%	21%	5%
Canyon Tributaries	0%	0%	5%	3%	72%	20%
Watershed Assessment Area Total	0.3%	13%	22%	17%	39%	9%

Table 4-4. Distribution of Stream Channel Confinement for the Three Watersheds

	Unconfined	Moderately Confined	Confined
Pine Hollow	12%	33%	55%
Jackknife Creek	18%	29%	53%
Canyon Tributaries	0%	5%	95%
Watershed Assessment Area Total	10%	23%	67%

Distribution of Channel Habitat Types

Based on channel gradient and confinement, the channels within the Pine Hollow – Jackknife Creek watershed assessment area were grouped into nine channel habitat types (Map 14). Table 4-5 and Figure 4-1 summarize the watershed assessment areas' channel habitat types and proportions. The sections below describe each of the channel habitat types and their distribution and location within the watershed assessment area.

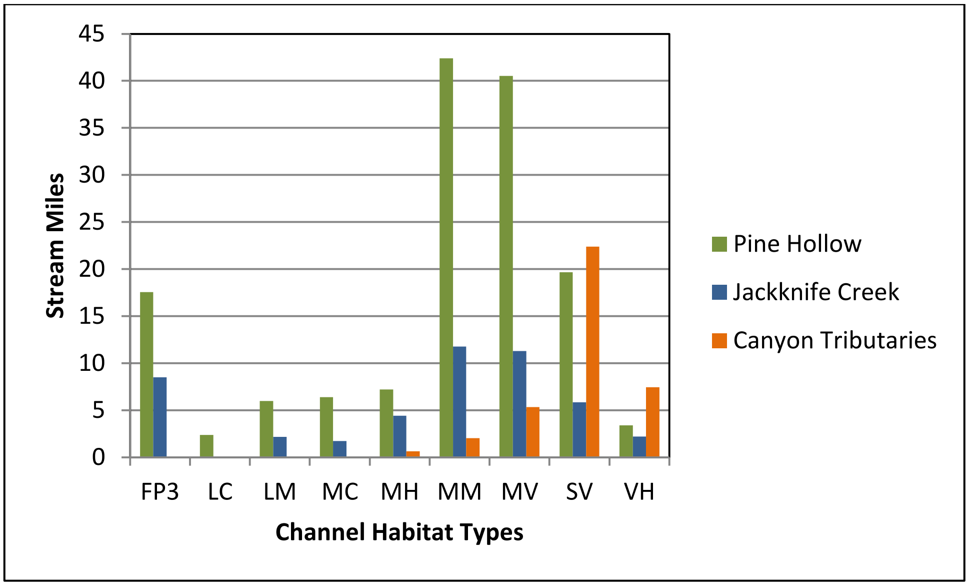
FP3 – Low Gradient, Small Floodplain

The streams with the low gradient, small floodplain (FP3) channel type are usually located in valley bottom areas of Pine Hollow and Jackknife Creek watersheds and comprise approximately 10% of the assessment area's stream channel network. Some FP3 channel types are present in the headwaters of Pine Hollow and Jackknife Creek. These are low gradient, small channels in the upland areas that flow through moderate gradient areas along the ridge tops and terraces before falling off steeply into the canyons. There are no FP3 streams in the Canyon Tributaries watershed, where the steep, confined channels do not allow for the formation of floodplains.

Table 4-5. Channel Habitat Type Distribution

Channel Habitat Type	Description	Pine Hollow		Jackknife Creek		Canyon Tributaries		Assessment Area Total	
		Stream Miles	Percent Streams	Stream Miles	Percent Streams	Stream Miles	Percent Streams	Stream Miles	Percent Streams
FP3	Low gradient, small floodplain	17.5	12%	8.5	18%	0.0	0%	26.0	10%
LM	Low gradient, moderately confined	6.0	4%	2.2	5%	0.0	0%	8.2	3%
LC	Low gradient, confined	2.4	2%	0.0	0%	0.0	0%	2.4	1%
MC	Moderate gradient, confined	6.4	4%	1.7	4%	0.0	0%	8.1	3%
MH	Moderate gradient, headwater	7.2	5%	4.4	9%	0.6	2%	12.2	5%
MM	Moderate gradient, moderately confined	42.4	29%	11.8	25%	2.0	5%	56.2	20%
MV	Moderately steep, narrow valley	40.5	28%	11.3	24%	5.3	14%	57.1	22%
SV	Steep, narrow valley	19.6	14%	5.8	12%	22.4	59%	47.8	28%
VH	Very steep, headwater	3.4	2%	2.2	5%	7.4	20%	13.0	9%

Figure 4-1. Miles of Channel Habitat Types



The low gradient FP3 channels are generally wider channels adjacent to the top of hill slopes where they are fed by higher gradient tributary streams. Some of these channel areas are downstream of alluvial fans or alluvial deposits and frequently are the storage areas for coarse sediments routed from high and moderate gradient channels. These channels, the most responsive to changes in flow and sediment, are often areas of coarse sediment deposition, particularly in the lower portions of Pine Hollow and Jackknife Creek. Because there are small floodplain areas present, this channel habitat type may contain stream-adjacent wetlands.

LM – Low Gradient, Moderately Confined

The low gradient, moderately confined (LM) channel habitat type is found in low gradient stream reaches with variable confinement from low terraces or hill slopes. The LM channel habitat type is found in about 3% of the streams within the watershed assessment area. All of the LM channels are found in Pine Hollow and Jackknife Creek watersheds; there are no channels of this type within the steep Canyon Tributaries watershed. The floodplain on LM streams is narrow and is generally about two to four times the width of the active channel.

LC – Low Gradient, Confined

Low gradient, confined (LC) channels are the least common channel habitat type in the watershed assessment area, comprising less than 1% of the stream network, and all LC channels are located within Pine Hollow watershed. Streams in this category are contained within gentle hill slopes and channel migration is controlled by the hill slopes, high terraces, or rock outcrops.

The channels are usually stable, with those confined by hill slopes or bedrock less likely to display bank erosion, or scour, than those confined by alluvial terraces. High-flow events are well-contained by banks or hill slopes. High flows in these well-contained channels tend to push debris to the channel margins.

MM – Moderate Gradient, Moderately Confined

The moderate gradient, moderately confined (MM) channel type occupies 20% of the watershed assessment areas' stream channel network. The MM channel type is widespread and includes several reaches on Jackknife Creek, with portions of its associated tributaries, including North Canyon, Hayes Canyon, Armstrong Canyon, and Kelsay Canyon, and many reaches of tributaries to Pine Hollow, including Big Pine Hollow, Fraser Canyon, Chapman Hollow, Brush Canyon, Little Pine Hollow, Dove Hollow, and Long Hollow Creek.

The MM channel type includes channels that have variable controls on confinement, including alternating valley terraces, adjacent hill slopes, and other landforms that limit channel migration and floodplain development. MM channels are similar to LM channels in that a narrow floodplain is usually present and it may alternate from bank to bank.

MC – Moderate Gradient, Confined

The moderate gradient, confined (MM) channel habitat type covers 3% of the streams within the watershed assessment area. The MC channel habitat type is not widespread with the exception of a few small reaches on Jackknife Creek; in the Pine Hollow watershed, this channel habitat type is only found in the Big Pine Hollow subwatershed, primarily in Brush Canyon, Little Pine Hollow, and Chapman Hollow.

This stream type generally occurs in narrow valleys and has little streamside terrace development. Hill and mountain slopes are found adjacent to the channel. These confining factors, with other controlling elements such as rock outcrops or bedrock substrates, limit the type and magnitude of channel response to inputs. Typical dominant substrates are coarse gravels and bedrock.

MH – Moderate Gradient, Headwater

Moderate gradient, headwater (MH) channel habitat types are common in Columbia River basalts, young volcanic surfaces, and broad channel divides. The MH channel habitat type occurs within 5% of the streams in the watershed assessment area. The MH channel habitat type stream reaches are dispersed in the upper portions of Pine Hollow Creek and its tributaries, including Brush Canyon, Little Pine Hollow, Laughlin Hollow, and Cramer Canyon, and the upper sections of Jackknife Creek and its tributaries, including North Canyon, Kelsay Canyon, and Hayes Canyon.

This MH channel habitat type is similar to LC channels, but is only found in the headwater areas that are usually above steelhead use. These moderate gradient headwater streams generally have low streamflow volumes and, therefore, low stream power. The confined channels provide limited sediment storage in low-gradient reaches. Channels have a small upslope drainage area and limited sediment supply. Sediment sources are limited to upland surface erosion.

MV – Moderately Steep, Narrow Valley

Moderately steep, narrow valley (MV) channel habitat type is widespread through the watershed assessment area, comprising 22% of the channels. The MV channel type reaches are dispersed through all of the Jackknife Creek, Pine Hollow, and Canyon Tributary watersheds.

MV channels are moderately steep and confined by adjacent moderate to steep hill slopes. High flows are generally contained within the channel banks. A narrow floodplain, one channel width or narrower, may develop within these reaches. MV channels efficiently transport both coarse bedload and fine sediments. The large amount of bedrock and boulders create stable stream banks; however, steep side slopes may be unstable.

SV – Steep, Narrow Valley and VH – Very Steep, Headwater

The steep, narrow valley (SV) and very steep, headwater (VH) channel habitat types are very similar, only differing in gradient. The SV channels are the most prevalent channel habitat type in the watershed assessment area and are associated with 28% of the stream network. The VH channel habitat type occupies 9% of the stream network. SV channels are found in constricted valley bottoms bounded by steep mountain or hill slopes. Vertical steps of boulder and wood with scour pools, cascades, and falls are common. VH channels are found in the headwaters of most drainages or side slopes to the main stem streams and commonly extend to ridge tops and summits. These steep channels may be shallowly or deeply incised into the steep mountain or hill slope. Channel gradient may vary due to falls and cascades.

SV and VH channel habitat type stream reaches are dispersed through all of the subwatersheds within the Jackknife Creek, Pine Hollow, and Canyon Tributary watersheds. All locations are on the steep tributaries that feed to the main stems of Jackknife Creek, Pine Hollow, and the John Day River.

Location of Channel Habitat Types Sensitive to Changes in Watershed Conditions

This section addresses the location of stream reaches that are the most responsive to changes in sediment, riparian vegetation, and peak flows. Information on the location of responsive reaches is important for understanding how stream habitat restoration and other conservation measures can potentially affect the stream system.

Table 4-6 shows the sensitivity ratings by channel habitat type in terms of anticipated response (WPN 1999). Fine sediment refers to material smaller than gravel, while coarse sediment refers to gravel, cobble, and boulders. Given the watershed assessment's location within eastern Oregon, where conifers or other large trees are less likely to grow along streams, large in-channel wood plays less of a role in shaping habitat. In these watersheds, riparian vegetation along streams plays a large role in providing bank stability and controlling erosion by providing soil structure and cover. These vegetation attributes affect fish habitat by narrowing the channel, which deepens water depths, and by limiting sediment in the channel. To reflect the importance of riparian vegetation in shaping stream habitat, the OWEB stream sensitivity table has been modified to replace in-channel wood with riparian vegetation. In this case, riparian vegetation includes trees, shrubs, and other vegetation that provide channel stability and control soil erosion. It is important to note that riparian vegetation also provides shade over the channel, which reduces solar radiation and helps streams maintain cool water temperature, but shade does not influence channel habitat and thus is not reflected in the channel sensitivity rating.

Table 4-6. Channel Habitat Types with Corresponding Sensitivity Ratings

Channel Habitat Type	Description	Fine Sediment	Coarse Sediment	Riparian Vegetation	Peak Flows
FP3	Low gradient, small floodplain	Moderate to High	High	High	Low
LM	Low gradient, moderately confined	Moderate to High	Moderate to High	Moderate to High	Moderate
LC	Low gradient, confined	Low	Moderate	Moderate	Low to Moderate
MC	Moderate gradient, confined	Low	Moderate	Moderate	Moderate

Channel Habitat Type	Description	Fine Sediment	Coarse Sediment	Riparian Vegetation	Peak Flows
MH	Moderate gradient, headwater	Moderate	Moderate to High	Moderate	Moderate
MM	Moderate gradient, moderately confined	Moderate	Moderate to High	High	Moderate
MV	Moderately steep, narrow valley	Low	Moderate	Moderate	Moderate
SV	Steep, narrow valley	Low	Low to Moderate	Moderate	Low
VH	Very steep, headwater	Low	Low to Moderate	Moderate	Low

Note: Based on channel responsiveness ratings in the OWEB Manual Appendix III (WPN 1999)

In general, responsive portions of the channel network are those channel habitat types that do not have the topographic and geologic controls which shape confined channels. For example, high gradient areas or stream segments confined by hill slopes or bedrock, will create confined channels. On the other hand, unconfined or moderately confined channels within the watershed assessment area will display changes in channel characteristics when flows, sediment supply, or riparian vegetation are altered. Flow, sediment supply, and riparian vegetation can all be modified (negatively or positively) through conservation action. The following are the most sensitive stream channel habitat types found in the watershed assessment area:

- FP3 – Low gradient, small floodplain
- LM – Low gradient, moderately confined
- MM – Moderate gradient, moderately confined

Locations of Channel Modifications

Stream channels within the Pine Hollow – Jackknife Creek watershed assessment area have been modified through a number of human activities. The primary activities that have affected channels are roads adjacent to streams, stream crossings, and the natural gas pipeline that crosses the Pine Hollow watershed. These human features in combination with high flows from flood events and sediment contributed from upland roads and crops interact to affect channel width and depth, sediment deposition, and riparian vegetation.

Extreme high flow events can have profound effects on watersheds, transporting and redistributing sediment and coarse material, changing channel locations, and modifying habitat. The 1964 Christmas flood, which is the largest flood on record for the area, moved substantial fine and coarse sediment through the watershed assessment area. This sediment is still transporting down the stream network, resulting in deep deposits of fine sediment and bedload in the low gradient portions of the stream channel, particularly in lower Pine Hollow and Jackknife Creek. Deposition of material in these areas erodes banks, widens the channel, and creates subsurface water flows through the coarse substrate, all of which negatively affect fish habitat.

Because recovery of vegetation and stream banks is slow in the watershed assessment area's arid environment, high flow events following the 1964 flood continue to move material down the stream network, eroding stream banks and limiting riparian vegetation growth. Streamside roads and road crossings can magnify flood effects due to soil compaction and routing of water and sediment into streams, thus modifying channels. There are numerous dirt and unimproved roads within the watershed assessment area. More than 27 miles of road are within 200 feet of a stream channel (Table 4-7). These stream-adjacent roads can contribute sediment to the channels, restrict channel migration, and limit the extent of riparian vegetation.

Stream crossings are associated with stream-adjacent roads (Map 15). There are 190 stream crossings within the watershed assessment area (Sherman County SWCD 2012, Shape Files). Table 4-7 shows the number of road crossings for each of the subwatersheds. Road crossings in the Pine Hollow watershed are concentrated in upper Big Pine Hollow Creek, Wilcox Creek, upper Long Hollow Creek, lower Pine Hollow Creek, and Cramer Creek. Jackknife Creek watershed crossings are primarily located in Marlin Canyon, Rutledge Canyon, and Kelsay Canyon. The Canyon Tributaries watershed road crossings are concentrated in the Buckskin Canyon subwatershed.

The condition of the stream crossings within the watershed assessment area has not been evaluated in detail, but aerial imagery illustrates a variety of crossings and conditions, including bridges (Figure 4-2), low water fords (Figure 4-3), and areas where there is substantial erosion associated with the crossing and its stream-adjacent road (Figure 4-4). The majority of the stream crossings in the watershed are fords that cross directly through the stream channel. These stream crossings and associated roads can affect stream habitat by directly impacting the channel in the area where vehicles cross, constricting riparian vegetation, and routing sediment into the stream during storm events.

Table 4-7. Length of Stream-Adjacent Roads and Number of Stream Crossings

Watershed	Subwatershed	Area (sq. mi.)	Total Length of Stream-Adjacent Roads (mi.)	Stream Crossings
Pine Hollow	Big Pine Hollow	46.88	5.6	38
	Eakin Canyon	23.64	3	31
	Long Hollow Creek	24.47	2.8	12
	Pine Hollow Creek	35.84	8.3	45
Jackknife Creek	Jackknife Creek	43.10	5.5	52
Canyon Tributaries	Buckskin Canyon	13.75	1.7	10
	Chimney Spring Canyon	18.7	0	0
	Cow Canyon	8.65	0.4	1
	Pete Enyart Canyon	9.95	0.2	1
Watershed Assessment Area Total		224.98	27.5	190

Figure 4-2. Bridge Crossing: Big Pine Hollow Creek

Source: Google Earth 2012

Figure 4-3. Low Water Ford: Pine Hollow Creek

Source: Google Earth 2012

Figure 4-4. Crossing with Adjacent Riparian Road and Evidence of Erosion: Big Pine Hollow Creek

Source: Google Earth 2012

The GTN natural gas pipeline and easement road crosses the watershed assessment area (Map 15). A portion of the pipeline was installed along lower Pine Hollow Creek. The pipeline was buried in the valley bottom parallel to, and in several locations under, the streambed for approximately five miles. Over time the stream channel has migrated laterally and exposed the pipeline. Where the water flows over the exposed pipeline, a plunge pool has evolved. In low water flow situations, the plunge pool is at an elevation comparable to the pipeline which creates a barrier for juvenile fish passage. In addition to the direct in-channel effects, the pipeline access road, particularly where it is adjacent to Pine Hollow Creek, can generate sediments that are routed into the stream channel.

Map 15 shows all of the channel modifications from stream-adjacent roads, road crossings, and the natural gas pipeline. Also shown on the map are a bridge and a dam for a water impoundment in upper Pine Hollow watershed, both of which are minor channel modifications. The most significant channel modification shown on the map is areas of sediment deposition and scour. Sediment and coarse and fine beadload are deposited in the lower reaches of Pine Hollow and Jackknife Creeks, creating channel widening, and in some locations subsurface flows. There are large areas along the middle reaches of Pine Hollow where significant bank erosion is evident from the aerial imagery.

Chapter 5. Hydrology and Sediment

Introduction

This chapter characterizes the watershed assessment area's natural hydrological conditions, flood patterns, and water uses. Hydrological processes are dynamic and highly complex. This chapter examines only primary components (stream flow, ground water, precipitation) and influencing factors (water use, land use) in order to create a basic understanding of the hydrology of the watershed assessment area. There are substantial data gaps for key hydrological characteristics within the watershed assessment area, including no data on stream flow and ground water contributions. As a result, information from nearby watersheds is sometimes used to infer hydrologic conditions within the watershed assessment area.

The evaluation of hydrological conditions generally follows Oregon Watershed Assessment Manual (WPN 1999) protocols. Hydrological information was obtained from a variety of sources including NOAA National Weather Service, PRISM Climate Group of Oregon, USGS National Water Information System, and Oregon Water Resources Department (OWRD) Near Real Time Hydrographic Data. Data were compiled on precipitation patterns and water storage, including groundwater, stream flow and flood history, soils and land cover type, land use and development, and water use.

This chapter addresses the following questions:

- What are the historical and current hydrological conditions?
- What are the peak flow and flood generating processes?
- What are the sources, locations, and rates of water withdrawals?
- What effect does water use have on low flows?
- What effect does land use have on peak and low flows?
- How has juniper encroachment affected hydrology?
- What effect does land use have on erosion and sediment delivery to stream channels?
- What soil and water conservation measures have been implemented?

Hydrological Conditions

Precipitation and Groundwater

Mean annual precipitation for the watershed assessment area ranges from 11 to 13 inches, falling primarily between October and June, though summer thunderstorms that produce heavy rainfall are common. Precipitation generally falls as rain at lower elevations and snow at higher elevations. The snowpack usually does not persist long and deep snowpack rarely develops because most of the watershed assessment area is below 3,000 feet in elevation. The primary peak stream flow generating process for the assessment area is winter rainfall. Major flood events are generated by warm rain falling on soil that is covered by ice and a layer of snow and by occasional high intensity summer thunderstorms. These events can cause considerable overland flow and stream flooding (Sherman County SWCD 2012).

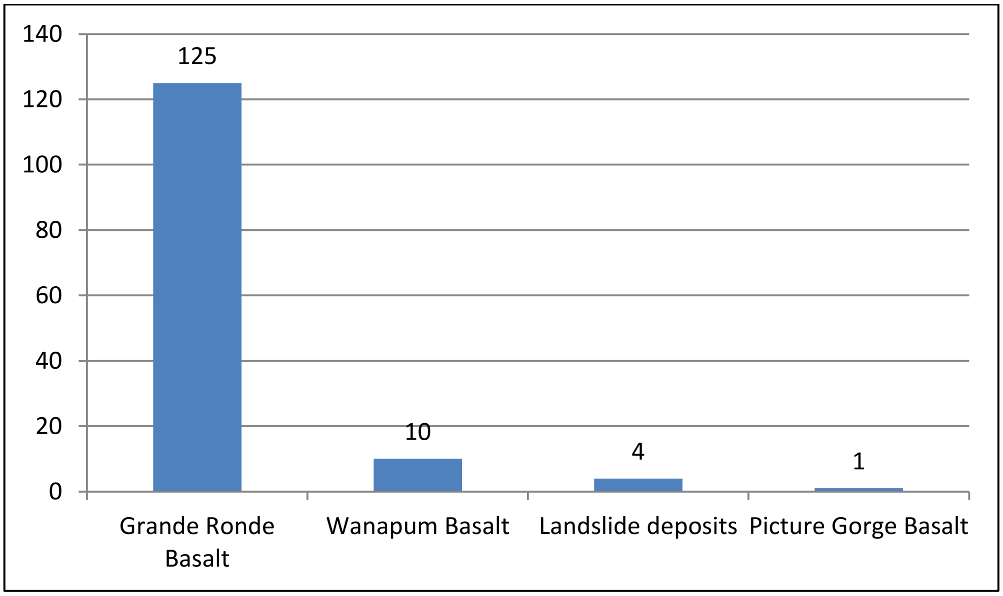
Groundwater contributions to stream flow cannot be estimated because groundwater monitoring data are not available within the watershed assessment area. There is information on the locations of springs within the assessment area, which helps to illustrate groundwater contributions (BLM 2001). A total of 136 springs were identified in the assessment area, an average of one spring per 1.6 square miles. Table 5-1 lists the density of springs for the watersheds and subwatersheds. With an average of one spring per 1.9 square miles, the Pine Hollow watershed has the highest density of springs for the three watersheds. Overall, the Canyon Tributaries watershed has the lowest density of springs, at one spring per 3.4 square miles. This watershed also has the greatest variability in spring density, with the highest density of springs, one spring per 0.6 square miles in the Buckskin Canyon subwatershed, and the lowest density of springs, one spring per 9.4 square miles in the Chimney Spring Canyon subwatershed.

Spring density within the watershed assessment area was also analyzed by geologic formation. Springs within the assessment area are predominantly found within the Grande Ronde basalt formation, which underlies over 68% of the area (Figure 5-1). Few springs are contained in other geologic formations in the watershed assessment area.

Table 5-1. Spring Density

Watershed	Subwatershed	Springs/Sq. Mi.
Pine Hollow	Big Pine Hollow	1/1.6
	Eakin Canyon	1/3
	Long Hollow	1/1.7
	Pine Hollow	1/1.2
	Subwatershed Average	1/1.9
Jackknife Creek	Jackknife Creek	1/2.7
Canyon Tributaries	Buckskin Canyon	1/0.6
	Chimney Spring Canyon	1/9.4
	Cow Canyon	1/1.3
	Pete Enyart Canyon	1/2.3
	Subwatershed Average	1/3.4
Watershed Assessment Area Total		1/1.6

Figure 5-1. Spring Density by Geological Formation



Source: Oregon Department of Geology and Mineral Industries (DOGAMI)

Stream Flow

There are no historical or current USGS or OWRD stream flow gauges located within the watershed assessment area that could provide data to characterize the variability in stream flow. Stream flow within the watershed assessment area was characterized by examining gauges that drain watersheds with similar attributes. Criteria for selecting representative watersheds were based on the guidelines in the Oregon Watershed Assessment Manual (WPN 1999) and Hydrologic Process Identification for Eastern Oregon appendix (WPN 2001). The guidelines for selecting a representative watershed require:

- a data collection record of at least 10 years;
- an area with similar geology and precipitation;
- a gauge on a drain basin of less than 150 mi^2 for peak flow data (larger basins encompass more variability in meteorological conditions making it difficult to determine causes of peak flow);
- a gauge on a drain basin in an area within the same order of magnitude as basin areas occurring in the assessment area for mean daily flow data;
- a similar mean basin elevation above the gauge; and
- no or insignificant out-of-stream diversions which would affect stream flow.

Four stream gauges were identified that met the criteria listed above and could potentially represent stream flow characteristics in the assessment area. Table 5-2 lists the watershed characteristics and data types for each gauge. All four gauges are situated in the Umatilla Plateau ecoregion which covers just over 40% of the assessment area. All but the gauge located in Lone

Table 5-2. Stream Gauges Selected to Represent the Assessment Area

Gauge ID	Operator/Status	Name/Location	Drainage Area (Sq. mi)	Data type	Data Range
14048020	USGS - Inactive	Grass Valley Canyon near Grass Valley, OR	8.15	Peak Flow	1958–1979
14047380	OWRD - Inactive	Lone Rock Creek near Lone Rock, OR	69	Mean Daily Flow	1966–2010
14048040	USGS - Inactive	Gordon Hollow at De Moss Springs, OR	8.86	Peak Flow	1959–1980
14048300	USGS - Inactive	Spanish Hollow at Wasco, OR	8	Peak Flow	1960–1979

Source: OWRD 2009

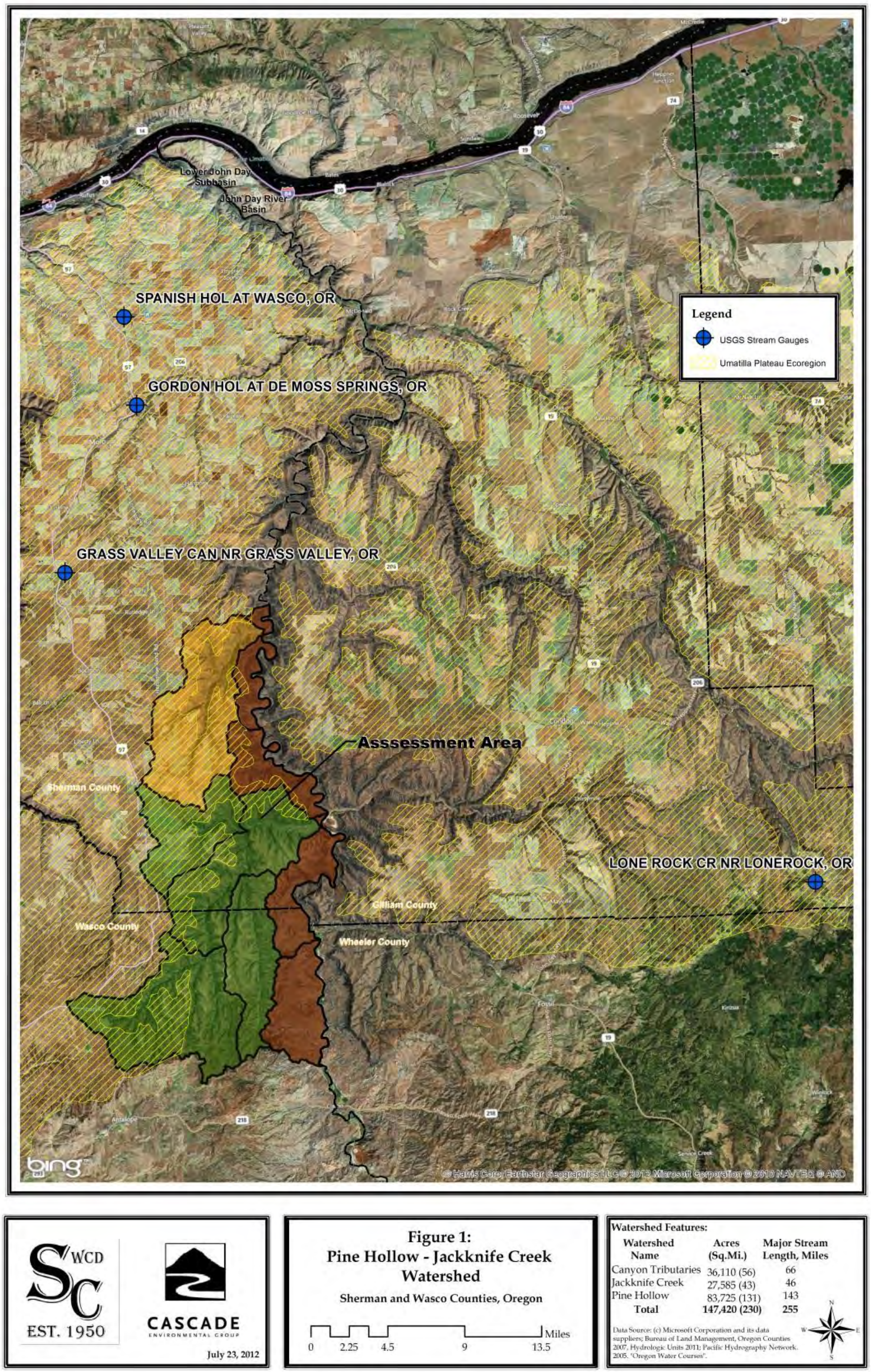
Rock Creek is situated in the Wanapum basalt formation; the Lone Rock Creek gauge is located in landslide deposits (both common geologic features within the assessment area). Figure 5-2 shows the location of the stream gauges in relation to the assessment area. Mean annual precipitation at the location of the gauges ranges from 11.5 to 15 inches (PRISM Climate Group 1981–2010).

Stream gauges in Grass Valley, Gordon Hollow, and Spanish Hollow have data records spanning from roughly 1958 to 1980 and drain watershed areas of 8–9 square miles. Peak flow information is the only data available for these gauges. The Lone Rock gauge was selected as the analog gauge because the data include mean daily flow and the gauge provides the longest term record of stream flow condition, from 1966 to 2010. However, because many data points are missing from the record, high quality data available for this gauge and the evaluation presented here spans 20 years, from 1991 to 2010. The gauge drains 69 square miles, which is within an order of magnitude of the subwatershed areas, which range from 8 to 47 square miles.

Mean Monthly Flow

Figure 5-3 displays the mean monthly flow of Lone Rock Creek in cubic feet per second (cfs). The hydrograph data illustrates a dramatic flux in stream flow over the course of the year, with flows commonly dropping to near zero from mid-July to mid-October and spiking during high flow periods during the winter and early spring. This yearly distribution of stream flow is also present within the Pine Hollow – Jackknife Creek watershed assessment area.

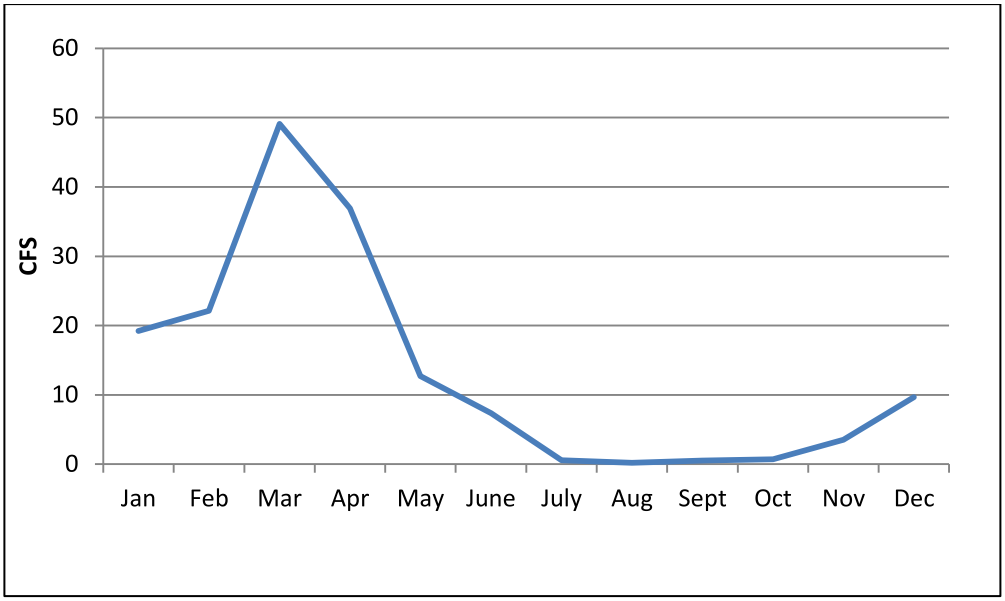
Figure 5-2. Location of Stream Gauges Selected to Represent Stream Flow Conditions



Watershed Name	Acres (Sq.Mi.)	Major Stream Length, Miles
Canyon Tributaries	36,110 (56)	66
Jackknife Creek	27,585 (43)	46
Pine Hollow	83,725 (131)	143
Total	**147,420 (230)**	**255**

Source: WRCC 2009 and EPA 2011

Figure 5-3. Mean Monthly Flow in CFS from Stream Gauge USGS 14047380: Lone Rock Creek for 1992–1999



Source: OWRD 2009

Flood Sources and History

Due to minimal snowpack development in the watershed assessment area, peak flow generating processes can be attributed largely to rainfall events with rain-on-snow, rain-on-frozen-soil events occurring only rarely.

Major flow events were recorded in the John Day River Basin in the years 1894, 1955, and 1964. Flows recorded during these floods by a stream gauging station located at McDonald's Ferry in the Lower John Day River, northeast of the watershed assessment area, recorded the following flood discharges (in cfs): 39,100; 24,900; and 42,800 (Bureau of Reclamation 2008). The 1964 Christmas flood, at 42,800 cfs, is the highest recorded flood. The 1964 flood was a rain-on-snow event.

Without stream flow data from the watershed assessment area, the extent and magnitude of the flooding in these events is unknown. The bedload and sediment deposits in the lower gradient depositional reaches of Pine Hollow and Jackknife Creek are attributed to the 1964 flood event. Since then, other major events that produced flood flows include an intense thunderstorm in the summer of 1978 that produced up to two inches of rain in two hours and generated flash floods in the valleys and canyons and a heavy rain-on-frozen-soil with snow event in the winter of 2005 that also resulted in high flows and flooding of stream channels (Brian Stradley, Sherman County SWCD, pers. comm. 2012). Subsequent flood events have interacted with sediments and material deposited in the stream channels from the 1964 flood, compounding stream bank erosion and sediment deposition within the watershed assessment area.

Water Diversions

Data for water use in the watershed assessment area was obtained from OWRD's database. Data provided include source, general location, and rate of use accorded by the water right. The database is derived from interpretation of paper records. The information contained therein is presented as recorded water rights and is not an accurate representation of current water withdrawals in the assessment area (OWRD 2009). The purpose of this section is to evaluate water diversions as a potential impact on hydrologic processes, particularly at low flows, within the assessment area. To protect the privacy of water-right holders within the assessment area, no attempt was made to pinpoint water use by individual right or to verify rates of use.

An Overview of Water Rights in Oregon

Under State of Oregon law, all water, both surface and groundwater, is publicly owned. Water rights accord an entity the beneficial use[1] of public waters of the State. Private users, such as municipalities and agricultural and industrial operations, must obtain a permit or water right in order to withdraw water from any source. Oregon's water laws are based on prior appropriation: the first party to secure a water right on a particular source is the last to be denied use in times of drought and low flow and is granted priority use regardless of the needs of stakeholders which have obtained a right to the same source at a later date (OWRD 2009).

Certain uses of water are exempt from the requirement to obtain a permit. Exempt uses for surface water generally apply to waters that do not naturally flow across the property boundaries from which they originate and include springs. Other exempt uses of surface water include stock watering, fire control, forest management activities, and rainwater collection. Exempt uses of groundwater include noncommercial lawn or garden watering, watering of school grounds, domestic purposes which do not exceed 15,000 gallons per day, and commercial and industrial purposes which do not exceed 5,000 gallons per day (OWRD 2009).

Oregon's water code was adopted in 1909. Water rights acquired before 1909 are "decreed" by an adjudication process that confirms and documents the rights, provided that the water use can be quantified and it can be proven that the water is being used in a beneficial way (OWRD 2009). Only one water right was identified within the assessment area as being eligible for adjudication and it was granted on December 31, 1907.

[1] Beneficial uses are assigned by basin. Beneficial uses within the assessment area include water supply, recreation, livestock watering, fish and aquatic life, aesthetics quality, and wildlife (ODEQ 2012).

Water Withdrawals and Rates of Use

According to the OWRD GIS data, 27 points of diversion[2] exist within the watershed assessment area (OWRD 2009). Primary uses include irrigation, municipal use, pond maintenance, livestock, storage, and recreation. There are only three irrigation diversion points within the watershed. One irrigation diversion point is on Butte Creek, very near or at the confluence of the John Day. The other two points of diversion allocated for irrigation use are sourced from groundwater wells in the first-order drainages of Sand Canyon in the Pine Hollow watershed and Vaughn Canyon in the Jackknife Creek watershed. Given the limited number of diversion points, irrigation has a negligible effect on stream flow within the watershed assessment area.

The water rights data shows that diversions for municipal use are the highest in number (eleven) and by withdrawal rates (0.67 cfs) for the assessment area. All municipal diversions are located in the assessment area's main population center, the city of Shaniko (population 46), located in the upper Pine Hollow watershed. The sources of the city's diversions are both surface water and groundwater wells.

Recreational water use comprises the highest rate of water use reported by total yearly volume and includes two points of diversion located in the Big Pine Hollow subwatershed. Both of these points are associated with an approximately 2.5-acre artificial lake constructed on the upper reaches of Big Pine Hollow and each features a withdrawal rate of 31 acre-feet, for a total of 62 acre-feet. This is an example of diversion points being duplicated where more than one water right exists at the same location. Because the right holder, the reported use type, and withdrawal rate are identical, it is likely that the actual withdrawal rate accorded by the right is 31 acre-feet.

In summary, water withdrawals within the watershed assessment area do not significantly affect stream flows during low water periods (mid-July through mid-October). Irrigation use is insignificant and the only water withdrawals of consequence within the assessment area occur in the upper reaches of Big Pine Hollow creek for the purposes of serving the town of Shaniko and surrounding settlements. It is reasonable to assume that impacts to the flow regime of Big Pine Hollow Creek from this municipal use are minimal because:

- the Shaniko area has a very low population density with limited development; and
- the sources of withdrawal are both groundwater and surface water. (It is not possible to conclude what the allocation is between surface and groundwater, but the full

[2] The actual number of physical points of diversion may be fewer than 27. In the OWRD spatial data, the point location is duplicated when more than one water right applies to a single physical diversion location.

withdrawal rate allocated by the water right is probably not exercised on an annual basis.)

Effects of Western Juniper on Hydrology

The extent of juniper cover within the assessment area and its impact on upland habitat condition is treated in detail in Chapter 6. For the purposes of this section, the focus is on the impact of juniper woodlands and encroachment on the assessment area's hydrological conditions, particularly stream flow effects.

Western juniper is historically a minor native component of habitats occurring within the watershed assessment area. Before European settlement, juniper was limited to areas less susceptible to fire, such as rimrock, scree slopes, and boulder fields. These landscape features have shallow, well-drained soils that support little production of fine fuels which limits fire frequency (Barrett 2007). Studies report that juniper has dramatically increased in cover and density since the late 1800s, expanding its range into sagebrush and bunchgrass steppe habitats and open woodlands (Miller et al. 2005). The cause of juniper expansion has been attributed primarily to alteration of natural fire regimes through fire suppression and livestock grazing that has resulted in the removal of grasses and other vegetation that provided fine fuel for fires (Miller et al. 2005). Juniper competes with native vegetation species and, over time, dominates habitats, altering community structure, habitat quality, and productivity. More research is required on how juniper directly influences specific components of a water budget for a given watershed, but proxy and anecdotal evidence has found that juniper encroachment can:

- affect local stream flows through the physical and biological processes of interception of precipitation and transpiration; and
- have a measurable effect on hydrological processes, including infiltration of water into the soil, runoff, and erosion.

The following section summarizes juniper's impact on hydrologic processes given in the technical bulletin, "Biology, Ecology, and Management of Western Juniper," produced by Oregon State University's Agricultural Experiment Station (Miller et al. 2005).

Interception of Precipitation

Through leaf interception, the juniper canopy can significantly reduce the amount of effective precipitation, or the quantity of precipitation that reaches the soil, in shrub-steppe communities. Precipitation that does not reach the ground through the canopy or down the stem is lost through the processes of evaporation and transpiration. While the percentage of interception varies by percentage of tree cover and the duration, intensity, and type of precipitation, interception values can range from 42 to 74% of precipitation when measured directly beneath the canopy.

Transpiration

Transpiration is the process by which vegetation takes water up from the soil and releases it into the atmosphere. A mature western juniper may transpire up to 25 gallons of water per day. Juniper has the ability to transpire any time the soil temperature is at or above 40°F, even when most other native vegetation is dormant. This induces moisture stress in native vegetation when it is breaking dormancy, resulting in a loss of native shrubs, grasses, and forb species in areas dominated by juniper (Barrett 2007). Die-off of vegetation means a reduction of protective plant cover, leading to increased overland flow of streams and soil erosion; less ground water moisture also contributes to a reduction of flows from seeps, springs, and streams.

Impact on Surface Water Flow

The base flow of a stream or spring is sustained by the infiltration of precipitation into the soil which then moves laterally underground along an impermeable layer until it surfaces in a stream channel or spring. The reduction of effective precipitation in natural shrub-steppe communities by increased juniper density means that less moisture infiltrates the soil and surface water features become depleted. Anecdotal evidence documents desertification of wet habitats due to an increase of juniper and the replenishment of streams, springs, and wetlands following juniper removal. Two long-term studies (Clary et al. 1974 and Baker1984 as cited in Miller et al. 2005) conducted in the Southwest demonstrated an annual stream flow increase by 157% over 8 years following juniper removal from the watershed. Wilcox (2002) concluded that juniper's effect on stream flow was based on two factors: (1) juniper features high canopy interception and (2) juniper often establishes in shallow soils underlain by permeable rock layers that are conducive to lateral movement of ground water.

Juniper Cover in the Assessment Area

Western juniper cover in the assessment area has been characterized in CSR Natural Resources Consulting's report "Upland Juniper Assessment of the Pine Hollow/Jackknife Creek Watersheds" (2011). Limited field sampling was conducted as part of the juniper assessment based on soil types throughout the Pine Hollow and Jackknife Creek watershed. Sample sites were categorized into three phases of juniper woodland succession based on evolving community structure and juniper cover, with Phase III exhibiting the longest evolution and cover. Spatial data are not available to accurately determine the extent of juniper cover in the assessment area; quantitative data available were limited to a selection of sites sampled during the assessment, thus it was only possible to describe general juniper cover within the assessment area.

In the Pine Hollow watershed, juniper cover at sample sites ranged from 5% in Phase I sites to 44% in Phase III sites. Juniper occurred primarily on canyon sideslopes and in draws and valley bottoms, aptly positioned to tap into groundwater and prevent rain and snowmelt from reaching drainages, as well as to increase the sediment load of streams by accelerating hill slope erosional processes. Considering juniper's rate of precipitation interception, the watershed may lose as much as 44% of the precipitation that falls over areas of dense juniper cover.

In the Jackknife Creek watershed, including Cow and Buckskin subwatersheds, much of the juniper cover (70–80%) was consumed in a July 2008 fire (CSR 2011). Prior to the fire, juniper cover was supported in these areas in dense and moderately dense stands, with rapid encroachment by juniper onto canyon sideslopes. Currently, these areas are recovering native bunchgrasses and annual grasses. The upper reaches of the Jackknife Creek watershed were not exposed to fire and currently support only sparse, widely scattered juniper. The effect of current juniper cover in these areas on hydrological processes is likely insignificant.

Effects of Land Use on Erosion

This section addresses the question of whether land use in the assessment area contributes to surface water runoff and soil erosion. Surface runoff occurs when rainfall rates exceed the capacity of soil and vegetation to infiltrate, intercept, and store water. Surface runoff can enhance peak flows, increase sedimentation of waterways, and impact water quality. Vegetation type and density, soil properties, and presence of impermeable surfaces affect interception, infiltration, and storage rates. In areas with high infiltration rates and a high capacity for storage, runoff is unlikely to take place unless the precipitation event is very severe. Changes in soil structure or vegetation can affect the infiltration rate and alter runoff and erosion intensity. Roads, agricultural crops, development, grazing, and fire can be significant factors in altering runoff and erosion patterns.

Roads

Roads represent areas in a watershed where water infiltration is dramatically reduced due to soil compaction, impermeable paved surfaces, or both. Reducing water infiltration increases runoff into streams. The amount of runoff and sediment generated by a road depends on the construction, surface, maintenance, weather conditions, and weight and frequency of traffic (WPN 2001). All roads within the assessment area are considered rural roads based on land use and population density. Most roads are private and have dirt or gravel surfaces. Of roads where surface and ownership data is available, 70% are private and 84% are dirt or gravel. It is assumed that private dirt or gravel roads are maintained less frequently and that the traffic they receive is light compared to paved state or county roads.

To determine the cover of the road surface and evaluate its potential effect on watershed hydrology, road density was calculated for each of the subwatersheds. Road density was calculated by multiplying the mileage of road in each subwatershed by an estimated average width of 35 feet (.006 mi) to yield road area, then dividing the road area by the area of the subwatershed. The calculation included all known roads occurring within the assessment area, including county, state, and private roads and paved, gravel, and dirt roads. Data sources include Sherman and Wasco County and digitized aerial photos.

The Oregon Watershed Assessment Manual assigns a threshold of concern to rural areas in which more than 8% of the watershed is covered by roads. At this level of road cover, there is high potential for peak flow enhancement (WPN 1999). Additionally, the manual indicates that road cover of 4–8% is considered of moderate concern and cover of less than 4% is of low concern.

Table 5-3 shows the overall road density within the watershed assessment area. The road density for the entire area is very low: 0.01 square miles of road per square mile of land area, which is just over 1% of the total watershed assessment area. Percentage area of roads for the subwatersheds is also very low, the highest value being 2% in the Long Hollow Creek subwatershed. The contribution of roads to surface runoff is probably insignificant given the very low road density within the watershed assessment area.

Table 5-3. Road Length and Density

Subwatershed	Area (sq. mi.)	Total Linear Length of All Roads (mi.)	Total Road Density mi./sq. mi.	Relative Potential for Peak-flow Enhancement
Big Pine Hollow	46.9	115.3	0.02	Low
Long Hollow Creek	24.5	74.1	0.02	Low
Eakin Canyon	23.6	37.2	0.01	Low
Pine Hollow Creek	35.8	73.5	0.01	Low
Jackknife Creek	43.1	54.0	0.01	Low
Buckskin Canyon	13.8	21.9	0.01	Low
Chimney Spring Canyon	18.7	39.90	0.01	Low
Cow Canyon	8.7	12.0	0.01	Low
Pete Enyart Canyon	10.0	19.9	0.01	Low
Watershed Assessment Area Total	225.1	447.8	0.01	Low

Agriculture and Rural Development

According to Oregon Watershed Assessment Manual guidelines (WPN 1999), the effect of agricultural activities on runoff and erosion rates is related to a number of factors including soil characteristics, type of crops planted, farming practices, slope of the land, and timing of erosion-causing events such as high intensity rainfalls or rain-on-snow, rain-on-ice events. Crop and livestock production that take place on hydric-rated soils (soils that do not absorb water readily) are a primary concern, while agriculture on non-hydric soils are a secondary, but still important, potential source of surface runoff and erosion. The K value of a soil indicates its susceptibility to sheet and rill erosion; the higher the K value, the more prone the soil type is to erosion. A K value greater than 0.4 is considered high, while a value less than 0.2 is low. The presence of vegetation helps stabilize soils, so whether cover crops are planted or fields are left fallow will influence the potential extent of erosion, as will the root structure of crops that are planted. Additionally, cultivation of areas with sloping topography will result in more erosion potential than will cultivation of less sloping areas.

There is no evidence of agricultural activities taking place on hydric soils in the watershed assessment area. Hydric soils are uncommon in the area, covering only about 1% of the total area. Most agricultural activities take place on Condon and Cantala soil series, on slopes of 1–7%. These soils feature a K value of 0.43, which indicates that they are vulnerable to erosion. The primary agricultural practice in the watershed assessment area is dryfarmed small grain production with summer-fallow alternate-year rotation; the primary crop is soft white winter wheat (Sherman County SWCD 2012). This production method is specially adapted to low rainfall areas and results in one wheat crop every two years followed by an idle summer-fallow period. Fallow fields are tilled and treated with herbicide to control weeds. Although fields are vegetated during the winter rainfall period, the practice of tillage and fallowing in the spring and summer can lead to extensive soil erosion, particularly during the summer cloudburst events common to the area.

Livestock (mostly cattle) grazing takes place primarily on Condon, Lickskillet, and Bakeoven soils on slopes of 2–20%. Lickskillet and Bakeoven soils have low to moderate K values of 0.15 and 0.23, respectively. Some grazing does takes place in riparian areas. The effect of grazing on erosion is influenced primarily by stocking rate and grazing regime. Poor grazing management (overstocked and continuous grazing) can lead to the destruction of vegetation, leaving soil exposed to erosive events. Grazing in riparian areas can result in direct input of sediments into streams as cattle remove sediment-trapping riparian vegetation and destabilize banks as they travel through the area.

There is minimal urban or rural development in the watershed assessment area. The limited development is made up of widely spaced farmsteads on the flat to gently rolling terraces and plateaus of Jackknife Creek and Pine Hollow Creek watersheds as well as the rural town of Shaniko, which has few buildings and low road density. The contribution of surface runoff or erosion by rural development is considered insignificant.

Soil and Water Conservation Measures

Measures to control surface runoff and erosion have been implemented in the watershed assessment area, primarily concentrated within the wheat production areas of upper Pine Hollow and Jackknife Creek (Table 5-5). Water and sediment control measures include the installation of water and sediment control basins (WASCBs), construction of terraces, and grass seeding of bare soil areas and water-storing swales. In addition to these measures, producers are increasingly leaving vegetation residue on fallow fields to increase the water- and sediment-trapping capacity. Both water and sediment control basins and terraces consist of earthen embankments that intercept surface runoff, either storing water until it infiltrates into the ground or conducting it to a stable outlet, thus reducing erosion and the amount of surface runoff reaching streams.

Other conservation practices in the watershed assessment area include the installation of livestock-exclusion riparian fencing and development of off-stream watering facilities. Fencing of riparian areas and off-stream watering facilities prevent livestock from accessing and damaging sensitive riparian areas. Most of the riparian fencing and off-stream water facilities have been installed in the Pine Hollow and Jackknife Creek watersheds (Table 5-5).

Table 5-4. Watershed Conservation Measures

Watershed	Subwatershed	Water and Sediment Control Basins	Terracing (mi.)	Fencing (mi.)	Water Developments	Grass Seeding (ac)
Pine Hollow	Big Pine Hollow	18	0	3.02	7	231.82
	Eakin Canyon	21	15.44	0.5	5	0
	Long Hollow	0	0	0	1	0
	Pine Hollow	10	0	3.37	2	74.49
	Total	49	15.44	6.89	15	306.31
Jackknife Creek	Jackknife Creek	43	45.81	14.56	15	345.18
Canyon Tributaries	Buckskin Canyon	0	1.85	1.88	1	93.22
	Chimney Spring Canyon	0	0	0	0	0
	Cow Canyon	1	0.68	0	1	0
	Pete Enyart Canyon	0	0	0	0	0
	Total	1	2.53	1.88	2	93.22
Assessment Area Total		**93**	**63.78**	**23.33**	**32**	**744.71**

Source: Sherman County SWCD

All of these upland and riparian conservation measures will reduce surface runoff and erosion generated by agriculture and grazing actives. Many of the soil and water conservation projects in the assessment area are facilitated by the USDA's Conservation Reserve Programs (CRP or CREP) and the Bonneville Power Administration's (BPA) Fish and Wildlife Programs. The CRP generally applies to upland agricultural areas with highly erodible soils, while the CREP applies to stream-adjacent riparian areas. BPA projects may include any of the above mentioned conservation measures.

There are approximately 181 miles of streams enrolled in the CREP, encompassing 1,931 acres in the Pine Hollow and Jackknife Creek watersheds (Brian Stradley, Sherman County SWCD, pers. comm. 2012). The CRP areas are primarily located in the northern portion of the watershed assessment area, with the highest concentration in the Jackknife Creek watershed, at 10,658 acres, and 2,618 acres enrolled in the Pine Hollow watershed (Brian Stradley, Sherman County SWCD, pers. comm. 2012).

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Chapter 6. Upland Habitat and Wildlife

Introduction

Upland vegetation and stream habitat are linked. Vegetation type and condition, natural and human disturbance patterns, and land management practices can all affect riparian and in-stream habitat, hydrology, and water quality. Many wildlife species require both upland and stream habitats for sources of food or water.

Upland habitat and wildlife in the assessment area were evaluated with various spatial datasets, including vegetation cover type, land use, and the Oregon Conservation Strategy's "focal habitats" (ODFW 2010). A variety of regional assessments and reports were also consulted. A complete list of wildlife species known to occur in the watershed assessment area is presented in Appendix A.

Both land cover and habitat, as defined by the Oregon Conservation Strategy, were evaluated to determine their spatial extent and distribution within the watershed assessment area. The Oregon Conservation Strategy is a non-regulatory, statewide approach to wildlife species and habitat conservation. The strategy combines existing plans, scientific data, and local knowledge into a broad vision and conceptual framework for long-term conservation of Oregon's native fish, wildlife, and habitats. The Oregon Conservation Strategy has identified habitat types and associated wildlife species that require conservation and habitat improvement.
This chapter addresses the following questions:

- What are the current vegetation communities?
- How do the watershed assessment area's vegetation communities relate to Oregon Conservation Strategy habitats and wildlife species?
- What are the status and trends of invasive plant species?
- What is the condition of juniper encroachment and what can be done to manage juniper?
- What is the status of wildlife populations?
- How are invasive animals, particularly invasive swine, affecting the watershed assessment area?

Upland Vegetation and Associated Wildlife Habitat

Upland vegetation communities are illustrated in a series of maps covering each of the watersheds within the watershed assessment area: Pine Hollow watershed (Map 16), Jackknife Creek watershed (Map 17), and Canyon Tributaries watershed (Map 18). Table 6-1 and Figures 6-1 to 6-3 summarize the proportions of the upland vegetation community types identified within the watershed assessment area. The summaries below describe each ecological type, the

Oregon Conservation Strategy focal species that occur within each of the communities, and the identified habitat threats.

Table 6-1. Summary of Upland Vegetation Community Types

Watershed	Big Sagebrush – Bunchgrass Steppe	Western Juniper	Agriculture (wheat, hay, pasture)	Eastside Foothill – Canyon Dry Grassland	Big Sagebrush Shrubland	Introduced Vegetation- Grassland	Scablands	Palouse Prairie
Pine Hollow	37%	26%	9%	8%	7%	5%	5%	0.3%
Jackknife Creek	35.2%	0.4%	43%	15%	4%	1%	0.4%	1%
Canyon Tributaries	64%	12%	0.1%	7%	3%	7%	3%	0.1%
Watershed Assessment Area Total	44%	16%	12%	8%	5%	4%	3%	0.3%

Figure 6-1. Current Vegetation in the Pine Hollow Watershed

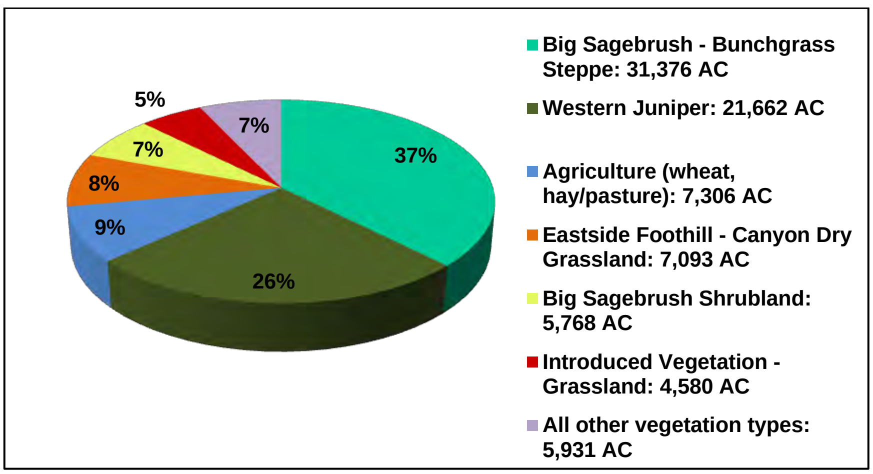


Figure 6-2. Current Vegetation in the Jackknife Creek Watershed

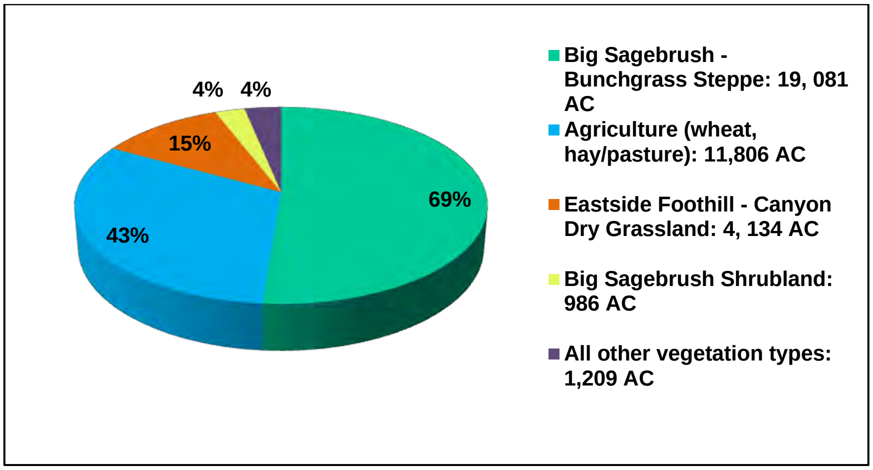
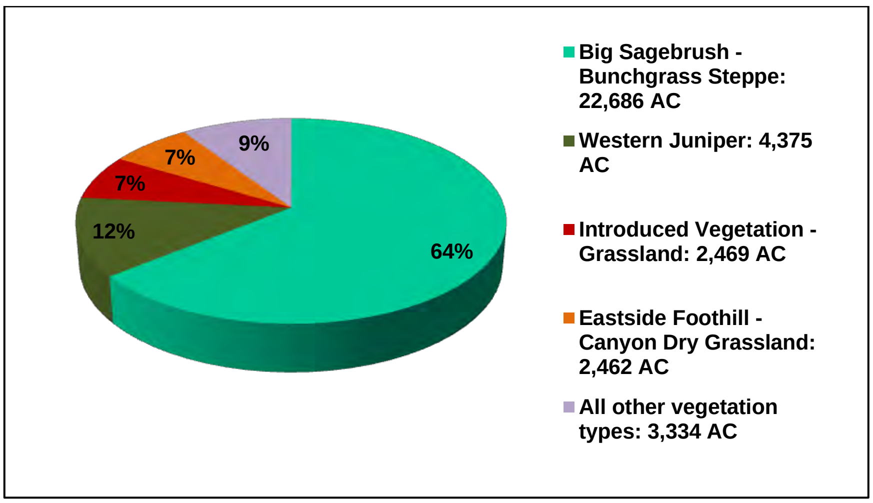


Figure 6-3. Current Vegetation in the Canyon Tributaries Watershed



Big Sagebrush – Bunchgrass Steppe

This shrub – steppe vegetation community is the dominant ecological type in the assessment area, comprising nearly 45% of the total land area. This land-cover type occurs on all landforms, soils, slopes, and aspects at elevations above 1,000 feet. It is characterized by an open shrub community dominated by perennial grasses and forbs (>25% cover) and contains 10–40% cover of Wyoming or basin big sagebrush, antelope bitterbrush (*Purshia tridentata)*, or other intermountain sage-like shrubs. Shadscale saltbrush (*Atriplex confertifolia),* yellow rabbitbrush *(Chrysothamnus viscidiflorus),* rubber rabbitbrush *(Ericameria nauseosa),* horsebrush *(Tetradymia* spp.), or prairie sagewort (*Artemisia frigida)* may be common, especially in disturbed stands. Associated graminoids include Indian ricegrass (*Achnatherum hymenoides),* plains reedgrass *(Calamagrostis montanensis),* thickspike wheatgrass *(Elymus lanceolatus* ssp. *Lanceolatus),* Idaho fescue, rough fescue *(Festuca campestris),* prairie Junegrass *(Koeleria macrantha),* Sandberg bluegrass, and bluebunch wheatgrass. Common forbs are spiny phlox (*Phlox hoodii*), and sandwort *(Arenaria* spp.).

Areas with deeper soils would commonly support basin big sagebrush, but have largely been converted for agriculture and other land uses. The natural fire regime of this ecological system likely maintains a patchy distribution of shrubs, so the general aspect of the vegetation is grassland. Shrubs may increase following heavy grazing or with fire suppression (NatureServe 2012). Grass cultivars, particularly 'Sherman' big bluegrass, a cultivar of Sandberg bluegrass, and 'Whitmar' beardless wheatgrass, a cultivar of bluebunch wheatgrass, are also significant components within the shrub – steppe land cover type. These cultivars were developed by either the USDA NRCS Plant Materials Program or the USDA Agricultural Research Service (ARS) in the 1930s and have since been widely seeded by land managers throughout the region as a means to address soil and water conservation issues in agriculture and to provide improved forage for livestock (Aubry et al. 2005).

The Oregon Conservation Strategy identifies the Big Sagebrush – Bunchgrass Steppe land cover type as "[Big] Sagebrush Shrublands and Steppe" habitat. Big sagebrush habitat features high structural diversity, providing cover, forage, and nesting sites for a variety of species. A diverse understory of bunchgrasses and forbs increases habitat value. This habitat is associated with strategy species that include greater sage-grouse, ferruginous hawk, loggerhead shrike, sage sparrow, Brewer's sparrow, sagebrush lizard, Washington ground squirrel, and pygmy rabbits (which often burrow along the interface where low sagebrush mixes with mountain big sagebrush). Other wildlife closely associated with sagebrush includes black-throated sparrow, sage thrasher, sagebrush vole, and pronghorn. According to the Conservation Strategy, this habitat is threatened by an altered fire regime, which promotes invasion of western juniper and other exotic vegetation, and by conversion to other land uses (primarily agriculture), which results in habitat loss, fragmentation, and soil erosion.

Western Juniper Woodlands

The western juniper woodland vegetation community covers nearly 16% of the total assessment area. It is defined as open woodlands and savannas dominated by western juniper, usually with an understory of sagebrush, bitterbrush, and bunchgrasses. Juniper is usually the only tree, though curl-leaf mountain mahogany (*Cercocarpus ledifolius*) may occasionally co-dominate in this system. Big sagebrush is the most commonly associated shrub species, but antelope bitterbrush, yellow and rubber rabbitbrush, horsebrush, and wax currant (*Ribes cereum*) may also be present. Graminoids include threadleaf sedge (*Carex filifolia*), Idaho fescue, Sandberg bluegrass, and bluebunch wheatgrass. Reptiles such as sagebrush, western fence, and side-blotched lizards are reported as characteristic of juniper woodlands (NatureServe 2012).

Juniper woodlands are composed of two habitat types: (1) old-growth woodlands with stands over 500 years old, characterized by well-spaced trees with rounded crowns, and generally localized on poor, rocky soils, rimrock, and scree slopes where fire frequency is low and (2) large areas where juniper has expanded into sagebrush and bunchgrass-dominated areas and stands are typified by young, pointed-crowned, densely spaced trees.

The Oregon Conservation Strategy identifies the young, dense juniper woodland type as an encroachment on native range and shrublands. Alteration of typical shrub – steppe and grassland fire regimes through fire suppression and removal of fine fuels by grazing livestock have allowed juniper to expand into historic shrub – steppe and grassland communities and made them unsuitable for species that require open sagebrush habitat. The negative impacts of juniper encroachment that have been reported are (CSR 2011):

- die-off of native shrubs and die-off or reduction in native grasses and forbs resulting in reduced biodiversity, habitat value for wildlife species, and forage for livestock;
- increase in overland water flow and soil erosion as a result of vegetation reduction or die-off (erosion rates can be as much as an order of magnitude higher on sites that have been dominated by juniper than on similar sites without encroachment); and
- interception of precipitation by juniper canopy, use of soil water throughout the year, and increased transpiration, altering the hydrologic cycle and hindering soil moisture recharge and growth of native vegetation; juniper establishment has been corresponded to a reduction in flow of local springs, seeps, and streams.

A management approach to control juniper encroachment developed by the Oregon Conservation Strategy includes prescribed fire regimes, mechanical removal of juniper, and development of markets for small juniper trees as a special forest product. Open, old-growth juniper stands, however, are maintained as important nesting habitat for songbirds and raptors, including ferruginous hawks, and habitat for small mammals, deer, and other ungulates (ODFW 2010).

Agriculture

Agricultural croplands account for 12% of the land area in the assessment area. They are located primarily in the Jackknife Creek watershed on ridge top terraces supporting deep to moderately deep soils. They extend down in elevation until the terrain becomes too steep for tillage or suitable soil type and depth is diminished. Virtually all land that is suitable for crop production is actively farmed (Brian Stradley, Sherman County SWCD, pers. comm. 2012).

East-Side Foothill – Canyon Dry Grassland

This dry, bunchgrass-dominated vegetation community comprises about 8% of the land area of the assessment area. This community occurs on steep canyon slopes at elevations of 300 to 5,000 feet. Because of the steep slopes, these are open, patchy grasslands, often rocky or stony, with occasional deciduous shrubs or trees. Slope failures are a common process. Fire frequency is presumed to be less than 20 years. The vegetation is dominated by patchy graminoid cover, cacti, and some forbs. Bluebunch wheatgrass, Idaho fescue, and plains pricklypear (*Opuntia polyacantha*) are common species. Deciduous shrubs such as snowberry, mallow ninebark (*Physocarpus malvaceus*), oceanspray (*Holodiscus discolor*), and currant (*Ribes* spp) are infrequent native species that may increase with fire suppression (NatureServe 2012).

The Oregon Conservation Strategy identifies this vegetation community as “Columbia Basin Grasslands and Prairie” and as important habitat for a number of strategy species that include grassland birds, raptors, and rare flora. NatureServe (2012) reports that two U.S. ESA-listed threatened species, northern pocket gopher and northern grasshopper mouse, are characteristic to the Eastside Foothill – Canyon Dry Grassland system.

Big Sagebrush Shrubland

The big sagebrush shrubland vegetation community is dominated by Wyoming or basin big sagebrush, bitterbrush, or other intermountain sage-like shrubs. This cover type comprises approximately 5% of the assessment area. This vegetation community is distinguished from Big Sagebrush – Bunchgrass Steppe communities by the dominance of shrub species, with grasses making up less than 25% of the cover. Similar to the Steppe community, it is a widespread cover type. Common graminoid species include blue grama (*Bouteloua gracilis*), needle and thread grass (*Hesperostipa comata*), basin wildrye (*Leymus cinereus*), and other perennial grasses as found in sagebrush – steppe communities. In disturbed sites, cheatgrass or other annual bromes and invasive weeds can be abundant (NatureServe 2012).

Wildlife habitat value and associated species for Big Sagebrush Shrublands are similar to Big Sagebrush – Bunchgrass Steppe habitat, described above. Big Sagebrush Shrublands are included in the Conservation Strategy in the “[big] Sagebrush Shrublands and Steppe” strategy habitat.

Rare and Threatened Habitats

Rigid Sagebrush, Buckwheat or Bluegrass Scabland, and Biscuit Scablands

Scablands are barren, rocky, and xeric shrub habitats common to the Columbia Plateau. They currently occur over 3% of the assessment area. Historically, this habitat type was a dominant type, most common on shallow-soiled ridge tops at a wide range of elevations. Vegetation is characterized by an open dwarf-shrub canopy dominated by rigid sagebrush along with other shrub and dwarf-shrub species, particularly buckwheat (*Eriogonum* spp). There is also low cover perennial bunch grasses, primarily Sandberg bluegrass, as well as scattered forbs including bulbous species such as onions (*Allium* spp.), balsamroot (*Balsamorhiza* spp.), and biscuit-root (*Lomatium* spp.) and drought-tolerant species such as bitterroot (*Lewisia rediviva*), stonecrop (*Sedum* spp.), and phlox.

Vascular vegetation cover is often less than 50%; cover of moss or lichen is up to 60% in undisturbed areas. Wildlife associated with this habitat includes the pygmy-horned and side-blotched lizard, western rattlesnake, and bushy-tailed woodrat (NatureServe 2012). Scablands are included in the Oregon Conservation Strategy in the "[low] Sagebrush Shrublands and Steppe" strategy habitat. Low sagebrush habitat is identified as important for the greater sage-grouse and other sagebrush-obligate species.

Ranging in elevations from 1,700 to 3,500 feet, scablands in the watershed assessment area and elsewhere in the Columbia Basin are found to form a mosaic with mounds of silty grassland soils, called "biscuits," creating a unique land pattern locally referred to as "biscuit scabland." Biscuits are 5 to 20 or more feet in diameter and usually about 20 to 36 inches deep, typically composed of Condon soils over basalt bedrock and surrounded by thin, rocky scabland soil (usually Bakeoven). They support perennial bunchgrasses and forbs and can comprise from 5% to over 30% of the area where they occur. Generally, where biscuits comprise over 40% of the area, the scablands are converted to agricultural use (Anderson et al. 2012). Biscuit scabland occurring in the assessment area is generally found in the Pine Hollow watershed.

Historically, scablands and biscuit scablands (where scablands grade into grasslands), were common throughout the assessment area. Conversion of biscuit scabland to cropland, fire suppression, grazing, and noxious weed colonization have all contributed to loss of this habitat type.

Palouse Prairie

The once-extensive Palouse Prairie grassland system is characterized by cool-season bunchgrasses occurring over rolling topography composed of loess hills and plains over basalt at elevations of over 1,000 feet. Bluebunch wheatgrass and Idaho Fescue along with needle and thread grass, prairie Junegrass, basin wildrye, Scribner needlegrass (*Achnatherum scribneri*), Giant wildrye (*Leymus condensatus*), or western wheatgrass (*Pascopyrum smithii*) typify this vegetation community. Shrubs commonly found include serviceberry (*Amelanchier alnifolia),* rose, snowberry, and hawthorn. Agricultural land conversion, excessive livestock grazing, range management practices, and invasion by noxious weeds have resulted in a massive conversion of palouse prairies to agriculture or sagebrush shrub-steppe and weedy annual grassland dominated by sagebrush and cheatgrass. In the assessment area, palouse prairie once comprised over 75% of the land area; it currently comprises less than 1%. Remnant grasslands are now typically associated with steep and rocky sites or small and isolated sites within an agricultural landscape (NatureServe 2012, ODFW 2010).

Invasive Vegetation Species

Invasive or noxious weeds are defined by the Oregon Department of Agriculture (ODA) as exotic, non-indigenous plant species that are injurious to public health, agriculture, wildlife, or recreation on private or public property. Invasive plants out-compete and replace native vegetation, increase erosion, degrade cropland and rangeland, and increase fire frequency and severity. Invasive vegetation generally provides little habitat value for wildlife, is unpalatable and even poisonous to livestock, and can severely reduce the overall quality and productivity of agricultural land. Control or eradication of widespread invasive weeds can be difficult and cost-prohibitive (ODA 2012).

Criteria for determining the economic and environmental significance of noxious weeds as described in the ODA's 2012 Noxious Weed Policy and Classification System is based upon:

- detrimental effects;
- plant reproduction;
- extent of distribution; and
- difficulty of control.

Noxious weeds are designated into categories at both the state and county level in Oregon. ODA classifies weed categories as "A," "B," or "T" according to the ODA Noxious Weed Classification System. Class A weeds are weeds of known economic importance which occur in the state in small enough infestations to make eradication or containment possible; or the species is not known to occur, but its presence in neighboring states makes future occurrence in Oregon seem likely. Infestations of weeds in this category are subject to eradication or intensive control when and where they are found. Class B weeds are those of economic importance that are regionally abundant, but which may have limited distribution in some counties. Infestations are subject to limited intensive control at the state, county, or regional level as determined on a site specific basis. Class T designated weeds are a priority noxious weed designated by the Oregon State Weed Board as a target for which the ODA will develop and implement a statewide management plan. Class T designated noxious weeds are species selected from either the “A” or “B” list. Sherman County maintains a list that has been decided at a more local level by the County Weed advisory board based on the actual threat to the county. The county classifies invasive weed categories as “A,” “B,” or “C.” The categorization is slightly different at the county level than the state level, but the decisions are likewise based upon economic impacts, the population size, and eradication potential.

Invasive weeds are widespread in the watershed assessment area. Species of primary concern include the annual grasses cheatgrass, medusahead rye (*Taeniatherum caput-medusae*), and North Africa grass (*Ventenata dubia*) and several herbaceous perennials including Russian knapweed (*Acroptilon repens*), diffuse knapweed (*Centaurea diffusa),* Dalmatian toadflax (*Linaria dalmatica*), and yellow star-thistle (*Centaurea solstitialis*). These weeds are known to occur throughout rangelands and croplands, roadsides, and riparian areas. Other species of concern that are still limited in distribution within the assessment area include the herbaceous perennials spotted knapweed (*Centaurea stoebe*), rush skeletonweed (*Chondrilla juncea*), hoary cress whitetop (*Cardaria draba)*, and leafy spurge (*Euphorbia esula*). Map 19 displays some of the mapped occurrences of noxious weeds and areas of control based on data from ODA, BLM, and Sherman County SWCD. This map represents a snapshot and is not a comprehensive representation of weed species within the watershed assessment area. ODA distribution and location maps were consulted to evaluate the presence and distribution of economically important noxious weeds within the assessment area. Appendix B summarizes the invasive weed species known to occur in the watershed assessment area and includes both the state and county-level designations.

Medusahead rye has recently grown to be a great concern not only throughout the watershed assessment area but throughout the entire state. This invasive plant species out-competes other grasses by extracting the majority of moisture well before perennial grasses have begun to grow. Medusahead is rich in silica and becomes unpalatable in late spring as forage for cattle or sheep. Once land is invaded by this grass, it becomes almost worthless, not supporting native animals, birds, or livestock. Medusahead rye changes the temperature and moisture dynamics of the soil, greatly reducing seed germination of other species and creating fuel for wildfires. Rush skeletonweed is also a large concern in the upland areas of the watershed assessment area and is being targeted for control by the counties.

Weeds are not only detrimental to rangeland productivity, they are also costly. Weed infestations continue into agricultural lands where they reduce the capacity to produce crops. Weeds in agricultural lands within the watershed assessment area are controlled by tillage and chemicals. On an average farm operation cropping 2,000 acres per year, weed control can range from $20,000 to $70,000 for one crop year (Sherman County SWCD 2012). Additional money is spent in efforts to eliminate source populations in non-production areas such as range and scabland.

Sherman County Road Department has implemented a weed control program for County and State road right-of-ways. Sherman County Weed District is responsible for implementing weed control in accordance with county, state, and federal law and assists in weed control and education programs to protect the economic and ecological value of agricultural land and wildlife habitat.

Upland Juniper Assessment of the Pine Hollow and Jackknife Creek Watersheds

This section summarizes the findings in "Upland Juniper Assessment of the Pine Hollow/Jackknife Watersheds," a study conducted by CSR Natural Resources Consulting for the Sherman County SWCD in 2011 (CSR 2011). The juniper assessment included field surveys and photo documentation within the Pine Hollow and Jackknife Creek watersheds.

Historically controlled by natural fire disturbance regimes, western juniper has extended its range to become detrimental to grassland and shrub-steppe habitats, altering community structure and hydrological cycles and degrading habitat value for wildlife and livestock. Once an infrequently occurring species, juniper has rapidly encroached upon the rangelands and canyonlands in the watershed assessment area.

The Jackknife Creek watershed has been subject to juniper encroachment for the past 80 to 100 years. Juniper in this area has now grown into dense to moderately dense stands throughout. In 2008, a lightning-ignited wildfire burned through the middle and lower parts of the Jackknife Creek drainage and destroyed up to 80% of the juniper stands in the area. The burned canyon bottom of the main stem of Jackknife Creek has since recovered to a diverse mix of native-seeded species ('Sherman' big bluegrass and 'Whitmar' bluebunch wheatgrass) and annual invasive grasses such as cheatgrass, medusahead rye, and North Africa grass, with other early successional forbs. Vigorous bluebunch wheatgrass stands have colonized the steep canyon side slopes at densities appropriate for serving soil stabilization and precipitation infiltration functions. The scattered surviving juniper is distributed in such a way that provides community structural diversity and habitat for birds and mammals. Much of the big sagebrush was consumed in the fire and has yet to recover.

The middle portion of the Jackknife Creek watershed has been colonized largely by invasive annual grasses and forbs, with only a remnant stand of bluebunch wheatgrass. Land management practices will be required to control non-native grasses and restore healthy native rangeland conditions. The upper reaches of the Jackknife Creek watershed, which were spared from fire, support big sagebrush – bunchgrass steppe in generally good ecological condition. Juniper stands in this area are young to middle-aged, but scattered in distribution, and contribute habitat value for wildlife. Early juniper management is prescribed to prevent an increase in tree density and avoid its effects on watershed condition.

Field surveys conducted in the Pine Hollow watershed indicate that rangeland health varies from “good ecological function” to “non-functioning.” These surveys categorized the woodland succession of juniper into age classes of Phase I–Phase III and conducted cover and general range health assessments within the different successional groups. Rangeland health assessment includes soil stability, hydrologic function, and biotic integrity ratings. Non-functioning areas that are dominated by medusahead rye, cheatgrass, and North Africa grass are widespread throughout the watershed. Late-phase juniper encroachment in the Pine Hollow watershed is evident, particularly on steep canyon side slopes and in valley bottoms, where densely spaced trees are successfully out-competing native vegetation and altering the natural hydrology.

Western Juniper Management Considerations

Restoration of these western juniper dominated areas through mechanical removal of juniper or prescribed burning can be difficult and costly. Moreover, removal of juniper can result in a release of resources that can increase productivity of invasive grasses. The following recommendations are taken from the western juniper assessment (CSR 2011). These management considerations are based on the assumption that the landowners, land management agencies, as well as others have an interest in maintaining healthy, functioning watersheds for the many uses and values they provide: long duration, dependable flows of quality water; healthy fish populations; productive wildlife habitats and healthy wildlife populations; and economic uses such as livestock grazing and fee hunting.

Without control efforts in the watershed assessment area, western juniper expansion and in-fill will continue, resulting in: greater tree density and its increased soil water consumption; increased canopy cover, resulting in rain and snow interception; diminishing flows of seeps, springs, and streams; declining diversity of wildlife habitats and wildlife; and reduced livestock forage production. With the continued exclusion of fire, the risk of unnaturally hot, destructive fire becomes more likely—until such time that fine- and ladder-fuels are insufficient to carry a fire, and the juniper stands become, in effect, "fire-proof."

Land maintenance efforts by landowners on lands that are in the earliest stages of encroachment (Phase I) are encouraged. Most of these areas occur in the north end of the watershed assessment area or on the fringes of terraces where young juniper are becoming established. Alternatively, an extensive prescribed-burn project, made up of discreet units within a wide area, might be considered.

Wildlife Populations

Wildlife populations in the watershed are influenced by location of available drinking water and agricultural production. NRCS wildlife upland habitat management practice code 645 indicates that the optimal distance to water is one quarter mile from food and shelter (Sherman County SWCD 2012). The semi-arid climate and lack of frequent perennial streams require wildlife to rely on natural springs and man-made watering sources throughout much of the watershed. Jackknife Creek watershed provides perennial water, particularly in the lower reaches of the watershed, in few places. Pine Hollow and its tributaries are more reliable for perennial water throughout the watershed. In the uplands, non-natural watering sources are provided by livestock watering facilities, wildlife watering facilities (guzzlers), and WASCBs.

Livestock and wildlife watering facilities can consist of simple troughs filled from domestic wells, solar and wind powered livestock wells in remote locations, or natural springs developed and piped to troughs. Larger wildlife such as deer and elk are able to utilize these types of watering facilities. Guzzlers are units that collect precipitation from an 8 foot by 8 foot roof and store it in a 500 gallon cistern accessible to wildlife for consumption. The guzzlers that are used in this area are usually designed for upland birds and smaller wildlife. The primary purpose of WASCBs is to capture excessive surface runoff and store it for safe release as groundwater inputs, while capturing sediment generated from erosion above the structure. The runoff stored in WASCOBs, before infiltrating into the ground, becomes an oasis for all resident wildlife species; it becomes a place to obtain drinking water and find shelter in tall grasses and brush surrounding the structure. Migratory birds utilize these structures as resting spots during migration to find food and nesting habitat.

Conversion of grasslands into crop production along with historical over-grazing which began in the 1860s, altered habitat dramatically for wildlife species that depend on grass plant communities. The conversion of native grasslands removed habitat for ground nesting species of birds, while simultaneously producing a more desirable habitat for non-native species such as pheasant. According to ODFW, non-native game birds, such as Ringneck pheasant, Chuckar partridge, Hungarian (gray) partridge, and Valley (California) quail, were introduced beginning in the early 1950s and continue to maintain populations within the watershed today (Sherman County SWCD 2012).

Wildlife Species

No historical data could be found on populations of large mammals within Sherman County. Verbal accounts of the first mule deer (*Odocoileus hemionus*) sighting in the watershed occurred in Rosebush Canyon in the early 1920s with pronghorn antelope (*Antilocapra americana oregona*) following in the mid-1950s (Sherman County SWCD 2012). The first account of Rocky Mountain elk (*Cervus canadensis nelsoni*) migrating through the watershed occurred in the late 1970s (Sherman County SWCD 2012). Historically, two subspecies of bighorn sheep (*Ovis canadensis*) were native to this region of Oregon. The Rocky Mountain subspecies (*O. c. canadensis*) inhabited the northeastern corner of the state from the John Day–Burnt River divide, north and east to the Snake River and the Oregon-Washington state line. The California subspecies (*O. c. californiana*) ranged over southeast and south-central Oregon and through much of the John Day and Deschutes River drainages (ODFW 2012). Settlement of the west brought with it overhunting, changes in land use, domestic livestock, and associated diseases which negatively impacted native bighorn populations, and bighorn were gone from Oregon by 1945. Their re-establishment has been very successful, but not without setbacks, particularly from disease outbreaks (ODFW 2010). California bighorn sheep were reintroduced into the John Day canyon in the East John Day unit in 1989 and in the West John Day unit in 1995 (BLM 2012).

ODFW management unit boundaries do not coincide with Pine Hollow watershed, Jackknife Creek watershed, or Sherman County boundaries. Therefore, population estimates within the watershed are difficult to conclude. No data exists for non-game species of wildlife within the watershed boundaries. According to ODFW there are no bald eagle nests within Sherman County (Sherman County SWCD 2012). There are no other documented wildlife species currently listed as endangered within the watershed assessment area.

County-wide population trends, however, show mule deer populations to be slightly increasing, pronghorn antelope decreasing, elk slightly increasing, and bighorn sheep stable and slowly increasing in numbers (Sherman County SWCD 2012). Predator populations are difficult to census, but are believed to be healthy for coyotes and at a low density of 3.8 mountain lions per 100 square miles according to ODFW (Sherman County SWCD 2012).

Invasive Wildlife: Feral Swine and Barbary Sheep

Two invasive wildlife species have been introduced into the watershed assessment area, feral swine and Barbary sheep. Feral swine are the greater concern, but Barbary sheep (Ammotragus lervia) could become an issue. An increase in the population of Barbary sheep is of concern because these sheep can pass diseases to the bighorn population (ODFW 2012a). This is a potential future problem as the John Day basin has one of the strongest bighorn sheep populations in the state.

Feral swine are defined by ODFW as animals of the genus Sus which (OAR 603-010-0055):

- are free roaming on public or private lands and are not being held under domestic management confinement;
- do not appear to be domesticated and are not tame; and
- do not meet the identification and description of escaped swine. (There has been no notification to the landowner, manager, or occupant made by the swine owner or their representative of specifically identified and described swine having escaped domestic management confinement within a radius of five miles during the past five days.)

Feral swine are prohibited in Oregon where they are considered a predatory animal on private land. On public land, they are considered non-game and non-protected. Feral swine in Oregon are the result of unintentional escapes from domestic swine facilities or intentional releases and have rapidly become a big problem in some areas of eastern Oregon. Feral swine are small but powerful animals and can range from solid black to red, striped, grizzled, or spotted. They reproduce quickly; it is estimated it would take a 70% harvest rate each year just to maintain the population at its current level (ODFW 2012a). Hunting is often used as a management tool, but studies have found that even with unlimited hunting, hunters are only able to remove up to 40% of a population each year (ODFW 2012a). Female feral swine are called sows and forage with their young; usually there are about six in a family group and several family groups of feral swine may join together to live in a larger group called a sounder. Male feral swine, called boars, usually lead solitary lives, though several boars may band together. The boars have four continually growing tusks which they use for defense and to establish dominance during breeding.

In general, feral swine can adapt to almost any kind of habitat, but they tend to inhabit swamps, brushlands, riparian zones, forests, and areas near agricultural fields. They are omnivores with a diet composed of acorns, forbs, grasses, fungus, leaves, berries, fruits, roots, tubers, corn, and other agricultural crops, along with insects, crayfish, frogs, salamanders, snakes, mice, eggs of groundnesting birds, small mammals, fawns, lambs, calves, kid goats, and carrion. Feral swine have cloven feet and flat elongated snouts which are very effective for rooting in the soil for food. They have a strong sense of smell and hearing, but very poor eyesight.

Although no quantitative damage assessments have been done, qualitatively feral swine can have a very significant impact on the watershed assessment area's riparian vegetation and on hillsides. According to information from ODFW, swine have been shown to restrict timber growth, reduce and remove understory vegetation, and destabilize soils in riparian areas and adjacent hillsides, causing increased erosion and compaction while simultaneously decreasing stream quality. Rooting and grubbing activities have been shown to facilitate the spread of noxious weeds and other nonnative vegetation, reducing site diversity and distribution of native species. Feral swine compete with native wildlife and livestock for food and habitat, prey on young native wildlife and livestock, and can transmit disease to wildlife, livestock, and humans. They have been observed to cause impacts to CREP riparian planting areas in the assessment area (Brian Stradley, Sherman County SWCD, pers. comm. 2012).

At this time, the overall impacts from feral swine in the watershed assessment area are moderate, but this issue could grow over time if the population increases (Brian Stradley, Sherman County SWCD, pers. comm. 2012). The populations in the assessment area are mostly concentrated in the Pine Hollow watershed with fewer observed in Jackknife Creek watershed. Based on assessments of feral swine fitted with radio-tracking collars, the animals generally stay within a two-mile radius of their home territory, but will move five to six miles per day and travel between watersheds if disturbed (Brian Stradley, Sherman County SWCD, pers. comm. 2012).

To limit the spread of invasive feral swine, the 2009 Oregon Legislature passed House Bill 2221 which requires landowners and land managers to notify ODFW when they become aware of free roaming feral swine on their property. A federal trapper is employed in Sherman County and spends a good amount of time in the watershed. There are fifteen traps between the two watersheds (five or six in the Jackknife Creek watershed and the remainder in the Pine Hollow watershed). It is legal to shoot feral swine throughout the year with a hunting license. The typical hunting strategy is on the ground, but aerial (fixed wing and helicopter) shooting has been used by both federal employees and occasional recreational hunters for population control (Brian Stradley, Sherman County SWCD, pers. comm. 2012).

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Chapter 7. Riparian and Wetland Habitat

Introduction

The purpose of this chapter is to evaluate the present condition of riparian and wetland areas throughout the watershed assessment area. Riparian areas are a dynamic area of interaction between aquatic and terrestrial systems. Wetlands and riparian areas generally have higher soil moisture than adjacent upland areas, giving them potential to have distinctive vegetative communities and unique habitat (WPN 1999; Clarke et al. 2001). Riparian corridors and their vegetation communities provide important ecological functions and can be a source of valuable natural resources by:

- providing organic matter and terrestrial insects that serve as food for aquatic life;
- contributing large wood that creates fish habitat and stream channel complexity;
- providing vegetative canopy to provide hiding areas for fish and shade to help moderate water temperatures;
- attenuating flood hazards by absorbing, slowing, and dissipating flood energy;
- retaining sediments;
- reducing bank erosion by increasing bank stability through vegetative root strength;
- filtering natural and man-made polluted run-off, particularly from nonpoint sources;
- providing wildlife habitat;
- increasing groundwater recharge and the slow release of water during dry periods;
- providing sources of forage for domestic and wild animals; and
- increasing wildlife habitat diversity.

There is a legacy of natural and human-caused disturbance in the watershed assessment area which affects the evaluation of current riparian conditions. For example, the 1964 Christmas flood event disturbed stream channels and riparian vegetation throughout the watershed and this has influenced what we see on the ground today. Similarly, past grazing practices degraded riparian areas and vegetation is still recovering.

The following questions are addressed in this chapter:

- What are the current conditions of riparian areas within the watershed assessment area?
- How do the current conditions of riparian areas compare to conditions potentially present or typically present for the ecoregion?
- How can riparian areas be grouped within the watershed assessment area to increase our understanding of what areas need restoration or conservation measures?

- What are the riparian area conservation measures?
- Where are the wetlands in the assessment area?
- What are the general characteristics of wetlands in the watershed assessment area?
- What are the opportunities to restore wetlands?

Riparian Assessment Methods

Riparian area conditions were assessed using the remote sensing methods outlined in the Oregon Watershed Assessment Manual (WPN 1999), supplemented by available relevant datasets, field surveys, previously produced reports, and communication with land managers. The riparian assessment is based almost exclusively on evaluation of digital aerial imagery and digital mapping tools and has not been field-verified. Additional field-verification will be necessary for site-specific project planning.

In order to focus the riparian assessment on the stream segments that are important for fish habitat, a subset of the watershed assessment area streams are included in the riparian area assessment. The riparian assessment focuses on streams mapped by ODFW as fish summer steelhead habitat, for a total of 44.9 miles of stream network and associated riparian areas.

Riparian areas were visually analyzed and measured using recent high-resolution digital aerial imagery sourced from Google Earth. Riparian areas are broken out into Riparian Condition Units (RCUs) and each stream bank was assessed separately. RCUs are a portion, or reach, of the riparian area for which riparian vegetation type, size, and density are similar. For each RCU, riparian vegetation type, cover, and shade over the stream channel were estimated.

Vegetation characteristics, Daubenmire cover classes (Daubenmire 1959), stream shading, presence of permanent discontinuities, and land use types were attributed to the assessment areas. Evidence of scour, sedimentation and deposition in the channel, and juniper encroachment were also recorded by reach. Permanent discontinuities, such as roads within the riparian area that span more than 30% of the riparian area and stream crossings, are noted.

The vegetation analysis of the riparian assessment compares current riparian vegetation to potential riparian vegetation as defined by the channel habitat type of a given stream reach and the Level IV ecoregion it is located in. Vegetation conditions were evaluated against the Potential Streamside Vegetation table (Table 7-1) for the Deschutes/John Day Canyon Ecoregion, described in the OWEB Watershed Assessment Manual Ecoregion Descriptions Appendix (WPN 1999). *Potential vegetation* refers to the historic vegetation present prior to European settlement. It is a general description of riparian vegetation likely to be found within the individual ecoregions and is meant to represent climax communities of native vegetation that have not been subjected to major disturbance for 120 years. Additional information on historic plant communities was found in the historic GLO survey notes from the public land surveys undertaken in the assessment area in the later 1800s. Plant species observed to be present along creeks are mentioned in the survey notes for some sections, but are not consistently noted. Riparian vegetation was not the primary concern of the surveyors, who were mainly interested in the potential of the land for crops and grazing.

Potential riparian vegetation descriptions include vegetation lists and riparian widths that vary by valley type (constraint) and riparian area for a given ecoregion. The riparian area is broken into zones based on distance from the stream channel. Channel constraint categories are determined for each reach (See Chapter 4, Channel Habitat Types and Modification).

Table 7-1. Potential Riparian Vegetation

Channel Constraint Group	Riparian Zone	Riparian Area Description
Constrained	0–25 ft.	**Type:** Hardwoods (white alder, willow) and shrubs such as willow and red-osier dogwood. Infrequent ponderosa pine. **Size:** Medium **Density:** Sparse
Semi-constrained	0–50 ft.	**Type:** Hardwoods (cottonwood galleries, white alder, willow) and shrubs such as willow and red-osier dogwood. Infrequent ponderosa pine. **Size:** Medium **Density:** Sparse
Unconstrained	0–75 ft.	**Type:** Hardwoods (cottonwood galleries, white alder, willow) and shrubs such as willow and red-osier dogwood. Infrequent ponderosa pine. **Size:** Medium **Density:** Sparse

Source: Table adapted from OWEB Watershed Assessment Manual, Appendix A (OWEB 1999)

Riparian Area Assessment

Table 7-2 shows the watersheds, streams, and channel length included in the riparian assessment. No streams in the Canyon Tributaries watershed were included because there is no mapped steelhead habitat.

Table 7-2. Streams Included in the Riparian Condition Assessment

Watershed	Subwatershed	Stream Name	Channel Length (miles)
Pine Hollow	Big Pine Hollow	Big Pine Hollow	7.97
		West Little Pine Hollow	0.13
		Brush Canyon	1.23
	Pine Hollow	Pine Hollow Creek	15.23
	Long Hollow	Long Hollow Creek	9.35
	Eakin Canyon	Hannafin Canyon	1.72
		Eakin Canyon	1.46
Jackknife Creek		Jackknife Creek	7.81
Watershed Assessment Area Total			44.9

The stream reaches included in the riparian assessment are all located in the Deschutes–John Day Canyon ecoregion. As discussed in detail in Chapter 4, stream channel habitat types included in the riparian assessment area are low gradient, small floodplain (FP3), low gradient, moderately confined (LM), low gradient, confined (LC), moderate gradient, moderate confinement (MM), moderate gradient, confined (MC), and moderately steep, narrow valley (MV).

Current Riparian Conditions

RCUs were rated from "excellent" to "very poor" riparian condition based on a comparison to potential ecoregion conditions. Table 7-3 displays the criteria used to rate each RCU. The rating framework assumes that a rating of "good" is representative of adequate potential conditions for the ecoregion. Good riparian condition is defined as narrow floodplain terraces vegetated by open mature deciduous woodlands with a well-developed shrub layer and moderate stream shading. Large-wood recruitment potential in the watershed assessment area is considered low overall because the Deschutes–John Day Canyons ecoregion does not support wide riparian areas (greater than 70 feet from the stream channel) or large numbers of conifer trees (WPN 1999). It is also assumed that RCUs rated as "good" will be typically free of stream channel sedimentation, scour, or stream-adjacent roads or stream crossings and have limited encroachment by juniper, as extensive juniper stands can affect local hydrology (CSR 2011).

Table 7-3. Riparian Condition Unit (RCU) Rating Criteria

Rating	Tree Cover (% of entire riparian area)	Total Vegetation Cover (% of entire riparian area)	Shade Class (% cover over stream)	Permanent Discontinuities	Sedimentation/ Scour
Excellent	>30	>50	>70	No	No
Good	20-30	>50	40-70	No	No/Minimal
Poor	10-20	<50	<40	Yes	Yes
Very Poor	<10	<50	<40	Yes	Excessive

Because the riparian areas on both banks have similar conditions, the RCUs of the opposing stream banks were combined into one RCU and labeled below as "stream miles." A summary of the riparian assessment data is presented in Figure 7-1. Table 7-4 provides an overview of riparian conditions for the streams that were assessed.

Figure 7-1. Summary of Riparian Area Conditions

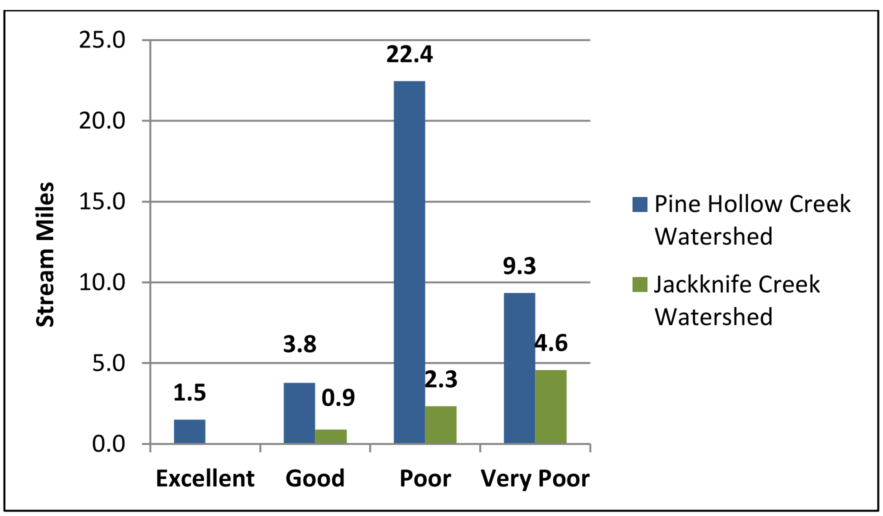


Table 7-4. Riparian Conditions for the Assessed Streams

Stream	Rating				Average Tree/Total Vegetation Cover	Average Juniper Cover	Average Shade Class	Percent Stream With Depositional Areas
	Excellent	Good	Poor	Very Poor				
Big Pine Hollow	26%	8%	61%	5%	26%/65%	4%	Low	25%
West Little Pine Hollow	100%	-	-	-	70%/90%	None	High	-
Brush Canyon	-	84%	16%	-	13%/54%	3%	Moderate	-
Pine Hollow	-	7%	93%	-	17%/44%	2%	Low	89%
Long Hollow Creek	-	-	100%	-	1%/61%	30%	Low	-
Hannafin Canyon	-	-	75%	25%	7%/28%	1%	Low	-
Eakin Canyon	-	-	-	100%	0%/25%	5%	Low	100%
Jackknife Creek	12%	-	43%	45%	17%/37%	<1%	Low	70%

Note: Percentages correlate with the percent of the total reach length of the streams included in the assessment only, not the entire length of mapped streams. Cover and depositional length values are averages of the entire assessed reach for the stream.

Most of the stream reaches included in the riparian assessment fell into the “poor” or “very poor” categories (Map 20). Approximately half of all assessed streams falling within the “poor” category are in Pine Hollow Creek watershed. Both the Pine Hollow Creek and Jackknife Creek watershed have streams and riparian areas that are not functioning at their potential. Stream and riparian conditions are impaired by limited vegetation cover, deposition and widening of the channel, juniper encroachment, and roads and other land use practices.

Approximately 3% of the riparian assessment reaches are rated “excellent.” The “excellent” rated reaches are all short, discrete stream segments located in Big Pine Hollow. These reaches have riparian vegetation cover provided by mature hardwood trees that entirely, or nearly entirely, conceal the stream channel and banks, indicating high levels of stream shading and riparian vegetation cover. The highly rated riparian reaches did not display channel areas with sediment or deposition or scour, stream-adjacent roads and stream crossings, or encroachment by juniper.

Approximately 11% of the riparian assessment reaches are rated “good.” These reaches include isolated fragments of Big Pine Hollow, Pine Hollow, Brush Canyon, and Jackknife Creek. Reaches rated as “good” generally have moderate riparian cover of mature hardwoods, along with shrubs and herbaceous species that nearly cover the entire riparian area, and moderate shade levels. Riparian vegetation discontinuities, such as roads, were negligible for these reaches and there is minimal presence of juniper in or adjacent to the riparian area.

Roughly 55% of the total riparian assessment reaches are rated “poor.” These reaches include long stretches of Big Pine Hollow, Pine Hollow, Hannafin Canyon, and Jackknife Creeks, and the entirety of the assessed portion of Long Hollow Creek. These riparian areas feature limited cover of mature hardwoods and other vegetation, leaving much of the riparian area bare and providing little stream shading. Almost all of the “poor” rated riparian areas are in lower gradient depositional stream reaches where there is evidence of sediment deposition and scour. These riparian areas have extensive juniper encroachment as well as dense upland juniper cover.

Approximately 31% of riparian assessment areas are rated “very poor.” These areas are located in lower Pine Hollow, Jackknife Creek, and Eakin Canyon Creeks, and the upper reaches of Hannafin Canyon and Jackknife Creeks. These areas feature very low to no mature hardwood cover and limited overall vegetation cover. These riparian areas are also generally located in lower gradient depositional reaches where the water surface is not visible because most of the stream flow is through the deep deposits of course and fine sediments.

Comparison to Historical Riparian Conditions

Reaches with “excellent” or “good” ratings generally were observed to have a developed riparian cover. Based on potential conditions for the ecoregion, riparian vegetation consists of hardwood deciduous trees and shrubs such as black cottonwood (*Populus balsamifera ssp. trichocarpa*), white alder (*Alnus rhombifolia*), willows (*Salix* spp.), and red osier dogwood (*Cornus sericea*), with typically less than a 30% crown closure. The tree species are adapted to disturbance, including deposition of sediment and gravels. Black cottonwood and white alder seedlings can persist with moderate amounts of sediment deposition.

The areas that appear to have changed from the historical conditions, or from potential ecoregion conditions, are those rated “poor” or “very poor.” These riparian areas were noted to have limited cover of mature hardwoods and other vegetation, leaving much of the riparian area bare and providing little stream shading. It is impossible to correlate historic tree cover without historical aerials or a detailed field assessment, but it is likely that these riparian areas have been affected by past grazing practices and invasive plants and animals (weeds, juniper encroachment, or feral pigs.) Almost all of the “poor” rated riparian areas occur in lower gradient depositional stream reaches where there is observed bank scour and channel widening and sedimentation. In a comparison of relatively recent historical aerial imagery (1994) with present-day imagery both juniper encroachment and changes in channel sediment deposition patterns were observed. Several reaches of the assessed riparian areas have no vegetation present and only gravels and bare soils were observed in the riparian area.

Riparian Shade and Cover

Riparian vegetation was also assessed for stream channel shading and total vegetation cover. The stream shade evaluation focuses on shade directly over the stream as determined by visibility of the channel surface and then classified by the following percent cover categories:

- >70% High: Stream surface not visible, slightly visible, or visible in patches.
- 40–70% Moderate: Stream surface visible, but banks not visible.
- < 40% Low: Stream surface visible, banks visible or partially visible.

Table 7-4 shows the shade ratings as "average shade class." All of the assessed reaches were averaged together to give one shade rating for the entire stream. The shade ratings for the individual reaches are shown on the map (Map 21). Shade levels were evaluated based on shade characteristics typical of eastern Oregon and small streams within the ecoregion.

The majority of streams in Pine Hollow Creek and Jackknife Creek watersheds have low shade levels of less than 40% (Figures 7-2 and 7-3). Many of the reaches with limited shade have been widened over time from flood scour and sediment deposition, which has reduced vegetation cover over the channel and effective shade levels.

Figure 7-2. Stream Shading in Pine Hollow Watershed

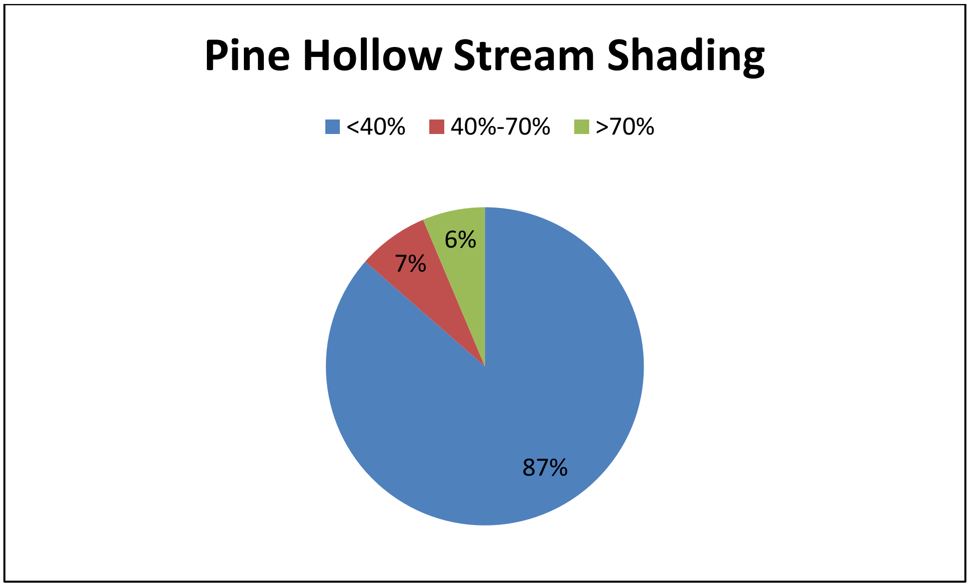
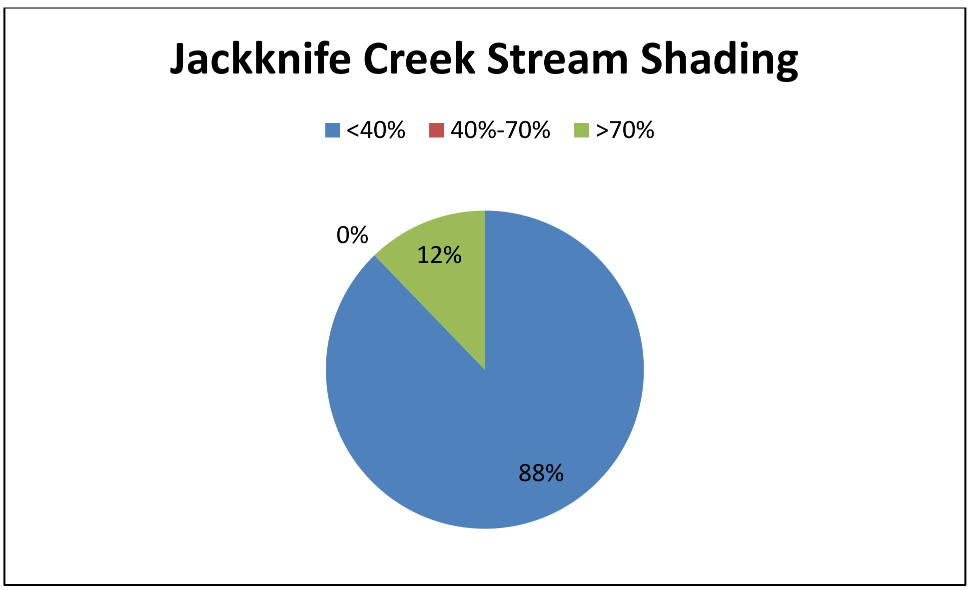


Figure 7-3. Stream Shading in Jackknife Creek Watershed



Riparian Area Conservation Measures

Conservation measures are summarized for the watershed assessment area in Chapter 5.
Two key conservation practices that provide riparian benefits are off-stream watering facilities and riparian fencing. Off-stream spring and other water developments provide an alternative water source for livestock and wildlife. These watering systems draw livestock and wildlife from the streams and associated riparian areas into uplands, reducing impacts to the vegetation, soils, and water quality, and improving quality of water available for use. Excess water is returned to the watershed through an overflow system. While no quantifiable effects have been measured, the Sherman County SWCD reports that periodic spot checks indicate that impacts to streams from livestock presence in riparian areas is much reduced (Brian Stradley, Sherman County SWCD, pers. comm., 2012).

CREP projects provide riparian fencing and vegetation control and planting. These projects target riparian areas for invasive control prior to planting. Current totals for invasive control include 644 acres in the Jackknife Creek watershed and 233 acres in the Canyon Tributaries watershed. CREP planting emphasizes a variety of overstory and understory species (Brian Stradley, Sherman County SWCD, pers. comm. 2012). Planted species include willow, cottonwood, red osier dogwood, blue elderberry (*Sambucus nigra* ssp. *cerulea*), Woods' rose (*Rosa woodsii*), current (*Ribes* spp.), snowberry, serviceberry (*Amelanchier alnifolia*), and mock orange (*Philadelphus lewisii*).

Wetland Assessment

The Clean Water Act defines wetlands as, "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support … a prevalence of vegetation typically adapted for life in saturated soil conditions" (EPA 1988). Wetlands include marshes, swamps, bogs, wet meadows, or similar areas that are in riparian zones or surrounded by dry lands. Wetlands are generally areas where water (hydrology) is at the surface, or within a foot of the surface, long enough to establish conditions of wetland (hydric) soils and create conditions for adapted plants (hydrophtes). Wetlands vary widely due to local differences in soils, topography, climate, hydrology, water chemistry, vegetation, and other factors, including human disturbance. Wetlands are also among the most productive ecosystems in the world, comparable to rain forests and coral reefs, and are a substantial source of biodiversity relative to the extent on the surrounding landscape (EPA 2001).

Wetland Assessment Methods

Relatively few sources of wetlands data exist for the watershed assessment area. The Oregon Wetlands Geodatabase (Oregon Natural Heritage Information Center and The Wetlands

Conservancy) dataset provides the most comprehensive data for the location and type of wetlands for the area. This database is a compilation of polygon data from numerous sources. This information set uses as a base all available digital data from the U.S. Fish and Wildlife Service National Wetland Inventory (NWI), mapping from the Department of State Lands Local Wetland Inventories, wetlands along Oregon Department of Transportation state highways, and mapping of individual sites by a variety of federal, state, academic, and nonprofit sources.

Although aerial imagery was consulted for the occasional verification of features, no aerial photo interpretation was performed for this assessment. This assessment also used a BLM hydrography dataset for Oregon and Washington. This dataset contains point features from the USGS High Resolution National Hydrography Dataset that includes features such as springs, seeps, wells, etc. with additional attributes added from the BLM Aquatic Resources Information Management System.

The Oregon Watershed Assessment Manual suggests removing all riverine-type wetlands from the assessment, only assessing wetlands that are greater than 200 feet from the channel to avoid having to examine the very complex wetland mapping that can occur near stream channels. For this analysis, wetlands within 200 feet of channels were left in, but the polygons mapped as riverine Cowardin type were removed. Per NWI convention, linear features such as rivers and streams in the Oregon Wetlands dataset are represented as polygons of 5 meter fixed width. Because most of these linear features are usually less than 5 meters in width, summaries of areas with these types are likely to greatly overestimate the actual area. For this reason, and to adhere to the methods outlined in the Oregon Watershed Assessment Manual, mapped riverine features have been removed from data analysis and quantification. The riverine system includes all wetlands and deepwater habitats contained in natural or artificial channels with periodically or continuously flowing water or which form a connecting link between two bodies of standing water. The Oregon Wetlands (per NWI convention) frequently lumps scrub-shrub or forested wetlands that occur along rivers into the riverine classification.

Given the small size of most of the wetlands and the scale of the watershed assessment area, wetlands are scattered small areas, rather than polygon shapes, and usually associated with streams or springs. Because of the small size of the wetlands, it was not feasible to accurately map the wetland areas and types. The following results provide an overview of wetlands employing the Cowardin Classification Code (Table 7-5).

Table 7-5. Cowardin Classification for Wetlands within the Assessment Area

System-Subsystem	Class	Water Regime or Special Modifiers
P (Palustrine)	**UB** = Unconsolidated Bottom **AB** = Aquatic Bed **US** = Unconsolidated Shore **EM** = Emergent **SS** = Scrub-Shrub **FO** = Forested	Water regime modifiers: **A**=Temporarily Flooded **B**=Saturated **C**=Seasonally Flooded **F**=Semi-permanently Flooded **H**=Permanently Flooded Special modifiers: **h**=Diked/Impounded

Wetland information not collected as part of this assessment included surface water connections between wetlands and streams, buffer condition, and wetland position in the watershed. Due to limitations in the scope of this project, the locations of wetlands were not field verified, nor were additional wetlands located and added to the existing wetlands data. Evaluation of historical watershed processes could offer an indication of potential for wetlands in the Pine Hollow, Jackknife Creek, and Canyon Tributaries.

Wetland Conditions

After removal of riverine wetland type, a total of approximately 207 acres of Palustrine wetlands were identified within the wetland assessment area. Wetlands in the assessment area are concentrated around streams, seeps, and springs. Most of these wetlands are stream-associated and seasonal in nature, unless they are located along perennial streams or springs. The Palustrine System wetland classification includes all nontidal wetlands dominated by trees, shrubs, emergents, or mosses. This classification is further described by adding terms that describe the vegetation, substrate, and water regime.

Wetlands in the assessment area are comprised of mostly seasonal or temporarily flooded, emergent, and scrub-shrub wetlands, with much fewer forested wetlands. Due to the nature of these assessment methods, many of the scrub-shrub or forested wetlands that are present (and visible in the aerial photos) along the streams and rivers are mapped as riverine, and thus are not included in the total wetland area. A field survey of the watershed assessment area is needed to accurately identify wetland areas.

Wetland Locations

Wetlands are found throughout the watershed assessment area, with the majority found in Pine Hollow, primarily because this is the largest watershed and not because of the characteristics of the watershed. Comparison of the location of the BLM-mapped springs with wetland locations shows that springs are an important source for hydrology for the wetlands in the assessment area. A small amount of wetlands were mapped as "diked, or impounded;" these wetlands have been created or modified by a human barrier or dam which obstructs the inflow or outflow of water. This modified wetland type comprises a small portion (~7%) of the watershed assessment area. A field effort would be needed to confirm the presence of wetlands depicted in the Oregon Wetlands data, but most of the mapped wetlands do occur in the correct topography or landscape position.

The majority of the wetlands within the assessment area fall in the Palustrine emergent category (Table 7-6). Palustrine emergent wetlands are wetlands dominated by rooted herbaceous plants, such as cattails and mixed grasses. Palustrine emergent wetlands make up the largest proportion of wetland area within each of the watersheds, occupying 47% of the total wetland area for the combined watershed assessment area.

Table 7-6. Wetlands in the Assessment Area

Cowardin	Acreage	%
Palustrine Emergent	97.9	47%
Palustrine Unconsolidated Shore (beaches, bars, flats)	49.8	24%
Palustrine Scrub-shrub	33.5	16%
Palustrine Aquatic Bed	6.9	3%
Palustrine Forested	2.6	1%
Palustrine Unconsolidated Bottom	16.5	8%
Total	**207.3**	**100%**

Palustrine unconsolidated shore wetlands cover approximately 24% of the watershed assessment area. Palustrine unconsolidated shore wetlands are those wetlands that have less than 75% rocky cover and less than 30% cover of vegetation.

Palustrine scrub-shrub wetlands are defined as wetlands that are dominated by shrubs and saplings less than 20 feet tall. Overall palustrine scrub-shrub wetlands make up 16% of the total wetland area in the watershed.

Palustrine unconsolidated bottom wetlands are those wetlands whose substrate is primarily mud or exposed soils, and have less than 30% vegetative cover. Palustrine unconsolidated bottom wetlands make up 8% of the total wetland area within the watershed assessment area.

Palustrine forested wetlands, which are defined as wetlands dominated by trees taller than 20 feet, occupy the smallest amount of area and make up about 3% of the total wetland area in the watershed assessment area. This total area is likely underestimated after the removal of the riverine cover class.

Palustrine aquatic bed wetlands are those that are dominated by plants that grow principally on or below the surface of the water for most of the growing season in most years. Palustrine aquatic bed wetlands make up about 7% of the total wetland area within the watershed assessment area.

Opportunities to Restore Wetlands

Without field surveys to confirm the accuracy of the mapping and to determine the level of function for the wetlands, only a cursory statement can be made on priority areas to target for restoration. Generally, wetland function in the assessment area can be improved through restoration by reducing invasive species, limiting livestock and wildlife impacts from grazing or watering, removal of impoundment structures, planting of native species, and placement of habitat features. Some of these conservation practices are being pursued by landowners and Sherman County SWCD.

Many of the conservation practices identified for riparian areas can be applied to wetland restoration efforts. Additional wetland restoration opportunities can be identified by comparing the wetland areas with the riparian condition evaluation. Areas of wetlands along riparian areas rated as “poor” or “very poor” will have limited wetland vegetation diversity and extent.

Chapter 8. Water Quality

Introduction

This chapter examines water quality concerns within the Pine Hollow – Jackknife Creek watershed assessment area. The assessment focuses on information provided by Oregon Department of Environmental Quality (DEQ). The DEQ has set standards for water quality to help protect the beneficial uses of Oregon's waters, as required by the federal Clean Water Act of 1972. Areas of water quality concern examined by DEQ include temperature, dissolved oxygen, pH, nutrients, bacteria, pesticides, and turbidity. This chapter will assess water temperatures in the watershed assessment area because this is the only water quality parameter of concern listed by Oregon DEQ that affects the area. Fish and other aquatic life are the beneficial uses of waters that are most sensitive to water temperature. Water temperature can have a large impact on fish populations. Another reason to focus on water temperature is because information on water temperature patterns in the watershed assessment area. While the other water quality issues of concern can also affect fish (particularly dissolved oxygen), there is very little available data available on the other parameters.

Stream flow and habitat modification are two other water quality issues that are evaluated by DEQ. This chapter also describes the status of these parameters in the watershed assessment area.

This chapter addresses the following questions:

- What are the beneficial uses of streams within the watershed assessment area?
- What are the water temperature criteria and standards that apply to the stream reaches in the assessment area?
- Are there streams identified in the watershed assessment area as water temperature-limited segments on the 303(d) list by the state?
- What are the watershed-specific factors that contribute to water temperature increases?
- What is the status of the flow and habitat modification 303(d) listings for streams within the watershed assessment area?
- Have conservation practices contributed to improvements in water quality?

Water Quality Assessment Methods

Oregon Administrative Rules (OAR 340-041-0170) designate beneficial uses for streams and other aquatic resources. Information on fish use and the applicable water temperature and stream flow criteria were obtained from DEQ (DEQ 2012). This information was supplemented by water temperature data collected by Sherman County SWCD and other agencies.

Water Quality Beneficial Uses

Of major concern for water quality throughout the state are the impacts to the beneficial uses of water in streams and rivers. The designated beneficial uses for aquatic resources in the John Day River and its tributaries include domestic water supplies, irrigation, livestock watering, fish and aquatic life, and other uses. The beneficial use for fish in the watershed assessment area focuses on three salmonid life stages: migration, spawning, and rearing. Resident redband trout and migratory summer steelhead are the salmonid species present within the watershed assessment area; spawning and rearing are the most sensitive life stages to high water temperatures.

Oregon Water Temperature Standard

Pine Hollow and Jackknife Creek are classified by DEQ as important for trout and steelhead migration, spawning, and rearing. Water temperature criteria and standards have been established to ensure survival of steelhead and trout through these life stages. The water temperature criteria account for accumulated temperature stress on adult and juvenile fish by evaluating data based on the seven-day-average maximum daily temperature. For example, sustained daily high temperatures over the course of multiple days will place more stress on fish than one day of high temperature followed by several days with lower temperatures; the seven-day-average of maximum daily water temperatures accounts for this variability. The water temperature criteria cited here are based on the average of the daily maximum stream temperatures for the seven warmest consecutive days during a year.

During the trout and steelhead spawning period of January 1–May 15, the water temperature should not exceed the DEQ standard of 55.4°F. During summer and early fall rearing and migration periods, the water temperature should not exceed the standard of 64.4°F. Because water temperatures often exceed the water temperature standard during the warm periods of summer and early fall, the sensitive life stages of trout and steelhead spawning and rearing are impacted by increased water temperatures.

Water temperature affects trout and steelhead in direct and indirect ways (DEQ 1996). The most direct effect is when temperatures are so warm they are lethal. The DEQ standard is based not on lethal temperatures (usually above 70°F), but on the range of sub-lethal effects. Sub-lethal effects lead to death indirectly, or they may reduce the ability of the fish to successfully reproduce and for their offspring to survive and grow. Sub-lethal effects include an increase in the incidence of disease, an inability to spawn, a reduced survival rate of eggs, a reduced growth and survival rate of juveniles, increased competition for limited habitat and food, and reduced ability to compete with other species, particularly warm water introduced species, such as bass (DEQ 1996).

Water Temperature Limited Streams in the Watershed Assessment Area

Streams that are found to exceed the water temperature standard are placed on DEQ's 303(d) list. ("303(d)" refers to the relevant section of the federal Clean Water Act.) Numerous streams in the John Day Basin are listed as water quality limited for temperature (Columbia-Blue Mountain Resource Conservation & Development Area 2005). Nearly 30 miles of stream channel within the watershed assessment area are listed on DEQ's 303(d) list because they have been found to exceed the water temperature standard for rearing and migration (Map 22). The water temperature-limited stream segments are within lower Pine Hollow (14.9 miles) and lower Jackknife Creek (14.4 miles).

Beginning in 1995, Sherman County Watershed Council, in cooperation with the Sherman County SWCD, has collected water temperature data within Big Pine Hollow and one of its major tributaries, Long Hollow. The water temperature dataset (1995–2006) was evaluated for maximum daily temperatures during the trout and steelhead rearing period (Sherman County 2012). Water temperatures at both sites exceeded the DEQ's standard of 64.4°F from approximately mid-July through mid-September.

Factors Contributing to Elevated Water Temperatures

The goals of the temperature standard are to prevent or minimize surface water temperature warming caused by human activity and to maintain the "normal" temperature regime through the year (DEQ 1996). Human and natural factors can influence stream temperatures. Climate, stream flow, channel morphology, and riparian vegetation can all contribute to variations in stream temperature. Stream flow, channel morphology, and riparian habitat can all be influenced by roads, livestock grazing, and upstream land use activities.

Water temperatures in the watershed assessment area have been affected by a combination of land management practices and natural events. As outlined in previous sections of the watershed assessment, the 1964 Christmas flood contributed sediment, gravel, cobbles, and other materials to stream channels. Sediment contributions to stream channels from the 1964 flood were magnified by the intense snowmelt and rain, generating soil erosion from the croplands in the upland portions of the watershed assessment area. These natural and human factors, compounded by subsequent flood events, scoured stream banks and widened channels in the low gradient reaches where there are excessive deposits of sediment and other materials. The widened channels, combined with reductions in riparian vegetation cover from historical livestock grazing practices, roads, and stream crossings have all contributed to more sun exposure on the stream channels, which in turn has led to increased water temperatures. The stream segments in Pine Hollow and Jackknife Creek that are listed as water temperature-limited (Map 22) all exhibit sediment deposition and widening (Map 15) and reduced riparian shade (Map 21). In addition, the upstream portions of Pine Hollow and Jackknife Creek that are not listed as water temperature–limited are also characterized by channel widening and limited riparian shade over the channel, all of which are probably contributing to increased water temperatures in these stream areas and in their downstream reaches.

Flow and Habitat Modifications and Conservation Practices to Improve Water Quality

DEQ also has water quality standards for stream flow and habitat. In the past, streams within the watershed assessment area have been added to the 303(d) list for modifications in natural stream flow and habitat. In 2002, private landowners, in cooperation with the Sherman County Watershed Council and Sherman County SWCD, were successful in persuading DEQ to remove Pine Hollow and Jackknife Creek from the 303(d) list for flow and habitat modifications.

It has been the ongoing goal of the Sherman County SWCD and the Sherman County Watershed Council to continue the restoration of upland hydrology and stream habitat through conservation practices such as water and sediment control basins, spring developments, and riparian restoration and protection through programs such as CREP. In addition, it is anticipated that, with continued conservation practices, Pine Hollow and Jackknife Creek will also eventually be removed from DEQ's 303(d) list for temperature.

Chapter 9. Fish Populations and Aquatic Habitat

Introduction

This chapter examines fish populations and habitat within the Pine Hollow – Jackknife Creek watershed assessment area. The variety of fish species present in the watershed is covered, with an emphasis on migratory steelhead and redband trout populations. This chapter will evaluate how changes in riparian and stream habitat and water temperature have affected these fish populations.

This chapter addresses the following questions:

- What are the fish species present in the watershed?
- What are the life history characteristics of steelhead and redband trout?
- What is the status of steelhead and redband trout in the John Day Basin and tributaries to the lower John Day?
- What is the distribution and population status of steelhead and redband trout in the watershed assessment area?
- What is the quality of fish habitat in the watershed assessment area?
- What are the conditions that are limiting steelhead and redband trout populations?

Fish Population and Habitat Assessment Methods

Information provided by Sherman County SWCD, ODFW, and BLM is used to summarize fish populations and stream habitat. Data and maps of channel habitat types, riparian shade, and other attributes described in previous chapters of the watershed assessment provide the context for evaluating the factors that are limiting fish populations within the watershed assessment area.

Fish Populations Present in the Watershed Assessment Area

There is limited information on fish species present in the Pine Hollow – Jackknife Creek watershed assessment area. Summer steelhead and redband trout, which are considered to be the anadromous and resident forms of the same species (*Oncorhynchus mykiss*), are present in Pine Hollow and Jackknife Creek (ODFW 2010). Other than migratory strategies, the two forms of trout are indistinguishable. Adult steelhead move out of the ocean, up the Columbia and John Day River to Pine Hollow and Jackknife Creek where they spawn. Juvenile steelhead reside in the streams for a period of time before moving downstream to the ocean and repeating the cycle. The resident form, redband trout, resides in the watershed throughout its life, often not moving more than a few hundred feet from the spawning area where it was born. Steelhead and redband trout populations, life history characteristics, and habitat needs are covered in more detail below.

Other native and introduced fish species found in John Day Basin streams are probably present in Pine Hollow, Jackknife Creek, and other streams, but very little is known about their status in the watershed assessment area. Native fish species that reside in the John Day Basin and possibly in the watershed assessment area's streams include the following (Columbia-Blue Mountain Resource Conservation & Development Area 2005):

- dace – speckled (*Rhinichthys osculus)* and longnose (*Rhinichthys cataractae*);
- redside shiner (*Richardsonius balteatus*);
- sculpins – mottled (*Cottus bairdi*) and torrent (*Cottus rhotheus*);
- suckers – large scale (*Catostomus macrocheilus*) and bridgelip (*Catostomus columbianus*);
- northern pike minnow (*Ptychocheilus oregonensis*); and
- Pacific lamprey (*Lampetra tridentata*).

Though not documented, these species may reside in the watershed assessment area. Dace, for example, have been observed in nearby Grass Valley Creek (Sherman SWCD 2006). Some fish species, including suckers and northern pike minnow, inhabit the lower John Day River and may access lower Pine Hollow and Jackknife Creek during portions of the year.

Introduced fish species reside in the lower John Day River and may access lower Pine Hollow and Jackknife Creek during high flow periods. Of the introduced species, smallmouth bass and channel catfish in particular provide a very popular fishery in areas once occupied by salmon and trout. There is concern that these introduced species have contributed to declines in John Day salmon and trout populations, but ODFW stomach content data suggest that predation by smallmouth bass is not significant (Columbia-Blue Mountain Resource Conservation & Development Area 2005).

Steelhead and Redband Trout Life Histories

All Columbia River steelhead upstream of The Dalles Dam, including Pine Hollow and Jackknife Creek populations, are summer-run fish that enter the river from June to August. Most juvenile steelhead smolt at two years, move down the river to the ocean, and spend one to two years in salt water before reentering freshwater, where they may remain for up to a year before spawning (ODFW 2010). Adult steelhead ascend main stem rivers and their tributaries throughout the winter, spawning in the late winter and early spring. The spawning nests, called redds, are usually placed in well oxygenated gravel areas that are free of excessive silt (ODFW 2010). Fry emerge from the gravels between May and the end of June.

Where redband trout and steelhead distributions overlap, they are externally indistinguishable from each other and have the same habitat requirements (Columbia-Blue Mountain Resource Conservation & Development Area 2005). Redband trout are three years old at maturity, with size varying depending on the productivity of individual waters. Few redband trout observed in eastern Oregon exceed ten inches in length (ODFW 2010).

It appears that redband trout have adapted to the harsh conditions present in most eastern Oregon streams, including Pine Hollow and Jackknife Creek. Redband trout inhabit streams in arid regions characterized by extreme variation in seasonal water flow, temperature, and dissolved oxygen levels (Behnke 1992). Redband trout possess genetic traits that allow the fish to persist at higher water temperatures than other species of trout (Behnke 1992). Sonski (1985) noted that redband trout raised in a hatchery continued to grow until the temperature reached 75°F.

Status of Steelhead in the John Day Basin and Watershed Assessment Area

Steelhead populations that spawn and rear in the Pine Hollow and Jackknife Creek watersheds are part of the wider John Day Basin population. A combination of no dams in the system that can block fish access to historical spawning grounds, high habitat quality in the North Fork John Day and other upper basin tributaries, and very little hatchery supplementation has resulted in relatively strong steelhead populations in the John Day system (ODFW 2010). The John Day River is managed exclusively for wild fish production and may be the only large Columbia River tributary that has no hatchery stocking program for anadromous fish.

Despite the strength of the John Day Basin steelhead population, the broader upper Columbia River population declined to the point that it is listed as threatened under the federal ESA. In 1999, the National Marine Fisheries Service (NMFS) listed Oregon's Middle Columbia steelhead populations as threatened under the ESA as part of the Middle Columbia River steelhead Evolutionarily Significant Unit (ODFW 2010). The original listing included both resident and anadromous populations, but this was revised in 2006 to delineate the anadromous, steelhead-only "distinct population segments" (DPS). NMFS listed the Middle Columbia River steelhead DPS as threatened in 2006 (ODFW 2010). The DPS consists of all historical steelhead populations in Oregon and Washington tributaries of the Columbia River upstream of the Hood River.

The John Day Basin major population group contains five populations of summer steelhead: Lower John Day, North Fork John Day, Middle Fork John Day, South Fork John Day, and Upper John Day (ODFW 2010). The Lower John Day summer steelhead population includes tributaries to the John Day River downstream of the South Fork John Day River, including Pine Hollow and Jackknife Creeks. This widespread population is the most differentiated ecologically from other John Day populations, occupying the lower, drier Columbia Plateau ecoregion. Habitat divergence and distance to other populations are the primary factors in delineating this as a separate population (ODFW 2010).

It is notable that Pine Hollow Creek is considered one of the major steelhead spawning streams for the Lower John Day River population. Other major spawning areas in the Lower John Day include Bridge, Mountain, Cottonwood, Hay, Middle Rock, Upper Rock, Long Rock, Thirtymile, Butte, and Grass Valley Creeks (ODFW 2010). Jackknife Creek is cited as having a steelhead population, but it is not listed as a major spawning area (ODFW 2010).

According to an analysis by ODFW and NMFS, the Lower John Day River summer steelhead population is at moderate risk for extinction based on current abundance and productivity. Spawner abundance in recent years has been highly variable; the most recent 10-year geometric mean number of natural-origin spawners was 1,800 (ODFW 2010).

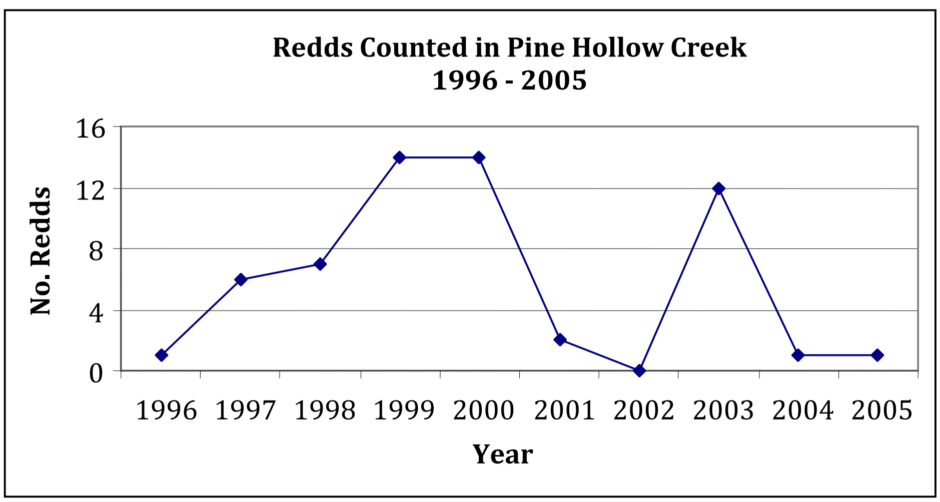
Distribution and Status of Steelhead Trout in the Watershed Assessment Area

Within the watershed assessment area, steelhead are found only in Pine Hollow and Jackknife Creek. The streams within the Canyon Tributaries watershed do not have steelhead because the streams are too short and steep to contain spawning and rearing habitat. There is some information available on the distribution, status and trends of steelhead populations in Pine Hollow and Jackknife Creek. ODFW has delineated potential steelhead spawning and rearing distribution in both systems (Map 23). Pine Hollow Creek has the greatest amount of habitat available to steelhead (36.9 miles), distributed within the main stem of Pine Hollow and several tributaries, including Eakin Canyon, Long Hollow, and Big Pine Hollow. Jackknife Creek has much less suitable steelhead habitat (7.7 miles), all concentrated within the lower portion of the main stem.

Several human-made fish passage barriers have also been identified by ODFW (Map 23). All of these barriers are in the upper portion of Big Pine Hollow. The status of these barriers has not been recently assessed, but one of them is a complete barrier to both adult and juvenile steelhead at an impoundment in the upper watershed. None of these barriers are of concern because they are at the upper end of steelhead distribution and block access to a very small amount of habitat.

ODFW, in cooperation with Sherman County SWCD and private landowners, has conducted inventories of redds, or spawning ground areas, in Pine Hollow since 1996 (Sherman County SWCD 2006). Initial inventories focused on three miles of the stream; after 1998 the inventory included four miles of spawning habitat. The redd count period described here is from 1996 to 2005, which provides a good evaluation of the variability in redd counts (Figure 9-1). Redd counts during this ten year period varied from no observations (zero redds) in 2002 to a high of fourteen redds in both 1999 and 2000. In five years, half the inventory period, only one or no redds were observed: 1996, 2001, 2002, 2004, and 2005. This extreme variability in redd counts is likely due to extremely low flow years that increase juvenile mortality due to higher water temperatures and loss of habitat where the channel goes dry. There were major drought years between 2001–2002 and 2004–2005 (Sherman County SWCD 2006).

Figure 9-1. Pine Hollow Redd Counts, 1996 to 2005



Source: Sherman County SWCD 2006

Fish Habitat Quality

There is limited information on the quality of steelhead habitat in Pine Hollow and Jackknife Creek. In April 1996, BLM, Sherman County SWCD, ODFW, and private landowners collaborated on a habitat survey of Pine Hollow Creek. This survey found that the main channel of Pine

Hollow consisted of 80% dry channel, with the most degraded and dry channel occurring in the lower five miles (Sherman County SWCD 2012). Reaches where surface waters flow subsurface affects both lower Pine Hollow and Jackknife Creeks where most of the largest material from the 1964 flood was deposited. The channel areas where eroded materials have been deposited degrade fish habitat in two ways. First, the sediments and other materials fill pools and other habitats, reducing the quality and quantity of fish habitat. Secondly, sections of stream channel that are dry from subsurface flow create impediments to fish movement. This is an issue during all times of the year, but particularly during warm periods when adult and juvenile fish will travel through the stream network seeking cooler water temperatures that can be found in deep pools or tributaries.

A proper functioning condition assessment of Jackknife Creek, completed in 2000, showed very similar results, with stream reaches being in either extremely degraded or nearly pristine conditions, depending on streambed gradient and strength of flood flows from upland sources (Sherman County SWCD 2012).

Both stream habitat assessments noted poor stream and riparian habitat conditions (Sherman County SWCD 2012). They observed that flooding over the past 50 years has damaged stream habitat complexity. Pools that once provided summer rearing and refuge during low flows have been washed out or filled with material from the floods. Channels have become wider and shallower, resulting in higher stream temperatures in summer and areas of dry channel. Diminished riparian canopy cover is also contributing to higher stream temperatures. The loss of riparian trees has resulted in low levels of large wood in the channel. Large wood in the channel provides fish habitat complexity by creating pools and cover for fish to hide from predators. These assessments observed that cottonwood trees, which provide the largest wood to the channel, were probably more abundant historically than at present (Sherman County SWCD 2012).

Key Factors Limiting Steelhead and Redband Trout Populations

This section describes habitat-related factors that limit the viability of steelhead populations in Pine Hollow and Jackknife Creek. Past floods and land use practices within the watershed assessment area have contributed significantly to the factors now limiting populations. Some of these land use practices continue today, but many are legacies from the past. For example, new management practices are reducing sediment contributions from the upper watershed. However, sediment from natural causes and past management practices is still working its way through the stream system.

Oregon's "Conservation and Recovery Plan for the Middle Columbia Steelhead Populations" (ODFW 2010) describes a number of habitat factors that are limiting the recovery of steelhead. Some of the John Day Basin limiting factors listed in the plan are evident in the Pine Hollow and Jackknife Creek Watersheds (for example, loss of habitat complexity), while there are others that are not an issue (for example, water diversions). Table 9-1 lists these limiting factors and summarizes their status within the Pine Hollow and Jackknife Creek watersheds based on the findings of this watershed assessment.

Table 9-1. John Day Basin Stream Habitat Factors Limiting the Recovery of Steelhead Populations and Status in Pine Hollow and Jackknife Watersheds

Stream Habitat Limiting Factor	Status of the Factor in the Pine Hollow – Jackknife Creek Watersheds
Habitat Complexity	**Significant Limiting Factor**. Overall habitat complexity is low. Channel widening from floods and sediment deposition has reduced pool frequency, widened the channel, and created subsurface flows. Stream-adjacent roads and crossings have affected stream and riparian habitat.
Sediment/Substrate Conditions	**Significant Limiting Factor**. Excessive sediment and coarse bedload deposition is evident in large sections of channel, particularly in the lower gradient reaches.
Changes in Peak/Base Flows	**Minor Limiting Factor**. There are no significant water diversions that affect low flows. Many of the human caused increases in flood peaks have been addressed. (Note: Future low flows may be affected by the hydrologic impacts of expanded juniper encroachment.)
Water Quality	**Significant Limiting Factor**. Water temperatures are elevated from channel widening and poor riparian cover and exceed DEQ's standard for salmonid spawning and rearing.
Habitat Access	**Significant Limiting Factor**. There appears to be few human-caused fish passage barriers and those that are present block very little habitat. Subsurface flows can prevent fish from moving between habitats and into cooler tributaries during low flow periods.
Riparian/Large Wood Conditions	**Significant Limiting Factor**. Riparian habitat has been affected by past grazing practices and roads. There are limited large riparian trees and wood in the channel to create pools and hiding cover.

Source: Limiting factors are derived from Oregon's "Conservation and Recovery Plan for the Middle Columbia Steelhead Populations" (ODFW 2010). Information for evaluating the significance of the limiting factors is derived from the Pine Hollow – Jackknife Creek watershed assessment.

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Chapter 10. Watershed Evaluation

Introduction

This chapter summarizes the findings of the watershed assessment and identifies key factors affecting watershed health within the Pine Hollow – Jackknife Creek watershed assessment area. The chapter also describes current watershed conservation actions, outlines opportunities for future restoration, and identifies information gaps.

Watershed Assessment Summary

The assessment area is composed of the Pine Hollow, Jackknife Creek, and Canyon Tributaries watersheds and their associated subwatersheds. The combined watersheds encompass a total of 147,421 acres. The Pine Hollow watershed covers the largest land area (83,725 acres; 131 square miles); followed by Jackknife Creek watershed (27,586 acres; 43 square miles); and the Canyon Tributaries Watershed (36,110 acres; 56 square miles). All of the streams within the Pine Hollow – Jackknife Creek watershed assessment area drain into the Lower John Day River, and the river is the eastern border of the assessment area. Elevations range from 3,911 feet to 704 feet at the John Day River.

The watershed assessment area has a continental climate characterized by low winter and high summer temperatures, low average annual precipitation, and dry summers. In most years, snow fall is infrequent, and very little accumulates. As a result, snow pack does not contribute substantially to stream flows. Stream flow diminishes rapidly through the late spring and summer months, with the lowest flows occurring during the period of mid-July to mid-October.

The majority of the watershed assessment area (77%) is privately owned, primarily consisting of rangeland and croplands. The remaining rangelands are administered by the BLM (21%) and the State of Oregon (2%). The croplands, primarily dryfarmed wheat production, occupy the ridge tops and rolling terraces along the western portion of the watershed assessment area and extend down in elevation until the terrain becomes too steep for tillage or soil type or depth is unsuitable. There are approximately 448 miles of roads within the watershed assessment area, with more than 27 miles of road adjacent to streams (within 200 feet of a stream channel) and more than 190 stream crossings, almost all of which are dirt roads.

The channels within the watershed assessment area were classified according to gradient and confinement. These attributes, and the associated channel habitat types, were mapped for all streams channels up to 16% gradient, for a total of approximately 231 miles of classified channels. Most of the channels within the watershed assessment area are highly or moderately confined and steep; there are very few unconfined, low gradient channels, and most of these are within the lower reaches of Pine Hollow and Jackknife Creek. Many of the streams begin as low gradient channels within the terraces and ridge tops before dropping steeply into the canyons. Most of these headwater areas are within the western portion of the watershed assessment area where croplands dominate the landscape.

Flood events have affected the watershed assessment area and associated stream and riparian habitats. The Christmas flood of 1964 had the greatest effect on the area of any of the flood events, causing extensive deposition of eroded materials in the lower portions of Pine Hollow and Jackknife Creeks. Subsequent floods have continued to scour banks and move materials down the stream channels. In the lower reaches of Pine Hollow and Jackknife Creek, where most of the flood materials were deposited, the streams flow subsurface in many areas.

A number of fish species are found within the watershed assessment area's streams, but ESA-listed steelhead, and the resident form, redband trout, are found only in Pine Hollow and Jackknife Creek. The streams within the Canyon Tributaries watershed do not have steelhead because the streams are too short and steep to contain spawning and rearing habitat. Pine Hollow Creek has the largest amount of habitat available to steelhead (36.9 miles) and Jackknife Creek has much less suitable habitat (7.7 miles).

Background: Watershed Health

Natural processes and land management activities affect watershed health. Watershed heath, which is broader than the factors that limit fish populations and water quality, is defined by characterizing disturbance patterns, watershed processes, and terrestrial, riparian and aquatic habitats. Natural disturbance patterns include floods, fire, and grazing and consumption of vegetation by deer, elk and other native animals. Natural watershed processes include:

- water interception, movement through soil and groundwater, and flow through springs and streams;
- soil erosion and sediment and coarse geologic materials (e.g., gravels and cobbles) movement and delivery to stream channels;
- logs, litter, other organic material, and nutrients from riparian and upland areas entering waterways; and
- solar radiation interception by vegetation (e.g., photosynthesis), the surface of the land, and water (i.e., increasing temperature).

Watershed process and disturbance patterns interact with climate, geology, and vegetation communities to create terrestrial and aquatic habitats. A healthy watershed is characterized by processes, disturbance patterns, and associated habitats that are within appropriate ranges and species composition. When watershed processes shift out of optimal ranges from land use management (e.g., too much sediment is delivered to stream channels) and altered disturbance patterns (e.g., changes in the frequency and intensity of fires), then habitats and the plants, animals, and humans that depend on them are affected.

While it is difficult to precisely define a "healthy watershed", the watershed processes, disturbance patterns, and habitats described in the Pine Hollow – Jackknife Creek watershed assessment are all help to describe the health of watershed assessment area.

Conservation Actions

Sherman County SWCD, watershed councils, landowners and other organizations have been working for more than 80 years on restoration and conservation actions to improve the health within the Pine Hollow – Jackknife watershed assessment area. The implementation of actions has been strategic and systematic, beginning with actions along the rolling ridge tops and working down the canyons. Because many of the key watershed issues are generated in the upper portions of the watershed assessment area, the upland areas have traditionally been the focus of restoration and conservation actions. Conservation activities in the upper watershed focus on dryland wheat and other crops. Increasingly, restoration and conservation actions are emphasizing the canyon areas, including improving rangeland and riparian vegetation through better livestock grazing practices and streamside fencing.

Land enrolled in CRP or CREP is managed for ecological health, water quality improvement, and wildlife habitat. The CRP generally applies to upland agricultural areas with highly erodible soils, while the CREP applies to stream-adjacent riparian areas. The CRP areas are primarily located in the northern portion of the watershed assessment area. Approximately 181 miles of streams within the watershed assessment area are enrolled in the CREP.

In 2004 the NRCS entered into an agreement with U.S. Fish and Wildlife Service and NMFS to work with landowners on implementing conservation practices to better protect bull trout and steelhead listed under the ESA (NRCS and USFWS 2004). The emphasis of the program is dry cropland and range operators in Gilliam, Sherman, and Wasco Counties, Oregon. By offering a "safe harbor" from ESA-related enforcement actions, the program has expanded conservation practices that improve stream and riparian habitat, water quality, and upland areas, including implementing water and sediment control efforts, better rangeland grazing practices, and reducing grazing impacts in riparian areas through fencing, off-channel watering, and planting.

Factors Limiting Watershed Health

While there has been significant progress made in improving the health of the Pine Hollow – Jackknife Creek watershed assessment area, there is more to be done to expand the types, extent, and effectiveness of conservation and restoration practices. The sections below summarize the findings of the watershed assessment by describing how modified disturbance regimes, watershed processes, and habitats are affecting watershed health. Restoration and conservation actions that will address the identified watershed issues of concern are listed.

Sediment and Flood Regimes

Actively cropped lands do not have the same hydrologic characteristics as the native grasslands that they replaced. Exposed soil and changes in the drainage network lead to more rapid and increased levels of runoff. The increased "flashiness" of these upland areas is exacerbated during rain-on-snow on frozen soil events, leading to rapid runoff and higher peak flows during flood events. The Christmas Flood of 1964 was largest recent flood event of this type. This flood eroded soils and scoured stream banks, resulting in large amounts of sediment and other material deposited in stream channels, particularly in the lower reaches of Pine Hollow and Jack Knife Creek. While the impacts of this flood are still apparent in the watershed, streams are slowly recovering. Improvements in upland conservation practices such as residue management, grass waterways, and WASCBs, are reducing the impacts on the watershed's hydrologic function by moderating peak flows, and reducing the amount of sediment contributed to stream channels.

There are, however, other factors that are affecting the hydrologic characteristics of the watershed assessment area. Shallow-rooted annual grasses, such as cheatgrass and medusahead rye, which do not have the same soil or water holding capacity as deeper-rooted native grasses are spreading through range lands and pastures. The spread of these grasses is lowering the water holding capacity of the system, affecting peak flows and sediment runoff during storm events.

Recommended Actions:

- Continue to emphasize upland structural and other conservation practices to reduce hydrologic flashiness, soil erosion, and sediment routing into stream channels.
- Continue large-scale treatments of medusahead rye.

Fire Regime

The frequency and magnitude of fire has changed. In some areas, fire suppression has resulted in juniper encroachment into native grasslands. Depending on recent fire patterns, the extent and severity of juniper encroachment varies across the watershed assessment area. In many areas, the continued exclusion of fire increases the risk of unnaturally hot, destructive fires. In addition to the increased fuel loading from juniper encroachment, cheatgrass, and medusahead rye are highly flammable and can also increase both fire risk and magnitude.

Recommended Actions:

- Target future juniper control in areas outlined in the recent juniper inventory report (CSR 2011).
- Continue large-scale treatments of medusahead rye and explore other options for controlling this species and limiting grassland fuel buildup, including investigating appropriate levels of livestock grazing.

Stream Flow

There is very little surface water withdrawal for irrigation purposes in the watershed assessment area. The most significant changes in stream flows, particularly low flows during the summer and early fall, is probably due to changes in hydrologic conditions from reduced water infiltration and storage due to impacts from croplands, juniper encroachment, and changes in the grassland community. Over time, juniper expansion will result in greater tree density and increasing soil water consumption, increased canopy cover and rain and snow interception, which will diminish the flow of seeps, springs and streams. In addition, the spread of cheatgrass and medusahead rye are lowering the water holding capacity of the system, which also affect stream flows.

Recommended Actions:

- Increase the volume of water held in cropland areas by continuing and expanding practices that improve water retention and infiltration.
- Continue large-scale treatments of medusahead rye and other measures to improve the health of rangeland plant communities.

Riparian, Wetland, and Stream Habitats

With the dry climate that characterizes the Pine Hollow – Jackknife Creek watershed assessment area, habitats that are associated with water are rare and particularly important. Healthy streams, riparian areas, springs, seeps, and wetlands are essential for thriving fish and wildlife populations.

Past floods and land use practices have contributed significantly to the factors within the watershed assessment area that are now affecting stream channels and riparian areas. The Christmas flood of 1964, combined with upland management practices that contributed additional runoff and sediment, scoured stream banks and moved large amounts of sediment and other material down the channels. Materials deposited in the low gradient reaches of Pine Hollow and Jackknife Creek is still working its way through the stream channel system. Deposition of sediment and coarse beadload is widening channels, increasing water temperatures, and, where there is subsurface stream flow, creating obstacles to fish movement.

Improved management practices are reducing sediment and runoff from the upper watershed, but recovery of the stream channels will take time. The most appropriate way to accelerate the healing of stream channels, fish habitat, and water quality, is to improve riparian areas. Throughout the watershed assessment area, riparian vegetation has been affected by historical grazing practices, stream-adjacent roads, road crossings, and invasive plant and animal species, particularly feral swine.

Recommended Actions:

- Continue to enroll more riparian areas in the CREP and monitor improvements in riparian vegetation and function (e.g., measuring shade enhancement).
- Evaluate stream adjacent roads and crossings for impacts on stream channels, riparian vegetation, and sediment contributions. Enhance riparian vegetation at roads and crossings, and where appropriate, decommission or improve roads or crossings (e.g., improving road drainage or placing appropriate coarse rocks or other material within a low water ford to reduce sediment inputs).
- Continue to control feral swine and track the population's status over time.

Upland Habitats

Upland habitats have been affected by the spread of weeds, changes in the fire regime, grazing practices, and native habitat conversion to cropland and other land uses. Noxious weeds are invading wildlife habitat, rangelands and croplands throughout the watershed assessment area. Large scale efforts are underway to control a number of weeds, including medusahead rye, Knapweed, skeleton weed, Canada thistle, and yellow star thistle. These efforts need to continue and expand along with ongoing vigilance the presence of other weed species.

Currently, juniper encroachment is not a significant problem in the watershed enhancement area, particularly in Jackknife Creek watershed were recent fires reduced juniper extent. Without future control measures, expansion of juniper will continue in the watershed assessment area, resulting in greater tree density, declining diversity of wildlife habitats, reduced livestock forage production, and hydrologic impacts.

Recommended Actions:

- Continue to control noxious weeds and monitor new infestations.
- Strategically remove junipers to improve hydrologic function, range conditions, and wildlife habitat.
- Where appropriate, continue to enroll cropland in the CRP program and manage these areas for plant health and wildlife habitat.

Data Gaps

There is limited information or data on the Pine Hollow – Jackknife Creek watershed assessment area's stream features, water quality characteristics, riparian and upland habitats, and fish populations. The watershed assessment primarily relied on aerial imagery and maps for evaluating the status of the area's resources and the findings were not field verified. The following is an outline of key data and information gaps identified in the watershed assessment:

Water Quality

- Continue to monitor water temperatures in Pine Hollow; expand water temperature monitoring into Jackknife Creek; and implement water temperature and shade monitoring in riparian enhancement areas in order to track improvement over time.
- Implement monitoring in Pine Hollow and Jackknife Creek of selected water quality parameters where data have not been collected, including dissolved oxygen and turbidity.

Channel Habitat

- Use the findings of the assessment's channel habitat typing to target field verification of channel types.
- Collect data on channel characteristics (e.g., channel width, substrate, bankfull width, and flood-prone width) at selected channel locations, including depositional areas, and track trends in channel condition over time. Combine channel characterization with data collection for riparian characteristics (see below).

Fish Species and Population Trends

- Continue to track steelhead redd numbers and trends in Pine Hollow Creek.
- Sample fish in selected stream reaches to document the distribution of non-salmonid fish species (e.g., dace and sculpins).

Riparian Areas and Wetlands

- Use the findings of the assessment's riparian condition and shade mapping to target field verification of riparian condition.
- Collect data on riparian characteristics (e.g., area width, species composition, and shade) at selected locations, and track trends in riparian condition over time. Combine riparian characterization with data collection for stream characteristics.
- Target select areas for characterizing wetland vegetation associated with streams or springs; use the information on wetland vegetation composition and management impacts to target restoration actions.
- Collect data on stream adjacent roads and stream crossings, including information sediment routing into stream channels, and stream and riparian impacts.

Upland Habitats

- Expand inventories of rangeland plant production, species composition, and overall plant community health.
- Continue to monitor juniper encroachment and use the information to target control efforts.

Noxious Weeds

- Expand efforts to inventory and track noxious weed locations and expansion in upland and riparian areas.

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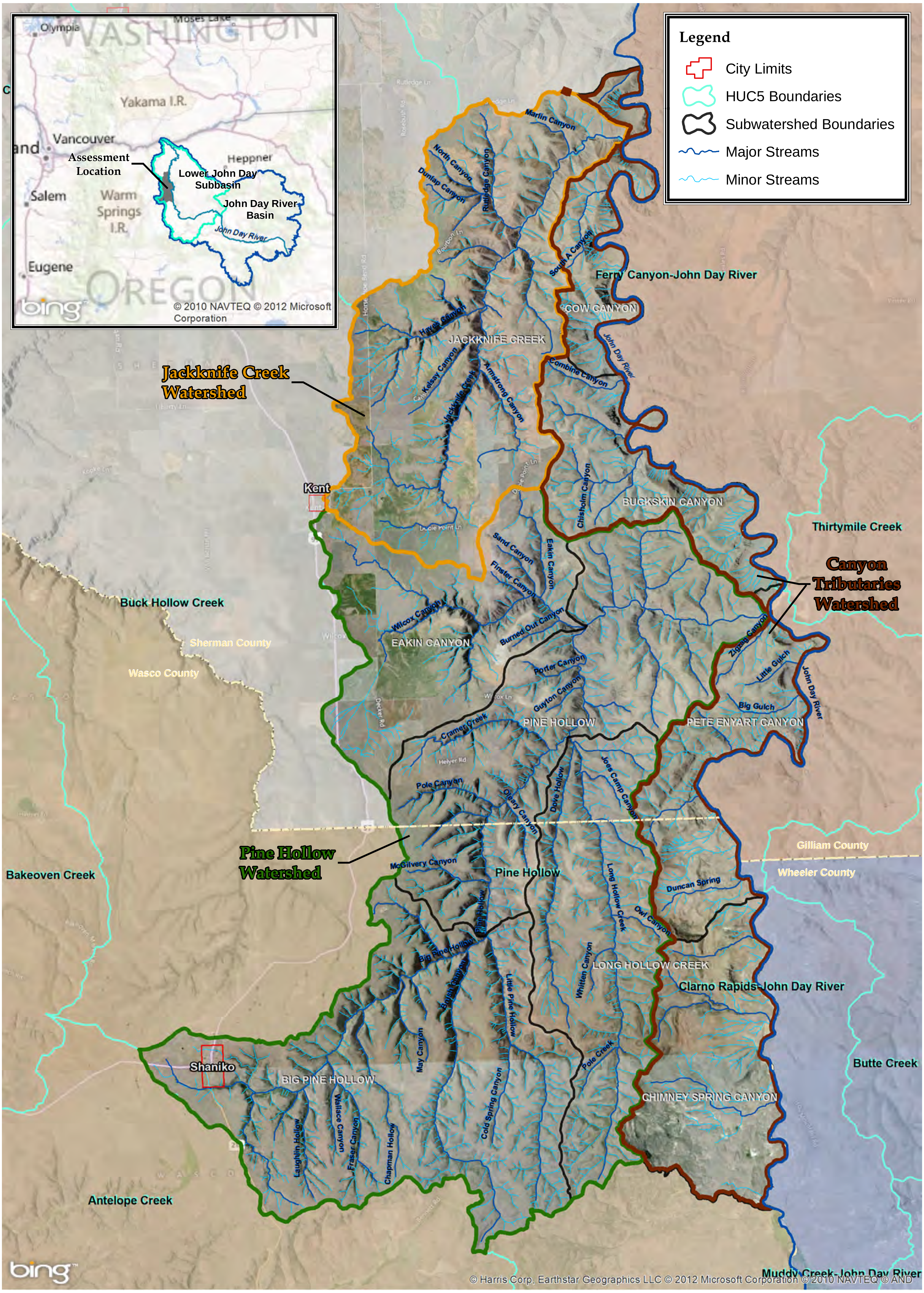
Maps



Watershed Features:

Watershed Name	Acres (Sq.Mi.)	Major Stream Length, Miles
Canyon Tributaries	36,110 (56)	37
Jackknife Creek	27,585 (43)	46
Pine Hollow	83,725 (131)	143
Total	**147,420 (230)**	**226**

Data Source: Bureau of Land Management, Oregon Counties 2007, Hydrologic Units 2011; Pacific Hydrography Network. 2005. "Oregon Water Courses".

Map 1: Pine Hollow - Jackknife Creek Watershed

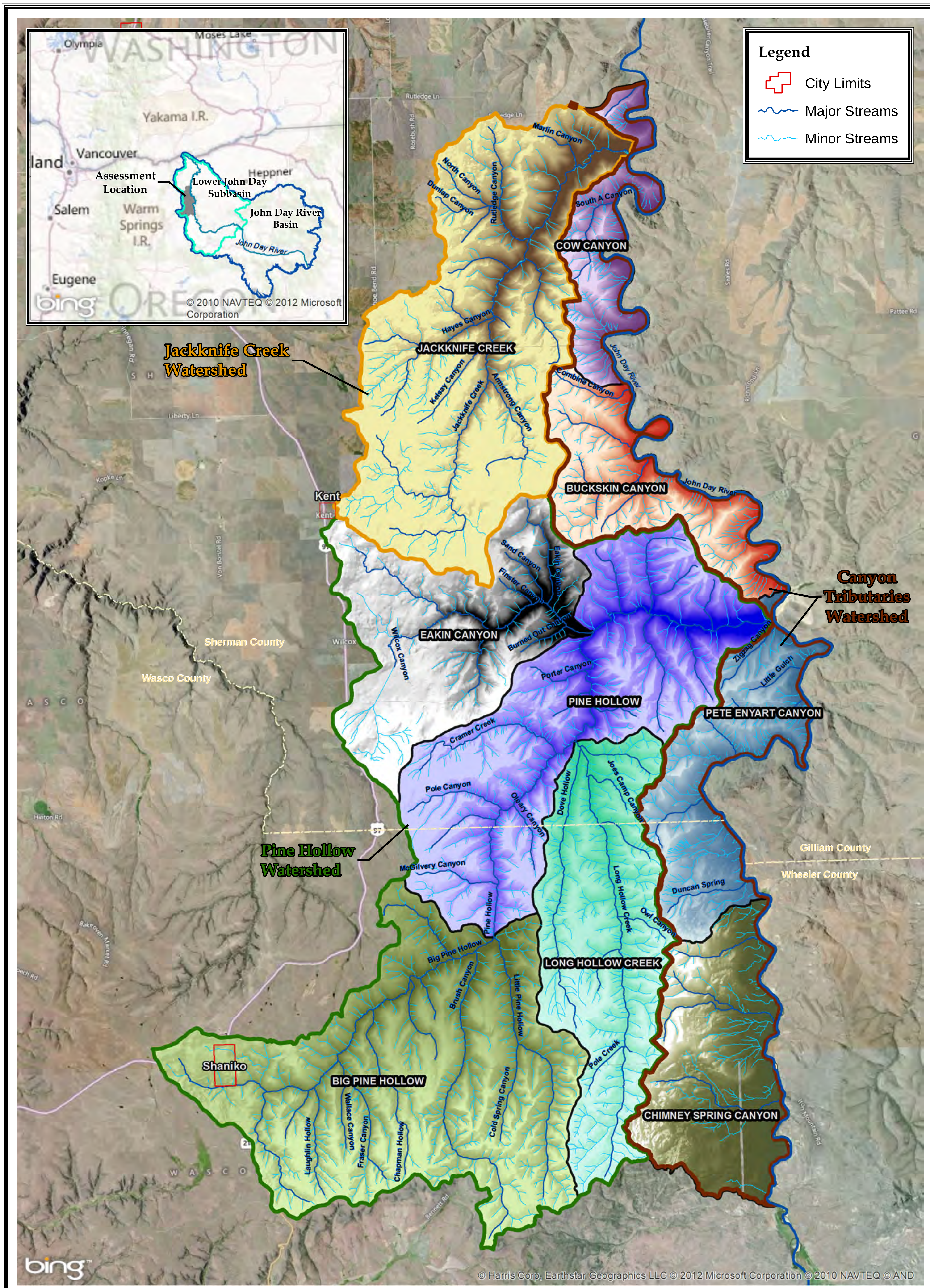
Sherman and Wasco Counties, Oregon

0 1 2 4 6 Miles

SC WCD EST. 1950

CASCADE ENVIRONMENTAL GROUP

July 23, 2012



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Data Source: USGS, Oregon 10m DEM, 1999; Bureau of Land Management, Oregon Counties 2007, Hydrologic Units 2011; Pacific Hydrography Network. 2005. "Oregon Water Courses".

N E S W

Map 2:
Pine Hollow - Jackknife Creek Subwatersheds

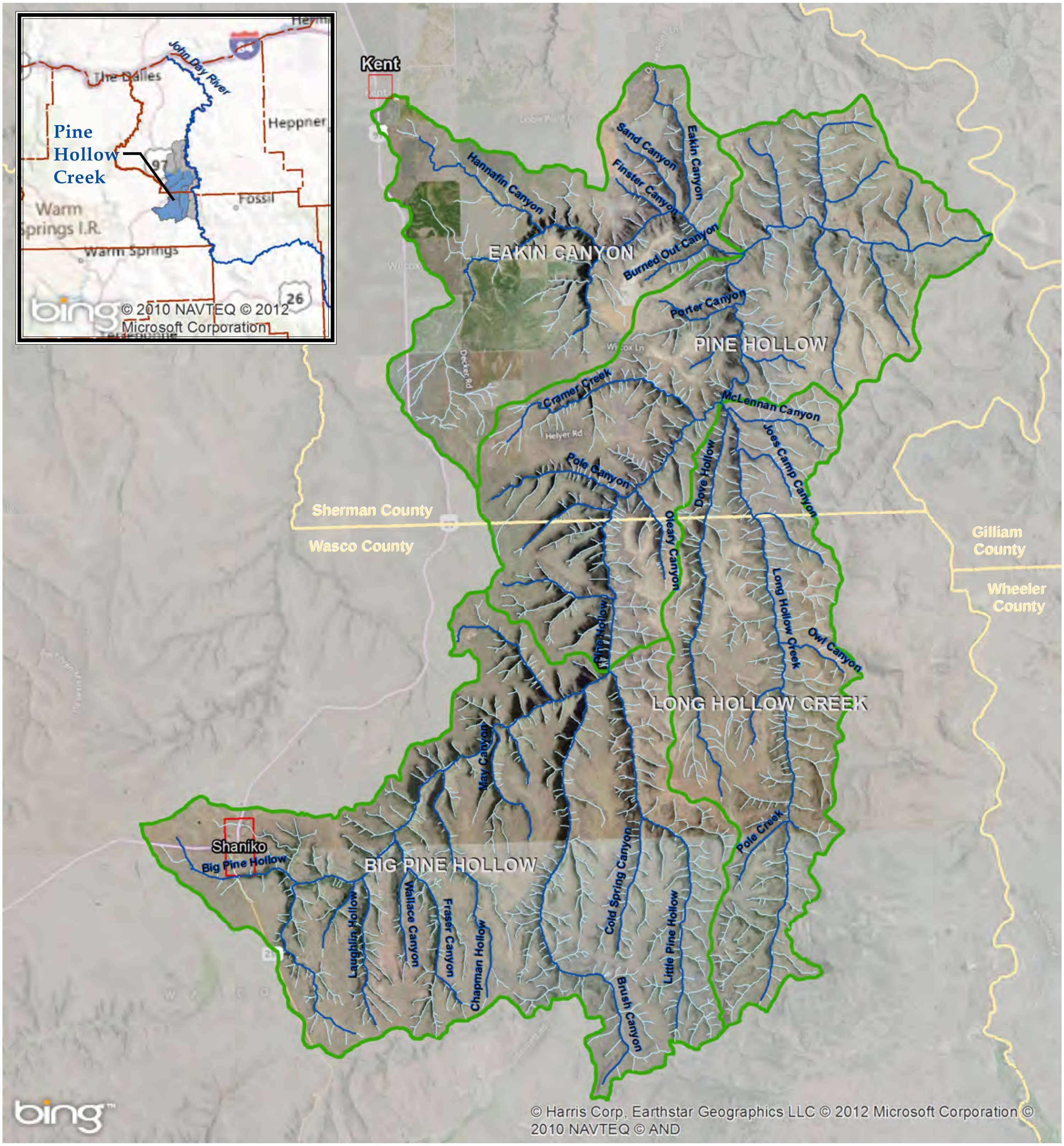
Sherman and Wasco Counties, Oregon

0 1 2 4 6 Miles

SWCD EST. 1950

CASCADE ENVIRONMENTAL GROUP

July 23, 2012



0 1 2 4 6 Miles

Scale: 1 inch = 2 miles

N S W E

Watershed Features:

Land Area: 83,724.6 acres (130.8 sq.mi.)
Major Stream Length: 143.3 miles
Subwatersheds: Big Pine Hollow, Eakin Canyon, Long Hollow Creek, Pine Hollow

Map 3: Pine Hollow Creek Watershed

SWCD EST. 1950

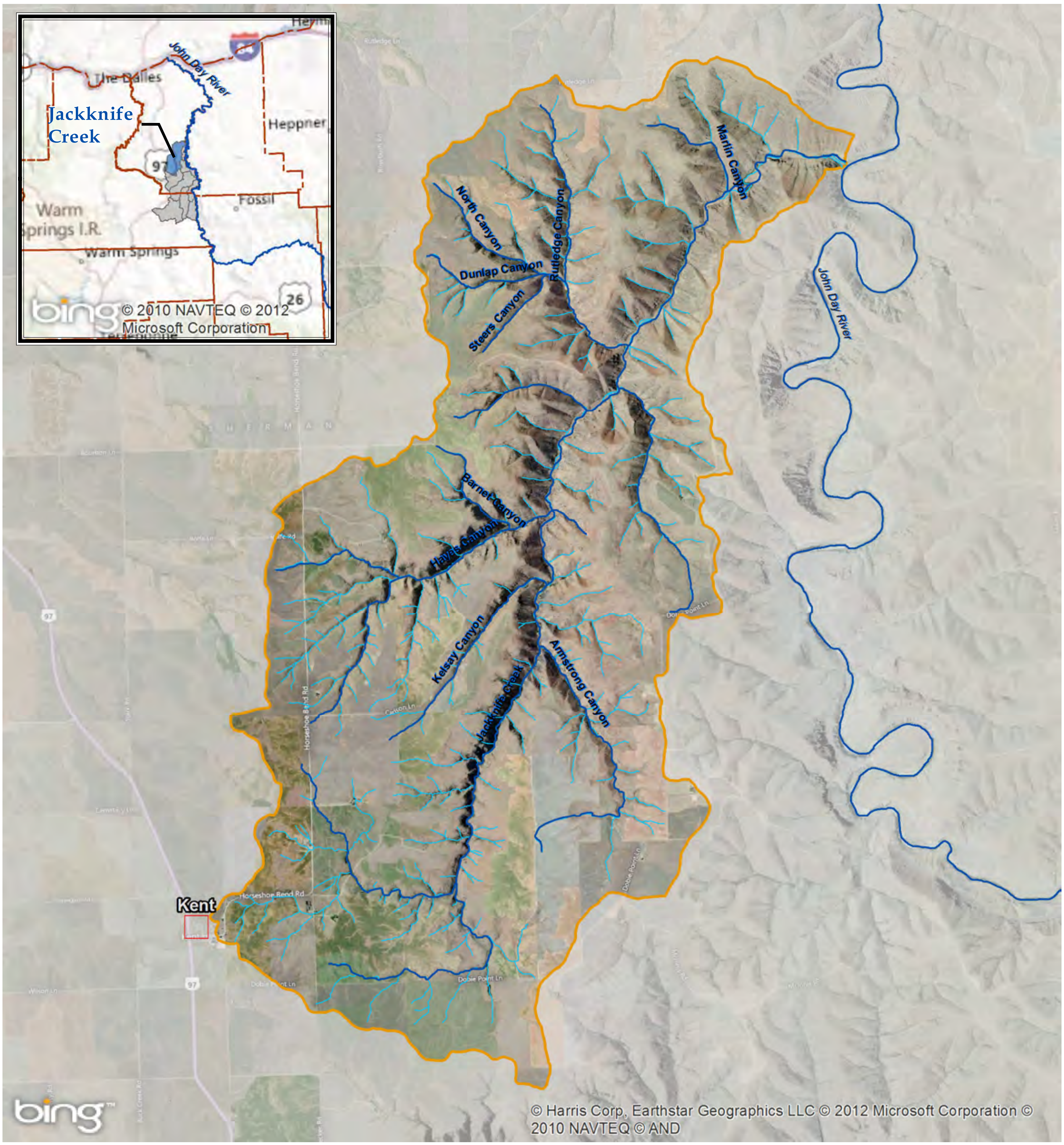
CASCADE ENVIRONMENTAL GROUP

Pine Hollow - Jackknife Creek Watershed

Sherman and Wasco Counties, Oregon

July 23, 2012

Data Source: (c) Bureau of Land Management, 2007, Oregon Counties; Pacific Northwest Hydrography Framework. 2005. " Oregon Water Courses".



0 0.5 1 2 3 Miles

Scale: 1 inch = 2 miles

N W E S

Watershed Features:

Land Area: 27,586 acres (43 sq.mi.)
Major Stream Length: 46 miles
Subwatersheds: none

Map 4: Jackknife Creek Watershed

SWCD EST. 1950

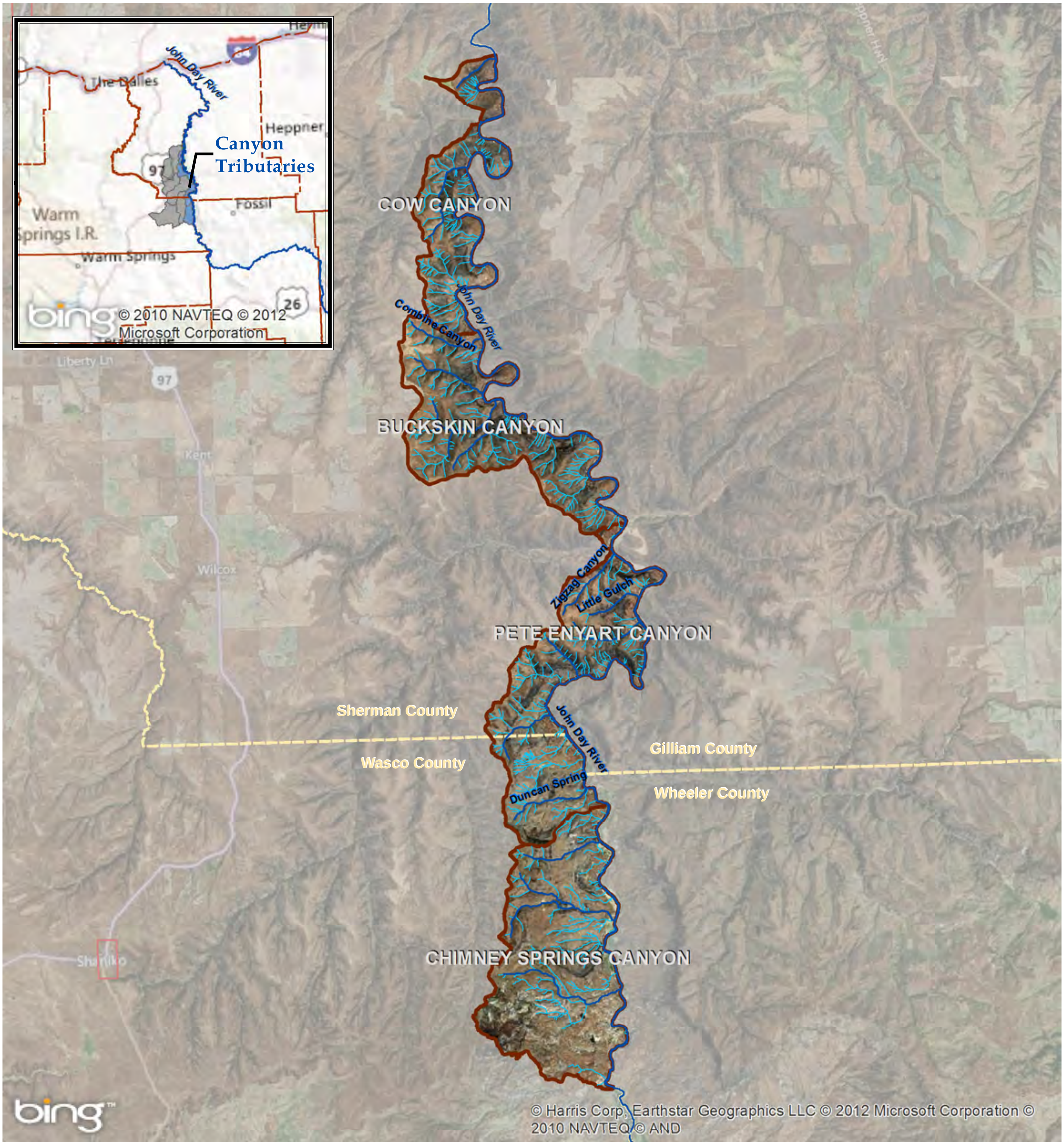
CASCADE ENVIRONMENTAL GROUP

Pine Hollow - Jackknife Creek Watershed

Sherman and Wasco Counties, Oregon

July 23, 2012

Data Source: Hydrography Framework. 2005. "Oregon Water Courses".



0 1.5 3 6 9 Miles

Scale: 1 inch = 4 miles

N W E S

Map 5: Canyon Tributaries Watershed

SWCD EST. 1950

CASCADE ENVIRONMENTAL GROUP

Pine Hollow - Jackknife Creek Watershed

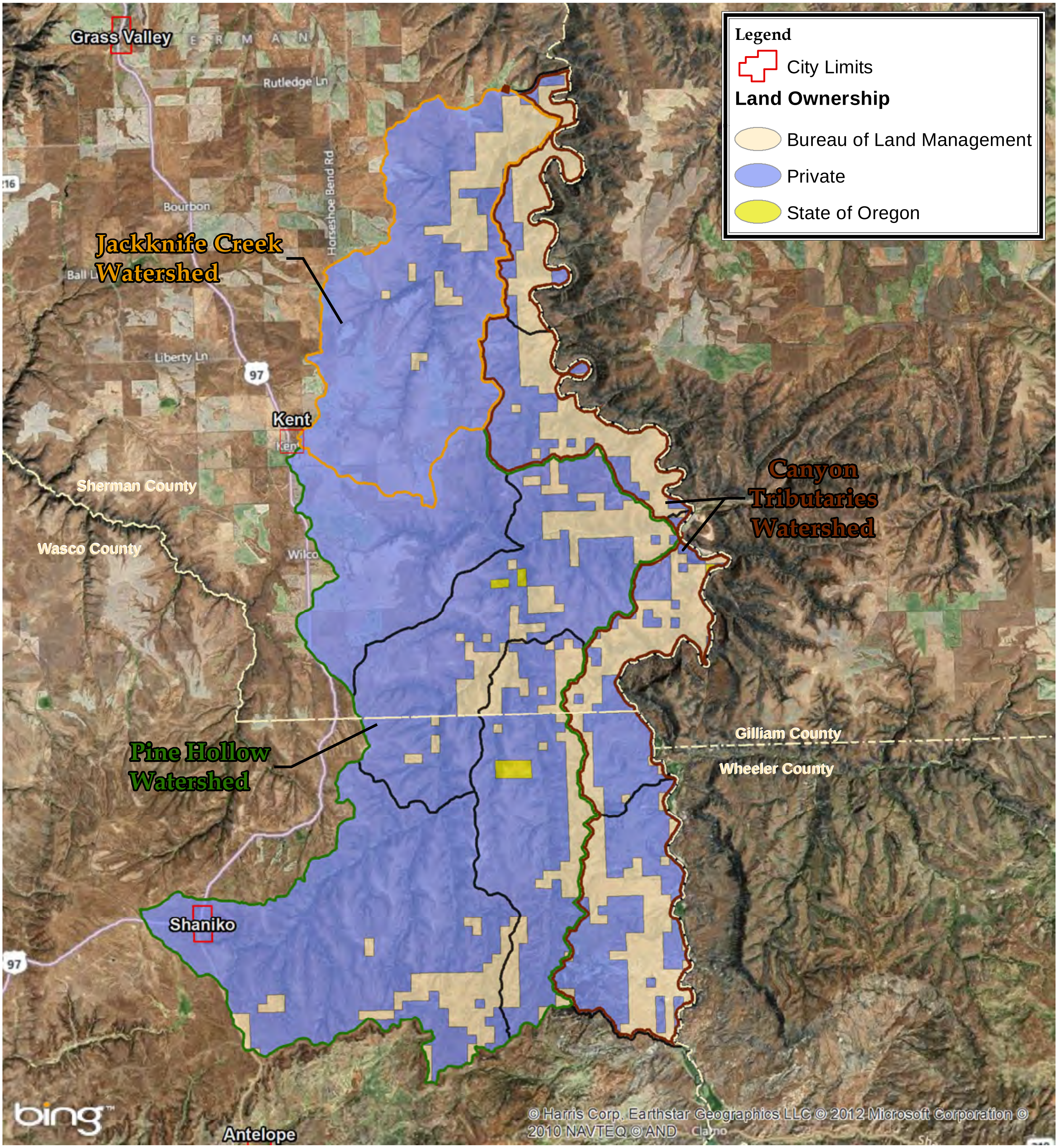
Sherman and Wasco Counties, Oregon

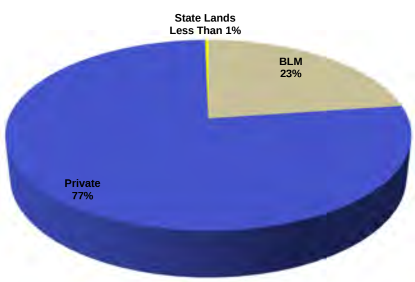
July 23, 2012

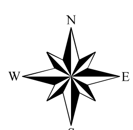
Data Source: Bureau of Land Management. 2007; Pacific Hydrography Network. 2005. "Oregon Water Courses".

Watershed Features:

Land Area: 36,110 acres (56 sq.mi.)
Major Stream Length: 37 miles
Subwatersheds: Buckskin, Chimney Springs, Cow, and Pete Enyart Canyons







0 1.25 2.5 5 7.5 Miles

Scale: 1 inch = 4 miles

Map 6: Land Ownership

SWCD EST. 1950

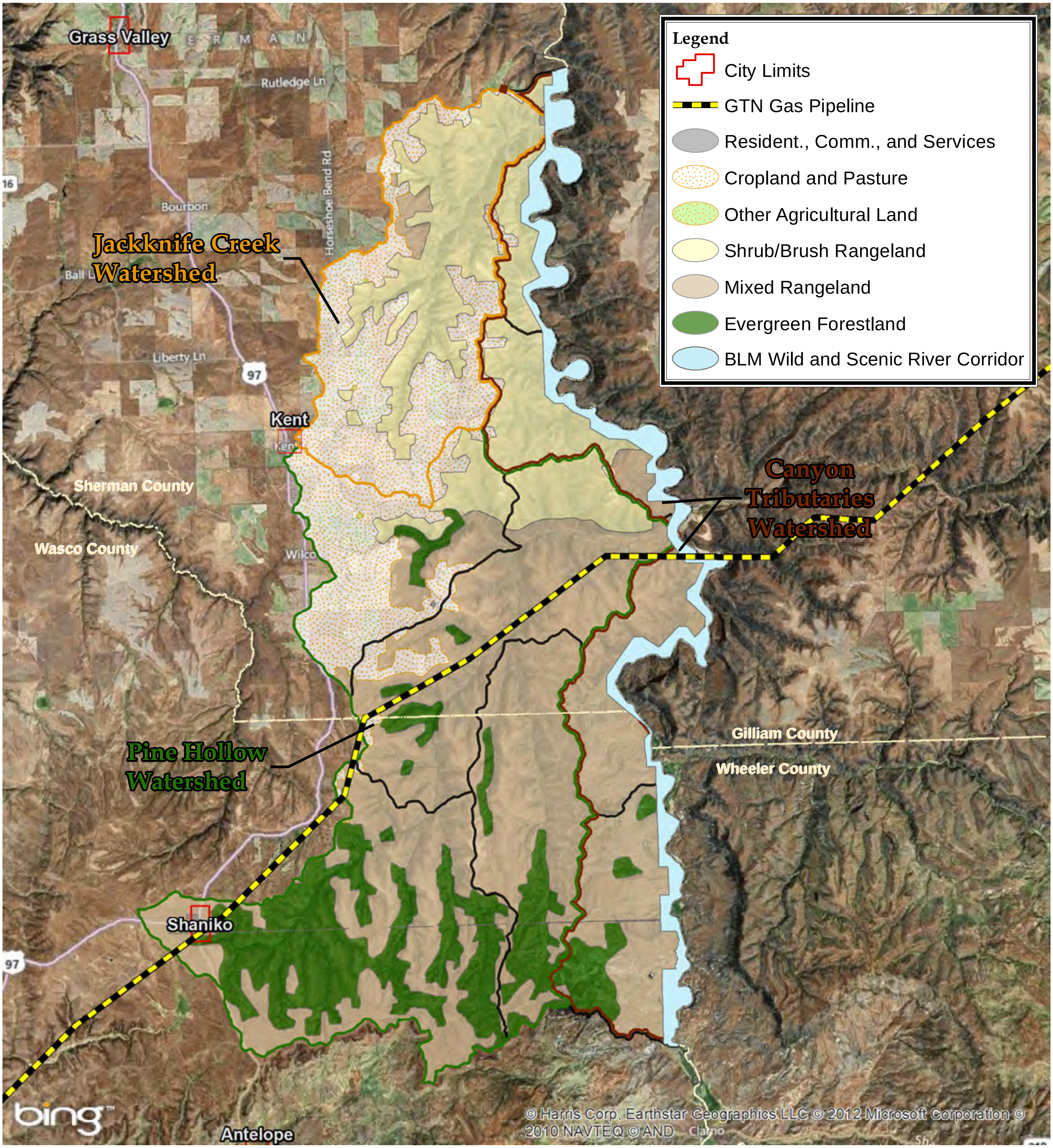
CASCADE ENVIRONMENTAL GROUP

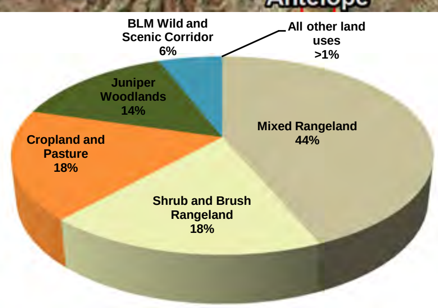
Pine Hollow - Jackknife Creek Watershed

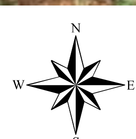
Sherman and Wasco Counties, Oregon

July 23, 2012

Data Source: Oregon Natural Heritage Program, Land Ownership and Stewardship; Bureau of Land Managment, 2007, Oregon Counties







0 1.25 2.5 5 7.5 Miles

Scale: 1 inch = 4 miles

Map 7: Land Use/ Land Cover

SWCD EST. 1950

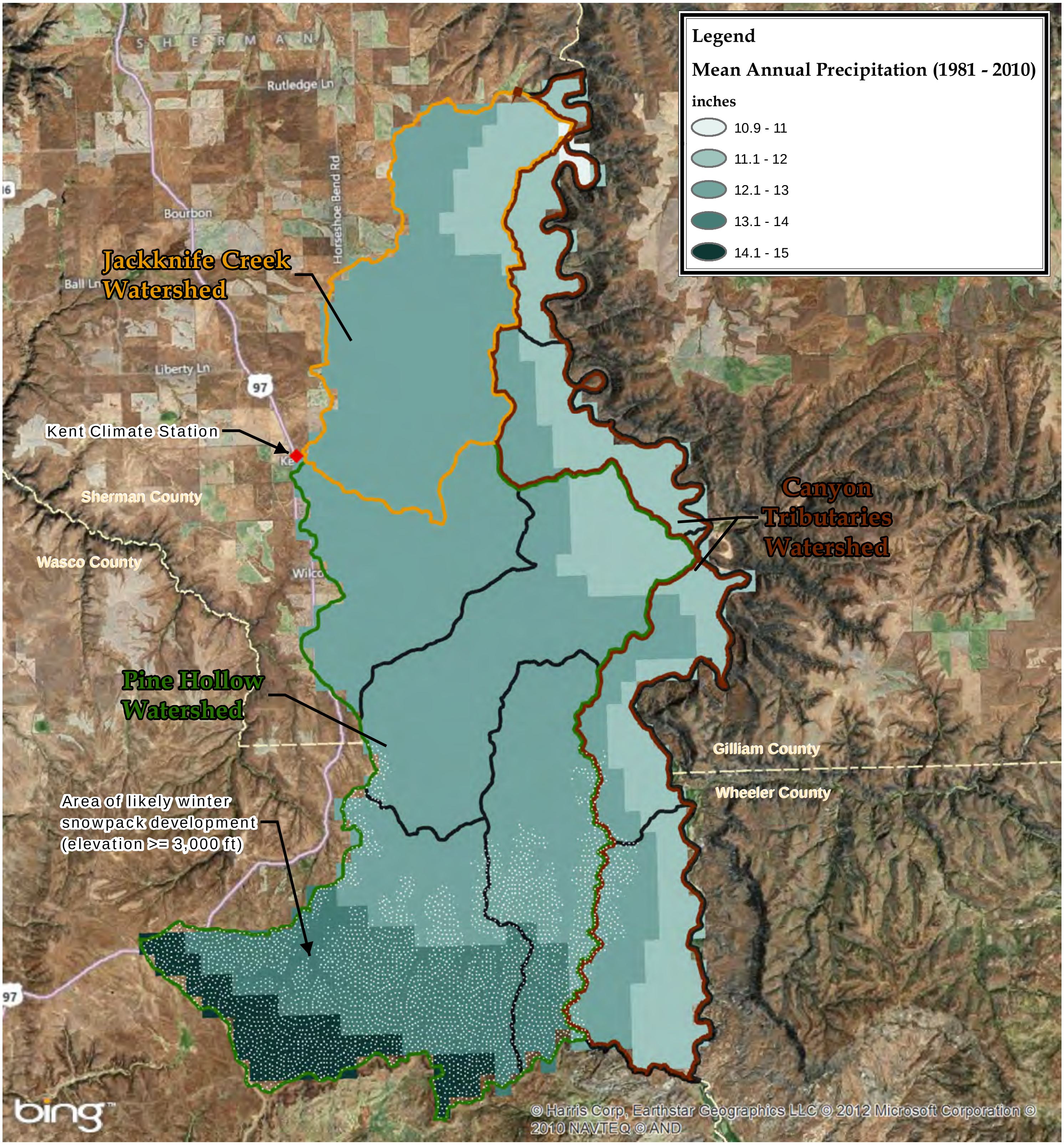
CASCADE ENVIRONMENTAL GROUP

Pine Hollow - Jackknife Creek Watershed

Sherman and Wasco Counties, Oregon

July 23, 2012

Data Source: EPA. 2008. "GIRAS Land use/Land cover Spatial Data of CONUS for BASINS"; Bureau of Land Management, 2007, Oregon Counties



0 1.25 2.5 5 7.5 Miles

Scale: 1 inch = 4 miles

N W E S

Map 8: Precipitation

SWCD EST. 1950

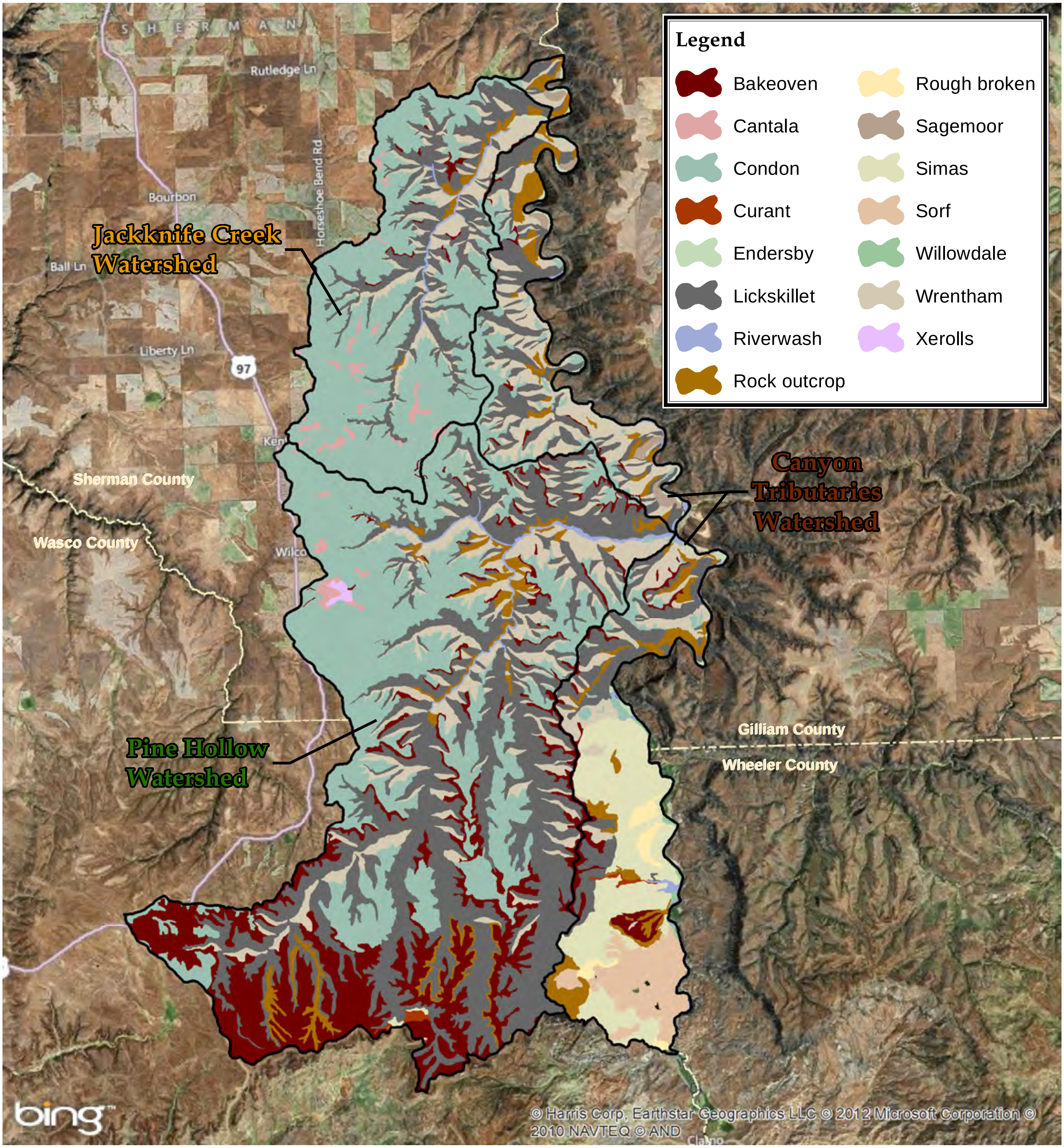
CASCADE ENVIRONMENTAL GROUP

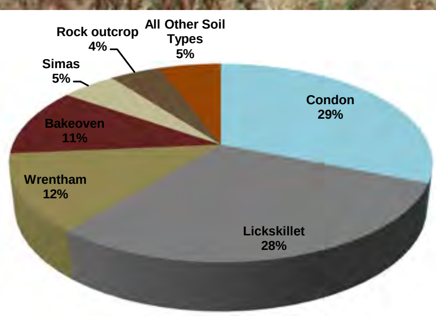
Pine Hollow - Jackknife Creek Watershed

Sherman and Wasco Counties, Oregon

July 23, 2012

Data Source: (c) 2010 Microsoft Corporation and its data suppliers; BLM, Counties, 2007; PRISM Oregon Climate Group, 2004.





0 1.25 2.5 5 7.5 Miles

Scale: 1 inch = 4 miles

Map 9: Soil Types

SWCD EST. 1950

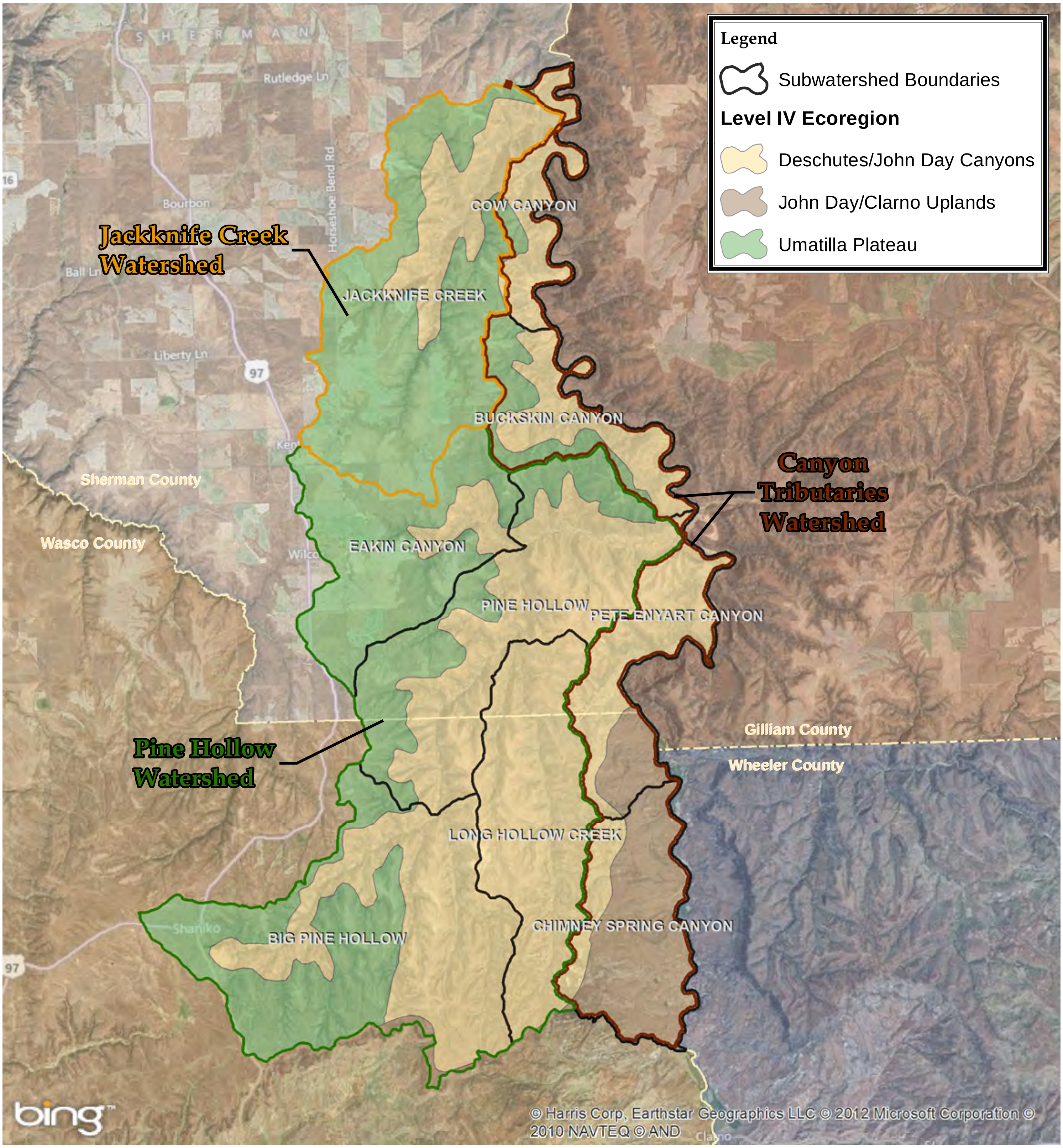
CASCADE ENVIRONMENTAL GROUP

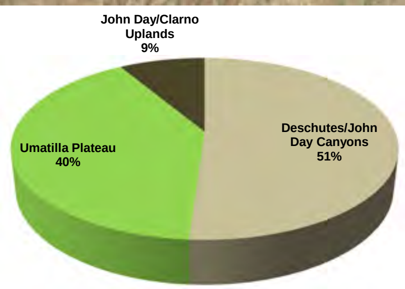
Pine Hollow - Jackknife Creek Watershed

Sherman and Wasco Counties, Oregon

July 23, 2012

Data Source: Soil Survey Staff, Natural Resources Conservation Service, U. S. Dept. of Agriculture. Soil Survey Geographic (SSURGO)Database for Wasco and Sherman counties. Available online at http://soildatamart.nrcs.usda.gov . Accessed 8/10/2012.





N
W E
S

0 1.5 3 6 9 Miles

Scale:1 inch = 4 miles

Map 10: Level IV Ecoregions

SWCD EST. 1950

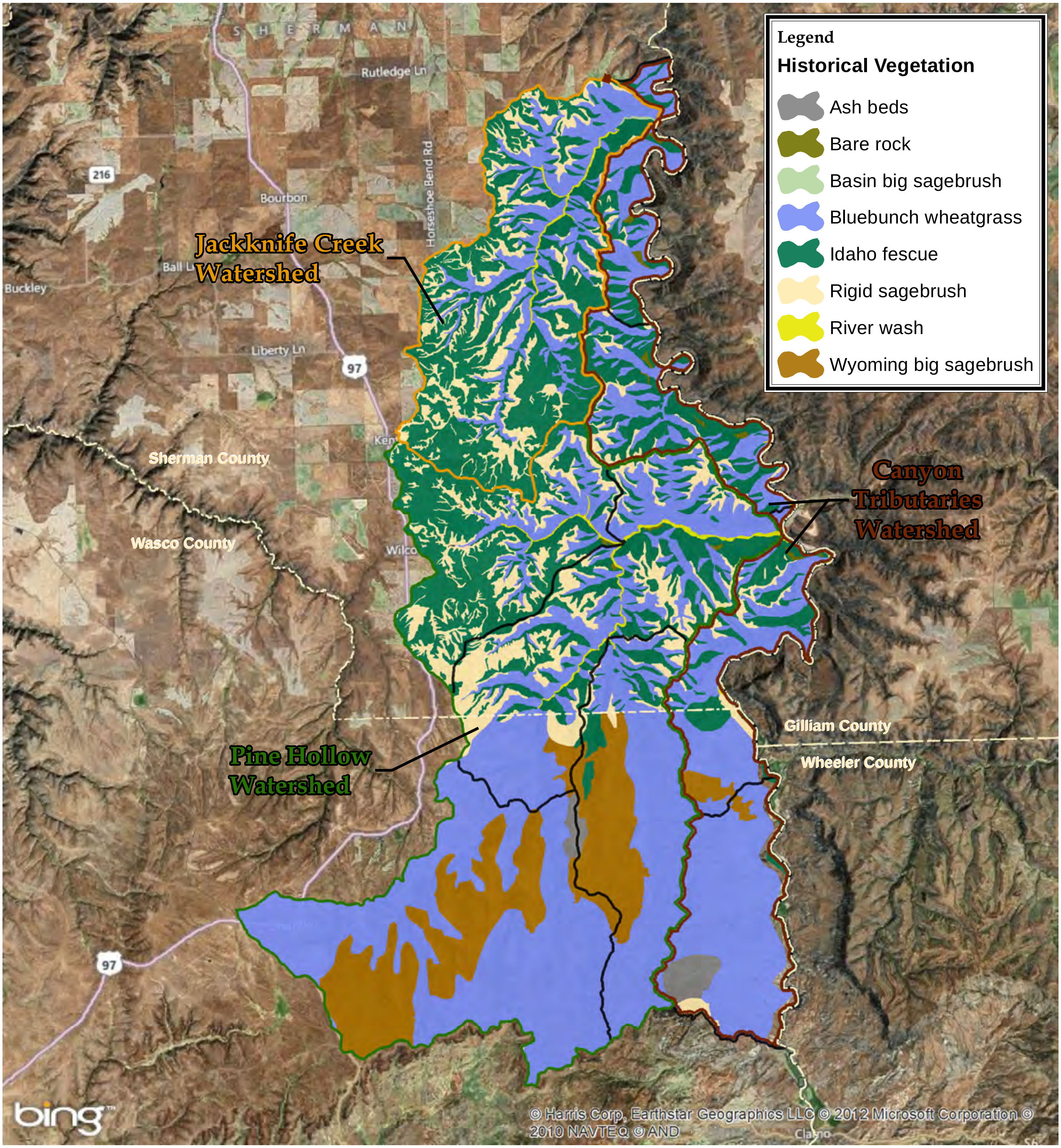
CASCADE ENVIRONMENTAL GROUP

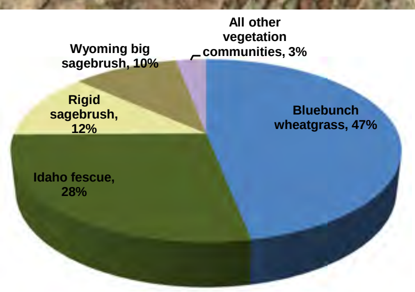
Pine Hollow -- Jackknife Creek Watershed

Sherman and Wasco Counties, Oregon

July 23, 2012

Data Source: (c) 2010 Microsoft Corporation and its data suppliers; U.S. Environmental Protection Agency. 2012. "Level IV Ecoregions of the Conterminus United States". Corvalis, OR





N
W E
S

0 1.5 3 6 9 Miles

Scale: 1 inch = 4 miles

Map 11: Historical Vegetation Communities

SWCD EST. 1950

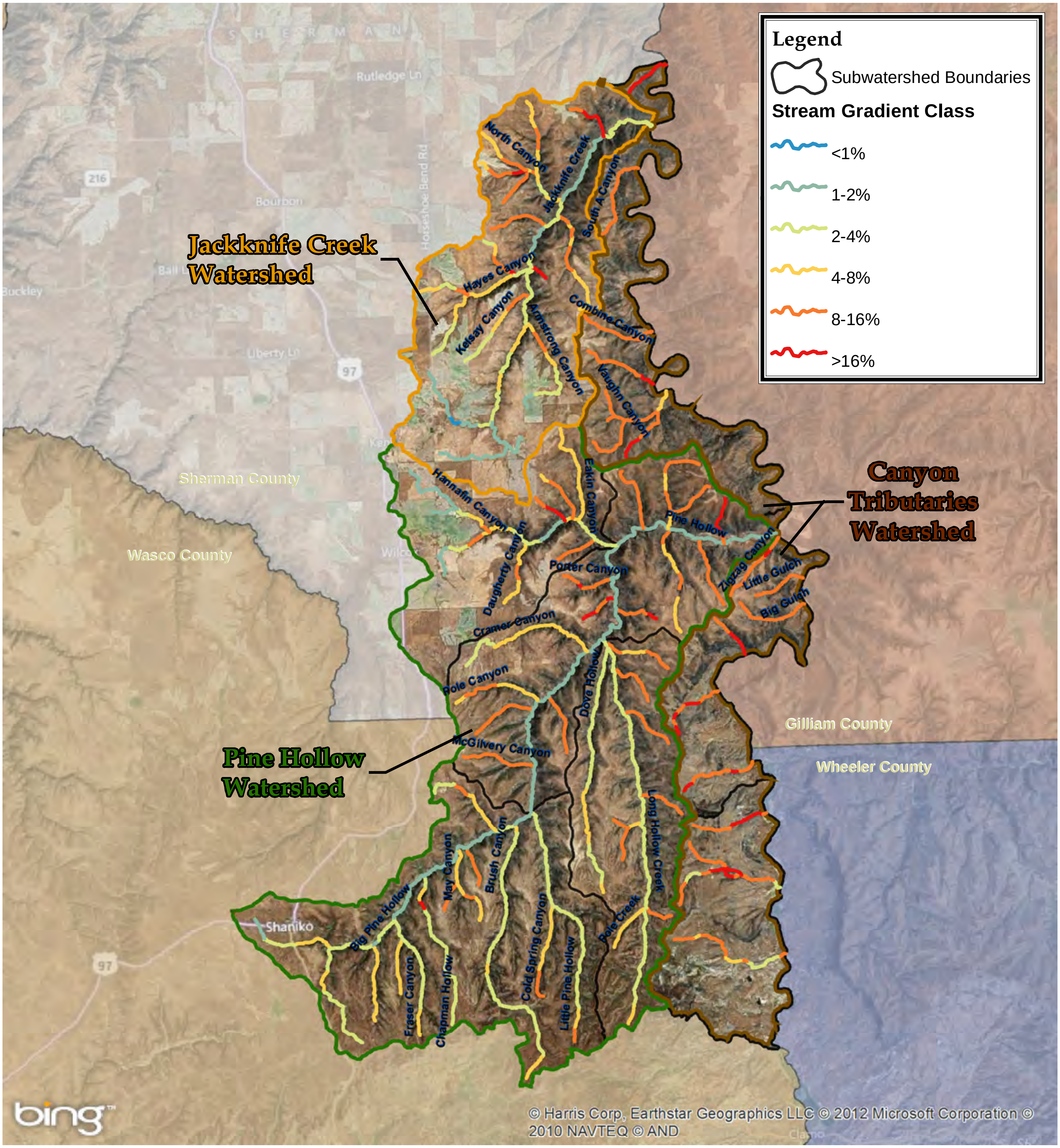
CASCADE ENVIRONMENTAL GROUP

Pine Hollow - Jackknife Creek Watershed

Sherman and Wasco Counties, Oregon

July 23, 2012

Data Source: Oregon Biodivieristy Information Center, Historic Vegetation 2002; Bureau of Land Management, 2007, Oregon Counties



0 1.5 3 6 9 Miles

N W E S

Gradient Class (%)	Percent of Streams
>1	0.3%
1-2	13%
2-4	22%
4-8	17%
8-16	39%
>16	9%

Map 12: Stream Gradient Classification

SWCD SC EST. 1950

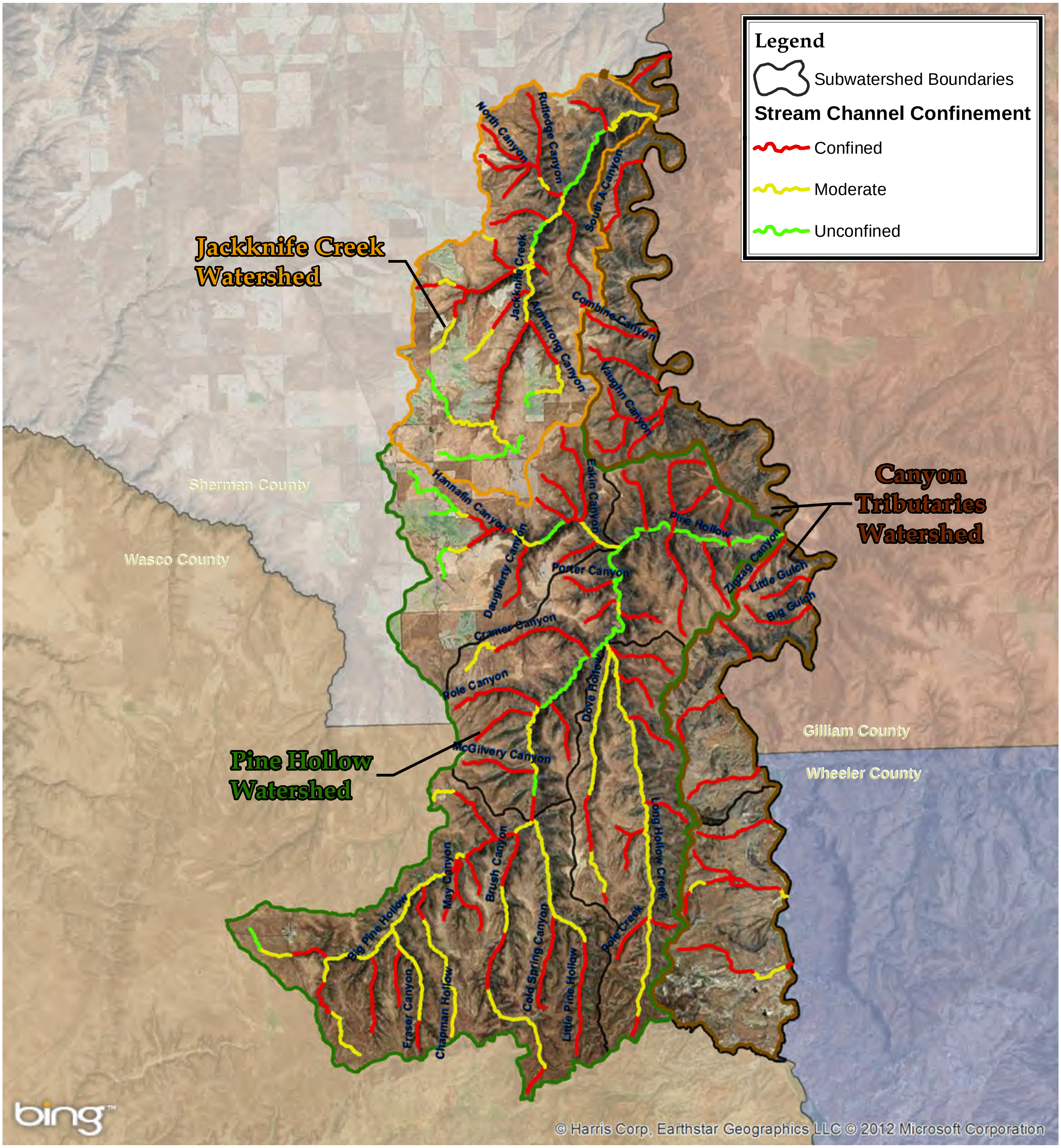
CASCADE ENVIRONMENTAL GROUP

Pine Hollow - Jackknife Creek Watershed

Sherman and Wasco Counties, Oregon

July 23, 2012

Data Source: Bureau of Land Management, 2007, Oregon Counties.



0 1.25 2.5 5 7.5 Miles

N S W E

Confinement Class	Percent of Streams
Unconfined	10%
Moderately Confined	23%
Confined	67%

Map 13: Stream Channel Confinement

SWCD EST. 1950

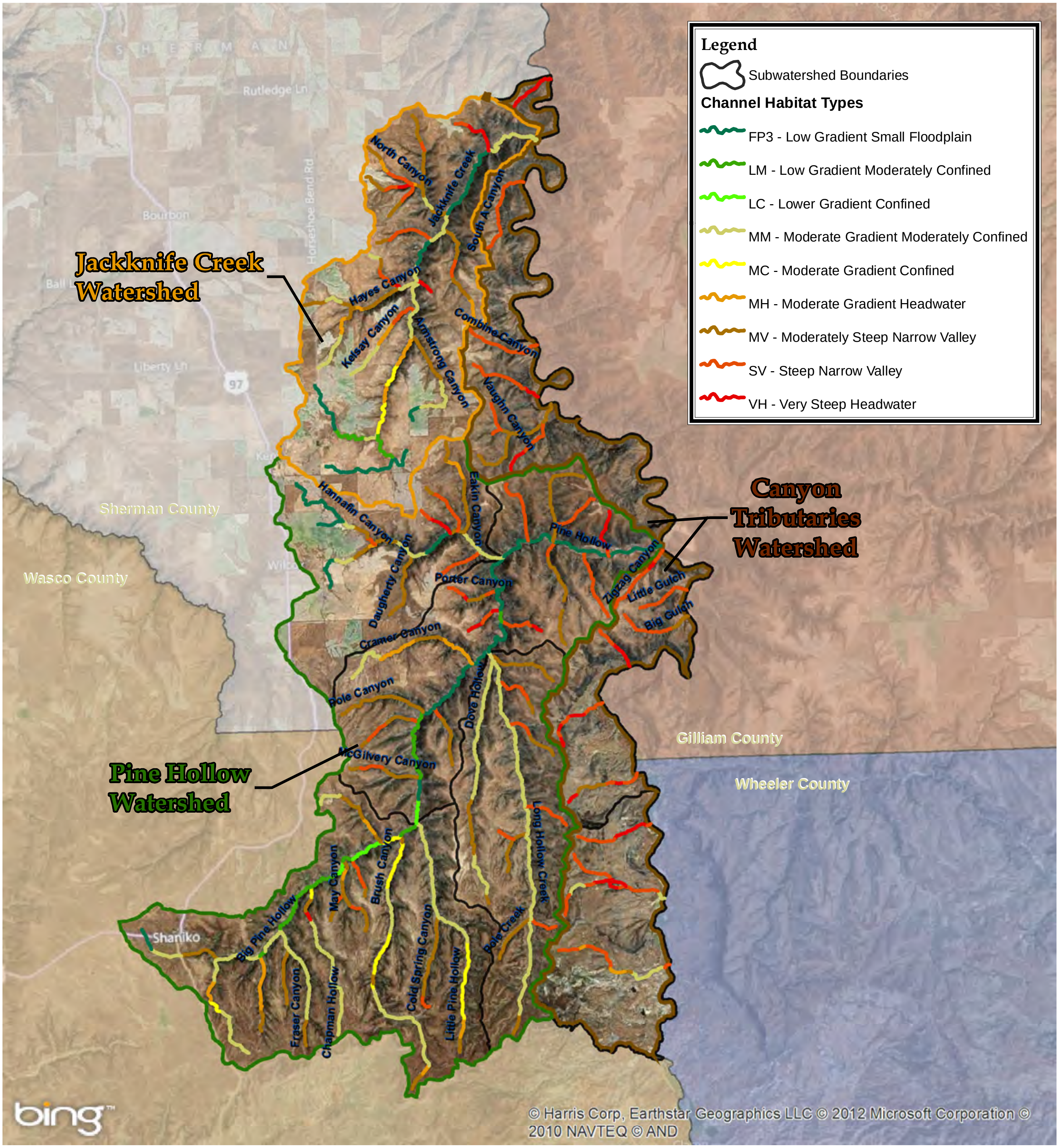
CASCADE ENVIRONMENTAL GROUP

Pine Hollow - Jackknife Creek Watershed

Sherman and Wasco Counties, Oregon

July 23, 2012

Data Source: Bureau of Land Management, 2007, Oregon Counties.



0 1.5 3 6 9 Miles

Scale: 1 inch = 4 miles

N S E W

Map 14: Channel Habitat Types

SWCD EST. 1950

CASCADE ENVIRONMENTAL GROUP

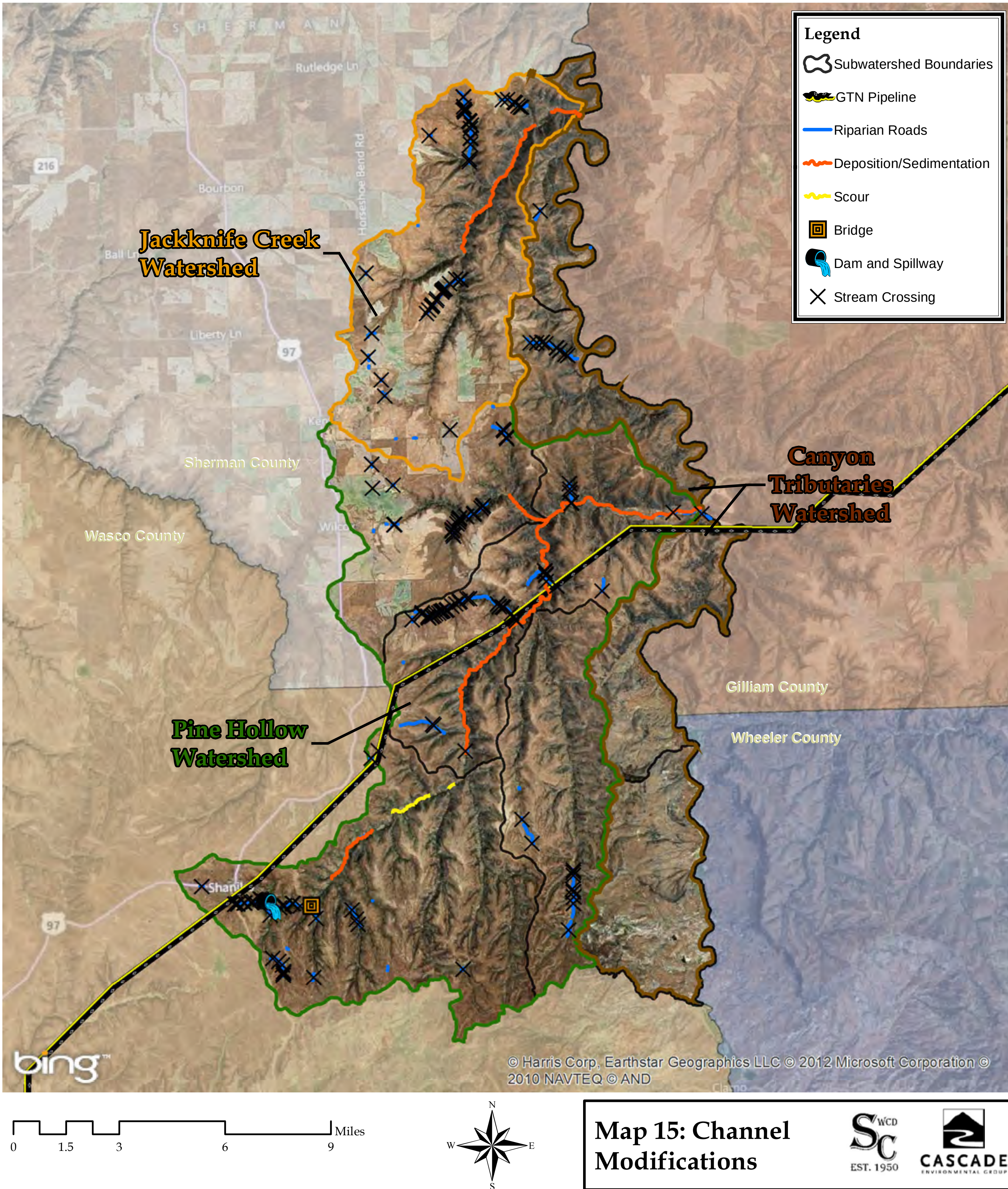
Pine Hollow - Jackknife Creek Watershed

Sherman and Wasco Counties, Oregon

July 23, 2012

Data Source: Bureau of Land Management, 2007, Oregon Counties.

Channel Habitat Type	FP3	LC	LM	MC	MH	MM	MV	SV	VH
Percent of Streams	10%	0.5%	3%	3%	5%	20%	22%	28%	9%



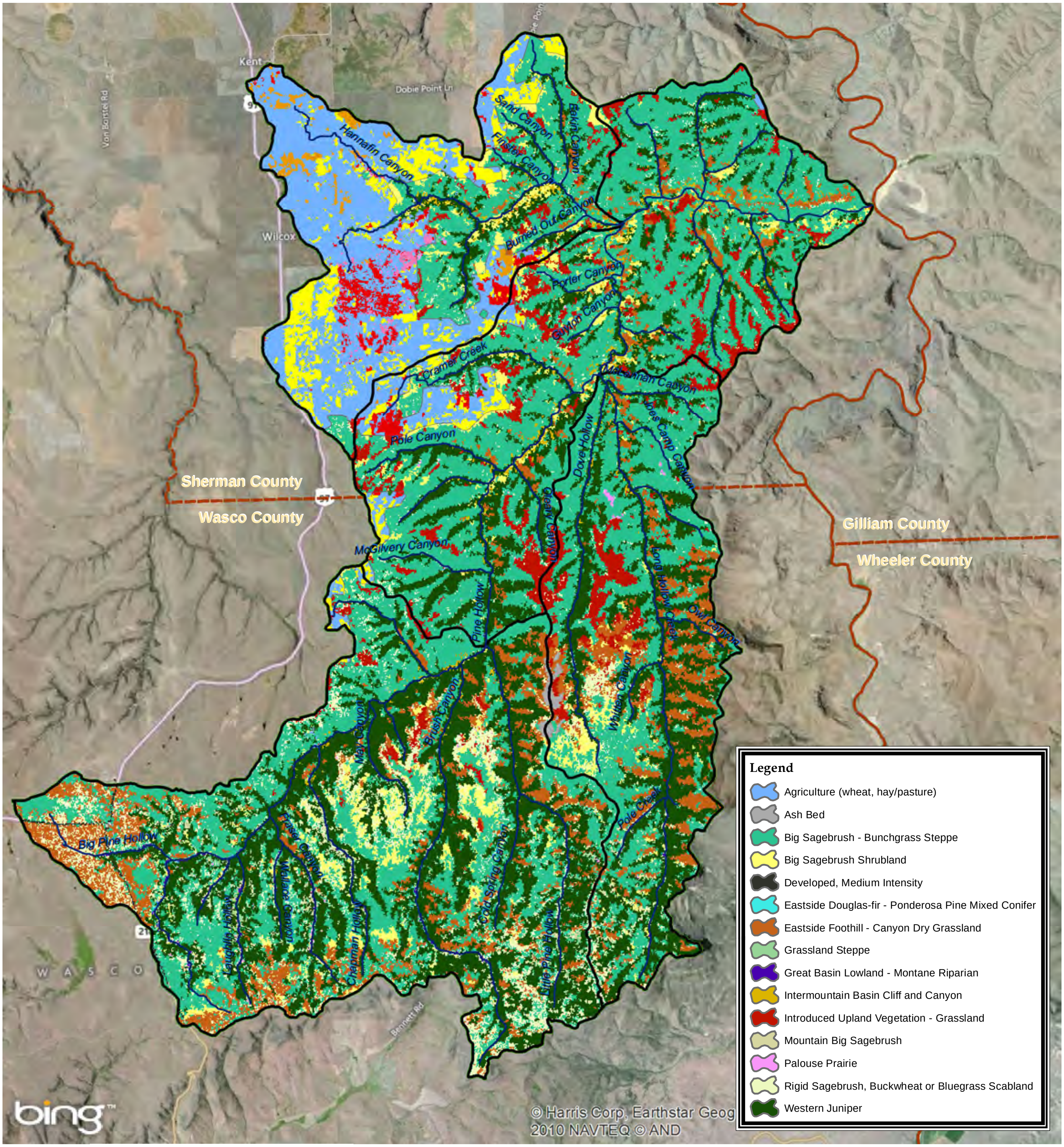
Map 15: Channel Modifications

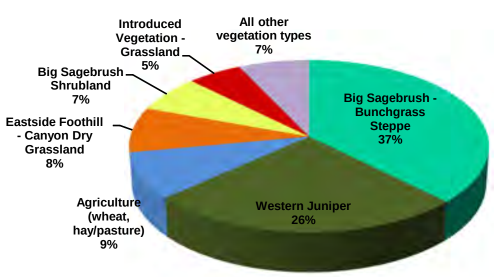
Pine Hollow - Jackknife Creek Watershed

Sherman and Wasco Counties, Oregon

July 23, 2012

Data Source: (c) 2010 Microsoft Corporation and its data suppliers; Bureau of Land Management, 2007, Oregon Counties; U.S. Dept. of Commerce, Oregon Water Resources Dept., Oregon Water Rights Database





0 1 2 4 6 Miles

Scale: 1 inch = 2 miles

N W E S

Map 16: Pine Hollow Watershed Vegetation Communities

SWCD EST. 1950

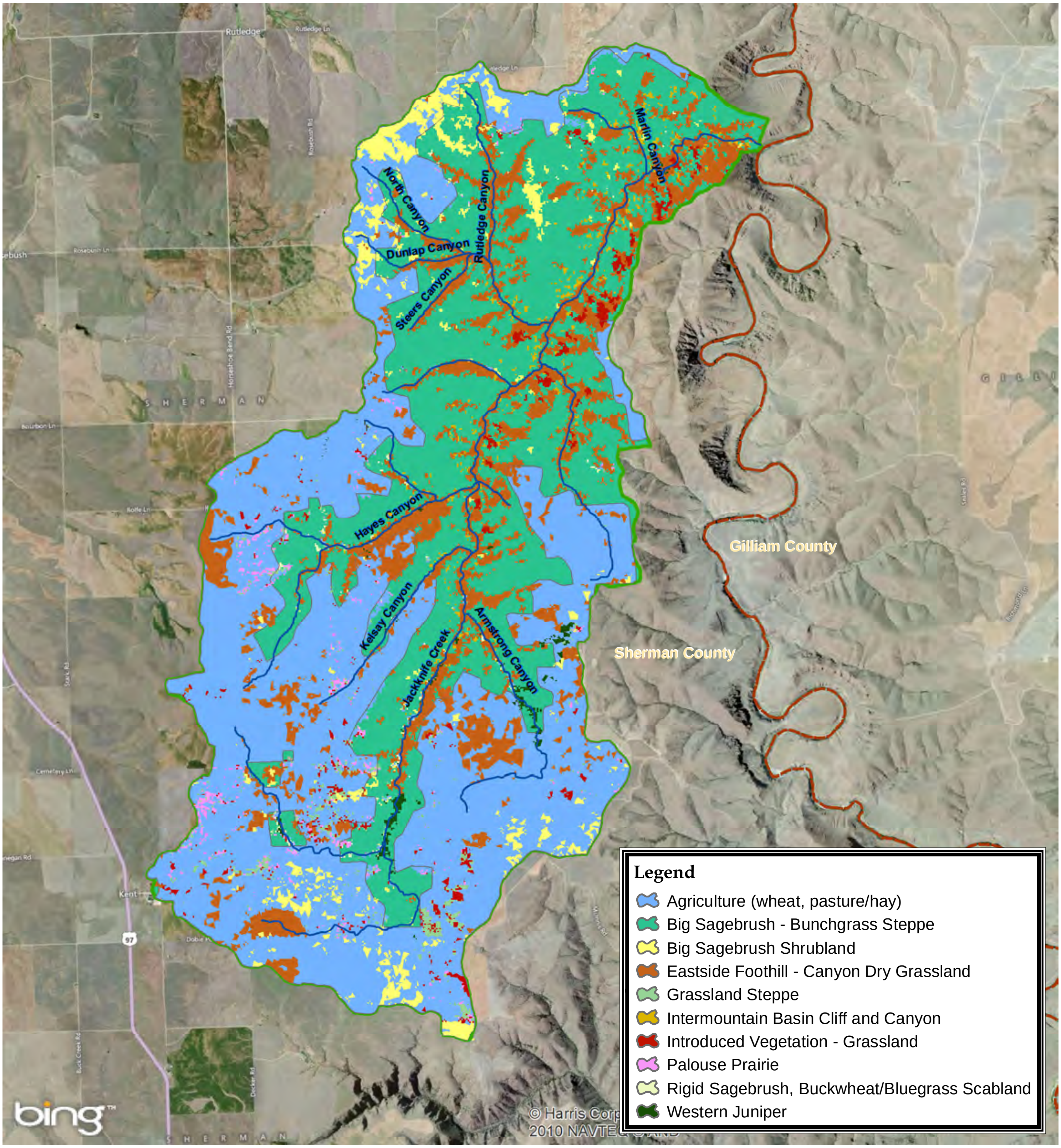
CASCADE ENVIRONMENTAL GROUP

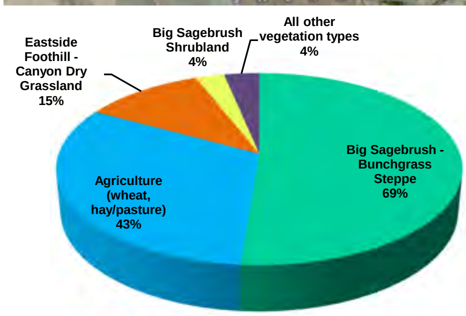
Pine Hollow - Jackknife Creek Watershed

Sherman and Wasco Counties, Oregon

July 23, 2012

Data Source: Eco-System Life Form Data, Institute for Natural Resources, Oregon State University, 2010





0 0.5 1 2 3 Miles

Scale: 1 inch = 2 miles

Map 17: Jackknife Creek Watershed Vegetation Communities

SWCD EST. 1950

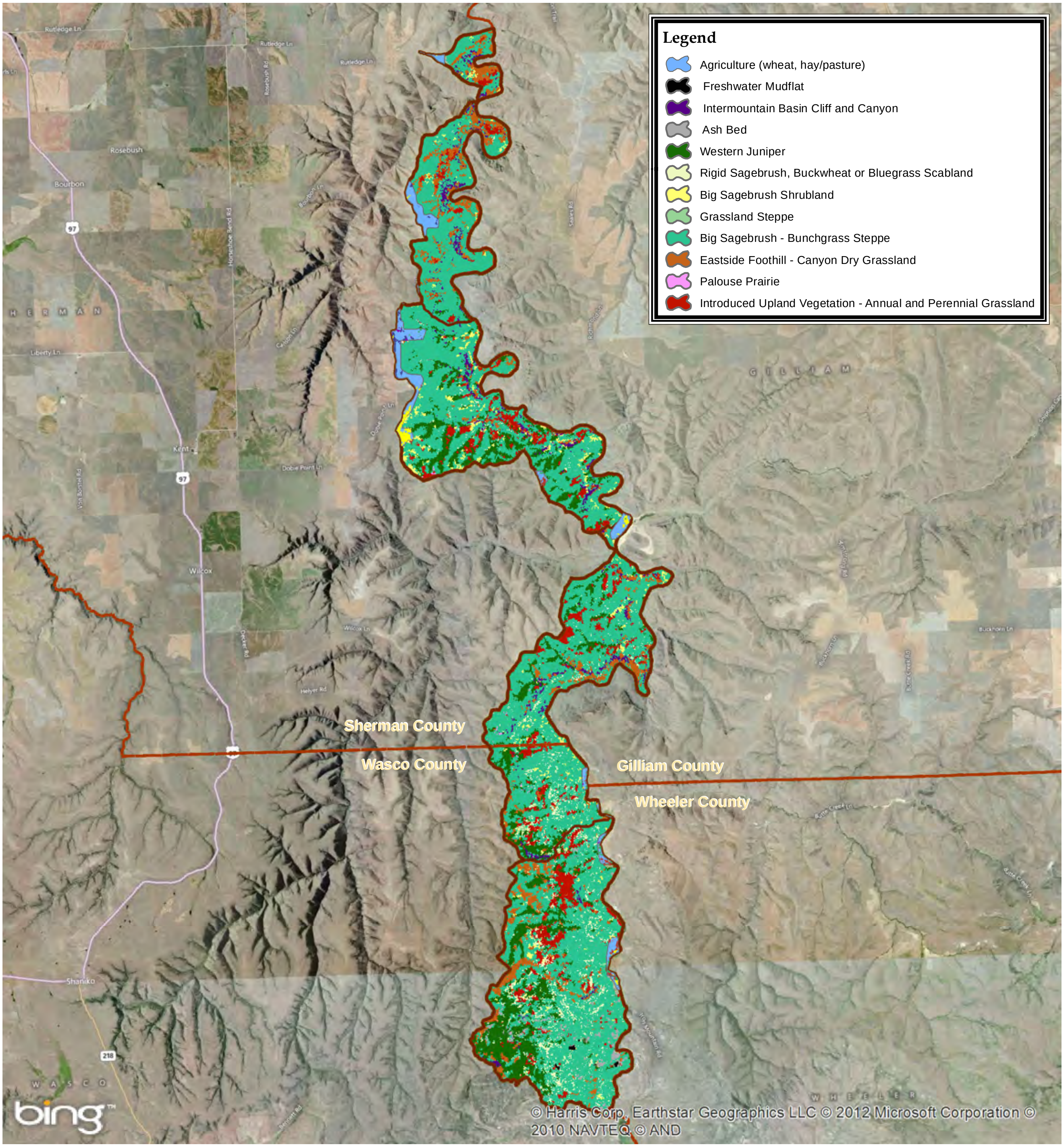
CASCADE ENVIRONMENTAL GROUP

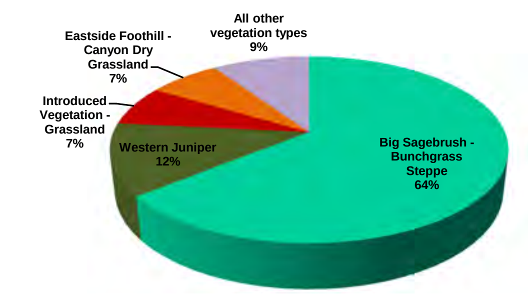
Pine Hollow - Jackknife Creek Basin

Sherman and Wasco Counties, Oregon

July 23, 2012

Data Source: Eco-System Life Form Data, Institute for Natural Resources, Oregon State University, 2010





0 1.5 3 6 9 Miles

Scale: 1 inch = 3 miles

Map 18: Canyon Tributaries Watershed Vegetation Communities

SWCD EST. 1950

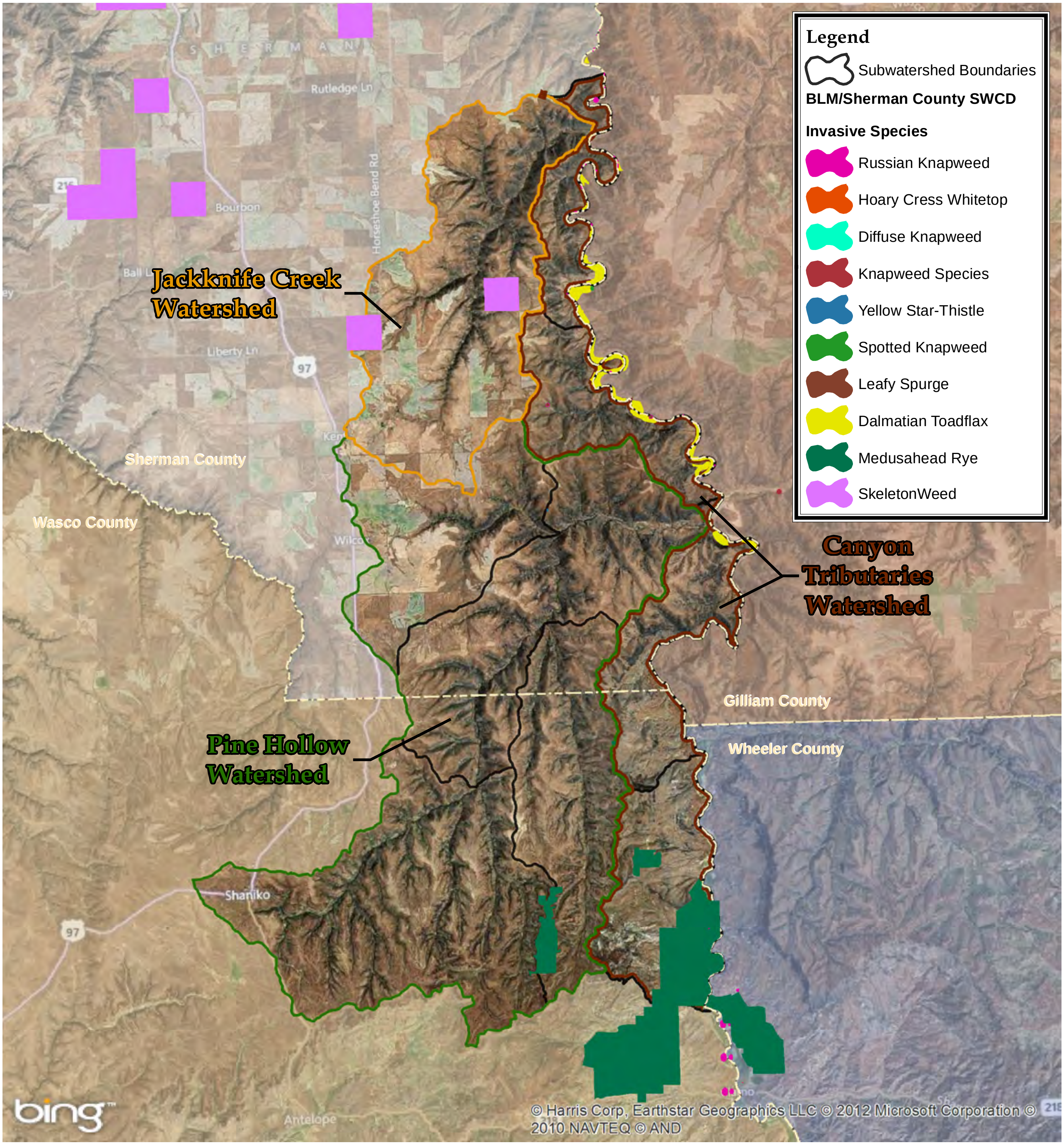
CASCADE ENVIRONMENTAL GROUP

Pine Hollow - Jackknife Creek Basin

Sherman and Wasco Counties, Oregon

July 23, 2012

Data Source: Eco-System Life Form Data, Institute for Natural Resources, Oregon State University, 2010



0 1.5 3 6 9 Miles

Scale: 1 inch = 4 miles

N
W E
S

Map 19: Invasive Plant Species

SWCD SC EST. 1950

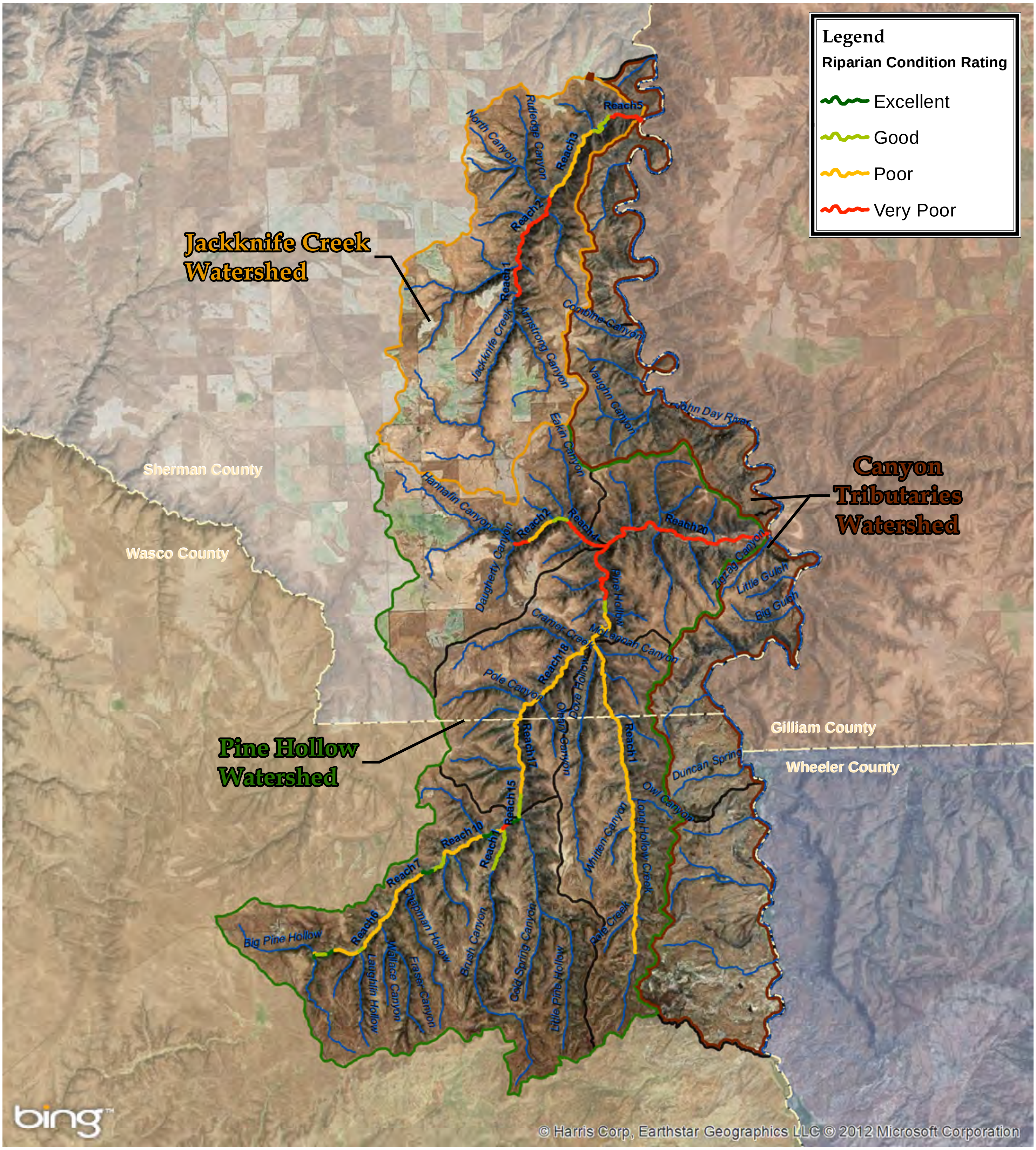
CASCADE ENVIRONMENTAL GROUP

Pine Hollow - Jackknife Creek Watershed

Sherman and Wasco Counties, Oregon

July 23, 2012

Data Source: Bureau of Land Managment, 2007, Oregon Counties;
Bureau of Land Management, 2012, Invasive Species Occurrences;
Sherman County Soil and Water Conservation District, 2012



0 1.25 2.5 5 7.5 Miles

Scale: 1 inch = 4 miles

N W E S

Map 20: Riparian Condition Assessment

SWCD EST. 1950

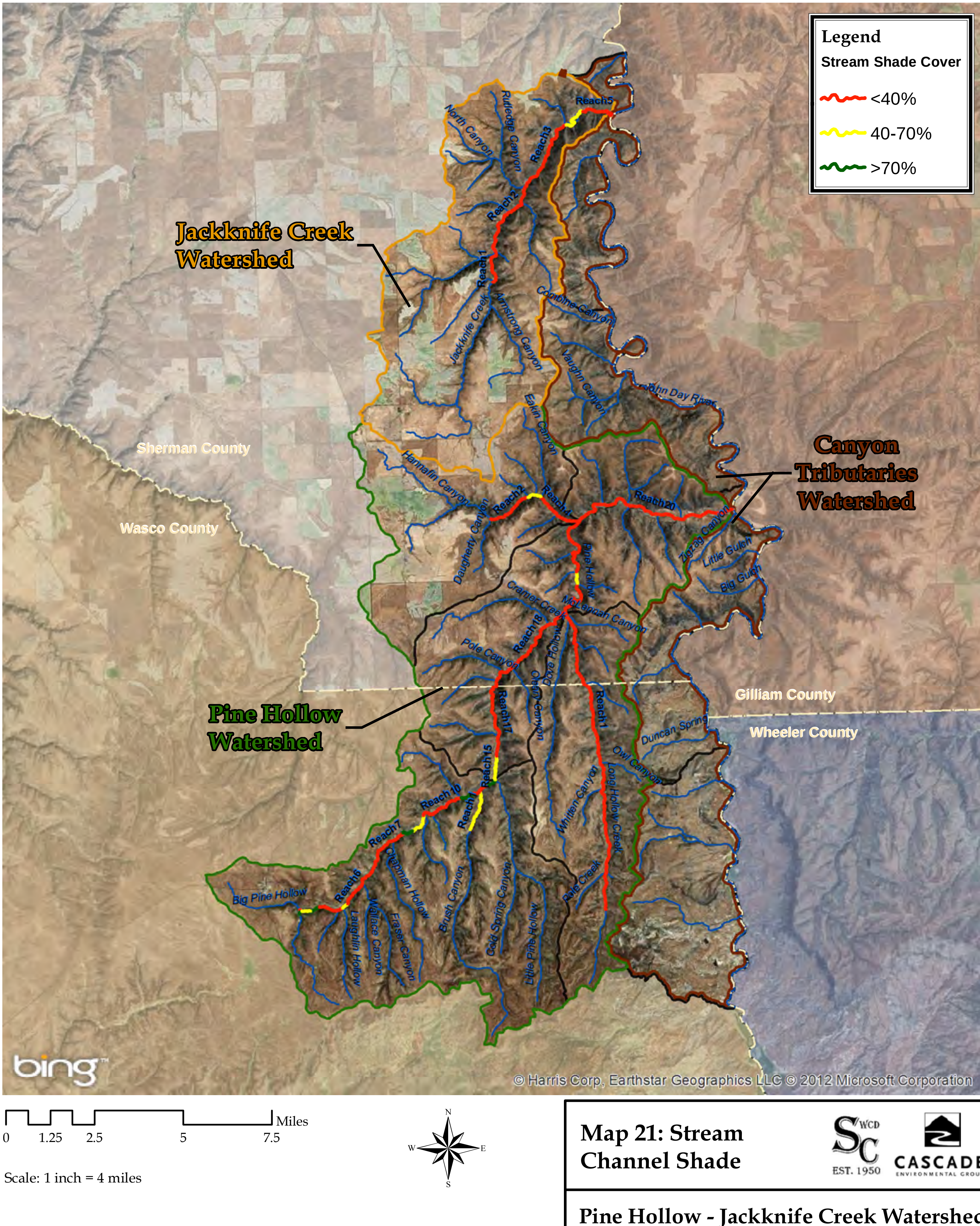
CASCADE ENVIRONMENTAL GROUP

Pine Hollow - Jackknife Creek Watershed

Sherman and Wasco Counties, Oregon

July 23, 2012

Data Source: Pacific Northwest Hydrography;
Bureau of Land Management, 2007, Oregon Counties



Scale: 1 inch = 4 miles

Map 21: Stream Channel Shade

SWCD EST. 1950

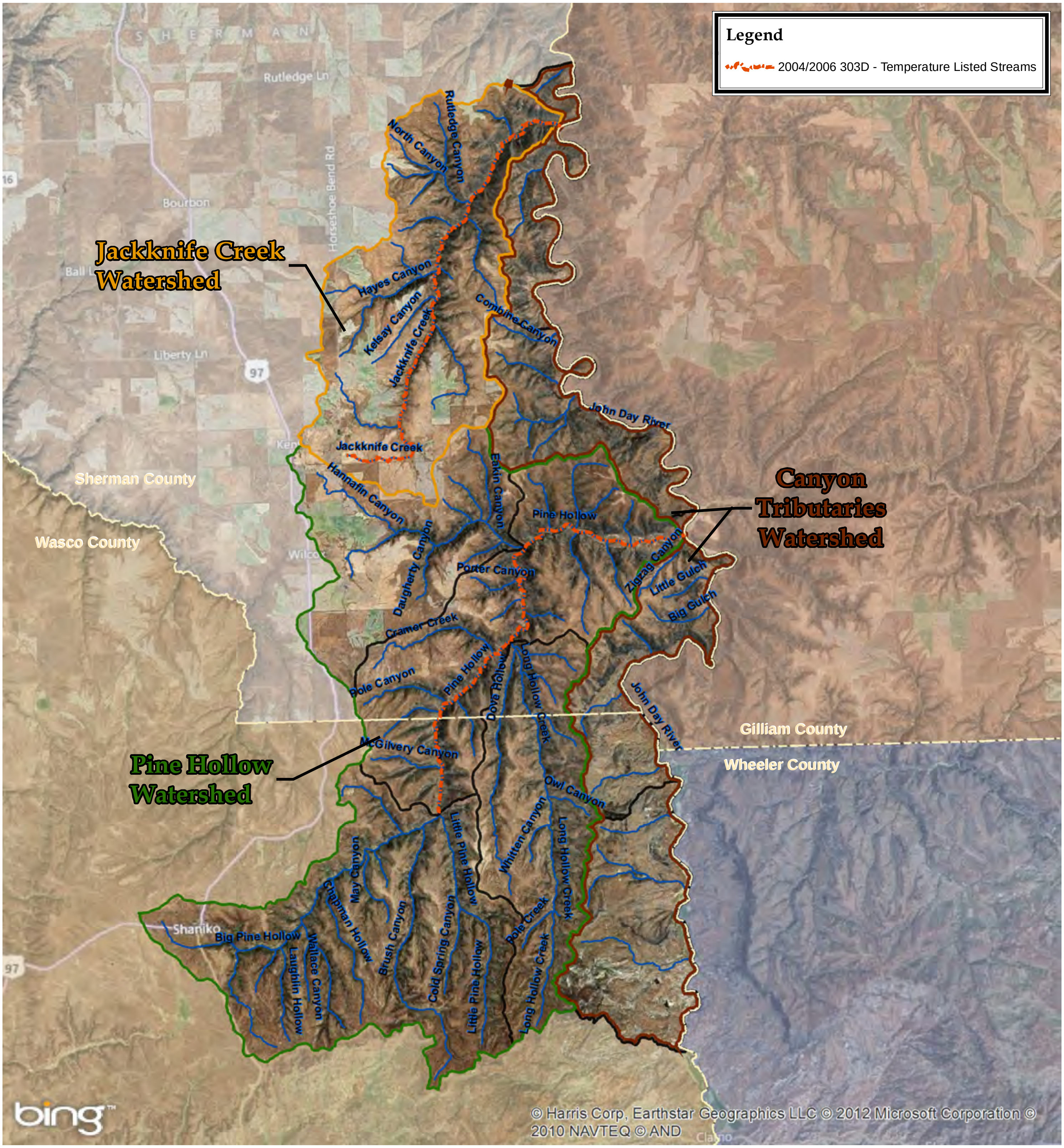
CASCADE ENVIRONMENTAL GROUP

Pine Hollow - Jackknife Creek Watershed

Sherman and Wasco Counties, Oregon

July 23, 2012

Data Source: Pacific Northwest Hydrography;
Bureau of Land Management, 2007, Oregon Counties



0 1.5 3 6 9 Miles

Scale: 1 inch = 4 miles

N S W E

Map 22: Water Temperature Limited Streams

SWCD EST. 1950

CASCADE ENVIRONMENTAL GROUP

Pine Hollow -- Jackknife Creek Watershed

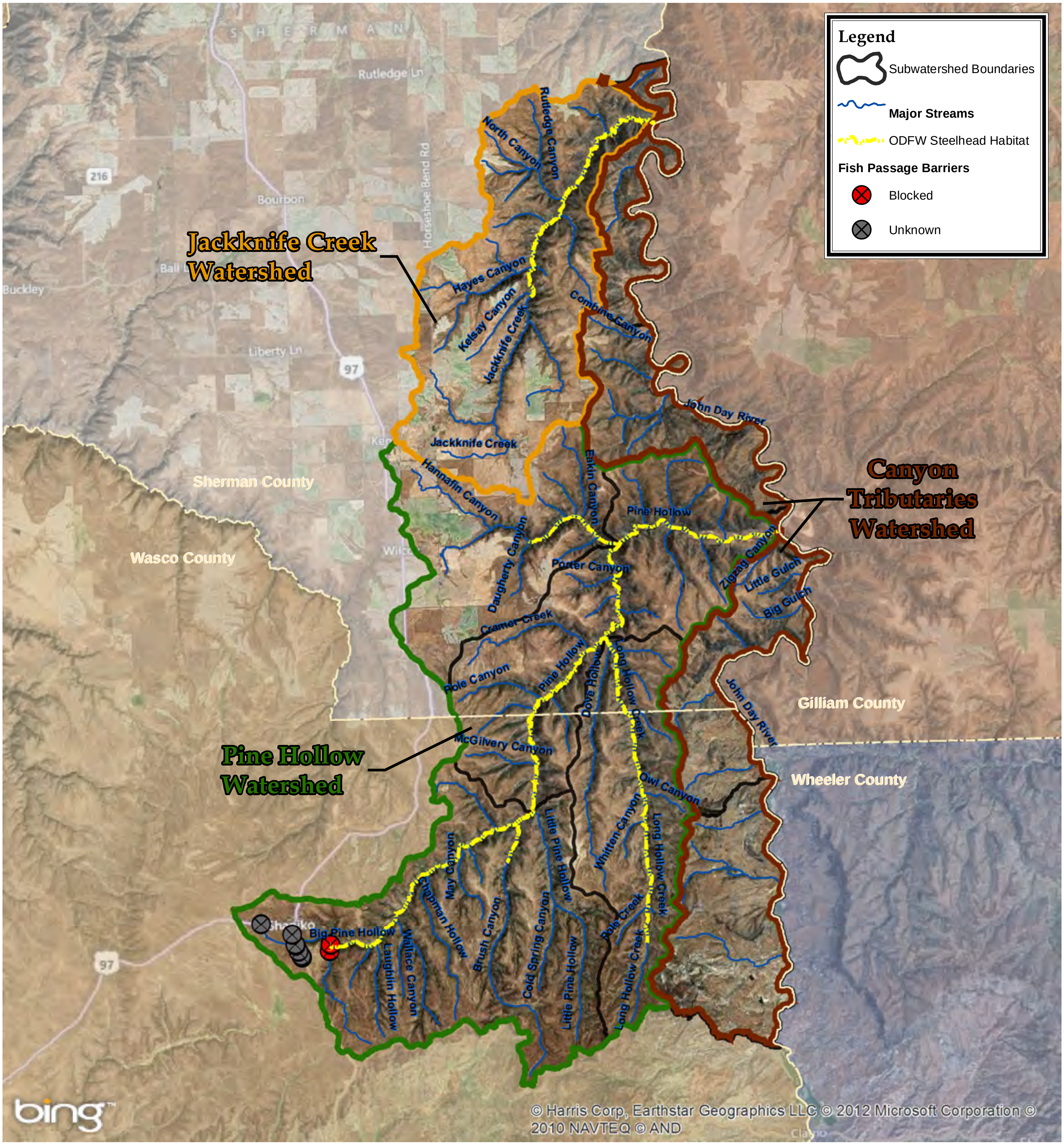
Sherman and Wasco Counties, Oregon

July 23, 2012

Data Source: Bureau of Land Managment, 2007, Oregon Counties; OR. Dept. of Environmental Quality, 2004/2006 Water Quality Assessment

Water Quality Details:

Stream Name	Miles Listed
Jackknife Creek	14.4
Pine Hollow Creek	14.9
Total	29.3



0 1.5 3 6 9 Miles

Scale: 1 inch = 4 miles

N W E S

Map 23: Steelhead Trout Habitat Distribution

SWCD EST. 1950

CASCADE ENVIRONMENTAL GROUP

Pine Hollow - Jackknife Creek Watershed

Sherman and Wasco Counties, Oregon

July 23, 2012

Data Source: Bureau of Land Management 2007, Oregon Counties; Pacific Hydrography Network. 2005. "Oregon Water Courses"; OR Dept of Fish and Wildlife, 2009

Steelhead Habitat Distribution Details:

Pine Hollow Creek: 36.9 miles
Jackknife Creek: 7.7 miles
Total: 81.5 miles

Appendices

Appendix A: Wildlife Species Known to Occur in the Assessment Area

Appendix B: Invasive Species Known to Occur in the Assessment Area

Appendix A: Wildlife Species Known to Occur in the Assessment Area

Element Code	Primary Common Name	Scientific Name	Family	Tax. Class	2010 Natural Areas Program Special Species	ESA Species of Concern
AAABH01070	Bullfrog	*Rana catesbeiana*	Ranidae	Amphibia		
AAABF02030	Great Basin spadefoot	*Spea intermontana*	Scaphiopodidae	Amphibia		
AAAAA01080	Long-toed salamander	*Ambystoma macrodactylum*	Ambystomatidae	Amphibia		
AAABC05100	Pacific chorus frog	*Pseudacris regilla*	Hylidae	Amphibia		
AAABB01030	Western toad	*Bufo boreas*	Bufonidae	Amphibia		
ABNND02010	American avocet	*Recurvirostra americana*	Recurvirostridae	Aves		
ABNGA01020	American bittern	*Botaurus lentiginosus*	Ardeidae	Aves		
ABNME14020	American coot	*Fulica americana*	Rallidae	Aves		
ABPAV10010	American crow	*Corvus brachyrhynchos*	Corvidae	Aves		
ABPBY06110	American goldfinch	*Carduelis tristis*	Fringillidae	Aves		
ABNKD06020	American kestrel	*Falco sparverius*	Falconidae	Aves		
ABPBM02050	American pipit	*Anthus rubescens*	Motacillidae	Aves		
ABPBJ20170	American robin	*Turdus migratorius*	Turdidae	Aves		
ABNJB10180	American wigeon	*Anas americana*	Anatidae	Aves		
ABPAE43050	Ash-throated flycatcher	*Myiarchus cinerascens*	Tyrannidae	Aves		
ABNKC10010	Bald eagle	*Haliaeetus leucocephalus*	Accipitridae	Aves		
ABPAU08010	Bank swallow	*Riparia riparia*	Hirundinidae	Aves		
ABNSA01010	Barn owl	*Tyto alba*	Tytonidae	Aves		
ABPAU09030	Barn swallow	*Hirundo rustica*	Hirundinidae	Aves		
ABNJB18020	Barrow's goldeneye	*Bucephala islandica*	Anatidae	Aves		
ABNXD01020	Belted kingfisher	*Ceryle alcyon*	Alcedinidae	Aves		
ABPBG07010	Bewick's wren	*Thryomanes bewickii*	Troglodytidae	Aves		
ABPAV09010	Black-billed magpie	*Pica hudsonia*	Corvidae	Aves		
ABPAW01010	Black-capped chickadee	*Poecile atricapillus*	Paridae	Aves		
ABNUC45020	Black-chinned hummingbird	*Archilochus alexandri*	Trochilidae	Aves		
ABNGA11010	Black-crowned night-heron	*Nycticorax nycticorax*	Ardeidae	Aves		
ABPBX61040	Black-headed grosbeak	*Pheucticus melanocephalus*	Cardinalidae	Aves		
ABPBX03070	Black-throated gray warbler	*Dendroica nigrescens*	Parulidae	Aves		
ABNJB10130	Blue-winged teal	*Anas discors*	Anatidae	Aves		
ABPBXB5020	Brewer's blackbird	*Euphagus cyanocephalus*	Icteridae	Aves		
ABPBX94040	Brewer's sparrow	*Spizella breweri*	Emberizidae	Aves		
ABPBA01010	Brown creeper	*Certhia americana*	Certhiidae	Aves		
ABPBXB7030	Brown-headed cowbird	*Molothrus ater*	Icteridae	Aves		
ABNJB18030	Bufflehead	*Bucephala albeola*	Anatidae	Aves	X	
ABPBXB9220	Bullock's oriole	*Icterus bullockii*	Icteridae	Aves		
ABNSB10010	Burrowing owl	*Athene cunicularia*	Strigidae	Aves		

Element Code	Primary Common Name	Scientific Name	Family	Tax. Class	2010 Natural Areas Program Special Species	ESA Species of Concern
ABPAY01010	Bushtit	*Psaltriparus minimus*	Aegithalidae	Aves		
ABNNM03110	California gull	*Larus californicus*	Laridae	Aves		
ABNLC23040	California quail	*Callipepla californica*	Odontophoridae	Aves		
ABNUC48010	Calliope hummingbird	*Stellula calliope*	Trochilidae	Aves		
ABNJB05030	Canada goose	*Branta canadensis*	Anatidae	Aves		
ABNJB11020	Canvasback	*Aythya valisineria*	Anatidae	Aves		
ABPBG04010	Canyon wren	*Catherpes mexicanus*	Troglodytidae	Aves		
ABPBY04030	Cassin's finch	*Carpodacus cassinii*	Fringillidae	Aves		
ABPBW01290	Cassin's vireo	*Vireo cassinii*	Vireonidae	Aves		
ABPBN01020	Cedar waxwing	*Bombycilla cedrorum*	Bombycillidae	Aves		
ABPBX94020	Chipping sparrow	*Spizella passerina*	Emberizidae	Aves		
ABNLC03010	Chukar	*Alectoris chukar*	Phasianidae	Aves		
ABNJB10140	Cinnamon teal	*Anas cyanoptera*	Anatidae	Aves		
ABPAU09010	Cliff swallow	*Petrochelidon pyrrhonota*	Hirundinidae	Aves		
ABNJB21010	Common merganser	*Mergus merganser*	Anatidae	Aves		
ABNTA02020	Common nighthawk	*Chordeiles minor*	Caprimulgidae	Aves		
ABNTA04010	Common poorwill	*Phalaenoptilus nuttallii*	Caprimulgidae	Aves		
ABPAV10110	Common raven	*Corvus corax*	Corvidae	Aves		
ABPBX12010	Common yellowthroat	*Geothlypis trichas*	Parulidae	Aves		
ABNKC12040	Cooper's hawk	*Accipiter cooperii*	Accipitridae	Aves		
ABPAE33160	Cordilleran flycatcher	*Empidonax occidentalis*	Tyrannidae	Aves		
ABPBXA5020	Dark-eyed junco	*Junco hyemalis*	Emberizidae	Aves		
ABNFD01020	Double-crested cormorant	*Phalacrocorax auritus*	Phalacrocoracidae	Aves		
ABNYF07030	Downy woodpecker	*Picoides pubescens*	Picidae	Aves		
ABPAE33090	Dusky flycatcher	*Empidonax oberholseri*	Tyrannidae	Aves		
ABNCA03030	Eared grebe	*Podiceps nigricollis*	Podicipedidae	Aves		
ABPAE52060	Eastern kingbird	*Tyrannus tyrannus*	Tyrannidae	Aves		
ABPBT01010	European starling	*Sturnus vulgaris*	Sturnidae	Aves		
ABPBY09020	Evening grosbeak	*Coccothraustes vespertinus*	Fringillidae	Aves		
ABNKC19120	Ferruginous hawk	*Buteo regalis*	Accipitridae	Aves		X
ABNNM08090	Forster's tern	*Sterna forsteri*	Laridae	Aves		
ABNJB10160	Gadwall	*Anas strepera*	Anatidae	Aves		
ABNKC22010	Golden eagle	*Aquila chrysaetos*	Accipitridae	Aves		
ABPBJ05010	Golden-crowned kinglet	*Regulus satrapa*	Regulidae	Aves		
ABPBXA0020	Grasshopper sparrow	*Ammodramus savannarum*	Emberizidae	Aves	X	
ABPAE33100	Gray flycatcher	*Empidonax wrightii*	Tyrannidae	Aves		
ABNLC01010	Gray partridge	*Perdix perdix*	Phasianidae	Aves		

Element Code	Primary Common Name	Scientific Name	Family	Tax. Class	2010 Natural Areas Program Special Species	ESA Species of Concern
ABPBY02030	Gray-crowned rosy-finch	*Leucosticte tephrocotis*	Fringillidae	Aves		
ABNGA04010	Great blue heron	*Ardea herodias*	Ardeidae	Aves		
ABNSB05010	Great horned owl	*Bubo virginianus*	Strigidae	Aves		
ABNLC12010	Greater sage-grouse	*Centrocercus urophasianus*	Phasianidae	Aves	X	
ABPBX74010	Green-tailed towhee	*Pipilo chlorurus*	Emberizidae	Aves		
ABNJB10010	Green-winged teal	*Anas crecca*	Anatidae	Aves		
ABNYF07040	Hairy woodpecker	*Picoides villosus*	Picidae	Aves		
ABPBJ18110	Hermit thrush	*Catharus guttatus*	Turdidae	Aves		
ABNJB20010	Hooded merganser	*Lophodytes cucullatus*	Anatidae	Aves		
ABPAT02010	Horned lark	*Eremophila alpestris*	Alaudidae	Aves		
ABPBY04040	House finch	*Carpodacus mexicanus*	Fringillidae	Aves		
ABPBZ01010	House sparrow	*Passer domesticus*	Passeridae	Aves		
ABPBG09010	House wren	*Troglodytes aedon*	Troglodytidae	Aves		
ABNNB03090	Killdeer	*Charadrius vociferus*	Charadriidae	Aves		
ABPBX96010	Lark sparrow	*Chondestes grammacus*	Emberizidae	Aves		
ABPBX64020	Lazuli bunting	*Passerina amoena*	Cardinalidae	Aves		
ABPBY06090	Lesser goldfinch	*Carduelis psaltria*	Fringillidae	Aves		
ABNJB11070	Lesser scaup	*Aythya affinis*	Anatidae	Aves		
ABNYF04010	Lewis's woodpecker	*Melanerpes lewis*	Picidae	Aves	X	X
ABPBR01030	Loggerhead shrike	*Lanius ludovicianus*	Laniidae	Aves		
ABNNF07070	Long-billed curlew	*Numenius americanus*	Scolopacidae	Aves		
ABNSB13010	Long-eared owl	*Asio otus*	Strigidae	Aves		
ABPBX11040	Macgillivray's warbler	*Oporornis tolmiei*	Parulidae	Aves		
ABNJB10060	Mallard	*Anas platyrhynchos*	Anatidae	Aves		
ABPBG10020	Marsh wren	*Cistothorus palustris*	Troglodytidae	Aves		
ABPBJ15030	Mountain bluebird	*Sialia currucoides*	Turdidae	Aves		
ABPAW01040	Mountain chickadee	*Poecile gambeli*	Paridae	Aves		
ABNLC24010	Mountain quail	*Oreortyx pictus*	Odontophoridae	Aves		X
ABNPB04040	Mourning dove	*Zenaida macroura*	Columbidae	Aves		
ABNYF10020	Northern flicker	*Colaptes auratus*	Picidae	Aves		
ABNKC12060	Northern goshawk	*Accipiter gentilis*	Accipitridae	Aves		X
ABNKC11010	Northern harrier	*Circus cyaneus*	Accipitridae	Aves		
ABNJB10110	Northern pintail	*Anas acuta*	Anatidae	Aves		
ABNSB08010	Northern pygmy-owl	*Glaucidium gnoma*	Strigidae	Aves		
ABPAU07010	Northern rough-winged swallow	*Stelgidopteryx serripennis*	Hirundinidae	Aves		
ABNSB15020	Northern saw-whet owl	*Aegolius acadicus*	Strigidae	Aves		
ABNJB10150	Northern shoveler	*Anas clypeata*	Anatidae	Aves		
ABPBX01050	Orange-crowned warbler	*Vermivora celata*	Parulidae	Aves		

Element Code	Primary Common Name	Scientific Name	Family	Tax. Class	2010 Natural Areas Program Special Species	ESA Species of Concern
ABNKC01010	Osprey	*Pandion haliaetus*	Accipitridae	Aves		
ABNKD06070	Peregrine falcon	*Falco peregrinus*	Falconidae	Aves		
ABNCA02010	Pied-billed grebe	*Podilymbus podiceps*	Podicipedidae	Aves		
ABNKD06090	Prairie falcon	*Falco mexicanus*	Falconidae	Aves		
ABPAZ01030	Pygmy nuthatch	*Sitta pygmaea*	Sittidae	Aves		
ABPBY05010	Red crossbill	*Loxia curvirostra*	Fringillidae	Aves		
ABNJB11030	Redhead	*Aythya americana*	Anatidae	Aves		
ABNKC19110	Red-tailed hawk	*Buteo jamaicensis*	Accipitridae	Aves		
ABPBXB0010	Red-winged blackbird	*Agelaius phoeniceus*	Icteridae	Aves		
ABNNM03100	Ring-billed gull	*Larus delawarensis*	Laridae	Aves		
ABNJB11040	Ring-necked duck	*Aythya collaris*	Anatidae	Aves		
ABNLC07010	Ring-necked pheasant	*Phasianus colchicus*	Phasianidae	Aves		
ABNPB01010	Rock pigeon	*Columba livia*	Columbidae	Aves		
ABPBG03010	Rock wren	*Salpinctes obsoletus*	Troglodytidae	Aves		
ABPBJ05020	Ruby-crowned kinglet	*Regulus calendula*	Regulidae	Aves		
ABNJB22010	Ruddy duck	*Oxyura jamaicensis*	Anatidae	Aves		
ABNLC11010	Ruffed grouse	*Bonasa umbellus*	Phasianidae	Aves		
ABNUC51020	Rufous hummingbird	*Selasphorus rufus*	Trochilidae	Aves		
ABPBK04010	Sage thrasher	*Oreoscoptes montanus*	Mimidae	Aves		
ABNMK01010	Sandhill crane	*Grus canadensis*	Gruidae	Aves		
ABPBX99010	Savannah sparrow	*Passerculus sandwichensis*	Emberizidae	Aves		
ABPAE35030	Say's phoebe	*Sayornis saya*	Tyrannidae	Aves		
ABNKC12020	Sharp-shinned hawk	*Accipiter striatus*	Accipitridae	Aves		
ABNSB13040	Short-eared owl	*Asio flammeus*	Strigidae	Aves		
ABPBXA3010	Song sparrow	*Melospiza melodia*	Emberizidae	Aves		
ABNME08020	Sora	*Porzana carolina*	Rallidae	Aves		
ABNNF04020	Spotted sandpiper	*Actitis macularius*	Scolopacidae	Aves		
ABPBX74080	Spotted towhee	*Pipilo maculatus*	Emberizidae	Aves		
ABPAV02010	Steller's jay	*Cyanocitta stelleri*	Corvidae	Aves		
ABNKC19070	Swainson's hawk	*Buteo swainsoni*	Accipitridae	Aves		
ABPBJ18100	Swainson's thrush	*Catharus ustulatus*	Turdidae	Aves		
ABPBJ16010	Townsend's solitaire	*Myadestes townsendi*	Turdidae	Aves		
ABPAU03010	Tree swallow	*Tachycineta bicolor*	Hirundinidae	Aves		
ABPBXB0020	Tricolored blackbird	*Agelaius tricolor*	Icteridae	Aves	X	
ABNKA02010	Turkey vulture	*Cathartes aura*	Cathartidae	Aves		
ABPBJ22010	Varied thrush	*Ixoreus naevius*	Turdidae	Aves		
ABNUA03020	Vaux's swift	*Chaetura vauxi*	Apodidae	Aves		
ABPBX95010	Vesper sparrow	*Pooecetes gramineus*	Emberizidae	Aves		
ABPAU03040	Violet-green swallow	*Tachycineta thalassina*	Hirundinidae	Aves		
ABNME05030	Virginia rail	*Rallus limicola*	Rallidae	Aves		

Element Code	Primary Common Name	Scientific Name	Family	Tax. Class	2010 Natural Areas Program Special Species	ESA Species of Concern
ABPBW01210	Warbling vireo	*Vireo gilvus*	Vireonidae	Aves		
ABPBJ15020	Western bluebird	*Sialia mexicana*	Turdidae	Aves		
ABNCA04010	Western grebe	*Aechmophorus occidentalis*	Podicipedidae	Aves		
ABPAE52050	Western kingbird	*Tyrannus verticalis*	Tyrannidae	Aves		
ABPBXB2030	Western meadowlark	*Sturnella neglecta*	Icteridae	Aves		
ABNSB01040	Western screech-owl	*Megascops kennicottii*	Strigidae	Aves		
ABPBX45050	Western tanager	*Piranga ludoviciana*	Thraupidae	Aves		
ABPAE32050	Western wood-pewee	*Contopus sordidulus*	Tyrannidae	Aves		
ABPAZ01020	White-breasted nuthatch	*Sitta carolinensis*	Sittidae	Aves		
ABPBXA4040	White-crowned sparrow	*Zonotrichia leucophrys*	Emberizidae	Aves		
ABNUA06010	White-throated swift	*Aeronautes saxatalis*	Apodidae	Aves		
ABNLC14010	Wild turkey	*Meleagris gallopavo*	Phasianidae	Aves		
ABPAE33040	Willow flycatcher	*Empidonax traillii*	Tyrannidae	Aves		X
ABNNF20010	Wilson's phalarope	*Phalaropus tricolor*	Scolopacidae	Aves		
ABNNF18030	Wilson's snipe	*Gallinago delicata*	Scolopacidae	Aves		
ABPBX16020	Wilson's warbler	*Wilsonia pusilla*	Parulidae	Aves		
ABNJB09010	Wood duck	*Aix sponsa*	Anatidae	Aves		
ABPBX03010	Yellow warbler	*Dendroica petechia*	Parulidae	Aves		
ABPBX24010	Yellow-breasted chat	*Icteria virens*	Parulidae	Aves		X
ABPBXB3010	Yellow-headed blackbird	*Xanthocephalus xanthocephalus*	Icteridae	Aves		
ABPBX03060	Yellow-rumped warbler	*Dendroica coronata*	Parulidae	Aves		
AMAJF04010	Ameican badger	*Taxidea taxus*	Mustelidae	Mammalia		
AMAFE01010	American beaver	*Castor canadensis*	Castoridae	Mammalia		
AMAFB05060	Belding's ground squirrel	*Spermophilus beldingi*	Sciuridae	Mammalia		
AMACC04010	Big brown bat	*Eptesicus fuscus*	Vespertilionidae	Mammalia		
AMALE04010	Bighorn sheep	*Ovis canadensis*	Bovidae	Mammalia		
AMAJB01010	Black bear	*Ursus americanus*	Ursidae	Mammalia		
AMALC02010	Black-tailed deer	*Odocoileus hemionus*	Cervidae	Mammalia		
AMAEB03050	Black-tailed jack rabbit	*Lepus californicus*	Leporidae	Mammalia		
AMAJH03020	Bobcat	*Lynx rufus*	Felidae	Mammalia		
AMAFF08090	Bushy-tailed woodrat	*Neotoma cinerea*	Cricetidae	Mammalia		
AMACC01120	California myotis	*Myotis californicus*	Vespertilionidae	Mammalia		
AMAFF03090	Canyon mouse	*Peromyscus crinitus*	Cricetidae	Mammalia		
AMABB02020	Coast mole	*Scapanus orarius*	Talpidae	Mammalia		
AMAFJ01010	Common porcupine	*Erethizon dorsatum*	Erethizontidae	Mammalia		
AMAJE02010	Common raccoon	*Procyon lotor*	Procyonidae	Mammalia		
AMAJA01010	Coyote	*Canis latrans*	Canidae	Mammalia		

Element Code	Primary Common Name	Scientific Name	Family	Tax. Class	2010 Natural Areas Program Special Species	ESA Species of Concern
AMAFF03040	Deer mouse	*Peromyscus maniculatus*	Cricetidae	Mammalia		
AMAFB08020	Douglas' squirrel	*Tamiasciurus douglasii*	Sciuridae	Mammalia		
AMABA01080	Dusky shrew	*Sorex monticolus*	Soricidae	Mammalia		
AMALC01010	Elk	*Cervus canadensis*	Cervidae	Mammalia		
AMAJF02010	Ermine	*Mustela erminea*	Mustelidae	Mammalia		
AMAFB05170	Golden-mantled ground squirrel	*Spermophilus lateralis*	Sciuridae	Mammalia		
AMAJA01030	Gray Wolf	*Canis lupus*	Canidae	Mammalia	X	
AMAFD01070	Great Basin pocket mouse	*Perognathus parvus*	Heteromyidae	Mammalia		
AMACC05030	Hoary bat	*Lasiurus cinereus*	Vespertilionidae	Mammalia		
AMAFF22010	House mouse	*Mus musculus*	Muridae	Mammalia		
AMAFB02020	Least chipmunk	*Neotamias minimus*	Sciuridae	Mammalia		
AMACC01010	Little brown myotis	*Myotis lucifugus*	Vespertilionidae	Mammalia		
AMACC01070	Long-eared myotis	*Myotis evotis*	Vespertilionidae	Mammalia		X
AMACC01110	Long-legged myotis	*Myotis volans*	Vespertilionidae	Mammalia		X
AMAJF02030	Long-tailed weasel	*Mustela frenata*	Mustelidae	Mammalia		
AMAFB05210	Merriam's ground squirrel	*Spermophilus canus*	Sciuridae	Mammalia		
AMABA01230	Merriam's shrew	*Sorex merriami*	Soricidae	Mammalia		
AMAJF02050	Mink	*Neovison vison*	Mustelidae	Mammalia		
AMAFF11020	Montane vole	*Microtus montanus*	Cricetidae	Mammalia		
AMAJH04010	Mountain lion	*Puma concolor*	Felidae	Mammalia		
AMAFF15010	Muskrat	*Ondatra zibethicus*	Cricetidae	Mammalia		
AMAFF06010	Northern grasshopper mouse	*Onychomys leucogaster*	Cricetidae	Mammalia		
AMAFC01040	Northern pocket gopher	*Thomomys talpoides*	Geomyidae	Mammalia		
AMAJF10010	Northern river otter	*Lontra canadensis*	Mustelidae	Mammalia		
AMAEB01060	Nuttall's cottontail	*Sylvilagus nuttallii*	Leporidae	Mammalia		
AMAFD03010	Ord's kangaroo rat	*Dipodomys ordii*	Heteromyidae	Mammalia		
AMACC10010	Pallid bat	*Antrozous pallidus*	Vespertilionidae	Mammalia	X	X
AMALD01010	Pronghorn	*Antilocapra americana*	Antilocapridae	Mammalia		
AMAEB04010	Pygmy rabbit	*Brachylagus idahoensis*	Leporidae	Mammalia	X	
AMAFF13010	Sagebrush vole	*Lemmiscus curtatus*	Cricetidae	Mammalia		
AMACC02010	Silver-haired bat	*Lasionycteris noctivagans*	Vespertilionidae	Mammalia		X
AMACC07010	Spotted bat	*Euderma maculatum*	Vespertilionidae	Mammalia	X	X
AMAJF06010	Striped skunk	*Mephitis mephitis*	Mephitidae	Mammalia		
AMACC08010	Townsend's big-eared bat	*Corynorhinus townsendii*	Vespertilionidae	Mammalia	X	X
AMABA01070	Vagrant shrew	*Sorex vagrans*	Soricidae	Mammalia		
AMAFB05020	Washington ground squirrel	*Spermophilus washingtoni*	Sciuridae	Mammalia	X	

Element Code	Primary Common Name	Scientific Name	Family	Tax. Class	2010 Natural Areas Program Special Species	ESA Species of Concern
AMAFF02030	Western harvest mouse	*Reithrodontomys megalotis*	Cricetidae	Mammalia		
AMACC03010	Western pipistrelle	*Pipistrellus hesperus*	Vespertilionidae	Mammalia		
AMACC01140	Western small-footed myotis	*Myotis ciliolabrum*	Vespertilionidae	Mammalia		X
AMAJF05020	Western spotted skunk	*Spilogale gracilis*	Mephitidae	Mammalia		
AMAEB03040	White-tailed jackrabbit	*Lepus townsendii*	Leporidae	Mammalia		
AMAJF03010	Wolverine	*Gulo gulo*	Mustelidae	Mammalia	X	X (Candidate)
AMAFB03020	Yellow-bellied marmot	*Marmota flaviventris*	Sciuridae	Mammalia		
AMAFB02030	Yellow-pine chipmunk	*Neotamias amoenus*	Sciuridae	Mammalia		
AMACC01020	Yuma myotis	*Myotis yumanensis*	Vespertilionidae	Mammalia		X
ARADB36130	Common garter snake	*Thamnophis sirtalis*	Colubridae	Reptilia		
ARADB26020	Gopher snake	*Pituophis catenifer*	Colubridae	Reptilia		
ARADB18010	Night snake	*Hypsiglena torquata*	Colubridae	Reptilia		
ARADB07010	Racer	*Coluber constrictor*	Colubridae	Reptilia		
ARADA01010	Rubber boa	*Charina bottae*	Boidae	Reptilia		
ARACF14030	Sagebrush lizard	*Sceloporus graciosus*	Phrynosomatidae	Reptilia		X
ARACF12030	Short-horned lizard	*Phrynosoma douglasii*	Phrynosomatidae	Reptilia		
ARACF17010	Side-blotched lizard	*Uta stansburiana*	Phrynosomatidae	Reptilia		
ARACB01040	Southern alligator lizard	*Elgaria multicarinata*	Anguidae	Reptilia		
ARADB21040	Striped whipsnake	*Masticophis taeniatus*	Colubridae	Reptilia		
ARACF14080	Western fence lizard	*Sceloporus occidentalis*	Phrynosomatidae	Reptilia		
ARADE02140	Western rattlesnake	*Crotalus oreganus*	Viperidae	Reptilia		
ARACH01110	Western skink	*Eumeces skiltonianus*	Scincidae	Reptilia		
ARADB36050	Western terrestrial garter snake	*Thamnophis elegans*	Colubridae	Reptilia		

Source: Oregon Natural Heritage Information Center, Montana Natural Heritage Program mtnhp.org and NatureServe.Oregon Wildlife Explorer. Wildlife Viewer.http://oe.oregonexplorer.info/Wildlife/wildlifeviewer/. Accessed 8/12/2012; 2010 Oregon Natural Areas Plan; U.S fish and Wildlife Service, Oregon Fish and Wildlife Office, 08/04/2012

Appendix B: Invasive Species Known to Occur in the Assessment Area

Common Name	Scientific Name	Sherman Co Class A Weeds	ODA Designation
Blessed Milkthistle	*Silybum marianum*	A	B
Camelthorn	*Alhagi pseudalhagi*	A	A
Canada Thistle	*Cirsium arvense*	A	B
Common Crupina	*Crupina vulgaris*	A	B
Gorse	*Ulex europaeus*	A	B
Halogeton	*Halogeton glomeratus*	A	B
Iberian Starthistle	*Centaurea iberica*	A	A
Italian Thistle	*Carduus pycnocephalus*	A	B
Jimsonweed	*Datura stramonium*	A	-
Kochia	*Kochia scoparia*	A	B
Leafy Spurge	*Euphorbia esula*	A	B, T
Knapweed Complex	*Centaurea (species)*	A	B (and T for spotted knapweed)
Mediterranean Sage	*Salvia aethiopis*	A	B
Musk Thistle	*Carduus nutans*	A	B
Rush Skeletonweed	*Chondrilla luncea*	A	B, T
Scotch Broom	*Cytisus scoparius*	A	B
Spikeweed	*Hemizonia pungens*	A	B
Tansy Ragwort	*Senecio jacobaea*	A	B, T
Yellow Starthistle	*Centaurea solstitialis*	A	B
Wild-proso Millet	*Panicum miliaceum*	A	-
Canada Thistle	*Cirsium arvense*	B	B
Dalmation Toadflax	*Linaria genistifolia-dalmatic*	B	B, T
Field Bindweed (Morning glory)	*Convolvulus arvensis*	B	B, T
Diffuse Knapweed	*Centaurea diffusa*	B	B (and T for spotted knapweed)
Perennial Sowthistle	*Sonchus arvensis*	B	-
Scotch Thistle	*Onopordum acanthium*	B	B
Scouring rush	*Equisetum laevigatum*	B	-
Showy Milkweed	*Asclepias speciosa*	B	-
Whitetop (Hoary Cress)	*Cardaria draba*	B	B
Wild Oat	*Avena fatua*	B	-
Yellow Starthistle	*Centaurea solstitialis*	B	B
Bull Thistle	*Cirsium vulgare*	C	B
Common Rye	*Secale cereale*	C	-

Common Name	Scientific Name	Sherman Co Class A Weeds	ODA Designation
Field Dodder	*Cuscuta campestris*	C	B
Jointed Goatgrass	*Aegilops cylindrica*	C	B
Klamath Weed (St. Johnswort)	*Hypericum perforatum*	C	B
Little Bur (Bur Buttercup)	*Ranunculus testiculatus*	C	-
Marestail	*Contza canadensis*	C	-
Medusahead Rye	*Taematherum caput-medusae*	C	B
Perennial Pepperweed	*Lepidium latifolium*	C	B, T
Poison Hemlock	*Conium macalatum*	C	B
Prickly Lettuce	*Lactuca serriola*	C	-
Puncturevine	*Triulus terrestris*	C	-
Quackgrass	*Elytrigia repens*	C	-
Russian Thistle	*Salsola iberica*	C	-
Spiny Cocklebur	*Xanthium spinosum*	C	B
Waterhemlock, Western	*Cicuta douglasii*	C	-
Wavyleaf Thistle	*Cirsium undulatum*	C	-