Bakeoven Watershed Assessment and Action Plan

Prepared by
Wasco County Soil and Water Conservation District

For
Bakeoven Watershed Council

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Table of Contents

Tables and Figures

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Bakeoven Watershed Assessment

Introduction

This Assessment has been undertaken by the Bakeoven Watershed Council, in partnership with Wasco County Soil and Water Conservation District. The purpose of the Assessment is to provide a description of conditions and trends in the Bakeoven Creek Watershed relevant to conservation of its natural resources. The objective is to discover where natural resources or processes are working, and where they need to be restored, particularly in regards to fish habitat and water quality.

The term "watershed" describes an area of land that drains to a single outlet. A watershed consists of a network of drainage pathways that can be underground or on the surface. These pathways converge into a stream and river system as the water moves downstream. Bakeoven Watershed includes all of the waters that drain into Bakeoven Creek, between its headwaters near Shaniko Oregon, to its mouth where it joins the Deschutes River in Maupin City Park. Because of the connectivity between groundwater, wetlands, streams and rivers within a watershed, any activity that affects the water quality, quantity, or rate of movement at one location may influence characteristics of the watershed at locations downstream. Everyone who lives, works, or plays within the watershed is part of this system.

The format used in this Assessment follows the Oregon Watershed Assessment Manual, developed for the Governor's Watershed Enhancement Board (July 1999). The assessment examines the history of the watershed, describes its features, evaluates its resources, and identifies issues within the watershed. Characteristics and processes of the watershed as a whole are analyzed, as well as conditions specific to individual streams.

Watershed Description

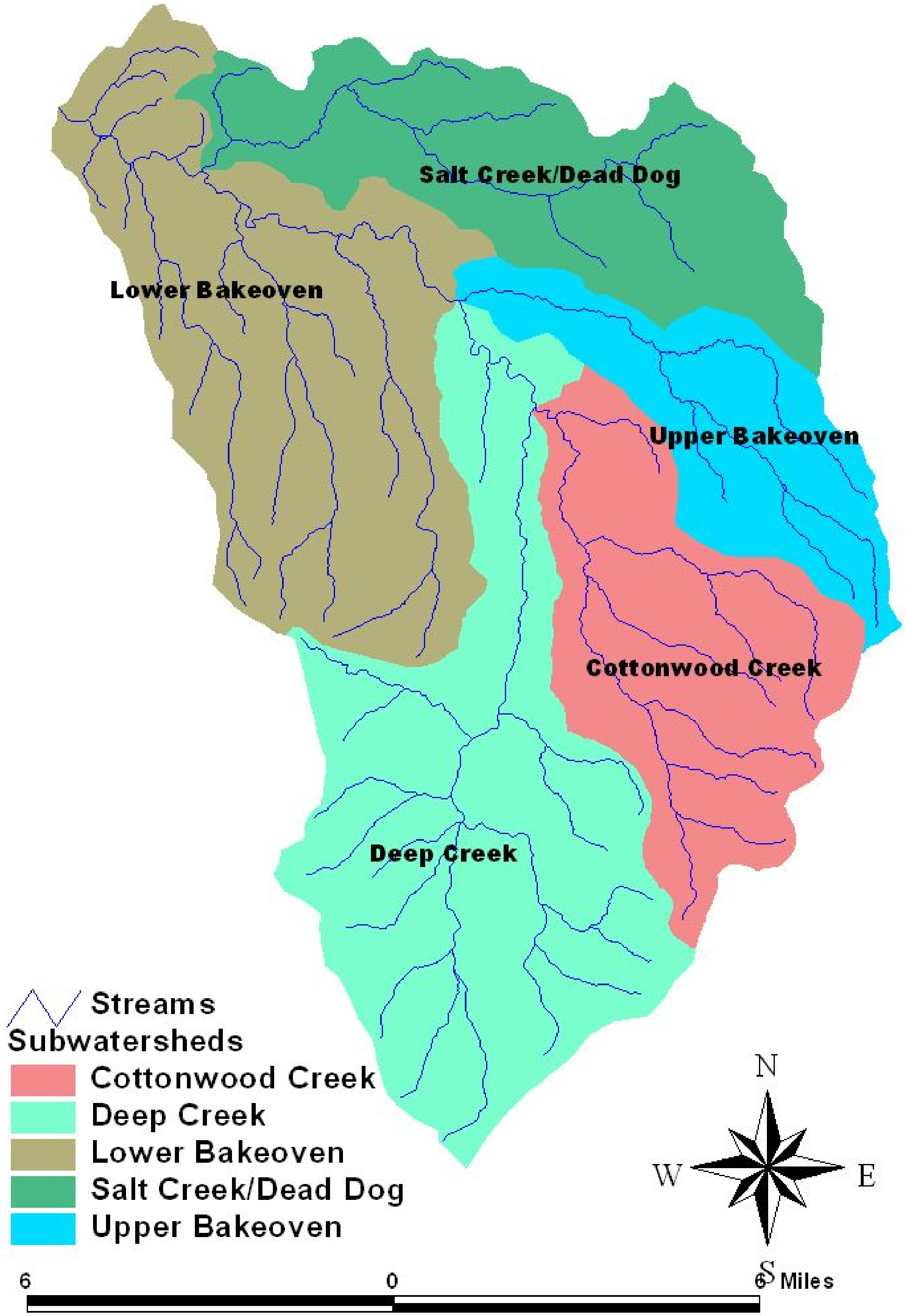
Bakeoven Watershed is approximately 98,042 acres in total extent. The headwaters are located in the Shaniko area in Southern Wasco County, east of the Deschutes River at elevations just above 3,200 feet. Bakeoven Creek flows to the Deschutes River at Maupin City Park, elevation 800', in the City of Maupin. The watershed receives about 10-14 inches of precipitation per year, most of it as rain. Snow falls in winter, but does not form a consistent snow pack. Historical accounts suggest snowpack may have been greater prior to 1920 (see chapter 1).

The stream network includes 190 miles of stream channel, including perennial, seasonal and ephemeral streams. For the purposes of this assessment, Bakeoven Watershed has been broken into five subwatersheds: Deep Creek, Cottonwood Creek, Upper Bakeoven Creek, Salt Creek/Dead Dog Canyon, and Lower Bakeoven (Figure 0-1). The dividing line between Upper Bakeoven Creek and Lower Bakeoven Creek is the confluence with Deep Creek. These subwatersheds will be used throughout the assessment to compare conditions in various parts of the watershed. Acreages of the subwatersheds are given in Table 0-1.

Table 0-1: Acreages of Subwatersheds.

Subwatershed	Deep Creek	Cottonwood Creek	Upper Bakeoven	Salt Creek/ Dead Dog	Lower Bakeoven
Acres	28,676	16,644	10,392	16,287	26,043

Figure 0-1: Bakeoven Watershed and its Subwatersheds



1) Historic Conditions

Historic conditions are described in order to provide a basis for comparison between the current condition and a historic condition. The historic condition should reflect a watershed that is comparatively unaffected by human land uses. Prior to 1860, Bakeoven Watershed had not yet attracted any of the westward-moving wave of American settlers. Bakeoven Watershed was not untouched by human hands, as it was used to a minor extent by Native Americans, who may have intentionally set fires to maintain grass stands. However, the pre-1860 condition provides us with a convenient comparison for present conditions.

Humans have used the resources of Bakeoven Watershed from as early as 10,000BC. Fish, wild game, and plant foods supported inhabitants for thousands of years. Many people lived and fished along salmon-bearing rivers and streams in the region.

It is believed that Bakeoven Watershed once displayed relatively favorable conditions for redband trout and summer steelhead production. Lush bunch grass plant communities covered much of the area and were interspersed with well-vegetated stream corridors. Variable habitat characteristics existed within constrained and semi-constrained stream reaches, providing a mix of single channel and multiple channel areas. In lower gradient reaches, stream channels were sinuous and bordered by thick deciduous vegetation and grasses. Beaver dams were common. Relatively good supplies of in-channel large wood and debris dams provided adult and juvenile cover and rearing habitat.

Bakeoven Watershed and surrounding areas exhibit some of the highest average slope and drainage densities in the entire Deschutes Subbasin (O'Connor et al. 2003), and these stream systems likely showed more response to climatic changes than other subbasin areas—though the magnitude of the climatic effects was moderated by healthy watersheds. As today, occasionally severe thunderstorms caused sudden and high flows, promoting more dynamic stream channel behavior and characteristics than typically found in other tributary streams within the Deschutes Subbasin. In streams where natural flows often dropped to low levels during summer months, late summer water temperatures became elevated, particularly during low precipitation years. Large floodplains with diverse vegetative communities helped stabilize flows and water temperatures. Beaver complexes and wet meadows also promoted sustained groundwater recharge (Deschutes Subbasin Assessment, 2004). Deep pools and recharge areas provided refuge for steelhead and trout when flows were low and water temperatures high.

In 1855, the US Government signed a treaty with the tribes of Middle Oregon. As a condition of this treaty, the Tenino and Wasco Indians ceded most of their traditional lands to the United States of America, and moved to the Warm Springs Indian Reservation. The Tribes reserved exclusive right to fish within reservation boundaries and the right to hunt, fish and gather in common with citizens of the USA at all other usual and accustomed places, including ceded lands.

In 1862, gold was discovered in Canyon City. An overland route was established from The Dalles that crossed the Deschutes River at Sherar's Ferry and continued on to the John Day River near present-day Clarno. Camps were established along Bakeoven Creek and near the present-day location of Shaniko.

Later, homesteaders established sheep ranches and dryland grain farms in the Bakeoven Watershed. The Homestead Act of 1862 required settlers to farm their land as a condition of "proving up" or taking title to the land. Consequently, a great many dryland grain fields were established in Bakeoven Watershed that were subsequently abandoned.

In 1900, a railroad was established from the Columbia River at Bigg's Junction to the newly organized town of Shaniko for the purpose of shipping wool from Central Oregon. The highest intensity of land use in the Bakeoven Watershed was around the beginning of the 20th Century, when Shaniko was known as the Wool Capitol of the World. After the railroads were built along the Deschutes River, bypassing Shaniko, the economy of Shaniko withered, leading to a shift from sheep to cattle.

The following chronology describes the historic events that drove the changes in land use described so briefly above.

1.1) Chronology of Events

YEAR	EVENT	SOURCE
10,000-14,000 BC	Bretz Floods deposit granite erratics in Bakeoven and Deschutes Canyons	Chaff in the Wind
10,000 BC	First human settlements in region.	Chaff in the Wind
1855	US Government signs treaty with Tenino and Wasco Indian Peoples, who cede most of traditional lands to USA, while reserving exclusive right to fish within Indian reservation boundaries and the right to hunt, fish and gather in common with citizens of the USA at all other usual and accustomed places, including ceded lands.	Chaff in the Wind
1860-1864	Construction of first bridge at Sherar's Falls, allowing Oregon Trail immigrants to bypass The Dalles and head directly for the Barlow Road from Cottonwood Canyon. Barlow Road was the only major land route to Willamette Valley until Columbia River Highway completed in 1916.	Chaff in the Wind
1862	Congress passes the Homestead Act, attracts Germans, Swiss, Irish, Scottish and English settlers to Central Oregon. Settlers in Southern Wasco County used land for sheep and cultivated to prove up. Some homesteaders bought out other claims to become large landowners.	
1862	Gold discovered at Canyon City. Travelers stopped at Bakeoven and Cross Hollows on the way to the gold fields. Name comes from a crude stone oven used by travelers to bake bread. Story says it was made by either a Frenchman or a German whose horses were stolen by Indians.	Shaniko: Wool Capital…

YEAR	EVENT	SOURCE
1862-1872	Most overland travel to the southeast follows route from Sherar's Falls to Cross Hollows and on to Canyon City. Springs at Cross Hollows attract settlement. Many wagons drawn by horses or oxen traveled up draws.	Shaniko People, Shaniko, From Wool Capital to Ghost Town
1864-1874	Thomas Ward operated the first inn and blacksmith shop at Cross Hollows.	Shaniko, From Wool Capital to Ghost Town
Date?	Sheep and cattle replace most horses. George and Fred Young try to claim all land from Cross Hollow to Sherar's Bridge. Sold out to Ewan McLennan, who tried to buy all land with springs.	Chaff in the Wind
Date?	Free grazing for horses on government land – William Booten, William Basket, Robin and Jim Brown.	Chaff in the Wind
Date?	Early settlers on Shaniko-Maupin Road: John Donaldson, Connolly Brothers, Wilbur Hearst, Clem and Bert Matthews, Anson Lindley, Dick Harris, Frank Fleming, Cecil Ashley, Dick Hinton, Andrew Brown, Elmer Brown, Andy Patjens, Hanry Wakerlig, Thomas Burgess, George Ward, Tony, Pete and Pat Conroy, Claud Wilson, John Karlen, Frank Buzan, Mary Wakerlig McKinley, Ed Wilson, Fred Zogg, Wallace Fargher	Shaniko People
Date?	Criterion Ridge county road	Shaniko People
1867	State of Oregon receives a grant for construction of a military wagon road from The Dalles to Fort Boise ID.	Shaniko From Wool Capital to Ghost Town
Date?	First owners of land near Cross Hollows: Johan and Elizabeth Ward bought 160 acres from The Dalles Military Road Co.	Shaniko From Wool Capital to Ghost Town
1868	Post Office established at Sherar's Falls.	Chaff in the Wind
1872	Richard R. Hinton arrives to homestead. Imperial Stock Ranch eventually reaches 15,000 acres under R.R. Hinton. Son James accumulates 200,000 acres, becoming the largest unincorporated sheep and cattle ranch in Oregon according to 1945 Oregon Census.	Shaniko From Wool Capital to Ghost Town
1872	Howard Maupin and son, Perry, operate the first ferry at Maupin.	Chaff in the Wind
1870s	Elmer Lytle of The Dalles plans to build Columbia Southern rail line south from Columbia River to near Cross Hollow.	Shaniko People

YEAR	EVENT	SOURCE
1871	Joseph Henry Sherar homesteaded the land on which the Bakeoven Stage stop was located.	Shaniko From Wool Capital to Ghost Town
1872	Andy Swift established Bakeoven Inn, blacksmith shop and livery barn. Sold it in 1873 to Thomas Burgess.	Shaniko From Wool Capital to Ghost Town
1874	August and Cicilia Scherneckau and partner Richard Closter bought holdings of Thomas Ward. Closter sold out and Scherneckau built a store, saloon and 16-room inn.	Shaniko From Wool Capital to Ghost Town
1875	Bakeoven Post Office	Shaniko From Wool Capital to Ghost Town
1879	Post office at Cross Hollows.	Shaniko From Wool Capital to Ghost Town
1884	Gold Rush slacked off. Scherneckau sold his holdings to Mr. Farr and moved to Astoria.	Shaniko From Wool Capital to Ghost Town
1896	Antelope incorporates.	Shaniko People
1900	Columbia Southern Railroad continues south from Moro to new town of Shaniko, near Cross Hollow. Shaniko comes from the German, "Scherneckau."	Shaniko From Wool Capital to Ghost Town, Shaniko People
Date?	Stills in the canyons	Shaniko People
1901	Shaniko Wool warehouse is the most extensive in the state, with capacity for 4 million pounds of wool.	Shaniko From Wool Capital to Ghost Town
1902	Population of Shaniko: 300	Shaniko From Wool Capital to Ghost Town
1903	Hotel Shaniko built and operated by James McHargue. Competes with prior existing Columbia Southern Hotel. Later, the Eagle Hotel became the third in Shaniko.	Shaniko People
1903	Three wool sales in Shaniko bring in the largest total sale of wool anywhere in the world.	Shaniko From Wool Capital to Ghost Town
1900-1905	Two room schoolhouse in Shaniko	Shaniko People

YEAR	EVENT	SOURCE
1905	Homestead Act enlarged, 320 acres for grazing. Fencing was forcing the bigger sheepherders to move their herds to the National Forest for summer range. Many homesteaders sold out after their claims were proved up.	Shaniko From Wool Capital to Ghost Town
1905-1910	Windmills enable deep wells	Shaniko People
1910	Shaniko Population: 600	Shaniko: From Wool Capital to Ghost Town
1911	Fire sweeps through Shaniko, decimating hotels and stores	Shaniko People
1911	Oregon – Washington Railroad & Navigation railroad built by Harriman Lines joined at North Junction. Line completed to Bend in 1911.	Chaff in the Wind, Shaniko People
1912	Wooden bridge constructed at Maupin.	Chaff in the Wind
1920's	Oil exploration in John Day canyon near Clarno.	Shaniko People
1921-1934	Shaniko High School	Shaniko From Wool Capital to Ghost Town
1924	The Dalles-California Highway follows route of county road.	Chaff in the Wind
1925-1955	Building and paving of US97 and various county roads brings workmen to Shaniko and keeps town alive.	Shaniko From Wool Capital to Ghost Town
1929	Bakeoven School, 8 students, district 49. The district had two schools with the other one being Fleming School nearer to Maupin.	Chaff in the Wind
1929	Great Depression: businesses in Shaniko close. Eastern Oregon Bank closes for good.	Shaniko From Wool Capital…
1930	Smallpox scare in Shaniko.	Shaniko People
1930	Sheep guano from stockyards is shipped to Willamette Valley for fertilizer. Supply was exhausted in about five years.	Shaniko From Wool Capital to Ghost Town
Date?	Warm Springs Indians stopped at Glade's restaurant to eat and sell salmon on their return from fishing at Celilo. In the autumn, they came from huckleberrying. They would camp three or four days on Porcupine Ridge to dig camas and gather herbs.	Shaniko People

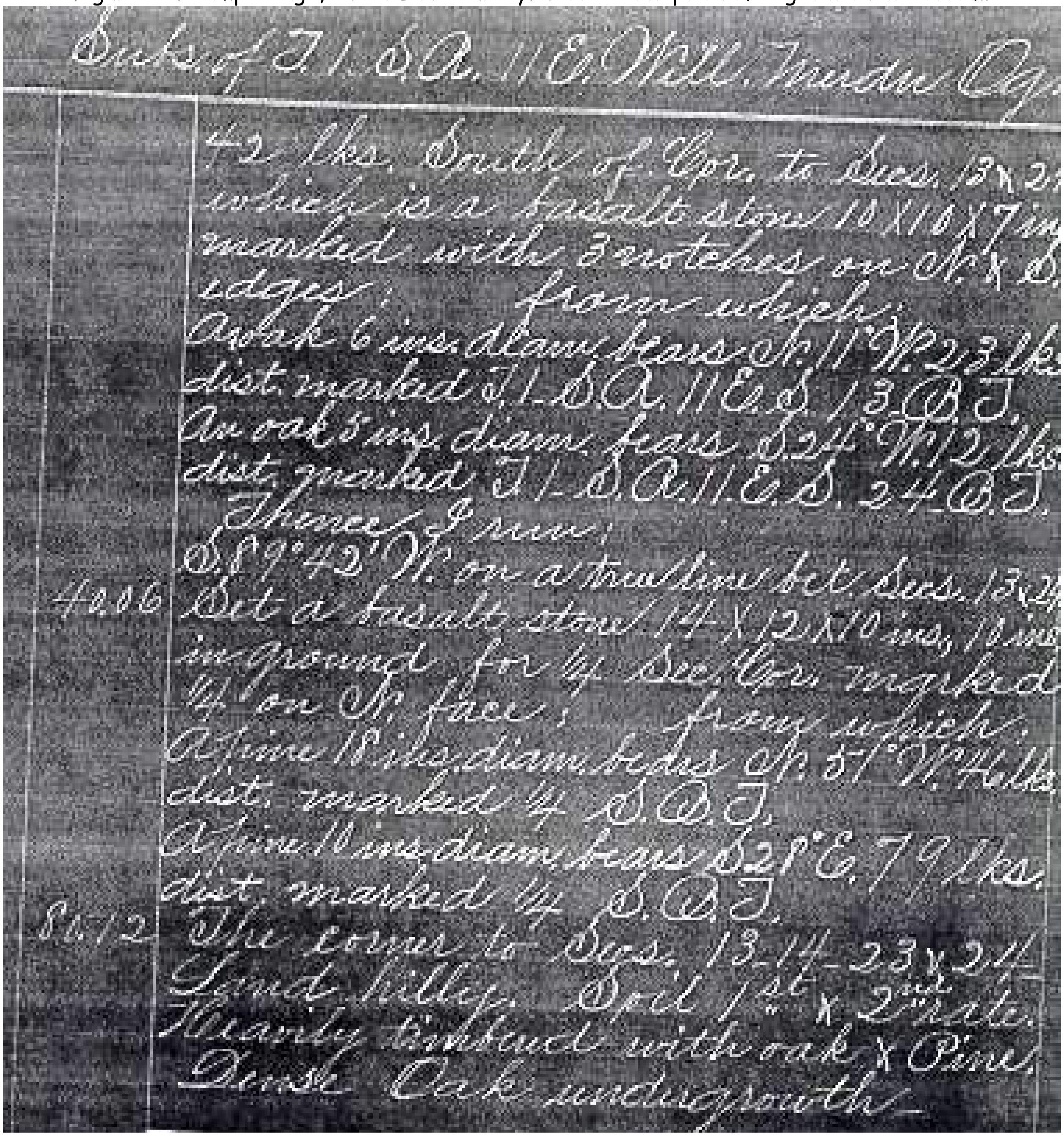
YEAR	EVENT	SOURCE
1940	Hinton sold partnership interest in 65,000 acres to George Ward. Ranch became known as Hinton-Ward Ranch. After Hinton retired, he sold out to Ward. Ranch converts to beef over time.	Shaniko From Wool Capital to Ghost Town
1943	Rail lines taken up from Shaniko to Kent. Biweekly service maintained. Later, rails were removed from Kent to Grass Valley.	Shaniko From Wool Capital to Ghost Town
1944	Families move out during World War II to get work. Shaniko school closed in 1944. Remaining grade schoolers (6) went to Antelope and remaining high schoolers (2-3) went to Moro.	Shaniko From Wool Capital to Ghost Town
1940's and 1950's	Shaniko Hotel serves as a local nursing home.	Shaniko From Wool Capital to Ghost Town
1959	Shaniko first referred to as a "Ghost Town" at the Oregon Centennial Expo. Attracts tourism.	Shaniko From Wool Capital to Ghost Town
1964	Rail line washed out in Spanish Hollow by flooding. All lines removed.	Shaniko From Wool Capital to Ghost Town

1.2) Presettlement Land Cover

In 1855, the US Government signed a treaty with the tribes of Middle Oregon. As a condition of this treaty, the Tenino and Wasco Indians ceded most of their traditional lands to the United States of America, and moved to the Warm Springs Indian Reservation. The Tribes reserved exclusive right to fish within Indian reservation boundaries and the right to hunt, fish and gather in common with citizens of the USA at all other usual and accustomed places, including ceded lands.

Following this treaty, American pioneer families began to move into Southern Wasco County. In response to this, Wasco County commissioned a series of public land surveys, which continued through the 1880's before they finished. Surveyors crossed the landscape, establishing township and section lines and noting timber, undergrowth, grass, soil types and land formations (Figure 1-1). These notes provide a basis for mapping the vegetation at the time of homesteading (Figure 1-2).

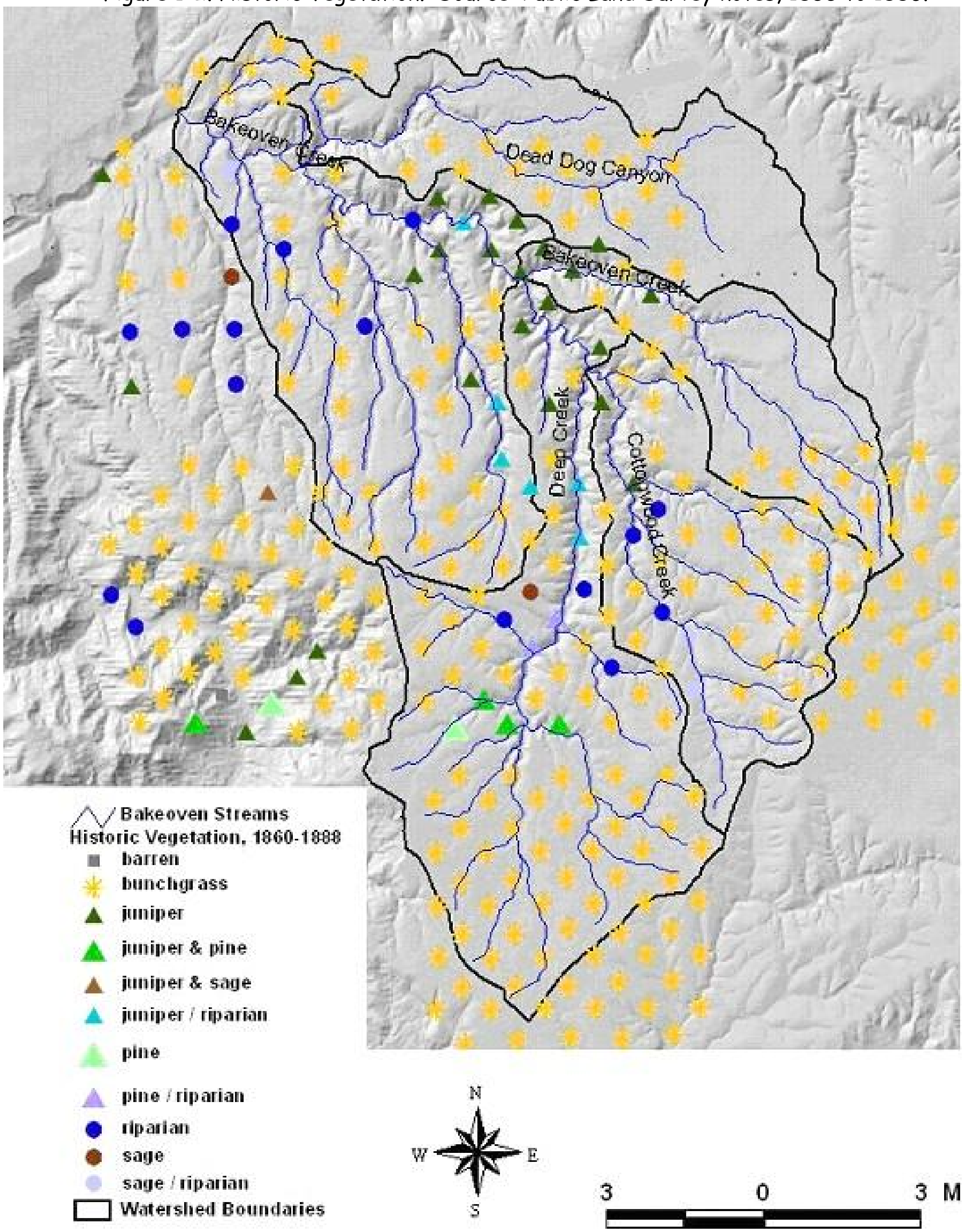
Figure 1-1. Sample Page, Public Land Survey. Note description of vegetation at bottom.



Subs of T1 S R 11 E Will. Meridian Or.

42 lks. South of Cor. to Secs. 13 & 24
which is a basalt stone 10 x 16 x 7 ins
marked with 3 notches on N & S
edges; from which
An oak 6 ins. diam. bears N. 11° W. 23 lks
dist. marked T1 S R 11 E S 13 B T.
An oak 5 ins. diam. bears S 24° W. 12 lks
dist. marked T1 S R 11 E S 24 B T.
Thence I run
S 89° 42' W. on a true line bet. Secs. 13 & 24
40.06 Set a basalt stone 14 x 12 x 10 ins, 11 ins
in ground for 1/4 Sec. Cor. marked
1/4 on N. face; from which
A pine 18 ins. diam. bears N. 51° W. 4 lks
dist. marked 1/4 S B T.
A pine 11 ins. diam. bears S 28° E. 79 lks.
dist. marked 1/4 S B T.
80.12 The corner to Secs. 13-14-23 & 24
Land hilly. Soil 1st & 2nd rate.
Heavily timbered with oak & Pine.
Dense Oak undergrowth

Figure 1-2. Historic Vegetation. Source: Public Land Survey notes, 1855 to 1886.



2) Stream Channels

2.1) Channel Habitat Types

The Oregon Watershed Assessment Manual presents a classification system to divide streams into "channel habitat types" to evaluate habitat conditions and productive potential (Watershed Professionals Network, 1999). This classification system uses features such as valley shape, degree of confinement, gradient, substrate, channel pattern and geology. The most influential factors are stream gradient and channel confinement.

Each channel habitat type has predictable attributes that influence fish use, sensitivity to disturbance and potential for improvement. Gradient determines whether a particular stream reach or segment is predominantly a deposition, transport or source area for sediment and large woody debris. Low gradient reaches (less than 2%) are depositional zones for woody debris and sediment, including spawning gravel. Depositional areas are highly productive for fish, offering a wide range of habitat elements. Moderate gradient reaches (2-4%) are transport areas for sediment and wood and are moderately productive for fish, although localized areas may be highly productive. High gradient reaches (4-10%) are transport zones with only fair productivity for fish, but high productivity for amphibians. Reaches with gradients over 10% are not usually fish-bearing.

Confinement is also a factor in determining channel habitat type. Confinement refers to the ratio of the channel width to the floodplain width. Unconfined channels (those with a floodplain width more than 4 times the width of the channel) have room to meander, and thus develop more diverse instream habitat than confined channels (those with a floodplain no more than 2 times the width of the channel). Unconfined channels will also have wider riparian areas. Flood velocities will be buffered as the flow spreads over the wide floodplain. Moderately confined channels are those with floodplains between 2 and 4 times the width of the channel. Channels can be confined naturally by steep, narrow valley walls, or natural terraces. Channels can become confined due to downward erosion caused by flood events or by diking, removal of large woody debris, and channelization activities.

Channel habitat types vary in how they adjust to changes in flow, sediment, woody debris and other inputs, and some channel habitat types are more sensitive to land use activities and restoration activities than others. Low gradient, less confined areas are most likely to show physical changes in channel pattern, location, width, depth, sediment storage, and bed roughness from land use effects and from restoration attempts. Research indicates that high gradient, highly confined channels are more resistant to human impacts.

Intermittent streams were also classified in this analysis.

Methods

Channel habitat types were delineated for 190 miles of streams, including perennial, intermittent and seasonal drainages, using USGS topographic maps (digital raster graphs analyzed with ArcView 3.3). Channel habitat types were based on slope and confinement, as well as position within the Watershed. Channel habitat type designations and related data were recorded in an ArcView database and mapped. The streams defined in this section were used throughout the later components of the watershed assessment. Aerial photographs were used to further determine confinement.

Results

7 channel habitat types were identified in the Watershed and are described in table 2-1. In order of prevalence, these were MV (moderately steep, narrow valley), MC (moderate gradient, confined), MH (moderate gradient headwater), LC (low gradient, confined), SV (steep headwater, confined), LM (Low gradient, moderately confined), and MM (moderate gradient, moderately confined).

Low gradient stream reaches constitute 12.4% (23.5 miles) of the stream network and include two channel habitat types: LM and LC. Most of these reaches are found in the Bakeoven and Deep Creek canyons, with a few low gradient channels in Dead Dog Canyon and other tributaries. However, localized areas of low gradient can occur within stream reaches designated by steeper channel habitat types.

Moderate gradient mainstem stream reaches constitute 70.3% (133.5 miles) of the stream network and include 3 channel habitat types: MV, MM, and MC. These reaches are typically found in the tributaries, such as Cottonwood Creek, Robin Creek and Salt Creek, and the upper ends of Bakeoven and Deep Creek. They characterize the reaches that start near the uplands and drop to the canyon bottoms. These may be either perennial or intermittent, but would typically have flow for at least half the year.

17.3% (33 miles) of the Watershed consists of moderate gradient to steep v-shaped headwater channels (MH and SV). These channel types are mostly found on seasonal drainages, draining the uplands and ridges. Table 2-2 shows the breakdown of channel habitat types by subwatershed. Figure 2-1 is a map of channel habitat types.

All channel types were moderately to tightly confined by canyon walls, minimizing the potential for wide floodplains. Moderately confined channel types will have a floodplain not more than four times the width of the stream, whereas a tightly confined channel type will have a floodplain not more than two times the width of the stream.

Table 2-1. Descriptions of channel habitat types found in White River Watershed

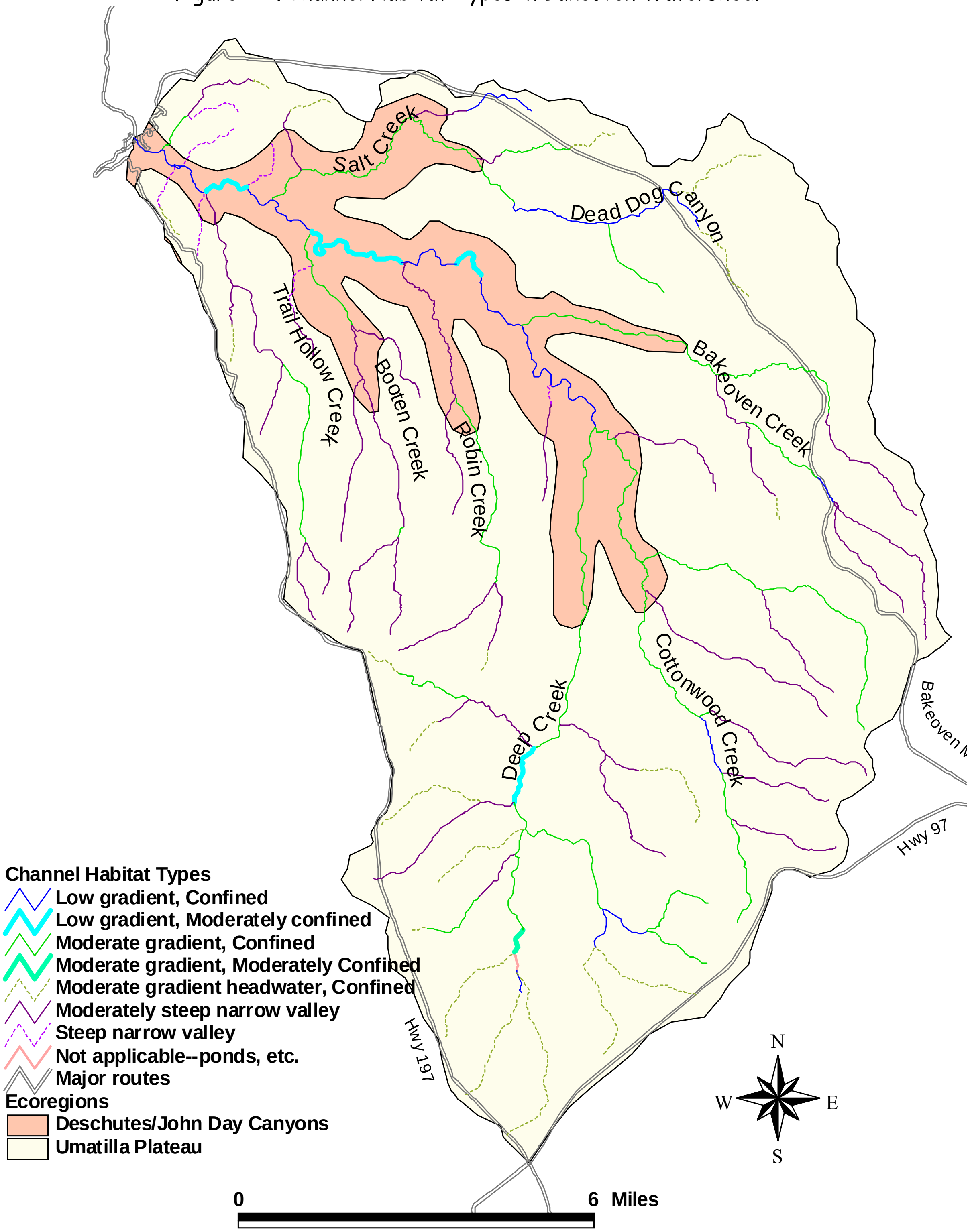
		Average gradient in Watershed	**Valley shape**	**Channel pattern**	**Confinement**	**Position in drainage**	**Dominant Substrate**
Low Gradient Mainstem							
LC	Low gradient, confined	1.4	Moderate gradient hill slopes w/ limited floodplain	Single channel, variable sinuosity	Confined by slopes or high terraces	Generally middle to lower in large basin	Boulder, cobble, bedrock with pockets of sand, gravel, cobble
LM	Low gradient, moderately confined	1.0	Broad, generally much wider than channel	Single w/ some multiple channels	Variable	Mainstem and lower end of main tributaries	Fine gravel to bedrock
Moderate Gradient Mainstem							
MV	Moderately steep, V-shaped valley	5.5	Narrow, V-shaped valley	Single channel, relatively straight	Confined	Middle to upper	Small cobble to bedrock
MM	Moderate gradient, moderately confined*	2.1	Narrow valley with floodplain or narrow terrace	Single channel, low to moderate sinuosity	Variable	Middle to lower	Gravel to small boulder
MC	Moderate gradient, confined**	2.9	Gentle to narrow V-shaped valley	Single channel, straight or conforms to hill-slope	Confined	Middle to lower	Course gravel to bedrock
Headwaters							
MH	Moderate gradient headwaters	3.6	Open, gentle V-shaped valley	Low sinuosity or straight	Confined	Upper, headwater	Sand to cobble, bedrock; possibly some boulders
SV	Steep V-shaped valley	11.5	Steep, narrow V-shaped valley	Single channel, straight	Confined	Middle to upper	Large cobble to bedrock

* “Moderately confined” means floodplain two to four times as wide as stream channel at bank-full.
** “Confined” means floodplain no more than twice as wide as stream channel at bank-full.

Table 2-2. Summary (in miles) of channel habitat types for stream channels in White River Watershed. Channel habitat types listed in order of frequency.

Subwatershed	**MV**	**MC**	**MH**	**LC**	**SV**	**LM**	**MM**	**TOTAL**
Lower Bakeoven	31.5	10.2	2.0	6.2	6.1	4.0	0.0	**60.0**
Salt Creek/Dead Dog	2.7	9.0	5.1	5.5	0.0	0.0	0.0	**22.3**
Upper Bakeoven	10.9	8.5	0.4	0.5	0.0	0.0	0.0	**20.3**
Deep Creek	11.9	16.6	18.9	5.3	0.4	1.1	0.5	**54.9**
Cottonwood Creek	16.0	15.6	0.0	1.1	0.0	0.0	0.0	**32.7**
Total miles	**73**	**60**	**26.5**	**18.5**	**6.5**	**5**	**0.5**	**190**
% of Watershed	*38.4%*	*31.5%*	*13.9%*	*9.7%*	*3.4%*	*2.7%*	*0.24%*	

Figure 2-1. Channel Habitat Types in Bakeoven Watershed.



2.2) Channel Modification

Channel modification refers to intentional changes to stream channel morphology due to human activities. Examples are roads or dikes built alongside a stream, thus restricting the stream to a relatively straight, narrow channel, and bridges and culverts that constrain the channel. Channels can also be degraded through erosion.

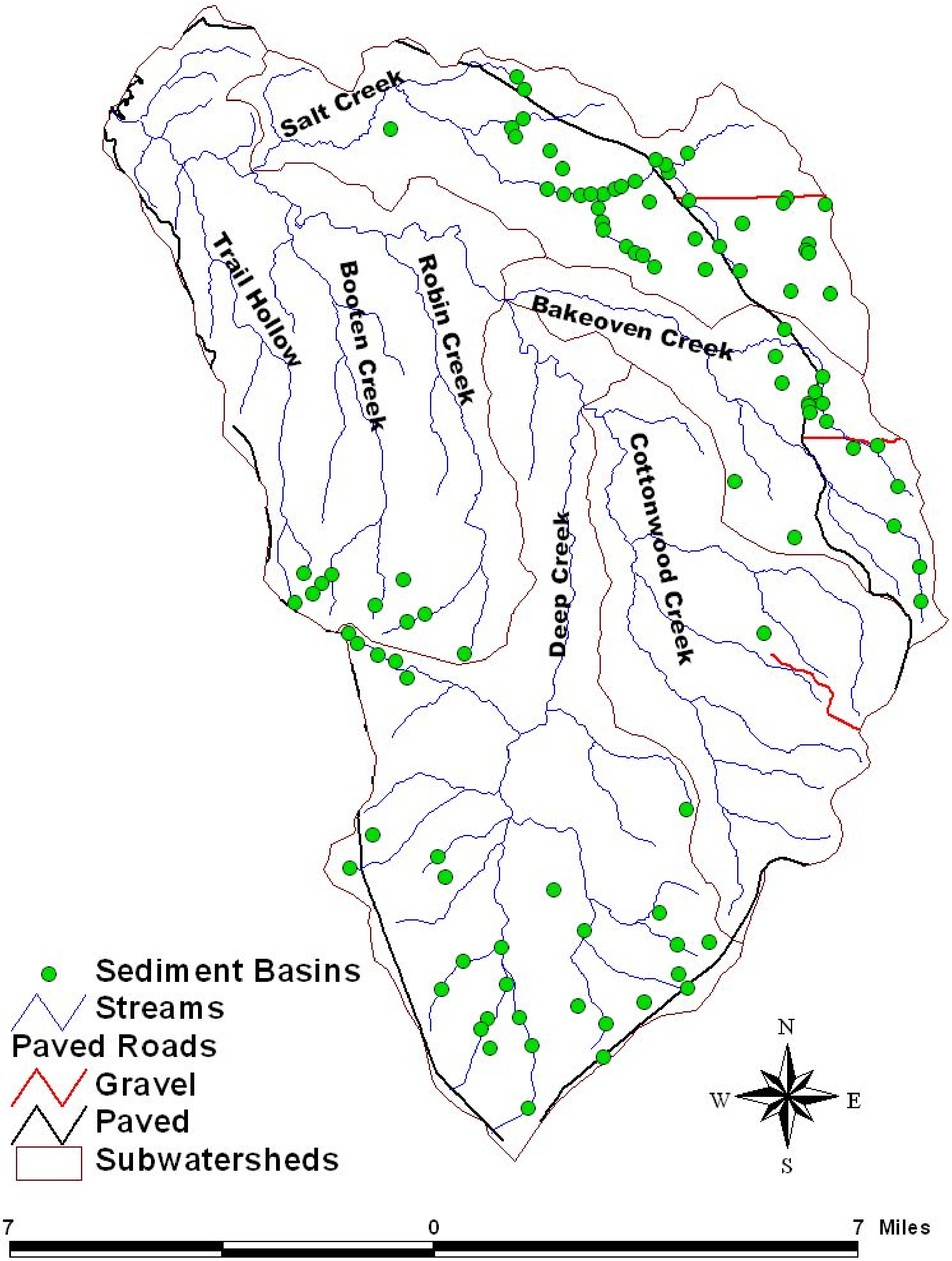
While there are almost 100 sediment basins in the watershed, these are almost all located in ephemeral draws. There are none in the mainstems of Bakeoven Creek or Deep Creek, except near the headwaters. There is only one in Cottonwood Creek. They are instead clustered in Dead Dog Canyon, and the headwaters of Booton, Trail Hollow, Robin, Bakeoven and Deep Creeks (figure 8-1). This may provide an opportunity for comparison studies. For instance, instream habitat or peak flows could be compared between Cottonwood Creek, Bakeoven Creek and Deep Creek. Currently, there are no flow monitoring devices in Cottonwood Creek, and an instream survey has not been completed.

Bakeoven is crossed by two bridges near the mouth. It is crossed by a culvert near the headwaters. Road crossings will be treated in further detail in chapter X. In general, these crossings are fords in the case of dirt roads and culverts in the case of gravel or paved roads. Streambank erosion will be treated in further detail in chapter 3. Compared to other watersheds in Oregon, Bakeoven is remarkably free of road impacts in the perennial streams. This can be explained by the deep, narrow canyon, low populations, private ownership and very large tracts.

Recommendations

- Conduct instream habitat studies in Cottonwood Creek, Deep Creek and Bakeoven Creek.

Figure 2-2: Sediment Basins in Bakeoven Watershed, 2005



3) Fish and Fish Habitat

3.1) Steelhead and Redband Trout

The primary fish species of concern in the Bakeoven Watershed is summer steelhead (*Oncorhynchus mykiss*). Summer steelhead in Bakeoven Watershed belong to the Mid-Columbia Evolutionarily Significant Unit (ESU), listed as threatened under the federal Endangered Species Act. Summer steelhead utilize Bakeoven Watershed for spawning and rearing.

Adult summer steelhead generally return to the Deschutes River from June through October and pass Sherars Falls from June through March, with peak movement in September or early October. Wild female steelhead typically outnumber males.

Steelhead spawn in the Bakeoven Creek system from January through mid-April. By contrast, spawning in the lower Deschutes River and westside tributaries usually begins in March and continues through May. Steelhead in the eastside tributaries of the Deschutes River may have evolved to spawn at an earlier time than in westside tributaries or the mainstem Deschutes River because stream flow tends to decrease earlier in the arid eastside watersheds. The proportion of mainstem and tributary spawning is unknown. Based on limited spawning ground counts in the mainstem and tributaries, managers believe that mainstem spawning accounts for 30 to 60% of the natural production (ODFW 1997).

Deschutes River summer steelhead emerge in late May through June depending on time of spawning and water temperature during egg incubation. Juvenile summer steelhead emigrate from the tributaries in spring from age-0 to age-3. Many juvenile migrants continue to rear in the mainstem lower Deschutes River before smolting.

Steelhead and trout are coldwater fish. In Bakeoven Creek, low flows and high temperatures may limit the quality of the creek for summer rearing. Some biologists speculate that juvenile steelhead migrate early to the Deschutes River (Deschutes Subbasin Assessment, 2004). Steelhead fry from small tributary streams may experience greater growth than those in the mainstem Deschutes River, and may have a competitive advantage as they move from tributary environments to the river (Zimmerman and Reeves, 1999). Many juvenile migrants continue to rear in the mainstem lower Deschutes River before smolting. Scale patterns from wild adult steelhead indicate that smolts enter the ocean at age-1 to age-4 (Olsen et al. 1991). Researchers believe that smolts leave the Deschutes River from March through June.

Lower Deschutes River wild summer steelhead typically return to the Deschutes after one or two years in the Pacific Ocean. Adult summer steelhead return to the Deschutes River and its tributaries from June through October and pass Sherars Falls from June through March, with peak movement in September or early October.

Effects of Hatchery Releases

Releases from out-of-subbasin hatcheries pose a threat to wild summer steelhead populations in the Deschutes Subbasin. Steelhead spawning surveys on Buck Hollow and Bakeoven Creek indicate that many of these fish are spawning with wild steelhead. These out-of-subbasin hatchery strays may be contributing significant amounts of genetic material to the wild summer steelhead population, which could have long term adverse effects on the subbasin steelhead production through reduced resilience to environmental extremes and diverse survival strategies. Out-of-subbasin strays also pose a disease threat. About 5% of the hatchery strays have tested positive for whirling disease (Engleking 2002).

Effects of Harvest

Since 1979, recreational angling regulations in the Deschutes River have stipulated that all wild fish be released unharmed. Tribal harvest of wild steelhead since 1998 has also been restricted at Sherars Falls, where most tribal summer steelhead harvest occurs. From 1993 to 2002, the annual harvest of wild steelhead in this subsistence fishery averaged 32 fish, with a range from 0 to 135 per year (French and Pribyl 2003). Significant tribal harvest of steelhead continues to occur in the mainstem Columbia (French 2004).

Summer Steelhead Redd Surveys and Fish Counts

Summer steelhead redds have been counted in Bakeoven Creek by ODFW each spring since 1990. The first survey in 1990 was from the confluence of Deep and Cottonwood creeks to the mouth of Bakeoven Creek. Since 1991, the survey has included lower Bakeoven Creek, from Sugarloaf Mountain to the mouth.

Since the 1997 survey the number of redds counted has risen from 35 to a high of 480 in April 2001, then tapered to 87 in April 2004 (Figure 3-1, Table 3-1).

Live and dead fish observed during redd surveys are noted as wild, hatchery, or undetermined. The adipose fin of hatchery steelhead is removed to make identification possible. However, it is not always possible to see whether or not a fish has an adipose fin, and a high percentage of live fish are counted as "undetermined". (Table 3-1).

Figure 3-1: Redds and live fish observed during annual steelhead spawning surveys

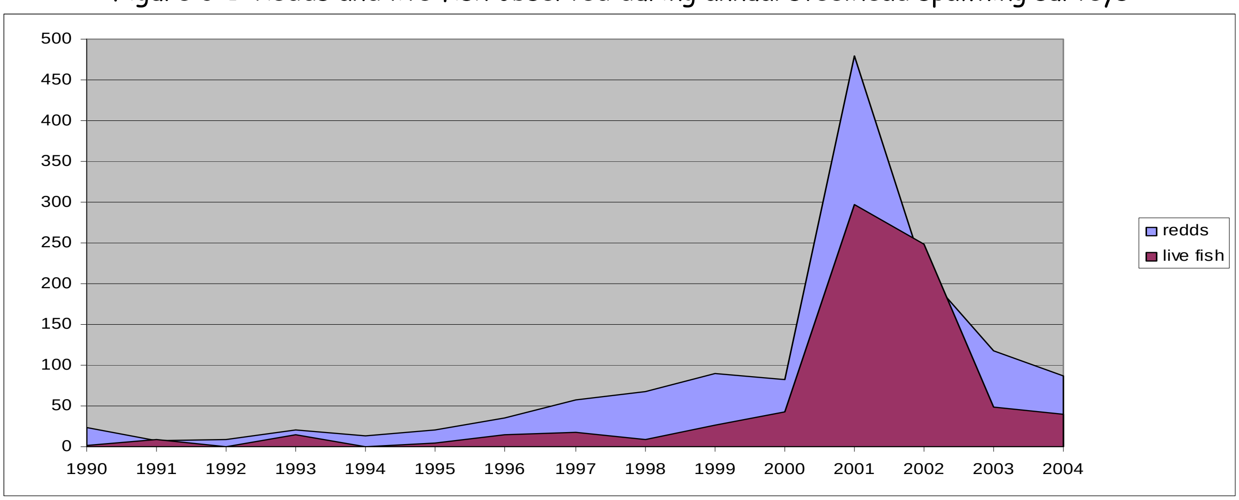


Table 3-1: Summer steelhead redd and fish counts, Bakeoven Creek.
Source: ODFW 2004.

		Redds	**Live Fish:**			**Dead Fish:**		
Date	Section		Wild	Hatch-ery	Undeter-mined	Wild	Hatch-ery	Undeter-mined
03/1990	Cottonwood/Sugarloaf	2	0	0	0	0	0	0
	Sugarloaf/Powerline	1	0	0	0	0	0	0
	Powerline/mouth	21	0	1	0	2	0	0
	Total	24	0	1	0	2	0	0
03/1991	Sugarloaf/Powerline	0	0	0	0	0	0	0
	Powerline/Mouth	8	5	0	4	0	0	0
	Total	8	5	0	4	0	0	0
03/1992	Powrline/Mouth	9	0	0	0	0	0	0
	Total	9	0	0	0	0	0	0
04/1993	Sugarloaf/Powerline	2	2	1	1	0	0	0
	Powerline/Mouth	19	0	2	9	0	0	0
	Total	21	2	3	10	0	0	0
04/1994	Powerline/Mouth	13	0	0	0	0	0	0
	Total	13	0	0	0	0	0	0
03/1995	Sugarloaf/Powerline	7	0	0	0	0	0	0
	Powerline/Mouth	13	1	3	1	0	0	0
	Total	20	1	3	1	0	0	0
03/1996	Sugarloaf/Powerline	14	0	0	0	0	0	0
	Powerline/Mouth	21	2	7	6	0	1	0
	Total	35	2	7	6	0	1	0
04/1997	Sugarloaf/Powerine	18	2	1	3	0	0	0
	Powerline/Mouth	39	2	7	2	0	1	0
	Total	57	4	8	5	0	1	0
03/1998	Sugarloaf/Powerline	11	2	1	2	0	0	0
	Powerline/Mouth	57	1	1	2	0	0	0
	Total	68	3	2	4	0	0	0
03/1999	Sugarloaf/Powerline	33	6	4	5	0	0	0
	Powerline/Mouth	56	7	2	2	0	0	0
	Total	89	13	6	7	0	0	0
03/2000	Sugarloaf/Powerline	22	5	0	8	0	0	0
	Powerline/Mouth	61	9	17	3	0	0	0
	Total	83	14	17	11	0	0	0
03/2001	Sugarloaf/Powerline	154	70	9	25	5	1	2
	Powerline/Mouth	326	88	19	86	4	0	0
	Total	480	158	28	111	9	1	2
03/2002	Sugarloaf/Powerline	23	10	2	15	0	0	2
	Powerline/Mouth	191	42	8	151	3	0	2
	Total	214	52	10	166	3	0	4
3/2003	Sugarloaf/Powerline	18	12	2	5	0	0	1
	Powerline/Mouth	99	5	2	21	0	0	0
	Total	117	19	4	26	0	0	1
04/2004	Sugarloaf/Powerline	29	7	2	9	0	0	0
	Powerline/Mouth	58	1	2	18	0	1	2
	Total	87	8	4	27	0	1	2

Redband Trout

Summer steelhead are a resident form of steelhead also found in Bakeoven Creek and neighboring tributaries. While redband are commonly seen near or with spawning summer steelhead in Bakeoven Creek (Jason Seales, ODFW, pers. comm.), redband usually spawn as much as 10 weeks later than steelhead, and they select spawning sites in deeper water with larger substrate than those selected by redband trout (Zimmerman and Reeves, 1999). It is not known, therefore, whether there is any genetic interchange between the two types.

Redband trout appear to show a greater tolerance for high water temperatures, low dissolved oxygen levels, and extremes in stream flows that frequently occur in desert climates (Deschutes Subbasin Assessment, 2004).

Redband are generally smaller at maturity than steelhead. They require finer gravel to spawn than do steelhead. Redband spawn in the spring, beginning at age 3 or 4. They continue to grow after they mature. Redband trout spawn in the lower Deschutes River and tributaries during spring and early summer, with most spawning occurring from April to June. Potential spawning, rearing and over-wintering occur where gradients are less than 8%.

The lower mainstem Deschutes River has the strongest population of resident redband trout in Oregon (Deschutes Subbasin Assessment, 2004), and supports a popular trout fishery. Wild redband trout are believed more abundant above Sherars Falls and most abundant in the Deschutes between the Reregulating Dam and Maupin. However, trout production capacity in many lower subbasin streams, including Bakeoven Creek, is depressed by degraded habitat, predation and competition (Deschutes Subbasin Assessment, 2004).

Fishing regulations have changed over the years to become more restrictive. Angling regulations and management strategies have changed to protect juvenile steelhead and to potentially increase certain size groups of wild redband trout (ODFW 1997). Current trout bag limit and tackle restrictions encourage catch and release angling.

Resident redband trout are listed by the state of Oregon as a Sensitive species. Resident redband trout were proposed for ESA listing throughout their range, but a listing was determined not warranted at that time.

Fish Sampling

During the 1995 Bakeoven Aquatic Inventory, fish sampling was conducted at four locations on lower Bakeoven and Deep Creeks. Red-side shiner and dace were found only at the lower two sampling sites. The first sampling site was near the mouth of Bakeoven Creek, the second site was just upstream of the confluence with Trail Hollow. Sucker, sculpin and redband trout were found at the first two sites, and at the 3rd site at the confluence of Deep and Bakeoven Creeks. Longnose dace were found at the fourth sampling site on Deep Creek at the mouth of Chandler Canyon, as well as at the three previous sites. Ninety seven percent of fish sampled were less than 4 inches in length. Large trout from 9 to 12 inches (23-30 cm) were observed in pools, but not sampled. More sampling would be necessary to be able to conclusively state the upper limits within the watershed for each species.

Dace (*Rhinichtys spp.*) are small fish that can reach a length of 6 inches though they usually average about 4 inches. Dace are bottom dwellers, and are solitary rather than schooling fish. Their diet consists primarily of insect larvae varying in size as the dace grow larger. Spawning occurs in spring in shallow gravelly streams. No nest is constructed, but the males guard a territory over which they entice the females to spawn. Dace are not abundant where found, so their value as forage for larger fish is minimal.

Sucker (*Chasmistes spp.*) is a non-game species that feeds on algae and small organisms on rocks. Suckers spawn in the spring and broadcast their eggs. Sexual maturity is reached when individuals reach about 5 inches in length. They can reach a maximum length of about 17 inches. They prefer colder water of small, swift rivers or streams with gravel to rocky bottoms, but are also found where current is more moderate and the bottom comprised of sand and mud. (National Marine Fisheries Service, 2004, www.nwr.noaa.gov/1publcat/docu/crep3bas.htm.

Sculpin (*Cottus spp.*) are eaten by redband trout and other trout species. Sculpin prefer streams with a boulder, cobble, and flat rock bottom for spawning and are sensitive to fine sediment levels. Sculpin grow to a maximum length of only 6-7 inches. They feed primarily on aquatic insect larvae. They may be good indicators of aquatic habitat conditions. (White River Watershed Analysis, USFS, 1995.)

3.2) Fish Habitat

Salmonids, which include steelhead and trout, are typically the fish species most sensitive to habitat conditions, and therefore serve as an indicator for habitat conditions. Salmonids have been in decline in the Pacific Northwest compared to their historic abundance, due to changes to their habitat.

Water temperature and water clarity are critical parameters for salmonids. Optimal riverine habitat is characterized by clear, cold water and relatively stable water flow, water temperature, and stream banks. Salmonids also require specific conditions for spawning, raising young, and over-wintering. These include clean gravels for spawning, instream "cover", and presence of both pools and riffles. A stream bed with a high percentage of clean gravels and a low percentage of silt is required for spawning. Eggs are deposited in redds (nests) made in the gravel. Eggs require gravelly substrates and high dissolved oxygen levels during development, and are suffocated when sediment becomes too fine. Both juvenile and adult fish require instream "cover" for protection from predators. Cover can be provided by boulders, logs, aquatic plants, water depth, turbulence, and overhanging banks. Both pools and riffles are essential habitat features. Pools are important for providing cover and shelter from fast moving water. Trout often over-winter in deep pools with extensive cover. Streams with deep, low velocity pools containing extensive cover have the most stable trout populations. Trout and steelhead generally select redd sites at the downstream edge of a pool or the head of a riffle, with moderate water velocities and a gravel substrate. Streams that are high in riffles generally support a greater diversity of invertebrates.

Riparian conditions along the stream bank contribute to instream habitat in several respects. Vegetation provides shade, which cools and stabilizes water temperature. Larger vegetation provides the greatest benefits. Vegetation also holds the soil, preventing erosion and filtering nutrients and other contaminants which otherwise could wash into the stream. "Percent of eroded bank" is one predictor of salmonid productivity. Vegetation provides another benefit by contributing "large woody debris" (LWD) to the stream system. Large woody debris, such as logs and large branches, provides cover and creates and maintains pools.

ODFW Aquatic Inventory Project, 1995-1996

The Bakeoven Aquatic Inventory Project, a comprehensive survey of stream and riparian conditions, was conducted by ODFW in 1995. Flooding in 1996 subsequently changed conditions drastically, however it provides a picture of stream conditions at the time the data was gathered, and a benchmark with which to compare current conditions. Results from the

Bakeoven Aquatic Inventory Project are summarized below. Data from the stream survey on habitat types, woody debris, bank stability, canopy closure and riparian vegetation are summarized. ODFW Habitat Benchmarks are used to evaluate habitat data, where possible. (Habitat Benchmarks, Kelly Moore, ODFW, 1997).

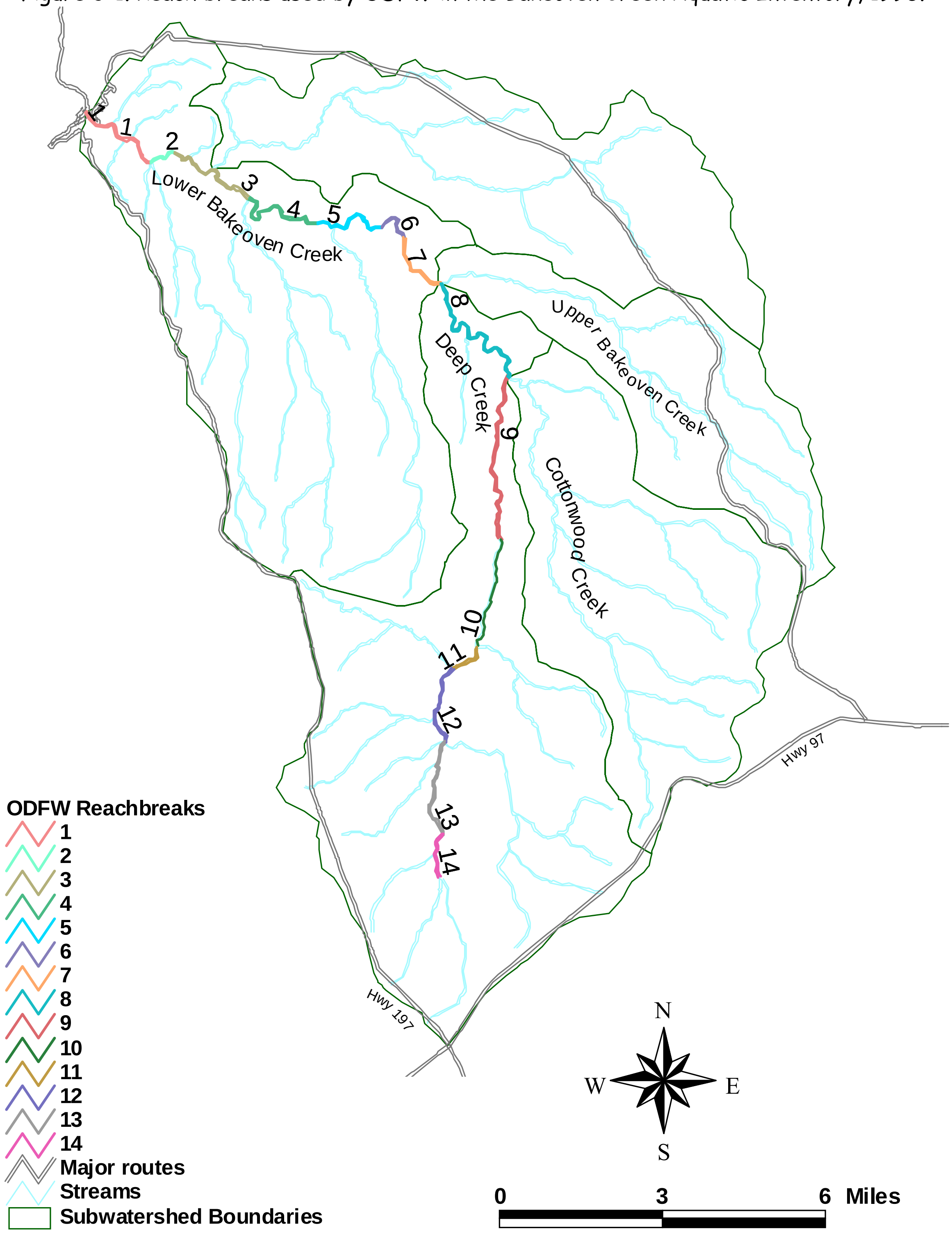
Aquatic Inventory Stream Survey Methods were developed in 1989 by the Oregon Department of Fish and Wildlife, in consultation with USFS research scientists and biologists. The information is used by biologists and land managers to establish priorities for habitat restoration efforts and monitoring programs. The methodology was designed to be compatible with other stream habitat inventory and classification systems. Information is collected and analyzed based on a hierarchical system of regions, basins, streams, reaches, and habitat units. (Aquatic Inventory Stream Survey Methods, Version 5.1, ODFW, June 1995. http://oregonstate.edu/~moorekel/).

ODFW developed Habitat Benchmarks as a tool for evaluating habitat conditions. The Benchmarks provide quantitative criteria for assessing habitat conditions. A range for desirable and undesirable conditions is given. The benchmarks provide a starting point for more detailed and meaningful analysis. "It is important to recognize that the capacity of a stream reach to meet benchmark values is a function of both its ecological setting, and patterns of land use and management." (Moore, 1997.)

Bakeoven and Deep Creeks were surveyed for aquatic habitat over the summer of 1995. The Bakeoven/Deep Creek Survey extends from Bakeoven's confluence with the Deschutes River and continues to the confluence with Deep Creek (9.15 miles). The survey then continues up Deep Creek, due to Deep Creek having greater water flow and a larger basin area than upper Bakeoven Creek. The Deep Creek survey extends another 14.23 miles.

There were fourteen reaches in the survey (Figure 3-1). Reaches 1 through 7 are below the confluence of Bakeoven and Deep Creeks. The Deep Creek survey extends from reach 8 to reach 14. Reach 9 begins at the confluence of Cottonwood and Deep Creeks. Stream reaches were surveyed during June, July, and September, beginning on June 12th and ending September 27th. (Reaches 1 through 6 were surveyed in June. Reaches 7 through 12 were surveyed in July. Reaches 13 and 14 were surveyed in late September.) Three weeks prior to the survey the creek system experienced a 5-year flood event.

Figure 3-1. Reach breaks used by ODFW in the Bakeoven Creek Aquatic Inventory, 1995.



Results

Habitat Types

Each reach was broken into units by habitat type, such as riffle, rapid, lateral scour pool, dry, etc. Habitat types were measured in square meters of wetted area. ***Riffles*** are defined as turbulent, shallow flow over submerged or partially submerged gravel or cobble, often with 5-15% of surface area as white water. ***Glides*** are generally deeper than riffles, with little flow obstruction, and low habitat complexity. ***Scour pools*** can occur mid-channel (straight scour pool), or next to a bank (lateral scour pool). Lateral scour pools may be formed by partial obstruction of a log, root wad, or boulder or bedrock. ***Backwater pools*** are found along channel margins, created by eddies around obstructions such as boulders, root wads, or woody debris. They are part of the active channel at most flow levels. Backwater pools provide important rearing habitat, and are usually formed by logs, root wads, or boulders. ***Rapids, cascades, and step/falls*** may or may not be barriers to fish passage, depending on gradient, length, and whether fish are able to jump upstream over the feature. ***Dry habitat*** can encompass the entire channel, or only a portion of it. Dry channel blocks fish passage and reduces available rearing habitat.

From reaches 1 through 9 the dominate habitat type was riffles. The dominate habitat type for reaches 10 through 12 was lateral scour pools. The dominant habitat type in reach 13 was cascades. The dominant habitat type in reach 14 was dry units. The deeper pools were found in reaches 3 and 4.

For the Watershed overall, riffles are the most prevalent habitat type, followed by dry habitat, glides, scour pools, rapids, and cascades. Backwater pools compose a low percentage of total habitat (1.1%).

Cottonwood Creek accounted for approximately 40% of water flow in lower Deep and Bakeoven creeks at the time of the survey.

Table 3-1: Summary of habitat types in lower Bakeoven and Deep creeks.

Habitat Type	Square Meters	Percent
Scour Pool	43,126	13.7
Backwater Pools	3,598	1.1
Glide	45,808	14.5
Riffle	109,842	34.8
Rapid	25,014	7.9
Cascade	15,279	4.8
Step/fall	1,217	0.4
Dry	71,271	22.6

Findings

- Riffles are most prevalent.
- Percent of dry habitat is also high, reducing available habitat for rearing and presenting barriers to migration.
- Percent of backwater pools in the Watershed is low.

Substrate

"Fines" include silt/organic, and sand. Clean gravel is required for spawning. Fine sediments can clog gravel so that eggs and fry cannot breathe. Twelve out of 14 reaches are above the benchmark for "Desirable" conditions (Table 3-2). Excess fine sediments were of concern in only one reach at the time of the survey.

Benchmarks for Fine Sediments for stream gradients below 3%: (All reaches in the stream survey area average less than 3% gradient.)

Desirable: <12%
Undesirable: >25%

Nine out of 14 reaches are above high benchmark of 35% for % of gravels. No reaches are below 15%, the "undesirable" benchmark.

Benchmarks for Gravels:

Desirable: >35%
Undesirable: <15%

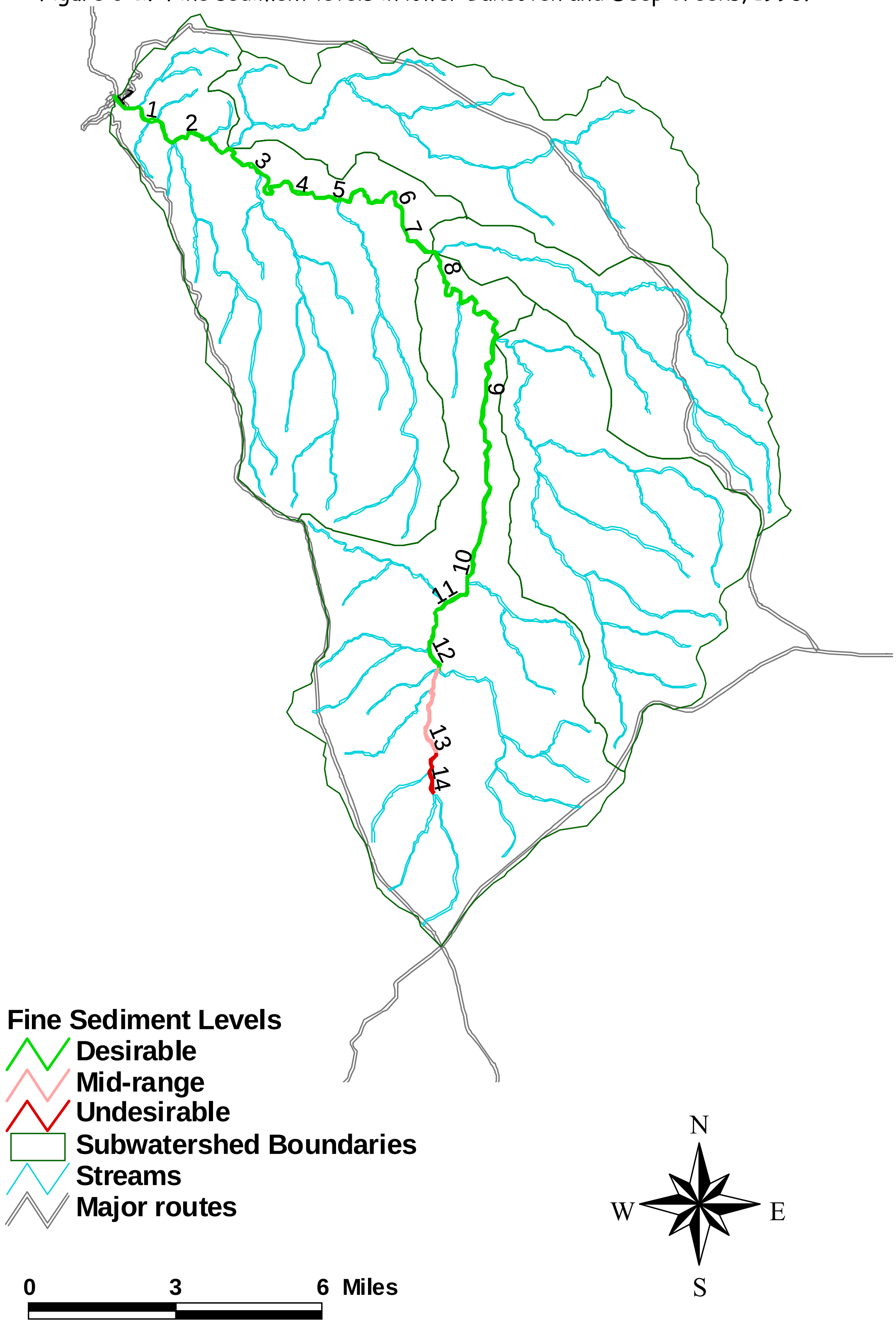
Table 3-2. Substrate composition in lower Bakeoven and Deep Creeks, 1995.

Reach	*Fines (silt/ sand)*	*Gravel*	*Cobble/ Boulder/Bedrock*
1	6 (Desirable)	45 (Desirable)	48
2	5 (Desirable)	58 (Desirable)	38
3	10 (Desirable)	52 (Desirable)	38
4	6 (Desirable)	48 (Desirable)	46
5	3 (Desirable)	51 (Desirable)	46
6	10 (Desirable)	44 (Desirable)	45
7	3 (Desirable)	53 (Desirable)	43
8	3 (Desirable)	44 (Desirable)	63
9	8 (Desirable)	35 (Desirable)	57
10	9 (Desirable)	31 (Mid-range)	59
11	5 (Desirable)	20 (Mid-range)	74
12	6 (Desirable)	32 (Mid-range)	62
13	14 (Mid-range)	27 (Mid-range)	58
14	53 (Undesirable)	17 (Mid-range)	30

Findings

- There are plenty of gravels in the majority of lower Bakeoven and Deep Creeks.
- Excess fine sediments were of concern in only one reach at the time of the survey.

Figure 3-2. Fine sediment levels in lower Bakeoven and Deep Creeks, 1995.



Dry Habitat

All reaches contained dry habitat including both “dry habitat” and “dry channel”. “Dry habitat” is dry sections of stream separating wetted channel units. Typical examples are riffles with subsurface flow or portions of side channels separated by large isolated pools. “Dry channel” is defined as a section of the entire main channel or side channel that is completely dry at time of survey. “Dry units” may not be a complete barrier to fish. Sections of “dry channel” are a barrier to fish unless an alternate channel is present.

Areas of dry channel were present in 8 reaches. Reach 14 had the highest percentage of dry channel (71.95%), followed by reach 1 (11.06), reach 8 (4.46%) and reach 5 (2.70%).Reach 6 had the highest percentage of dry habitat (84.3%), followed by reach 14 (72%), and reach 3 (29%).

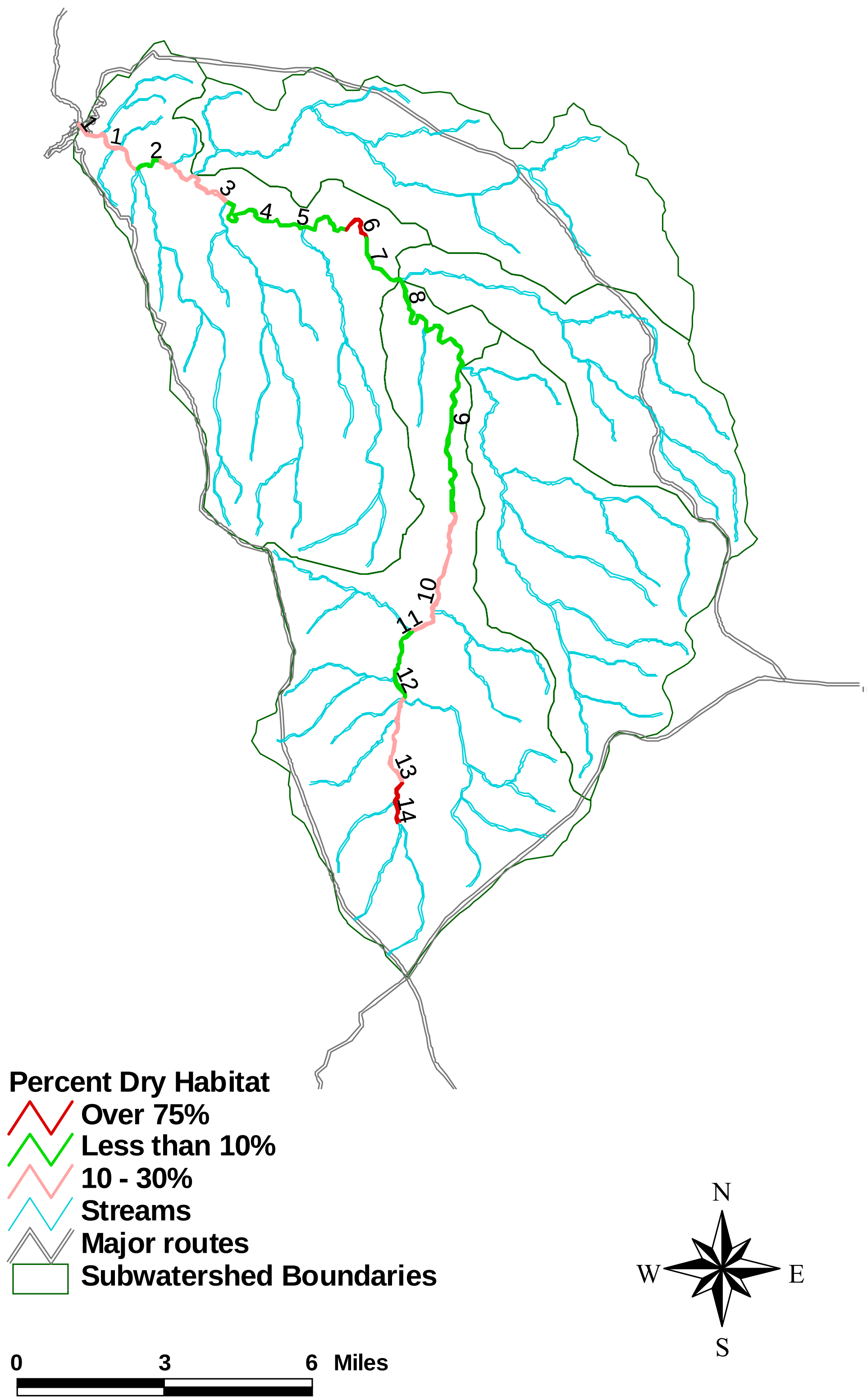
Table 3-3. Dry Stream Habitat in lower Bakeoven and Deep Creeks, 1995.

Reach	Total Dry Habitat	Dry Channel
1	24.5%	11.1%
2	6.9%	--
3	29.0%	0.2%
4	7.0%	0.3%
5	9.2%	2.7%
6	84.3%	--
7	1.3%	0.6%
8	9.9%	4.5%
9	7.2%	--
10	18.4%	0.5%
11	21.9%	--
12	5.5%	--
13	12.2%	--
14	72.0%	72.0%

Findings

- Dry habitat and dry channel throughout the Watershed reduce rearing habitat and present seasonal barriers to fish migration.

Figure 3-3. Percent of Dry Habitat in lower Bakeoven and Deep Creeks, 1995.



Channel Width to Depth Ratio

Repeated flood erosion and deposition can cause streams to become wider and shallower, leading to wider temperature fluctuations. The benchmark for "desirable" width to depth ratios is <10. The benchmark for "undesirable" conditions is >30.

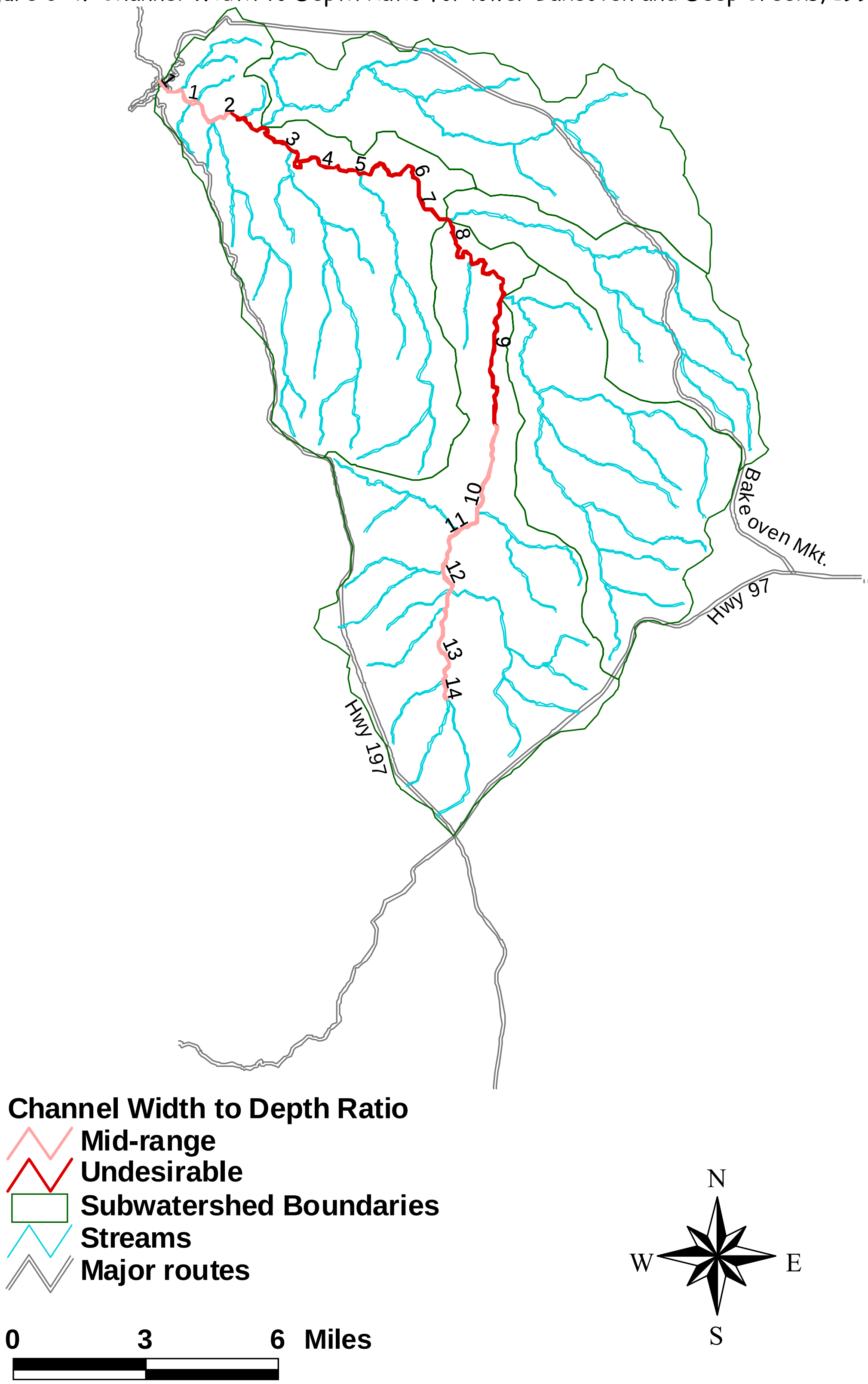
Table 3-4. Active Channel Width to Depth Ratio in lower Bakeoven and Deep Creeks, 1995.

Reach	**Av. Width (meters)**	**Av. Depth (meters)**	**Channel Width to Depth Ratio**	***Rating***
1	11.1	0.5	22.2	Moderate
2	8.5	0.4	21.3	M
3	25.6	0.5	51.2	Undesirable
4	22.8	0.6	38.0	U
5	20.9	0.5	41.8	U
6	25.9	0.7	37.0	U
7	23.1	0.5	46.2	U
8	16.2	0.5	32.4	U
9	14.4	0.4	36.0	U
10	15.5	0.6	25.8	M
11	13.5	0.5	27.0	M
12	10.5	0.6	17.5	M
13	12.0	0.6	20.0	M
14	6.8	0.6	11.3	M

Findings

- Half the reaches in the Bakeoven Survey had undesirable width to depth ratios (reaches 3 through 9), and no reaches meet the benchmark for "desirable" width to depth ratio.

Figure 3-4. Channel Width to Depth Ratio for lower Bakeoven and Deep Creeks, 1995.



Pools

Pool Frequency

The desirable range for pool frequency is 5 to 8 channel widths between pools. Four reaches met this benchmark (reaches 3, 4, 5, and 10). More than 20 channel widths between pools is considered undesirable. Six reaches are above 20 for pool frequency (reaches 1, 2, 6, 7, 8, and 14).

Residual Pool Depth

Pool depths >0.5 meters are considered desirable for streams under 7 meters wide. Depths below 0.3 meters are considered undesirable. The average depth of scour pools in lower Bakeoven and Deep creeks is greater than 0.5 meters for all reaches. Dammed and backwater pools are somewhat shallower, but none are below the low benchmark of 0.2 meters. Five reaches have an average depth above the high benchmark for dammed and backwater pools.

Complex Pools (Pools with more than four pieces of wood)

No complex pools were identified during the 1995 stream survey. Therefore, all reaches are below the low benchmark for presence of complex pools.

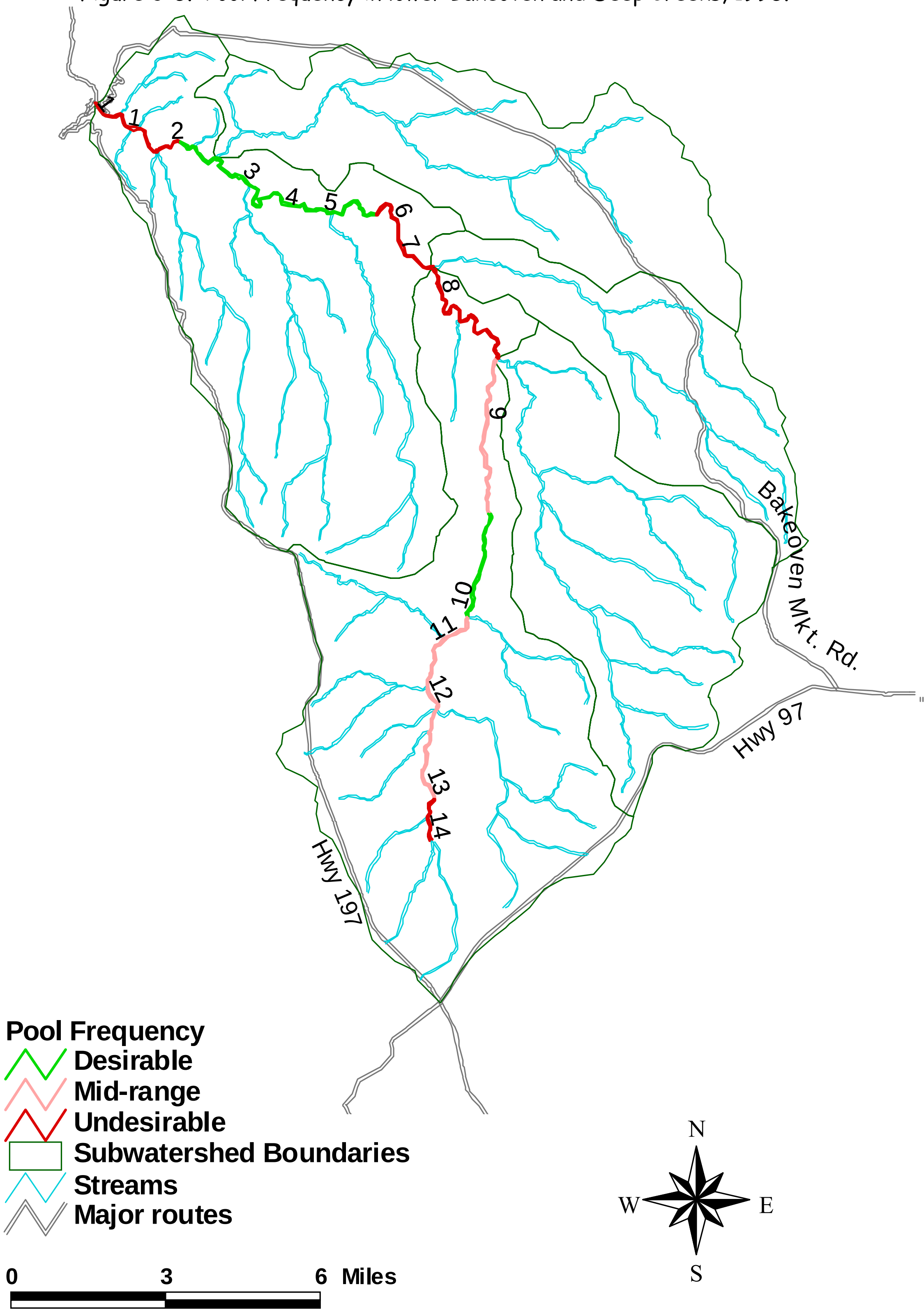
Table 3-5: Pool Habitat in lower Bakeoven and Deep Creeks, 1995.

Reach	Total Pools	#/km	Pool Frequency: Channel Widths Between Pools	Average Depth: Dammed and Backwater Pools	Average Depth: Scour Pools	Complex Pools (w/wood)
1	18	3.8	23.8 (U)	0.46	0.70 (D)	0
2	2	1.6	71.8 (U)	-	1.55 (D)	0
3	23	6.5	6.0 (D)	1.00 (D)	1.24 (D)	0
4	23	7.6	5.8 (D)	0.80 (D)	0.99 (D)	0
5	22	7.1	6.7 (D)	0.55 (D)	0.73 (D)	0
6	4	1.7	22.4 (U)	0.25	0.90 (D)	0
7	5	2.0	22.2 (U)	-	0.59 (D)	0
8	17	2.9	21.3 (U)	0.20	0.86 (D)	0
9	39	6.3	11.1	0.35	0.62 (D)	0
10	39	8.2	7.9 (D)	0.38	0.74 (D)	0
11	10	7.2	10.4	-	0.72 (D)	0
12	23	6.8	13.9	0.50 (D)	0.57 (D)	0
13	21	6.1	13.7	0.53 (D)	0.54 (D)	0
14	4	1.8	83.9 (U)	2.00	0.60 (D)	0

Findings

- Overall, *pool frequency* is lower than "desirable" for Bakeoven . (Six reaches are in the undesirable range, and only 4 reaches are in the desirable range.)
- *Complex pools* (with wood complexity) are completely lacking.
- Average *pool depth* is in the "desirable" or "acceptable" range for all reaches.

Figure 3-5. Pool Frequency in lower Bakeoven and Deep Creeks, 1995.



Riparian Vegetation

Riparian vegetation consisted primarily of alders in very dense, young groves 6 to 12" in diameter (15-30cm). (This size class represented a quarter of trees sampled.) Throughout the survey, deciduous trees ranged in size from 3 cm to 50 cm in diameter (1.2" to 20").

Table 3-6 shows the average number of trees in a 5 meter wide area (averaging 4 transects), and their sizes as "diameter at breast height". For all reaches, 61.5% of the trees sampled were 1.2 to 6" in diameter (3 to 15 cm). Just over a quarter were 6 to 12" (15 to 30 cm) diameter. About a tenth were 12 to 20". Only 2.5% were 20 to 36 inches. A higher proportion of larger deciduous trees (6-12" and 12 to 36") was found in reaches 9 through 11.

Table 3-6. Riparian vegetation: Average number of trees in 5m band, broken down by size class, 1995.

Reach	**3-15cm (1.2-6")**	**15-30cm (6-12")**	**30-90cm (12-36")**	***Total***
1	42.8	4.8	2.3	49.9
2	26.5	0.0	0.0	26.5
3	3.6	0.6	2.0	6.2
4	1.3	3.3	0.7	5.3
5	3.0	0.4	0.2	3.6
6	0.0	0.5	0.5	1.0
7	0.5	0.5	0.5	1.5
8	1.8	2.6	1.0	5.4
9	3.6	6.8	3.6	14.0
10	2.9	5.7	2.8	11.4
11	4.0	9.0	1.0	14.0
12	3.0	2.0	1.0	6.0
13	3.7	5.0	2.3	11.0
14	1.0	1.0	1.0	3.0
% of size range	(61.5%)	(26.6%)	(11.9%)	

Findings

- Only 10% of trees were over 12" diameter, and only 2.5% were over 20". These larger trees are necessary to providing "key pieces" of woody debris for complex pools.
- Recruitment potential for large woody debris (LWD) in Bakeoven Watershed is low, particularly for largest trees.

Woody Debris

Large woody debris provides instream habitat complexity by creating pools. Alder, cottonwoods, and other hardwoods (aspen and birch) and some pine provide the woody debris for this stream system. Cottonwoods are of particular importance due to their size.

There was a considerable amount of small woody debris present in the system from the flood prior to the survey. Large wood volume, however, was very low. Most of the small wood present did not provide significant habitat complexity.

Woody debris of size at least 3 meters long and 0.15 meters in diameter (approximately 9 ¾ feet long and 6 inches in diameter) was recorded for each reach. Pieces larger than ten meters long and 0.6 meters in diameter (approximately 32 ¾ feet long and 2 feet in diameter) are considered "key" pieces. No "key pieces" were found in lower Bakeoven and Deep creeks during the survey. Reaches 10, 9, 8 and 1 had the most pieces of woody debris. Reaches 2, 6, 3, and 14 had the fewest pieces. Deep Creek overall had substantially more pieces than lower Bakeoven.

ODFW Habitat Benchmarks for large woody debris apply only to forested basins, and therefore were not used for Bakeoven Watershed.

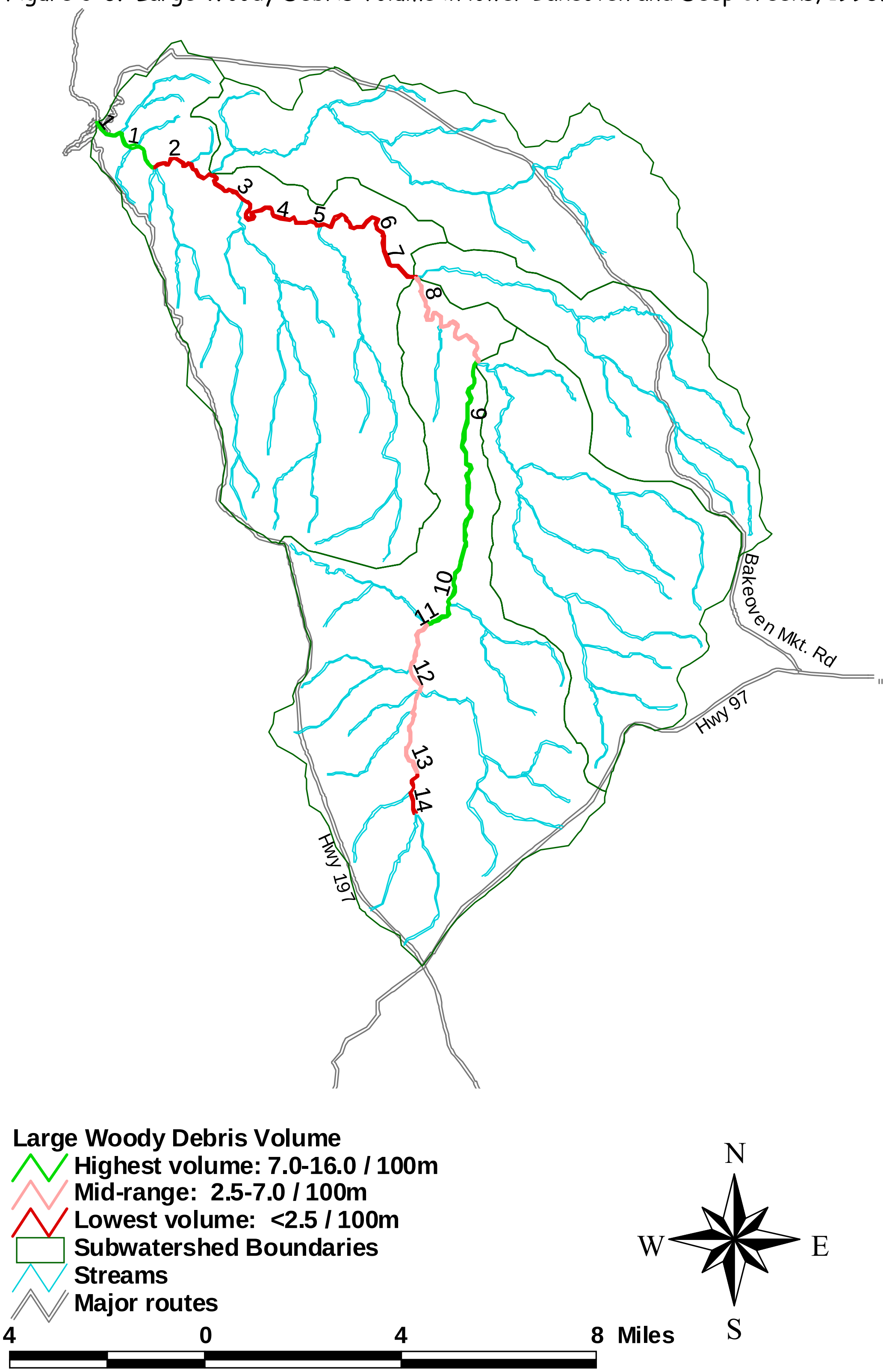
Table 3-7. Large Woody Debris in lower Bakeoven and Deep Creeks, 1995.

Reach	Pieces/100m (>3m x 0.15m)	Key pieces (>10m x 0.6m)
1	7.0	0
2	0.1	0
3	0.5	0
4	0.8	0
5	2.3	0
6	0.2	0
7	1.1	0
8	4.3	0
9	8.2	0
10	15.6	0
11	13.9	0
12	4.3	0
13	5.2	0
14	1.5	0

Findings

- "Key" pieces of large woody debris are lacking in Bakeoven Watershed.
- Large woody volume for the Watershed was low.

Figure 3-6. Large Woody Debris Volume in lower Bakeoven and Deep Creeks, 1995.



Canopy Closure

Canopy closure and ground cover were quantified for the riparian corridor from 0 to 10 meters from mid-channel, 10 to 20 meters, and 20 to 30 meters from mid-channel. An ODFW benchmark for riparian canopy closure was not listed.

Table 3-8. Canopy closure and ground cover for riparian zones 0-10m, 10-20m, 20-30 m, 1995.

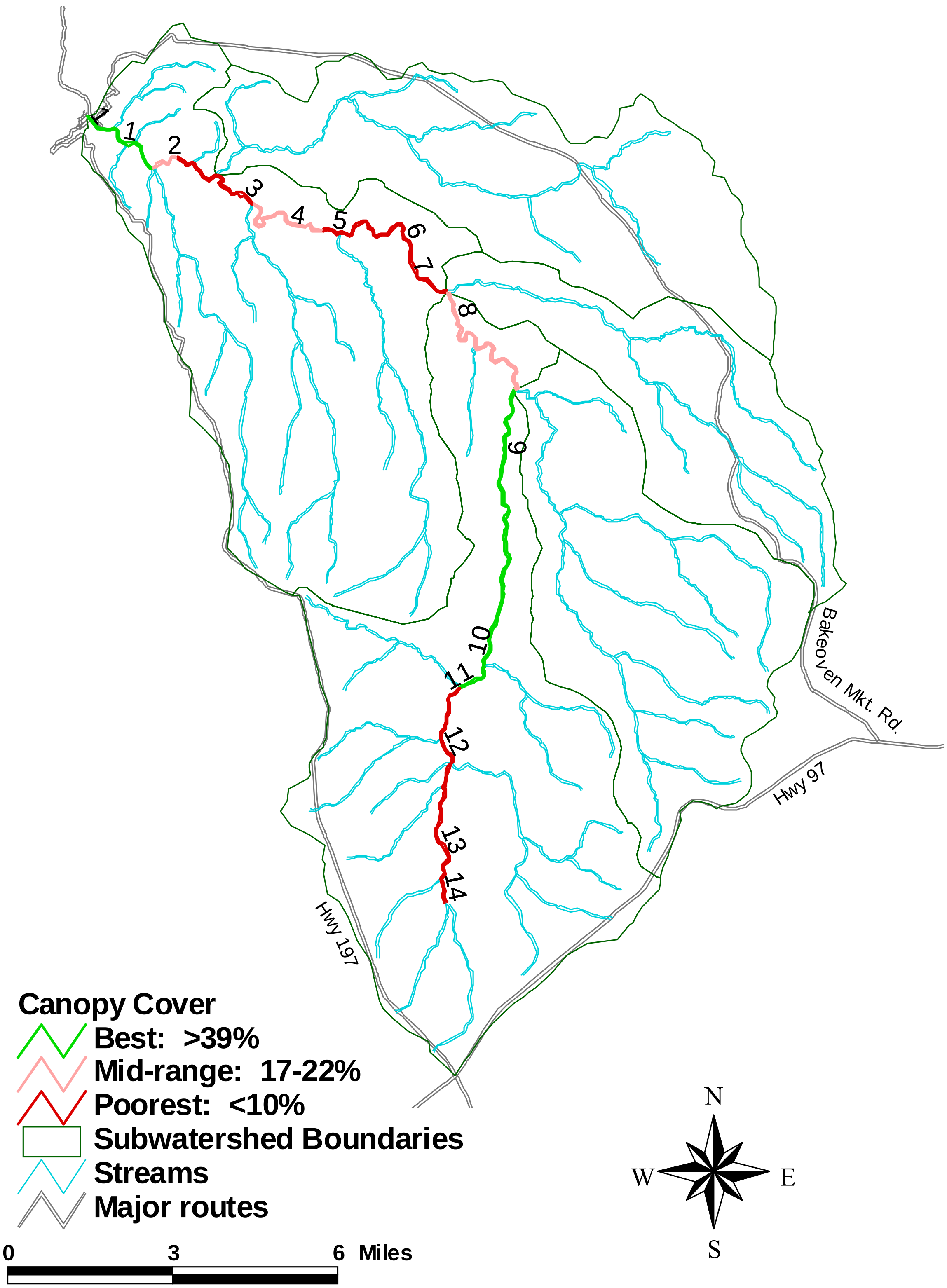
Reach	*Rating*	***% Canopy Closure:***		
		Zone 1 (0-10m)	**Zone 2 (10-20m)**	**Zone 3 (20-30m)**
1	B	39	30	25
2	M	21	5	0
3	**P**	7	3	6
4	M	17	3	3
5	**P**	9	9	0
6	**P**	0	0	5
7	**P**	0	0	2
8	M	22	11	3
9	B	48	16	9
10	B	39	13	4
11	B	48	4	30
12	**P**	9	12	15
13	**P**	10	9	13
14	**P**	8	3	0

B=best, M=mid-range, P=poorest.

Findings

- For the inner riparian zone shown in Table 3-8, only 4 reaches had canopy closure >39%. Half of the reaches in the survey area had riparian canopy cover of less than 10%

Figure 3-7. Canopy closure for inner riparian zone (0-10 meters), 1995.



Bank Stability

Bank stability was recorded, noting bank condition by percentage of reach as vegetation stabilized, non-erodible (bedrock), boulder,-cobble, or actively eroding. No Habitat Benchmark exists for bank erosion. The U.S. Forest Service goal is <20% actively eroding banks. Undercut banks, as long as they are stable, are a desirable fish habitat feature, offering cover from predators and sun.

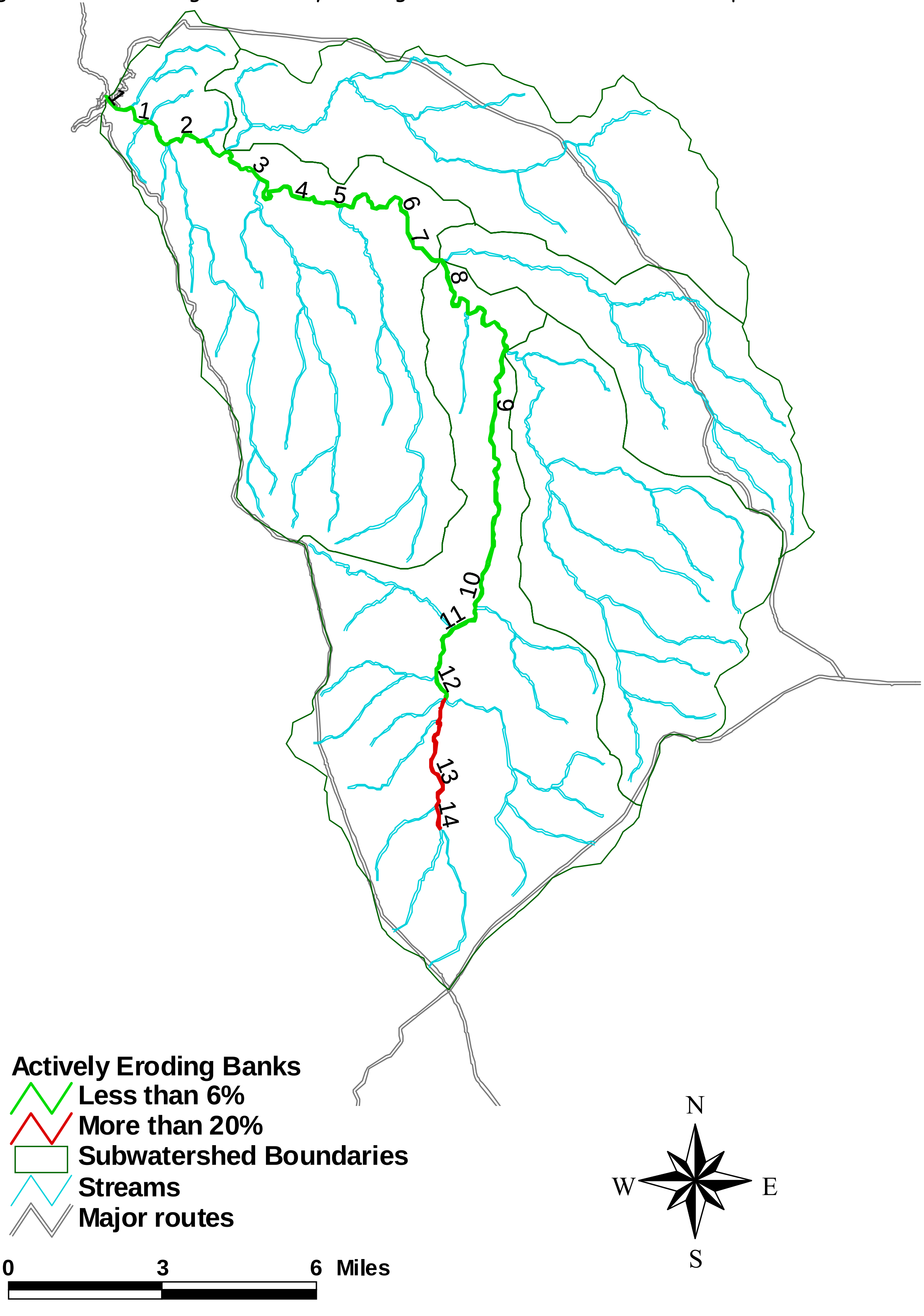
Table 3-9. Bank Stability in lower Bakeoven and Deep Creeks, 1995.

Reach	Actively Eroding	Undercut Banks
1	0.0%	3.82%
2	1.6%	1.25%
3	1.2%	2.34%
4	2.2%	1.20%
5	1.5%	1.05%
6	0.0%	0.15%
7	0.0%	0.00%
8	1.5%	1.38%
9	2.7%	3.32%
10	5.3%	3.41%
11	0.0%	2.98%
12	4.6%	2.56%
13	21.8%	4.76%
14	30.4%	0.26%

Findings

- Only two reaches were found with a percentage of actively eroding banks over 20%.
- The highest percentage of undercut banks was found in reaches 13, 1, 10, and 9.

Figure 3-8. Percentage of actively eroding bank in lower Bakeoven and Deep Creeks, 1995.



Summary of Habitat Survey Data

For the 1995 stream survey, reaches 9, 10, 11, and 1 ranked best overall for habitat conditions using fine sediment , dry habitat, channel width to depth ratio, pool frequency, woody debris, and canopy closure as habitat indicators. Reaches 6, 3, 14, 2, and 7 ranked poorest.

Gravels are plentiful in most of the survey area.

Fine sediment is in “desirable” range for all but 1 reach.

Dry channel limits rearing habitat and presents barriers to migration.

Channel width to depth ratio is“undesirable” in reaches 3-9. No reaches are in “desirable” range.

Pool frequency is low overall, six reaches (14, 2,1, 6, 7, 8) have “undesirable” conditions.

Average pool depth is desirable or acceptable in all reaches.

Large woody debris volume is low throughout survey area. “Key” pieces are completely lacking.

Canopy cover was very low for much of survey area.

Bank stability was found to be actively eroding at >20% in only 2 reaches (13, 14).

Key Issues

Alterations to the hydrology and vegetation of the Watershed have resulted in loss of instream habitat and riparian function. Less water is stored and released to streams throughout the year, contributing to higher peak flows, and lower low flows. Flooding over the past 40 years has damaged instream habitat complexity. Pools that once provided summer rearing and refuge during low flows have been washed out during major floods. Channels have become wider and shallower, resulting in higher stream temperatures in summer and areas of dry channel. Diminished canopy cover contributes to high stream temperatures as well.

Loss of riparian vegetation has resulted in low levels of woody debris throughout the Watershed. Large woody debris provides in-stream habitat complexity by creating pools. Cottonwoods which provide the largest woody debris, or “key” pieces, are believed to have been more abundant historically than at present.

4) Hydrology

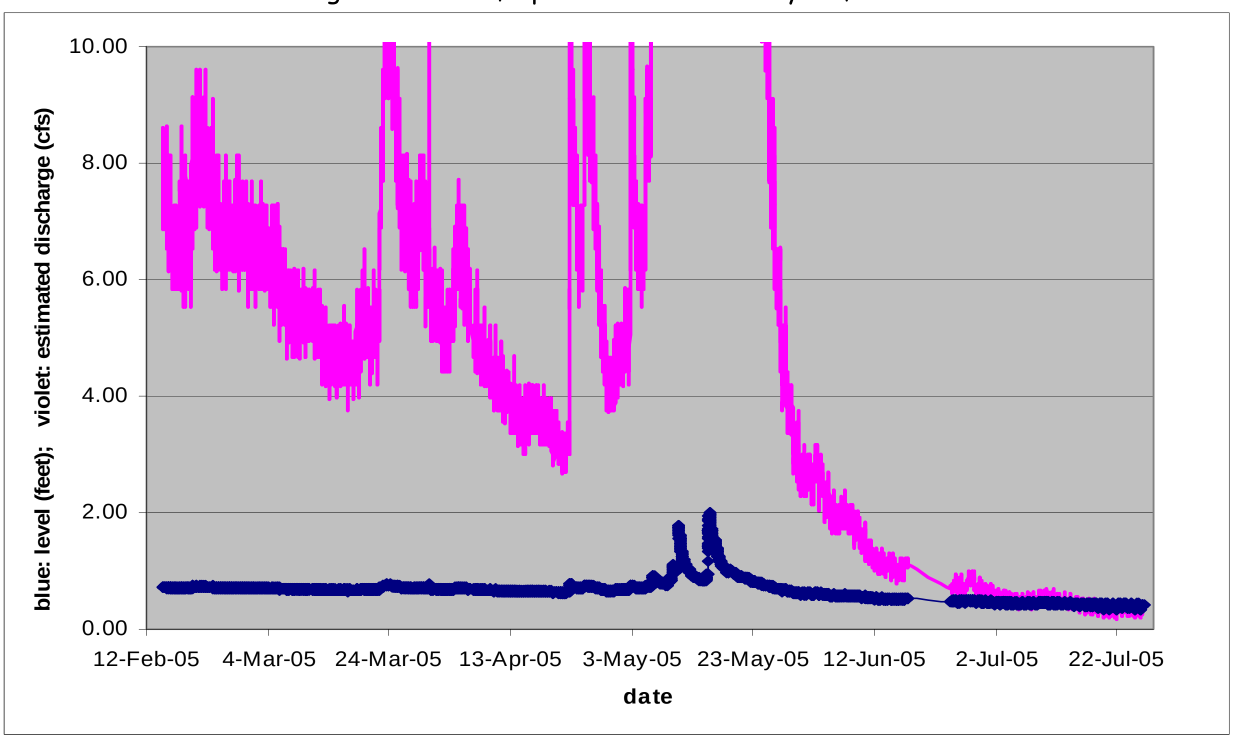
This chapter characterizes climate conditions and flow history of the Watershed, and assesses the potential effects of land use on natural watershed hydrology.

4.1) Stream flow

Elevation varies from 840 feet at the mouth to 3,250 feet at Shaniko Junction. Mean annual precipitation is between 11 and 14 inches. Precipitation may fall as snow or rain during the winter. The heaviest runoff events are likely to occur in late winter, early spring, and are associated with rain-on-snow events. In recent years, no more than a few inches of snow have typically accumulated at any one time. However, accounts of early settlers indicate that, in the early part of the 20th Century, snowpack might be several feet thick (Shaniko: From Wool Capital to Ghost Town).

In 2004, Wasco County SWCD installed an electronic staff sensor at the mouth of Bakeoven Creek to begin to develop a model of stream flow. Flow measurements were collected on June 22 2004, August 9th 2004, April 5th, 2005 and July 7th 2005 to correlate staff readings with discharge. On none of these dates did discharge exceed 8 cfs. Estimated discharge from February 2005 to July 26th, 2005 is summarized in figure 4-1. Discharges during the majority of the month of May exceeded 8 cfs and therefore could not accurately be estimated.

Figure 4-1. Water Level and Estimated discharge at mouth of Bakeoven Creek, February 14 2005 to July 26th 2005.
Source: Wasco Co. SWCD staff gage data, correlated with discharge readings on June 22 2004, August 9th 2004, April 5th 2005 and July 7th, 2005*.



*R^2=0.8712 for values below 8 cfs. No discharge readings have been taken for values above 8 cfs.

Several years of monitoring will be necessary before Bakeoven flows can be characterized. In general, one can state that high flows are associated with runoff events, and that summer baseflows are less than one CFS at the mouth in August and September. Some reaches consistently run subsurface, even in the mainstem of Bakeoven Creek (figure 3-3).

There are no surface water irrigation diversions on Bakeoven Creek. The small amount of irrigated acreage in Bakeoven Watershed is watered from wells. Streamflows in Bakeoven Creek are therefore not obviously influenced by irrigation practices. However, flows may be augmented at certain times by irrigation runoff.

4.2) Runoff

Runoff is the difference between precipitation and moisture storage. Moisture storage takes place primarily in the soil. Where soil infiltration rates are slow, and soil moisture holding capacity is low, runoff may be intense, even in relatively minor storm events. Changes in soil structure or vegetation that affect the infiltration rate will alter runoff intensity. These changes can affect magnitude, duration and impact of floods. Land use changes that lead to widespread changes in the type of vegetation on a landscape, such as agriculture, fire, grazing, or timber harvest, can be a significant factor in altering runoff patterns. This analysis is based on the USDA Soil Conservation Service Technical Release 55 (June 1986) runoff model, “Urban Hydrology for Small Watersheds” and the Engineering Field Manual, Chapter 2, “Estimating Runoff and Peak Discharge” (August 1989).

Methods

Soils were mapped using data from the Trout Creek/Shaniko Soil Survey (USDA, 1970). The soils are grouped into four categories; A, B, C, and D, based on texture and depth. “A” and “B” soils have the fastest infiltration rates and the least surface runoff. “D” soils have the slowest infiltration rates, and the most runoff. “C” soils are intermediate in all properties. In Bakeoven Watershed, “A” and “B” soils compose only 0.2% of the landscape. “C” soils compose 28% of the Watershed, and “D” soils account for 71.8%. Table 4-1 shows the acreage and percentages of soils in Bakeoven, and Figure 4-3 shows their distribution.

Figure 4-3. Hydrologic Soil Groups in Bakeoven Watershed.
Source: Northern Wasco County Soil Survey (USDA, 1986).

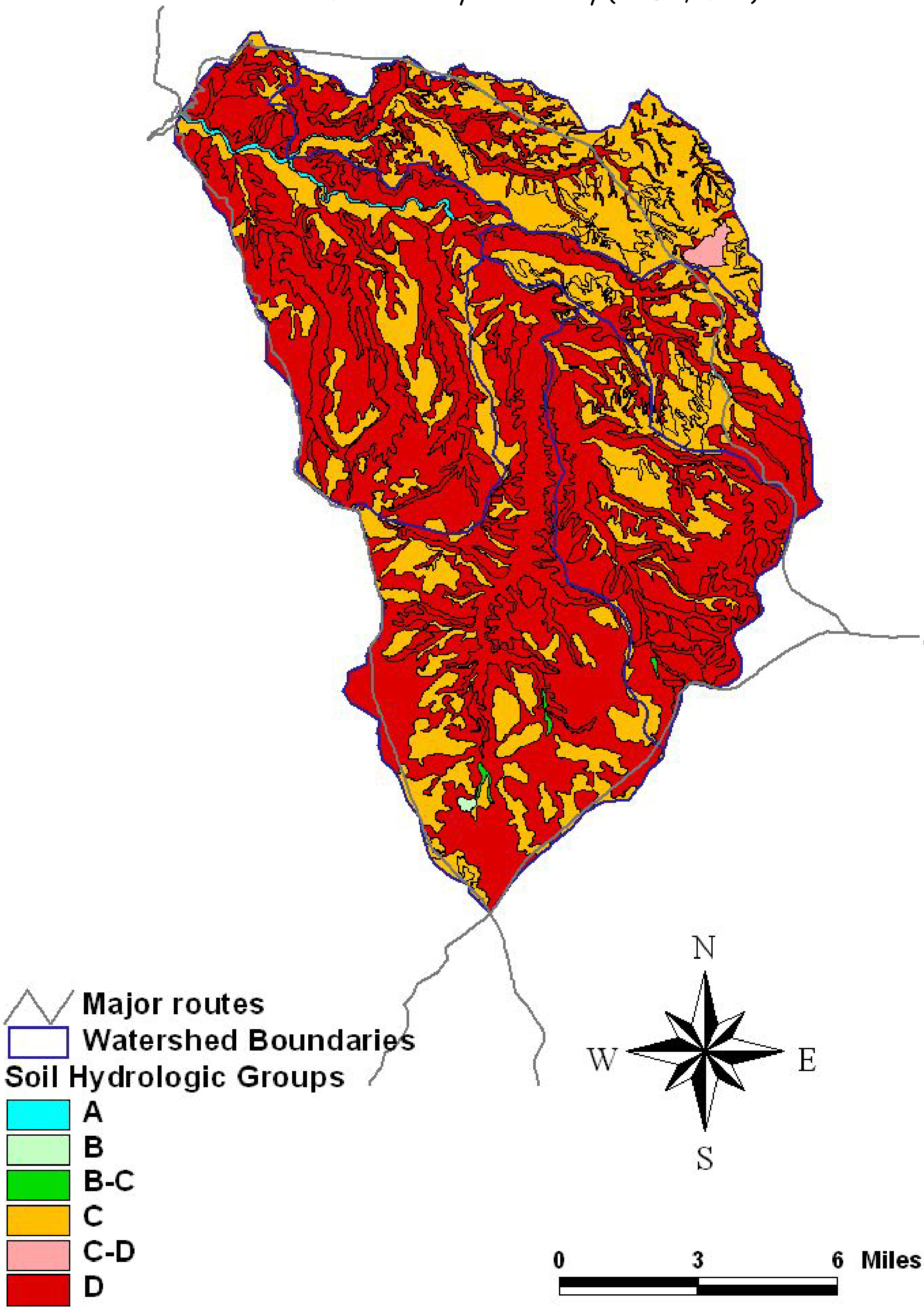


Table 4-1. Soil types and groups in Bakeoven Watershed.

Soil Group	*Soil Type*	*Acreage*	*% of Watershed*
"A"	**Riverwash**	**448.4**	
"B"	**Willowdale loam**	**97.4**	
"B-C"	**Mixed alluvial land**	**144.5**	
"			**"A" & "B": 0.2%**
"C"	**Condon silt loam, 2-12% slopes**	**81,997.7**	
	Condon-Bakeoven complex, 2-20% slopes	**21,710.3**	
	Wrentham-Rock outcrop complex, 35-70% slopes	**5,521.7**	
"C-D"	**Playas**	**340.8**	
			"C" soils: 28.0%
"D"	**Bakeoven very cobbly loam, 2-20% slopes**	**9,529.1**	
	Bakeoven-Condon complex, 2-20% slopes	**244,904.4**	
	Lickskillet extremely stony loam, 40-70% slopes	**16,171.0**	
	Lickskillet very stony loam, 15-40% slopes	**10,968.8**	
			"D" soils: 71.8%

The cover type and cover condition for each field or tract were determined using aerial photos, records from the Farm Services Agency, and consultation with NRCS staff. The condition of vegetation largely depends on the management history of the land, as well as current practices. The acreage of each field or tract varied considerably. Cover types included clean-tilled crop, minimum tilled crop, irrigated crop, grass/forb/shrub, riparian tree/shrub, buildings and farmsteads, and bare ground. Grass/forb/shrub in poorer hydrologic condition included annual grass and scab. Grass/forb/shrub in fair to good condition included improved range, native bunchgrass, and land enrolled in CRP.

Table 4-2. Runoff curve numbers for selected cover types and soils in Bakeoven Watershed (Source: NRCS TR-55, 1986)

	Soil Classification			
Practice/Cover Type	***"A"***	***"B"***	***"C"***	***"D"***
Crop – "Clean till"			88	91
Crop – "Minimum till" (residue management)			84	87
Crop – Irrigated			71	78
Grass/forb/shrub: Poor (annual grass or scab)		80	87	93
Grass/forb/shrub: Fair (bunchgrass or improved range)		71	81	89
Grass/forb/shrub: Good (CRP, bunchgrass, or improved range)		62	74	85
Riparian tree/shrub: Poor Condition	48	67	77	83
Riparian tree/shrub: Good	30	48	65	73

Figure 4-4. Land use prior to 1987

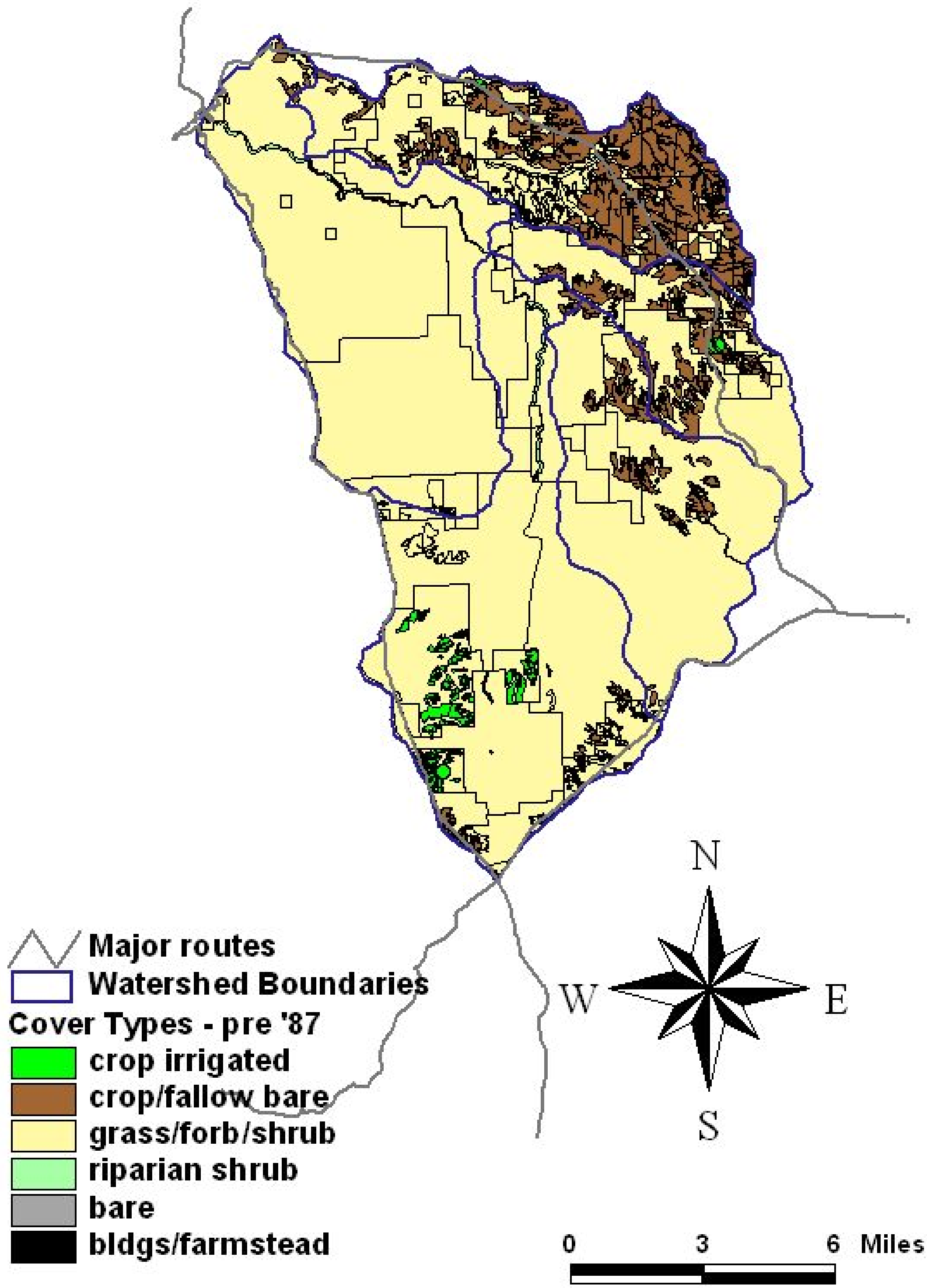
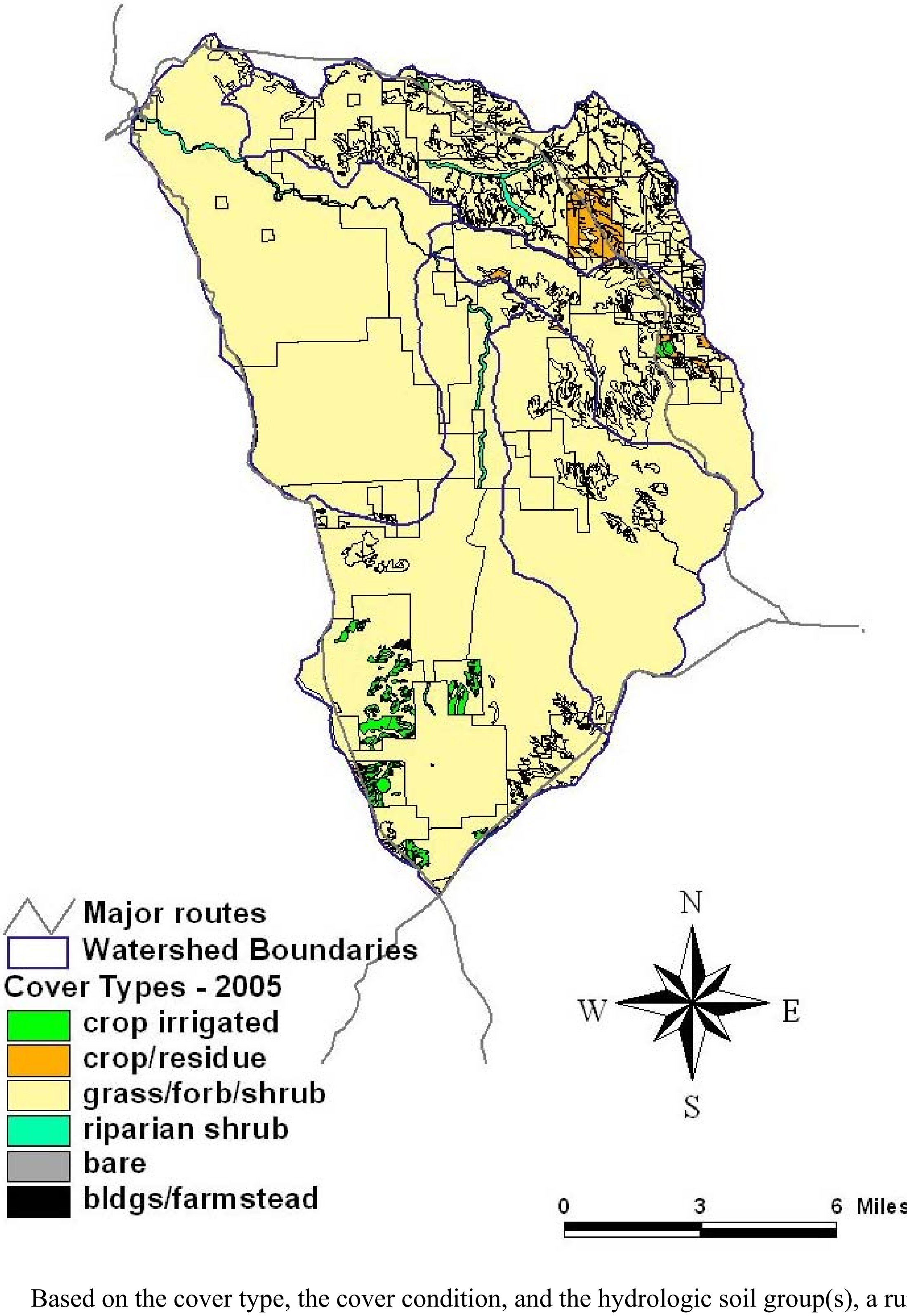


Figure 4-5. Current (2005) Land Use



Based on the cover type, the cover condition, and the hydrologic soil group(s), a runoff curve number (RCN) was determined for each field or tract. Where land units were very large, a weighted average of the run-off ratings for the soil groups represented within the tract was calculated. Runoff Curve Numbers very from 1-99, based on the infiltration rate of the soil-cover combination. Higher numbers imply lower infiltration rates, and thus higher runoff levels. Lower numbers retain moisture in the landscape, and thus mitigate both flood and drought events. Runoff curve numbers allow runoff depth to be calculated in inches for various types of storm events, at various points in history, based on historic vegetation, and changes in farming and ranching practices through time. Table 4-1 shows runoff curve numbers used for major cover types and soils in Bakeoven.

Runoff curve numbers were then used to calculate the amount of runoff in inches that could be expected from a two-year rainfall event (1.4" of rain in a 24 hour period). This analysis was done for three time periods—prior to settlement (about 1860), prior to implementation of the Conservation Reserve Program (pre-1987), and current (2005).

In this analysis, which is based on FSA land units (fields and tracts), riparian vegetation is only shown separately from the surrounding tract if it has been enrolled in CREP. For the purposes of this analysis, the assumption was made that vegetative cover conditions were "poor" before enrollment and use exclusion, due to the heavy grazing that occurred throughout Bakeoven in the early 20th Century. The assumption was also made that these areas are moving toward "good" condition, with re-establishment of woody vegetation. It should be noted that this is a generalization, as conditions varied along these stream reaches to some degree. (It should also be noted that it is possible to manage grazing in riparian areas in a manner that promotes "good" vegetative and hydrologic conditions.)

Results

Figure 4-6 shows estimated runoff rates from a two-year event under pre-settlement conditions. Figure 4-7 shows estimated runoff rates prior to implementation of the first Farm Bill (1987); while figure 4-8 shows estimated runoff rates under current conditions.

Historic conditions were characterized by perennial bunch grasses on the uplands and forested riparian corridors in the canyon bottoms. The average runoff level during a two-year precipitation event was 0.17 inches.

Between 1860 and 1987, croplands were tilled using moldboard plows, and rangelands were grazed first by sheep and later by cattle. Large pasture sizes were utilized, and these pastures relied on the creeks for water supplies. By 1987, runoff rates had increased to an average of 0.41 inches (over 100% increase) across the watershed.

Since 1987, average runoff has decreased to 0.32 inches due to improved grazing rotations, establishment of perennial grass cover on marginal croplands, and establishment of forested riparian buffers. This is still nearly double the runoff of presettlement times, and has a significant effect on the condition of the stream, riparian areas and canyon bottoms.

It should be noted that these numbers are estimates only, and are based on incomplete information. In order to establish the true current condition of the rangelands, trained personnel would have to do range site surveys in several locations on each separate pasture unit.

Recommendations

- Work with participating landowners to improve range conditions until all rangeland acres exhibit vegetative characteristics that approximate presettlement conditions (perennial grasses mixed with forbs and a few shrubs.)

Figure 4-6. Runoff in inches from a two-year precipitation event prior to settlement (1860)

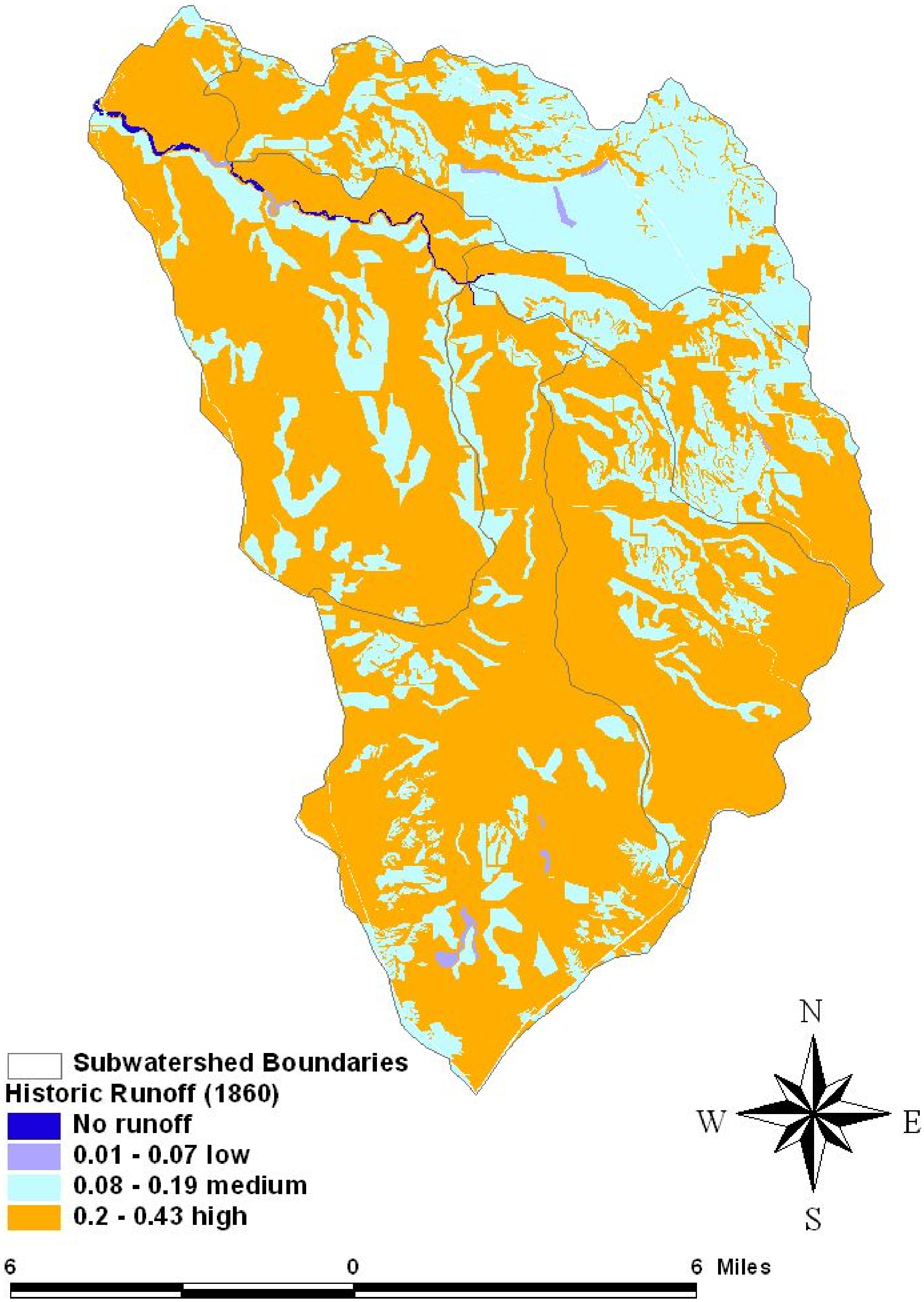


Figure 4-7. Change in Runoff from presettlement (1860) to pre-Farm Bill (1987)

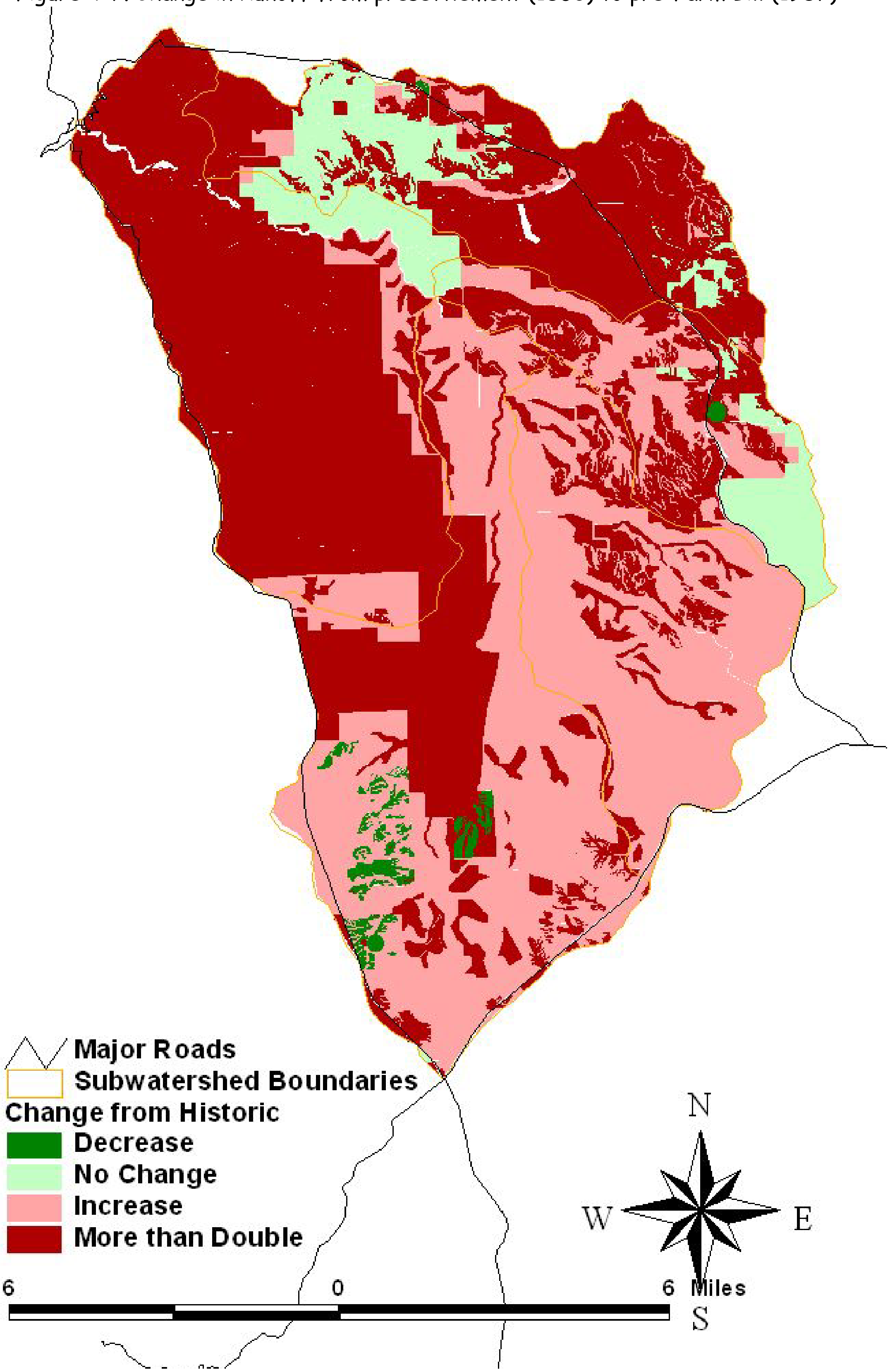
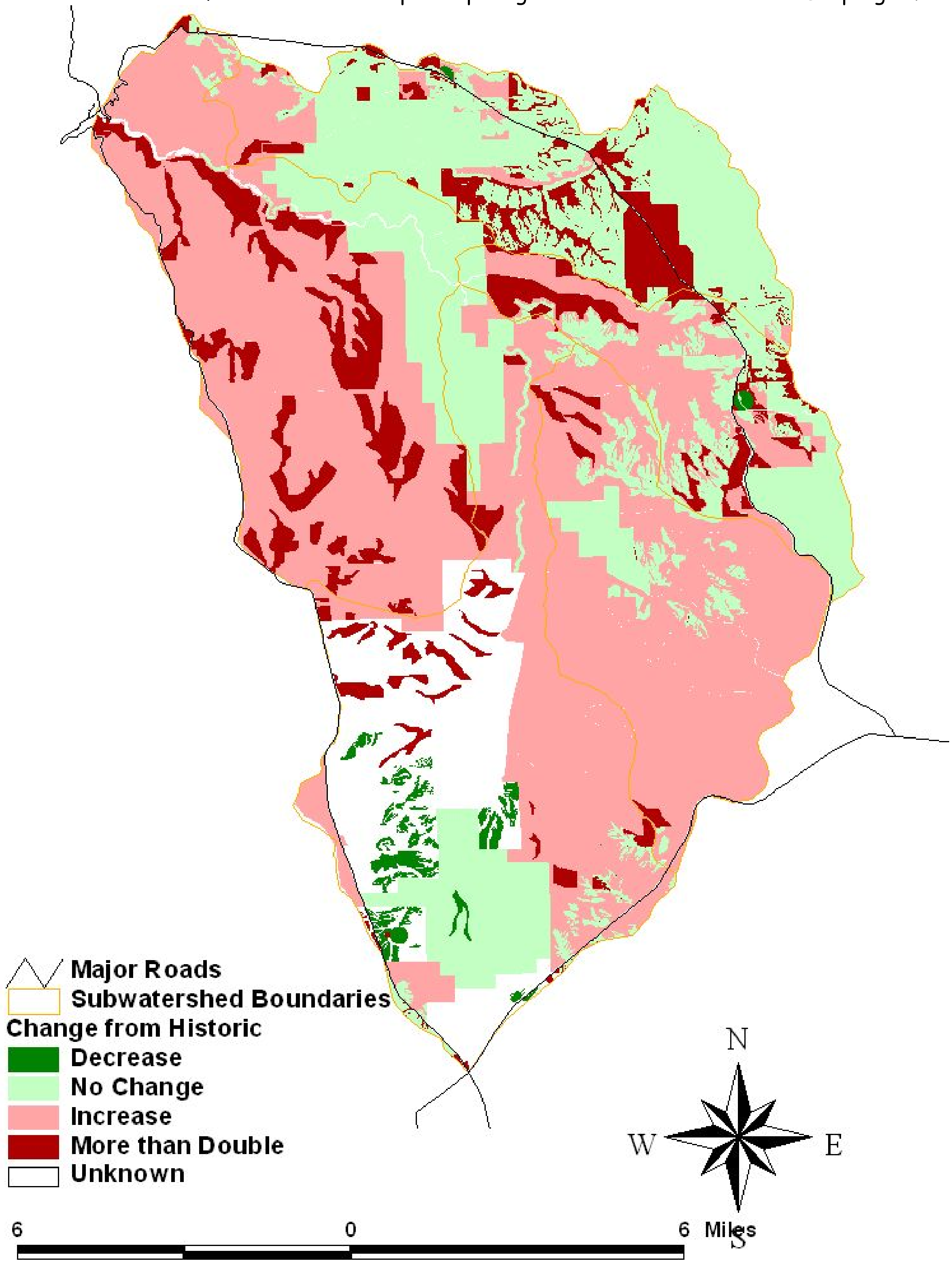


Figure 4-8. Change in runoff under current (2005) conditions compared to presettlement (1860). Note: no data available for landowners not participating in watershed council or USDA programs



4.3) Erosion

Whereas section 4.2 analyzed the movement of water over the soil surface, this section will analyze the loss of soil associated with that runoff. Erosion can occur anywhere, but disturbed soils are particularly susceptible. Therefore, this analysis focuses exclusively on croplands.

Cropland erosion is a potential contributor to stream sedimentation. Cropland erosion occurs in two characteristic patterns: as sheet and rill erosion or as concentrated flow ("gully erosion"). The first is a gradual process of downhill creep across the entire field. It is difficult to detect and difficult to measure except under controlled experimental conditions. Such experimental conditions have been used for more than 50 years by the USDA Agricultural Research Service to develop and improve the Revised Universal Soil Loss Equation (RUSLE – NRCS Field Office Technical Guide 2002). RUSLE is used to predict the long-term average soil loss due to sheet and rill erosion from any given field under a particular crop rotation and management style. Sheet and rill erosion does not translate directly into stream sedimentation, because soil lost from a field may not all be delivered to a stream. The delivery ratio is a factor of distance from a stream and intervening topography, land cover, and other factors. It is not well understood and is too complex to be modeled here.

Concentrated flow or gully erosion is erosion caused by flowing water collected in streams in a vulnerable field. It leads to clearly visible and measurable gullies in the field, and has a very high sediment delivery ratio, usually near 100%. This is a very site-specific phenomenon. Practices that reduce sheet and rill erosion also tend to reduce gully erosion, as do structural practices. Because it is so visible and disruptive to farm operations, gully erosion has been substantially addressed over the years by both vegetative and structural practices, such as sediment basins.

This assessment used RUSLE to predict soil loss due to sheet and rill erosion in tons per acre per year based on soil erodibility, length and slope of field, vegetation and rainfall equivalent.

Methods

The Revised Universal Soil Loss Equation is represented as:

$$A=(Req)(LS)(C)(K)(P)$$

where A is *soil loss* in tons per acre per year,

Req is a *rainfall equivalent* that takes into account both annual rainfall levels and local rainfall patterns,

LS is a combination of the average *length* and *slope* of the field,

C is the *vegetative cover factor*, which is determined by the crop and crop rotation (table 4-6),

K is the *inherent erodibility* of the soil. Each soil in the soil survey is assigned a K value. K values in Fifteenmile varied from 0.10 to 0.49, with 96% of the cropland soils having values of 0.43 or 0.49.

P is the *practice factor* that takes into account such things as terraces, strip cropping and contour plowing. Structural practices are not well mapped in the Fifteenmile Watershed. According to RUSLE, structural practices such as those used in Fifteenmile Watershed reduce sheet and rill by no more than 10%. Therefore, P was held at 1 in this calculation.

Table 4-3. Crop Rotation and Vegetative Cover ("C") Factors used in this Assessment

Crop Rotation	**Assumption**	**"C"**
Winter Wheat/Summer Fallow with Moldboard Plow	Typical practice prior to 1980's.	0.180
Winter Wheat/Summer Fallow with Chisel Plow & 20% residue after planting	"Minimum Till", Typical practice in existing dryland crop fields	0.110
Irrigated Wheat	Irrigation leads to strong root growth, high residue	0.080
Irrigated Hay	Similar in properties to improved grass stands	0.001
Annual grasses or poor quality grass/forb/shrub	Crop fields not replanted to grass	0.020
Perennial grass/forb/shrub	CRP or improved grass stands	0.001

The NRCS Field Office Technical Guide also identifies one other parameter—the soil loss tolerance, "T". T is the amount of soil that can sustainably be lost from a given soil per year. It is approximately equal to the rate at which soil is built up on that soil. Table 4-4 shows T for cropland soils in Bakeoven Watershed.

Figure 4-4: Soil Loss Tolerance (T) on cropland soils in Bakeoven Watershed

Soil Type	**T (tons per acre per year)**
Bakeoven (stony scablands)	0
Condon Bakeoven Complex	2
Condon Silt Loam	2
Lickskillet Very Stony Loam	1
Playas	1
Willowdale Loam	4

The database developed for the hydrology model (see above) was clipped to include only lands that were in dryland crop production either in 2005 or 1980 (figure 4-4). Each farm field or portion thereof was assigned Req, LS, C and K factors. These were multiplied together to get A, the predicted long-term soil loss under current conditions. C factors were then assigned for the each farm field under 1980 conditions (table 4-6), to provide a historic trend. Req, LS and K are all environmental factors that change only negligibly over time.

Results

Table 4-5 summarizes results of the analysis, and figure 4-9 shows them visually.

Prior to 1980, all grain growing fields, irrigated and nonirrigated alike in Bakeoven Watershed had erosion rates exceeding 5 tons per acre per year. Irrigated hay fields did not have a significant erosion rate, unless it was gully erosion generated by overirrigation. Erosion rates varied up to 15.84 tons per acre per year.

Since that time, all except for 1,244 acres of dryland grain have been converted to pasture or CRP, largely eliminating the high erosion rates. The remaining 1,244 acres of dryland grain are managed using minimum till techniques, which have erosion rates varying from 5.6 to 7.9

tons per acre per year. All of these fields are on condon silt loams or condon-bakeoven complexes, with a soil loss tolerance of 2 tons per acre per year.

Table 4-5. Average erosion levels and remaining acres exceeding soil loss tolerance, "T"

Erosion Levels	**1980**	**2005**
Acres of cropland	13,424	2387
Ave (tons/acre/year)	10.16	3.30
Range (tons/acre/year)	0.06-15.84	0.06-7.92
Acres exceeding soil loss tolerance "T"	12,281	1,244

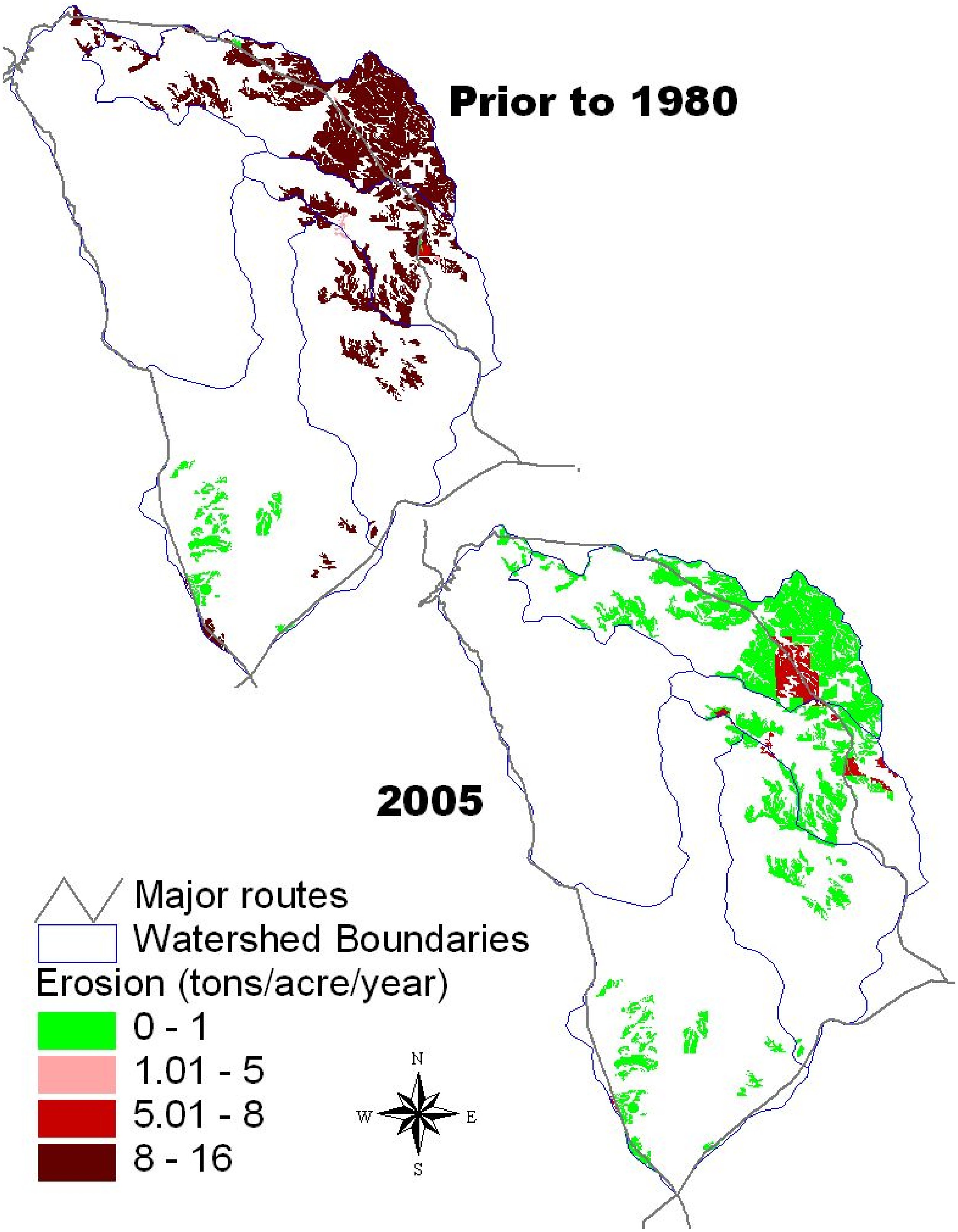
The Lower Deschutes Agricultural Water Quality Management Area Plan (OAR 603-095-0640(2)(a) (C) establishes an erosion standard of not to exceed 5 tons per acre per year for the protection of water quality. Remaining croplands in Bakeoven Watershed still exceed this level.

Conversion of these croplands to no till would reduce erosion rates to about 20% of their current level (1.1 to 1.6 tons per acre per year), bringing all croplands into compliance with the Lower Deschutes Agricultural Water Quality Management Area Plan, and bringing all oft hem within their soil loss tolerance of 2 tons per acre per year.

Recommendations

- Convert remaining nonirrigated cropland acres (T=2 tons/acre/year) to no-till techniques (1,244 acres).

Figure 4-9: Cropland Erosion Rates Prior to 1980 and Present



5) Riparian Conditions

Riparian vegetation is important as a source of shade and large woody debris, and to filter out sediment from storm events. Large woody debris (large tree trunks, stumps or branches) is an important structural element for fish habitat. Shade affects stream temperature. Riparian vegetation serves to filter out fine sediments carried by runoff that can smother eggs in spawning gravels, and is the source for organic matter needed by the aquatic food chain. Trees, shrubs and other riparian vegetation also help stabilize streambanks.

The purpose of this assessment is to evaluate current riparian vegetation along stream channels in the Watershed compared to the site potential. This information can be used to identify areas where riparian vegetation has been degraded and where it is in good condition, and thus prioritize areas for riparian restoration or protection.

Methods

This analysis looked at all major streams and channels, (including intermittent streams and seasonal drainages). Riparian vegetation was evaluated using color aerial photography taken in summer 2003, backed up by black and white aerial photography taken in summer 1995. Historic survey notes, local observations, and comparison to surrounding areas in aerial photos provided additional information on which to base a judgement.

Riparian vegetation was evaluated by dividing each stream into reaches, or units, known as “riparian condition units”. Riparian condition units (RCUs) are stream reaches for which vegetation type, size and density remain approximately the same. Each side of each stream was evaluated separately. The riparian zone width considered for each RCU was based on the ecoregion and the channel habitat type for the RCU. In the ecoregions of Bakeoven Watershed, the riparian zone varies from 25’ to 50’, depending on whether the channel is constrained, or semi-constrained for the given reach. No unconstrained reaches were identified in Bakeoven Watershed.

The Oregon Watershed Assessment Manual delineates and describes ecoregions within Oregon State. According to the Manual, Bakeoven Watershed contains two ecoregions. “Deschutes/John Day Canyons” is the ecoregion present in the deeper canyons of the Watershed. The “Umatilla” ecoregion covers the remainder of the watershed, including uplands and smaller canyons. Potential riparian vegetation and riparian zone widths are given for each ecoregion.

Each RCU was classified by Potential Riparian Vegetation (Figure 5-1), based on ecoregion and observation of surrounding areas in the aerial photos. “Potential vegetation” refers to the historic vegetation present prior to settlement. Potential vegetation for each ecoregion is described in the Oregon Watershed Assessment Manual. Additional information regarding historic plant communities was found in historic survey notes from the Public Land Surveys undertaken for Wasco County in the latter 1800s. The survey notes are organized by township, range, and section. Plant species that were present along creeks are mentioned in the survey notes for some sections, but are not noted consistently for every section. Riparian vegetation was not the primary concern of the surveyors, who were mainly interested in potential of the land for crops and range animals.

Each RCU was then rated by whether it had the potential vegetation or not. Vegetation type, size, and density are considered in rating the RCU as either meeting, or not meeting its vegetative potential. It was not possible to determine tree species or tree size with certainty from the aerial photographs. These will need to be verified in the field.

Vegetation types present in Bakeoven Watershed include hardwoods, mixed hardwoods and conifers, shrubs and shrubby hardwoods, grass, and agricultural crops. Tree size is catagorized as small (<4 inches trunk diameter), medium (4-12 inches), or large (12-24 inches). Stand density is catagorized as sparse (<1/3 ground exposed), or dense (>1/3 ground exposed).

In seasonal drainages, potential vegetation was considered to be the same as upland vegetation – predominantly grass, sometimes with upland trees or shrubs.

Aerial photographs from summer 2003 were used to determine the extent and density of vegetation in the Watershed. The ODFW Habitat Inventory from 1995 was a resource for information about species and size of vegetation along Deep Creek and lower Bakeoven Creek. Additional field observations will be needed to verify size and species in the remainder of the Watershed.

Where the condition of the riparian vegetation did not meet vegetative potential, and no known restoration efforts have been undertaken, recommendations for restoration efforts are given.

Results

Potential Riparian Vegetation

Potential Riparian Vegetation is shown in figure 5-1. For the Deschutes/John Day Canyons Ecoregion, potential vegetation described in the Oregon Watershed Assessment Manual is medium sized hardwoods with infrequent ponderosa pine. These hardwoods include alder, water birch, and willow, with cottonwood where broader flood plains are present.

In the Umatilla Ecoregion, shrubs and shrubby hardwoods are the potential vegetation. These include alder, birch, willows, red osier dogwood and spirea. Some species of the Umatilla Ecoregion overlap with those of the Deschutes/John Day Canyon Ecoregion. Generally, riparian vegetation is expected to be smaller in the Umatilla Plateau Ecoregion.
Potential density of vegetation for both Ecoregions is considered to be “sparse”.

From the historic survey notes we know that cottonwood extended far into Deep Creek, as it does today. The Survey notes also indicate that cottonwood extended up Cottonwood Creek within the Deschutes/John Day Canyon Ecoregion, and possibly farther. Higher reaches of Cottonwood Creek supported willow, according to the survey notes. Cottonwood was also noted on Robin Creek, along with juniper. Aspen and birch were noted in higher reaches of Trail Hollow and Booten Creeks.

Current Riparian Vegetation

Current Riparian Vegetation is shown in figure 5-2. Though the expected density of vegetation was considered to be “sparse” for the entire Watershed, this expectation was surpassed in some reaches in both ecoregions. Areas of predominantly grass and/or forbs, and reaches with extensive areas of bare soil are also mapped. Mixed Hardwoods and Ponderosa Pine were the prevalent vegetation in the upper reaches of Deep Creek. Figure 5-3 shows reaches meeting and not meeting vegetative potential. These reaches and the reasons for not meeting potential are listed below.

- Lower Bakeoven Creek (below the confluence with Deep Creek) has several reaches lacking adequate riparian vegetation.
- Salt Creek and the lowest reach of Dead Dog Canyon are mapped as Deschutes/John Day Canyon Ecoregion, with potential for medium-sized hardwoods. Riparian vegetation is extremely sparse or nonexistent in these

reaches. The unnamed tributary just downstream of Salt Creek has similar characteristics.

- Lower Booten Creek, a tributary of lower Bakeoven, has excessively sparse vegetation compared to similar reaches nearby.
- Deep Creek has two reaches with large areas of bare soil.
- Lower Cottonwood Creek, a major tributary of Deep Creek, is mapped as being within the Deschutes/John Day Canyon ecoregion, with potential for medium-sized hardwoods. Riparian vegetation appears to be excessively sparse in two of the reaches within the Deschutes/John Day zone. By contrast, tributaries of Cottonwood Creek to the East outside of the zone appear to support rather dense vegetation.
- Riparian buffers have been installed on many miles of stream, some of which are mapped as meeting potential and some of which are mapped as not meeting potential.

Table 5-1. Stream miles meeting and not meeting vegetative potential in Bakeoven Watershed.

Subwatersheds	Total Miles	Miles Not Meeting Potential	Miles enrolled in Riparian Buffer Programs
Lower Bakeoven	36.2	5.0	10.6
Salt Creek/Dead Dog	13.4	4.4	5.1
Upper Bakeoven	12.3	0.00	4.5
Deep Creek	33.1	0.9	7.2
Cottonwood Creek	19.7	1.6	0.0
Totals	**114.8**	**11.8**	**27.4**

Confidence in the Accuracy of the Results

It is possible that the ecoregions, as mapped, do not fully portray the vegetative potential of all reaches in the Watershed. Some may have a lower potential than mapped, and some may have a higher potential. For example, the upper reaches of Deep Creek support dense (medium sized) hardwoods beyond the Deschutes/John Day Canyon ecoregion zone as mapped.

Conversely, Salt Creek and lower Dead Dog Canyon in the Salt Creek subwatershed may not be capable of supporting a riparian zone of medium sized hardwoods. Natural factors such as hydrology and aspect may reduce the ability of the Salt Creek drainage to support vegetation. Salt Creek flows towards the southwest into Bakeoven Creek, sloping towards the sun during the warmest hours of the day. These factors will need to be investigated further when determining restorative actions to be taken.

Furthermore, the method used here can not fully capture the need for riparian restoration. The method used here relies on aerial photography, which can only capture the dominant vegetation. Deficiencies in undergrowth species are not visible from the air.

Figure 5-1. Potential Riparian Vegetation in Bakeoven Watershed.

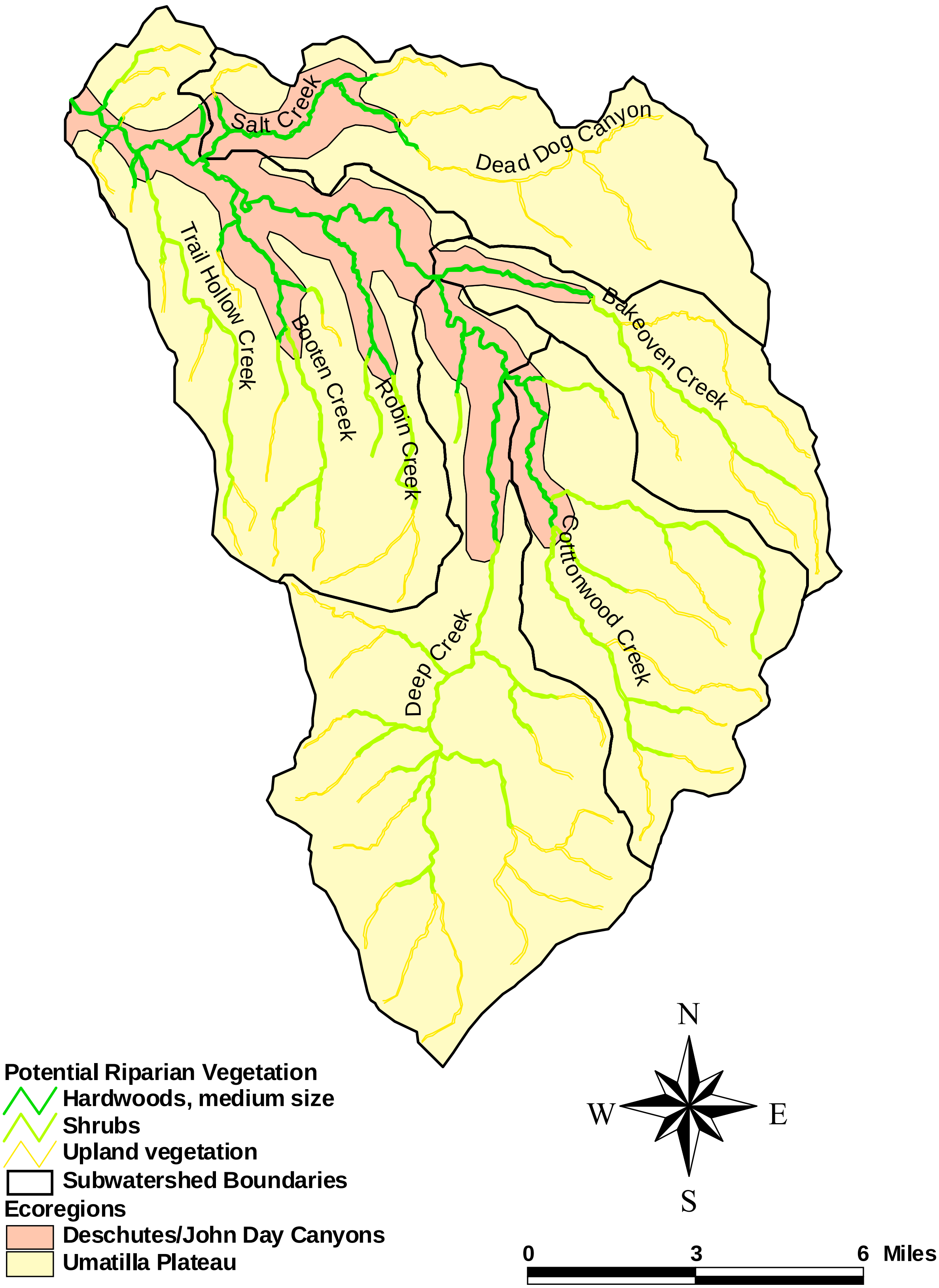


Figure 5-2. Current Riparian Vegetation in Bakeoven Watershed.

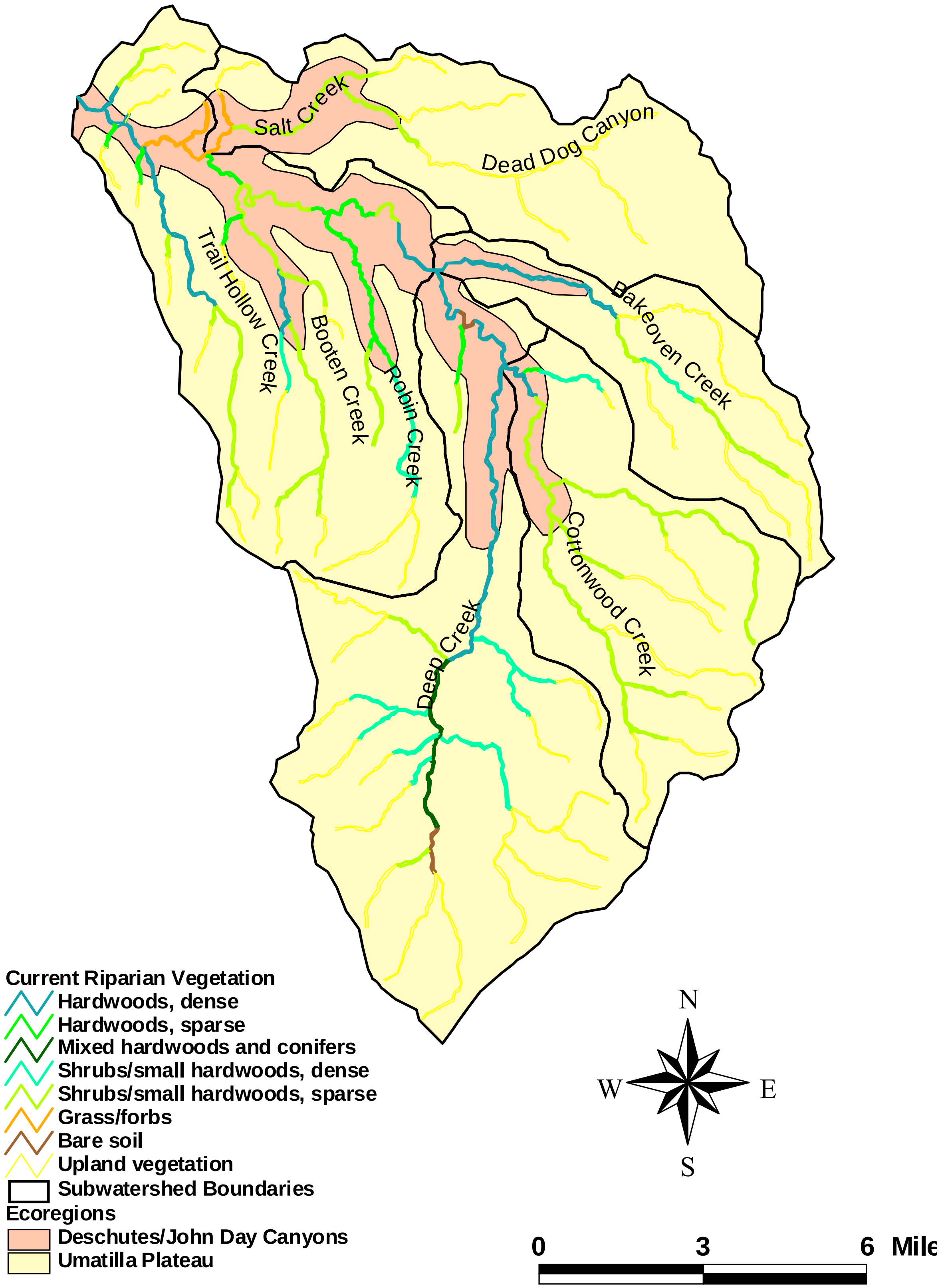
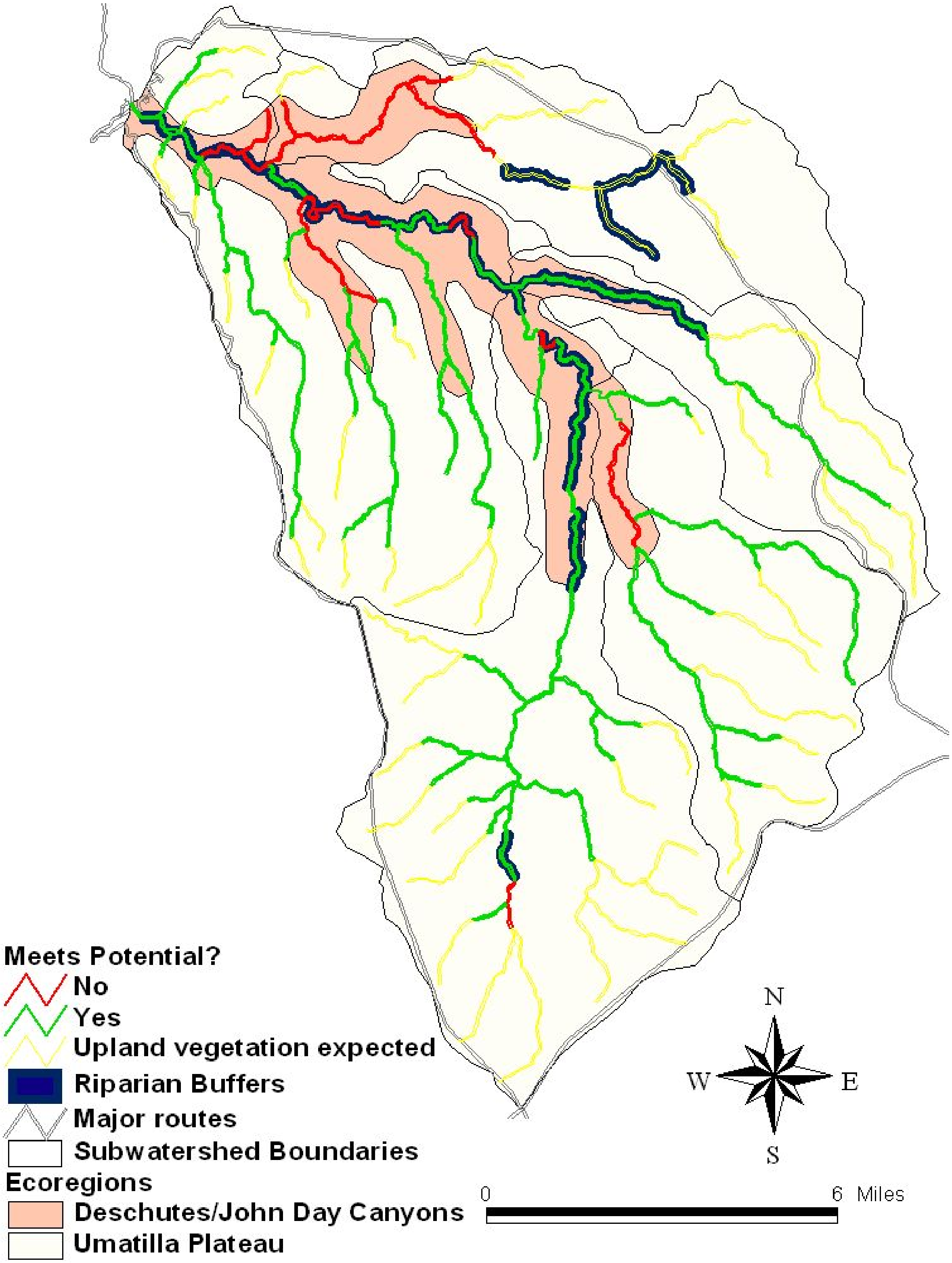


Figure 5-3. Riparian vegetation meeting and not meeting potential in Bakeoven Creek, with comparison to riparian buffers.



Recommendations

The most direct approach to restoring riparian conditions would be to establish riparian buffers along those reaches identified as not meeting potential and to then replant them with native species. It is interesting to note that more miles of riparian buffers have already been installed than were identified in this process as not meeting potential. Meanwhile, many miles of stream that don't meet potential have not yet been addressed in this manner (Table 5-1, Figure 5-3.) Riparian buffers are only established in areas where a conservation technician (SWCD or NRCS) has identified a need for restoration. Often this need may not show up from an aerial photo, but will be clear from the ground as missing ecosystem components (for example undergrowth.) Therefore, this analysis can not be used as an absolute measure of the need for riparian restoration, though it might be capable of identifying the worst areas.

Some landowners prefer not to set riparian corridors aside, leaving them as part of the pasture system while managing them carefully for improving conditions. This approach is valid, but more difficult to document. In cases where key riparian areas are not to be put into buffers, monitoring is needed to determine the trend.

Objectives:

- Protect and restore all riparian areas identified in this process as not meeting potential
- Protect all riparian corridors in the John Day/Deschutes Canyon Ecoregion.
- In areas where landowners are not interested in riparian buffers, develop management plan and establish long-term monitoring program to document trend.

These three objectives affect an additional 13.3 miles of riparian corridors, the majority of them in the lower reaches of Salt Creek, Cottonwood Creek and Booten Canyon as well as upper Deep Creek.

6) Wetlands

Wetlands are "areas that are transitional between terrestrial and aquatic ecosystems, where the water table is at or near the surface, or the land is covered by shallow water." (Wetland Plants of Oregon and Washington, Jennifer Guard, 1995.) Wetlands contribute to critical functions in the health of a watershed. They provide a means of storing, filtering, and slowing water during high flow events, and also provide a means of recharging the groundwater table, thereby helping to maintain streamflows. Additionally, wetlands provide critical habitat for fish, amphibians, birds, and many other types of wildlife. Wetlands are legally protected by federal, state, and local regulations. Determining the location and extent of wetlands in the watershed is essential in planning for growth, development, or any kind of project.

Lakes and reservoirs are considered lacustrine wetlands. Streams and riparian areas can also be considered wetlands where hydric soils are present. These are known as riverine wetlands. Palustrine wetlands (also known as "vegetated" wetlands) include natural and man-made ponds, springs, marshes, wetland prairies, shrub swamps, and wooded wetlands. They can occur beside lakes and rivers, or as isolated wetlands within upland areas.

Methods

The major source for this inventory was the National Wetlands Inventory (NWI) of the U.S. Fish and Wildlife Service. National Wetlands Inventory categorizes wetlands by system, substrate or vegetation, seasonality, and as natural or constructed. The Inventory identifies two system types in the Bakeoven Watershed, riverine wetlands (stream systems), and palustrine wetlands ("swamps" or springs). Each is further categorized by the seasonality of moisture, whether it is natural or constructed, and other modifiers.

Data from the National Wetlands Inventory (NWI) was compared to 2003 aerial photography to confirm the location of wetlands and to add in constructed wetlands added since the NWI was completed.

Three attributes are used to identify wetlands; presence of water loving vegetation, hydric soils, and a hydrologic regime involving inundation or saturation for 2 weeks or longer during the growing season. Hydric soils are those that develop under saturated conditions.

All wetlands have hydric soils, but not all hydric soils are considered wetlands. The location of hydric soils gives an indication of where wetlands may have been present at some time in the past. They may, but do not necessarily, represent wetlands that have been lost as a result of impacts occurring from human settlement.

Hydric soils are formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions, i.e., a lack of oxygen. Soils that are sufficiently wet because of artificial measures are also included in the concept of hydric soils. Conversely, soils which have been drained (artificially modified) are also considered hydric if the soils, in an unaltered state, were hydric. (NRCS Field Office Technical Guide: Section II-iii-M – Hydric Soil Interpretations, 9/01).

Hydric soils are identified in the field by the presence of certain observable features that may form in the absence of oxygen. Such features include oxidized root channels, mottles, (colored splotches and streaks), and gleying (grayish or blueish colors). These features indicate chemical differences in the soil due to varying oxygen concentrations. The particular features that are present depend upon which elements or compounds are found in the "parent material" (rock) and vegetation of the site, as well as duration of saturation, and other factors. (USDA

NRCS, Field Indicators of Hydric Soils, Version 3.3, 1996, and Michigan Department of DEQ, www.michigan.gov/deq).

Soils considered hydric in the Bakeoven Watershed are identified in the NRCS Field Office Technical Guide. Any changes to hydrology that have occurred since the most recent soil surveys were completed have not been mapped.

Results

A total of 343 individual wetlands cover 295 acres in the Bakeoven Watershed, or 0.3% of the total area of the Watershed (Table 6-1, Figure 6-1).

Naturally occurring wetlands comprise 236 acres. There are approximately 100 manmade wetlands in the Watershed, totaling 59 acres. These constructed wetlands are mostly man-made ponds and sediment basins, but also include the saturated areas downstream of such structures, where these were clearly visible in aerial photos.

Seasonal wetlands comprise 176 acres of the Watershed, or 81% of total wetland acres.

More than 161 springs or seeps were mapped. Each of these produce a wetland typically of less than 0.2 acres in size, though the exact boundaries of such small areas can not be accurately mapped from aerial photos.

The largest wetlands are found in the Lower Bakeoven and Deep Creek subwatersheds. Lower Bakeoven Creek (below Trail Hollow) runs through a 78-acre seasonal riverine wetland that is saturated in times of high flows. In Deep Creek, a natural wetland covers 55 acres in the upper reach of Deep Creek Canyon. Several ponds have been built in and upstream of this natural wetland. In addition, Chandler Canyon boasts a 42-acre wetland.

Salt Creek/Dead Dog Canyon has the lowest number of naturally occurring wetlands. Of the 26 acres of mapped wetlands in this subwatershed, only about 3 are naturally occurring. The rest are constructed.

There are no naturally occurring open-water lakes in the Watershed.

Hydric Soils

Figure 6-1 shows the location of hydric soils in the Bakeoven Watershed, in relation to wetlands. Hydric soils compose approximately 980 acres of the Watershed. Of these, 821 acres are not considered to be wetlands. In most cases these soils occur next to wetlands. There are three significant areas of hydric soils that are not wetlands.

First, the floodplains of Lower Bakeoven Creek downstream of Deep Creek are mapped as hydric soils, as are the floodplains of Salt Creek downstream of Dead Dog Canyon. However, most of these floodplains do not consistently have the hydrophilic (water-loving) vegetation that would be required for it to be called a wetland. This is probably due to the current “flashy” nature of the Bakeoven Watershed, in which high flows periodically damage the riparian corridor.

Second, the 340-acre dry lake bed near the headwaters of Dead Dog Canyon is considered a hydric soil, though it does not currently have the surface water or moisture-loving vegetation necessary to call it a wetland.

Third, there is a 60-acre area of Willowdale Loam at the headwaters of Deep Creek, upstream of the large wetland described above. Willowdale loam generally includes inclusions of riverwash, which is considered a hydric soil. In this case, the area appears on aerial photos to be somewhat green in summer, and to feature a braded channel due to runoff. This area may in fact be a wetland, but field verification would be necessary to confirm.

Table 6-1. Wetland acres by subwatershed.
Sources: National Wetlands Inventory and USDA aerial photos 2003. Note: Not all riverine wetlands included.

Subwatershed	Total Acres in sub-watershed	Total Wetland Acres	Riverine Wetlands	Palustrine Wetlands	
				Natural	*Constructed*
Lower Bakeoven	26,043.3	90.3	78.4	9.7	2.16
Salt Creek/Dead Dog	16,402.4	26.3	0	3.2	23.1
Upper Bakeoven	10,392.0	13.9	0	10.7	3.2
Deep Creek	28,676.0	138.6	0	109.4	29.2
Cottonwood Creek	16,644.3	25.5	0	25.5	0
Totals	98,158.0	294.6	78.4	158.5	57.66

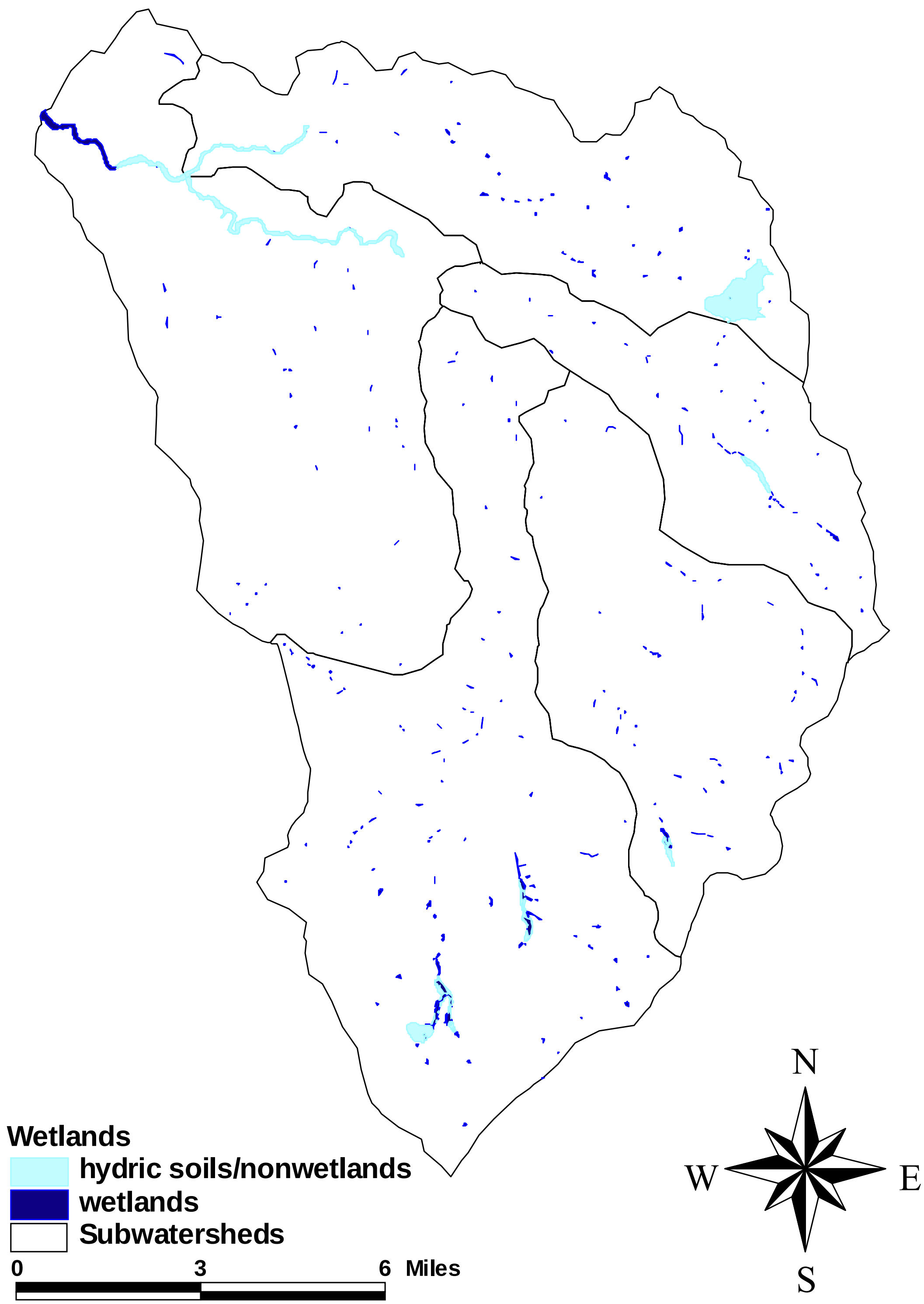
Confidence in the Accuracy of the Results

The purpose of this assessment was to inventory wetland locations, types, and approximate acreage in the Watershed using existing data and aerial photo analysis. On-the-ground surveys will be necessary to verify the extent and condition of wetlands if the Bakeoven Watershed Council identifies wetland restoration as a priority. In particular, the size and shape of many of the smaller wetlands was not carefully analyzed.

Most streams were left out of this analysis, unless the area of saturated soils was wide enough to map.

Irrigation practices and infrastructure create seasonal man-made wetlands that may or may not have been included in this analysis.

Figure 6-1. Wetlands and Hydric Soils in the Bakeoven Watershed.
Source: National Wetlands Inventory, US Fish and Wildlife Service – http://www.nwi.fws.gov as modified by aerial photography analysis, using photos from summer 2003



7) Road Network

Roads were analyzed for two different effects in this assessment. Overall density of roads may have an effect on peak flows, while roads within 200 feet of a stream may have a localized effect on sediment delivery to a stream.

7.1) Runoff due to Roads

Road density is an indicator of potential hydrologic change (and sediment delivery) within a watershed. Paved and unpaved roads alike convert natural areas into permanent openings and compacted surfaces with little or no infiltration. Roadside ditches intercept, channel and re-route subsurface and surface runoff, allowing it to enter streams more quickly. As watershed road density increases, runoff is funneled quickly and directly to streams, affecting the ability of the watershed to slow and store runoff. Different types of roads have greater or lesser effects on hydrology, depending on their width, degree of compaction, condition, location, design, and the amount of impervious surface associated with a given amount of roads.

Methods

ArcView GIS was used to build and refine a roads data layer for each subwatershed based on black and white aerial photography from 1995 and from 2002. All roads of any kind that could be seen or inferred on the aerial photos were digitized, along with roads marked on USGS topographic maps. This included paved and unpaved roads, "jeep trails", and driveways. Some roads that have recently been closed may still be visible on aerial photography. See figure 7-1 for a map of all identified roads.

Subwatersheds were analyzed separately. Based on studies conducted in Pacific Northwest watersheds (Bowling and Lettenmeier, 1997), the Oregon Watershed Assessment Manual assigns a high degree of concern in rural areas when more than 8% of a given watershed is covered by roads. The Assessment Manual assumes that roads in rural areas average 35 feet in width, including hardened area, shoulders and ditches. Such an assumption is probably relatively accurate for county roads, but exaggerates the size of farm and ranch roads. Based on the previous two assumptions, a subwatershed was rated high potential for impact if road densities exceeded 12.2 mi./mi^2 (This equals 8% of the surface area). Medium ratings were assigned for half the density of a high rating (6.1 mi./mi^2).

More information regarding the basis for this analysis is available online from the Oregon Watershed Assessment Manual (http://www.oweb.state.or.us).

Results

Only 44.0 miles of paved and gravel roads exist in the watershed. With few exceptions, all other roads were native soil (i.e. two tracks of compressed soil). Road densities in various watersheds and land use zones are summarized in Table 7-1. Analysis shows a low overall potential for impact from roads in each subwatershed. Localized effects may still occur. In particular, see the section on sedimentation for an analysis of riparian roads.

Table 7-1. Roads Density Summary.

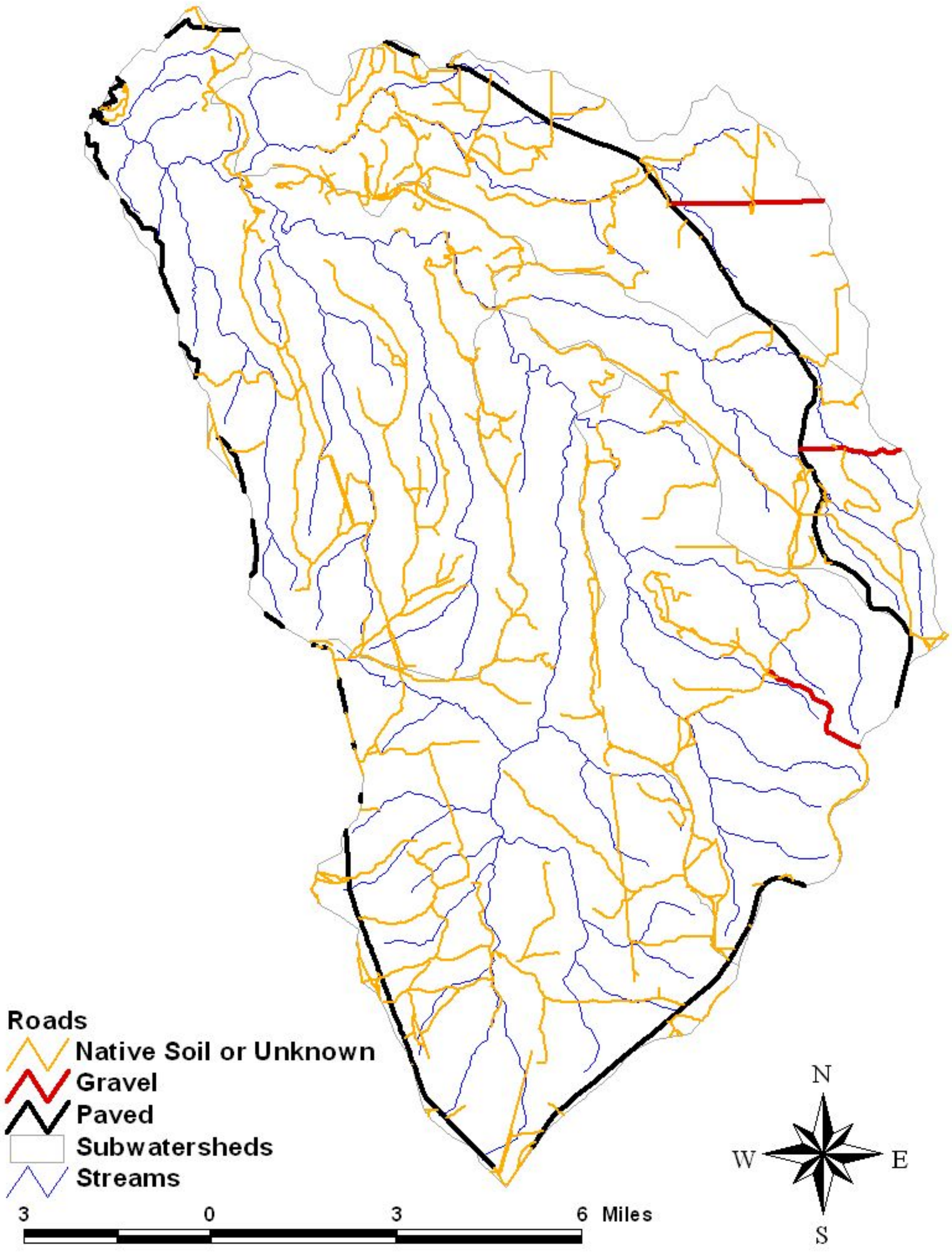
Subwatershed	**Miles Roads**	**Area (mi.^{2})**	**Road Density** *(mi./mi^2)*	**Potential for Impact***
Lower Bakeoven	169.7	40.7	4.2	Low
Salt Creek/Dead Dog	84.1	25.6	3.3	Low
Upper Bakeoven	55.3	16.2	3.4	Low
Deep Creek	205.7	44.8	4.6	Low
Cottonwood Creek	104.3	26.0	4.0	Low
Totals	619.1	153.3	4.0	Low

- A medium potential for impact corresponds to 6.1-12.2 mi/mi^2 (8% of surface area – Bowling and Lettenmeier, 1997).

Confidence in the Accuracy of the Results

Not all roads are equal. No analysis was conducted of the state of repair of the roads, which may have a significant effect on their runoff impacts.

Figure 7-1. Roads map used for road density calculations.
Source: 1995 and 2002 Aerial photography.



7.2) Sedimentation due to Riparian Roads

Fine sediments can enter a stream through a variety of natural and human-related causes. Natural sources include landslides and burns. Sedimentation can be related to land use through road runoff or road failure. This portion of the assessment is focused on sedimentation due to road location.

Rural roads in poor repair can add sediment to the streams by triggering landslides. Culverts in poor repair can trigger road failure.

While the last section looked at overall road-density throughout the watershed, this section looks at road density within the riparian corridor. Roads within 200 feet of the stream can contribute significant amounts of sediment through concentrated road runoff, even when the road itself is in good repair. The Oregon Watershed Assessment Manual provides a protocol for quantifying this effect by cataloging all roads within 200 feet of the stream, and then further categorizing them based on the steepness of the slope above them. Roads on or below slopes greater than 50% pose a higher potential for problems, because they are more prone to failure and collect more sediment than do roads on shallower slopes.

Methods

The USDA streams data layer (that used throughout this assessment) was updated carefully for accuracy against the USGS topographic maps and aerial photos using ArcView. Where the two did not agree, the streams layer was updated to agree with the aerial photo. Using ArcView GIS 3.3, a 200' buffer was created on either side of all streams. The updated roads layer was clipped based on this buffer, creating a data layer that only included roads with 200 feet of a stream. The riparian roads layer was then carefully examined with the topographic layer in the background. Each road segment was catalogued as to whether the slope above it was more or less than a 50% slope. The density of riparian roads was calculated in terms of road miles per stream mile to give an intuitive measurement of relative impact.

Results

Figure 7-2 shows riparian roads. The highest percentages of riparian roads were in Salt Creek/Dead Dog Subwatershed, in which 40% of the streams were paralleled by a road (Table 7-2).

While Bakeoven Watershed had a low overall rate of riparian roads, a high percentage of the riparian roads were on steep slopes. Along Cottonwood Creek, 93% of the riparian roads were on slopes over 50%. Those marked in red are on slopes over 50%. If the opportunity arose to remove a road, or to improve surface drainage on a road, these steep riparian roads would be the highest priority because they have the highest risk of negative impact to the stream.

Deep Creek Subwatershed was relatively untouched by roads in the riparian areas. Only 12% of stream miles were impacted by riparian roads, and of those roads, relatively few (31%) were on slopes over 50%.

Figure 7-2: Riparian Roads—roads within 200 feet of stream, with emphasis on roads on slopes greater than 50%.

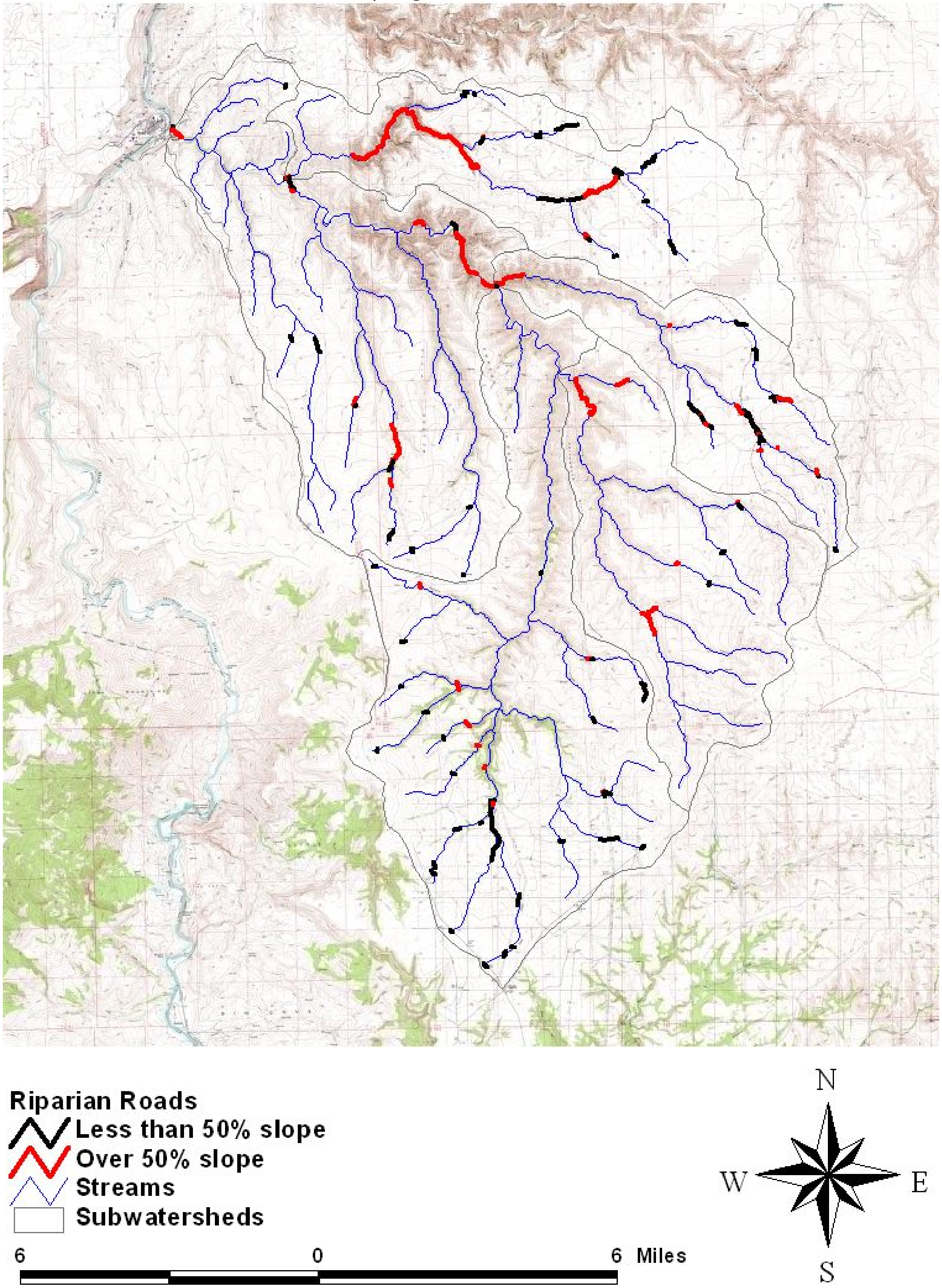


Table 7-2. Riparian road densities and riparian roads on steep slopes (>50%)

Subwatershed	**Stream Length**	**Riparian Roads (within 200'of stream)**		**Riparian Roads with slope >50%**	
	Miles	Miles of riparian road	Roads per stream	Miles of steep roads	% of riparian roads
Lower Bakeoven	60.0	6.38	0.11	4.38	69%
Salt Creek/ Dead Dog	22.3	9.01	0.40	5.91	66%
Upper Bakeoven	20.3	4.66	0.23	3.57	77%
Deep Creek	54.9	6.57	0.12	2.05	31%
Cottonwood Creek	32.7	2.71	0.08	2.53	93%
OVERALL	**190**	**29.33**	**0.15**	**18.44**	**63%**

Confidence in the Accuracy of the Results

This study was based on aerial photos rather than on-the-ground surveying. Some roads included in the survey may have since been removed. New roads may have been built. No study was made of the condition of these roads, which can have a significant effect on their impact on water quality and fish habitat. As noted above, surveys should be completed to find the true trouble spots.

Recommendations

- Visit identified riparian roads, inventory state of repair and impact on creek.
- Identify roads that can be closed, obliterated, or relocated further from the stream.

8) Water Quality

The term "water quality" includes a number of factors that can negatively affect beneficial uses of water. These factors include chemical contamination, temperature, algae, and others.

The Oregon Department of Environmental Quality (ODEQ) is required by the Federal Clean Water Act (1972) to establish water quality standards to protect the beneficial uses of the State's waters. Based on the water quality standards, ODEQ is then required to: identify stream segments where the standards are not being met, develop a list of these water-quality limited water bodies (called the 303(d) list from Section 303(d) of the Clean Water Act); and develop a Total Maximum Daily Load (TMDL) allocation for each water body included on the 303(d) lists. The TMDL describes the maximum amount of pollutants (from all sources) that may enter a specific water body without violating water quality standards. The most current 303(d) list for Oregon is dated 1998, although a new one will be released before the end of 2002.

Concerns about the quality of the water in streams are based on concerns about the potential impacts on the beneficial uses of the water in that stream. The designated beneficial uses listed for the waters in the Bakeoven Watershed are anadromous fish passage and salmonid fish rearing (OAR 340-41-522).

The most commonly documented water quality problem in the state of Oregon is temperature. Elevated water temperatures are detrimental to cold water fish species and other aquatic life. Elevated temperatures can kill fish directly through the breakdown of physiological regulation of vital bodily processes such as respiration and circulation (Heath and Hughes, 1973). The most common and widespread cause of thermally induced fish mortality, however, is attributed to indirect effects, such as: interactive effects of decreased or lack of metabolic energy for feeding, growth or reproductive behavior; increased exposure to pathogens (viruses, bacteria and fungi); decreased food supply (impaired macroinvertebrate populations); and increased competition from warm water tolerant species (Brett, 1952; Hokanson et.al., 1977). Cold water fish include trout and steelhead, both of which are present in the Bakeoven Watershed.

In 1998, stream reaches in Bakeoven Watershed were included on the 303d List for not meeting the state's water quality standards for stream temperature (1998 303(d) list) (table 7-1). This listing was based on data collected in 1994, a drought year. In 2002, DEQ made the decision not to list any streams as water quality limited if the listing would be based solely on 1994 data. This applied to Bakeoven Creek. Therefore, in 2002, Bakeoven Creek and Deep Creek were listed as a "potential concern" for summer stream temperature. Bakeoven Creek was also listed as water quality limited for habitat and flow modification, but does not require a TMDL for these parameters.

Stream temperature is affected by both natural and human-related factors, such as the climate, geographic location, temperature of the groundwater and springs feeding the streams, stream flow volume, stream morphology and levels of shade afforded by streamside vegetation. While climate and geographic location are outside of human control, riparian condition, channel morphology and stream flow volume are affected by land use activities. Specific land use activities which can increase summertime stream temperatures in the Bakeoven Watershed include:

- Riparian vegetation disturbance reduces stream surface shading via decreased riparian vegetation height, width and/or density, thus increasing the amount of solar radiation reaching the stream surface;
- Localized channel widening increases the stream surface area exposed to solar heating;
- Changes in upland hydrology can reduce the amount of stored water available for summer flow, thus affecting the summer stream temperature.
- Impoundment of water behind dams may increase or decrease the temperature of the water downstream of the dam depending on how and when water is released from the dam.

Given that a stream is fed by a spring with a fairly steady year-round temperature, water will heat up more the longer it is exposed to sunlight. A stream with lower flows or less shade will heat faster than a stream with higher flows or more shade. In addition, channel morphology affects the rate of heat transfer. Given the same volume, a wide, shallow stream will heat faster than a narrow, deep stream, due to the greater surface area exposed to sunlight. Lateral erosion during a high flow event can create wide, shallow stream channels with minimal vegetation, and thus cause an increase in the summer temperature of the stream. Recovery occurs over time as riparian vegetation is reestablished, reinforcing the banks, narrowing the active channel, and reducing exposed surface area.

Temperature Standard

The stream temperature standard is designed to protect cold water fish rearing and spawning as the most sensitive beneficial use. Optimum temperatures for steelhead vary with lifestage. Oregon Department of Environmental Quality has recently set new temperature criteria based on biological requirements of salmonids. During the spawning period (January 1 to May 15), DEQ calls for water temperatures not to exceed 13C (55.4F). During rearing and migration periods (i.e. summer), the water temperature should not exceed 18C (64.4F). These numeric triggers are based on a seven-day moving average of the daily maximum temperatures. The use of this type of average recognizes that fish can likely tolerate a day or two of higher temperatures, as long as elevated temperatures are not sustained for a longer period of time (such as a week).

Qualitative triggers specify conditions that deserve special attention, such as the presence of threatened or endangered cold water species, dissolved oxygen violations and/or discharge into natural lake systems. The occurrence of one or more of the stream temperature triggers will invoke the temperature standard.

Once the temperature standard is invoked, a water body is designated as water quality limited for temperature (Table 7-1). For such water quality limited water bodies, the temperature standard specifically states that "no measurable surface water temperature increase resulting from anthropogenic activities is allowed" (OAR 340-41-525(2)(b)(A). In the development of a TMDL for temperature, the natural thermal dynamics of the system and anthropogenic contributions to stream heating are assessed.

Monitoring

Wasco County SWCD has collected water temperature data at five sites during the summer rearing period since 2000 (Figure 8-1). In 2004, an IFPnet weather monitoring station (www.IFPnet.com) collected water temperature at one site during part of the spawning period (Figure 8-1).

During the rearing period, Bakeoven Creek and Deep Creek both exceeded the state water temperature standard **every year at four sites**. The fifth site—Lower Bakeoven Creek—met the standard in two out of four years (figure 8-2). This monitoring site is directly downstream of an area of subsurface flow. It is believed that this subsurface flow moderates the water temperature for a distance downstream.

During the spawning period of 2004, the temperature at the mouth of Bakeoven Creek exceeded the temperature standard of 13C from April 7th, 2004 to May 15th 2004 (Figure 8-3). By June 20th, it had exceeded the rearing temperature standard as well.

Figure 8-1. Electronic temperature monitoring sites of Wasco County Soil and Water Conservation District.

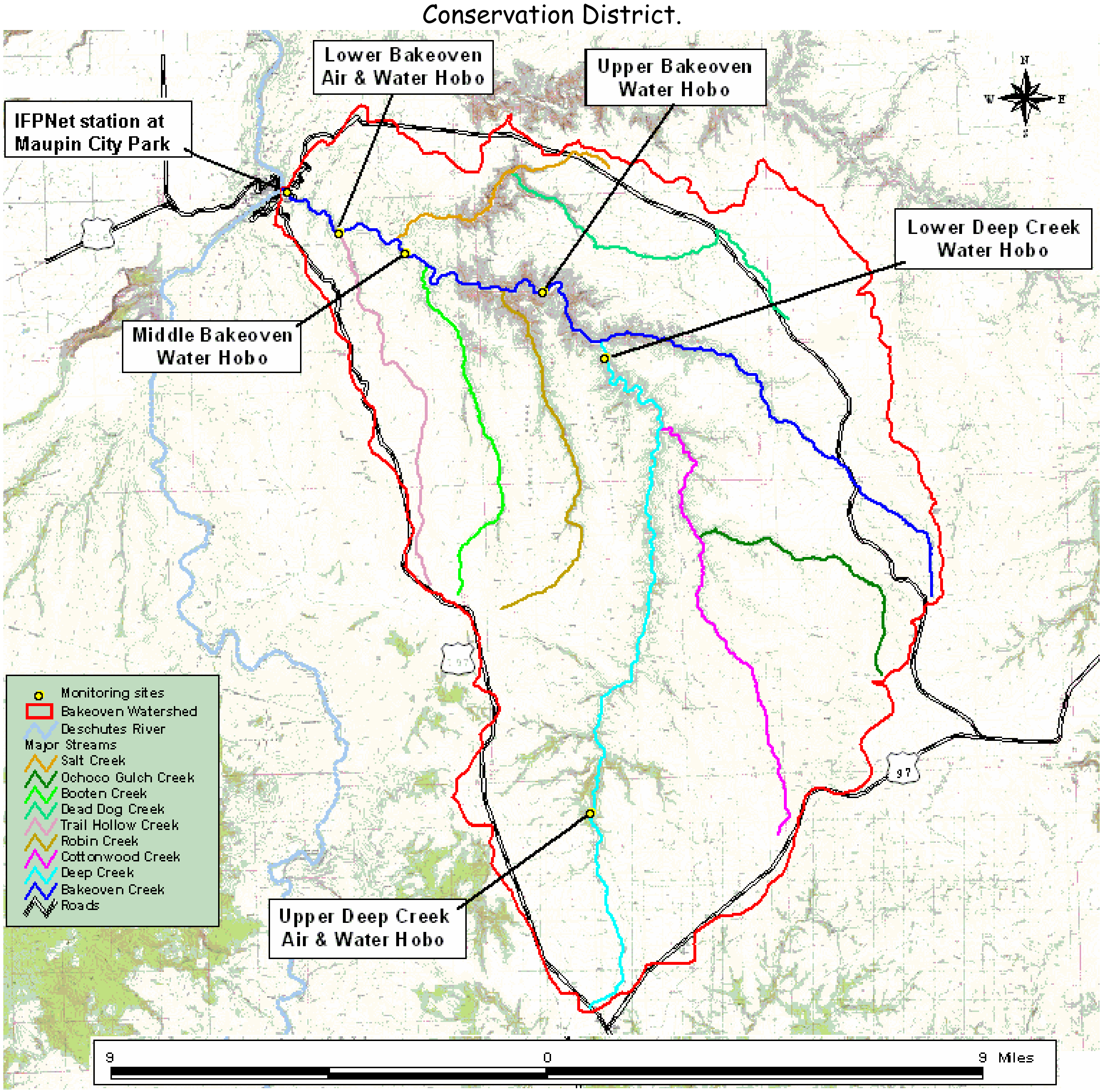


Figure 8-2. Lower Bakeoven Water Temperature Data - 949' elevation. (7-Day Running Average Daily Maximum Temperatures)

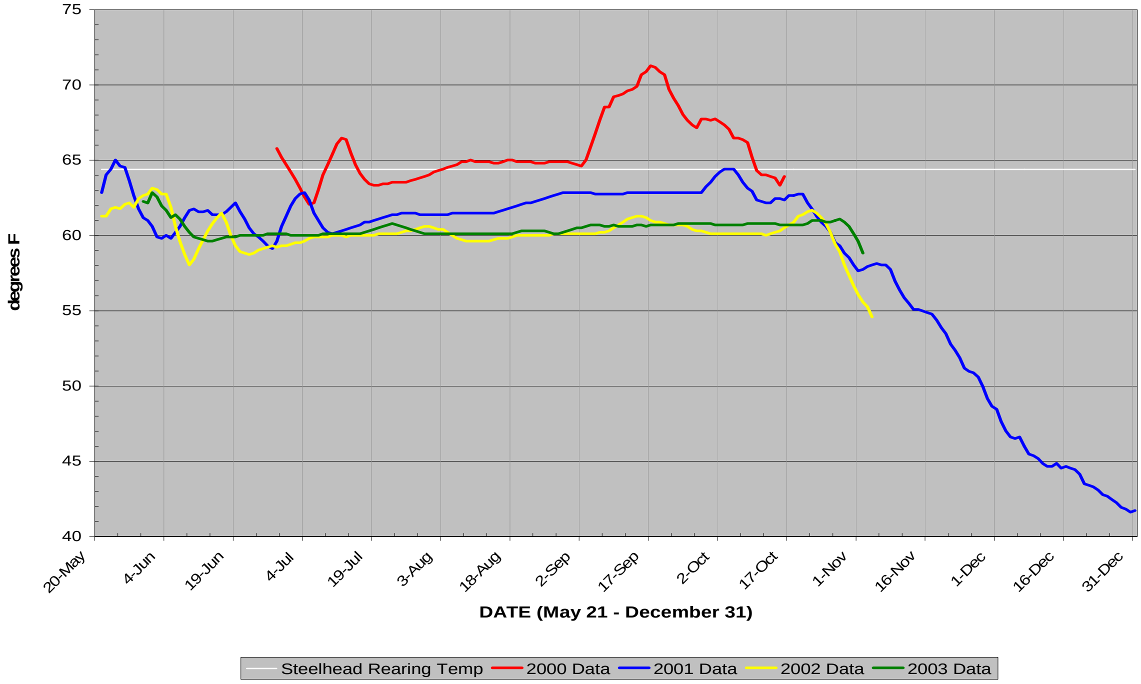
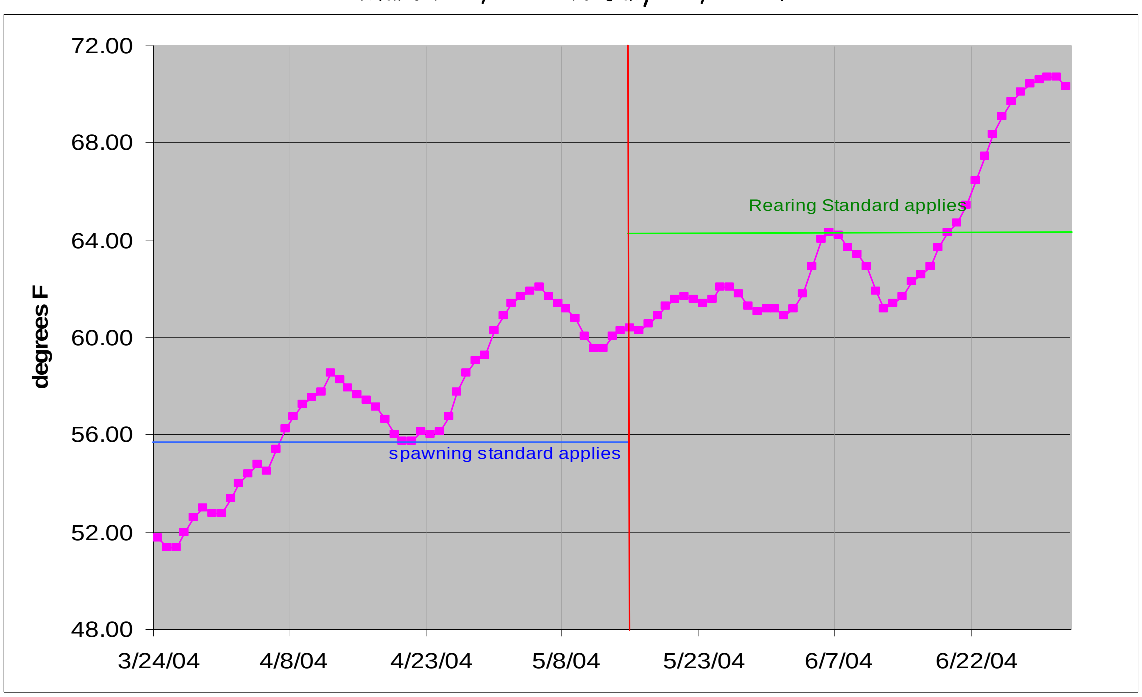


Figure 8-3. Seven-day Average of Daily High Temperatures, Bakeoven Creek near Mouth, March 24, 2004 to July 2nd, 2004.



Recommendations

- Riparian restoration and protection as described in chapter 5.
- Restoration of upland hydrology as described in chapter 4.

9) Wildlife and Wildlife Habitat

9.1) Plant Communities

Sources used to describe upland habitat, plant communities and wildlife in the Bakeoven Watershed are IBIS (Interactive Biodiversity Information System, http://nwhi.org/ibis/subbasin/subs2.asp), USDA Farm Services Agency in-house land use data, USDA aerial photography (summer 2003), National Wetlands Inventory (NWI) and the USDA Soil Survey for Trout Creek-Shaniko area.

Ten classes of wildlife habitat were defined for the Bakeoven Watershed, each with different values for wildlife. These habitat types are listed by acreage in Table 9-1 and mapped in figure 9-1.

Bakeoven Watershed features a comparatively uniform pattern of wildlife habitat, compared to most other Deschutes River tributaries. The entire watershed receives twelve or less inches of rainfall per year, and rests at elevations between 800 and 3,250 feet above sea level. Because of this uniformity, 99% of the Bakeoven Watershed historically consisted of two types of wildlife habitat: Shrub-Steppe on the plateau and Eastside (Interior) Canyon Shrub on the steep slopes of the canyon walls. The remaining acreage (less than 1,100 acres) was riparian or wetland.

Changes to Native Grasslands and Shrub-Steppe

In total acreage, the greatest change to wildlife habitat is the conversion of shrub-steppe to various land uses, such as irrigated and dry cropland, mixed agricultural environs, buildings and urban environs and Conservation Reserve Program (CRP) lands. Net conversion to these land uses totals 14,700.24 acres.

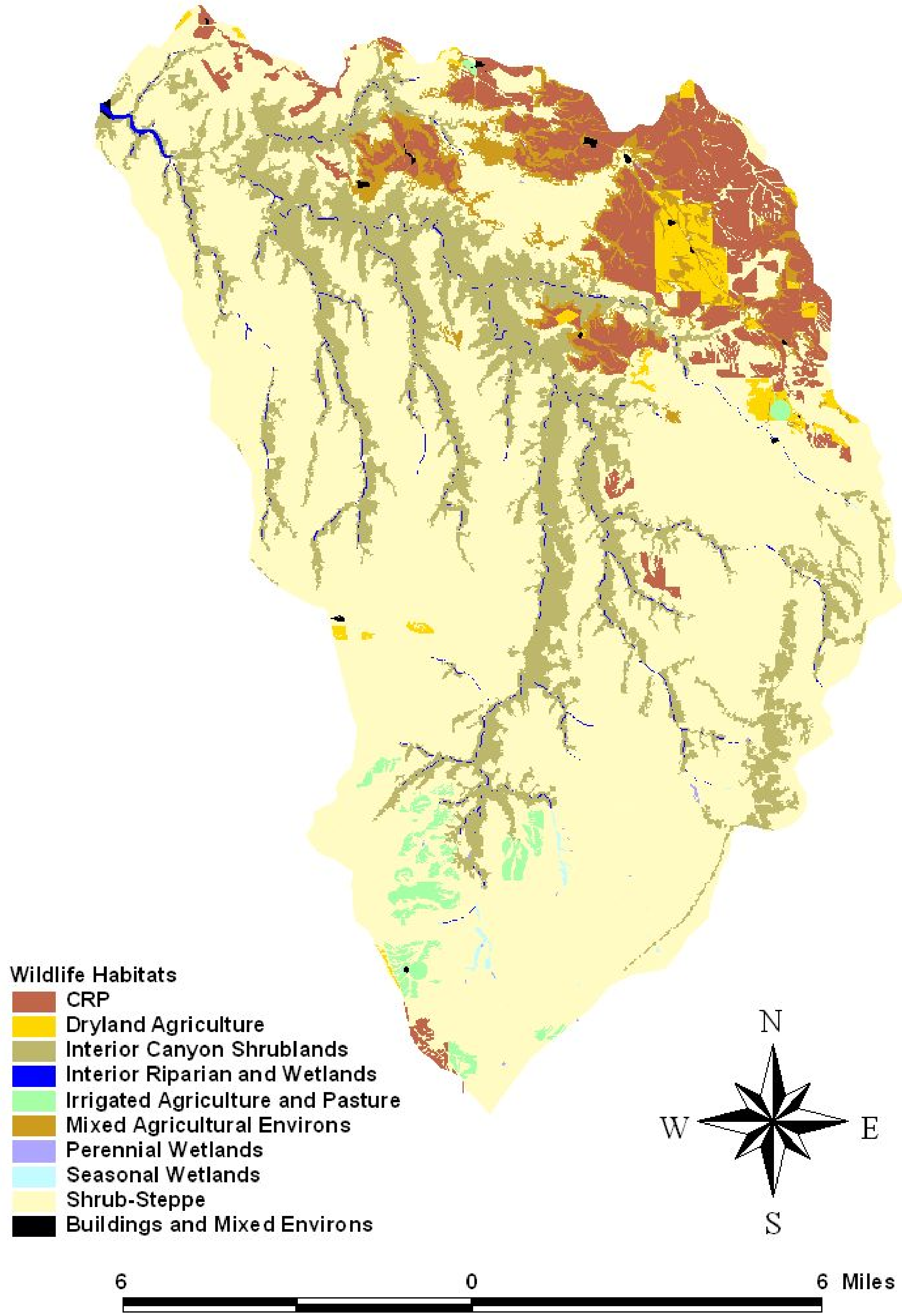
Croplands provide feed for grazing wildlife and upland birds, but provide little cover or nesting opportunities, due to frequent disturbance from farm operations. Similarly, residential landscaping provides feeding opportunities, but brings with it so many disturbances that many species are unable to utilize it. CRP lands, however, have many of the same wildlife values as shrub-steppe. CRP can provide more or less wildlife values depending on the plant species present and how the land is managed. CRP lands currently total 8,510 acres in Bakeoven Watershed.

Changes within the sage-steppe mosaic are more difficult to quantify. Comparison of the current landscape with historic records indicates that the amount of sagebrush and juniper in the sage-steppe landscape has been steadily increasing over the last century. The reasons for this include heavy grazing in the first half of the century, resulting in a decline in perennial bunchgrasses and suppression of fire, which favors sage and juniper.

Table 9-1. Wildlife Habitat Summary

HABITAT TYPE	**Description**	**Historic (estimated)**	**Current**
Shrub-Steppe	Mosaic of grasslands and shrublands.	80,350.64	66,255.85
Eastside (Interior) Canyon Shrub	Steep slopes and rocky soils encourage small woody shrubs with little grass cover.	16,828.05	16,433.79
CRP	Former croplands converted to perennial grass stands and grazed no more than once every three years.	0.00	8,510.37
Mixed Agricultural Environs	Roads, disturbed areas and former croplands.	0.00	3,192.84
Dryland Agriculture	Currently planted to grains.	0.00	1,587.08
Irrigated Agriculture and Pasture	Irrigated with wheel lines or center pivots.	0.00	1,292.92
Eastside (Interior) Riparian	Forested stream corridors	935.40	666.65
Seasonal Wetland	Seasonal ponds and marshes	130.99	175.35
Buildings and Mixed Environs	Residences, farm buildings, landscaping, driveways and roads.	0.00	117.03
Perennial Wetland	Perennial ponds and marshes	26.82	40.02
TOTAL		**98,271.9**	**98,271.9**

Figure 9-1: Wildlife Habitat Types in Bakeoven Watershed
Source: IBIS, USDA data, National Wetlands Inventory, and other analyses conducted as part of this assessment.



Changes to Wetlands Habitat

As noted in the wetlands section, riverine wetlands have decreased by approximately 400 acres due to hydrologic changes in the watershed. Heavy flood events and low summer flow have combined to suppress expected vegetation along some of the middle reaches of Bakeoven and Deep Creeks.

Meanwhile, approximately one hundred small ponds and sediment basins have been constructed throughout the watershed with a total acreage of 58 acres. Part of the rationale for these structures is to protect the riparian corridor from heavy flows and to capture, store and safely release water during the dry season. In some cases, artificial wetlands have developed downstream of these structures and were mapped by aerial photo. In other cases, the aerial photo appeared to reveal a dark color downstream of the sediment basin, but the color could not be positively identified as being due to vegetation.

9.2) Plant Species

Sensitive or Listed Plant Species

Bakeoven Watershed has no federally listed threatened or endangered plant species. It does have several species considered sensitive by the Oregon Natural Heritage Foundation. These are listed in Table 9-2.

Table 9-2. Sensitive and listed plant species in Bakeoven Watershed

Common Name	**Scientific Name**	**Listing Status**	**Habitat Description**	**Last Recorded Observation**
Beaked Cryptantha	*Cryptantha rostellata*		Dry. Flat clay soil	1995
Bristle-flowered Collomia	*Collomia macrocalyx*		Open, sparse vegetation, sagebrush community	1982
Hamblen's Lomatium	*Lomatium farinosum var. hambleniae*		Basalt clay soils, scabland	2002
Hepatic Monkeyflower	*Mimulus jungermannioide s*	State listed: Species of Concern	Shaded and moist rock walls and overhangs	1991
Howell Milk-vetch	*Astragalus howellii*		Disturbed soil, road side	1986
Tygh Valley Milk-vetch	*Astragalus tyghensis*	State Listed: Threatened	Biscuit-scabland	1996

Noxious Weeds

According to Merle Keys, Wasco County Weedmaster, Bakeoven Watershed has far fewer noxious weeds than other parts of the county. Diffuse knapweed (*Centaurea diffusa*) is the only widely distributed noxious weed, although there are also pockets of

Canada thistle and a few species of mustards (Keys, personal communication, 9/28/2004). Mr. Keys noted that Bakeoven Watershed was well protected from invasions, because there are few roads, and in particular, very little access to the creek. Private landowners are highly aware of the noxious weed issue and take care to treat any weeds that they find. Along the Deschutes River, the City of Maupin does a thorough job of controlling weeds at Maupin City Park, and Mr. Keys himself controls weeds along the Deschutes from Maupin to Sherar's Falls as part of a contract with the Bureau of Land Management.

Several biological control agents are available for knapweed species, many of them established in Wasco County.

Future threats could come in the form of earth-disturbing activities, such as the fiber-optic cable installation. The nearby Antelope Creek watershed has yellowstar thistle *(Centaurea solstitialis),* musk thistle (*Carduus nutans*) and Scotch thistle (*Onopordum acanthium*).

Recommendations

- Diligent control and eradication of Canada thistle and other weeds present in small amounts or not yet present.
- Establish multiple species of biological control of knapweeds.

9.3) Wildlife Species

Bakeoven Watershed has no federally listed threatened or endangered wildlife species. It does have several species considered sensitive by the Oregon Natural Heritage Foundation. These are listed in Table 9-3.

Large mammals associated with Bakeoven Watershed include beavers, deer, antelope, elk, coyote, cougar, and occasionally black bear.

Figure 9-3. Sensitive or Listed Wildlife Species

Common Name	Scientific Name	Listing Status	Habitat Description	Last Recorded Observation
Night Snake	*Hypsiglena torquata*		On bottom of creek in rocks and gravel. Sage brush and grasses on side of creek with rocky cliffs and rolling hills.	1952
Purple Lipped Juga (snail)	*Juga hemphilli maupinensis*		Semi-arid terrain and river	1988
Swainson's Hawk	*Buteo swainsoni*	State listed: Sensitive/ Vulnerable	Sagebrush prairie with widely spaced junipers	1992

Invasive Wildlife Species

Feral pigs (*Sus scrofa*) have been introduced to the area directly east and south of Bakeoven Watershed, including parts of Wasco, Sherman, Wheeler, Crook, Klamath and Jefferson Counties. The existing populations have resulted from a combination of ranch escapes and unauthorized releases for hunting. Oregon is not alone. Feral pig populations are established throughout the southeastern U.S. and are well documented in many western states. Feral pigs in California are estimated at more than 133,000.

Feral pigs are a threat to the environment because they root up riparian soils, looking for roots and fungi. Large boars have tusks and can weigh up to 500 pounds. Sows with litters can be aggressive and attack people. There are few predators in the area capable of threatening a pig. Pigs breed very quickly. Feral swine can serve as reservoirs for pseudorabies virus (PRV) and *Brucella suis*, and these pathogens have been detected in feral swine populations throughout much of their range in the United States.

> "Feral pigs have been shown to restrict timber growth, reduce and/or remove understory vegetation, and destabilize soils, causing increased erosion and compaction, while simultaneously decreasing stream quality. Rooting and grubbing activities have also been shown to facilitate the invasion of noxious weeds and other non-native vegetation. (OSU, Coblentz and Bouska)"

The Oregon Invasive Species Council names feral swine one of the top 100 invasive species threats in Oregon. Oregon State University Department of Fisheries and Wildlife recently completed a risk assessment study on feral swine in Central Oregon that argues for eradication:

> "Given the current knowledge of feral pig distribution and numbers in Oregon, it is probable that the existing populations could be eradicated with reasonable costs and efforts. However, a parallel probability exists that these populations could grow and expand in manner similar to populations in California, so that complete statewide eradication efforts would be too costly to attempt, and would offer little or no hope for long-term success. Fortunately, the outlook for control of Oregon's feral pig populations is not yet bleak… However, without enhancing public knowledge, restricting imports of all wild pigs for trophy hunting ranches, and somehow limiting livestock escapes, feral pigs will always be a part of Oregon's biotic landscape, albeit on a small scale. (OSU, Coblentz and Bouska)"

For the past several years, Wasco County SWCD has received small grant funding from Oregon Department of Agriculture to kill feral pigs. The total take since 2001 is 119 pigs, not enough to stop the spread of feral pigs. USDA Animal and Plant Health Inspection Service (APHIS) Veterinary Services has been running blood tests on some of the carcasses, surveying for diseases, but has found none. Wasco County SWCD intends to continue this program. However, due to the wide distribution of feral pigs in Central Oregon, eradication will probably not be achieved without a State-led effort.

Recommendation

- Immediate and concerted eradication effort led by or funded by State of Oregon.

10) Economic Impacts of Conservation

Landowners that engage in conservation work appear to reap an economic benefit in terms of land value and income generating potential. Among landowners participating in the Bakeoven Watershed Project, this appears to be a consensus.

According to Bob Krein, owner of A&K Ranch, both their carrying capacity and income increased after they completed their resource management system. Randy Warnock of Warnock Ranches said that his ranch had increased its volume of grass and doubled its stocking rate since buying the ranch in the late 1980's. They attribute this success to fences, upland water and quick grazing rotations through many pastures.

According to Dan Carver, the Carver Ranch has made similar strides in the last two decades. In 1988, the Carver Ranch consisted of 23,000 acres in two pastures, which produced 200 cow-calf pairs, and had to feed they hay in the winter. Now, the ranch has been divided into 40 pastures, is stocked with 500 pairs, and no longer relies on hay at all. Dan Carver attributes this success less to individual practices and more to the ethic that is developed along with a conservation plan. The plan alone returns dividends because one's mind thinks in terms of health of the land rather than the cow. He notes that the conservation plan itself costs nothing.

Rangeland condition on the Carver Ranch improves every year, and with it, water quality and quantity. The creek is fenced into a rotational pasture, and the recovery of the riparian area and water has been dramatic. The BLM permits the pasture for use between November 1st and May 1st.

The Carver Ranch also derives a significant income from dryland crop production. They have switched to no-till farming to reduce soil erosion and improve soil quality. Over a two year cycle, no-till saves four trips over the field. He saved about $20,000 the first year, and reduced his crew by at least one man (a rock picker and driver). Dan Carver says that they are still in the learning stage regarding no-till. He started out spring cropping every year, which he believes is the right way to do it, because it allows him to control weeds with minimal herbicide and fertilizer. About four years ago, an accumulation of droughts caused him to start buying crop insurance, which led him to start planting fall crops. Fall crops can be insured for 26 bushels in the Bakeoven area, whereas spring crops can only be insured for 17 bushels. As a result of this switch, his weeds are coming back, and his inputs are increasing. He says he will probably have to go to some kind of compromise rotation to fight the weeds. All this supports his point that conservation is management, not practices.

These observations from landowners are generally corroborated by Mark McKinnon, a farm appraiser at Farm Credit Services in Prineville Oregon. He says that cross fencing and upland water increase the value of a ranch by 2-5%. Alternatively, farms can be appraised based on their carrying capacity. An animal unit month (one cow-calf pair grazing for one month) is valued at $2,000 to $2,500. However, McKinnon notes that in the future, ranches are likely to be evaluated based on their potential for recreation, not livestock production. Wildlife practices may yield a greater economic benefit than livestock practices.

11) Summary of Issues and Recommendations

Tables 11-1 and 11-2 summarize the issues of concern identified in this assessment, and the major data gaps that prevent a complete assessment of conditions. The updated Bakeoven Action Plan will address these concerns and data gaps.

Table 11-1. Major issues identified by watershed assessment and recommended responses.

Issue	Recommended Responses
Overall level of runoff increased more than 100% in some areas, compared to presettlement.	• Improve vegetative conditions throughout watershed. • Develop grazing management plans with participating landowners to improve range conditions until all rangeland acres exhibit vegetative characteristics that approximate presettlement conditions (perennial grasses mixed with forbs and a few shrubs.)
Unsustainable rates of soil erosion occur on 1,244 acres	• Convert all remaining nonirrigated croplands (T=2 tons/acre/year) to no-till techniques (1,244 acres).
Streambank erosion and loss of riparian vegetation has led to wide, shallow channels lack of large woody debris, low pool frequency, elevated water temperature and reduced spawning/rearing habitat.	• Increase summer base flows through improved upland water storage. • woody debris placements • Protect and restore all riparian areas identified in chapter 5 as not meeting potential. • Protect all riparian corridors in the John Day/Deschutes Canyon Ecoregion. • In cases where landowners are not interested in riparian buffers, develop grazing management plan and establish long-term monitoring program to document trend.
All perennial streams exceed water quality standards for temperature.	
Elevated streambank erosion in Upper Deep Creek may be linked to elevated fine sediments in the same reaches.	
Dry habitat and dry channel in Lower Bakeoven and Deep Creeks reduce rearing habitat and present seasonal barriers to fish migration.	
Shrub-steppe wildlife habitat has been converted to other uses	• Reseed with native perennial grass species. • Grazing management.
Invasive exotic plant species are present, and others are nearby.	• Diligent control of species present in small amounts or not yet present. • Establish biological controls for knapweed. • Avoid soil disturbance • Increase public awareness of value of native plant communities and measures to protect or restore them.
Feral pigs present nearby since 1990's	• Continue Wasco County SWCD efforts to kill pigs in Wasco County. • Immediate and concerted feral pig eradication effort led by or funded by State of Oregon.

Table 11-2. Data gaps

Parameter	Recommendation
Information on range conditions is incomplete. Data needed on some land ownerships.	• Survey range conditions on participating land ownerships as part of all new projects.
Instream habitat surveys not updated after 1996 flood; no instream data from Cottonwood, Salt Creek and Upper Bakeoven.	• Conduct instream habitat studies in Cottonwood Creek, Deep Creek and Bakeoven Creek.
Road inventories needed to determine condition of roads, particularly within 200' of stream.	• Visit identified riparian roads, inventory state of repair and impact on creek. • Replace, improve or eliminate troublesome crossings to reduce sedimentation.

Bakeoven Action Plan

Update 2005

Covering time period 2005-2015

This document is an update to the Bakeoven Action Plan adopted in January 1996. It takes into account information from the Bakeoven Watershed Assessment (2005), and is compatible with the Deschutes Subbasin Plan (2004).

This plan is written to cover a ten (10) year timeframe (2005 to 2015). Bakeoven Watershed Council will also develop and adopt a series of biennial work plans that specify projects to be completed with each two year period. The first of these biennial work plans was adopted in January 2005 and covers the period from July 2005 to June 2007.

This document includes only a brief description of the watershed and the issues of concern. It does not include detailed descriptions of studies or conclusions, nor does it include technical references. For in-depth discussion and references, see the Bakeoven Watershed Assessment listed above.

Watershed Council Goals and Objectives

All goals and objectives described below are to be achieved by 2015, at which time, a new watershed assessment may be conducted to determine remaining issues.

Goal 1) Reduce runoff and erosion on all croplands to below "T", the soil soil tolerance.

"T" is 2 tons per acre on most cropland soils in Bakeoven Watershed.

Objective 1A: All crop fields in Bakeoven Watershed will be managed in ways that cause less than 2 tons per acre per year of soil loss.

Priority: HIGH

Resolution of upland issues is a prerequisite to successfully addressing most instream issues.

Discussion

Natural Resources Conservation Service, Wasco County Soil and Water Conservation District, and Oregon State University Extension Service work in partnership throughout Wasco County to provide education and incentives for the adoption of no-till and direct seed farming techniques. These farming practices increase water infiltration rates on agricultural lands by factors of 40 to 100 times, compared to conventional tillage practices. Erosion from no-till fields is reduced to less than 2 tons per acre per year. No-till techniques have already been piloted in Bakeoven Watershed.

Actions

- Provide cost-share for conversion to no-till farming to interested dryland farmers.

Objective 1B: All crop fields in Bakeoven will be farmed in a manner that improves soil quality and increases organic matter.

Priority: HIGH

This objective is a high priority, because resolution of upland issues is a prerequisite to successfully addressing most instream issues.

Ongoing Activities

Soil quality can be improved by reversing the loss of organic matter caused by tillage operations, and increasing beneficial soil organisms. The former can be achieved through adoption of no-till/direct seeding practices. Additional farming practices that encourage beneficial soil organisms include rotational crops, and avoidance of certain soil treatments, such as fumigation and anhydrous ammonia injection. Keeping a crop in the field every year encourages soil microorganism communities. On the other hand, repeated cropping of the same grain is not desirable due to the potential for buildup of insects, weeds and diseases. Therefore, it is desirable to develop non-grain rotational crops, corn, winter peas, safflower, canola, mustard, linola, and flax, which may be grown for sale, or for "green manure," i.e. for their beneficial soil effects. Oregon State University continues to work on research and development of rotational crops, as well as market development to make them economically viable. A somewhat less desirable alternative would be the development of government incentives for the use of alternative crops.

Actions and Schedule

- Bakeoven Watershed Council supports efforts to develop markets for alternative crop rotations. Action agency: Oregon State University Extension Service, WyEast Resource Conservation and Development Board (RC&D).
- Secondarily, government incentives may substitute for markets. Action agencies: Wasco County SWCD and NRCS.

Objective 1C) Reduce runoff from crop and rangelands to levels comparable with native prairie soils.

Priority: HIGH

Actions

- Improvements in vegetative conditions, such as will result from no-till and careful range management, will increase upland water storage in soils. Appropriate actions are specified under objectives 1A and B and goal 3.
- Construct sediment basins in key locations on ephemeral draws to intercept and slow runoff.

Goal 2) Protect and improve riparian and instream habitat.

Objective 2A: Allow establishment and development of adequate riparian vegetation for streambank stability and shading, consistent with site capability.

Priority: HIGH

Ongoing Activities

Riparian corridors are being addressed extensively through a number of programs, including the Conservation Reserve Enhancement Program (CREP), Continuous-Signup Conservation Reserve Program (CCRP) and Bakeoven Salmon and Steelhead Habitat Restoration Program (ODFW).

The Continuous Conservation Reserve Program (CCRP) is run by the USDA Natural Resources Conservation Service (NRCS) and the Farm Service Agency (FSA). The program was established in 1999 under the 1996 Farm Bill and was re-authorized in the 2002 Farm Bill. CCRP enrolls private lands under a ten to fifteen year contract under which the landowner agrees to use the land exclusively as a forested riparian buffer and is in turn paid a rental rate for the land so dedicated. Forested riparian buffers vary in width between 35 and 180 feet on either side of the stream. Landowners share the cost of planting trees, building fences and other practices with the federal government.

The Conservation Reserve Enhancement Program (CREP) is a joint effort of the State of Oregon and the NRCS. This program is similar to the CCRP program, but the State provides additional cost-share dollars to provide additional incentive for landowners to enroll. This program is only available on streams that are either anadromous or covered by an Agricultural Water Quality Management Plan.

Wasco County Soil and Water Conservation District supports the CCRP and CREP programs by providing two full-time planners.

Approximately 50 stream miles are eligible for CREP in Bakeoven Watershed. As many as 65 miles of small side tributaries may be eligible for CCRP. As of June 2005, 25 miles of anadromous streams in Bakeoven Watershed had been enrolled in the Conservation Reserve Enhancement Program, and another 0.05 miles were in the planning process. Another 3.3 miles of side tributaries had been enrolled in the Continuous Conservation Reserve Program, and 0.46 miles were in the planning process.

Some landowners choose not to enroll their streams in riparian buffer programs, but to manage their grazing carefully to protect riparian values. This approach requires more effort and is riskier, but can be successful. Such reaches must be monitored closely to confirm an improving or stable condition trend.

Actions and Schedule

- Enroll into CREP all riparian areas in the John Day/Deschutes Canyon Ecoregion or identified in this process as not meeting potential (13.3 additional miles) bringing the total to 90% of eligible miles.
- Enroll an additional 11 miles of small tributaries into CCRP, bringing the total enrollment to 22% of the eligible miles.

- In areas where landowners are not interested in riparian buffers, develop management plan and establish long-term monitoring program to document trend.

Objective 2B: Prevent invasion of feral pigs into new areas.

Priority: HIGH

Actions

- Continue Wasco County SWCD efforts to kill pigs in Wasco County.
- Immediate and concerted feral pig eradication effort led by or funded by State of Oregon.

Objective 2C: Reduce sediment from roads at all identified problem spots.

Priority: MEDIUM

Actions

- Inventory and identify roads, fords or culverts that cause gully erosion, deliver sediment directly to streams, or constrict floodplain function.
- Replace, improve or eliminate troublesome crossings to reduce sedimentation.

Objective 2D: Improve instream habitat in perennial streams.

Priority: LOW

This objective will be addressed only after upland and riparian objectives have been largely met.

Actions

- Conduct instream habitat studies in Cottonwood Creek, Deep Creek and Bakeoven Creek.

Implement instream measures, such as large woody debris or boulder placements, and streambank bioengineering, in locations identified as particularly in need.

Terms and Acronyms

Terms

CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
ESU	Evolutionarily Significant Unit
NWI	National Wetlands Inventory
OARs	Oregon Administrative Rules
OHV	Off-highway Vehicle
RCU	Riparian Condition Unit
RM	River Mile
RUSLE	Revised Universal Soil Loss Equation
TMDL	Total Maximum Daily Load

Agencies and Organizations

BLM	Bureau of Land Management
BOR	Bureau of Reclamation
CTWSRO	Confederated Tribes of the Warm Springs Reservation
DEQ	Department of Environmental Quality
DRC	Deschutes Resources Conservancy
JFDIC	Juniper Flat District Improvement Company
NRCS	Natural Resource Conservation Service
ODEQ	(Oregon) Department of Environmental Quality
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish and Wildlife
ODOT	(Oregon) Department of Transportaion
OWEB	Oregon Watershed Enhancement Board
OWRD	Oregon Water Resources Department
SWCD	Soil and Water Conservation District
USFS	United States Forest Service
WRD	(Oregon) Water Resources Department

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