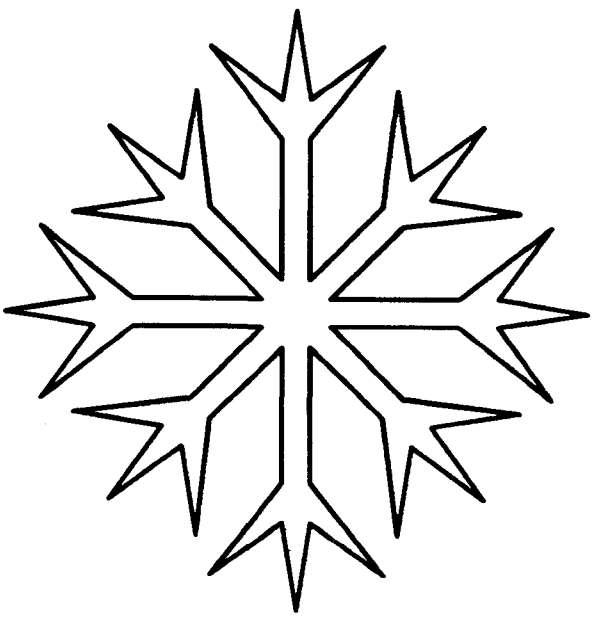
BIG MARSH WATERSHED ANALYSIS

JUNE 1997



Deschutes National Forest
Crescent Ranger District

EXECUTIVE SUMMARY

BIG MARSH WATERSHED ANALYSIS

DESCHUTES NATIONAL FOREST

MAY, 1997

The Big Marsh Watershed Analysis is written to help guide provincial and project planning on the Crescent Ranger District of the Deschutes National Forest. The analysis area includes three subwatersheds: Crescent Lake, Crescent Creek, and Big Marsh which is a Key Watershed.

The Purpose of the analysis was to develop conceptual strategies to sustain viable ecosystems. Analysis was completed using the Federal Guide for Watershed Analysis, Ecosystem Analysis at the Watershed Scale, version 2.2, 1995; and the Watershed Evaluation for Viable Ecosystems (WEAVE) process developed on the Deschutes National Forest in 1993, to help clarify and implement the Federal Guide. The WEAVE process melds social values, biological capabilities, and physical characteristics of the landscape at a watershed scale. The WEAVE process includes five phases which are as follows: A) Orientation and context setting, B) Data gathering and analysis, C) Information sharing (also called team teaching), D) Synthesis and integration, and, E) Landscape goals and opportunities.

Analysis was completed for three basic areas called domains: Physical, Biological, and Social. The physical domain includes climate, air quality, geology, soil resources, soil quality, and water resources. The biological domain includes historic, current, and potential vegetation, riparian resources, and wildlife. The social domain includes historic, current, and potential human interactions within the context of the watershed.

The watershed was divided into six similarly functioning areas called landscape areas. These areas have similar plant associations, recreational values, social functioning, and wildlife concerns. Area boundaries were refined using roads and natural landmarks and watershed and district borders. Trends common to all landscape areas were identified by resource specialists and served as a focal point for the analysis. Some trends impacted certain landscape areas more heavily than others.

Chapter 4 focuses on the analysis of the trends. All resource information for each identified trend is synthesized and analyzed. In chapter three, these trends were categorized as either red, yellow, or green for each landscape area. Red implies a "red flag" signifying urgency for intervention to prevent further deterioration of a resource, endangered species, or to ensure species viability. Yellow indicates something must be done soon to prevent the resource from becoming a red trend. Green indicates the urgency is not great or the trend maintains or enhances ecosystem sustainability and should continue.

Red flag trends include the reduction of late and old structured stands, increased fragmentation, the spread of non-native species and noxious weeds, regulation of water from dams, ditches and diversions, and a decline in the health of the riparian habitat in some areas. It should be noted that these some of these red trends were rated as yellow or green in other landscape areas. Other identified trends include increased commercial use of forest products, increased recreational demands, potential declines in water quality, increasing susceptibility for high severity fires, and deteriorating soil quality.

Development of landscape goals and opportunities was completed in chapter 5. Goals, objectives, and opportunities were developed for each of the six landscape areas. Opportunities include a variety of potential activities ranging from restoration to maintenance and monitoring.

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CHAPTER 1

BACKGROUND INFORMATION

ROD AND PILOT WATERSHEDS

On April 13, 1994 the Record of Decision for the *Final Supplemental Environmental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Forest Related species within the Range of the Northern Spotted Owl* (Northwest Forest Plan) was signed, which amends the Deschutes National Forest Land and Resource Management Plan. The Record of Decision (ROD) requires that watershed analysis be completed in Key Watersheds prior to the occurrence of new management activities. The ultimate goal is to complete watershed analyses in all watersheds to guide provincial planning as well as project planning. Key Watersheds were identified by building on work completed by the Scientific Panel on Late-Successional Forest Ecosystems and the Scientific Analysis Team. Seven Key Watersheds, including the Big Marsh Watershed, were identified on the Deschutes National Forest.

WEAVE

Watershed Evaluation and Analysis for Viable Ecosystems (WEAVE) is the process developed on the Deschutes National Forest in November 1993 and updated in April 1994, and is consistent with "Ecosystem Analysis at the Watershed Scale, Version 2.2, 1995". WEAVE is a broad-based, ecosystem analysis which incorporates the original requirements of watershed analysis with landscape ecology concepts in a comprehensive holistic process. It melds social values, biological capabilities, and physical characteristics of the landscape at a watershed scale. The process provides: an efficient strategy for carrying out the analysis, checklists to ensure that relevant topics are not overlooked, suggested analytical techniques, strategies for synthesis, and recommended products. It is a five-step process that begins with Phase A, determination of the general elements of the watershed, stratification of the landscape, and identification of the key issues for each of the stratifications. Phase B involves an in-depth data analysis of the physical, biological, and social domains. Phase C involves team teaching which results in each team member having a basic understanding of all dimensions of the landscape. Using the information from Phase C, ecological relationships are explored and integrated trends, causes, and factors at risk in the watershed are identified during Phase D. Phase E is the final step and includes the determination of goals and management opportunities for each of the areas in the stratified landscape. See Figure 1 for a diagram of the WEAVE process.

The WEAVE process provides the framework necessary to begin Watershed Analysis on the Deschutes National Forest. The intent is to provide consistency and guidance while allowing enough flexibility for each analysis to be tailored to the relevant questions in a particular watershed. The process is dynamic.

The purpose of the Big Marsh Watershed Analysis, as defined in the WEAVE document, was to develop conceptual strategies to sustain viable ecosystems. The focus of the watershed team was to mutually understand, identify, and document **key** trends, their causes and associated risks, and determine where they fit within the historic range of variability. The team outlined strategies to meet human needs while sustaining viable ecosystems and biodiversity. Broad landscape goals, objectives and opportunities were recommended, as well as means to meet aquatic conservation objectives and appropriate riparian boundaries. The scope of watershed analysis did not include project planning or decisions.

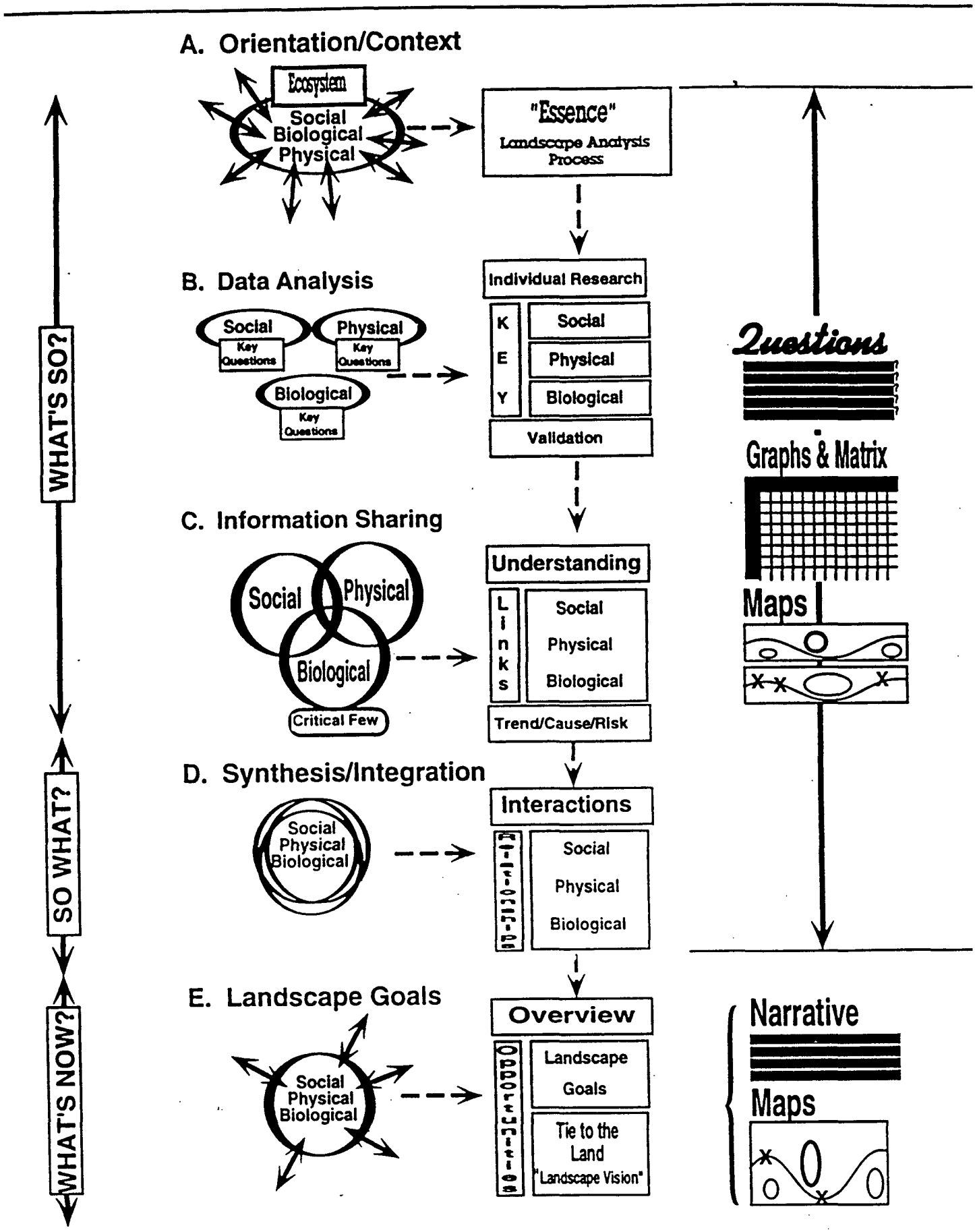
The goals of the watershed analysis were to :

- Begin to understand ecological components and interactions on the landscape.
- Establish the historic range of variability for vegetative conditions in the watershed.
- Facilitate understanding of the mechanisms of landscape change.
- Address social values, expectations, and effects.
- Provide guidance for project-level planning.

- Provide guidance to meet the Aquatic Conservation Strategy.

WEAVE Process

FIGURE 1



Recommend Riparian Reserve boundaries.
- Provide a basis for developing monitoring strategies.

Upon review, the watershed team confirmed that the 6-Step procedure from the "Federal Guide for Watershed Analysis" was completed through this watershed analysis effort.

AQUATIC CONSERVATION STRATEGY

The Aquatic Conservation Strategy (ACS) was developed to restore and maintain the ecological health of watersheds and aquatic ecosystems contained within them. The goal is to maintain the "natural" disturbance regime. The ACS strives to maintain and restore ecosystem health at watershed and landscape scales to protect habitat for fish and other riparian-dependent species and resources and restore habitats that are currently degraded.

Projects within watersheds need to be reviewed to determine their compatibility with the ACS objectives. There are nine ACS objectives listed on page B-11 of the ROD for the NWFP. Management actions that do not maintain the existing condition or lead to improved conditions in the long-term would not meet the intent of the Aquatic Conservation Strategy and should not be implemented.

BIG MARSH WATERSHED

The Northwest Forest Plan (NWFP) allocations for the Big Marsh Watershed and the acreage that they encompass are listed in the chart below:

Table 1 – 1, NWFP Land Allocations

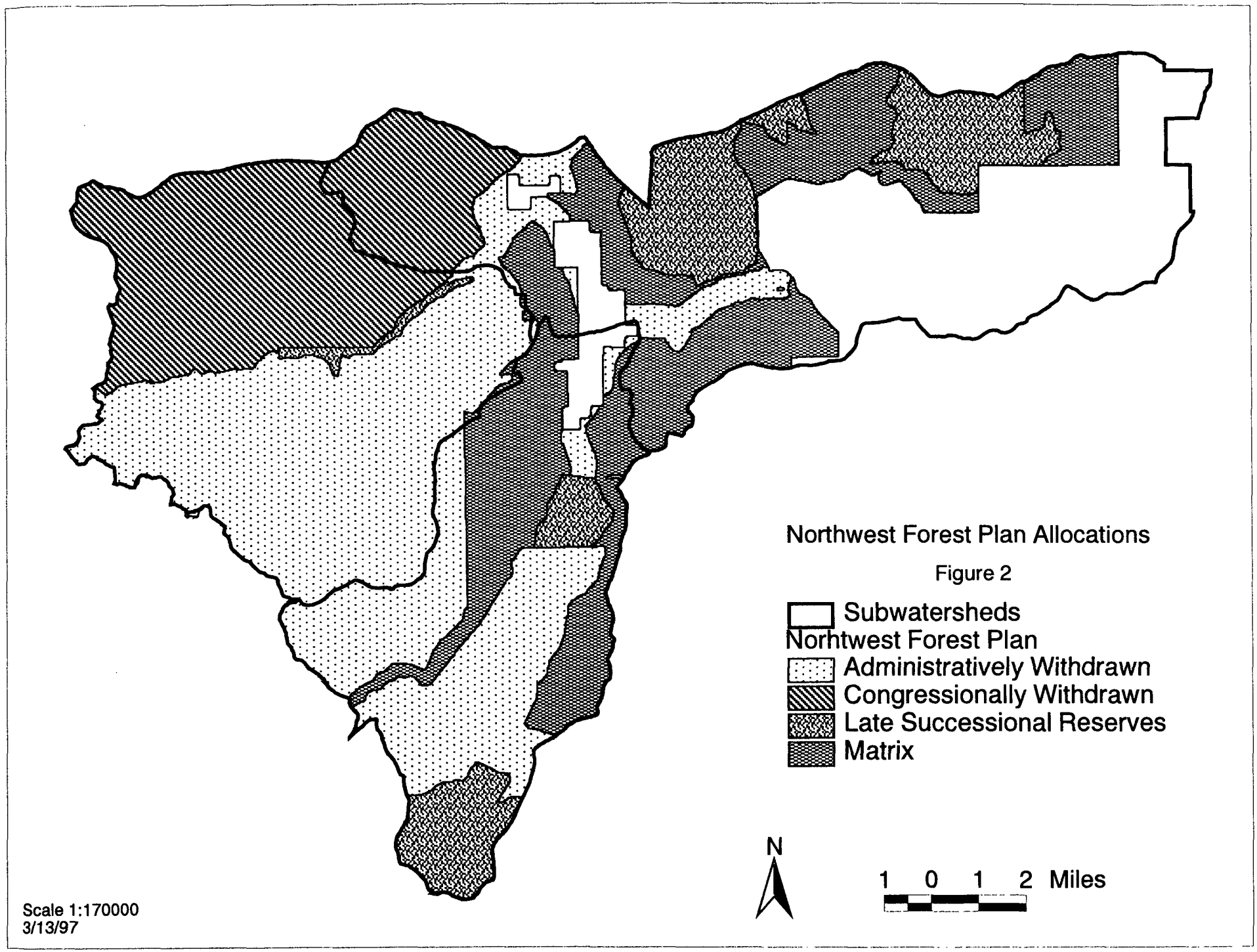
NWFP Land Allocations	NWFP Acres Within Watershed
Administratively Withdrawn Areas	39,783
Congressionally Reserved Areas	15,357
Late-Successional Reserve	13,478
Matrix	25,006
Total Acres	93,624

See Figure 2 for a map of the NWFP Land Allocations. A portion of the Big Marsh Watershed is located outside the boundaries for the NWFP.

The Deschutes National Forest Management Area delineations as determined by the Land and Resource Management Plan (LRMP) for the Big Marsh Watershed are listed below:

Table 1 – 2, LRMP Management Areas

LRMP Management Area	LRMP Acres Within Watershed
Bald Eagle	994
General Forest	30,483
Intensive Recreation	6,522
Oregon Cascades Recreation Area	33,633
Old Growth	886
Private Land	15,335
Scenic Views	7,830
Wild and Scenic River	3,562
Wilderness	21,155
Total Acres	120,405


Northwest Forest Plan Allocations
Figure 2
Subwatersheds
Northwest Forest Plan
Administratively Withdrawn
Congressionally Withdrawn
Late Successional Reserves
Matrix
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Scale 1:170000
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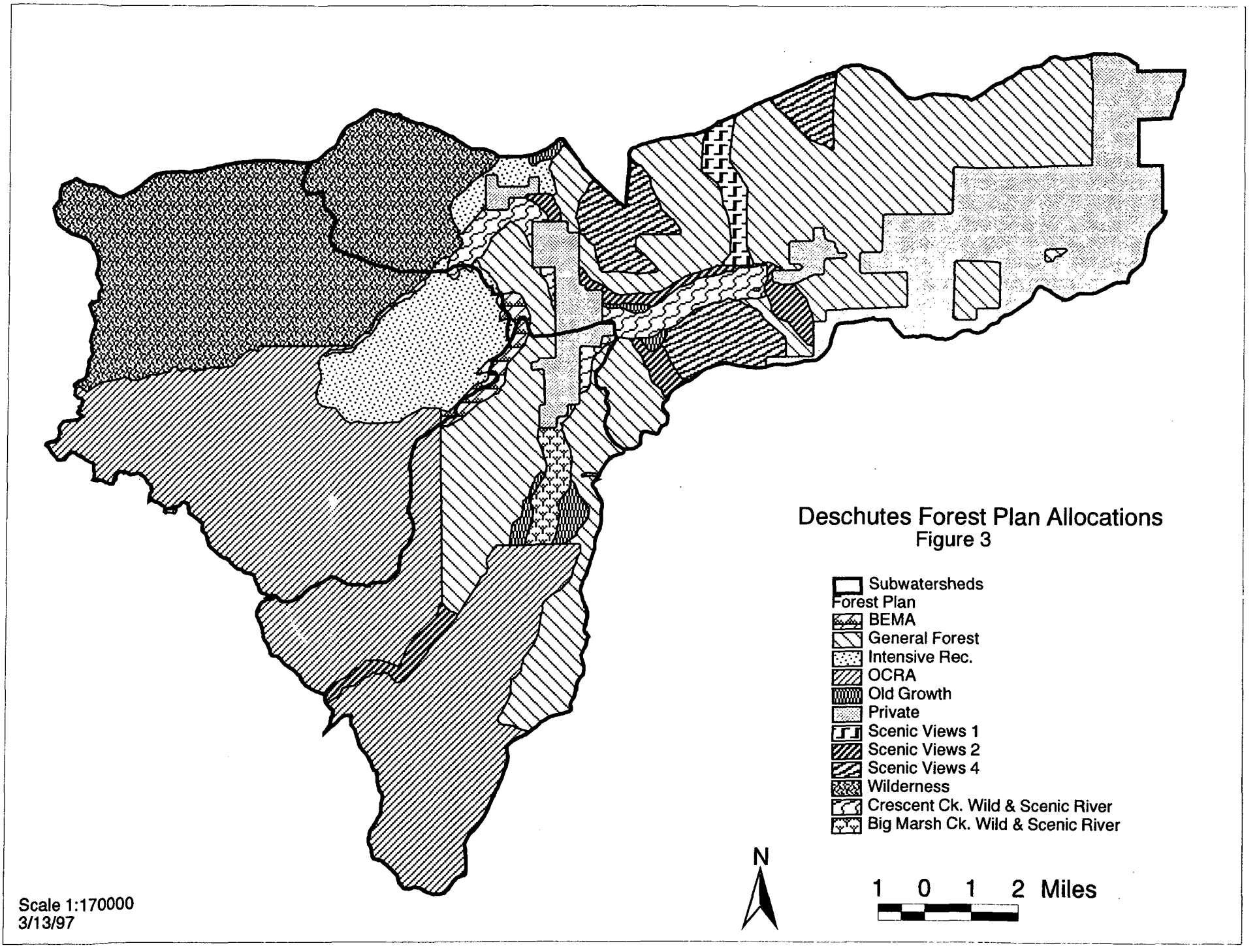
Deschutes Forest Plan Allocations
Figure 3
Subwatersheds
Forest Plan
BEMA
General Forest
Intensive Rec.
OCRA
Old Growth
Private
Scenic Views 1
Scenic Views 2
Scenic Views 4
Wilderness
Crescent Ck. Wild & Scenic River
Big Marsh Ck. Wild & Scenic River
N
1 0 1 2 Miles
Scale 1:170000
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See Figure 3 for a map of the Deschutes LRMP Management Areas. A portion of the Big Marsh Watershed is located outside the Deschutes National Forest boundaries.

KEY WATERSHEDS

The Big Marsh Watershed extends from Diamond Peak east to the confluence of Crescent Creek with the Little Deschutes River, and south from Crescent Lake to Tolo Mountain. The western edge of the watershed is the crest of the Cascades. The watershed includes approximately 120,405 acres and consists of three subwatersheds: Crescent Lake, Crescent Creek, and Big Marsh which is designated as a key watershed. Refer to Figure 4 for the general location of the Big Marsh Watershed and Figure 5 for the key landscape features.

The Northwest Forest Plan delineates Key Watersheds, which provide high quality habitat for at-risk stocks of resident fish species. They are to serve as refugia for maintaining and recovering habitat for these at-risk species. These refugia include areas of high quality habitat as well as areas of degraded habitat. Key Watersheds with high quality conditions will serve as anchors for the potential recovery of depressed stocks. Key watersheds of lower quality habitat have a high potential for restoration and will become future sources of high quality habitat with the implementation of a comprehensive restoration program.

Big Marsh Subwatershed is 29,827 acres in size and contains a unique, high-elevation, marsh-meadow known as Big Marsh. The majority of Big Marsh Creek is designated as a Wild and Scenic River. The subwatershed contains two Late-Successional Reserves (LSRs), the Upper and Lower Big Marsh LSR and a portion of the Oregon Cascades Recreation Area. The Big Marsh Subwatershed was designated as a Tier 1 (Aquatic Conservation Emphasis) Key Watershed which contributes directly to the conservation of at-risk resident fish populations. For Big Marsh subwatershed this includes the redband trout. No anadromous salmonids exist in this watershed, and bull trout have been extirpated with no possibility of re-introduction. It also has a high potential of being restored as part of a watershed restoration program. This subwatershed is part of a network of 143 Tier 1 Watersheds which are designated to ensure that refugia are widely distributed across the landscape.

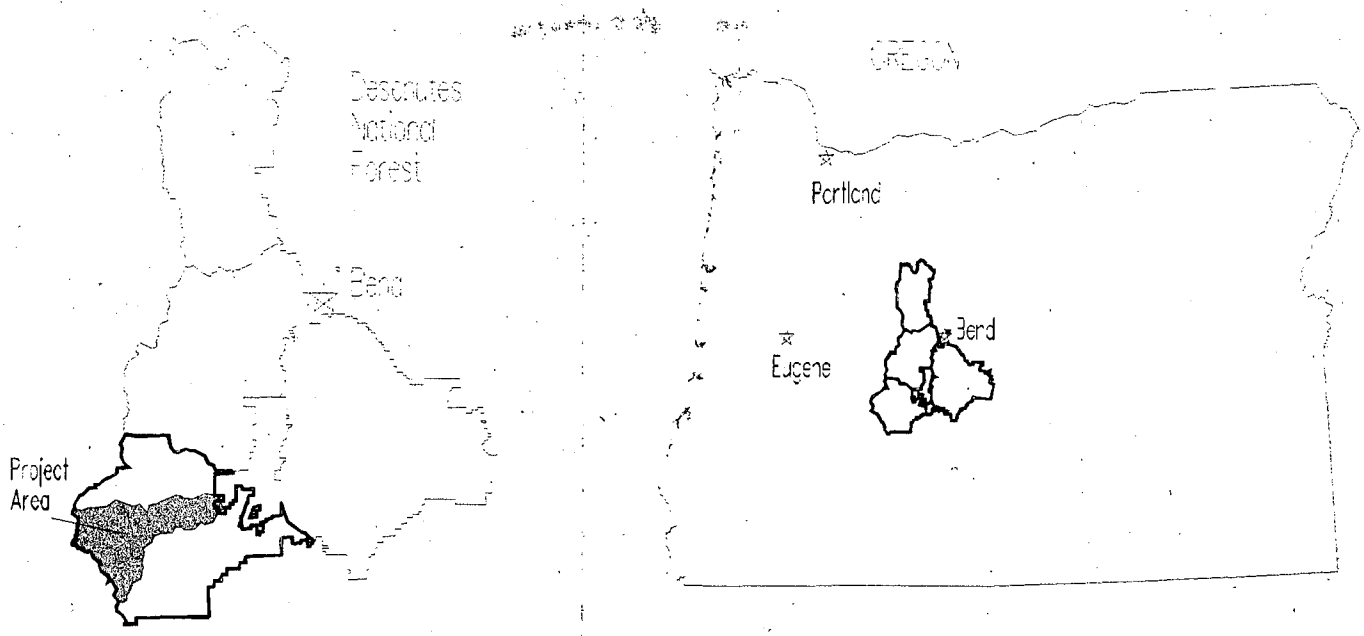
The Crescent Lake Subwatershed includes both Crescent and Summit Lakes which are 3,822 and 454 acres in size respectively, a portion of the Diamond Peak Wilderness and the Oregon Cascades Recreation Area, and the Crescent Lake LSR. Crescent Lake is a natural lake that was originally dammed and enlarged in 1922 for irrigation purposes. The subwatershed is 38,135 acres in size.

The third subwatershed is Crescent Creek and is 53,626 acres in size. Crescent Creek flows through the subwatershed from the outlet of the dam at Crescent Lake. A portion of Crescent Creek is designated as a Wild and Scenic River. This subwatershed also contains a portion of the Davis LSR.

ORGANIZATION OF THE DOCUMENT

Chapter 1 introduces the concept and basis for watershed analysis, as well as the process developed by the Deschutes National Forest in conducting such an analysis. It also discusses some of the goals of watershed analysis.

Chapter 2 describes the current condition of the watershed by resource area. These conditions serve as the baseline for making management decisions as to the direction needed to meet the goals and desired condition for each landscape area.

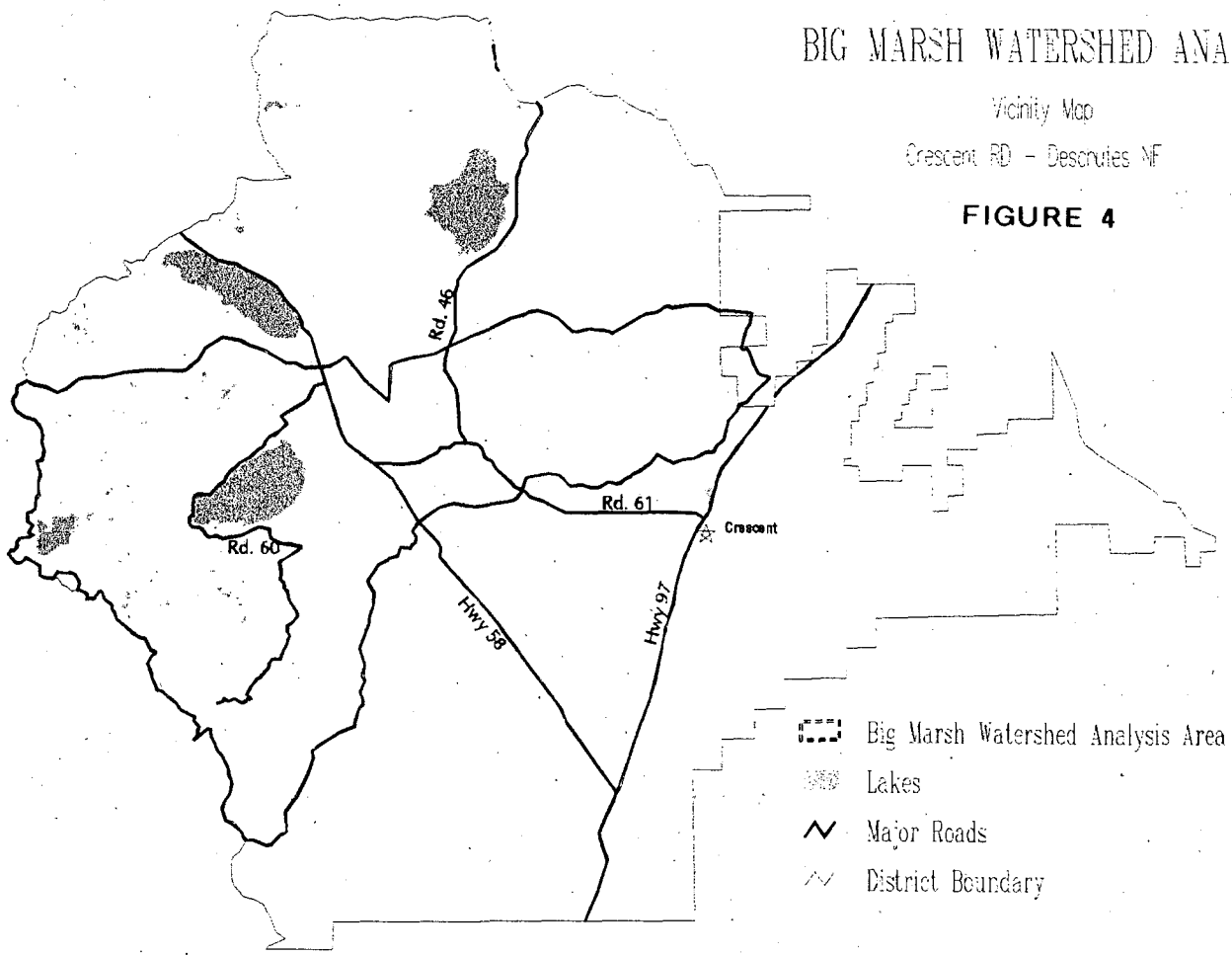


BIG MARSH WATERSHED ANALYSIS

Vicinity Map

Crescent RD - Deschutes NF

FIGURE 4



Deschutes National Forest

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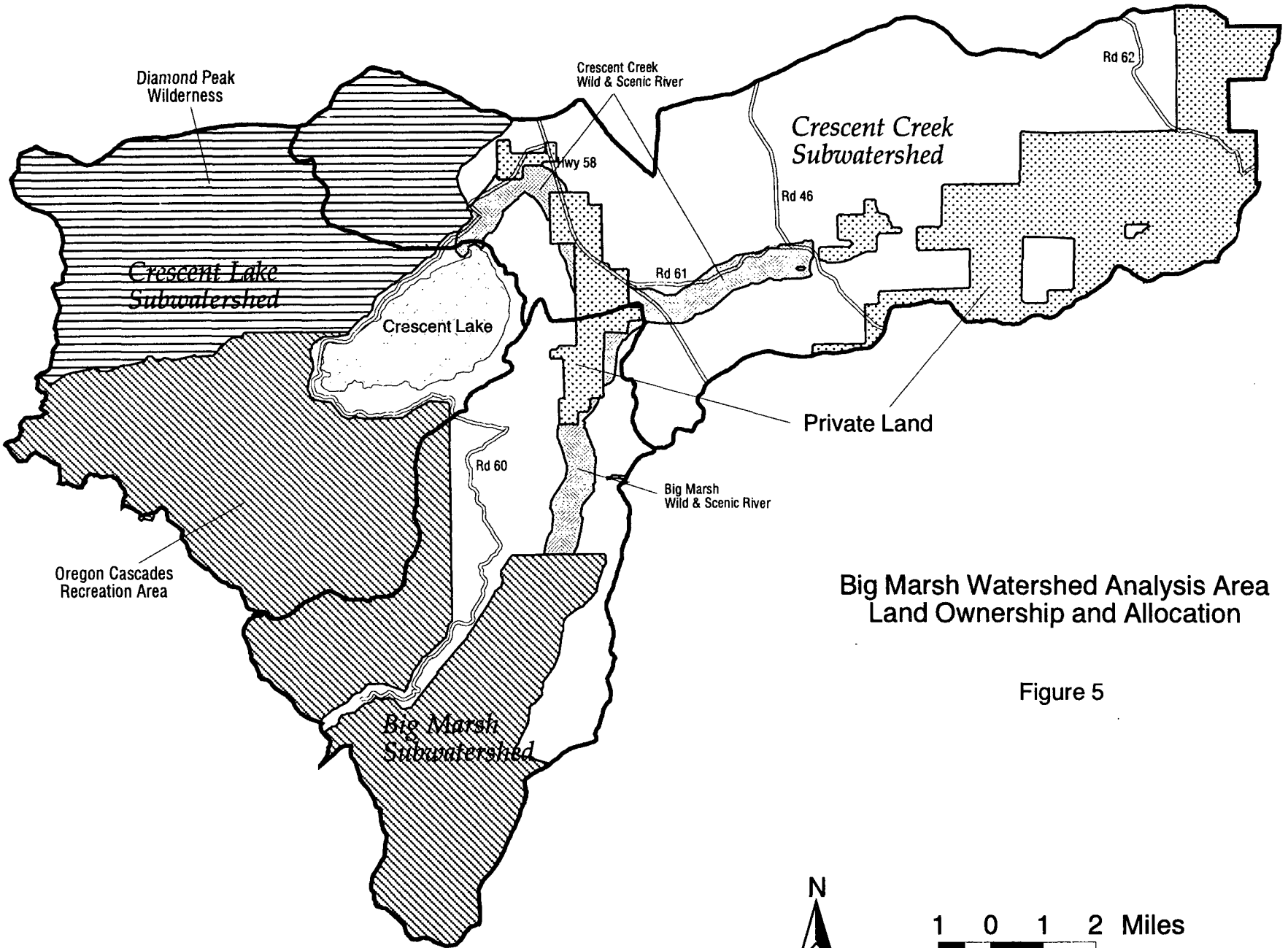


Big Marsh Watershed Analysis Area
Land Ownership and Allocation

Figure 5

Chapter 3 discusses the ten major trends in the watershed identified by the Interdisciplinary Team (IDT). The dynamics of each trend are described in detail. These trends are further discussed as to how prominent they are in each landscape area and how each trend affects different resource areas. Tables are included to help display the information. These trends are believed to be the main factors affecting the current ecological functioning of Big Marsh Watershed. Trends can have positive or negative effects on the watershed.

Chapter 4 is the analysis of the trends and describes in detail the findings of the specialists as to how each of the trends is affecting the resources in the watershed. In some cases, the effects of these trends on resources were better illustrated when discussed by landscape area, while in other cases, differences were better displayed by analyzing differences and effects by Plant Association Group.

Chapter 5 discussed goals and opportunities of each landscape area. The goals were identified by the IDT as the desired condition of each landscape area. The opportunities are actions that could be taken to help move the landscape areas in the direction of the goals identified.

CHAPTER 2

EXISTING CONDITION

PHYSICAL DOMAIN --
SOILS

Parent Material

Soil development in the Big Marsh Watershed has been influenced by four primary parent materials located on a variety of volcanic or glacial landforms. The parent materials include, individually or in combination, glacial outwash, glacial till, igneous basaltic lava and sand to gravel-sized pumice and ash volcanic tephra. Surface materials consist of pumice and ash tephras expelled from Mt. Mazama approximately 7,600 years ago.

The youth and coarseness of the surface tephra material provides an inherently marginal level of productivity on the upland soils within the watershed. Underlying glacial outwash and till material provides a barrier to the downward flow of subsurface water and creates seasonally high water tables in the areas where this material is present.

Landforms

Landscape position and surrounding landforms within the Big Marsh Watershed have also influenced soil development and vegetative growth. The watershed has elevations ranging from approximately 4,300 feet to 8,744 at the top of Diamond Peak. The area is a combination of the High Cascades and LaPine Basin physiographic regions as designated in the Soil Resource Inventory for the Deschutes National Forest. The southwestern edge of the watershed is bounded by the volcanic formations of the High Cascades, with two primary glaciated valleys extending into the LaPine Basin to the northeast. Volcanic landforms are also present in the form of cinder cones, shield volcanoes, and two surface lava flows that occurred following the Mazama tephra deposits. The various aspects and elevational gradients provided by these landforms have influenced soil development as a direct result of the biomass produced and supported on these sites.

Climate

The moderate elevation and proximity of the watershed to the crest of the High Cascade provides a relatively harsh climate in which to support vegetative growth. Morning temperatures within the watershed are often below freezing, even during the summer months. The cold mornings and low mean annual temperatures result in cryic soil temperature regimes (mean annual temperature between 32° and 46° Fahrenheit) throughout the watershed, regardless of landscape position. Extreme daily fluctuations in temperature contribute further to a short growing season and slow weathering of the coarse and young soil profiles present within the watershed. Overall productivity within the watershed is low to moderate. A moderate annual precipitation level of 20 to 60 inches, found in a gradient from east to west across the watershed, offsets this only slightly. Precipitation falls primarily in the form of snow, with occasional spring, summer and late fall rains. The presence of vegetative cover, surface organic matter and coarse wood is important within this watershed to maintain the productivity and offset the limited resiliency of the soils present.

Soil Types

Five broad soil type groups can be classified within the watershed. These groupings reflect differences in soil characteristics, response to management and vegetation types. The primary Soil Resource Inventory mapping units found within the watershed for each type group are in parenthesis.

Soil type groups:

1) Wet/Riparian -- See Figure 6.
 a) High seasonal or year round water table.
 b) Primarily drainage bottoms and wet meadows having glacial material in the subsurface.
 c) Support diverse types of vegetation (forbs/grasses, trees, and shrubs).
 d) Variable textures and rock fragment contents.

2) Upland: moderate elevation --
 a) Moderate depths of coarse textured Mazama tephra and/or residual soils over basaltic lavas or outwash sediments.
 b) Elevation generally below 5,500 ft.
 c) Cryic soil temperatures.
 d) Moderate productivity (site class 4 and 5).

3) Steep slope uplands -- See Figure 7.
 a) slopes of 30 to 70%
 b) upland characteristics
 c) variable productivity based on rock content and soil depth.

4) Very Low Site Quality -- See Figure 8.
 a) Thin layers of Mazama tephra and/or thin residual soils on lava; pumice flats; bare lava; or cinders.
 b) Often a matrix of soil and rock outcrops.
 c) Low productivity with limitations on reforestation.
 d) Marginally weathered, coarse profile.
 e) Low available water holding capacity.

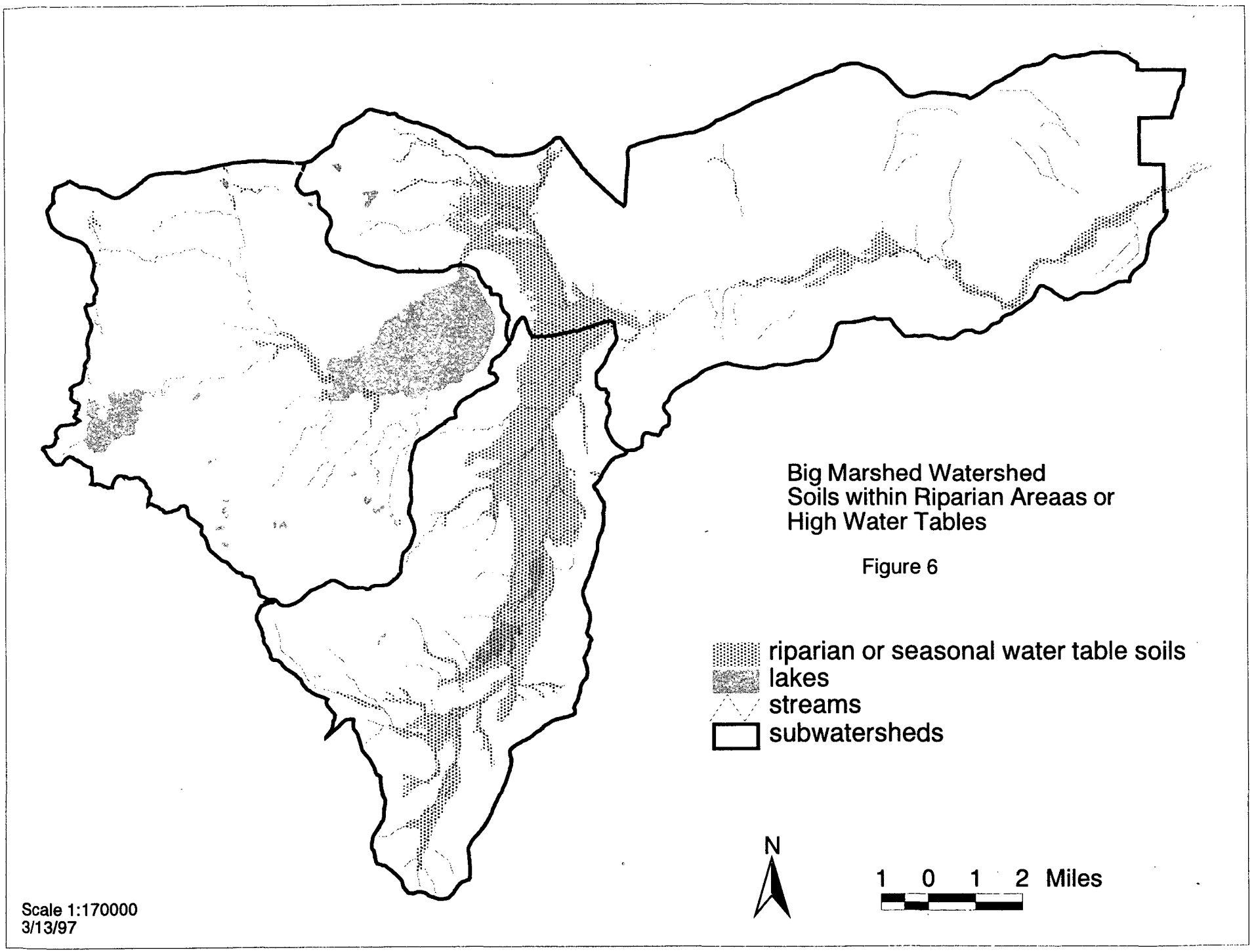
5) Alpine Uplands/Steep Slopes --
 a) Moderate depths of Mazama pumice and ash.
 b) Elevation above 5,500 ft/cryic soil temperatures.
 c) Marginal site productivity.
 d) Deep seasonal snowpack.

WATER RESOURCES

The Big Marsh Watershed drains 120,000 acres, contains twenty-five named lakes as well as numerous other water bodies less than three acres in size, and eight fish-bearing streams. (Figure 8) The water resources in the Big Marsh Watershed include the following: 1) Summit Lake, 2) numerous small lakes in the headwater area above Crescent Lake, 3) three main creeks and several small intermittent drainages that flow into Crescent Lake, 4) Crescent Lake, Big Marsh Creek, and its tributaries which are the main water sources for Crescent Creek, and 5) Crescent Creek which flows into the Little Deschutes River.

Summit and Cascade Mountain Lakes

Summit Lake is located at an elevation of 5,553 feet and is named because it is situated in proximity to the divide between the Willamette and Deschutes River Basins. B. J. Pengra and W. H. Odell first used the name in 1865 while making a reconnaissance for the Oregon Central Military Road. The lake has a drainage basin of approximately 5,000 acres. There are no perennial surface streams into the lake; inflow is by snowmelt runoff, direct precipitation, and subsurface seepage. Surface outflow is into Summit Creek, which discharges into Crescent Lake located four miles to the east. The shape of the lake basin is complex with several deep holes and underwater ridges and hills. The shoreline is also highly indented, particularly along


Big Marshed Watershed
Soils within Riparian Areaas or
High Water Tables
Figure 6
riparian or seasonal water table soils
lakes
streams
subwatersheds
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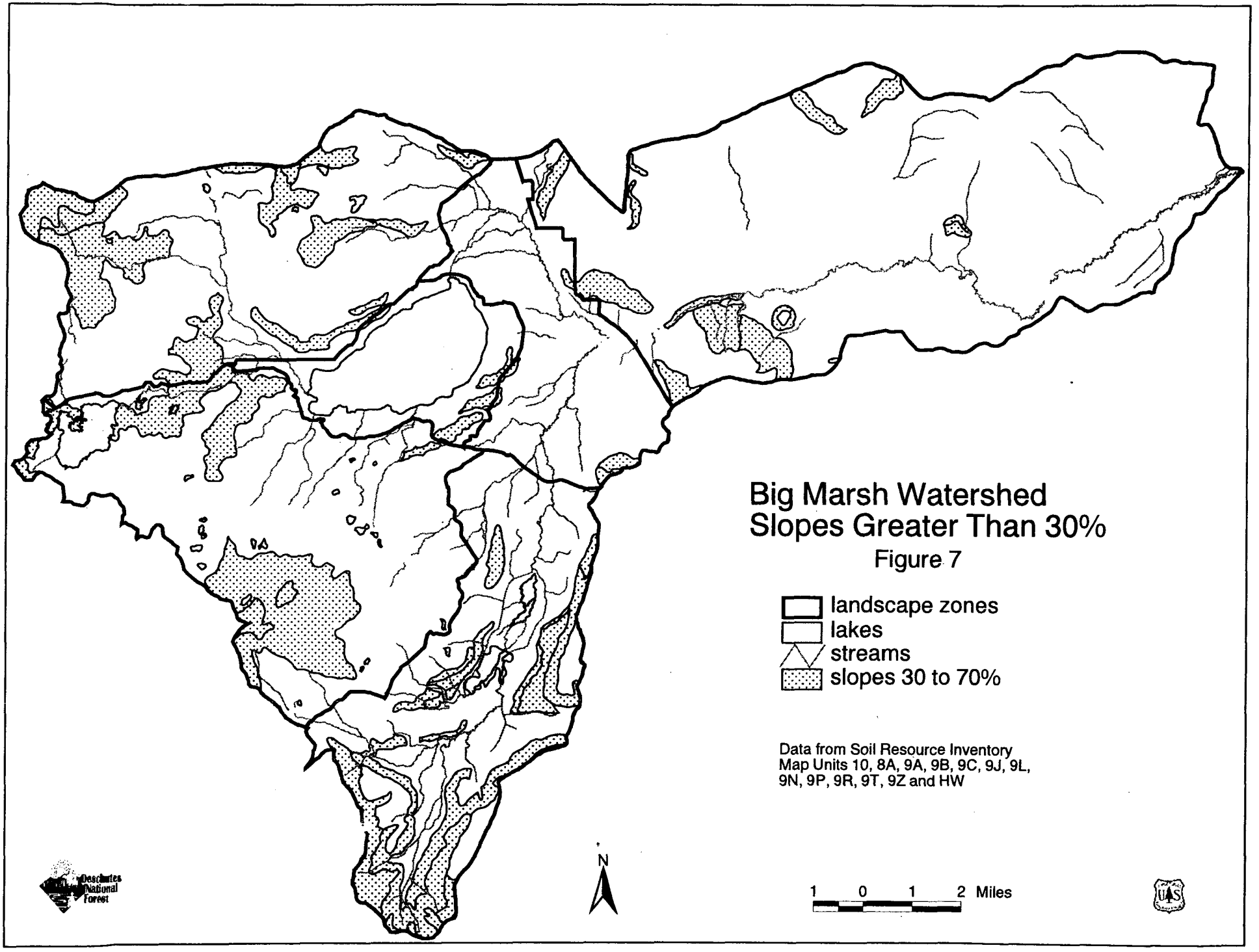
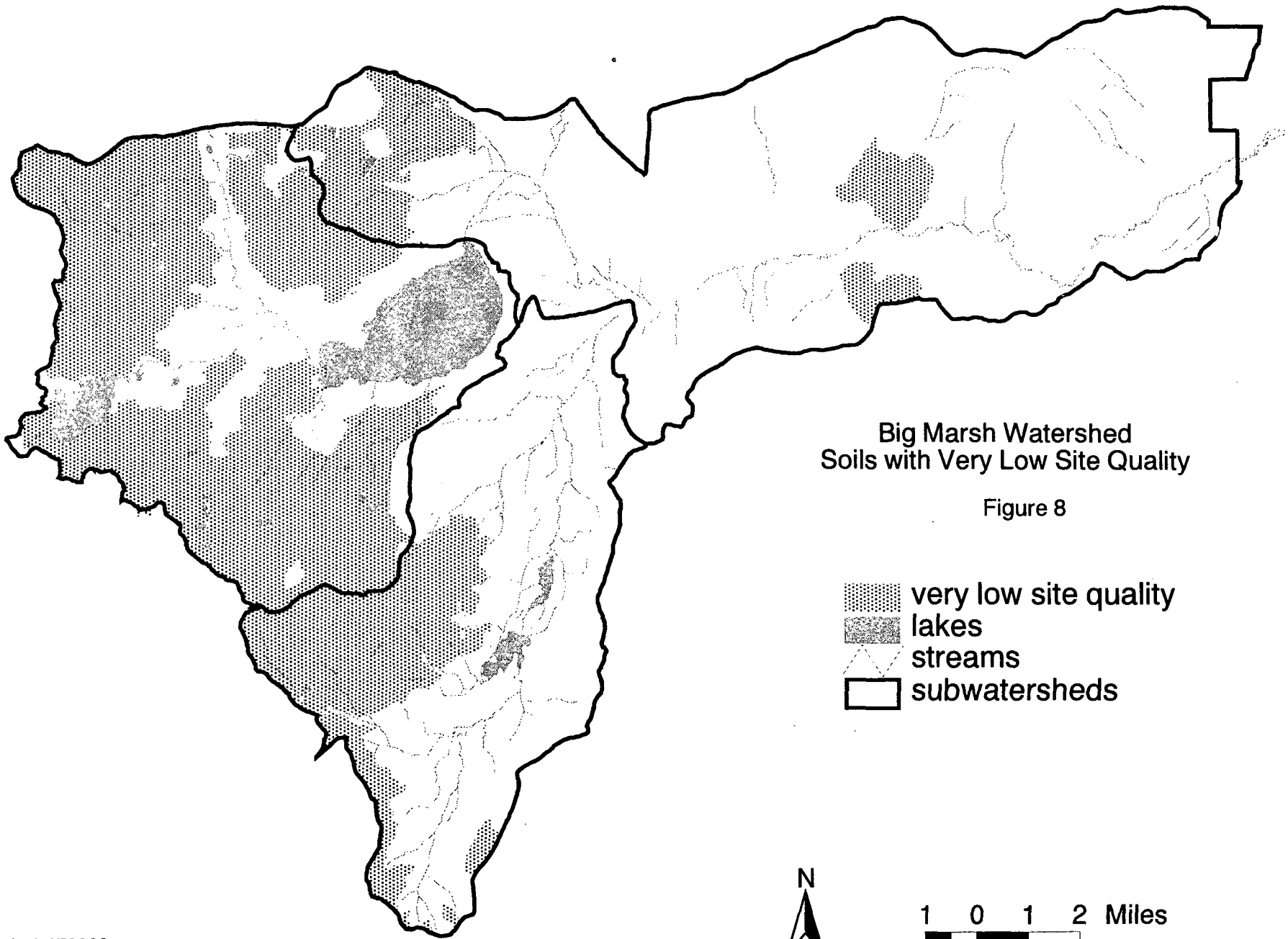

Big Marsh Watershed
Slopes Greater Than 30%
Figure 7
landscape zones
lakes
streams
slopes 30 to 70%
Data from Soil Resource Inventory
Map Units 10, 8A, 9A, 9B, 9C, 9J, 9L,
9N, 9P, 9R, 9T, 9Z and HW
Deschutes National Forest
N
1 0 1 2 Miles


Big Marsh Watershed
Soils with Very Low Site Quality
Figure 8
very low site quality
lakes
streams
subwatersheds
N
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the northern shore, which is flanked by a lava flow. This lake is ultraoligotrophic and the water is very transparent (Johnson et al. 1985).

Numerous high elevation lakes are scattered throughout the Diamond Peak Wilderness and Oregon Cascades Recreation Area. These lakes range in size from one-tenth to 42 acres in size and generally have limited drainage basins. Some of the larger, such as Fawn and the Windy Lakes, have drainage basins of between 500 and 1,000 acres. These lakes are oligotrophic.

Summit Creek is the outlet for Summit Lake. Mountain, and Whitefish Creeks drain the balance of the high elevation areas within the watershed. Summit and Mountain Creeks are the tributaries for Whitefish Creek, which drains into Crescent Lake. The flow from these creeks is highly variable throughout the year, in fact, during the summer months portions of the creeks may become dry with only subsurface flow.

Crescent Lake

The elevation at Crescent Lake is 4,839 feet. It is one of several large, deep lakes in Oregon formed by the erosive and depositional activity of glaciers during the Pleistocene Epoch. It lies in a broad, glacially scoured valley behind a moraine dam left behind during the glacial retreat (Johnson et al. 1985). Odell Lake was formed in the same manner. Crescent Lake is five miles long and four miles wide and has a maximum depth of 265 feet. The primary surface inflow to the lake is from Whitefish Creek; several smaller intermittent streams contribute during the snowmelt season. Crescent Creek, a tributary of the Deschutes River, is the outlet stream.

In 1922 a small earth and wooden dam was constructed across the lake outlet to store water for irrigation in the Tumalo area via Crescent Creek, Little Deschutes and Deschutes Rivers. In 1956 the Bureau of Reclamation constructed a 40-foot earth and concrete structure which elevated the lake surface at full pool to an elevation of 4,847 feet with a surface area of 4,008 acres. The Tumalo Irrigation District has 86,860 acre-feet of usable storage under permit; the natural lake basin contained approximately 500,000 acre-feet of volume. At minimum pool the elevation of the lake surface is 4,823 feet and the surface area is 3,470 acres (ODFW 1996). During the year the surface elevation of the lake generally fluctuates by several feet due to withdrawals for irrigation purposes.

Crescent Lake is exposed to strong winds, which result in a deep (50-60 feet) thermocline during summer stratification. Water transparency is excellent. Crescent Lake is oligotrophic and the water quality is good at this time. The presence of eutrophic algae has been found in the lake and indicates the possibility of impacts from human activities on and around the lake. The soils around Crescent Lake are very porous and have little capacity to absorb and retain nutrients. In a study conducted in 1985, little evidence of eutrophication existed, despite considerable human use (Johnson et al. 1985). There have been no formal studies conducted since 1985.

Big Marsh and Big Marsh Creek

Big Marsh Creek originates from snowmelt runoff on Tolo Mountain and travels north approximately 15 miles to its confluence with Crescent Creek. The drainage basin is approximately 30,000 acres. Otter Creek and several smaller tributaries drain into Big Marsh Creek, which provides the primary water source for Big Marsh. Big Marsh is a 1,900 acre marsh/meadow that is unique due to its large size, high elevation (4,730 feet), and diversity of vegetation and wildlife that it sustains. In addition to Big Marsh Creek, several free-flowing springs are located along the west side of Big Marsh which also add water to the system.

Big Marsh Creek was formed by a series of glaciers, which eroded a deep canyon. The last major glacier melted approximately 13,000 years ago. As it melted, the glacier left moraine

deposits that formed a large lake about four miles long and one mile wide. Over time, the lake filled with sediment and created what is now Big Marsh (ODFW 1996).

Big Marsh has had an interesting history. The first recorded sighting of the marsh was in 1865 and at that time a series of beaver dams at the lower end of the marsh resulted in a water depth of between 12 and 20" across the marsh. As a result of the Swamp Land Act, Big Marsh became privately owned in 1906. Both cattle and sheep grazed the area at various times. In 1946, Big Marsh Creek was diverted from its natural stream course where it enters the marsh. Two ditches were constructed on the west and east sides of the marsh and used to drain the marsh and increase the suitability of the area for grazing.

In 1982 the USFS purchased Big Marsh from Diamond International. As a result of an Environmental Assessment that was completed in 1988, initial restoration of Big Marsh towards its natural condition began. In 1989 a water control diversion was installed in the east ditch which allowed a progressive, regulated, redirection of about half of the diverted ditch water back into Big Marsh Creek as well as the marsh itself. In addition, check dams were constructed in both the east and west ditches to increase water infiltration into the marsh and cause bank overflow. At this time approximately one-half of the water volume from the east ditch now flows through Big Marsh Creek. The creek channel has been scoured by the influx of this water and has begun to redefine its channel. The east and west ditches have also been breached in several locations which allows additional water to flow into the marsh itself. However, more restoration needs to occur in order for Big Marsh to function fully as a natural, high elevation marsh.

Due to grazing and other activities, vegetative cover and instream wood are missing along the majority of Big Marsh Creek resulting in increased water temperatures, sloughing, and erosion along the streambanks. USFS thermograph data show substantial water temperature increases (14 degree Fahrenheit temperature rise) as water passes through Big Marsh. Some temperature rise may be a natural function of the marsh, however, it is suspected that part of the increase is due to the decrease in vegetative cover and instream wood. In addition, water temperatures continue to rise further downstream. Approximately 3.5 miles of Big Marsh Creek are located on private land. Livestock grazing has occurred on this land and resulted in deteriorated streambanks and poor stability (ODFW 1996).

Crescent Creek

Crescent Creek originates at Crescent Lake and travels approximately 30 miles to its confluence with the Little Deschutes River. The drainage basin includes approximately 150 square miles. Big Marsh Creek is the only tributary. Historically, Crescent Creek drained a melting glacier at the present site of Crescent Lake and was much larger than it is today. Approximately 4,000 years ago the Black Rock lava flow erupted and forced Crescent Creek around the south end of the flow. The old stream channel is still visible today.

Crescent Creek is a low velocity stream through most of its length with an average drop of less than 45 feet per mile. The Tumalo Irrigation District regulates flow at Crescent Lake for irrigation purposes. Low flows generally occur between September and April while water is being stored in Crescent Lake. Flows are high the remainder of the year when water is released for irrigation. Downstream, low flows are moderated by Big Marsh Creek. Water temperatures increase as the water moves downstream, despite the fact that some stream reaches contribute cooler water to the system. Habitat degradation, primarily bank instability and sedimentation, occurs as a result of the rapid release of water from Crescent Lake and the fluctuating stream flows.

BIOLOGICAL DOMAIN --
VEGETATION

Vegetative structure is a critical factor in evaluating the physical, biological and social processes taking place in the Big Marsh Watershed. Vegetative structure results as a function of, among other things, the processes associated with climate, topography, disturbance events, succession, and time. Climate and topography remain fairly constant over time compared with the other processes mentioned. Disturbance events include insect attacks, disease infestations, windstorms, fire, and management activities of humans. Successional processes are usually typified by invasion of seral species, followed by vertical structure development to the point where mid and late seral species increase and, in some cases, replace the earlier seral species. The mid to late seral species are present until another disturbance occurs and sets the process back to an earlier successional stage.

Factors relating to vegetative structure include impacts of landscape disturbance events, processes of vegetative succession, and fragmented vegetative structure. Each of these factors will be discussed in the context of plant association groups (PAGs). Much of the discussion of PAGs and vegetative succession will take place in Chapter 4 during analysis of the 10 identified trends.

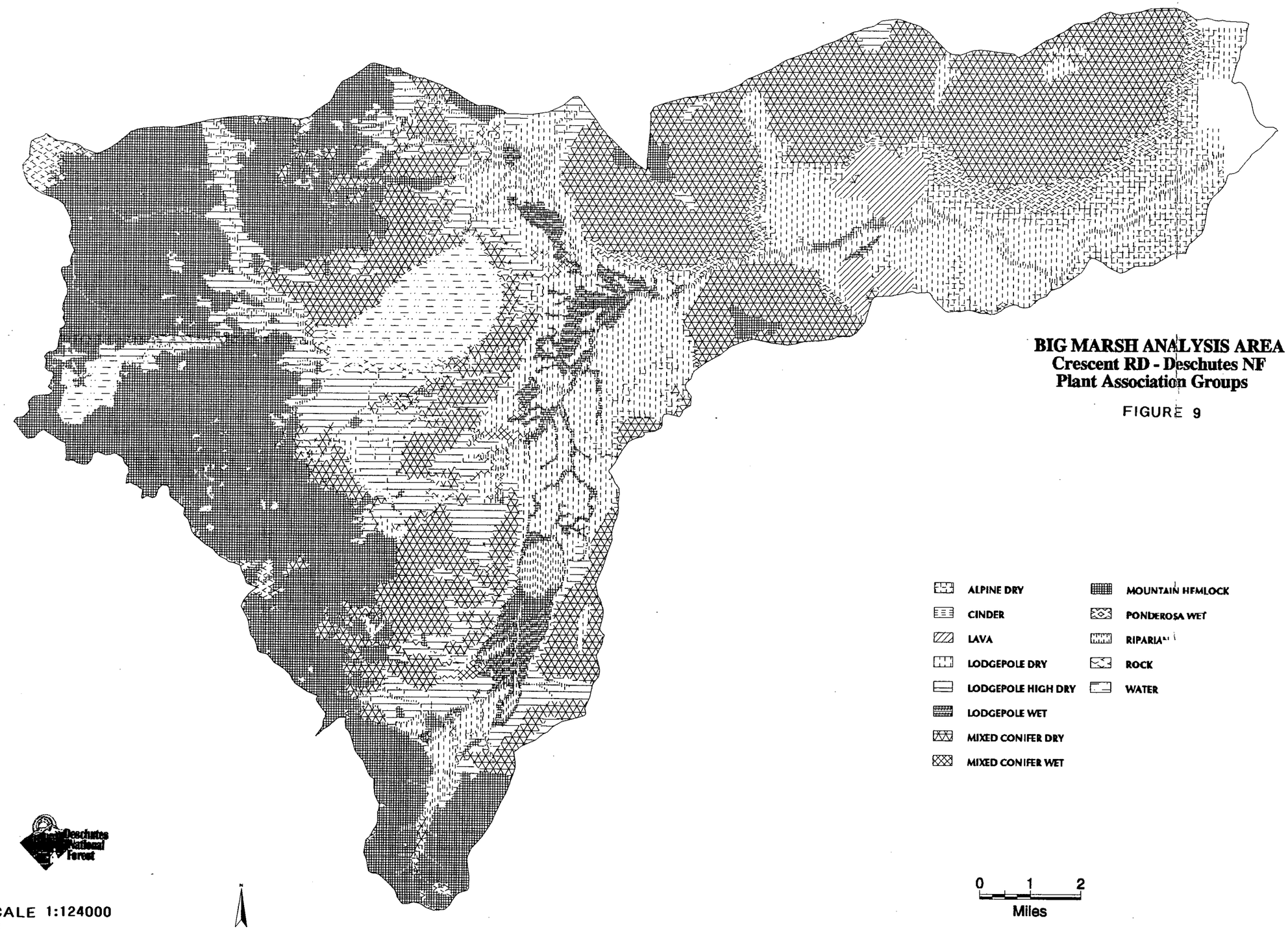
PAGs are comprised of the groupings of various plant associations as described in Appendix G. The dry versus wet grouping is based on site productivity, with dry sites being less productive than wet. The high elevation lodgepole dry occurs mainly at higher elevations, 4,800-5,000 feet, than the lodgepole dry, but there is some elevational overlap. The following table includes the acreage of each PAG that is located on National Forest land within the Big Marsh Watershed. Areas not represented in this chart are private land and any acreage classified as cinder, lava, rock, wet meadow, riparian, or water.

Table 2 - 1, Acres and Percent of Landscape by Plant Association Group

Plant Association Group (PAG)	Acres	Percent
Lodgepole Dry	12,648	13.5%
Lodgepole Wet	1,904	2.0%
Lodgepole High Elevation Dry	12,036	12.9%
Ponderosa Dry	1,120	1.2%
Ponderosa Wet	834	0.9%
Mixed Conifer Dry	31,659	33.9%
Mixed Conifer Wet	773	0.8%
Mountain Hemlock Dry	32,454	34.8%
Total	93,431	100%

These acreages do not take into account lands that are not forested, such as water, meadows, lava, etc.

See Figure 9 for a map of the distribution of the PAGs.



BIG MARSH ANALYSIS AREA
Crescent RD - Deschutes NF
Plant Association Groups

FIGURE 9

- ALPINE DRY
- CINDER
- LAVA
- LODGEPOLE DRY
- LODGEPOLE HIGH DRY
- LODGEPOLE WET
- MIXED CONIFER DRY
- MIXED CONIFER WET
- MOUNTAIN HEMLOCK
- PONDEROSA WET
- RIPARIAN
- ROCK
- WATER

Deschutes National Forest

SCALE 1:124000

0 1 2
Miles

09
BH-
Source - Deschutes NF files

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Stand Structure And Factors Relevant To All Pags

Impacts of landscape disturbance events

Timbered stands of vegetation which have not been disturbed in the past few decades or longer are moving towards later successional stages in their development, which often implies an increase in forest structure complexity. The exclusion of fire through fire suppression efforts has allowed fuels to increase in both amount and distribution throughout the vegetative canopy structure. Tree density, measured in number of trees per acre, has increased to the point where mortality is frequent in many stands. This mortality results in part from the suppressed and intermediate-sized trees that are unable to compete for the light and moisture necessary for their survival. In other cases, mortality occurs in dense stands of trees due to their susceptibility to insect and disease infestations.

Such complex structured stands can be found to some extent in every forested PAG within the watershed. These complex stands provide necessary habitat for a wide variety of wildlife species. The increasing fuel amounts and complexities within the stands cause protection from stand replacement fire to be increasingly difficult as time goes by. In addition, virtually all insect and disease organisms are regulated by the amount of host trees available to them. When a particular set of conditions, such as species mixture, age class, or stocking density occurs widely over a landscape, insect and disease agents will eventually be present to exploit that condition (USDA 1994).

As these conditions continue, especially in the absence of vegetative manipulation by harvest or fire, the risk of stand replacement events increases in at least two ways. First, the larger the area of homogeneous stand conditions, the more host trees are available to support epidemic levels of insect and/or disease activities. Second, as fuel beds become heavier and more complex, their resistance to fire control increases, especially during extreme fire behavior conditions. The result is that both the risk and scale of landscape disturbance events will continue to increase as the trend towards contiguous late seral structured stands continues.

Fragmented vegetative structure

Fragmentation of the timbered stands has resulted in a pattern which is easily observable from an aerial perspective. The vegetative structures of these fragmented stands have been modified by human activity, fire, insect, and/or disease activity. These disturbances have had the greatest effects on the landscape when they resulted in very simple structures, which often contain a smaller diversity of plant and animal species than would be found in later successional stages of stand development.

BOTANY

Sensitive Plants

The following are species on the Region 6 Regional Forester's Sensitive Species List that are known to occur within the Big Marsh Watershed: Jepson's monkeyflower, *Mimulus jepsonii* (MIJE), bog clubmoss, *Lycopodiella inundata* (LYIN), Bolander's hawkweed, *Hieracium bolanderi* (HIBO), and Peck's milkvetch, *Astragalus peckii* (ASPE2).

Jepson's monkeyflower is found in dry, open forest or forest openings. Bog clubmoss is located along bogs, on shores of ponds and streams, and in meadows. This species was discovered on the Crescent Ranger District in 1996. It was not previously suspected to occur on the Deschutes National Forest. Bolander's hawkweed is located in mixed conifer and non-forested areas. ASPE2 is found in openings and open lodgepole pine forests.

Other plants on the R6 Sensitive Plant List with potential habitat in the Big Marsh Watershed include: tall agoseris (*Agoseris elata)*, Sierra onion (*Allium campanulatum)*, pumice grape-fern (*Botrychium pumicola)*, green-tinged paintbrush (*Castilleja chlorotica)*, Newberry's gentian (*Gentiana newberryi)*, water lobelia (*Lobelia dortmanna)*, and ground cedar (*Lycopodium complanatum)*. See Appendix C for habitat descriptions of R6 listed plants that are known or suspected to occur on Crescent Ranger District of the Deschutes National Forest.

The historical distribution and abundance of plant species that are currently proposed, endangered, threatened, or sensitive (PETS) is unknown. Historic survey information is not available.

The majority of the Big Marsh Watershed has not been surveyed for PETS plants. Surveys have been completed in project areas that have occurred since 1990. Additional surveys need to be completed to determine the presence, abundance, and distribution of PETS plants within the watershed.

Species Of Concern (Northwest Forest Plan)

The Northwest Forest Plan (NWFP) recognizes that there are a variety of species associated with late-successional forests which play key roles in ecosystem functions. While past attention has focused primarily on late-successional vertebrate species such as the northern spotted owl, the NWFP addresses biodiversity concerns in a wider context. As one part of the consideration of plant and invertebrate animal biodiversity the plan requires "survey and manage" provisions for species of concern be applied as standards and guidelines common to all land allocations (ROD, C-4).

The survey and manage provision provides benefits to fungi, lichens, bryophytes, vascular plants, and other species. At this time very little specific information exists on most species of concern. Most habitat descriptions are based on few records and will be broadened as new sites are discovered. The following discussion is an effort to assess and apply existing information.

Fungi

No surveys for fungi have been performed in the Big Marsh Watershed. Review of the NWFP Appendix J2, which discusses known information on species of concern, lists the following 11 species as occurring within the Deschutes National Forest. Survey and Manage strategies, habitat descriptions, and PAG associations are noted for each species in Appendix C.

Bolete -- *Gastroboletus subalpinus*
Rare bolete -- *Gastroboletus ruber*
False truffle -- *Nivatogastrium nubigenum*
False truffle -- *Rhizopogon truncatus*
Rare false truffle - *Alpova alexsmithii*
Rare false truffle -- *Rhizopogon flavofibrillosus*
Rare false truffle -- *Rhizopogon evadens var. subalpinus*
False truffles - Rare Undescribed Taxa -- *Hydnotryna, Martellia*
Rare truffle -- *Elaphomyces anthracinus*
Rare truffle -- *Elaphomyces subviscidus*
Uncommon gilled mushroom- *Hygrophorus caeruleus*

A review of species ranges and habitat requirements found at least 44 additional species which may have potential habitat in the Big Marsh Watershed. Most of these fungi are mycorrhizal or

ectomychorrhizal species which are found in association with specific host tree species, in this case, with old-growth pine, Douglas-fir, or true firs.

Lichens

Regional lichen surveys were done in 1994, 1995, and 1996 on the Deschutes National Forest. The following Survey and Manage species were found and may have potential habitat in the Big Marsh Watershed:

Rare nitrogen-fixing lichen -- *Pseudocyphellaria rainierensis*
Pin Lichen -- *Calicium* sp.
Riparian Lichen -- *Collema* sp.
Rare Nitrogen-fixing Lichen -- *Lobaria hallii*
Nitrogen-fixing lichens -- *Lobaria pulmonaria, Nephroma helveticum, Nephroma resupinatum, Pseudocyphellaria anomala, Pseudocyphellaria anthrapsis*

Lichen inventories have been done in the Big Marsh Watershed in conjunction with regional air quality monitoring studies. See Appendix C for the lichen species found in the watershed. Review of the NWFP Appendix J2, which discusses known information on species of concern lists one additional lichen species which may have suitable habitat within the watershed.

Aquatic lichen -- *Hydrothyria venosa*

Survey and Manage strategies and habitat descriptions are noted for lichen species in Appendix E.

Bryophytes

No surveys for bryophytes have been performed in the Big Marsh Watershed. NWFP Appendix J2 does not list any known sites in the Big Marsh Watershed or the Deschutes National Forest. The Deschutes National Forest has recorded sites for one J2 bryophyte species on the forest.

Liverwort -- *Tritomaria exsectiformis*

A review of bryophyte species listed on Table C-3 of the ROD identifies other species that may have potential habitat in the Big Marsh Watershed. Most of these species are associated with riparian areas and/or the mixed conifer wet plant association group. These species include:

Liverwort -- *Marsupella emarginata var. aquatica*
Moss -- *Scouleria marginata, Scouleria aquatica*
Moss -- *Thamnobryum neckeroides*

The Aquatic Conservation Strategy in the NWFP is designed to protect and enhance aquatic and riparian dependent species. Streams, seeps, springs, ponds and lakes in the Big Marsh Watershed provide suitable habitat for the listed lichen and bryophyte species.

See Appendix C for habitat descriptions for the species listed above and for a list of other rare bryophytes that may have potential habitat in the Big Marsh Watershed.

Vascular Plants

Surveys for vascular plants have been performed in project areas in the Big Marsh Watershed.

A review of plant lists from surveys conducted for projects identifies one species on the NWFP Appendix J2 list that has been found in the Big Marsh Watershed:

> Sugar stick, candy stick -- *Allotropa virgata* (ALVI) -- This species occurs primarily in closed-canopy pole, mature, and old-growth seral stages in Douglas-fir and true fir in elevations from 250-10,000 feet. ALVI has an obligate mycorrhizal relationship with a fungus and vascular plant for establishment and survival. One of the mycobionts may be matsutake mushroom *Tricholoma magnivelare.* Large woody debris and long rotations are important to the viability of this plant. It occurs on sites that are associated with past fires.

Another plant on the Table C-3 list that may have potential habitat in the Big Marsh Watershed is:

> Mountain lady slipper -- *Cypripedium montanum* (CYMO) -- This species occurs is a broad range of habitats. Specific moisture and temperature regimes may be less critical than the presence of specific symbiotic fungi.

Invertebrates

Mollusks

No surveys of mollusks have been performed in the Big Marsh Watershed. Review of NWFP Appendix J2 does not list any known sites or potential habitat in this watershed. Many mollusk species are rare local endemics and are restricted to small geographic areas. Riparian areas and perennial seeps and springs may be important for localized mollusk populations.

Arthropods

Arthropods are dealt with in the NWFP with general mitigation measures and regional surveys. There is a significant lack of information on the distribution, taxonomy, and habitat dynamics for arthropod species. Additional surveys and research are needed to enable managers to more effectively provide for the needs of species in all these groups within the context of ecosystem management.

Noxious Weeds

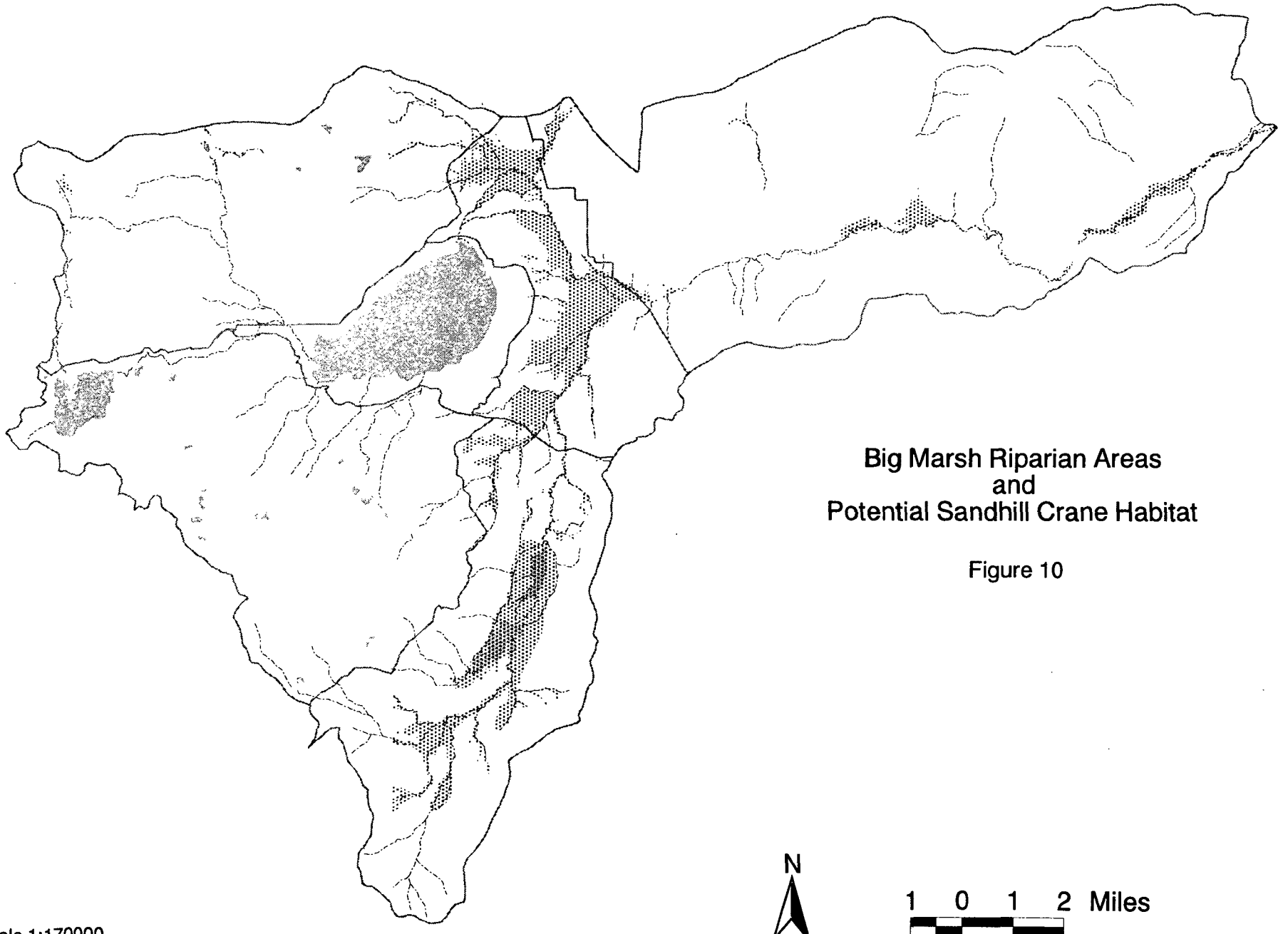
Noxious weeds are of particular concern in the Big Marsh Watershed as they are across the landscape. When small weed infestations are left unchecked, they can grow and spread across the land much like a slow-moving biological wildfire. However, land consumed by wildfire usually recovers. Land consumed by noxious weeds may not.

In portions of the Big Marsh Watershed, such as around Crescent Lake, Crescent Lake Junction, Big Marsh and major travel routes, aggressive, invasive noxious weeds have become established that directly affect native plant species composition, fish and wildlife, soils, water quality and quantity, and recreation. In other areas of the watershed, including the Diamond Peak Wilderness and Oregon Cascades Recreation Area, minimal inventories for noxious weeds have been conducted, so their presence has not been established. However, there is a high probability that noxious weeds are already established in those locations and that further introduction and spread will occur.

See Appendix C for complete list of noxious weeds and their habitats.

RIPARIAN RESOURCES

Riparian/Wetlands/Floodplain vegetation occupies in excess of 1,200 acres, or about 1% of the analysis area in Big Marsh watershed, with significant streamside acreage adjacent to the large amount of streams within the watershed. The various vegetative types associated with these areas include the following: open meadows which are either grasslands or willow/grasslands; intermittent stream channels are comprised of a combination of open meadows and meadows intermixed with conifer; and stream channels are occupied by mixed conifer as the overstory, mountain alder as the shrub component, and freshwater marsh and grasslands as the ground cover. See Figure 10 for a map of the riparian areas.



Big Marsh Riparian Areas
and
Potential Sandhill Crane Habitat

Figure 10

N

1 0 1 2 Miles

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3/13/97

WILDLIFE

There are 289 species of wildlife that are known or suspected to utilize habitat within the Big Marsh Watershed at some point throughout the year. The species may utilize the watershed for breeding, foraging, and/or resting habitat. Riparian areas are used by 182 of those species. See the wildlife species list in Appendix C.

Species habitats include foraging, reproduction, roosting, perching, and any other habitat utilized by a species through its life cycle. Not only does habitat quantity and quality affect species, but disturbance both human-caused and natural may also influence the ability to forage, reproduce, or disperse. Past logging, suppression of wildfire, and increased human disturbance have lowered the quality of habitat for many species.

Table 2-2 is a chart of the Proposed, Endangered, Threatened, or Sensitive (PETS) wildlife species and other selected species known or suspected to occur within Big Marsh Watershed.

Table 2 - 2, PETS or Selected Wildlife Species

Species	Status*
Peregrine Falcon	E
Bald Eagle	T
Northern Spotted Owl	T
Western Snowy Plover	T
Fisher	C2
Preble's Shrew	C2
Wolverine	C2
Northern Goshawk	C2
Long-billed Curlew	C3
Marten	SS
American White Pelican	SS
Black-backed Woodpecker	SS
Flammulated Owl	SS
Great Gray Owl	SS
Greater Sandhill Crane	SS
Pileated Woodpecker	SS
White-headed Woodpecker	SS

* E - Federally Endangered; T - Federally Threatened; C2 - Federal Candidate, Category 2; C3 - Federal Candidate, Category 3; SS - State of Oregon Sensitive

Note: In 1996 the Fish and Wildlife Service changed the designation of federally listed species in the Candidate range. Those listed as Category 2 and 3 are no longer on the list as these categories were eliminated from listing process. It is kept here for information and tracking of selected species.

Historic condition information for the species listed above that are not currently known to exist in the Big Marsh Watershed but do have suitable habitat can be found in Appendix B. In addition, Appendix B contains habitat requirements and descriptions of the following species.

Bald Eagle -- Historic Condition

Bald eagles historically nested and foraged on Crescent Lake where they fed on bull trout, rainbow trout, whitefish, and waterfowl. Bald eagles most likely wintered in the dense, unfragmented stands adjacent to Crescent Lake. Between 1971 and 1991 an average of 0.7

nestlings were produced per year at the southeast nest site (Isaacs and Anthony 1991).

Current Condition

The watershed currently provides nesting habitat for one known pair of bald eagles and suitable nesting habitat for an additional pair in the Bald Eagle Management Area on the north side of Crescent Lake. See Figure 11 for the location of the Bald Eagle Management Areas and other suitable nesting habitat. Suitable large diameter trees for eagle nesting and roosting in close proximity to the lake are not abundant. Good thermal cover exists within the BEMAs at Crescent Lake and provides winter roosting habitat for eagles.

Crescent Lake provides foraging opportunities. Fluctuating water levels at Crescent Lake have impacted the lakeside riparian habitat, resulting in changes in the fishery and waterfowl populations. Eagles have had to modify their diet or move to other locations based on these changes. Recreation uses also occur around the majority of the lakeshore, and cause disturbance to eagles. The cumulative effects of modified prey resources and increased human use have reduced habitat effectiveness for this species near Crescent Lake.

Northern Spotted Owl -- Historic Condition

The historic range of the northern spotted owl was probably much as it is today. Fire would have played its natural role and many stands would not have been as dense or multi-structured as they are today. More frequent wildfires would have created a diversity of structural stages across the landscape. Openings would have been created by natural disturbances (fire, wind, and insects), but would have left biological legacies of the previous stand, which provide biodiversity. The fragmentation of the landscape that occurs in a patchwork pattern today as a result of timber harvesting would not have occurred. Historic density levels for the spotted owl are not known.

Current Condition -- Location Within Range:

Big Marsh Watershed is located along the eastern edge of the northern spotted owl range. Spotted owl pairs are generally located within the mature/old growth mixed conifer PAGs associated with the buttes or high elevation mountains. There are five pairs of owls within the watershed (four of the pairs are located in Late Successional Reserves and one pair is located in the wilderness). The Crescent District has a total of nine pairs of owls with one resident male that has not successfully bred. On the Willamette National Forest the closest known spotted owl pair is 2 1/4 miles northwest of Willamette Pass and a single response occurred 1 1/2 miles west of the Pass. Other documented pairs occur west of Waldo Lake.

Relative Population/Habitat Within Range:

Eastside owl populations and Big Marsh Watershed densities are low in comparison with population densities in the remainder of the owl range. The eastside population is at the fringe of the owl range and the birds have adapted to different habitat types than westside owls.

Eastside owls may provide genetic diversity that will enhance overall species adaptability.

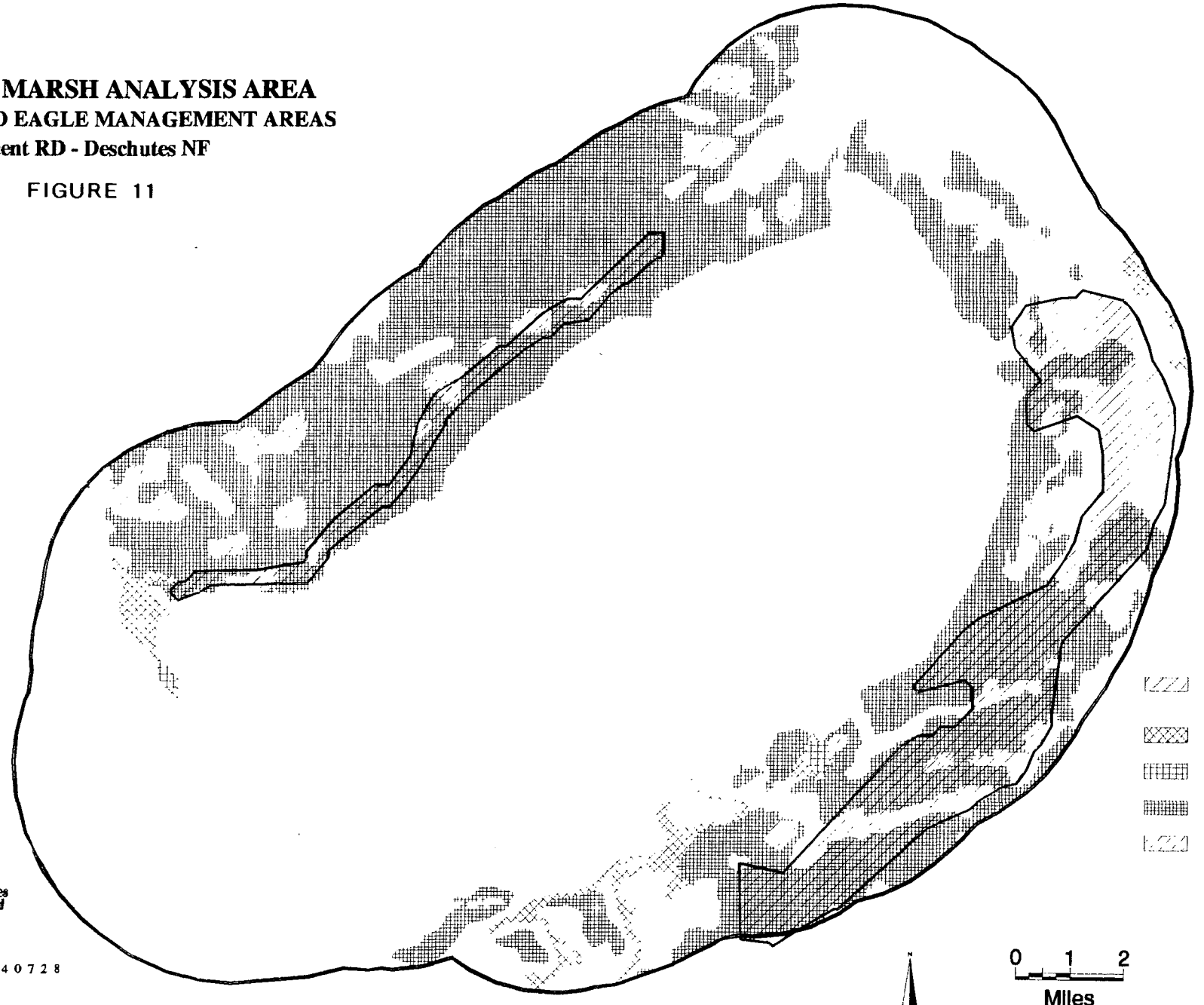
Owls on the east side of the Cascades have adapted to areas containing a slightly different stand structure, vegetative species composition, and prey base than spotted owls of the west side of the Cascades. Spotted owls may utilize lodgepole pine stands as dispersal and foraging habitat given the availability, abundance, and proximity of this habitat type.

There are two Late Successional Reserves within the watershed that were designated to provide habitat for the spotted owl; Crescent Lake and Upper Big Marsh LSRs. Upper Big Marsh has

had minimal impacts from humans with the exception of the suppression of wildfires. Human disturbance has occurred within the Crescent Lake LSR as a result of the 73 summer homes that are located along a portion of the north shore of the lake. See Figure 12 for a map of nesting, roosting, foraging and dispersal habitat for the spotted owl.

BIG MARSH ANALYSIS AREA
BALD EAGLE MANAGEMENT AREAS
Crescent RD - Deschutes NF

FIGURE 11



Deschutes National Forest

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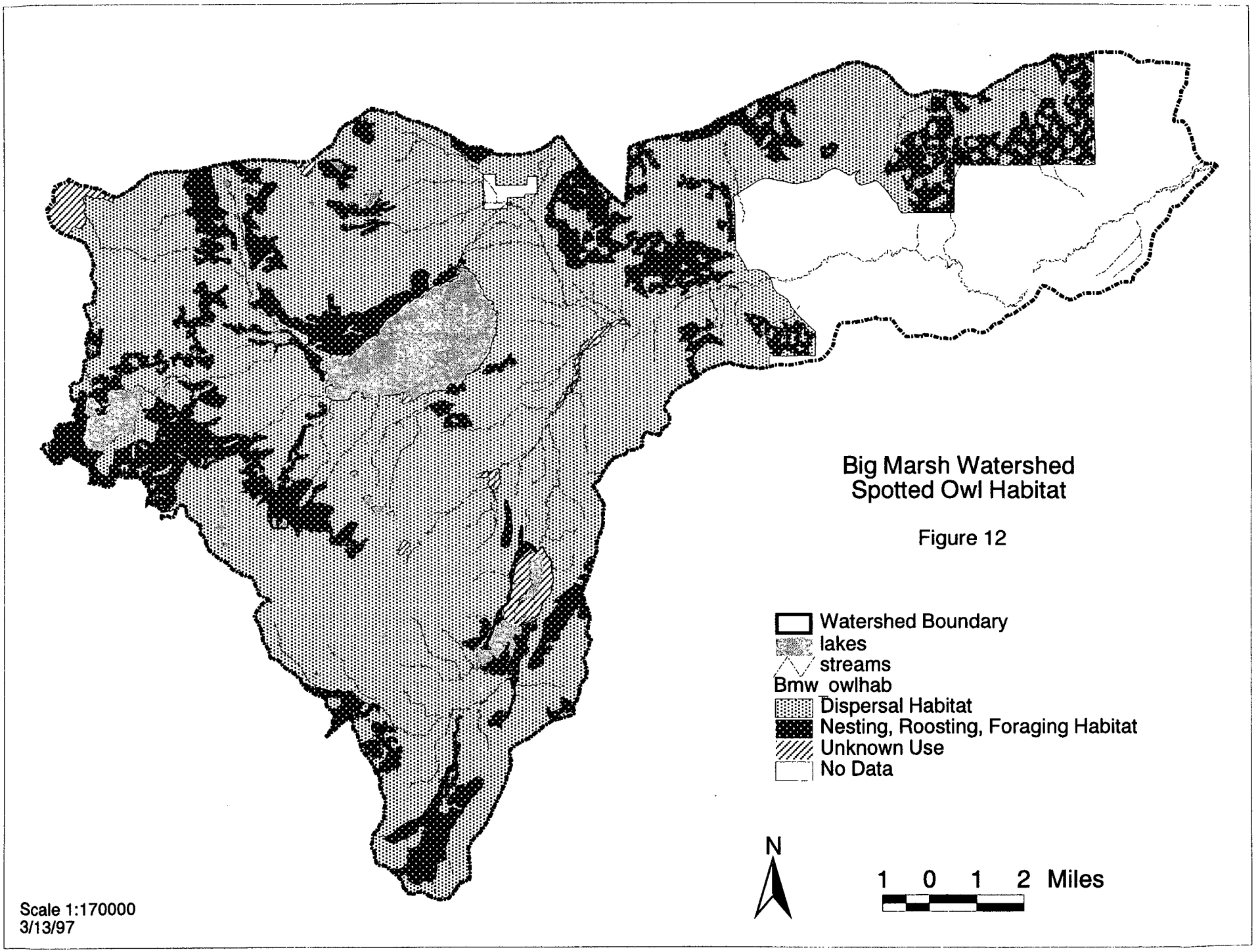
Source - Deschutes NF files


Big Marsh Watershed
Spotted Owl Habitat
Figure 12
Watershed Boundary
lakes
streams
Bmw_owlhab
Dispersal Habitat
Nesting, Roosting, Foraging Habitat
Unknown Use
No Data
N
1 0 1 2 Miles
Scale 1:170000
3/13/97

Past timber harvest activities have reduced and fragmented suitable spotted owl habitat within the watershed except within OCRA, wilderness, and portions of some of the LSRs. Timber harvesting and fragmentation within the mixed conifer plant association groups have resulted in a reduction in the amount of suitable habitat for the spotted owl.

In the ponderosa pine and mixed conifer dry PAGs, historic harvest of ponderosa pine stands and fire suppression activities have resulted in the growth of a dense understory of white fir. These activities have created better quality spotted owl habitat in the ponderosa pine and mixed conifer dry plant association groups. This habitat, however, is generally not stable over time.

Northern Goshawk -- Historic Condition

Historically, suitable habitat for the goshawk would have been located in the mixed conifer, ponderosa, and lodgepole pine stands that had denser canopy covers (Reynolds et al. 1982). Stands of a variety of size structures would have been used. Historically, the distribution of the habitat would have been in more contiguous blocks than currently exists. Suitable goshawk habitat has been fragmented by areas of past timber harvesting which have a more open canopy cover. The exclusion of fire has resulted in an increase in the number of stands that have a dense understory and are multi-structured.

Current Condition

Goshawk habitat has been fragmented by past timber harvest activities and firewood collection. The majority of the mixed conifer, ponderosa, and lodgepole pine stands within the watershed provide foraging habitat for the goshawk. The exceptions are primarily in areas where clearcuts occurred and the canopy cover is too low or where stands have sustained a large amount of insect and disease damage and the overstory is sparse. Nesting habitat is located in areas having the densest canopy cover and larger diameter trees on average (DeStefano and Meslow 1992, Reynolds et al. 1982, Moore and Henny 1983). See Figure 13 for a map of suitable nesting, post-fledgling, and foraging habitat.

Some of the lodgepole pine stands within the watershed (especially those north of Big Marsh and east of Crescent Lake) are dying due to the age of the stands and/or insect outbreaks. As these stands begin to fall apart in the next 5-15 years and the canopy cover falls below 40%, these acres will change from providing nesting and post-fledgling habitat to foraging habitat. These acres will cycle back into nesting habitat within 40-50 years. During the cycling period, goshawks may relocate to adjacent suitable mixed conifer or lightly infected lodgepole pine stands.

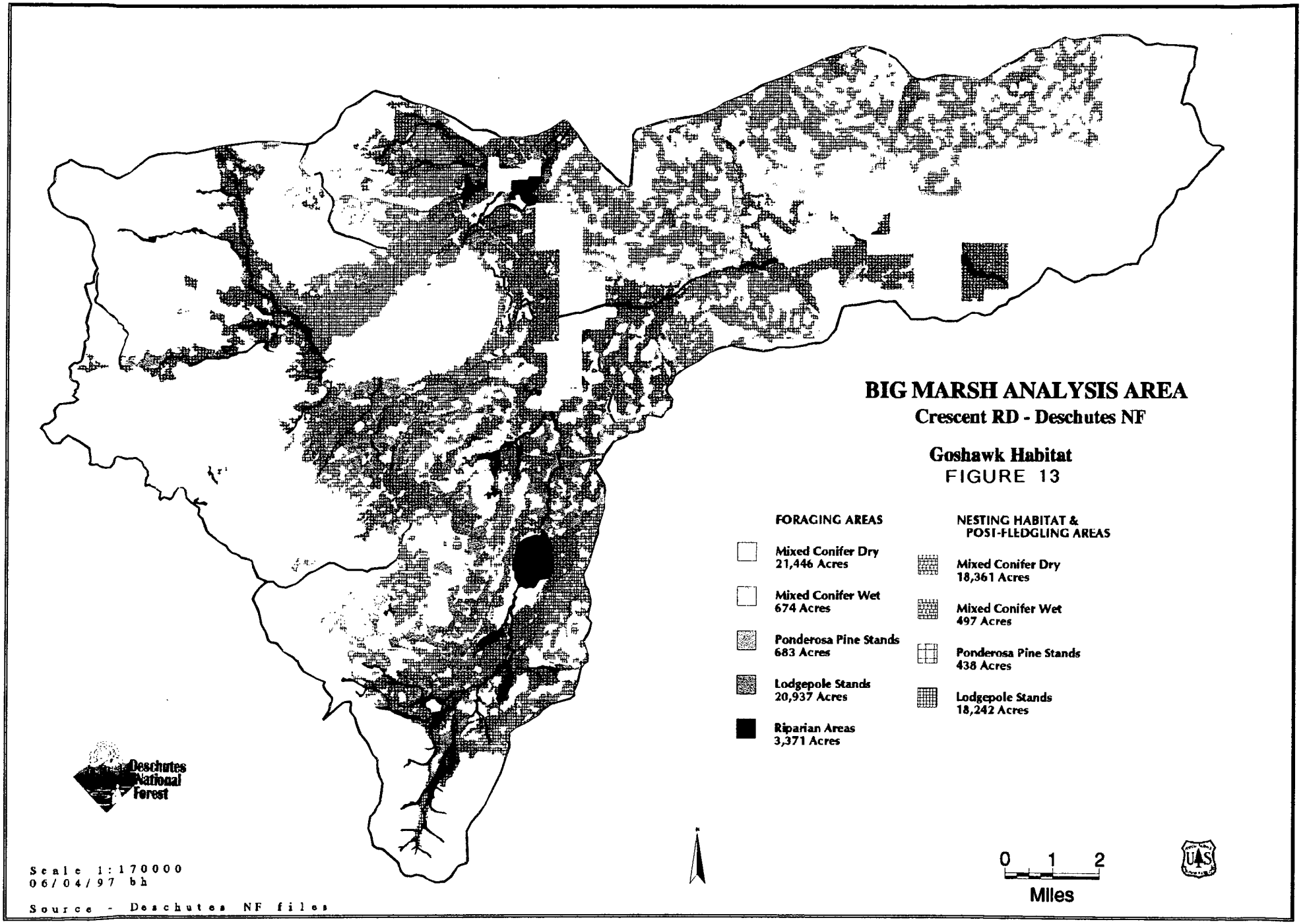
Wolverine, Fisher and Marten -- Historic Condition

The geographic distribution of marten, fisher, and wolverine in Oregon has been dramatically reduced over the past 40-50 years and is most likely attributable to the loss of late successional forest habitat (Carey 1997, Buskirk and Ruggiero 1994). Within the watershed historic wolverine habitat was likely similar to current conditions, since few management activities have occurred in the high elevations of this watershed. Marten and fisher habitat would have been located throughout the mixed conifer, lodgepole, and mountain hemlock plant associations. Within the past few decades the mixed conifer and lodgepole pine stands have been fragmented by timber harvest activities which reduce the canopy cover, the amount of down woody debris and the suitability of the habitat for marten and fisher.

Current Condition

Little information is available on the occurrence and distribution of wolverine and fisher within the

watershed and within Central Oregon. Within the watershed a fisher sighting was recorded in 1996 and two wolverines were documented, one in 1995 and one in 1994 (Crescent District Records). Numerous marten have been observed throughout the watershed. Recent track plate


BIG MARSH ANALYSIS AREA
Crescent RD - Deschutes NF
Goshawk Habitat
FIGURE 13
FORAGING AREAS
Mixed Conifer Dry
21,446 Acres
Mixed Conifer Wet
674 Acres
Ponderosa Pine Stands
683 Acres
Lodgepole Stands
20,937 Acres
Riparian Areas
3,371 Acres
NESTING HABITAT & POST-FLEDGLING AREAS
Mixed Conifer Dry
18,361 Acres
Mixed Conifer Wet
497 Acres
Ponderosa Pine Stands
438 Acres
Lodgepole Stands
18,242 Acres
Deschutes National Forest
0 1 2
Miles
Scale 1:170000
06/04/97 bh
Source - Deschutes NF files

counts, snow tracking and bait stations have identified riparian areas and areas with high densities of down woody material as being important to marten.

The preferred habitats of the wolverine and fisher are located at higher elevations and contain a dense, continuous canopy cover. Both species prefer remote areas that lack human disturbance. Wolverine and fisher corridors likely occur (north to south) through the wilderness and OCRA along areas of high elevation to Willamette Pass. These corridors are relatively stable and
healthy and are minimally impacted by humans.

Fisher travel corridors occur along the mixed conifer belt, with riparian habitats providing significant travel areas. Private land development has probably caused fragmentation of connective habitat for fisher. The last documented sighting within the watershed occurred in 1986. Sightings to the south on the Chemult Ranger District and Crater Lake National Park show that fisher are still in the area.

Habitat for marten, and to some extent fisher, has been heavily fragmented in the Big Marsh Watershed due to timber harvesting in areas outside the Wilderness and OCRA. Clearcuts, decreasing amounts of mature timber, and removal of dead and down trees for firewood have detrimentally impacted the suitability of the habitat for these two species.

Marten use a variety of travel corridors, since the animal can use various plant association groups (lodgepole pine, ponderosa pine, mixed conifer, mountain hemlock, and riparian areas). Travel corridors are not likely a limiting factor for this species. See Figure 14 for the location of suitable marten habitat within the watershed.

Black-backed Woodpecker -- Historic Condition

Historic habitat for the black-backed woodpecker would have been located throughout the lodgepole pine and mixed conifer plant associations. Both plant associations would have cycled into and out of suitable black-backed habitat, although mixed conifer would have provided suitable habitat for a larger portion of its life cycle. Stands with extremely low canopy covers, i.e. less than 11%, and/or those that are smaller than 5 inches in diameter, would not have functioned as either nesting or foraging habitat (Goggins 1988, Goggins 1989). Large-scale fires or insect and disease epidemics would have created short-term habitat for the species over a large portion of the landscape, but would have converted it to an earlier seral stage which would not function as habitat for a period of time.

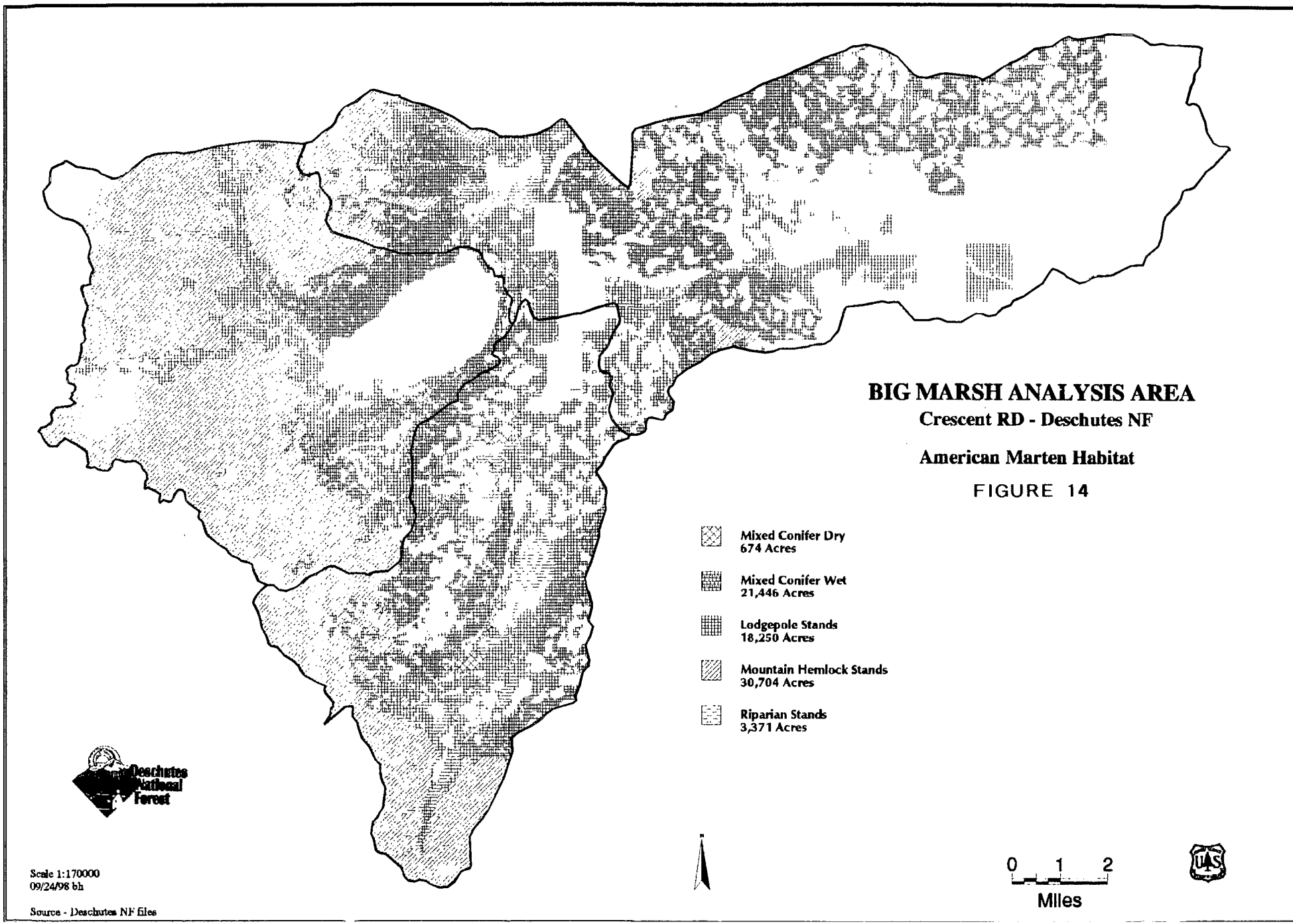
Clearcutting and the harvesting of mountain pine beetle killed lodgepole pine in the past several decades made portions of the landscape unsuitable as habitat for the black-backed woodpecker. This was due to the low canopy cover and/or the early vegetative structural stages that resulted from these activities.

Current Condition

Approximately 47,000 acres of suitable nesting or foraging habitat for the black-backed woodpecker is present within the watershed today in the lodgepole pine and mixed conifer plant associations. Some of this habitat is experiencing mortality and blowdown especially in the lodgepole areas north of Big Marsh and east of Crescent Lake. If the canopy cover in these areas falls below approximately 11% as a result of natural mortality or timber harvesting, they will no longer function as habitat in the short-term. As these stands regenerate and become pole-sized or larger, they will again provide habitat for the black-backed woodpecker.

Within the mixed conifer plant associations habitat for the black-backed woodpecker is

fragmented by the clearcuts that occurred primarily on the buttes. Black-backs prefer large blocks of suitable habitat of approximately 1000 acres in size (Goggins 1989). Numerous sighting of black-backed woodpeckers have been recorded throughout the watershed (Crescent


BIG MARSH ANALYSIS AREA
Crescent RD - Deschutes NF
American Marten Habitat
FIGURE 14
Mixed Conifer Dry
674 Acres
Mixed Conifer Wet
21,446 Acres
Lodgepole Stands
18,250 Acres
Mountain Hemlock Stands
30,704 Acres
Riparian Stands
3,371 Acres
Deschutes National Forest
Scale 1:170000
09/24/98 bh
Source - Deschutes NF files
0 1 2
Miles

Records). See Figure 15 for a map of potential black-backed woodpecker habitat.

Flammulated Owl -- Historic Condition

Historically, the amount of habitat available for the flammulated owl was greater than that which is present currently. The flammulated owl utilizes open-canopied mature ponderosa pine and mixed conifer dry habitat. The birds were known to exist within the watershed, but historic population density information is not known.

Current Condition

The lack of low intensity fires due to aggressive fire suppression has reduced most of the suitable habitat for the flammulated owl within the ponderosa pine and mixed conifer PAGs and has caused the development of a more closed canopy in the ponderosa pine stands. There is no documentation of flammulated owls occurring within the watershed, but it is strongly suspected that they are present, especially around Crescent Lake.

Great Gray Owl -- Historic Condition

Habitat historically existed within the Big Marsh Watershed for the great gray owl around riparian areas, meadows, and lodgepole wet stands, but population density information is unavailable.

Current Condition

Two recent sightings of great gray owls have occurred within the watershed (1995 and 1997, Crescent District Records) and one immediately adjacent to the watershed (1997, Crescent District Records). The potential for additional birds to be present within the watershed is high, since suitable nesting and foraging habitat is located in and around Big Marsh and along Big Marsh, Whitefish, and Crescent Creeks. The amount and distribution of suitable habitat is very similar to historic habitat. See Figure 16 for the location of suitable great gray owl nesting and foraging habitat.

Greater Sandhill Crane -- Historic Condition

Sandhill cranes utilized wet meadows and shallow marshes and wetlands; Big Marsh would have provided optimal habitat. Historic population levels within the watershed are unknown.

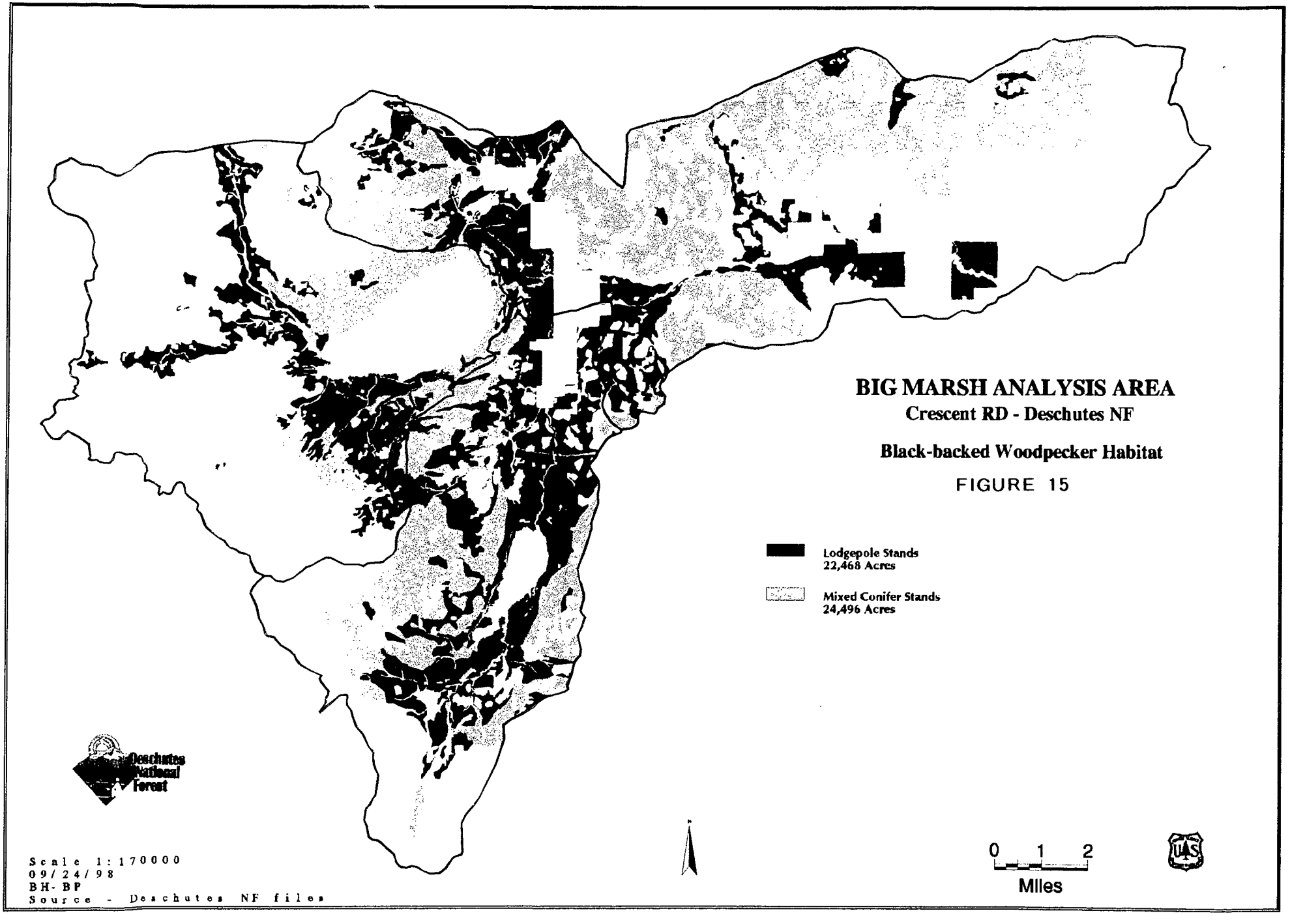
Current Condition

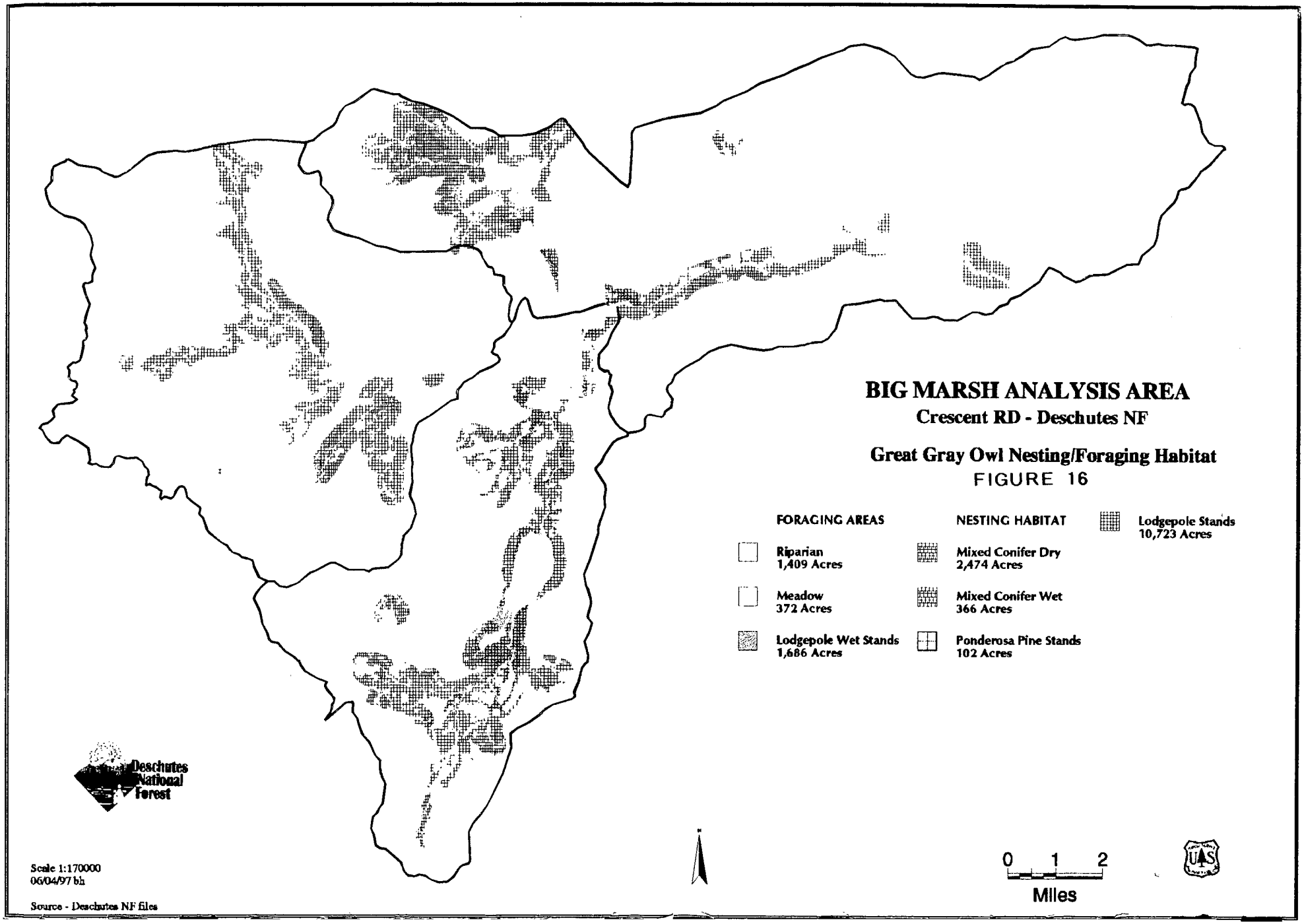
Big Marsh provides optimal nesting and foraging habitat. During the spring and summer sandhill cranes can be heard and/or observed at Big Marsh. Two confirmed nests were located at the marsh in 1996 and 1997, however, six or more nesting pairs most likely utilize the area based on the amount of adult and juvenile activity observed at Big Marsh (Crescent District Records and Observations). Additional areas used by sandhills are the riparian areas along Big Marsh Creek. One additional nesting pair is located on Big Marsh Creek approximately one-half mile upstream from the confluence with Crescent Creek.

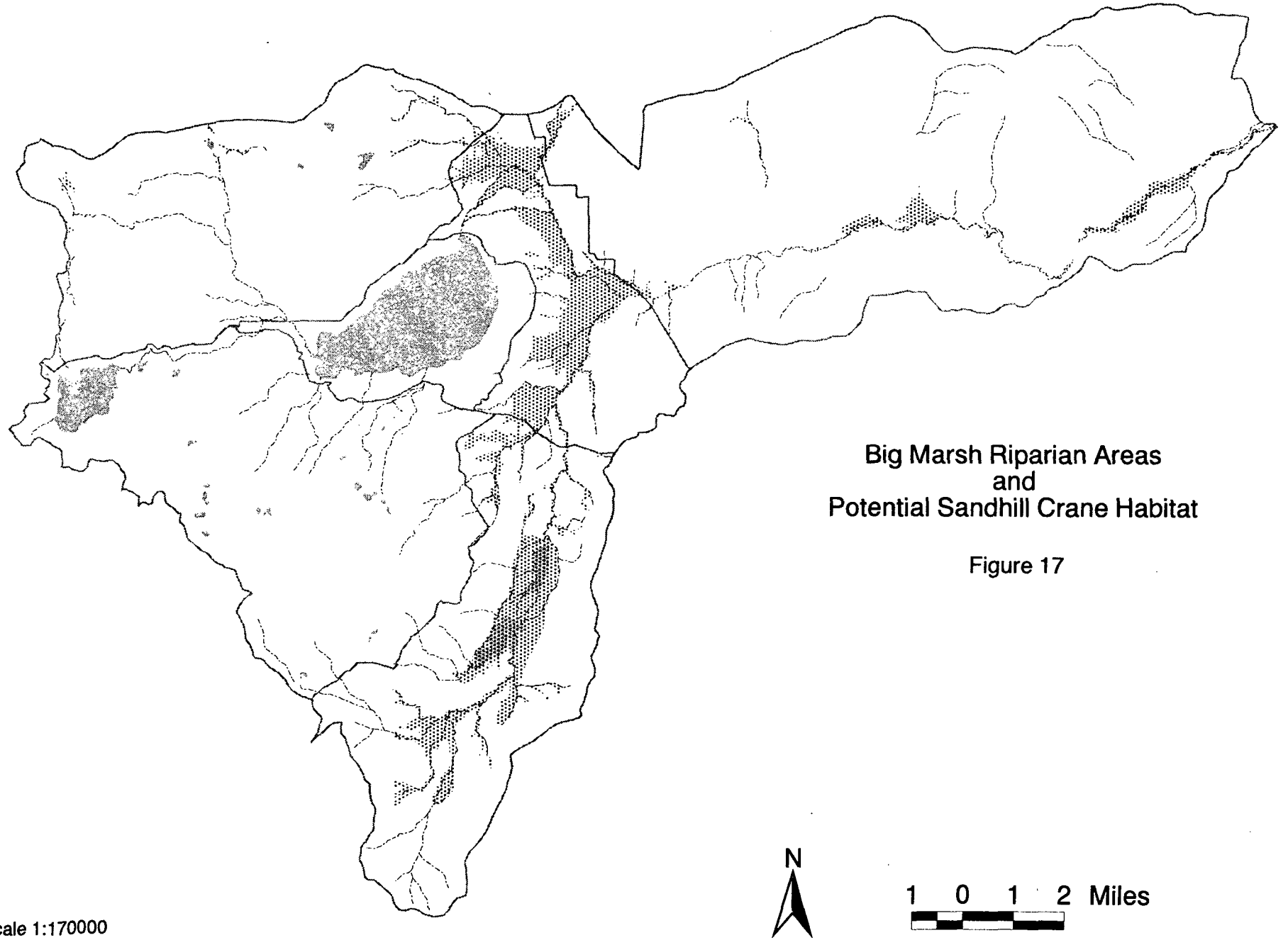
Sandhill crane nests and young are susceptible to coyote, raven, raccoon, and skunk predation as well as to predation by uncontrolled domestic dogs. Sandhill cranes are also susceptible to disturbance from humans and land development. See Figure 10 for the location of riparian areas with potential habitat for sandhill cranes.

Pileated Woodpecker -- Historic Condition

Pileated woodpeckers utilize old growth and mature stands within the mixed conifer plant associations. The preferred foraging substrates include large diameter trees and dead and down


BIG MARSH ANALYSIS AREA
Crescent RD - Deschutes NF
Black-backed Woodpecker Habitat
FIGURE 15
Lodgepole Stands
22,468 Acres
Mixed Conifer Stands
24,496 Acres
Deschutes National Forest
0 1 2
Miles
Scale 1:170000
09/24/98
BH-BP
Source - Deschutes NF files


BIG MARSH ANALYSIS AREA
Crescent RD - Deschutes NF
Great Gray Owl Nesting/Foraging Habitat
FIGURE 16
FORAGING AREAS
Riparian
1,409 Acres
Meadow
372 Acres
Lodgepole Wet Stands
1,686 Acres
NESTING HABITAT
Mixed Conifer Dry
2,474 Acres
Mixed Conifer Wet
366 Acres
Ponderosa Pine Stands
102 Acres
Lodgepole Stands
10,723 Acres
Deschutes National Forest
Scale 1:170000
06/04/97 bh
Source - Deschutes NF files
0 1 2
Miles



Big Marsh Riparian Areas
and
Potential Sandhill Crane Habitat

Figure 17

N

1 0 1 2 Miles

Scale 1:170000
3/13/97

material. The historic abundance and distribution of mature and old growth mixed conifer was greater and more widespread than the current condition. Timber harvest activities and personal and commercial firewood collection over the past several decades resulted in reductions in large diameter trees and downed woody debris and caused fragmentation of the habitat. Historic pileated woodpecker population density information is not available.

Current Condition

Pileated woodpeckers are known to occur within the watershed. Currently, habitat is limited to the mid-elevational mature and old growth mixed conifer forests which have not been fragmented by
harvest activities and the sparse distribution of large diameter white fir within the watershed.

The area in and around Big Marsh contains the best habitat for pileated woodpeckers. Several documented sightings have been recorded within the watershed. A potential nesting pair may be located in the vicinity of the trailhead on the east side of Big Marsh, as adults have been observed in the area for the past several years. No nest search was conducted.

White-headed Woodpecker -- Historic Condition

White-headed woodpeckers utilize open-canopied ponderosa pine and mixed conifer stands. ODFW documented provincial declines following the selective harvesting of ponderosa pine would indicate historical potential populations were greater than currently exist.

Current Condition

There are a few documented white-headed woodpecker observations within the watershed. Habitat does exist around the Crescent Lake area throughout the ponderosa pine and mixed conifer dry PAGs and along Crescent Creek on the buttes.

Loss of many of the large ponderosa pines may have reduced existing populations. Another factor within the mixed conifer dry and ponderosa pine PAGs is that active fire suppression has occurred since the early 1900s, which has reduced the number and size of low intensity fires. Within the mixed conifer dry PAG, this has resulted in the development of an understory of white fir. Ponderosa pine and Douglas-fir are still the primary large tree component but not the dominant stand component. There is a risk of losing additional ponderosa pine habitat due to direct competition with white fir and high habitat susceptibility for stand replacement fires.

Yellow Rail -- Historic Condition

Yellow rails utilized shallow freshwater marshes and wet meadows (with less than 7 cm of water) for nesting in the western United States (Terres 1991). Optimal habitat was probably available to yellow rails at Big Marsh prior to sheep and cattle grazing, which began in the late 1800s. Since then, the marsh was continually grazed until 1984. The marsh was drained from the 1940s until 1989 when a diversion was built to send the majority of water back into the main creek channel. Breeding bird surveys conducted between 1987 to 1994 did not locate yellow rails at the marsh (Crescent District Records).

Current Condition

There are few nesting yellow rail populations known to occur in the western United States. In Oregon, breeding sites include Klamath Lake Marsh, Klamath Basin, Sycan Marsh, and Big Marsh. Breeding bird surveys at Big Marsh identified one male yellow rail in 1996 and four in 1997 (Crescent District Records).

Aquatic Species

Long-toed salamander (*Ambystoma macrodactylum*)
Northwestern salamander (*Ambystoma gracile*)
Rough-skinned newt (*Taricha granulosa*)
Pacific tree frog (*Pseudacris regilla*)
Tailed frog (*Ascaphus truei*)
Western toad (*Bufo boreas*)
Cascades frog (*Rana cascadae*)
Spotted frog (*Rana pretiosa*)

Historic Condition

No historic documentation of aquatic populations has been identified, however, human impacts have likely reduced the distribution and survival of amphibians in some locations within the watershed. Given the recent introduction of non-native fish and loss of riparian habitats in localized disturbance areas, it is likely that the Cascades and spotted frogs were more widely distributed throughout the watershed.

Current Condition

The species listed above have all been documented within the Big Marsh Watershed, with the exception of the northwestern salamander and tailed frog. There is potential habitat for both of those species, but their presence is unconfirmed (Crescent District Records). Big Marsh itself contains a large population of spotted frogs and is the largest area of suitable habitat in which an extant population has been found (Hayes 1995).

A factor that most likely influenced amphibian populations is the introduction and continued stocking of fish in many of the lakes that historically did not contain a fishery. Non-native fish are competing for food and cover, as well as directly preying upon endemic amphibians. A local survey documented that a stocked trout had consumed ten long-toed salamanders. Roland Knapp, a University of California Research Biologist, has documented dramatic declines in amphibian and endemic fauna in historically fishless lakes that had been stocked.

Declines in endemic population levels and distribution of amphibians have occurred where continued non-native fish stocking occurs and where extensive recreational use and cattle grazing have adversely affected riparian habitats. These factors may pose migration barriers within and between watersheds.

Increased recreational use and development along lakes and streams may degrade riparian habitats that are critical to amphibian populations, predominately around Crescent Lake and on private land portions of Crescent and Big Marsh Creeks. It is expected that recreational pressure will continue to center around aquatic areas and degrade adjacent riparian habitats, thus reducing amphibian habitats and dispersal capabilities. Along with increased recreational use, comes the increased risk of contamination spills, recreational dumping, bank erosion, and removal of riparian vegetation.

Big Game -- Historic Condition

Elk were historically present and have been documented in the Big Marsh area for the past 40 years (Crescent District Records). Deer and elk populations within the watershed have increased over time as a result of past timber harvest activities which created forage (harvest units) in close proximity to cover. In addition, there has been an increase in the amount of effective deer and elk cover where fire suppression has resulted in dense understories of white

fir. Stands infected with insects or those that experienced blowdown and have an abundance of downed logs have provided additional security habitat.

Current Condition

Accurate population densities for deer and elk are not known, however, both species are commonly observed and abundant sign of their presence can be found. Reports of observations of 60 or more elk at Big Marsh have been recorded (Crescent District Records).

A Key Elk Area is located to the east of Big Marsh. This area provides high quality fawning and calving habitat. Increased human use of riparian areas has displaced some animals from historic calving and/or fawning areas. Traffic on Highway 58 results in motor vehicle collisions with deer and elk. Future land management activities with an emphasis on restoring and conserving late-successional forests in the watershed will most likely reduce the amount of forage for deer and elk to quantities more consistent with historic levels (within 20 years).

FISH

Cascade Mountain Lakes

There are numerous high elevation lakes located along the western third of the watershed within Diamond Peak Wilderness and OCRA. These lakes are generally small in size and are naturally fishless. The Oregon Department of Fish and Wildlife (ODFW) began stocking some of the Cascade Mountain Lakes as early as 1912 using packhorses. Currently, the lakes are stocked annually or biennially using a helicopter (ODFW 1996). ODFW stocks brook trout, coastal rainbow trout, and cutthroat trout in the lakes.

The Cascade Mountain Lakes have a low natural productivity (oligotrophic), due to the low nutrient input and the short growing season. As a result, little natural reproduction is occurring among the stocked fisheries. Many of the Cascade Mountain Lakes also lack spawning areas, which also contributes to the lack of natural reproduction. In addition, winter kill affects the production of some lakes (ODFW 1996).

Currently, no waters within the Big Marsh Watershed support populations of bull trout or any anadromous fish populations. The current status of introduced non-native species and existing dams prevents consideration of re-introduction of these species into the watershed.

Summit Lake

Summit Lake, like the Cascade Mountain Lakes, was naturally fishless. The earliest record of fish stocking occurred in 1905 when lake trout were stocked. This is the only record of lake trout stocking in Summit Lake (ODFW 1996). Lake trout have persisted through natural reproduction.

Other species that are currently present include rainbow and brook trout. Kokanee and cutthroat trout have also been stocked, but did not do well. There is low survival among all species of stocked fish due to low nutrient input, lack of spawning areas, and predation by lake trout.

Inflow into Summit Lake is from snow melt, precipitation, and subsurface seepage, there are no perennial streams that feed the lake (Johnson et al. 1985). As a result, there is low nutrient input and low natural productivity within the lake, (ultraoligotrophic).

Even though Summit Lake is a popular fishing site, access is limited to a few months of the year due to the elevation and the lake's northern aspect.

Whitefish Creek

The flow of Whitefish Creek is highly variable, the spring flow may be five times higher than the fall flow (0.5 cfs or lower) (ODFW 1996). Sections of the creek may become subsurface during drier times of the year. The section of the creek immediately upstream of the confluence with Crescent Lake is deficient in large woody debris, thermal vegetation cover, and deep pools; has unstable banks, and is deeply incised. This same section of the creek often becomes subsurface before meeting the lake, and as a result, does not provide spawning habitat. Spawning success may also be limited by sandy substrates and embeddedness in all reaches of the stream, in part, due to eroding banks.

Brook trout and sculpins are the only fish that use Whitefish Creek more than 0.1 miles above Road 60 (USFS Records). Brook, rainbow and brown trout, sculpin, and kokanee use the stream reach below Road 60 when it has a surface flow. The intermittent flows in the upper reaches of the creek are most likely responsible for its lack of fish. In addition, falls in the upper section may limit upstream access for fish, even during high flows.

Crescent Lake

Whitefish Creek is the primary inflow tributary to Crescent Lake. The lake has low productivity (oligotrophic) and very little growth of aquatic vegetation due to the lack of shoal area, lack of suitable substrate and the annual drawdown. The outlet structure on Crescent Lake Dam is screened to prevent fish from passing down into Crescent Creek and there are no provisions for upstream passage over the dam.

Fish species indigenous to Crescent Lake included: bull trout, redband rainbow trout and mountain whitefish. Bull trout have been extirpated. The fish species that are present today are: rainbow, brown, and lake trout; mountain whitefish; kokanee; Tui chub; and reticulate sculpin.

The first fish stocking in Crescent Lake occurred in 1915 when brook trout were released. Brook trout were stocked until 1939. Lake trout were first released in 1917 and then restocked again in 1957. Brown and rainbow trout and kokanee are stocked today (ODFW 1996).

Kokanee reproduce naturally in Crescent Lake, however, natural recruitment is limited by a shortage of spawning areas. Kokanee spawn in Whitefish Creek and in the areas that have springs, but during drought or low water years, these areas are inaccessible to the kokanee. The lake trout fishery has been naturally sustained since 1917. Redband trout were indigenous to Crescent Lake, where they spawned in the spring-fed streams and outlet of Crescent Creek. Due to genetic mixing of many rainbow trout introductions, it is unlikely that genetically distinct redband trout remain. Historic spawning areas have been inundated or blocked off by the dam.

A disease called *Ceratomyxa shasta* is present in Crescent Lake and affects rainbow and brook trout. Some strains of rainbow trout resistant to this disease have been released in the lake. Some natural rainbow and brown trout production occurs within the lake, however, it is limited by a lack of spawning areas.

Bull trout were indigenous to Crescent Lake but have been extirpated due to habitat modifications. The last record of bull trout in Crescent Lake was in 1979. Bull trout need stream environments with stable, cold flows in the fall and winter for spawning and rearing. That habitat was provided by the spring fed streams in the vicinity of Spring Camp. Those spring areas were inundated with the construction of the dam, and currently, suitable habitat to support the bull

trout does not exist in Crescent Lake (ODFW 1996).

Mountain whitefish are indigenous to the lake. Their population numbers have remained fairly stable, and they currently comprise a large portion of the lake's total fish population.

Crescent Creek

Cover is a limiting factor along Crescent Creek, especially within areas where grazing occurs. Reduction in cover along the streambanks leads to increased bank erosion and, as a result, causes embeddedness of the gravels. Portions of the creek have good cover provided by willows and sedges. The vegetation in these locations stabilizes the bank and provides shade and cover for fish.

Indigenous populations of redband rainbow trout are being replaced by introduced brown and brook trout, due to habitat changes that favor the introduced species (i.e. open, meandering, sections of the stream that have less thermal cover and are warmer in temperature). Brown trout are also more aggressive and longer lived than rainbow trout. Rainbow trout is still the most abundant species in Crescent Creek.

Big Marsh Creek

Instream cover is the greatest limiting factor in Big Marsh Creek. Large woody debris is absent from many sections of the creek. In addition, the overhead canopy of thermal cover trees is missing along a large portion of the creek and most likely is a result of historic grazing. Deteriorated streambanks and poor bank stability are also present in areas where grazing occurred.

In 1989 a diversion structure was installed in the east ditch of Big Marsh to incrementally redirect water from the ditches back to Big Marsh Creek. Approximately 50% of the water is currently redirected into Big Marsh Creek.

Thermograph data from Big Marsh shows that the water temperature rises as much as 14° Fahrenheit within the marsh. Average daily high temperatures were 47.2°F upstream and 61.2°F downstream of the marsh (ODFW 1996). These temperature rises are likely a result of the lack of cover and cut banks in Big Marsh Creek and the ditches.

Fish species present in Big Marsh Creek include brown and brook trout, mountain whitefish, Tui chub, and sculpins. Rainbow trout are notably absent from sections of Big Marsh Creek, due to habitat conditions and competition with other introduced fish. Bull trout were once likely inhabitants of the creek but are no longer present. With the exception of some headwater and tributary streams, current habitat conditions do not favor their reintroduction.

SOCIAL DOMAIN
CULTURAL RESOURCES

Prehistory and History

The prehistoric occupation of the Big Marsh Watershed pre-dates the eruption of Mount Mazama (roughly 7,600 years ago) as evidenced by a single site where cultural material has been found below the deep pumice. In addition, other archaeological sites post-date the Mazama eruption. Most sites occur near sources of permanent water (lakes, streams, and springs) and indicate seasonal occupation for the purpose of harvesting floral and faunal resources. Locations of piled rock cairns within and adjacent to the watershed tend to indicate a potential spiritual significance to portions of the watershed, including peaks, lakes, and rivers, in prehistory.

It is not fully understood which cultural groups occupied the watershed, however, bands of Columbia Plateau, Klamath, and Northern Paiute peoples most likely utilized the resources of the watershed. The watershed was not exclusively any single group's territory, nor was it occupied year-round.

Prehistoric access to the area followed watercourses and game trails. Once use became established through time, trails developed that provided access to hunters, stockmen, trappers, and explorers. These trails established the pattern for future access in historic and modern times.

Pioneer settlers, stockmen, and trappers were present in the earlier part of the century and loggers began to appear as early as 1915. The area became more attractive once access was improved through completion of the railroad. Construction of the modern route of Highway 58 brought even more recreationists. Tourists began visiting more frequently and enjoyed lake, stream, and snow-based activities. Trapping for subsistence, traveling from one hunting area to another, and grazing are all activities that happened more in the past than today.

These activities have left their marks on the landscape. The most predominant evidence of prehistoric activities are lithic scatters, which are found clustered around lakes and along creeks throughout the watershed. No known sources of raw lithic material (obsidian) have been identified but it is likely that localized basalt outcrops were investigated.

Both modern trails and campsites reflect the historic pattern of use in the area; stockmen and trappers have blazed trees for trail markers in various places. The remains of homesteads, cabins, fence lines, corrals, and wagon roads are reminders of those historic activities. The advent of Forest Service custodial stewardship in the early 1900s through pre-World War II left many marks on the landscape including improved roads and trails, Forest Guard Stations, campsites, picnic areas, and designated "roadless" or "primitive" areas. In addition, the resorts and recreational residences (such as at Crescent Lake), reflect a pattern of recreation use that became popular during the 1920s and remains so today for a certain segment of the recreating public.

Social Context

The Big Marsh Watershed is a cultural landscape that has been inherited. Its physical and biological characteristics have been modified over time to accommodate the changing needs and values of people. In general terms, human use of the resources within the Big Marsh Watershed has changed within the last 100-150 years from subsistence-based to recreational based use. From evidence found within the watershed, it is estimated that people came to the area approximately 8,000 years ago to take advantage of the food resources - plants and animals. The influx of European immigrants brought different uses to the land such as visible

transportation routes, relatively permanent dwellings, and the distribution of water rights.

Today, management of the watershed reflects the increasing need to protect and enhance our National Forests as open space, biological, and spiritual reserves. This shift in values is partly due to continuing population growth, redistribution to rural areas, and lifestyle changes (Bedwell 1997). At the risk of oversimplification, the following is a list of communities that presently have obvious connections to resources within the Big Marsh Watershed. Each community listed represents a set of existing values and expectations linked to specific resources within the Big Marsh Watershed. The 1994 Odell Pilot Watershed Analysis describes these communities in greater detail and explains the evolution of their relationship to the area (pp. 2-18 to 2-23 and 3-82 to 3-86).

American Indians: Klamath Tribe, Burns Paiute Tribe, Confederated Tribes of Warm Springs Reservation.

General expectations: Protection of and unrestricted access to cultural resources and areas of significance; freedom to hunt and gather traditional plants and animals.

Western Oregon: Eugene and Oakridge

General expectations: Quality and diverse recreation settings ranging from motorized to non-motorized, primitive to resorts; high quality scenery/big trees; convenient vehicular access to recreation settings; healthy ecosystems; firewood; and timber products.

Local rural industrial communities: Crescent, Gilchrist

General expectations: Continued supply of timber, commercial use of forest resources such as gravel and cinders; unrestricted access for hunting, fishing, and firewood gathering to enhance subsistence; the continuation of traditional recreation activities at traditional sites; and a healthy, safe water supply.

Local rural recreation/residential communities: Crescent Lake Junction, Crescent Lake recreation residences, LaPine

General expectations: High quality scenery/big trees; quality and diverse recreation settings; convenient, unrestricted access; a healthy, safe water supply; destinations to attract tourism; protection of private property; seclusion, law enforcement; commercial use of forest resources; and firewood.

Central Oregon urban area: Bend

General expectations: Quality and diverse recreation settings; high quality scenery/big trees; healthy ecosystems; firewood; unrestricted and convenient access to desired Forest settings.

Transient commercial mushroom pickers: Primarily Southeast Asian

General expectations: Commercial use of matsutake mushrooms; motorized access to picking areas, group camp accommodations; convenient market area; human resources including interpreters and law enforcement; and informational signs.

Irrigation districts: Tumalo Irrigation District, local private lands

General expectations: Adequate water supply throughout the crop growing season (April-

September) via Crescent Lake, Crescent Creek, Little Deschutes and Deschutes Rivers to an irrigation canal in Bend; diversions off Big Marsh Creek.

General public and international tourism: American citizens, international tourists

General expectations: A legacy of public land that is described in our National environmental laws - the National Forest Management Act (requires Forest Plan), Wilderness Act, Endangered Species Act, Wild and Scenic Rivers Act, Pacific Crest National Scenic Trail, National Scenic Byways, Clean Water Act, Clean Air Act, cultural resource protection; wildfire protection; diverse recreation settings and services; sustainable yield of forest products; and interpretive/informational/educational services.

All of these social expectations and values are related to specific resources within the Big Marsh Watershed. The landscape areas delineated during Phase A of the WEAVE process illustrate where these values and the associated resources are located within the watershed. In many instances, there is a range of diverse, and often conflicting, social values placed on a single or limited resource. Conflicting values for resources such as Big Marsh and the water within Crescent Lake have been identified as issues and trends for the Big Marsh Watershed Analysis.

Existing Recreation Settings And Access

The Big Marsh Watershed provides a wide spectrum of recreation opportunities ranging from the solitude and challenge of Diamond Peak Wilderness to the comforts of a resort within a forest setting. Primary access to this area is via State Highway 58, which stretches from its eastern end at Highway 97 to its western end at Interstate 5, just south of Eugene. The majority of recreation visitors to the watershed are from the Willamette Valley. It is an easy 90 miles from Eugene to the end of Highway 58 at its junction with Highway 97, allowing relatively quick access to all recreation opportunities in this watershed. See Figure 3. The 1995 average daily traffic counts indicate peak travel occurred in August, with 4,136 vehicles per day. Passenger cars account for approximately 1/3 of the counts on both Highways 58 and 97.

During the winter, most of the public land in the watershed with the exception of Diamond Peak Wilderness is open for over-the-snow vehicle travel when snow cover is adequate to protect resources. Approximately 125 miles of snowmobile trails are available on the Crescent Ranger District, with significant portions located within the watershed. Many of the trails are groomed and maintained by a local snowmobile club. Other than Diamond Peak Wilderness, dedicated areas for cross-country skiing are limited in the watershed, with the Willamette National Forest offering a developed area with signed trails just west of Willamette Pass Ski Area.

Road Densities

The overall road density for each subwatershed, including private lands and water, has been calculated as follows:

Table 2 - 3 - Overall Road Density by Subwatershed

Subwatershed	Miles per Square Mile
Big Marsh	1.60
Crescent	2.25
Crescent Lake	0.44

The road density for each subwatershed on Forest Service land, excluding water, lava and wilderness, has been calculated as follow:

Table 2 - 4 - FS Road Density Excluding Water by Subwatershed

Subwatershed	Miles per Square Mile
Big Marsh	1.66
Crescent	3.65
Crescent Lake	0.92

Refer to Figure 18 for a map of the roads within the watershed. For additional road density information, see Appendix D.

Impacts of Roads on Wildlife

The extent, frequency, and duration of disturbance from all sources affect an animal's ability to survive and reproduce during stressful periods. Human disturbance may cause abandonment of young and/or habitats. Some species are more susceptible to disturbance than others, such as the wolverine, fisher, and sandhill crane. Traffic on roads, whether it be cars, trucks, motorcycles, ATV's, snowmobiles, mountain bikes, or people on foot, all contribute to the disturbance of wildlife.

In addition to providing an avenue for disturbance, roads tend to fragment habitat. This fragmentation may make it difficult for wildlife to migrate or disperse. Fragmentation via roads also reduces the amount of interior habitat and increases the proportion of edge habitat, which is favorable to some species of wildlife and detrimental to others.

DELINEATIONS OF LANDSCAPE AREAS

Six areas in the watershed were identified and delineated by the watershed team as having distinct physical, biological and social issues. In delineating these areas it was easier to organize and analyze issues unique to each area. Information included for each of the resource areas was spatially delineated, to the extent possible, on maps and overlays, which were then combined to determine where there were areas with common concerns, habitat types, and functionality. Boundaries were fine-tuned by using road and land allocation maps, which helped in identifying logical boundaries. The six areas are called landscape areas. Refer to Figure 19 for the location of the landscape areas within the watershed. These landscape areas will be referred to throughout the remainder of this document.

The six landscape areas and a brief description are:

Landscape Area A - This area follows the Diamond Peak Wilderness boundaries within the Crescent Ranger District.

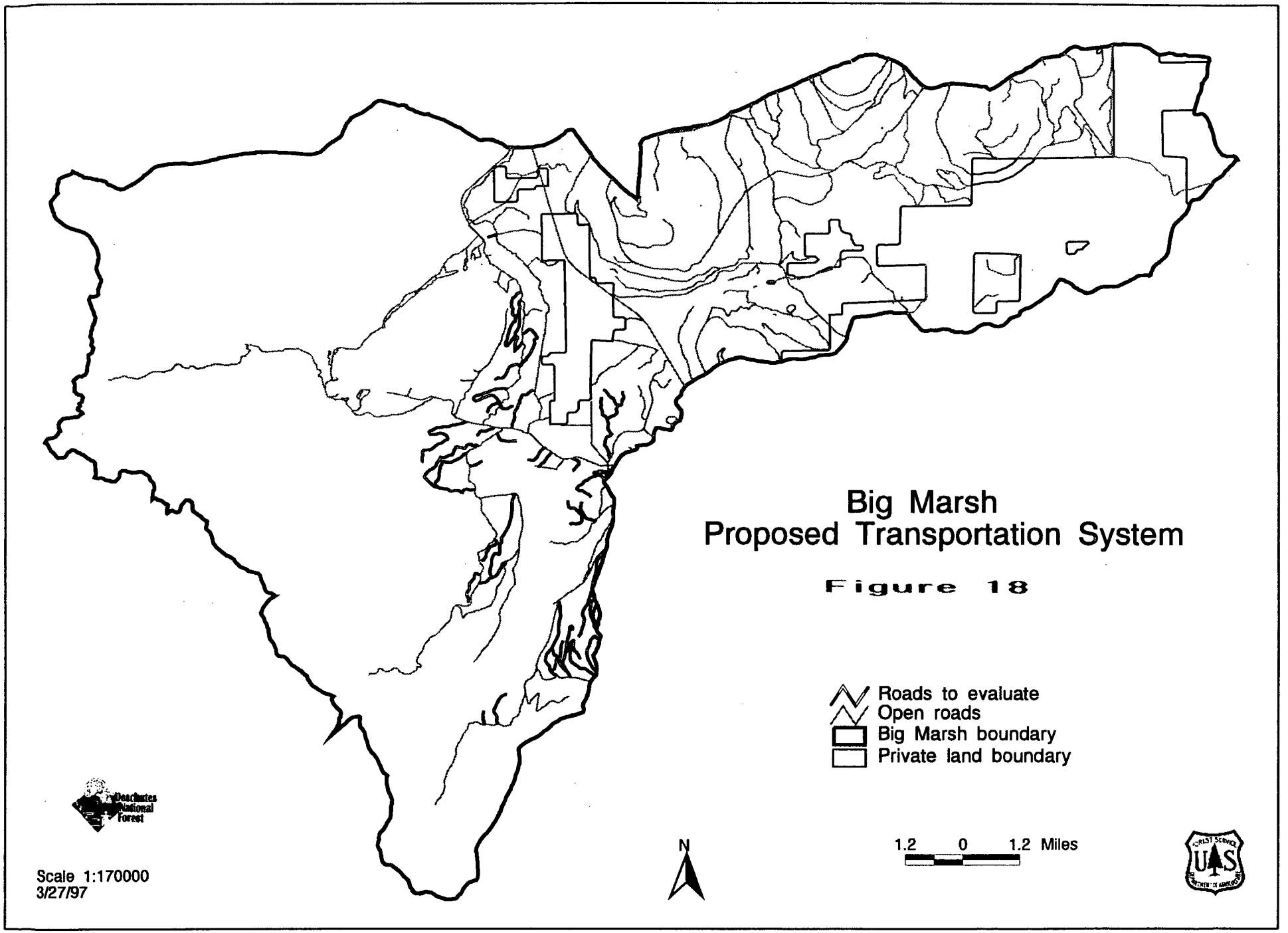
Landscape Area B - This is the area around Crescent Lake, and includes the Crescent LSR as well as a Bald Eagle Management Area on the northwest side of the Lake

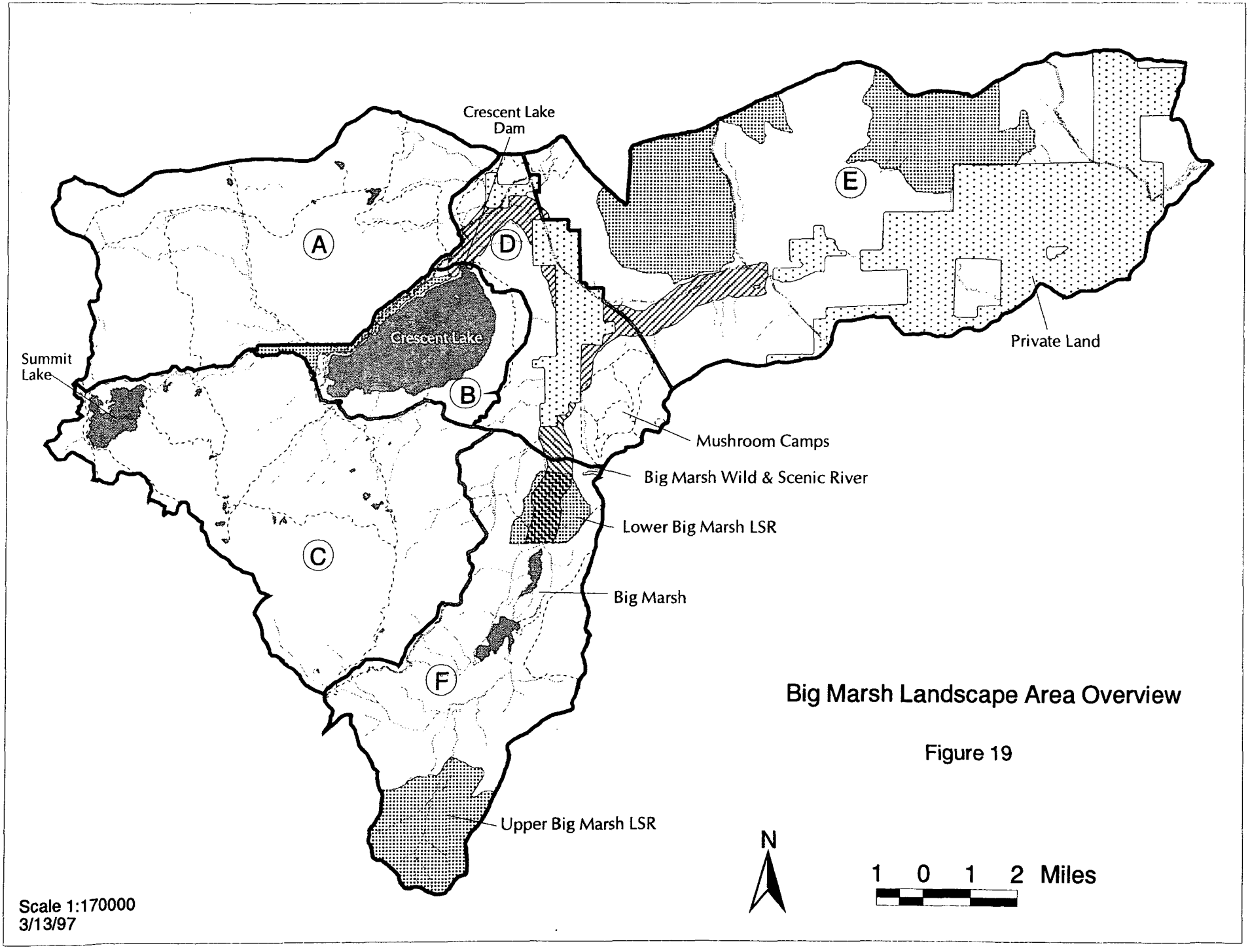
Landscape Area C - This area is all within the Oregon Cascades Recreation Area (OCRA) and as such, is managed by the plans contained in the Deschutes Forest Plan under the OCRA management guidelines.

Landscape Area D - This area includes the Crescent Lake Junction Area along highway 58. This area is the one most influence by human presence. This area also contains portions of the Crescent Creek Wild and Scenic River as well as Big Marsh Wild and Scenic River. There is also a substantial amount of private land within this landscape area.

Landscape Area E - This area contains some matrix lands with considerable past and present harvest activity. A large portion of the Davis LSR is also contained in this landscape area. Crescent Creek Wild and Scenic River also runs through this area.

Landscape Area F - This area is centered on Big Marsh proper, a unique high elevation marsh containing many distinctive flora and fauna for this area. This landscape area also contains Upper and Lower Big Marsh LSRs.


Big Marsh
Proposed Transportation System
Figure 18
Roads to evaluate
Open roads
Big Marsh boundary
Private land boundary
Deschutes National Forest
Scale 1:170000
3/27/97
N
1.2 0 1.2 Miles



Big Marsh Landscape Area Overview

Figure 19

Chapter 3

TRENDS

DEFINITION OF A TREND

A trend is a result of factors which over time influence change on a given element or portion of the ecosystem. In this document, the discussion of trends in phase D concerns trends which have been identified from past and current conditions, and to a certain extent, future conditions. If the causal factors of the trend continue, then the trend is expected to continue. If the causal factors stop or are reversed, then the trend is not expected to continue, or it may change. Restoration opportunities exist for elements or portions of the ecosystem that are not resistant or where the recovery is expected to take longer than desired.

TREND DESCRIPTIONS

Listed below is a summary of the trends. Each trend is divided into six subtrends which describe the trend as it relates to the six landscape areas identified by the interdisciplinary team as described in chapter 2. Trends are assigned a color which corresponds to the urgency of management actions needed to stop or reverse the trend. In most cases, this trend rating varies by landscape area because of various geographic areas, plant associations and human influence in each of these areas. Each trend has been described in general, then in more detail as it pertains to the landscape area.

Each trend was ranked according to its sensitivity (susceptibility, the ability to resist change in properties, and resiliency, the ability to self restore) and risk, and was then identified as being a *red, yellow or green trend.* The colors indicate a combination of the level of risk and sensitivity. Red implies a "red flag", which means that the there is an urgent need for something to be done, such as management activities or intervention to prevent further deterioration of that resource, endangered species or species viability. Yellow indicates that something needs to be done soon to prevent the resource from becoming a red trend. Green indicates that management opportunities exist within that trend, but that the urgency is not great or that the trend was good and should continue.

Listed below is a summary of the trends by landscape area. Landscape areas are displayed in detail at the end of this chapter in figures 20-25.

Trend 1. Reduction of late and old structured forest stands and a corresponding increase in seedling, sapling, and pole dominated stands; reduction of open, large tree stands dominated by ponderosa pine and associated early seral species; and increasing stand densities and late seral species in the understory.

1A. Yellow - This landscape area contains primarily mountain hemlock, which is within its HRV, with some dead and dying lodgepole due to insect infestations.

1B. Red - Mixed conifer dry stands have a substantial seedling, sapling and pole component and are at risk for loss of highly valued scenery and LOS without management action to reduce density. Structural stages for mixed conifer dry are well outside HRV for most categories (See p.1-14 chapter 4)

1C. Yellow - A large mountain hemlock component which is within the HRV for stand structure comprises a majority of this landscape area. There is also some mixed conifer dry and lodgepole components, where fire exclusion is beginning to show its effects.

1D. Red - This area contains lodgepole pine and mixed conifer stands, many of which have experienced some degree of harvest or salvage. This area also contains a large amount of private land which has been developed, therefore preventing the attainment of LOS.

1E. Red - A large amount of timber harvesting has occurred in this area on both Forest Service and private land. The LOS stands remaining are dense and many are imminently susceptible to catastrophic loss due to insect disease or fire. Much of this area is being treated under the Seven Buttes EA and will help set a course towards attaining sustainable levels of LOS.

1F. Red - The mixed conifer dry within this landscape area has been affected by fire exclusion. Many of the stands are imminently susceptible.

Trend 2. Increased fragmentation and reduced connectivity in late and old structured forest and riparian habitats.

2A. Green - Since this area is Wilderness, comprised mostly of mountain hemlock, precluded from timber harvesting and contains no roads, little fragmentation or loss of connectivity has occurred. Natural fragmentation results from laminated root rot pockets in the mountain hemlock and mountain pine beetle in the lodgepole.

2B. Yellow - Some fragmentation and loss of connectivity within this landscape area has already occurred as a result of campgrounds and summer homes. Additional fragmentation could occur in the densely stocked mixed conifer stands from insects and disease.

2C. Green - Since this area is OCRA, comprised primarily of mountain hemlock, harvesting of timber is uncommon and contains few roads, little fragmentation and loss of connectivity have occurred. Natural fragmentation results from laminated root rot pockets in the mountain hemlock, mountain pine beetle in the lodgepole, and insects, disease, and fire in the mixed conifer.

2D. Red - This area contains lodgepole pine and riparian habitat, both of which have been heavily impacted by private land ownership. The area is heavily fragmented and maintains little connectivity for MIS species, big game, and other riparian associated species. This is an important link in connectivity between Crescent and Odell Creeks.

2E. Red - A significant amount timber harvesting has occurred in this area on both FS and private land. The area is heavily fragmented by regenerated areas, thereby limiting the connectivity within the area.

2F. Yellow - The landscape area has had some timber harvesting, causing moderate fragmentation, especially in the northeast and northwest sections. Water in Big Marsh has been partially re-diverted into the main channel from the ditches, so connectivity within the marsh itself is improving. The marsh is a sensitive area where fragmentation and connectivity loss could easily occur. In addition, many of the mixed conifer dry stands within the area are heavily stocked and may require treatment in the near future.

Trend 3. The susceptibility for high severity fires is increasing due to fuels buildup

3A. Yellow - Moderate levels of fuels are building up within the mountain hemlock plant association even though it is still within its HRV. However, substantial fuel buildup has occurred in that portion of the landscape area that is mixed conifer dry, especially near the southern portion of Red Top Mountain. In addition, the number of human-caused fires is increasing throughout this area because of increased human use.

3B. Yellow - The areas in and near developed recreation sites and past harvest areas have had much of the large down woody debris removed from these sites. However, recreation use also results in an increased number of human-caused fires and the possibility of extensive property loss in the event of large scale fire. In areas outside of the developed recreation sites and past harvest units, there is considerable fuels buildup in the mixed conifer dry and lodgepole dry stands.

3C. Yellow - Fuels are building up within the mountain hemlock plant association even though it is still within its HRV, however, substantial fuel buildup has occurred in the lodgepole pine as a result of the mountain pine beetle. In the mixed conifer dry plant association, fire exclusion has played an important role in the increased amount of fuel present. In addition, the number of human-caused fires is increasing.

3D. Red - There is a fuels buildup in and around the homes of the urban interface, causing substantial risk to human life and property. The large industrial camp used by mushroom pickers substantially increases the risk of fire because of the large numbers of campfires, cigarettes etc. within a relatively small space. Many decadent lodgepole pine stands extend to the banks of Crescent and Big Marsh Creeks, placing the riparian areas at risk of severe fire.

3E. Red - Many of the regenerated areas within this landscape area will undergo precommercial thinning in the next 5-10 years. This slash will remain on the ground and poses an extremely high fire hazard. In addition, many of the forested stands also have higher levels of fuels as a result of fire exclusion. Seven Buttes will help alleviate some of these concerns, although pre-commercial thinning slash may need to be addressed.

3F. Yellow - This area contains two late successional reserves (LSR) As within any undisturbed stand within this watershed, fuels are building and increasing the risk of large fire. Lower Big Marsh LSR is almost completely composed of lodgepole pine and is susceptible to a stand replacement type fire. Upper Big Marsh LSR is a mountain hemlock PAG and fuels are not much of a concern at this time. Other areas outside of the LSR are in much the same status as landscape areas D and E.

Trend 4. The introduction and spread of non-native species is increasing the threat to native plant and animal species

4A. and 4C. Yellow - In the Wilderness and OCRA the primary non-native species of concern are introduced non-native fish in the high elevation lakes. These lakes were naturally fishless. Introduced fish result in changes to the forage base, including plankton and amphibians as well as other species up the food web. Another concern is the introduction of non-native plants and noxious weeds from horses and people on the trails.

4B. Red - Again, non-native fish species have been introduced into Crescent Lake. These species compete or have competed with native species including the bull trout. Introduced fish result in changes to the forage base. Another concern in this area is the number of noxious weeds that are present. Noxious weeds are located around the lakeshore, especially in campgrounds and other areas where substantial site disturbance has taken place.

4D and E. Red - Noxious weeds and non-natives are typically found in areas where site disturbance has occurred as a result of grazing, recreation, logging, road building, water control, railroads and fire. These plants can cause changes in species composition by

outcompeting native plants. Non-native fish species are also located in Big Marsh and Crescent Creeks. These fish can out-compete native species and alter habitat.

4F. Red - See description for landscape areas D and E. Big Marsh has several problems with non-native species and noxious weeds. Reed canary grass is located in patches throughout the marsh, especially in the north end. This species outcompetes native grasses and sedges and is extremely difficult to eliminate. Other non-native species are located in the marsh. There have also been unconfirmed reports of bull frogs in the marsh which would pose a large threat to native populations of the spotted frog.

Trend 5. The regulation of water quantity from dams, ditches, and diversions is affecting many components of the ecosystem.

5A and C. Green - There are no diversions within either of these landscape areas.

5B. Red - Crescent Lake dam causes extreme fluctuations in the lake level. These changes in lake level affect many aspects of the aquatic ecosystem, from the success of fish spawning to the aquatic plant communities to invertebrates. In addition, the fluctuations are increasing shoreline erosion, leading to water clarity problems in the lake.

5D. Red - Variable instream flows from Crescent Lake into Crescent Creek cause many problems in stream and streamside communities. Downstream irrigation demand in the summer causes greatly increased flows, while water storage needs for the lake cause greatly reduced flows in the fall and winter. These unnatural flows also create soil erosion and interrupt and/or destroy recreational opportunities along Crescent Creek.

5E. Yellow - The effects in this landscape area are much the same as those in area D, although they are not as noticeable due to the distance from the dam. Crescent creek has more contributing tributaries to soften the impacts from changes in flow from Crescent Lake dam, although they are still significant. Water diversions on private land are also occurring for grazing and irrigation purposes in this landscape, having impacts to some of the same resources as mentioned previously. Methods to deal with future requests to exercise private water rights on public land will need to be addressed.

5F. Yellow - The main diversion in Big Marsh proper has affected all aspects of the marsh ecosystem. These diversions have affected the natural succession of Big marsh from a lake to a marsh to a meadow.

Trend 6. Water quality has declined and there is the potential for further decline.

6A and 6C. Green - Due to the roadless and non-commercial aspects of these landscape areas, water quality has remained excellent in most places. Some high elevation dispersed sites are showing signs of sanitation disposal problems that could pose a problem to water quality in the future. In addition, some lakes are showing a soil compaction problem due to heavy fishing use. This compaction could lead to increased erosion and sedimentation leading to some water quality concerns.

6B. Yellow - Concerns in this landscape area are centered around the developed recreation sites surrounding Crescent Lake. Summer recreation homes close to the lake may pose a risk to water quality from inadequate septic systems. Other sanitation and compaction problems associated with developed campgrounds are posing a risk to the water quality of the lake.

6D - Red - Many of the same issues that concern Crescent lake development are an issue in this landscape area. In a letter documenting on-site inspection of the Crescent Lake Junction area by the Klamath County Department of Human Services, specific problems with inadequate sewage disposal in the area were identified. Increased human use and inadequate septic systems may pose a threat to Crescent Creek. Other sources of potential water contamination are the old railroad dumpsite, increased human use surrounding the mushroom camp, increased water temperature and lack of overhead cover.

6E. Yellow - Timber harvesting, roads, increased water temps, private land cattle grazing, and little overhead cover are the main concerns for water quality in this landscape area.

6F. Green - Big Marsh proper has some water quality concerns due to elevated water temperatures. Elevated temperatures are the result of loss of some overhead cover and the water diversion in the ditches. The physical structure of the ditch differs from the structure of the natural channel, allowing solar radiation to increase water temperature above those expected in a proper functioning marsh.

Trend 7. The health of the riparian habitat has been impacted by human activities such as private land development, trail and road construction, recreation, grazing, and water diversion.

7A and 7C. Green- The riparian communities in these two areas are in generally good condition. There are a few minor impacts to the riparian habitat through poor stream crossings on some trails and localized trampling and soil compaction around high elevation lakes, especially those with high fishing pressure.

7B. Red - Developed recreation sites around Crescent Lake are impacting the riparian habitat in heavily used areas. This heavy use is causing soil compaction, loss of vegetation and erosion. The Dam at Crescent Lake also causes lake level fluctuations as discussed in trend #5, and subsequent erosion. This fluctuation also impacts the ability of some fish to use Whitefish and Kaboom Creek as possible spawning areas and reduces productivity in the shoal areas.

7D. Yellow - Fluctuating water levels are having a great impact on the riparian habitat of this landscape area. Grazing on private land, increased recreation effects like those discussed in trend 7B , the effects from past harvest operations and development, all negatively affect the riparian areas. Fluctuating water levels in Crescent Creek also removes riparian vegetation and leads to erosion, elevated water temperatures, and loss of quality spawning gravels.

7E. Red - The situation in this landscape is similar to the one described in landscape area D, except for a greater impact from heavier harvest and grazing activities.

7F. Yellow - The big marsh diversion has greatly impacted the riparian habitat of this landscape area. With the partial return of water to the main channel, the habitat is improving. Past grazing practices may have reduced native riparian vegetation cover from its historic levels.

Trend 8. Areas of inherently moderate soil quality are moving toward an existing low quality state.

8A. and 8C. Green - Because of the lack of timber harvest in the wilderness, and the lack of human development, only 5% of this landscape area is impacted.

8B. Red - Fluctuating water levels on Crescent lake are contributing to soil erosion. Shoreline development and recreation are contributing to large areas of soil compaction, erosion and displacement.

8D. Yellow - Private development and timber harvest activities pose the biggest threat to soil quality in landscape area D.

8E. Red - 40% of this landscape area (including private land) is already detrimentally impacted because of past harvest practices and private land use and development.

8F. Green - Only 5% of this landscape area is impacted from limited timber harvest and grazing.

Trend 9. Commercial use is increasing-- requests to extract commodities and commercially utilize resources within the watershed are increasing and diversifying.

9A. and 9C. Green - very little of these two landscape areas have been impacted by extraction commodities or commercial utilization. Because of their management allocation, they should not be affected in the near future.

9B. Yellow - Commercial use around Crescent Lake is increasing and putting a greater demand on recreational facilities and settings. Demands on the water resource from irrigation uses and recreation are increasing and conflicting.

9D. Yellow - The Crescent Lake Junction area is dependent on forest products as well as tourist dollars for its economic well being. Timber, mushroom harvesting, snowmobiles and skiers all contribute to this service-oriented community. The newly developed Little Odell Butte industrial camp for commercial mushroom pickers is located at the south end of this landscape area. This 600 acre camp accommodates up to 1000 commercial pickers during the September through October mushroom season.

9E. Yellow - This area receives a fair amount of timber harvest activity, firewood cutting, mushroom harvest, gravel and cinder extraction and other special uses. This is increasing pressure on all forest resources.

9F. Yellow - This area is similar to landscape area E except for a smaller base of available timber because of OCRA.

Trend 10. Recreational use is increasing. The demand for public lands to provide a diversity of outdoor recreation settings is increasing with an emphasis on access to primitive and semi-primitive settings that accommodate popular dispersed activities. The need for public education on forest land and resource management is increasing.

10A and C. Green - The increasing demand for primitive settings will increase the need for management strategies in these areas to protect and enhance their values.

10B. Yellow - The Crescent Lake area is the gateway to the Diamond Peak Wilderness and Oregon Cascades Recreation Area both winter and summer. Crescent Lake provides some of the best opportunities for family recreation on the district and its diverse and scenic recreation values make it a unique and highly valued resource. The Deschutes Forest Plan designates this area as Intensive Recreation, with strips of Bald

Eagle Management areas along the northwest and northeast sides of the lake. The incompatibility of portions of these two overlapping management areas may cause problems in management options in the future. Crescent Lake area would be a prime location for providing additional educational opportunities.

10D. Yellow - Crescent Junction is the main business and service center for much of the watershed, providing food, gasoline and lodging. There are three snoparks in the area, (with the goal of two) providing abundant winter recreation opportunities. Increased use of this "hub" area is placing a greater demand on sewage and water facilities (see trend #6). This area would provide good exposure for educational outreach and opportunities.

10E. Green - This area provides diverse opportunities for recreation, including hunting, camping, hiking and mushroom picking. The segment of the Crescent Creek Wild and Scenic River that contains the "outstandingly remarkable values" is located within this landscape area. These values must be protected and enhanced.

10F. Yellow - The Oregon Cascades Recreation area covers much of this landscape area, with two Late Successional Reserves also in this area. Big Marsh itself is located within the OCRA and is a unique area in that it's a relatively large, high elevation wet meadow/marsh hosting a diverse wildlife population. The Big Marsh area has the potential for greatly increased recreational use from hunters, wildlife and bird watchers, hikers, fishermen and canoeists. Big Marsh creek is also a designated Wild and Scenic River and its "outstandingly remarkable values" must be protected by law. With increased recreation will come increased demand on both the recreation opportunities and the unique natural values of the marsh. These conflicting demands will challenge managers to provide creative compromises for the protection of the marsh and maintenance of diverse recreation opportunities.

Table 3-1 shows the ten trends and the risk ratings by color and landscape area. There are ten main trends, each subdivided by landscape area to better display the particular issues and their importance in each landscape area. In many cases, one trend may have been rated very differently in one landscape area versus another. Some landscape areas are composed of plant association groups that are more affected by a certain trend than other PAGs. For example, the mixed conifer dry plant association group is more susceptible to the loss of LOS than the mountain hemlock plant association and thus those landscape areas with high amounts of mixed conifer dry received a red rating, while the wilderness and OCRA areas which are primarily composed of mountain hemlock, received a yellow rating.

TABLE 3-1 TRENDS BY LANDSCAPE AREA and TREND RATING

TREND #	LANDSCAPE AREA					
	A	B	C	D	E	F
Trend #1 - Reduction of late and old structured forest stands and a corresponding increase in seedling, sapling, and pole dominated stands; reduction of open, large tree stands dominated by ponderosa pine and associated early seral species; and increasing stand densities and late seral species in the understory.	Yellow	Red	Yellow	Red	Red	Red
Trend #2. - Increased fragmentation and reduced connectivity in late and old structured forested and riparian habitats.	Green	Yellow	Green	Red	Red	Yellow
Trend #3. - The susceptibility for high severity fires is increasing due to fuels buildup.	Yellow	Yellow	Yellow	Red	Red	Yellow
Trend #4 - The introduction and spread of non-native species is increasing the threat to native plant and animal species.	Yellow	Red	Yellow	Red	Red	Red
Trend #5 - The regulation of water quantity from dams, ditches, and diversions is affecting many components of the ecosystem.	Green	Red	Green	Red	Yellow	Yellow
Trend #6. - Water quality has declined and there's the potential for further decline.	Green	Yellow	Green	Red	Yellow	Green
Trend #7. - The health of the riparian habitat has been impacted by human activities such as private land development, trail and road construction, recreation, grazing, and water diversion.	Green	Red	Green	Yellow	Red	Yellow
Trend #8 - Areas of inherently moderate soil quality are moving toward an existing low quality state.	Green	Red	Green	Yellow	Red	Green
Trend #9 - Commercial use is increasing - Requests to extract commodities and commercially utilize resources within the watershed are increasing and diversifying.	Green	Yellow	Green	Yellow	Yellow	Yellow
Trend #10 - Recreational use is increasing - The demand for public lands to provide a diversity of outdoor recreation settings is increasing with an emphasis on access to primitive and semi-primitive settings that accommodate popular dispersed activities. The need for public education on forest land and resource management is increasing.	Green	Yellow	Green	Yellow	Green	Yellow

Table 3-2 displays each trend and describes in more detail the suspected causes of the trend and the primary and secondary resources that are affected by the continued presence of the trend.

Table 3-2 - TRENDS, CAUSES & RESOURCES AT RISK FOR THE BIG MARSH WATERSHED

TRENDS	CAUSES	RESOURCES AFFECTED
1. Reduction of late and old structured forest stands and a corresponding increase in seedling, sapling, and pole dominated stands; reduction of open, large tree stands dominated by ponderosa pine and associated early seral species; and increasing stand densities and late seral species in the understory. *Applies to all Landscape Areas; especially B, D, E, and F.*	-regeneration harvesting -development of private land -exclusion of low severity fire -economic feasibility (need for wood products) -insects and disease -drought -forest succession	-change in stand structure -change towards earlier structural stages -change in spatial arrangement of structural stages across the landscape -reduction in wildlife and plant species associated with late and old structured stands -decrease in species associated with contiguous habitat and increase in those associated with edge -biological diversity -LOS dependent species -increased tree stress, and a continual decline in tree vigor -increased potential for more mortality from bark beetles and defoliators -decrease in scenic quality -increased site productivity due to increased duff layer -precommercial thinning in young stands results in increase fuel loading across the landscape -increase in road density -reduction in down woody debris and snag densities -increased fuel and potential for large, high severity fires

TRENDS	CAUSES	RESOURCES AFFECTED
2. Increased fragmentation and reduced connectivity for late and old structured and riparian habitat *Applies primarily to Landscape Areas D and E.*	-past harvest practices - regeneration and understory thinning -spatial layout of harvest units -economic feasibility (demand for wood products and cost of logging) -land ownership and development - homes and businesses -human access patterns (trails and roads) -disturbance patterns -forest product/resource utilization - timber, grazing, special forest products	-lack of normal biological processes -altered disturbance patterns -biodiversity -natural succession -dispersal habitat -Management Indicator Species habitat, e.g. marten and northern goshawk -big game fawning/calving habitat -decreased scenic quality- -potential loss of LOS dependent species -road density -hydrologic function -water quality -increased demand for recreation and commodities -increased impacts to riparian areas -decrease in quality of fish habitat -erosion and sedimentation -increased risk of fire -illegal dumping

TRENDS	CAUSES	RESOURCES AFFECTED
3. Susceptibility of landscape to high severity fires is increasing because of fuels buildup. *Applies to all Landscape Areas, especially D and E.*	-National policy (fire suppression) -Forest Service direction (fire suppression) -harvest practices -social values -recreational values -arrangement of fuel loadings -scenery -urban interface	-increased stocking levels or stand density -reduction in species associated with fire dependent ecosystems -increased potential for large, high severity fires -scenery (obstructed views) -biodiversity -increased risk of property loss -vegetation management options -*maintenance of ecosystem balance* -nutrient recycling -productivity -natural succession -reduction in commodities and property values -accumulation of litter and duff and down woody debris -reduced vigor -increased risk of mortality from insects and disease -increase in erosion and sedimentation -air quality/smoke emissions -recreation loss -public and firefighter safety -increase potential for damage to soils from high severity wildfires

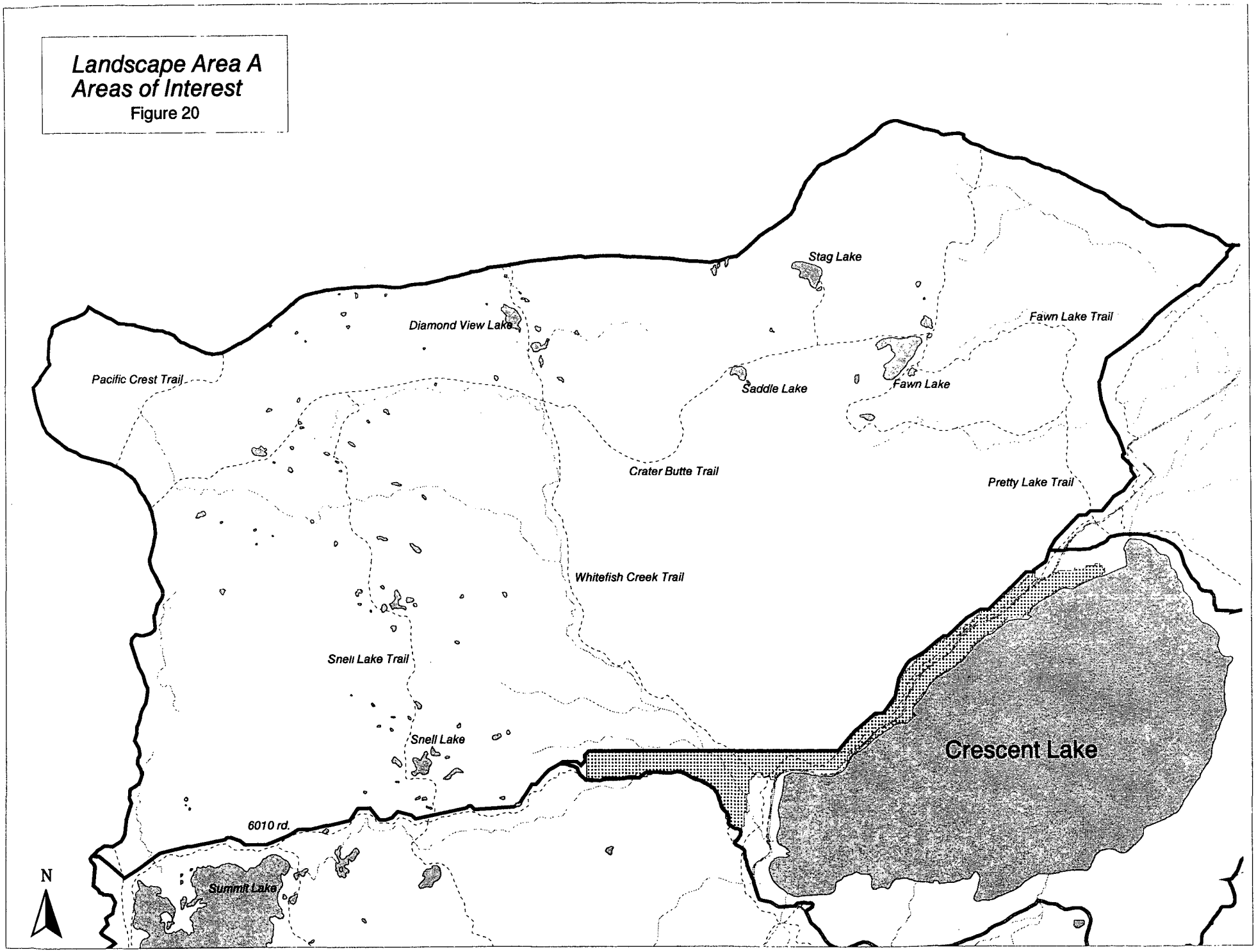
TRENDS	CAUSES	RESOURCES AFFECTED
4. The introduction and spread of non-native species is increasing the threat to native plant and animal species	-intentionally planted (non-native fish, grasses and clover near historical grazing areas. -Introduction and unintentional spread, especially along travel corridors -non-native fish planted in certain lakes and streams -population isolation (fish) -non-native plants introduced via trails and pack animals -non-native fish stocked into high mountain lakes -fluctuating water level in Crescent Lake -high use areas speed the spread of noxious weeds -high traffic areas increase non-native plant spread through vehicular traffic -fluctuating instream flows in Crescent Creek hinder native fauna success -Diversion in Big Marsh Creek	-changes in species composition -decrease in native species -biodiversity -zooplankton and phytoplankton -erosion -compaction -riparian degradation -decrease in nesting habitat -non-native fish and amphibians -aquatic invertebrates -real estate devaluation -reed canary grass established in big marsh -scenery -reduction in native amphibian and invertebrate populations -recreational access -increased use of herbicides -increased control costs -loss of baseline information for scientific research by introduction of non-native plants.

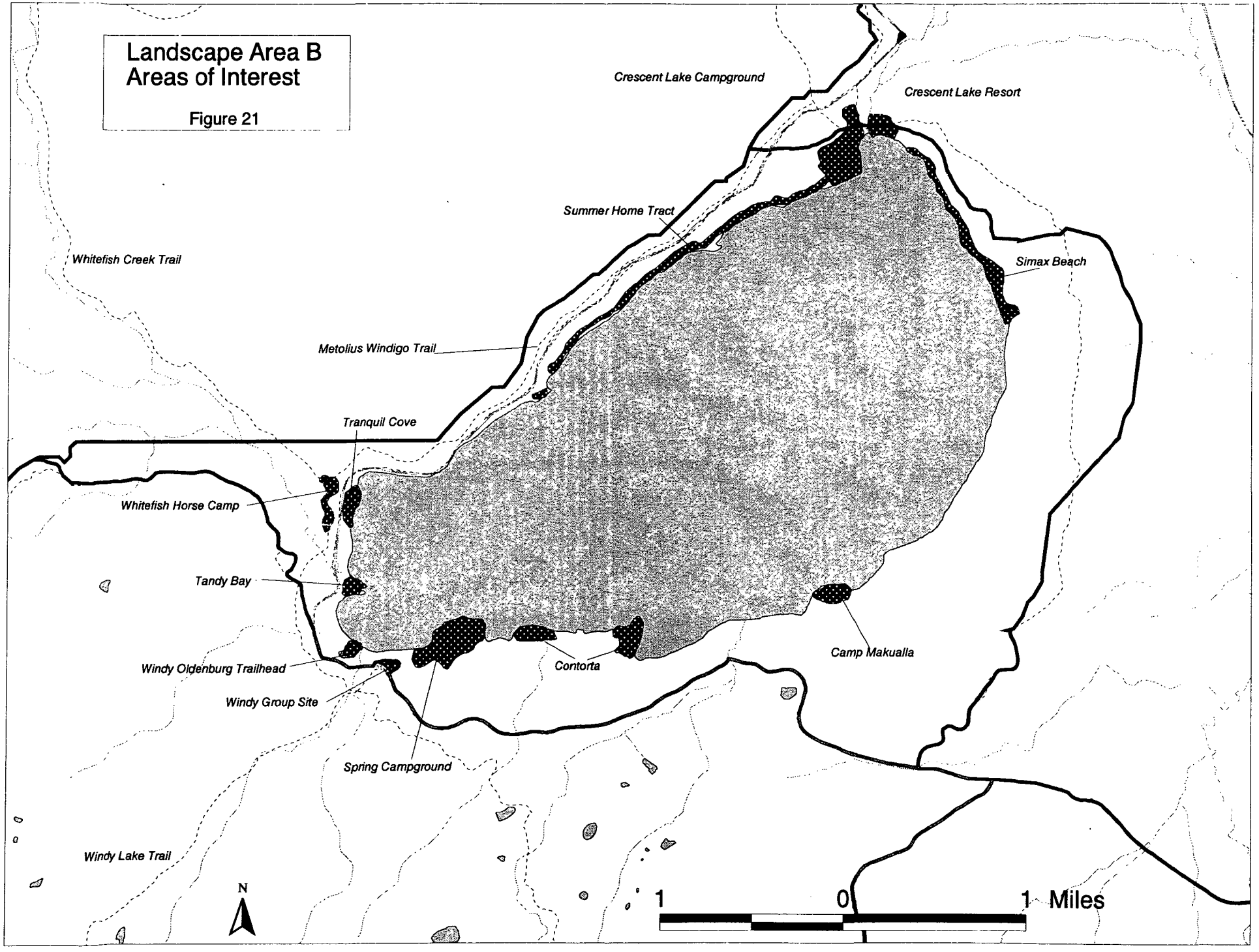
TRENDS	CAUSES	RESOURCES AFFECTED
5. The regulation of water quantity from dams, ditches, and diversions is effecting many components of the ecosystem.	-waters releases from Crescent lake for irrigation needs and the variance in natural flows from rain and snow melt -diversion of Big Marsh creek and side channel springs -other private diversions of Big Marsh creek.	-life cycles of all aquatic life-forms are being affected -erosion is being accelerated downstream of the dam as well as shoreline erosion in Crescent lake. -Fishery population-aquatic plants and invertebrates -cultural resources -loss of overstory trees along lakeshore due to erosion -riparian habitat degradation -loss of recreational access -loss of bald eagle nesting and winter roosting habitat and loss prey base because of decreased spawning habitat of kokanee salmon -elevated water temperature -water quality -loss of recreation opportunities -replacement of native species by non-natives -loss of redband trout habitat -scenery
6. Water quality has declined and there is the potential for further decline	-development of both public and private land -waste water treatment -septic systems -lack of overhead cover -railroad -recreation -mushroom pickers -grazing (cattle and big game) -dispersed recreation sanitation -timber harvesting -roads -lakes and streams have little inherent buffering capacity	-decrease in recreation experience -water clarity -public health (drinking water) -increased sedimentation -increased erosion -decreased health of aquatic ecosystem -decrease in fisheries production -damage to riparian vegetation -damage to riparian associated species -species replaced with non-natives -decline in non-native amphibians -infiltration rates -increased water temps. -runoff

	-porous nature of soils	-spawning habitat -property values -cost of doing business
TRENDS	CAUSES	RESOURCES AFFECTED
7. The health of riparian habitat has been impacted by human activities such as private land development, trail and road construction, recreation, grazing, and water diversion.	-grazing (cattle and big game) -diversions -recreation -development -harvest practices -fire suppression -roads -riparian trail crossings -dispersed site use near high elevation lakes -summer homes around Crescent Lake -increased recreational use in developed sites and dispersed sites -drastic fluctuations in instream flow on Crescent Creek -diversion on Big Marsh Creek	-riparian vegetation -soil quality -water quality & clarity -fisheries -aquatic invertebrates -recreation -increased risk of non-native species invasion -infiltration rates -Wild and Scenic River values -erosion, sedimentation -loss of cover in riparian habitat -loss of species intolerant of grazing
8. Areas of inherently moderate soil quality are moving toward and existing low quality state, especially in landscape areas D and E.	-harvest methods -compaction -displacement of organic layer and A horizon -fluctuating water levels around Crescent Lake -summer home access roads -recreation caused compaction -rate of water release from Crescent lake causing streamside	-plant vigor and reproductive capacity -fine root systems of all plants in compacted areas -microbial processes in soil -erosion -loss of screening vegetation in developed recreation sites. -ability of soil to hold moisture -sedimentation -spawning habitat -eagle habitat -quality of recreation experience

	erosion in Crescent Creek	-increase susceptibility to noxious weed invasion -aquatic communities -exposes cultural resources	
TRENDS	CAUSES	RESOURCES AFFECTED	
9. Requests to extract commodities and commercially utilize resources within the watershed are increasing and diversifying.	-economic dependence of forest products -communities land-locked by federal land -technological changes (i.e., cellular phones, computer technology), continual development and maintenance of facilities and roads, limited water resources -recreation based economy -enhanced subsistence for local rural commentates -matsutake harvest and market -increase in eco-tourism -new trends in outdoor recreation -railroad	-water quantity and quality -scenery -recreation settings -habitat connectivity and effectiveness -vegetation succession -natural role of fire -hydrological function -soil quality -LOS dependent species -displacement of wildlife species from otherwise suitable habitat during critical movement periods.	
10. Recreational use is increasing - The demand for public lands to provide a diversity of outdoor recreation settings is increasing with an emphasis on access to primitive and semi-primitive settings that	-continued population growth -lifestyle changes -redistribution to rural areas -development of private land -expansion of urban areas -increase in developed recreation sites to sustain resources -trend to go outdoors for relaxation and education	-riparian function -soil quality -wildlife habitat effectiveness -quality of recreation settings (primitive and semi-primitive) -user conflicts -loss of big trees because of hazard removal in developed sites -root damage because of	-erosion -air quality -aquatic communities -law enforcement -solitude -scenery -non-native populations -illegal activities -cultural resources

accommodate popular dispersed activities. The need for public education on forest land and resource management is increasing	-eco-tourism -shift toward a recreation based economy	compaction	


Landscape Area A
Areas of Interest
Figure 20
Stag Lake
Diamond View Lake
Fawn Lake Trail
Pacific Crest Trail
Saddle Lake
Fawn Lake
Crater Butte Trail
Pretty Lake Trail
Whitefish Creek Trail
Snell Lake Trail
Snell Lake
Crescent Lake
6010 rd.
Summit Lake
N


Landscape Area B
Areas of Interest
Figure 21
Crescent Lake Campground
Crescent Lake Resort
Summer Home Tract
Whitefish Creek Trail
Simax Beach
Metolius Windigo Trail
Tranquil Cove
Whitefish Horse Camp
Tandy Bay
Windy Oldenburg Trailhead
Windy Group Site
Contorta
Camp Makualla
Spring Campground
Windy Lake Trail
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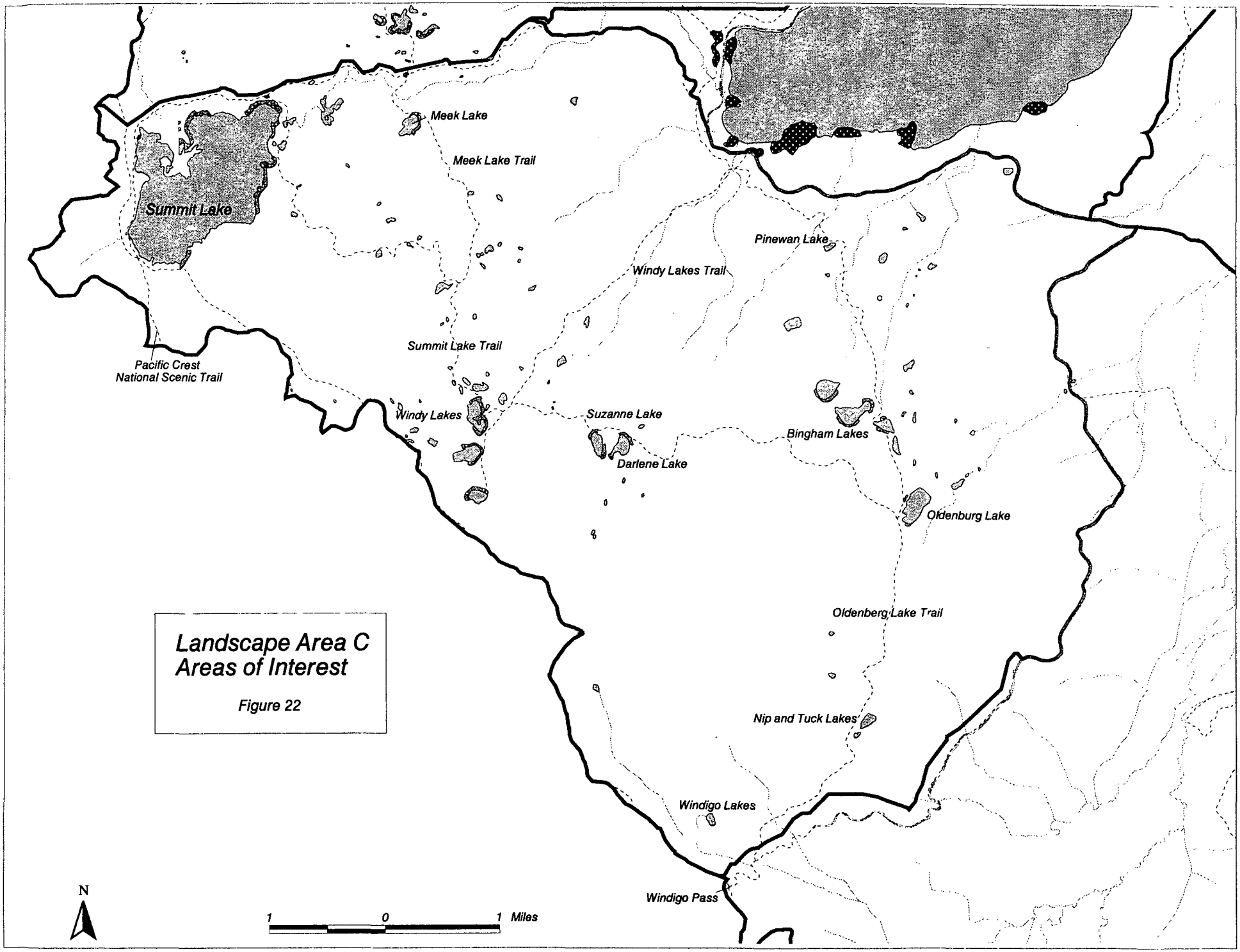
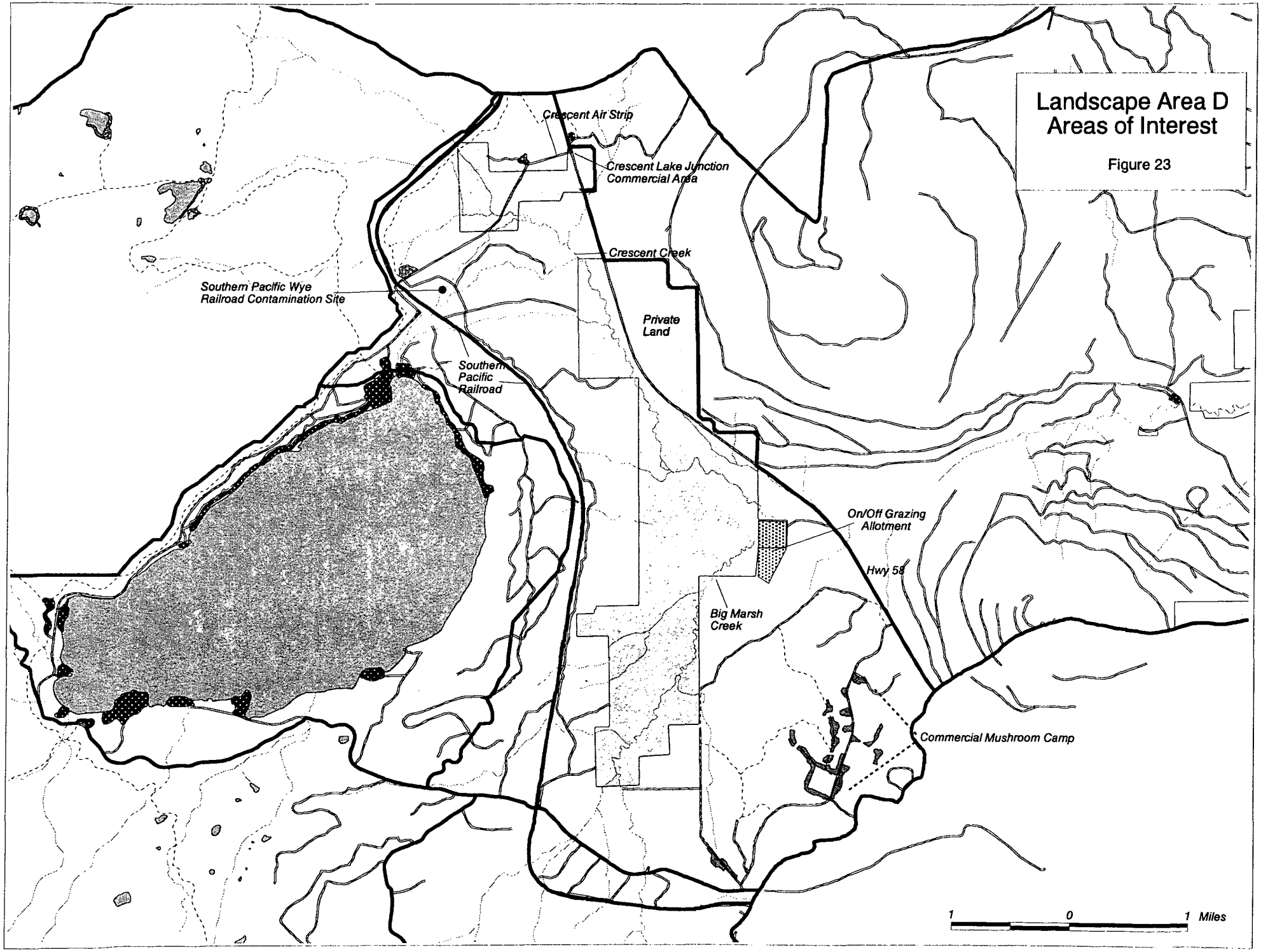


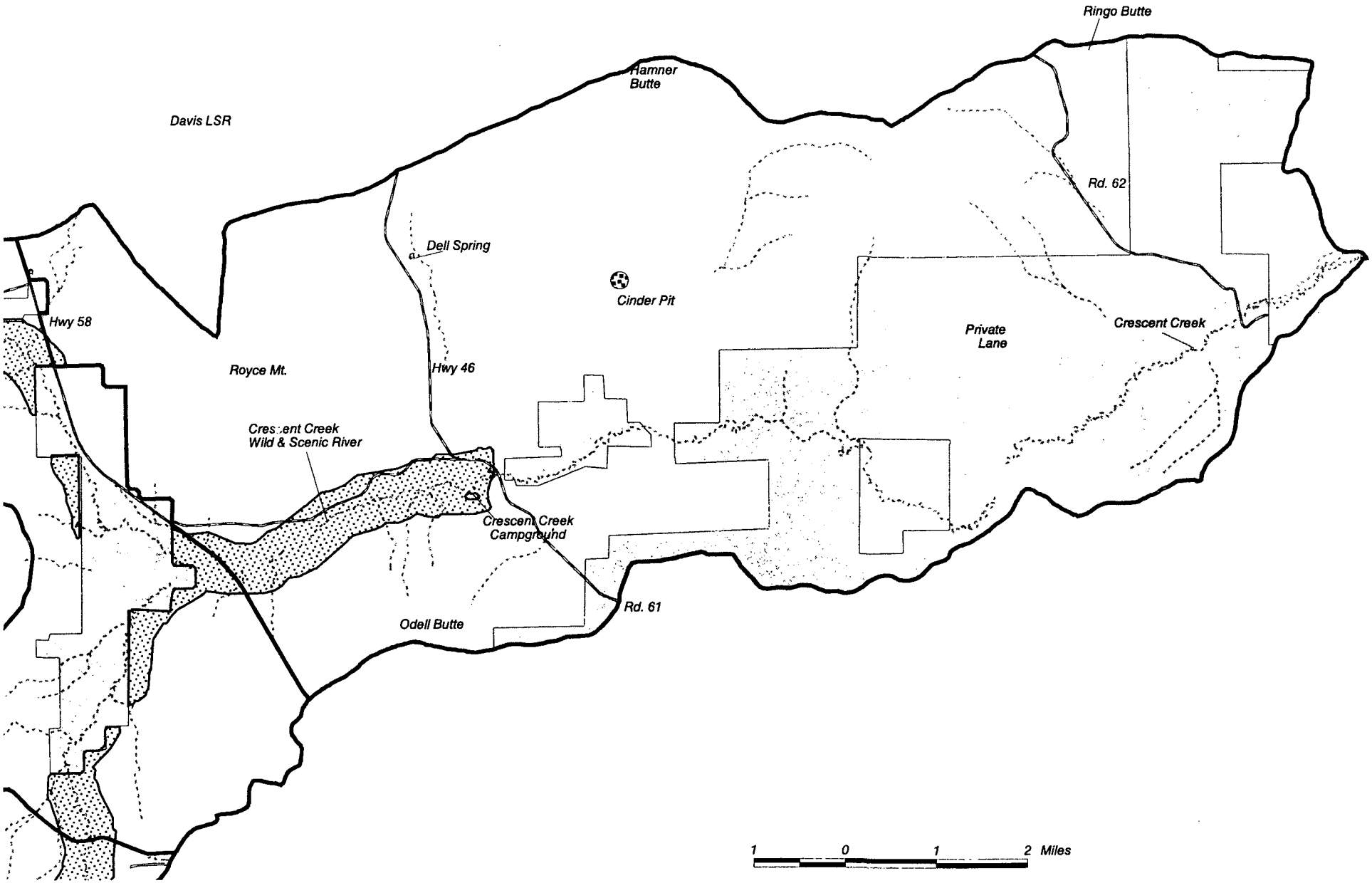
Landscape Area C
Areas of Interest

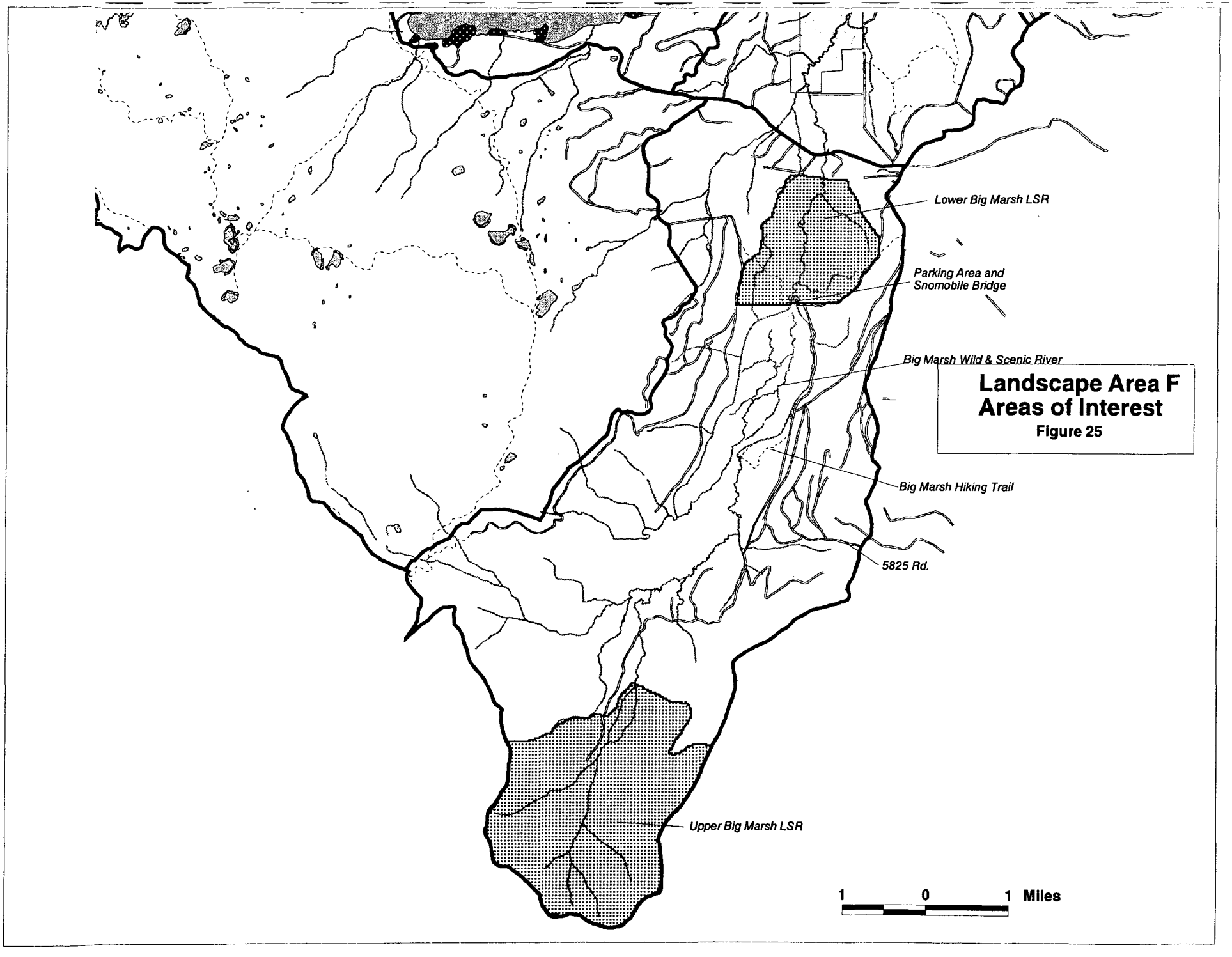
Figure 22


Landscape Area D
Areas of Interest
Figure 23
Crescent Air Strip
Crescent Lake Junction
Commercial Area
Crescent Creek
Southern Pacific Wye
Railroad Contamination Site
Private
Land
Southern
Pacific
Railroad
On/Off Grazing
Allotment
Hwy 58
Big Marsh
Creek
Commercial Mushroom Camp
1
0
1 Miles

Landscape Area E
Areas of Interest

Figure 24





Landscape Area F
Areas of Interest
Figure 25

CHAPTER 4

ANALYSIS OF TRENDS

This chapter analyzes in more depth how each resource is affected by the ten identified trends. In some cases, trends are discussed by how they affect the identified landscape areas (see fig 19-24). In other cases, especially fire and vegetation, trends affect the landscape in relation to the Plant Association Groups (PAG). In those cases, the affects of the trend is discussed by PAG. Each trend is also discussed as to how it affects the different resource areas

Trend 1 - Reduction of late and old structured (LOS) forest stands and a corresponding increase in seedling, sapling, and pole dominated stands; reduction of open, large tree stands dominated by ponderosa pine and associated early seral species; and increasing stand densities and late seral species in the understory.

VEGETATION (trend 1)

To understand how this trend was identified and why it is so significant, one must understand the rationale and methods behind the analysis that led to the conclusions in trend 1.

Vegetation was analyzed using the concept of "Historic Range of Variability" (HRV) of successional states. A pivotal assumption in the use of HRV is that an element or process that is outside the range of natural variability cannot be sustained naturally (Caraher et al. 1992). In determining the historic ranges of variability two approaches are integrated: 1) the notion of "natural states", as described by Swanson et al. (1993), and 2) the natural disturbance regimes associated with each plant association group (PAG).

The first approach assumes that the landscape is composed of definable vegetative "states" or conditions that change through time as altered by succession and specific disturbance regimes (Swanson et al. 1993). In this approach, the length of time required to pass through each of these "states" determines how much of the landscape will be characterized by a state at any point in time. Also important is the total length of time required to progress from bare ground to the climax vegetative state. For instance, in lodgepole pine, the "climax state" could be reached in 120 years, whereas this condition in mountain hemlock associations may require 300 years to attain.

The second approach involves natural disturbance regimes, which are distinct for each plant association group. These regimes vary in terms of the agents involved, as well as in periodicity, intensity, and magnitude of the affected area. Low intensity, high frequency disturbances modify the natural state much less dramatically than high intensity, low frequency disturbances such as stand replacement fires. Where high intensity disturbances affecting a large area are likely to occur, the natural range of variation must necessarily be broad in order to encompass the entire array of natural states that could occur through time.

As the progression through natural states was integrated with the disturbance regime for each PAG, estimates were made as to how much of each condition would exist on the ground at any point in time. The ranges of numbers reflect the natural variation through time, and take into consideration the dynamic nature of the system where succession and disturbances are continually operating.

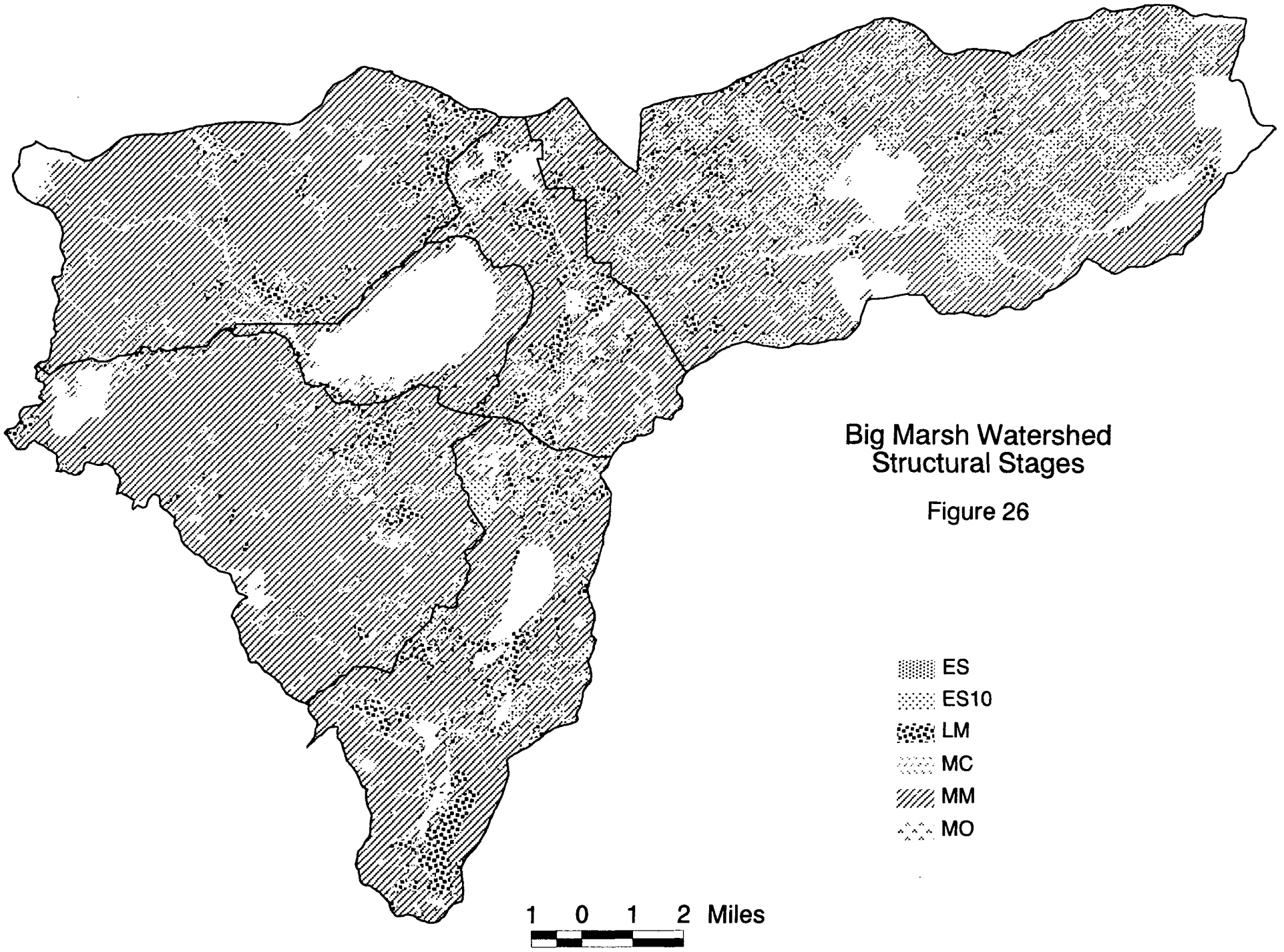
Table 4-1 contains a list and description of the structural stages that were used to stratify the existing and historic vegetative conditions in the Big Marsh Watershed.

Table 4 - 1, Structural Stage Descriptions

Code *	Structural Stage	Description
ES Early/Single	Stand Initiation	One canopy stratum (may be broken or continuos), one dominant cohort of seedlings or saplings. Grass, forbs or shrubs may be present with early seral trees.
EM Early/Multi	Understory Reinitiation	The overstory canopy is discontinuous. Two or more canopy layers are present. Overstory trees may be poles or of small or medium diameter. Understory trees are seedlings or poles.
MO Mid/Open	Stem Exclusion/Open Canopy	One discontinuous canopy stratum. One cohort of tree stems excluding competition. Trees may be poles or of small or medium diameter. Understory shrubs, grasses, or forbs may be present.
MC Mid/Closed	Stem Exclusion/Closed Canopy	Canopy layer is closed and continuous. One or more strata may be present. Lower canopy strata, if present, is the same age as the upper stratum. Trees may be poles or small or medium diameter. Understory shrubs, grasses, or forbs may be present.
MM Mid/Multi	Multi-stratum without Large Trees	The overstory canopy is discontinuous. Two or more canopy layers are present. Large trees are uncommon in the overstory. Horizontal and vertical stand structure and tree size are diverse. The stand may be a mix of seedlings, saplings, poles, or small or medium diameter trees
LM Late/Multi	Multi-stratum with Large Trees	The overstory canopy is broken or discontinuous. Two or more canopy layers are present. Medium trees and large-sized trees dominate the overstory. Trees of all sizes may be present. Horizontal and vertical stand structure and tree sizes are diverse.
LS Late/Single	Single-stratum with Large Trees	The single dominant stratum consists of medium sized or large trees. One or more cohort of trees may be present. An understory may be absent or consist of sparse or clumpy seedlings or saplings. Grasses, forbs, or shrubs may be present.

*Note: E, M, and L refer to early, mid, and late structural stages; S and M in the second digit refer to single and multi-stratum; O and C in the second digit refer to open and closed canopy. The structural stage of the forested area within the watershed is addressed by plant association group for each landscape area. The eight plant association groups (PAG) are shown in Table 2-1 and Figure 9. The structural stage for each plant association group is shown in Tables 4 -2 through 4 - 9, by landscape area and displayed in Figure 26. The source for the structural stage

INSERT FIGURE 26 - STRUCTURAL STAGE MAP


Big Marsh Watershed
Structural Stages
Figure 26
ES
ES10
LM
MC
MM
MO
1 0 1 2 Miles

is the 1988 LANDSAT imagery with interpretation done by Pacific Meridian Resources, which has been updated for timber harvest activities that have occurred since 1988. However, one problem that must be noted in using this information (Tables 4 - 2 through 4 - 9) is that the amount of acreage shown as multi-stratum without large trees (MM) is greater than the actual condition on the ground, and the amount of acreage shown as multi-stratum with large trees (LM) is smaller than the actual condition. This was discovered when comparing the landsat data with data from stand exams on another project. Not enough comparisons have been made to have a reasonable estimate of the amount of error.

As far as vegetation is concerned, the components of trend 1 are best discussed by plant association group, as each PAG has different structural and successional dynamics which affect the loss of LOS.

PONDEROSA PINE PAG

See Figure 9 for the distribution of ponderosa dry and wet across the watershed.

Table 4 - 2, Structural Stage for Ponderosa Pine Dry by Landscape Area

Structural stage	HRV Range %	Landscape Area							
			A	B	C	D	E	F	total
ES		acres		31		46	251		328
	0-10	percent		50.0		13.8	36.5		29.3
EM		acres							
	5-30	percent							
MO		acres							
	13-50	percent							
MC		acres				4			4
	0-10	percent				1.2			0.4
MM		acres		31		284	436	37	788
	15-60	percent		50.0		85.0	63.5	100	70.3
LM		acres							
	0-20	percent							
LS		acres							
	20-50	percent							
Total Acres				**62**		**334**	**687**	**37**	**1,120**

Table 4 - 3, Structural Stage for Ponderosa Pine Wet by Landscape Area

Structural stage	HRV Range %	Landscape Area							
			A	B	C	D	E	F	total
ES		acres				8	173		181
	0-10	percent				88.9	21.0		21.7
EM		acres							

	5-30	percent							
MO		acres							
	13-50	percent							
MC		acres							
	0-10	percent							
MM		acres				1	644		645
	15-60	percent				11.1	78.1		77.3
LM		acres					8		8
	0-20	percent					0.9		0.9
LS		acres							
	20-50	percent							
Total Acres						**9**	**825**		**834**

Both the ponderosa wet and dry PAGs are outside the historic range of variability (HRV) for virtually all successional stages with the exception of mid-seral, closed canopy (MC) and late seral, multi-stratum (LM).

The decrease in the percentage of late seral stands as compared to historic conditions is due to regeneration and overstory removal harvest activities. Following harvest activities, these stands were planted and are now in the early seral, single-stratum stage (ES), which is why there is a high percentage of stands in this seral/structural stage.

The increase in the percentage of mid-seral, multi-stratum stands results from the exclusion of fire for several decades from ponderosa pine stands. Fire exclusion has allowed significant ingrowth of the ponderosa and lodgepole pine seedlings, which are currently pole-sized or larger.

Ponderosa Pine Disturbance Events

The majority of the disturbance that has occurred within the ponderosa pine areas resulted from timber harvesting and its associated activities and took place within the past 45 years. The first harvest entries into ponderosa pine stands reduced potential tree mortality from bark beetles (*Dendroctonus* species), which flourish in overstocked ponderosa pine stands (USDA 1990). Other entries in the 1960-1980s consisted of even-aged management that converted overmature stands into young, thrifty, fast growing stands. Most of the fragmentation of the late and old structured stands resulted from these entries.

Vegetative Succession in Ponderosa Pine

The portions of the ponderosa pine stands which have not had regeneration harvest activities currently have late and old structural components. The exclusion of fire from these stands over the past 80 years or more has contributed to the development of complex fuel beds as tree and brush mortality increased.

Fire exclusion has also allowed less fire resistant species such as lodgepole pine to become established in the ponderosa pine stands. At present, most disturbances that do not remove the lodgepole pine seed source should expect a predominance of lodgepole regeneration in response. Areas where lodgepole pine regeneration has become established are more susceptible to stand replacement fires, since the lodgepole creates an effective fuel ladder.

As result of fire exclusion and management practices, stand conditions within the ponderosa pine PAG include increases in lower and mid story canopy densities, down woody debris, needle

cast, bark sluff at base of large trees, and bitterbrush growth and distribution. Fires in this altered ecosystem will have more fire intensity and severity than historically would have occurred.

LODGEPOLE PINE PAG

Table 4 - 4, Structural Stage for Lodgepole Dry by Landscape Area

Structural stage	HRV Range %	Landscape Area							
			A	B	C	D	E	F	total
ES		acres	3	10	10	332	910	362	1,620
	0-70	percent	0.8	4.0	4.0	7.6	20.1	11.8	12.8
EM		acres							
	0-10	percent							
MO		acres	10		52	29	11	18	120
	0-20	percent	2.7		21.0	0.7	0.2	0.6	0.9
MC		acres	209			47	7	209	472
	0-50	percent	56.2			1.0	0.1	6.8	3.7
MM		acres	119	61	93	3,633	3,434	2,093	9,733
	0-10	percent	32.0	95.3	37.3	83.2	76.8	68.3	74.5
LM		acres	31		34	326	170	382	1,003
	0-10	percent	8.3		37.7	7.5	3.8	12.5	7.9
LS		acres							
	0-30	percent							
Total Acres			**372**	**64**	**249**	**4,367**	**4,562**	**3,064**	**12,648**

Table 4 - 5, Structural Stage for Lodgepole Wet by Landscape Area

Structural stage	HRV Range %	Landscape Area							
			A	B	C	D	E	F	total
ES		acres				57	4	50	111
	0-30	percent				8.6	2.7	4.6	5.8
EM		acres							
	0-50	percent							
MO		acres							
	0-20	percent							
MC		acres	3					3	6
	5-50	percent	42.9					0.3	0.3
MM		acres	2			317	72	612	1,003
	5-10	percent	28.6			47.9	49.3	56.1	52.7
LM		acres							
	0-80	percent							
LS		acres							

	0-60	percent							
Total Acres			7			662	146	1,089	1,904

Table 4 - 6, Structural Stage for Lodgepole High Dry by Landscape Area

Structural stage	HRV Range %	Landscape Area							
			A	B	C	D	E	F	total
ES		acres	188	54	272	20	104	410	1,048
	0-70	percent	6.7	5.2	6.7	3.7	19.3	13.2	8.7
EM		acres							
	0-10	percent							
MO		acres	62	155	183	4		11	415
	0-20	percent	2.2	15.1	4.5	0.0		0.3	3.4
MC		acres	46	7	85	15		46	199
	0-50	percent	1.6	0.7	2.1	2.8		1.5	1.6
MM		acres	2,182	672	2,909	431	407	2,080	8,681
	0-10	percent	78.2	65.3	72.0	79.4	75.5	67.2	72.1
LM		acres	313	141	588	73	28	550	1,693
	0-10	percent	11.2	13.7	14.6	13.4	5.2	17.8	14.0
LS		acres							
	0-30	percent							
Total Acres			**2,791**	**1,029**	**4,037**	**543**	**539**	**3,097**	**12,036**

See Figure 9 for the distribution of lodgepole dry, wet and high elevation dry the watershed.

For the lodgepole dry and lodgepole high elevation dry PAGs the mid seral, multi-stratum (MM) structural stage is extremely abundant as compared to the HRV. Within the HRV elsewhere, however, several seral/structural stages are on the lower edge of the HRV. These stages include: early seral, single-stratum (ES); mid seral, open canopy (MO); and late seral, single-stratum (LS).

The lodgepole wet PAG is below the HRV in the mid-seral, closed canopy (MC), but is within HRV elsewhere. The lodgepole PAGs have wide ranges of variability due to the historic disturbance cycle of insect attack, fire, regeneration, maturity, and insect attack again. These events seemed to occur on large, contiguous acres as the stands develop towards the later seral stages, such as LM, and their susceptibility to infestation by the mountain pine beetle increases.

Mountain pine beetles have impacted portions of the watershed in the 1980s, especially along Crescent Creek and east of Crescent Lake, and set the stands back from late or old to earlier successional stages.

Lodgepole Pine Disturbance Events

The lodgepole PAGs have had some modification of the historic disturbance systems through human utilization of beetle-killed trees, the conversion of such stands to managed stands, and the suppression of fires. The primary impact of the harvest activities has been to remove most of the residual stand structure following beetle attacks and move the stands to single-storied, even-aged conditions. In addition, microclimate modifications are suspected when the woody biomass is removed from those sites, which makes cold sites more harsh.

The removal of beetle-killed lodgepole pine occurs as salvage and fuelwood gathering. These activities reduce the amount of down woody debris on the site, which reduces fire hazard but also reduces the effectiveness of the habitat for some species of wildlife. Harvesting of the residual green lodgepole trees leaves little or no structural diversity to the canopy.

Harvesting has also impacted soils with detrimental compaction of skid trails and landings. This could affect survival and growth of the residual and establishing stands over time; this typically occurs on 10 - 40% of the area.

Vegetative Succession in Lodgepole Pine

The cycle for the lodgepole PAGs is generally mortality of mature lodgepole from beetles, fire, regeneration, periodic low intensity fires in small areas, maturation of the overstory, and back to mortality from beetles. Portions of this PAG are presently in the post-epidemic portion of the cycle, which means that the beetle-killed stands have generally moved from late or old successional stages towards earlier stages. In other areas of the PAG, stands are approaching the mature stage.

Lodgepole stands have been heavily harvested in recent history. After harvest, most of the slash in units was piled with bulldozers and burned. The areas where harvesting did not occur are nearing the end of their life span, which is about 80 to 120 years. In addition, the exclusion of fire has resulted in increased needle cast and down woody material within those stands which puts those stands at risk to stand replacement fires. Fires in this altered ecosystem will have more intensity and severity than historically would have occurred, and the fires will occur over a broader portion of the ecosystem.

MIXED CONIFER (wet and dry)

Table 4 - 7, Structural Stage for Mixed Conifer Dry by Landscape Area

Structural stage	HRV Range %	Landscape Area							
			A	B	C	D	E	F	total
ES	0-20	acres	78	81	326	103	4,147	450	5,185
		percent	2.1	5.1	8.0	17.5	23.0	11.7	16.3
EM	0-20	acres							
		percent							
MO	15-50	acres		1	64		2		67
		percent		0.0	1.6		0.0		0.2
MC	7-20	acres	7		118		6	7	138
		percent	0.1		2.9		0.0	0.2	0.4
MM	10-55	acres	3,030	1,411	3,538	477	12,794	3,287	24,595
		percent	83.5	90.4	87.4	80.8	71.4	85.3	77.7
LM	8-30	acres	511	67		10	1036	108	1674

		percent	14.0	4.3		1.7	5.4	2.8	5.3
LS	15-60	acres							
		percent							
Total Acres			**3,626**	**1,560**	**4,046**	**590**	**17,985**	**3,852**	**31,659**

Table 4 - 8, Structural Stage for Mixed Conifer Wet by Landscape Area

Structural stage	**HRV Range %**	**Landscape Area**							
			A	**B**	**C**	**D**	**E**	**F**	**total**
ES	0-10	acres				3		16	19
		percent				2.5		3.8	2.4
EM	0-30	acres							
		percent							
MO	5-20	acres							
		percent							
MC	8-20	acres	5					5	10
		percent	22.7					1.2	1.3
MM	10-40	acres	17	68	126	117		404	732
		percent	77.3	85.0	100	97.5		95.0	94.7
LM	10-40	acres		12					12
		percent		15.0					1.6
LS	1-3	acres							
		percent							
Total Acres			**22**	**80**	**126**	**120**		**425**	**773**

See Figure 9 and for the distribution of mixed conifer dry and wet across the watershed.

The mixed conifer dry PAG has four structural stages outside of the historic range of variability. The mid-seral, open canopy (MO); mid-seral, closed canopy (MC); and the late-seral, single-stratum (LS) are below the historic levels. Tne mid-seral, multi-stratum (MM) is above historic levels.

The mixed conifer wet PAG has five structural stages outside of the historic range of variability. The mid-seral, open canopy (MO); mid-seral, closed canopy (MC); the late-seral, multi-stratum (LM); and the late-seral, single-stratum (LS) are below the historic levels. The mid-seral, multi-stratum (MM) is well above historic levels.

The difference between the HRV and current acreages in both mixed conifer PAGs is due, in part, to fire exclusion. Many of the existing stands have had fire excluded from them for several decades. The exclusion of fire has allowed significant ingrowth of the true firs and shade tolerant seedlings which are all pole-sized or larger. In addition, most of the stands that have not had much harvest activity would fall in the MM or LM stages. Portions of the mixed conifer dry are

located within the Diamond Peak Wilderness, which does not allow timber harvesting, and OCRA, where harvesting is uncommon. The mixed conifer wet PAG is primarily located in the vicinity of riparian areas which generally are not harvested.

The lack of sufficient acres of late-seral stands is also due, in part, to regeneration and overstory removal harvest activities. These harvest activities caused the stands to move from the late-seral to earlier seral stages. In addition, late-seral stands are lacking due to the relative frequency and intensity of historic fire entries. These fires were low intensity, favored early seral species, and kept less fire tolerant species abundance at low levels. The several decades which have passed since fire exclusion began have not been sufficient to allow medium and large shade tolerant species to dominate these sites.

Existing Vegetative Condition in Mixed Conifer

Within the mixed conifer wet PAG the size/species/structure stages which are in greatest over-abundance include the pole-sized and small-tree stages of white fir. Given that white fir is highly susceptible to many insects and diseases, it is likely that stands dominated by this species will experience changes in structure. Most of the disturbances such as root diseases and bark beetles do not produce drastic changes in species composition; instead, they cause the stands to be dominated by firs of smaller sizes as these recolonize the openings created in the stands.

Where mixed conifer wet stand densities are high, there is the likelihood that seral species (lodgepole pine and ponderosa pine) may be removed either through competition with white fir or through the selective bark beetles which prey on the pine species (mountain pine beetle and western pine beetle). *The result would be a shift in succession toward the later stages, which* are dominated by fir.

Fire exclusion efforts have probably had the most profound effects within the mixed conifer dry PAG (Agee 1993). This PAG is most likely to experience large-scale and dramatic changes in size, structure, and species composition due to disturbance from insects and diseases.

Severe imbalances exist within the mixed conifer dry PAG with respect to the HRV. The greatest shortages between historic and current acreages occur in the open park-like ponderosa pine stands. The structural stage which is dominant on the landscape and occurs in excess of the mixed conifer dry HRV is the mid-seral, multi-stratum condition.

The structural stage distribution within the watershed clearly reflects the influence of fire exclusion and also suggests that stand densities are very high. Due to high stand densities of the true fir in the understory, disturbance agents which thrive on true fir (including the fir engraver, defoliating insects, and Armillaria root disease) could have immediate and continuing effects on the fir component. In addition, extreme competition between the true firs and the ponderosa pine trees will also place the ponderosa at risk and will greatly increase the rate at which the pathogens and insects of pine are likely to express themselves. These effects are most visible where the fir component is largest and most abundant.

Disturbance Events in Mixed Conifer

The majority of the disturbance that has occurred within the mixed conifer areas resulted from timber harvesting and its associated activities and took place within the past 45 years. The first harvest entries reduced potential ponderosa pine mortality from bark beetles, which flourish in overstocked stands (USDA 1990). Other entries in the 1960-1980s consisted of even-aged

management that converted overmature stands into young, fast growing stands. Most of the fragmentation of the late and old structured stands resulted from these entries.

Vegetative Succession in Mixed Conifer

The portions of the mixed conifer stands which have not had regeneration harvest activities currently have late and old structural components. The exclusion of fire from these stands over the past 80 years or more has contributed both to the increase of later seral species encroachment and in the development of complex fuel beds as tree and brush mortality increased. In addition, development of dense brush in some areas has resulted in a situation where abundant ladder fuel conditions exist.

As result of fire exclusion and management practices, stand conditions within the mixed conifer PAGs include increases in lower and mid story canopy densities, down woody debris, needle cast, and bark sluff at base of large ponderosa pine trees. Fires in this altered ecosystem will have more fire intensity and severity than historically would have occurred, because stand density contributes greatly to vertical continuity and surface fuel buildup, especially in the mixed conifer dry PAG.

MOUNTAIN HEMLOCK PAG

Table 4 - 9, Structural Stage for Mountain Hemlock Dry by Landscape Area

Structural stage	HRV Range %	Landscape Area							
			A	B	C	D	E	F	total
ES	NE	acres	133		60		75	9	277
		percent	1.0		0.4		11.8	0.2	0.8
EM	NE	acres							
		percent							
MO	NE	acres	4		8				12
		percent	0.0		0.1				0.0
MC	NE	acres	22		63			22	107
		percent	0.1		0.4			0.5	0.3
MM	NE	acres	12,852	12	13,771		493	3786	30,914
		percent	97.4	100	98.2		78.1	82.4	95.3
LM	NE	acres	183		121		63	777	1144
		percent	1.4		0.9		10.0	16.9	3.5
LS	NE	acres							
		percent							
Total Acres			**13,194**	**12**	**14,023**		**631**	**4,594**	**32,454**

See Figure 9 for the distribution of mountain hemlock across the watershed.

The mountain hemlock dry PAG is considered to be within the historic range of variability. Studies have shown that the range of variability on these sites is very broad and cycles over periods of 600 to 1,200 years or more.

The high elevation forest of the Big Marsh Watershed is characterized by mountain hemlock as a major component of the overstory vegetation. Subalpine fir, pacific silver fir, white bark pine, high elevation lodgepole pine, and white fir are all found in the overstory and understory.

The disturbance processes affecting the mountain hemlock PAG cause patterns of structure, density and species composition in the vegetation to slowly develop over many hundreds of years. These patterns occur so slowly, in fact, that they develop along with overall changes in climate and geologic events.

In this century it is assumed that the trend in the mountain hemlock PAG shifted towards more "climax" or hemlock forests (over the more seral lodgepole), and an associated increase in the abundance and size of laminated root disease mortality centers resulted. These assumptions are based on the fact that recorded disturbances (or lack thereof) have been those which favor proliferation of the hemlock forest and the root disease. In other words, there have been no recorded fires of significant size, and there have been two significant bark beetle epidemics (one in the early 1900s and one in the 1980s). Up to this point in time, human fire suppression has probably had little or no observable influence on these stands (Dickman and Cook 1988), and, in addition, there has been little management within the hemlock forest in this watershed.

Existing Vegetative Condition in Mountain Hemlock

The mountain hemlock PAG is dominated by the later successional species and the pole and small tree structure classes. The abundance of mountain hemlock-dominated stands implies that a large-scale disturbance such as fire or extensive windthrow has not occurred for a long time. As such, the disturbance agents of lodgepole pine (mountain pine beetle, lodgepole pine dwarf mistletoe) are exerting limited influence at this time due to limited presence of their host tree. The most significant disturbance agent in these stands would be laminated root rot which is creating and expanding patches within the stands dominated by mountain hemlock.

Disturbance Events in Mountain Hemlock

Most of the mountain hemlock PAG is located in the Diamond Peak Wilderness and OCRA, where harvest activities have not occurred. Disturbance events consist primarily of historic stand replacement fires, with an estimated frequency of 600 to 1,200 or more years, and root rot pockets caused by laminated root rot (*Phellinus weirii*) (Dickman and Cook 1988).

The root rot centers range from very small (< 1 acre) pockets to nearly 300 acres in size. Due to the slow rate of expansion of the root rot centers, approximately one foot per year, they fill in with vegetation that is more tolerant or immune to the root rot (Dickman and Cook 1988). Hence, several feet into the root rot centers, there is well established vegetation providing cover for wildlife, diversity in stand structure, and soil stability.

Vegetative Succession in Mountain Hemlock

Historic vegetative successional processes are continuing relatively undisturbed by human activities. Fire suppression within this century seems to have had very little affect on the successional processes in the mountain hemlock PAG.

Fragmentation in Mountain Hemlock

As discussed under disturbance events, only a very small portion of these PAGs have been impacted with harvest or other management activities. Most of the current fragmentation of the late and old stands is a result of the root rot pockets and is expected to increase as the pockets

grow in size. In time, perhaps several hundred years when the fuel beds become complex, these stands may experience large stand replacement fires.

Insect/Disease Activity and Stand Structural Patterns in Mountain Hemlock

The later successional mountain hemlock dominated portion of the PAG is comprised of laminated root disease mortality pockets. These pockets are structurally composed of an outer edge of mortality as the root disease progressively spreads radially through root contacts to adjacent mountain hemlocks, colonizes, and kills them. In the older parts of the mortality center, tree reproduction has become reestablished (although with a higher proportion of resistant species like lodgepole pine and western white pine). Structurally, the infection centers are more open than the characteristically dense uninfected hemlock forest; and the progressive mortality and regeneration associated with these centers have created a variety of gap patterns across the landscape. Centers also have larger numbers of snags and a higher volume of down woody debris. Although they are not affected by the laminated root disease, the western white pine is experiencing high mortality rates as a result of white pine blister rust (*Cronartium ribicola* Fisch).

VEGETATION SUMMARY OF ALL PAGs

After review of Tables 4 - 2 through 4 - 9 and review of recent aerial photos, the following points are significant in relation to stand structure. Regeneration harvest (clearcutting, seed tree cutting, and shelterwood cutting) which was done primarily from about 1970 to 1990, has reduced the amount of late and old structured stands and increased the amount of seedling, sapling, and pole size stands. This is true for the lodgepole dry, ponderosa pine dry and wet, and mixed conifer dry PAGs, and affects Landscape Areas D, and E, and to a lesser extend area F and B. This results in fragmentation of habitats for wildlife species that are dependent on larger blocks of late and old structured stands.

Data also seems to indicate a lack of the large tree single-stratum structure in the ponderosa dry and the mixed conifer wet and dry. This is the open, large tree dominated ponderosa pine stands, with occasional Douglas-fir and/or true fir included on mixed conifer sites. These stands have developed into multi-storied stands from the exclusion of low-severity fires or management activities. Severe imbalances exist within these open large ponderosa stands with respect to their Historic Range of Variability (HRV) Currently less than 1% of the acres are in this size class. The structural stages which are dominant on the landscape and occur above the HRV include the pole-sized and small-tree components of the climax species. These abundance's and shortages clearly reflect the influence of fire exclusion and also suggest that stand densities are very high.

Of all the identified PAGs, the mixed conifer dry PAG is the one most susceptible to the loss of late and old structures stands and the increase in small diameter seedlings, saplings and poles. Mixed conifer dry is also the most common PAG in the watershed. Regeneration cutting in the past two decades has fragmented most of the areas outside of the Wilderness and OCRA boundaries. These have been restocked with ponderosa pine or a pine dominated mix. On the remaining stands, fire exclusion has allowed the climax true firs (mostly white fir) and Douglas-fir to dominate the understory. This crowding has accelerated the mortality of the large ponderosa and sugar pine to the point that they will soon be lost from many sites. The high densities are also retarding the growth of individual trees so that as the large trees die they are not replaced. There has been a gradual but major shift over several decades from an open stand condition dominated by large pine to a very dense condition dominated by pole to small and medium diameter true firs.

In the ponderosa and mixed conifer stands where a dense understory has developed in a large tree, ponderosa pine dominated stand, stand density continues to increase and the vigor of the overstory declines. As the vigor of the overstory ponderosa continues to decline, bark beetles will kill these trees over time, significantly reducing the amount of large ponderosa pine. On ponderosa PAG sites, the understory trees are ponderosa pine, and a substantial amount of lodgepole pine on some sites. On mixed conifer PAG sites, the understory trees are primarily true fir, with some lodgepole pine, Douglas-fir, and other associated species. As the amount of true fir increase across the landscape, and stand densities in mixed conifer stands increase, the amount of mortality from fir engraver beetle will also increase, with the potential for mortality to reach catastrophic levels from fir engraver and spruce budworm.

As these conditions continue, particularly in the absence of vegetative manipulation by harvest or fire, the risk of stand replacement events increases in at least two ways: 1) First, the larger the area of homogeneous stand conditions, the more food is available to support epidemic levels of insect and/or disease activities, and 2) as fuel beds become heavier and more complex, their resistance to fire control increases, especially during extreme fire conditions. (See discussion in Trend 3).

Insects and Disease For All PAGs

Bark beetles are the main insect causing mortality to stands in the last several years, as indicated by annual aerial surveys. Mountain pine beetle mortality in lodgepole is the most significant in terms of number of trees killed. The areas that have incurred high mortality are between Crescent and Odell Lake within the Wilderness and east of Crescent Lake. Various other areas incurred lighter mortality. Mountain pine beetle has caused scattered mortality in western white pine, sugar pine, and occasionally whitebark pine. Scattered large ponderosa pine have been killed by the western pine beetle. Fir engraver and Douglas-fir beetle have caused limited mortality to true fir and Douglas-fir respectively.

Armillaria, annosus, and laminated root diseases are present in the watershed, however, for the most part, are not very significant agents in terms of growth reduction or mortality. Laminated root disease is significant at higher elevations in the mountain hemlock type, and can be viewed as an agent that provides diversity within the root rot pockets that it causes.

White pine blister rust has caused mortality wherever white pine, sugar pine, or whitebark pine are present.

Dwarf mistletoe is present to varying degrees in lodgepole and ponderosa pine in the watershed. There are some lodgepole stands that have very heavy mistletoe infection. Fire exclusion and other management activities have caused an increase in the incidence of mistletoe.

FUELS (trend 1)

Much of the fuels discussion concerning the historical role of fire in each of the PAGs is discussed in the above section on vegetation.

The potential loss of LOS could be directly related to fire. From a fuels standpoint, the increase in understory density has created a vertical path (ladder effect) for surface fire to quickly move into the forest canopy and threaten what late and old structure stands that remain. This is true for the mixed conifer, ponderosa pine, and lodgepole pine PAGs. These ecosystems are dependent on more frequent fire return intervals to maintain the balance of the system by keeping the understory regeneration more open, surface fuels reduced, and nutrients recycled. The increased size and intensity of future fires will most likely be outside the historic range of variability and result in loss of large blocks of LOS.

Continued fire suppression will result in increased mortality of large trees from insects and disease and increased competition for nutrients; species conversion to plants less resistant to fire; and further accumulation of down woody debris and understory vegetation. Without the reintroduction of prescribed fire or other treatments that mimic fire, the likelihood of stand replacement fires will continue to increase, as will loss of LOS stands in subsequent high intensity fires

See Trend 3 for a more complete discussion of the fuels situation by PAG in Big Marsh Watershed.

WILDLIFE (trend 1)

The reduction of LOS habitat could affect many wildlife species. While large blocks of LOS habitat are being provided in Landscape Areas A, C, and F, contiguous habitat to other areas within and adjacent to the watersheds is lacking, especially at lower elevations. Connectivity is needed between large blocks of habitat to provide for genetic transfer among populations of the same species, provide prey base habitat , and to provide suitable habitat for species dispersal. Most of the LOS loss is occurring in Landscape Areas, B, D , and E.

There has been a loss of large trees due to timber harvesting. Large trees are an important habitat component for breeding and roosting wildlife. Species such as the brown creeper create nests under the large loose bark, while several species of bats (myotis) utilize this bark for roosting. Bald eagles, golden eagles, and great blue herons depend on large trees to create their nests in. Cavities in large trees are used by various species such as marten, fisher, bear, and squirrels for denning, nesting, or resting.

The loss of large snags to firewood cutting, timber harvesting, and safety hazard reduction has eliminated much of the habitat needed by primary and secondary cavity users. Areas that typically lack snags are recreational use areas adjacent to water bodies, and streams in the lodgepole forests (firewood collection), and mixed conifer PAGs (timber harvest). Many waterfowl species including the wood duck, Barrow's goldeneye, bufflehead, common goldeneye, and common merganser, have shown a decline, possibly due to the loss of snags.

Deer and elk populations within the watershed have increased over time as a result of past timber harvest activities which created forage (harvest units) in close proximity to cover. In addition, there has been an increase in amount of effective deer and elk cover where fire suppression has resulted in dense understories of white fir. Stands infected with insects have provided additional security habitat in areas of abundant downed logs. Increased stand densities may also aid in the creation of large snags due to the increased mortality.

LANDSCAPE AREA B

The mixed conifer PAG contains significant numbers of ponderosa pine with an understory of pine associated species. This plant association group and its close proximity to Crescent Lake provide habitat for nesting roosting and foraging bald eagles. The denser stands provide superior habitat for wintering bald eagles. These stands are on the northwest and southeast shore of Crescent Lake. The area around Camp Makualla is typical of this type of wintering bald eagle habitat. Continued loss of the large tree component of the LOS stands would significantly impact this important habitat.

The exclusion of fire has created denser, multi-storied stands that provide suitable habitat for the spotted owl and wintering bald eagles, however, preferred eagle nesting habitat is located in open, park-like ponderosa and mixed conifer stands. The dense understory that currently exists within the mixed conifer stands is increasing the mortality of the large trees needed for eagle nesting and roosting. These dense, multi-storied stands may not be sustainable due to the increased risk of fire and insect and disease infestations. A balance needs to be achieved between retaining suitable habitat to meet wildlife species needs, i.e. spotted owl and eagle, and maintaining habitat that is sustainable.

This landscape area is important to other LOS associated species that utilize habitat in close proximity to water, including: great gray owls, American marten, fisher, and woodpeckers.

Previous regeneration harvest units have little remaining down woody material, snags, green tree replacements or biological legacies from the pre-harvest stands. This has removed habitat for American marten, flammulated owls, white-headed woodpeckers and a variety of species that utilize ponderosa and mixed conifer stands. Effective interior late-successional and old growth habitat is also reduced. by the edge effect of harvesting.

LANDSCAPE AREA D

A large percentage of this landscape area is within the lodgepole dry PAG. This PAG has experienced some mortality in the 1980s from the mountain pine beetle epidemics, which

changed later seral lodgepole to earlier seral stages. Salvaging of dead and dying lodgepole occurred, and resulted in the removal of snags and down woody material that provide habitat for black-backed woodpeckers, American marten, and northern goshawks. The majority of stands in the lodgepole PAG are currently in the mid-seral stage without large trees. Habitat is currently provided for the above species, but if harvesting is to occur, efforts should be made to retain levels of snags and down woody debris that will continue to provide suitable habitat.

LANDSCAPE AREA E

Current vegetation management projects in this landscape area have focused on reducing stand density in mature forests to reduce the risk of insects and disease. Thinning from below and uneven-aged management increases stand vigor, and reduces canopy cover and stand complexity. This type of management changes wildlife habitat to favor more open canopy species. Vegetative treatments also alter the natural recruitment and retention of snags and down woody material within mature stands. In some cases, treatment of stands for forest health necessitates the need for artificial snag creation. This short-term reduction of LOS type habitat will affect the northern spotted owl, goshawk, American marten and other LOS associated species.

Much of Landscape Area E is within the Seven Buttes Planning area. Seven Buttes project will treat 2100 acres of this watershed in the next five years, 580 of which are in the Davis Late Successional Reserve (LSR). The Seven Buttes Environmental Assessment (EA), which analyzed approximately 90% of Landscape Area E in 1996, addressed the issue of LOS and connectivity. LOS forests serve as critical habitat for Deschutes Forest Management Indicator Species (MIS) and species of concern in the Northwest Forest Plan including: American marten, northern goshawk, black-backed woodpecker, and great gray owls.. Treatments within the LSR were designed to protect the long-term LOS habitat by reducing stocking densities in areas that were at high risk to insect and disease outbreaks. The silvicultural prescriptions, the amount of area treated, and the juxtaposition of treatment units ,were designed to minimize impacts to spotted owl nesting, roosting and foraging (NRF) habitat and associated LOS species habitat. There was a tradeoff of short-term loss of nesting and roosting habitat for long-term habitat sustainability. The US Fish and Wildlife Service was consulted and concurred with the project (see Biological Opinion of October 18, 1996). In areas outside the LSR, effects from loss of LOS would be the same as described in Landscape Area D.

LANDSCAPE AREA F

Limited harvesting has occurred within this landscape area. For the areas that have been treated, see the effects listed under Landscape Areas B, D, and E. The majority of this landscape area is within the OCRA and has not been harvested. Mixed conifer and lodgepole dry are the primary PAGs in this area. See the information listed under the previous landscape areas in regards to increasing stand densities and loss of LOS and the effects on wildlife species.

BOTANY (trend 1)

Many late-successional and old growth associated fungi benefit from the biological legacies that persist from old growth stands, including coarse woody debris, habitat structures, and host species. Mycorrhizal fungi require live hosts, including conifers, and many species of vascular plants, which, in turn, depend on the fungi for uptake of nutrients and water. Many species of fungi require the microclimate that is provided by old growth stands. Coarse woody debris is an important substrate for many fungi and other LOS associated plant species. The short rotation scenario in the matrix (80-120 years) will not provide an adequate renewable supply of large down logs over successive rotations. Forest management may have positive effects for some

species such as increasing the sustainability of fungal diversity within managed stands as a result of increased structure, age-class distribution, and diversity of species.

The Northwest Forest Plan includes provisions that benefit LOS associated species by including provisions to retain old growth fragments, especially in LSRs; by allowing for coarse woody debris and green tree retention in the matrix; and by providing 100-acre habitat areas around spotted owl activity centers. Patches of old growth distributed across the matrix are important refugia for late successional plant species as well as lichens and bryophytes, as well as a source of innoculum for dispersal into adjacent stands.

One of the mitigation measures in the NWFP that would benefit LOS species is the provision for a well-distributed network of late successional and old growth stands throughout the landscape. The extremely slow growth rates and long periods required for certain late successional and old growth associated lichens and other plants to colonize stands emphasizes the considerable importance to these species of existing old stands and old trees within younger stands. The largest, oldest trees with the most diverse structural characteristics; trees that have abundant epiphytic flora (provide a source of genetic material and propagules for a greater number of species); and leaning trees (important for pin lichens) should be selected for retention.

SOCIAL (trend 1)

The loss of late and old-structured forest stands has been referred to as the loss of our ancient forests or old growth. These terms relate to a range of social values attached to the famous big trees of the Pacific Northwest such as the yellow-bellied ponderosa pine and the Oregon state tree, Douglas-fir. It is difficult to measure the aesthetic and spiritual value of these big trees within the Big Marsh Watershed. However, public comments concerning the harvest of big trees (21"+ in diameter) on the Deschutes National Forest validates a general concern for the preservation of old growth/large diameter trees.

Within the Big Marsh Watershed there is a diversity of plant association groups (PAGs). Each plant association group has its desired social function as well as an inherent wildlife and ecological function. Of all of the PAGs, the mixed conifer dry PAG is the most complex to manage. From a scenic perspective, it can be managed to provide an open park-like stand of ponderosa pine or a mixed conifer stand that highlights large Douglas-fir.

These same stands can also be valued and managed to provide habitat for endangered species such as the northern spotted owl which requires a dense, multi-storied canopy stand. In order to achieve the desired long-term social functions of a mixed conifer dry stand, i.e. either a scenic function, wildlife function, or a combination over time, a deliberate decision must be made in the short-term to move a stand toward its desired condition. Otherwise, successional processes will continue and limit management options in the future.

LANDSCAPE AREAS A, C and F

The presence of large trees is expected in the Diamond Peak Wilderness and Oregon Cascades Recreation area where timber values are superseded by the recreational, spiritual values and wildlife associated with large trees. National law designates these areas to be preserved or managed to protect their primitive or semi-primitive recreational settings. Within these primitive type settings, evidence of ecological processes is an expected component of the scenery. Visitors may anticipate observing snags, fire scars, or blowdown in the landscape. In areas where the loss of big trees is due to the lack of natural disturbances, the introduction of such disturbance patterns may be appropriate and acceptable to the public. However, an emphasis should be placed on mimicking natural disturbance patterns in terms of line, form, color, and texture.

LANDSCAPE AREA B

Maintaining the beauty and diversity of vegetation in this intensive recreation area is a high priority. Vegetation in campgrounds and picnic areas is essential in creating feelings of openness or privacy, providing sun and shade, allowing scenic views and providing wildlife habitat to further enhance the recreation experience. The use of this environment by both humans and wildlife makes management of the vegetation a complex issue. There is an opportunity to greatly enhance the sustainability of the big trees and their associated social and biological functions if a multi-disciplinary team could comprehensively evaluate the existing situation and propose appropriate short-term actions.

Crescent Lake Campground has a very diverse tree population, with old-growth ponderosa pine and Douglas-fir being special attractions. Smaller diameter white fir encroachment is diminishing the big tree feel of this area, as well as creating competition that is detrimental to these large trees. Many of the white fir in the campground died last summer, and there is evidence of fir engraver beetle infestation. Lodgepole in the campground are also under pine beetle attack, with the level of mortality yet to be determined. A silvicultural evaluation of this campground is needed, with a goal of preserving and enhancing the health of desirable species through thinning and removal of diseased trees. Camp Makualla (the Boy Scout Camp) and the recreation residences have similar problems and are also in need of evaluation.

The recreation residences are located along the edge of a BEMA within the mixed conifer dry PAG. These stands have developed dense understories as a result of fire exclusion. The large ponderosa pine and Douglas-fir are being stressed and some are experiencing mortality. These trees which could provide beneficial habitat for wildlife, including eagles, are often considered hazard trees due to the proximity to homes and roads. Reducing the understory density within these stands should alleviate some of the competition and mortality within these stands.

Spring Campground is located in a stand of lodgepole pine with no understory, creating a very open feel with little or no screening between campsites. The openness of this stand allows spectacular views of Crescent Lake and Diamond Peak. The overall health of the lodgepole stand seems quite poor, with many trees weakened due to rot. Soil compaction and root exposure are critical issues in this campground. These problems, in combination with periodic high winds off the lake, increase the need for silvicutural evaluation of this area, as well as immediate hazard evaluation of all trees.

Contorta Point is also located in a lodgepole stand suffering from soil compaction and root exposure due to unregulated vehicular travel. Plans for Youth Conservation Corps crews to place barrier posts in this campground in the summer of 1997 will help to prevent further damage. There is a need to mitigate compaction and plant vegetation in this campground in an effort to reduce erosion and ensure sustained vegetative cover.

Trend 2 - Increased fragmentation and reduced connectivity in late and old structure stands and riparian habitats.

VEGETATION (trend 2)

Increased fragmentation is predominantly the result of regeneration harvest (clearcutting, seed tree cutting, and shelterwood cutting). This type of harvest increases the amount of seedling sapling and pole-sized stands and thereby increases fragmentation of large blocks of habitat, especially for late and old structure associated species. The majority of the disturbance has occurred within the mixed conifer dry and the ponderosa pine PAGs over the past 45 years. In the 1960s, 70s, and 80s, silviculturists determined that even-aged management, with its conversion of overmature stands into young, fast growing stands, was the best way to manage mixed conifer and ponderosa pine. Most of the fragmentation of the late and old structured stands resulted from these entries. Even with vegetation management activities, it will take several decades to return these even-aged stands of regeneration back to complex structured stands.

Fragmentation of timbered stands, primarily in the mixed conifer and ponderosa pine PAGs in Landscape Areas D and E, has resulted in a patchwork of stand patterns which are easily observed from aerial surveys. These fragmented, early seral patches, usually result in a smaller diversity of plant and animal species than would be found in later successional stages of stand development.

The arrangement of the structural stages across the landscape is vastly different from that which historically occurred. Early seral stands are generally located in 40 acre patches across the landscape with later seral stands located between the patches. With historic disturbances, larger patches of both early and later seral stands would have been distributed across the landscape.

Recent harvest practices have focused on leaving a sufficient canopy cover and understory component to retain at least marginal LOS and connectivity habitat for the short-term, with the goal of sustaining sufficient amounts of this type of habitat for the long-term.

WILDLIFE (trend 2)

Timber harvest, road building, urban development, and a host of other natural and human caused disturbances are among the elements that fragment LOS habitat and reduce connectivity between patches of LOS habitat. Lack of connectivity may result in genetic isolation of populations and vulnerability to predation during dispersal for some species. Fragmentation also results in poor habitat and reduced birth rates, higher juvenile mortality, and higher adult mortality for many species. Riparian areas also function as travel and dispersal corridors for both terrestrial and aquatic species and serve an important connectivity function. Approximately 182 species utilize the riparian areas throughout the watershed. These areas are extremely important for primary and secondary cavity nesting species requiring riparian areas for all or a portion of their life cycle. It is also important to small mammal and amphibian populations requiring moist micro-site habitat and down woody material. (See Appendix B for species habitat descriptions)

While large blocks of LOS habitat may be provided in Landscape Areas A, C, and F, contiguous habitat to other areas within and adjacent to the watershed is lacking, especially at low elevations. Connectivity is needed between large blocks of habitat to provide genetic transfer among populations of the same species, prey base habitat, corridors for dispersal of individuals and populations, and ensure viability of a species within its range. This connectivity is valuable for plant as well as wildlife species.

Factors contributing to reduced connective habitat loss include: past regeneration harvests; firewood collection, which removes snags and down woody debris; current timber management; transportation system, i.e. roads, skid trails, and summer and winter recreation trails; commercial forest product collection, which may remove a potential food source; and fire suppression activities, which modifies natural succession, recruitment of snags and down woody material, and creates dozer lines around the fire perimeter which act in the same manner as a road as far as a barrier to connectivity.

Connective habitat needs to be in widths that provide interior habitat conditions or conditions that provide cover from natural predators. For animals to disperse, especially juveniles, security is a prime factor for successful establishment of unoccupied available and suitable habitat.

Fragmentation reduces habitat for species that require large home ranges with continuous habitats and species that use interior, non-edge influenced, habitats. Species preferring edge and earlier seral stages are favored in a fragmented landscape to the detriment of species preferring LOS and interior habitat. Species that prefer earlier seral stands include deer, elk, barred owl, red-tailed hawk, brown-headed cowbird, European starling, and coyote among others. Species that utilize LOS and interior habitat that are most impacted by fragmentation include: spotted owl, goshawk, marten, fisher, great gray owl, pygmy owl, and neotropical migratory birds. See Trend 1 for additional species that utilize LOS and interior habitat.

Past timber harvest activities have reduced and fragmented suitable spotted owl habitat within areas outside the Wilderness and OCRA. Habitat loss and fragmentation within the mixed conifer PAGs have detrimentally affected the owl in several ways. These effects include: a reduction in the available habitat for spotted owl territories; increase in the amount of energy needed to successfully reproduce, thus reducing individual fitness and reproductive potential; reduction in dispersal capabilities; and increase in competition and predation with other raptors such as the great horned owl and goshawk. Barred and great horned owls have successfully adapted to fragmented habitats and are known to compete with the spotted owl for habitat (space) and prey; and may potentially consume spotted owls as prey. Habitat fragmentation in the mixed conifer zone has reduced north to south dispersal corridors for the spotted owl, whereas the east to west corridors that occur within the mountain hemlock zone are stable.

LANDSCAPE AREAS A and C

These two landscape areas have only minor breaks in connectivity because of the lack of past timber harvest. OCRA and the Wilderness areas are not scheduled for regular timber harvest. Some trail crossings in the Wilderness and OCRA are causing minor riparian damage and possible breaks in riparian connectivity. This damage includes trampling of riparian vegetation, bank instability, erosion and soil compaction, which increase runoff and sedimentation. Species that may be affected include: wolverine, marten, amphibians, and other riparian associated species. For the most part, however, connectivity is not an issue in these two watersheds.

LANDSCAPE AREA B

Some breaks in connectivity are occurring along the lakeshore of Crescent Lake especially during periods of heavy recreational use. Some of the disruptions in connectivity are caused by developed recreation sites, user-defined trails, human disturbance, compaction and erosion, roads, damage to riparian vegetation, and removal of down woody debris.

LANDSCAPE AREAS D, E, and F

Past harvest practices, cattle grazing, roads, land development, and other private land uses in riparian and riparian buffer areas have altered riparian habitat, especially along Crescent Creek. These practices have caused breaks in connectivity; increases in riparian temperatures, sunlight, erosion, compaction, sedimentation, runoff, and damage to riparian vegetation; and changes in moisture regimes. The grazing and trampling of sedges, forbs, willows and shrubs detrimentally impacts habitat for nesting birds, waterfowl, and small mammals. Other species that may be affected include: great gray owl and big game.

Land development and cattle grazing have resulted in displacement of species requiring riparian and adjacent forested habitats that are more susceptible to human disturbance. Species also dispersing or moving from summer to winter ranges have altered their travel patterns and are circumventing the developed areas of Crescent Lake Junction.

BOTANY (trend 2)

Within Landscape Areas D and E, increased fragmentation and reduced connectivity has likely adversely affected most or all LOS dependent vascular plant, bryophyte, fungus, and lichen species with regard to seed, spore, and propagule dispersal; gene flow; and viability concerns. However, a loss of connectivity may also be beneficial to some species which prefer a more open habitat.

Large and relatively unfragmented habitat areas may be important to maintain viability and promote gene exchange for *Allotropa virgata*, due to its small, ephemeral seeds and obligate mycorrhizal relationship. Small LOS fragments are suspected to contribute significantly to the predicted viability of ALVI, due to the limited dispersal capability of this species and the fragments' function as corridors. Smaller fragments are also presumed important to the mycorrizal fungi which are symbiotic with ALVI (USFS Appendix J2 1994).

Older stands that are well-distributed geographically would improve the likelihood of survival and persistence of lichens and bryophytes in the ecosystem. Many old growth forest lichen species require the ecological continuity of old stands in order to persist. These stands are important refugia, particularly for lichens and bryophytes that have limited dispersal capabilities.

SOCIAL (trend 2)

LANDSCAPE AREA A
Some minor fragmentation by trails and/or trailheads exists in this landscape area.

LANDSCAPE AREAS B, C, D, E, F

There are several social implications caused by increased fragmentation. Most of these implications have been or will be discussed in greater detail under other trends documented in this analysis. Fragmentation has lowered the integrity of the landscape in terms of scenery, wildlife habitat, and other values that are important to the public. Fragmentation of vegetation across the watershed, especially the clearcutting of late and old-structured forest stands, has prompted a re-evaluation of how timber is extracted from our National Forests. This period of re-evaluation and lower timber outputs has affected the timber industry and consequently the economic stability of many communities.

Future forest management activities will most likely be focused on restoring the connectivity of the landscape. Opportunities to address the public demand for attractive scenery, effective wildlife habitat, access, forest wood products, etc. should be integrated into these restoration efforts.

Trend 3 - The susceptibility for high severity fires is increasing due to fuels buildup

FUELS and VEGETATION (trend 3)

It is widely accepted that fire suppression policies for most of this century have initiated trends of heavier ground fuel accumulations and changes in stand structures, which could result in greater instances of stand replacement fires. Almost 80 years of effective fire suppression, coupled with pre-commercial thinning slash throughout the forest, have led to an increased susceptibility to high severity fires throughout the watershed.

Fuel buildup can be described as; 1) the amount of litter and down woody material that accumulates normally on the surface of the forest floor, but would have been reduced through time in the more frequent fire return interval regimes, 2) tree and brush invasion, or overstocking of a stand due to fire exclusion, 3) forest residue (slash) being left after harvest due to changing management direction, and 4) slash created by precommercial thinning in past harvested stands to increase the health, size, and vigor of a stand.

The nature of fires and fuel buildup is perhaps best discussed in the context of plant association groups. Each PAG accumulates fuels and responds to fire in different ways.

PONDEROSA PINE

Historically, fires were of low intensity, rarely scorching the crowns of the mature trees. This can be inferred from the pattern of scarring found on residual trees and from early accounts of wildfires in this forest type. "Ordinarily, a fire in yellow-pine [old large trees] woods is comparatively easy to check. Its advance under usual conditions may be stopped by a patrolman on a fire line a foot or so wide, either with or without backfiring. The open character of the woods makes the construction of fire lines relatively easy, and in many cases horses may be used to plow them." (Munger 1917).

Bill Hopkins, Area 4 Ecologist, estimates fire return intervals of 8 to 12 years for low intensity fires and 150 years for stand replacement fires. It is estimated that the low intensity fire size ranged from one-half acre to five or ten acres and that stand replacement fires were approximately 150 acres in size (Hopkins 1995).

Frequent underburns killed most of the small understory trees and shrubs which colonized the sites during brief fire-free intervals, maintaining an open, park-like appearance (Agee 1992). These open and park-like stands had substantial grass and forb cover. (Wickman 1992) Frequent, light burning allowed bunchgrasses and most forbs to recover rapidly, so herbaceous vegetation dominated the understory. The natural landscape pattern was a seemingly unbroken parkland of widely spaced tree clumps and continuous herbaceous understory" (Agee 1992).

In pre-settlement stands, downed logs were probably clumped at the same scale as the live tree components from which they were created, and such clumps contributed to local increases in fire behavior. It is doubtful that logs remained long on the forest floor to provide wildlife habitat, as they were probably consumed by the next several frequent fires on the site (Agee, 1993).

Approximately 6% of the Big Marsh Watershed falls within the ponderosa pine disturbance regime, and most of that acreage is in Landscape Area E.

The current condition of the ponderosa PAG indicates changes in stand structure because of fire suppression. Changes include an increase in lower and mid-story stand density, down woody

debris, needle cast, bark sluff at the base of large trees, and increasing bitterbrush growth and distribution. Fires in this altered ecosystem will have more intensity and severity than would have occurred historically.

MIXED CONIFER (dry and wet)

Mixed conifer forests show the most frequent fire activity of all eastside forests, especially those on drier sites (Agee 1993). Frequent fires in the drier plant associations of these PAGs are likely due to higher site productivity and the associated increase in the amount of fine dead fuels and shrub component needed to carry a fire.

Fire return intervals were estimated by Bork (1985) at 9 to 25 years, while Hopkins (1995) estimates them to be 30 to 50 years in the lower elevations (1500 to 4000 feet) and 50 to 80 years in the higher elevations (4000 to 5000 feet). McNeil and Zobel (1980) found an increasing fire return interval with elevation. The average fire return interval was 9 to 42 years along an elevational gradient. Fire return intervals in mixed conifer are quite variable and a specific fire regime for the entire area is difficult to determine. Hopkins estimates the average fire size for low intensity fires ranged from 50 to 100 acres and that stand replacement fires were 200 to 500 acres in size.

Historical fire intensities and frequencies ranged from frequent, low intensity fires to infrequent, high intensity fires. This is considered a moderate severity fire regime with a mix of low, moderate, and high intensity fires all common. Most mixed conifer plant associations were more open in appearance than they are today and were dominated by ponderosa pine. Such open sites were less likely to burn intensely, because of the frequency of low intensity fires (Agee 1993). As these low intensity fires burned, they removed understory ladder fuels and consumed debris on the forest floor. Fires that occurred after an extended fire-free period would generally have been more intense and caused more tree mortality by torching and active crown fire events, and consumed more forest floor fuels which increases severity. This scenario created patches or openings where 70 to 80 percent of the overstory trees were killed by fire, but would vary in size depending on the weather, fuel, and vegetation conditions on the site at the time of the fire.

Approximately 30% of the Big Marsh Watershed falls within the mixed conifer disturbance regime.

Currently, stand conditions resulting from management practices and fire suppression include increases in lower and mid-story stand density, down woody debris, needle cast, duff, and bark sluff at the base of large ponderosa pine trees. Fires in this altered ecosystem will have greater fire intensity and severity than historically would have occurred. Stand density contributes greatly to vertical continuity and surface fuel buildup, especially in the mixed conifer dry PAG.

LODGEPOLE PINE - Mid-Elevation

Agee (1991) describes typical fires in moist lodgepole sites as the selective removal of about one third of the stands every 60 years, either by insect, fire or the interaction between them. Some lodgepole stands on moist sites were burned in crown fire events, but those appear to be limited in extent. More common were partial mortality fires which left some residual forest structure on the landscape and did not burn at a landscape scale due to patchy fuel continuity. (WEAVE 1994)

Lodgepole dry sites had a fairly frequent disturbance pattern involving small, low intensity fires associated with lightning strikes on the buttes dominated by ponderosa pine. These fires backed down the buttes, and extended into the lower-lying lodgepole stands. Most stand replacing events occurred during 20 to 30 year intervals and involved 50 to 1,000 acres per event. These

stand replacing events caused virtually complete mortality, resulting in a subsequent even-aged stand. Regeneration of these arid sites took considerably longer, and thus eliminated a second regeneration fire as found in the high elevation lodgepole sites (WEAVE 1994).

Dry lodgepole pine sites are classified as climax stands, and are distinguished from other lodgepole pine stands by the lack of other species and absence of understory shrubs. These sites have a moderate severity fire regime (Agee 1993), although fires of any severity can occur. Agee estimated fire return interval of 60 to 80 years.

The effectiveness of fire suppression has delayed the natural process of fire to "clean up" the fuel loadings that normally occur. In this area, the life span for lodgepole is between 80 to 120 years. Within 5 to 10 years after the stand dies it will have collapsed to the ground, increasing fire severity and intensity.

Approximately 27% of the Big Marsh Watershed falls within the lodgepole pine disturbance regime.

Current conditions: Lodgepole has been heavily harvested in the past as clearcuts, shelter woods, or salvage harvest. After harvest, most of the slash in units was dozer piled and burned, especially in Landscape Area E. The areas where harvesting has not occurred are reaching the end of their life span. The exclusion of fire has allowed increases in needle cast and down woody material, which increase the risk of stand replacement fires. Fires in this altered ecosystem will have more fire intensity and severity than historically would have occurred.

MOUNTAIN HEMLOCK & HIGH ELEVATION LODGEPOLE PINE

Fire is the primary large-scale disturbance in the high elevation forest (Subalpine fire regime). Most other disturbances operate at the tree or small stand scale. Due to the lack of fire resistance of the major tree species in these forests, most fires are stand replacement fires. The estimation of fire intensity in high elevation forests is complicated by the erratic, often weather-driven nature of these fires (Agee 1993). Crown fires can occur when foliar moistures are low and may be aided by lichen draped within the canopy.

The high elevation forest of the Big Marsh Watershed is characterized by mountain hemlock as a major component of the overstory vegetation. Subalpine fir, pacific silver fir, white bark pine, high elevation lodgepole pine, and white fir are all found in the overstory and understory.

All subalpine plant associations will burn, but not under all conditions. In the mountain hemlock PAG, closed or parkland forest has the highest probability of burning, due to the dead fuel loads that can be desiccated during east wind events and the presence of flammable lichens in crowns low to the ground (Agee and Smith 1994). These fires tend to be erratic and unpredictable. Although infrequent in most Pacific Northwest subalpine forests, fires have been important in shaping the landscapes we see today. The fire suppression period during the twentieth century so far has not had much impact on landscape structure in subalpine zones, because of the fairly long fire return intervals. (Agee 1993)

Fires in high elevation lodgepole pine sites tend to be patchy, low intensity burns and, depending on continuity and aspect, usually involve smaller acreages. Typically, stand replacing fire events are associated with adjacent mixed conifer stands. A fire would generally become established in the mixed conifer stand, generating sufficient intensity to extend into adjacent lodgepole pine stands. Stand replacing events in lodgepole occurred every 60 years on south slopes and 120 years on north slopes. Patch size remained small, between 10 and 100 acres. Often, regeneration after a stand replacing event would include lodgepole pine establishing dense reproduction in the site previously occupied by mixed conifer, followed by a second

ignition within 40 to 50 years. This second event, or "re-burn", would eliminate lodgepole reproduction. Over time, the better site would revert back to mixed conifer, over-topping the remaining lodgepole and adding fuel loading to the forest floor (WEAVE 1994).

Approximately 26% of the Big Marsh Watershed falls within the mountain hemlock disturbance regime.

Current conditions: The mountain hemlock PAG is within the HRV.

RIPARIAN

Fire generally has two types of impacts on riparian zones: 1) direct impacts are those associated with burning in the riparian zone; and 2) indirect impacts are associated with burning at another location on the landscape, which affects sediment transport, and water quality and quantity as it moves through the burned riparian zone.

Fire has fewer effects in riparian systems than associated upslope forests, because these areas are more moist, have more deciduous vegetation, and have higher dead and live fuel moistures. Usually, riparian areas do not burn, or they burn at reduced intensity. However, headwater riparian areas sometimes burn with higher than average intensity than surrounding slopes, due to the channeling effect of wind in an area generally containing higher biomass than found elsewhere. Some of the hottest burn sites in the 1988 Dinkelman Fire near Wenatchee occurred in riparian areas. There appears to be an interaction effect between fire, weather and riparian areas. Under normal conditions, riparian areas burn less than slopes, but under extreme events, riparian areas may burn hotter (Agee 1992).

The unpredictability of many fire effects upon water resources relates, in part, to the wide range of topographic conditions, site differences in soil characteristics and moisture content, variations in fuel moisture and fuel loads, density of vegetation, various micro-climates associated with a given slope, aspect and topographic position, and variability in weather patterns before, during, and after the occurrence of a fire. The result is a mosaic of fire severity and effects across a hillside or landscape, even from the same fire. (Beschta 1990)

Approximately 4% of the Big Marsh Watershed falls within the riparian disturbance regime.

Current conditions: Typically, fire from surrounding lodgepole stands contributes to fire entering riparian areas. The Southwest portion of Big Marsh meadow had a prescribed fire of 73 acres burned on 4/23/92. Green up had occurred prior to the fire, so effective reduction of decadent forbs was not achieved.

TABLE 4-10, FUEL MODELS BY LANDSCAPE AREA

Fuel Model	**Percentage of Landscape in Fuel Model**					
	Landscape Area					
	A	B	C	D	E	F
FM - 1	0	0	1	9	2	3
FM - 3	0	0	0	0	0	7
FM - 6	3	4	1	3	2	2
FM - 8	45	5	44	19	37	25
FM - 9	9	15	3	25	34	18
FM - 10	14	7	8	7	6	9

FM - 11	25	12	38	35	10	35
FM - 12	0	0	0	<1	<1	<1

See Appendix A for a description of fuel models.

TABLE 4-11, CROWN FIRE RISK BY LANDSCAPE AREA

Risk of Crown Fire	**Percentage of Landscape Area in Risk Category**					
	Landscape Area					
	A	B	C	D	E	F
Low	22	17	28	38	52	36
Moderate	43	9	42	19	15	27
High	24	13	23	24	18	21
Extreme	7	3	2	2	5	4

In both tables, percentages do not equal 100% because areas such as rock and water were included in the calculations.

See Appendix A for a discussion of crown fire risk calculation.

WILDLIFE (trend 3)

Refer to the Wildlife discussion under Trend 1 for additional information.

Fire exclusion over the last 80 years has dramatically changed the vegetation across the majority of the landscape. As described under the fuels/vegetation section, stand densities have generally increased, resulting in better quality habitat for some species of wildlife. Some of the species that have benefited from fire exclusion are the spotted owl and goshawk from denser, multi-storied stands; marten from additional down woody debris that would have been removed by fire; and some neotropical bird species among others. Species that have been detrimentally affected by fire exclusion are: bald eagles as a result of the reduction in open park-like ponderosa and mixed conifer stands, and flammulated owl and white-headed woodpeckers due to the reduction in large ponderosa pines and more open canopies.

The exclusion of fire has created habitat for several species of concern. However, due to the density of the stands, stress, and increased risk of insect, disease and fire epidemics, this habitat may be unsustainable in the long-term. Across the landscape a balance of habitats needs to be achieved, some of which are sustainable and others which are suitable for wildlife species such as the spotted owl. In east-side Cascade ecosystems, this type of spotted owl habitat may not be sustainable in the long-term.

BOTANY (trend 3)

With the exclusion of wildfire within the watershed, the risk of high severity fire occurring over large areas has increased. High severity fire could be detrimental to listed vascular plant, bryophyte, lichen, and fungi species. Coarse woody debris would be reduced or eliminated, which is necessary for fungi and associated vascular plants such as *Allotropa Virgata* (ALVI), candy stick. Impacts would also occur to trees, which are a substrate for epiphytic lichens and bryophytes; function as fungal hosts; provide canopy closure and shade; and retain moisture and other conditions needed by LOS dependent species. Following a fire, the potential for invasion and spread of noxious weeds is increased.

Early seral species, such as *Mimulus jepsoni* (MIJI), monkey flower, may be enhanced by low-intensity fire. Fire suppression is considered one of the main factors contributing to the decline of ALVI. One of the mitigation measures for ALVI is to conduct surveys within sites planned for prescribed burning and establish monitoring sites to evaluate the effects of fire on its establishment and survival (USFS Appendix J2 1994).

SOCIAL (trend 3)

Human safety especially in Landscape Areas D and E is becoming an increasing concern to home and landowners within the area. Opportunities to improve human safety and the protection of property should be part of any restoration activities. In the summer of 1997, the Crescent and Odell Lakes Rural Fire Protection District will construct a Community Services Center that will include a fire hall. This will greatly improve the opportunities to prevent catastrophic losses of life, property, and natural resources within the area. The planning and construction of this building is partly funded by US Forest Service grant money associated with the President's Northwest Economic Initiative.

A majority of the scenery that is enjoyed within the Big Marsh Watershed is also impacted by the increasing risk of catastrophic fire. The accumulation of fuels within the mixed conifer dry plant association group (PAG) detracts from the visibility and sustainability of the desired large diameter trees enjoyed in recreation settings across the watershed. The visibility of park-like ponderosa pine stands has been diminished by an encroaching understory due to the exclusion of wildfire and/or management activities.

Restoration activities should be designed to help sustain and enhance large trees that play a significant role in forest landscape aesthetics. Short-term effects such as scorch and blackened boles should be measured against the long-term benefits of sustaining the large trees in the mixed conifer dry PAG. In some areas such as the Wilderness and Late Successional Reserves a fire management plan must be completed before fire can be used as a tool to restore landscapes and help sustain valued forest landscape scenery. Air quality may become an issue for prescribed and natural burn projects.

Trend 4 - The introduction and spread of non-native species is increasing the threat to native plant and animal species.

VEGETATION (trend 4)

Noxious weeds are of particular concern in the Big Marsh Watershed as they are all across the country. The noxious weed problem has been described as an "explosion in slow motion" or "a biological wildfire racing beyond control". Indeed, when small weed infestations are left unchecked, they can grow and spread across the land much like a slow-moving biological wildfire. However, land consumed by wildfire usually recovers; Land consumed by noxious weeds may not.

Noxious weeds are a red trend in Landscape Areas B, D, E, and F due to aggressive, invasive noxious weeds being established in those Landscape Areas that directly affect native plant species composition, fish and wildlife, soils, water quality and quantity, and recreation (Refer to Table 4-12 for a complete list of noxious weeds and their known locations within Big Marsh watershed). In Landscape Areas A and C the trend is yellow. Noxious weeds are not known to be established in the Diamond Peak Wilderness and the Oregon Cascades Recreation Area. However, no inventories for noxious weeds in these areas have been conducted, and the potential that noxious weeds are already established and the potential for introduction and spread of noxious weeds to these areas is extremely high.

Habitat for noxious weeds is created by ground-disturbing activities. Roadways, campgrounds, dispersed campsites, intensive recreation areas, trails and trailheads, and harvest units are readily invaded by noxious weed species with seeds dispersed by vehicles, equipment, humans, and animals. Some noxious weeds and other non-natives are intentionally planted in conjunction with grazing (legumes and forage grasses, including reed canarygrass, at Big Marsh, Landscape Area F).

The noxious weed that are known to occur in the Big Marsh Watershed Analysis area are:

Table 4-12

Common Name	Scientific Name	Species Information
Spotted Knapweed	*Centaurea diffusa*	Occurs in Landscape Areas B, D, and E.
Diffuse Knapweed	*Centaurea maculosa*	Occurs in Landscape Areas B, D, and E.
Canada Thistle	*Cirsium arvense*	Occurs in sandy areas on the shore of Crescent Lake (Landscape Area B), and on the Highway 46 roadside (Landscape Area E).
Bull Thistle	*Cirsium vulgare*	Occurs on the shoreline of Crescent Lake (Landscape Area B), and in harvest units in Landscape Area E.
Scotch Broom	*Cytisus scoparius*	This weed is widespread on the west side and plants were located and pulled along Highways 46 and 58 in Landscape Area E.
St. Johnswort	*Hypericum perforatum*	Occurs at Crescent Lake near the dam and along the shoreline and roadsides in Landscape Area B, and on the roadsides of Highways 46 and 58 and County Roads 60 and 61 in Landscape Areas D and E.
Dyer's Woad	*Isatis tinctoria*	A site was located and the weeds pulled along Highway 58 near Crescent Creek on

		the boundary of Landscape Areas D and E.
Dalmation Toadflax	*Linaria dalmatica*	Occurs in Landscape Area D on private land at Crescent Lake Junction.
Common Toadflax	*Linaria vulgaris*	Occurs in Landscape Area E.
Reed Canarygrass	*Phalaris arundinacea*	Occurs throughout Big Marsh (Landscape Area F), a large patch is located at the north end, a smaller patch is at the south end, and pockets are scattered throughout the marsh, especially along the ditches and creeks. Also from 6020 rd to Hwy. 58 along the Creek.

Four methods are used to control the spread of noxious weeds: 1) prevention, 2) detection, 3) control, and 4) site rehabilitation. Prevention and detection are the most effective and least expensive ways to control the spread of noxious weeds. These methods would be most effective in Landscape Areas A and C. In Landscape Areas B, D, E, and F where noxious weeds are already established, control and site rehabilitation are the methods that need to be implemented. Restoration projects in Big Marsh should include analysis and planning to control the spread of reed canarygrass.

Prevention methods include: 1) Ability to identify weeds; 2) Remove all weed seeds from vehicles, clothing, pack animals, and camping gear when moving from weed infested areas to uninfested areas; 3) Pull weeds when found. If weeds don't have flowers or seeds, they may be left in place after pulling. If flowers are present, then pull and place in a plastic bag and burn in a safe place; 4) don not pick weeds and take them home; 5) When weeds are found, let the land managing agency or land owner know so they can take steps to eradicate or control the weeds; 6) for heavy equipment operated in weed infested areas, clean thoroughly before moving to non-infested areas. This will be especially important for any equipment that may be used in the Big Marsh Restoration Project where reed canarygrass is of particular concern. 7) Drive, hike, ride, and camp only on established roads and trails away from infested areas, 8) feed pack animals only feed that is certified "weed free" within 96 hours before entering non-infested areas, 9) when using pack animals in non-infested areas, carry only feed that is certified "weed free".

Techniques to control the spread of noxious weeds include: 1) Education to identify noxious weeds and implementation of proper land management practices to deter spreading; 2) Chemical control involves the use of herbicides to reduce or eradicate weed infestations; 3) Biological control involves the use of beneficial organisms that feed on specific noxious weeds; 4) Mechanical or physical control involves disrupting or halting the growth of noxious weeds by pulling, tilling, mowing, mulching, burning, covering, or flooding.

Site rehabilitation should always be implemented to prevent noxious weeds from becoming reestablished after control techniques have been successful. Site rehabilitation incorporates careful monitoring of a noxious weed problem that has been successfully controlled, and using one or some combination of control techniques as necessary to stay on top of the problem. Site rehabilitation may require a substantial time commitment and will include repeated follow-up control measures.

WILDLIFE (trend 4)

There are several terrestrial non-native wildlife species that could potentially displace sensitive native species.

The brown-headed cowbird parisitizes native bird species by laying their eggs in other species nests. The surrogate parents raise the cowbird young to the detriment of their own young. Cowbirds are increasing in areas where fragmentation is occurring. This species prefers edge-type habitat near openings, including old clearcut units, suburban areas, and campgrounds. Reductions in populations of parisitized species may be occurring at a watershed scale.

The house sparrow is a secondary cavity nesting species that was introduced from Europe during the colonization of the Americas. This species is closely associated with human development and high use recreation areas. These sparrows are aggressive and will out-compete swallows, blue birds and other secondary cavity nesting species for nest sites.

The European starling is also a secondary cavity nesting species that was introduced much like the house sparrow. Like the house sparrow, this species is also associated with human development and will congregate in subdivisions and high recreation use areas. They may displace larger primary cavity nesters such as flickers and woodpeckers after they have excavated their nests, forcing them to construct new nests and reducing their reproductive success.

FISHERIES (trend 4)

The presence of introduced non-native species of fish is widespread throughout the watershed. In many locations non-native fish are out-competing and replacing native populations of fish. In other areas, non-native fish have been introduced to waters that were historically fishless and may be affecting other aquatic life-forms (amphibians, plankton, aquatic invertebrates and plants). Yearly or biennial stocking of non-native fish occurs in many of the lakes due to poor or non-existent natural reproduction rates.

LANDSCAPE AREA A

Most of the water in this Landscape Area was naturally fishless before the European settlers. Whitefish Creek and its' tributaries, Summit and Mountain Creeks, are probably the only waters which had native populations of fish. The species list of natives probably included bull trout, redband/rainbow trout, and mountain whitefish. Currently, bull trout have been extirpated from the entire watershed and redband/rainbow trout are severely reduced or non-existent in this Landscape Area. Mountain whitefish populations are stable in Crescent Lake and may use Whitefish Creek seasonally, when access is available. Brook trout are present in Whitefish Creek in fragmented populations and in six of the wilderness lakes. The impacts of these introduced fish upon the native flora and fauna is relatively unknown. Amphibian and plant surveys have only been conducted around Fawn Lake and species diversity, numbers and range are unknown for the balance of the landscape area.

LANDSCAPE AREA B

Crescent Lake currently has non-native populations of lake trout, rainbow, brown and brook trout, kokanee salmon and native mountain whitefish. Bull trout were last observed in the lake in 1979. Habitat changes, water storage and flow regimes, and the loss of spawning areas are probably more significant for bull trout extirpation than the competition with non-natives. Genetically distinct redband/rainbow trout are unlikely to be present due to the long-term, yearly stocking of hatchery rainbow trout. The influences of non-native fish upon the native flora and fauna of Crescent Lake is not known.

LANDSCAPE AREA C

Most of the water bodies in this landscape area were historically fishless. Some of the small spring-fed tributaries to Crescent Lake may have had seasonal spawning or resident fish populations. Use of these waters has disappeared due to reduced flows and submergence below the current lake basin. There are six lakes in Landscape Area C which have had brook and/or cutthroat trout introduced into them. Summit Lake contains brook, rainbow, and lake trout--all non-native species. As in Landscape Area A, little natural reproduction is occurring. Because they were naturally fishless, these lakes have very likely had impacts upon their native aquatic species.

LANDSCAPE AREA D

There are fragmented pockets of redband/rainbow trout in favorable habitat. However, habitat changes in the balance of the landscape area currently favor brown and brook trout over the native redband/rainbow trout. Changes in channel morphology have created slower, meandering streams favoring non-natives. Removal of riparian vegetation, overstory trees, and grazing is responsible for some of the habitat changes. The dam at Crescent Lake isolated and eliminated bull trout from Crescent Creek before they disappeared from Crescent Lake in 1979. Habitat changes and non-native competition do not currently favor the re-introduction of bull trout.

LANDSCAPE AREA E

Habitat changes and non-native competition similar to area D are responsible for the reduced numbers of redband/rainbow trout found in this area. Many acres of this landscape area are in private ownership and are heavily grazed. This trend is unlikely to reverse considering the present habitat conditions, ownership and use.

LANDSCAPE AREA F

Non-native German brown and brook trout have moved up through Crescent Creek and into Big Marsh Creek and its tributaries. They have replaced or severely depressed the native redband/rainbow trout population. As in areas D and E, habitat changes and degradation are partly responsible for dwindling numbers of redband/rainbow trout. Big Marsh is a stronghold for an isolated population of spotted frogs. Returning natural flows to the original channel in the center of the marsh will probably benefit this population. An unsubstantiated report of bullfrogs in Big Marsh could have devastating effects upon the spotted frogs, should it turn out to be true.

SOCIAL (trend 4)

The social implications of the increased introduction and spread of non-native species within Big Marsh Watershed encompass both commercial and recreational uses of the forest. Recreational uses such as fishing can directly benefit from the introduction of desirable non-native fish. Commercial use of the forest by resorts benefit from these fisheries because they attract tourists to the area. However, some non-native fish can often be detrimental to native flora and fauna of the watershed. Non-natives, such as those used for bait, can spread into an area and compete with the desired native and non-native fisheries.

Non-native plants such as noxious weeds impact recreational uses by invading recreation sites. Noxious weeds can out-compete native wildflowers; detract from pristine wilderness areas; cause human allergic reactions; and lower the scenic integrity of an area. Noxious weeds can also reduce the value of rangeland and timber land by preventing the growth of desired vegetation. The prevention of these consequences requires rules and regulations for horse feed, vehicular traffic, and a pro-active educational program for forest users.

Trend 5 - The regulation of water quantity from dams, ditches and diversions is affecting many components of the ecosystem.

FISHERIES (trend 5)

The Crescent Lake Dam is the one factor most responsible for problems facing the fishery in the Big Marsh Watershed. The water level and flows above and below the dam are having watershed impacts. This management of water has an effect upon every landscape area except areas C and F. In Landscape Area F the diversion of Big Marsh Creek into the drainage ditches at Big Marsh has seriously altered the water flow and water table throughout the marsh. Water diversions for grazing purposes have had a lesser impact upon the aquatic resources. See figure 27 for a map of lakes and streams in the Big Marsh watershed.

LANDSCAPE AREA A

The manipulation of water levels in Crescent Lake affects Whitefish Creek's ability to flush sediments from its mouth at Crescent Lake. In the fall, the resulting pumice bar frequently blocks movement of fish into or out of the lake. Fish hatched in the fall or spring may become isolated near the mouth and die from hostile water conditions as this section becomes de-watered. The pumice bar also blocks the passage of fish attempting to spawn upstream. Crescent Lake is already lacking in spawning areas and the denial of suitable gravels in Whitefish Creek contributes to the non-sustainability of the fishery.

LANDSCAPE AREA B

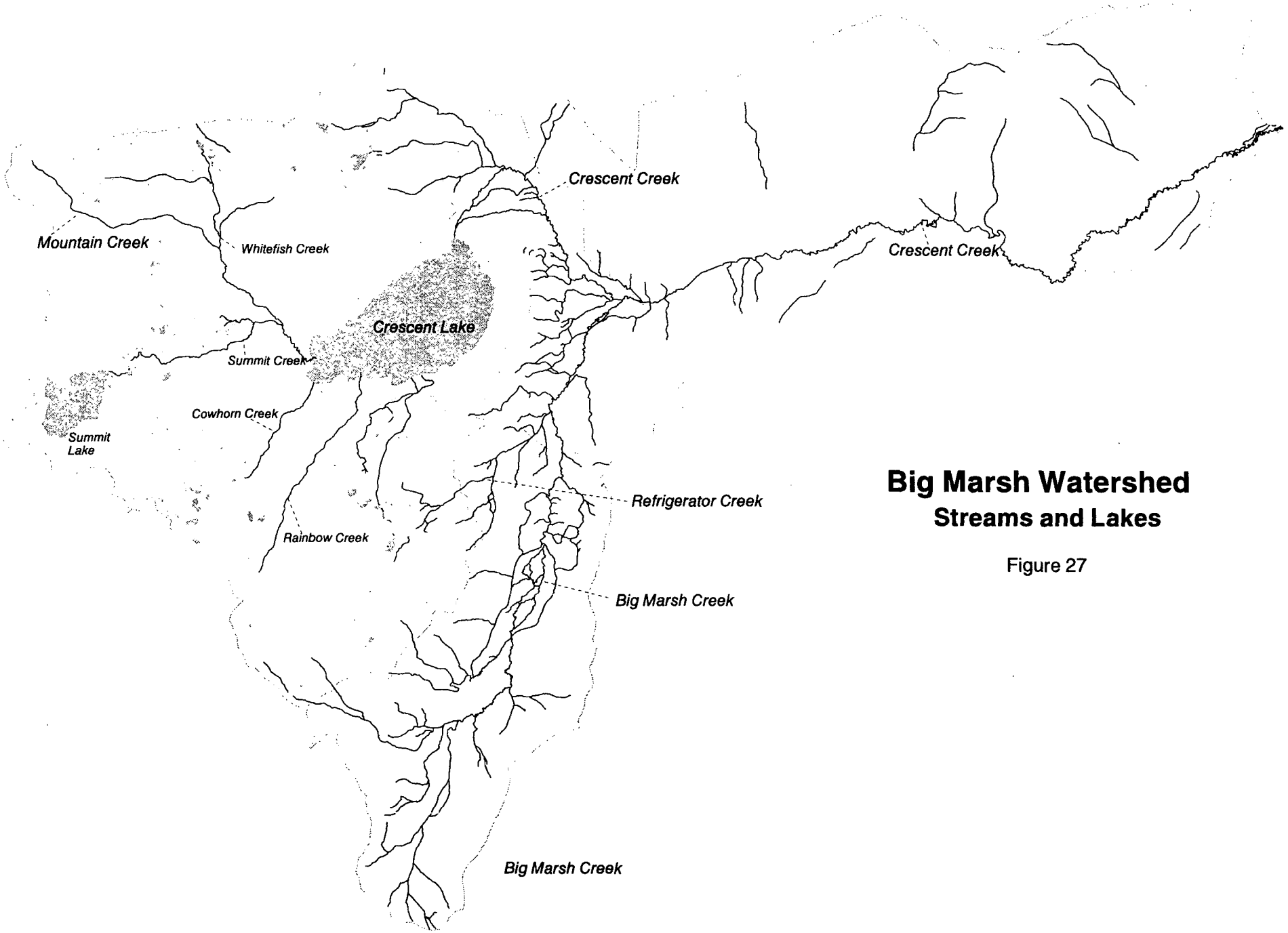
The fluctuating water level in Crescent Lake prevents aquatic vegetation, both emergent and submergent, from becoming established. The lack of vegetation reduces the productivity of the shoal areas. This area is critical for the rearing and feeding of juvenile fish. Some species of aquatic invertebrates cannot become established and complete their life cycles. The lack of aquatic vegetative cover and the pool level drawdown causes the unraveling and erosion of the shoreline, further degrading the spawning gravels in the lake basin. Additionally, the shoreline erosion may result in the loss of overstory trees along the lake edge, increasing the risk to the health of the riparian community and contributing to erosion. The increase in the lake pool, due to the dam, has raised the water level far enough to submerge springs along the shoreline that historically had been used for spawning purposes by stream-spawning species. In the fall, drawdown of the water level may leave these springs above the waterline and unreachable to lake shoreline spawning fish.

LANDSCAPE AREA C

There are no regulated water flows in area C. Some streams have irregular flows and may become intermittent in the fall. This fluctuation in water flow and availability certainly has a negative affect upon the fisheries located there by impacting life cycle stages.

LANDSCAPE AREA D

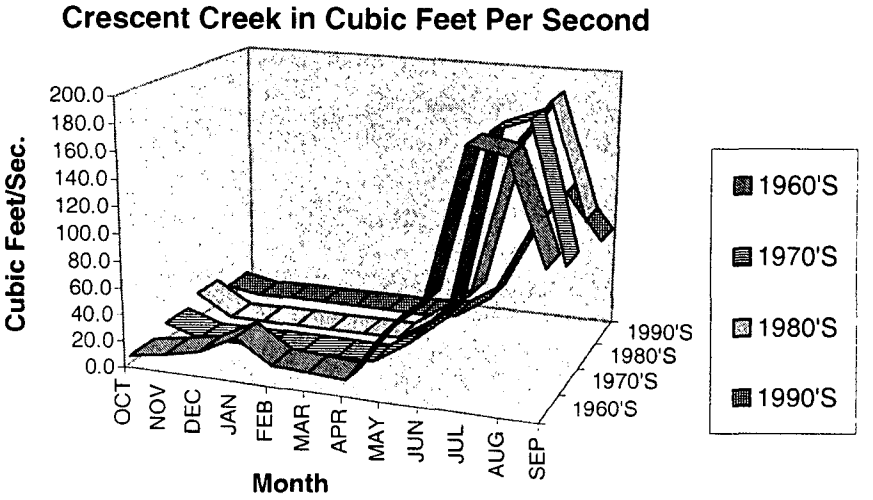
Instream flow fluctuations caused by irrigation demands are the greatest limiting factor for fish habitat, especially upstream of its confluence with Big Marsh Creek. In the 1994-1995 water year, flows fluctuated from a 1 cubic feet per second (cfs) daily average on January 11 to a 127 cfs daily average on August 10 (ODFW, 1996). The regulated water flows in Crescent Creek have had negative impacts upon the fishery downstream. Water availability is responsible for fishery population fluctuations. Reduced flows or complete de-watering, in the fall and winter, reduce spawning success and increase winter kill caused by ice conditions. Aquatic vegetation has difficulty becoming established. The flow manipulations affect all the aquatic species and



Big Marsh Watershed
Streams and Lakes

Figure 27

Crescent Creek Chart
Figure 28



RELEASES FROM CRESENT LAKE DAM													
INTO CRESCENT CREEK													
Listed in Cubic Feet/Second													
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1966	10.6	26.8	49.4	106.1	38.0	31.4	23.0	106.8	135.6	193.2	180.4	137.4	1,038.8
1967	4.8	6.4	7.1	7.5	7.2	7.6	7.1	6.7	10.4	228.8	212.4	142.5	648.6
1968	3.3	2.5	1.9	2.0	2.1	2.2	2.0	75.2	136.0	215.5	143.2	60.1	646.0
1969	3.4	3.6	4.5	3.5	3.0	1.5	1.4	1.4	1.4	96.2	177.2	80.9	377.9
1970	38.8	2.8	2.9	3.2	3.2	3.5	3.7	4.0	30.5	182.7	236.2	80.3	591.7
1971	29.9	1.8	2.2	3.3	3.8	5.3	5.8	6.3	7.0	129.5	222.0	212.2	629.2
1972	0.7	1.1	1.0	1.0	0.7	26.3	18.4	102.8	133.6	212.1	248.0	188.7	934.4
1973	58.2	73.4	2.3	2.4	2.7	3.1	6.4	66.4	165.5	238.7	227.8	25.6	872.4
1974	0.0	0.0	0.3	2.1	1.4	1.6	16.1	29.7	221.1	233.3	230.1	168.0	903.7
1975	3.8	3.7	3.8	4.0	41.4	74.6	51.6	26.3	225.5	270.7	245.9	92.1	1,043.3
1976	6.6	4.9	4.9	7.6	48.4	59.4	10.1	26.3	228.8	249.8	238.9	152.7	1,038.3
1977	18.7	1.3	1.7	2.5	2.3	2.5	24.6	122.9	151.5	192.4	159.0	64.1	743.5
1978	3.7	4.1	0.7	0.4	0.3	0.2	0.0	42.8	85.0	171.3	120.4	22.8	451.7
1979	3.8	3.0	3.7	4.2	4.9	5.9	5.7	6.3	63.2	188.1	213.6	139.3	641.8
1980	4.8	2.4	4.7	5.2	5.7	6.1	6.3	65.0	70.8	106.5	133.6	61.6	472.6
1981	23.0	2.5	5.0	0.0	0.0	0.0	0.0	12.5	56.3	139.2	126.7	33.7	398.8
1982	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34.2	82.7	84.7	37.0	238.6
1983	4.3	4.9	5.0	4.5	4.1	4.7	5.4	5.7	53.9	120.6	120.7	112.8	446.6
1984	33.3	20.4	80.5	119.5	84.8	67.3	66.7	106.4	238.6	166.9	129.1	45.6	1,159.0
1985	40.1	35.7	93.6	92.1	82.2	47.0	21.2	106.0	175.9	175.0	160.9	100.6	1,130.3
1986	9.7	6.5	7.0	7.2	6.6	42.9	28.3	107.0	201.4	201.4	188.2	99.7	906.2
1987	6.7	6.6	6.8	7.1	6.2	6.4	6.3	36.6	72.0	194.4	180.6	127.7	657.5
1988	7.0	6.9	7.2	7.0	6.2	6.9	7.1	51.4	72.0	103.0	145.1	182.8	603.1
1989	7.1	5.6	5.8	5.8	5.9	7.0	6.3	5.7	29.2	105.7	135.0	90.6	409.7
1990	2.9	6.9	8.3	8.5	7.8	9.4	9.2	0.0	10.6	93.6	205.0	200.1	572.2
1991	23.9	4.1	4.4	4.7	4.3	4.7	4.6	5.1	4.5	105.1	165.4	106.1	436.8
1992	21.1	5.6	6.4	6.9	6.7	6.6	5.1	6.8	55.5	103.4	29.7	4.8	258.4
1993	4.2	2.9	3.0	2.8	3.5	4.1	3.7	7.2	11.8	36.0	152.8	127.7	359.6
1994	6.0	5.8	8.3	9.0	4.8	5.8	6.2	10.7	74.6	147.7	58.6	9.6	347.1
1995	4.6	3.3	2.2	1.1	6.4	4.3	3.4	3.9	12.8	53.4	112.1	60.6	268.0
1996	6.1	4.6	4.8	5.1	5.2	3.6	3.5	7.8	25.1	93.8	187.6	117.3	464.3
1997	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CFS AVERAGE BY DECADE													
1960'S	5.5	9.8	15.7	29.8	12.6	10.7	8.4	47.5	70.8	183.4	178.3	105.2	
1970'S	12.6	3.8	4.1	4.0	3.9	3.7	3.6	21.8	44.5	180.8	192.2	91.0	
1980'S	18.8	2.7	2.9	3.0	3.0	3.1	3.2	21.7	43.7	156.0	194.6	108.4	
1990'S	8.6	4.1	4.7	4.8	4.8	4.8	4.4	6.4	24.3	79.1	113.9	78.3	

cause bank erosion, which affects spawning gravels downstream. Water quality, in the form of turbidity and elevated temperatures, affect the fitness of fish attempting to complete their life cycles in this landscape area. Replacement of native fish species by non-natives may occur because of habitat changes caused by water fluctuations.

LANDSCAPE AREA E

Regulated water flows from Crescent Lake also affect this area. However, those effects are moderated because Big Marsh Creek enters Crescent Creek upstream of this landscape area. Increased flows from the water releases at the dam may contribute to erosional processes in this area. Water diversions on private property may also be occurring. All of these processes affect turbidity, temperature, reduced cover and habitat, and embeddedness to spawning gravels. These factors contribute to reducing the overall fitness of the fishery.

LANDSCAPE AREA F

Big Marsh was grazed by cattle from 1890 until 1917. Sheep grazed the marsh from 1917 until 1945. In 1946 the owner drained the area to improve the grazing potential. Draining was accomplished by digging six miles of diversion ditches on the east and west sides of the marsh area, and then diverting the stream and springs into these side ditches.

The water diversion in Big Marsh into the side channels has de-watered the marsh and altered the aquatic species associated with it. The side channel ditches, with less cover, rounded sides and fewer gravels, favor brown and brook trout over redband/rainbow trout. Consequently, fewer and fewer redband/rainbow trout are observed in fish surveys in Big Marsh. Current habitat conditions and the presence of non-native competition does not favor the re-introduction of bull trout back into Big Marsh Creek.

A land exchange in 1982 brought Big Marsh into public ownership. In 1989 an Environmental Assessment (EA) documented the analysis of the proposed Big Marsh project. The project provided for returning water into the natural channels and provided opportunities for habitat enhancements and improved dispersed recreation.

At this time it is estimated that about 50% of the natural flow is going into the original Big Marsh area. In the 1989 EA, the majority of individuals providing input favored restoring Big Marsh to a natural marsh ecosystem. Many of the individuals favored not only restoring a marsh ecosystem but reverting it as nearly as possible to its original condition.

WILDLIFE (trend 5)

Fluctuations in the lake level at Crescent Lake have caused a reduction in the amount and diversity of aquatic and terrestrial vegetation adjacent to or along the shoreline as compared to historic conditions. This vegetation is important to small mammals and nesting birds, especially waterfowl. Waterfowl are a prey species for bald eagles, so reductions in their numbers cause eagles to utilize other prey.

The Big Marsh area was drained in 1946 to enhance cattle grazing. The Forest Service acquired the marsh in 1982 and installed a diversion in 1989 that redirected water from the drainage ditches to the main channel through the middle of the marsh. Over the past six years since the diversion was installed, marsh species have increased, most notably in the species requiring dense growths of sedges and rushes and shallow standing water. Species that were confirmed in the 1996 bird surveys that had not previously been recorded at the marsh include: yellow rail, Virginia rail, wood duck, green heron, pied-billed grebe, marsh wren, common

merganser, and common goldeneye. It is anticipated that additional species will continue to show up in the surveys as the marsh continues to restore itself.

Big Marsh is also occupied by nesting sandhill cranes, snipes, soras, phalaropes, sandpipers, herons, and bitterns; a multitude of neotropical migrants including: orange-crowned, yellow-rumped, and MacGillvary's warblers; western tanagers, savannah sparrows, marsh wrens, and a variety of thrush and swallow species. Several species of waterfowl, including cinnamon teals, ring-necked ducks, and Canada geese, utilize the marsh, but their numbers are limited by the lack of open water.

SOCIAL (trend 5)

The fluctuating water level at Crescent Lake impacts both recreational and commercial uses of the lake. Recreational access to the lake is difficult to provide and maintain at both the high and low water levels. At Crescent Lake Campground two boat ramps have been constructed to provide access during low and high water levels. The State Marine Board and Forest Service are both interested in maintaining only one facility at this location. One of the existing boat ramps will need to be modified to maximize the access opportunities at all water levels. There is a need to determine what the future maximum and minimum water levels will be at the lake in order to determine an appropriate design elevation for the ramp.

Camp Makualla, the Crescent Lake Resort, recreation residences, and other developed Forest Service facilities face the same problem. Their waterfront facilities are old and need replacement, but fluctuating water levels make it difficult to determine at what elevation they should be constructed. The resort has to shift its marina facilities around to accommodate the fluctuating water levels. To be cost effective in the short and long-term, the designers and managers of these facilities should understand how the Tumalo Irrigation District intends to manage the water level in the lake in the future.

From an aesthetic viewpoint, the fluctuating water level lowers the scenic integrity of the lake by causing erosion, big tree mortality, and excess development to provide high and low water access. The recreational experience is compromised by the effects to scenery, as well as, the impacts to the fisheries, and increased boating hazards during low water periods.

LANDSCAPE AREAS D and E

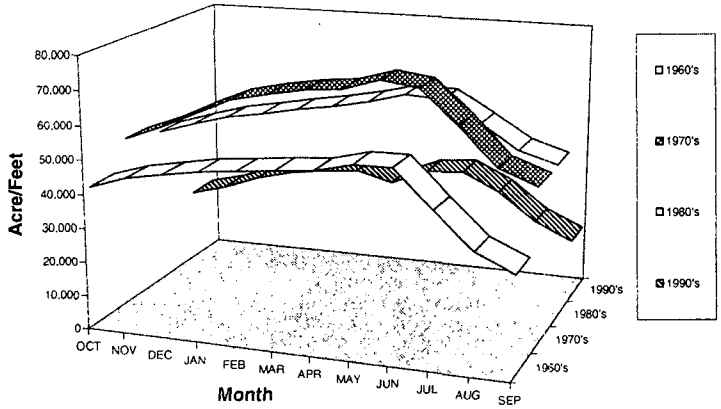
In addition to the social values of providing a highly functional riparian zone and productive fishery in Crescent Creek, it should be noted that there is an aesthetic value associated with having an adequate instream flow in Crescent Creek. Home and land owners on or adjacent to Crescent Creek enjoy living by a creek with running water. The periods of low or no flow impact their experience, as well as the experience of visitors to Crescent Creek Campground or the gorge at the base of Odell Butte. Also, quick releases of high volumes of water can damage docks and other facilities adjacent to the creek.

Homeowners, landowners, and the Forest Service need to work with the Tumalo Irrigation District to understand what to expect in the future in terms of instream flows throughout the year. The Wild and Scenic River planning process may help facilitate discussions with the irrigation district, recreating public, landowners, and the Forest Service.

Figure 29 shows the water storage for the past four decades in Crescent Lake

Crescent Lake Chart
Figure 29

Crescent Lake Storage In Acre-Feet



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP		
1966	68100	70260	70640	68700	68050	69300	70640	70410	65920	56300	46700	40490		
1967	43200	47220	49840	53450	54190	55250	55510	60030	66190	52620	39830	32670		
1968	36330	38430	40590	42430	45880	47440	48220	46250	38730	25200	17650	15340		
1969	17230	23050	25800	29760	30510	31380	32600	41000	47810	42100	31300	26620		
1970	26410	28350	32200	39160	41370	42910	44210	49020	52770	41370	26880	23840		
1971	25380	31120	34710	42540	45920	49280	50650	60340	70070	68090	56500	46850		
1972	51970	58630	65030	71650	76160	83250	86840	89820	91840	84970	73340	66340		
1973	68400	69100	76690	81770	85430	87780	89820	90340	81380	67070	53820	54940		
1974	57870	64650	69500	76120	79820	83290	84070	89110	89540	82630	72410	66040		
1975	70640	75580	81570	86290	87980	87350	86140	90700	87350	78380	66660	64700		
1976	69020	74090	79970	84380	84260	82740	84300	90620	83410	73850	64380	59160		
1977	61440	64340	66500	68280	69680	71260	70260	64690	57870	45620	36440	34270		
1978	35460	40490	49870	51670	52880	53600	54940	54220	51510	42030	35030	34890		
1979	35140	36520	38390	40890	43220	44650	46220	51740	49240	36660	23340	15900		
1980	18840	20920	23050	27670	29290	30220	32350	32020	30300	24120	15300	13240		
1981	13180	15800	20540	22150	25900	27340	28780	30660	29400	19760	12610	10970		
1982	12700	15340	23800	26700	32460	35030	37700	44880	51480	50840	47250	47700		
1983	51170	54340	60550	63860	68130	72470	74430	81460	85900	84340	80400	76240		
1984	77880	82740	85670	83510	83060	83760	83800	87030	83440	80870	77180	78850		
1985	81380	87670	86560	84030	82630	83170	85820	86370	82700	74510	66880	63770		
1986	67290	70600	73110	76400	81960	84300	86530	86530	80910	71610	62930	60870		
1987	63880	67450	69290	72140	73890	74780	77100	80050	77680	67140	56960	50100		
1988	50690	51890	54450	56500	56840	57750	60530	60490	59050	52240	42660	31590		
1989	32460	36080	37290	38870	39780	42100	46070	51890	55280	49650	42730	38470		
1990	39678	40926	41658	44246	45772	46143	51742	54188	55854	49244	36112	24885		
1991	25200	27020	27880	29320	30548	32250	33730	36480	38650	31770	20920	13800		
1992	13870	14885	17326	18245	19225	19015	23192	23765	19400	12750	9360	8536		
1993	8808	9383	10373	11772	12307	16215	18722	28784	34706	34014	24605	17755		
1994	19155	20330	21905	23192	24220	24300	25200	27000	22080	11600	8488	6770		
1995	6770	8182	8261	9833	12144	13747	15731	20794	23715	21713	12575	9443		
1996	10055	15285	26117	32391	38164	40557	46621	56088	59359	55975	47485	43780		
1997	48258	58046	71580	79232	77963	77356								
MEAN	40870	44335	48147	51161	53114	54687	55886	59251	58824	51259	42217	38026		
MAX	81,380.00	87670	86560	86290	87980	87780	89820	90700	91840	84970	80400	78850		
MIN	6770	8182	8261	9833	12144	13747	15731	20794	19400	11600	8488	6770		
Decade Averages														
1960's	41,215	44,740	46,718	48,585	49,658	50,843	51,743	54,423	54,663	44,055	33,870	28,780		
1970's	50,173	54,287	59,443	64,275	66,672	68,611	69,745	73,060	71,498	62,067	50,880	46,693		
1980's	46,947	50,283	53,431	55,183	57,394	59,092	61,311	64,138	62,614	57,508	50,490	47,180		
1990's	21,474	24,257	28,138	31,029	32,543	33,698	30,705	35,300	36,252	31,009	22,792	17,853		

Trend 6 - Water quality has declined and there is the potential for further decline.

Water quality is being affected by water quantity, erosion, increased human uses, poorly functioning riparian communities, antiquated or overburdened septic systems, and toxic waste dumps in the watershed. Some of the landscape areas have high water quality, while others are suffering from the problems listed above.

HYDROLOGY (trend 6)

LANDSCAPE AREA A

Water quality is considered to be excellent due to the roadless and non-commercial nature of this landscape area. Threats to water quality in this area include erosion from trails and stream crossings and compaction of soils from use patterns and dispersed campsites around high country lakes. Fishing opportunities may increase use and cause soil compaction around some of the more productive lakes. Sanitation disposal also has the potential of contributing to a decline in water quality around some of the wilderness lakes. Sedimentation to gravels could affect spawning success. Reduced water quality affects the overall fitness of all resident fish.

LANDSCAPE AREA B

This landscape area faces many challenges to its water quality. Developed recreation sites, summer recreation homes, increasing winter use, and year-round boating opportunities all contribute to potentially declining water quality. Inadequate septic systems, soil compaction and toxic fuels from boating are threats to water quality. Increased nutrients from septic systems can lead to changes in the benthic and plankton communities. These changes can affect the fitness of some fish species. Soil compaction from recreation sites and summer homes may lead to erosion from increased run-off. Manipulation of the water level in the lake has led to soil erosion along the shoreline. The deposition of sediments from erosion reduces success of spawning areas found within the lake and subsequent turbidity reduces penetration of sunlight into the highly productive shoal areas. Less production of food will produce smaller or fewer fish.

Water transparency and quality are good in Crescent Lake at this time. The lake is considered to be oligotrophic, however, the presence of eutrophic algae has been found in the lake and indicates the possibility of impacts from human activities on and around the lake. The soils around Crescent Lake are very porous and have little capacity to absorb and retain nutrients. To date, little evidence of eutrophication exists, despite considerable human use, however, efforts to reduce nutrient input need to be made to retain this condition(Johnson et al. 1985).

LANDSCAPE AREA C

This landscape area has excellent water quality for the same reasons as area A. It also faces the same threats to its future water quality. In addition, some threats to Summit Lake include pollution from boating, sanitation disposal around the lake, and channelization of water down the boat ramp, which causes sedimentation in the lake.

LANDSCAPE AREA D

Water quality is at risk in this area due to increasing human uses (industrial mushroom camp, mushroom pickers, increased recreation, increasing septic systems, roads, and harvest activities on private lands), inadequate septic systems, toxic substances at the old railroad dump site,

increased water temperatures from loss of overhead vegetative cover and reduced water flows during some periods of the year. Each of these factors affects the ability to survive for all life stages of fish and amphibians.

LANDSCAPE AREA E

Erosion and streamside cover are the greatest threats to water quality in this landscape area. In addition, area E inherits its water characteristics from Landscape Area D. Erosion is the result of timber harvesting, high road density, private land cattle grazing, and to some extent, fluctuating water flows. Spawning gravels are harmed by sediments. Lack of streamside cover contributes to erosional processes and elevates water temperatures. Water temperatures during the summer are often above 60° F, a temperature that reduces the fitness of salmonids, and reduces the amount of usable habitat available to fish.

LANDSCAPE AREA F

Water quality is affected by the lack of cover and instream wood in this landscape area. Also, the drainage ditches within Big Marsh proper have greater solar exposure, because of the side contours, and higher temperatures than the natural channel in the middle of the marsh would experience. Increased water temperatures reduce the fitness of all life stages of salmonids.

Since the installation of the diversion in 1989, the marsh has begun to restore itself. Big Marsh Creek has started re-scouring its channel, eventually, cut banks will develop. Marsh vegetation has also increased and will provide some stream shade. Additional restoration activities planned within the marsh during the summer of 1997 could assist in improving the water quality.

SOCIAL (trend 6)

The social value of clean water relates to the issue of public health and safety. The Oregon Department of Environmental Quality and Klamath County Department of Human Services Public Health Division are the governmental agencies mandated to respond to water quality issues within the Big Marsh Watershed. Landowners including the Forest Service are held accountable for meeting the water quality standards set forth by these agencies. The following information describes how the existing water quality issues are being addressed in each landscape area.

LANDSCAPE AREAS A, C, and F

The primary tool used to manage water quality within the Diamond Peak Wilderness is through educational programs targeting the proper disposal of wastes. Education is also heavily relied upon in the Oregon Cascades Recreation Area (OCRA) which encompasses both Landscape Areas C and F. Presently, there are a few vault toilets located at Summit Lake, but there are no existing facilities at Big Marsh. Vault toilets can be considered as a viable solution to any water quality problem in the OCRA, if the problem recreation site is accessible by road. Otherwise, a more primitive toilet may be constructed to direct waste disposal to an appropriate area.

LANDSCAPE AREA B

The natural composition of the soils around Crescent Lake and generally within the watershed increases the risk of water pollution from standard underground wastewater/sewage disposal systems like the basic septic system. The opportunities for nitrogen to be sufficiently fixed in pumice soils before entering the groundwater or Crescent Creek are inherently limited. Therefore, additional acreage is usually required for septic systems in order to properly dispose of wastewater/sewage within the watershed (Baggett 1997).

The proper disposal of wastewater is an ongoing issue at Crescent Lake. However, there is no monitoring data to support a trend toward declining water quality from improper wastewater disposal, nor is there information that identifies sources of pollution around the lake. However, the vault toilets at Contorta Point on Crescent Lake have failed. Plans to replace the vault should begin immediately to avoid further contamination of nearby water. What is also known and of concern is the increased use and size of recreation residences around the lake which translates to additional gallons of wastewater being disposed on a limited track of land. Camp Makualla is also proposing additional toilet and shower facilities. It is unknown at this time whether this development would affect the safety of the swimming area at the Boy Scout camp (Baggett 1997).

At this time, there is no long-term strategy for wastewater treatment around Crescent Lake that encompasses existing and future development such as: the expansion of facilities including recreation residences, the Boy Scout Camp, Crescent Lake Resort, or USFS recreation facilities. Adjustments to wastewater disposal are being made on a case-by-case basis. With the limited land base in which to dispose of wastes, recent adjustments to septic systems that utilize additional acreage may limit future septic adjustments proposed by neighboring homeowners or the US Forest Service. Consequently, waste disposal may become more expensive in the future due to the limited area in which to dispose of additional waste.

LANDSCAPE AREAS D AND E

Landowners in Landscape Areas D and E face similar problems. Again, there is limited data that supports the trend toward declining water quality in Crescent Creek. However, Klamath County Department of Human Services Public Health Division issued a letter to the Crescent Lake Junction Community Action Team (CAT) in 1994 that outlines their concerns for existing and future development in the area. The letter also outlines the limitations of on-site sewage disposal systems in the area. These limitations have restricted development within the Crescent Meadows Subdivision and the number of allowable customers per business at Crescent Lake Junction. This letter is located in the project file.

The Community Action Team at Crescent Lake Junction identified the need for conducting a wastewater/sewage disposal feasibility study at the Junction as one of its top priority action items in their Community Action Plan (Community Action Plan 1994). At this time a feasibility study has not been conducted. However, there is an opportunity to obtain a $10,000 grant for such a study by the Oregon Economic Development Department (OEDD), but the community must first form a sanitation district. Presently, only one business, Schad's Family Restaurant, is being limited by its current septic system. Therefore, there is not unanimous support within the community to form a district. Consequently, the owner of Schad's is now considering a possible land exchange with the Forest Service to expand the acreage of Schad's septic system.

There is an existing need to continue working with the community, Klamath County, and Department of Environmental Quality to ensure that the groundwater and water within Crescent Creek remains healthy and safe to drink while allowing community development to continue. The current rural development programs and the Wild and Scenic River planning process will continue to help facilitate these needed interactions.

Trend 7 - The health of the riparian habitat has been impacted by human activities such as private development, trail and road construction, recreation , grazing, and water diversion.

The health of the riparian community varies widely within the analysis area. It ranges from very good to poor, and is affected by all the reasons mentioned in the trend.

FISHERIES (trend 7)

LANDSCAPE AREAS A and C

The riparian communities are generally in good condition in the wilderness. There are some minor problems associated with trail stream crossings and user impacts around some heavily used lakes. Thermal cover and erosion control are the functions necessary to maintain good stream temperatures and quality spawning gravels.

LANDSCAPE AREA B

The riparian habitat around Crescent Lake is greatly influenced by the number of developed recreation sites. These activities are causing soil compaction and reducing the vigor and health of the riparian community. The water fluctuations caused by water releases at the dam are causing shoreline erosion, which, in turn, is affecting riparian habitat. The loss of riparian habitat around the lake results in increased erosion. This leads to the loss of quality spawning areas and reduced productivity in the shoal areas.

LANDSCAPE AREA D

Riparian habitat along Crescent Creek is being affected by: water fluctuations caused by the dam, development, grazing on private land, increasing recreation use, and the removal of down woody debris. The removal of riparian vegetation leads to erosion and elevated water temperatures. Spawning gravels become imbedded and water temperatures are elevated beyond optimal ranges.

LANDSCAPE AREA E

This landscape area has the same factors influencing its riparian community as area D, except that harvest and grazing influences are greater. Again, erosion and elevated water temperatures are the result, and spawning gravels and water quality are affected. These factors may favor non-native species of fish over natives.

LANDSCAPE AREA F

Riparian habitat has been affected by the water diversion in Big Marsh and the historic cattle grazing. Species composition and vigor of the plant community have been altered. Altered vegetation and plant communities may lead to increased water temperature, which, again, would favor the introduced German brown and brook trout over the native redband/rainbow trout.

SOCIAL (trend 7)

The social implications of healthy or unhealthy riparian areas are documented in greater detail in other sections of this analysis. The impacts to fisheries, water quality, soils, commercial uses (such as grazing), and scenery do not need to be reiterated here. The following information identifies some specific riparian areas within the watershed that are impacted by recreational

use. It is worth noting that in areas of recreation and riparian interface, recreational use patterns can be designed to protect and enhance both the health of the riparian area and the desired recreational experience.

LANDSCAPE AREA A

Some problems in this area that directly affect water quality involve stream crossings along several trails. Bridges are needed on the Snell Lake Trail and the Crater Butte Trail at their respective crossings of Mountain Creek. Mountain Creek empties into Whitefish Creek, which empties into Crescent Lake. The Pretty Lake Trail along Crescent Creek is experiencing erosion which could be mitigated through redesign and reconstruction of steep portions. Restoration crews will be constructing bridges over Mountain Creek in 1997, but plans for Pretty Lake Trail are pending.

LANDSCAPE AREA B

Treatment of existing and potential shoreline erosion is needed in the Crescent Lake area. Of particular concern are the shorelines adjacent to the summer homes, Simax picnic area, and Tranquil Cove. Proposals for mitigation in all these areas have been made, with some barrier posting to occur at Contorta Point this summer in an effort to protect existing vegetation. Other projects remain unscheduled at this time. Whitefish Creek empties into Crescent Lake just north of Tandy Bay. Erosion here is a concern as well, as Whitefish Creek is susceptible to washouts. Sediment buildup at the mouth of Whitefish occurs as the water level rises in Crescent Lake.

LANDSCAPE AREA C

The Windy Lakes Trail provides access to the interior of this area from the Windy-Oldenberg Trailhead near Crescent Lake on State Highway 60. This trail is quite steep and is so deeply cupped in places that mountain bike pedals cannot fit within its width. Travel around these cupped areas adversely impacts vegetation and causes further erosion. The slope on this trail also causes channelization of runoff into the adjacent creek, carrying sediment into Crescent Lake. Redesign of this trail is needed to mitigate these problems.

WILDLIFE (trend 7)

See Trend 2 for a discussion on the importance of riparian habitat for wildlife species.

BOTANY (trend 7)

Changes in plant species composition caused by the intentional (reed canarygrass; Kentucky bluegrass and other non-native species) and accidental introduction of non-native species associated with human activities have adversely affected riparian habitat. These plants compete with native species and change the diversity within riparian communities.

Trend 8 - Areas of inherently moderate soil quality are moving toward an existing low quality state.

SOILS (trend 8)

The existing soil quality within a given area is a function of the inherent character of a given soil (parent material, organic matter content, depth, water holding capacity, rock fragment content), the local climate (moisture and temperature), and the impacts from human activities such as vegetative management and recreation. Activities that alter soil strength, organic content, or the natural horizonation of a given profile can adversely affect physical, biological and chemical processes that directly relate to the productivity on that site. Altered soil quality has been identified as a red flag trend within Landscape Areas B and E, a yellow flag trend in Landscape Area D, and a green flag trend in Landscape Areas A, C and F.

LANDSCAPE AREA B

Trend Causes

The primary causes responsible for altered soil quality in Landscape Area B have been identified as (1) fluctuating water levels on Crescent Lake and, (2) recreation use and development along the shoreline of Crescent Lake. These mechanisms have been relatively consistent within this landscape area for the past fifty years, although recreation use has increased in the past ten years due to a growing population base and the increased popularity of the area. Water levels behind the dam have been determined by "on demand" irrigation needs since construction of the dam, creating extreme draw downs in years of low summer moisture regimes and relatively low draw downs when moisture was adequate during the growing season.

Extent of impacts

(1) The banks of Crescent Lake have experienced wave scoured and dry ravel erosion of the soil material present. The extent of erosion from wave scouring appears to be directly related to the height and duration of water levels in relation to the soil layers present. High water levels occurred in the early 1970s and are present at the time of this analysis to a slightly lesser degree. These levels scoured and removed the glacial till material in the subsurface of the bank, undercutting the coarse Mazama pumice tephra that overlies it.

Dry raveling has occurred during periods of low water as the subsurface and surface layers dry out. The coarse pumice tephra in the surface layers is the most susceptible to this process, one which has increased the bank angle and caused the bank edge to recede in many places. Much of the material that has raveled to the shoreline reaches the water as lake levels rise, then is carried off into the lake as the levels recede.

All of these processes have occurred to varying degrees around the lake, with the bank edges having receded beyond the existing upland tree line and the bank angles approaching 90 degrees along stretches of the eastern and northwestern shores. This process is degenerative to the soil resource since this material is not replaced under natural conditions in a lakeshore system. While the actual area of loss is not a large percentage of the landscape area, its historic function as a riparian and transition area along the lakeshore has been lost as an element within this portion of the watershed.

(2) The increased recreational use and development of the lakeshore has caused compaction and erosion problems to varying degrees around the lake, most extensively around developed campgrounds on the southern shores. Vegetation has been trampled and removed, exposing mineral soil susceptible to movement by water from storm events. Rill erosion is occurring off of

some upland areas, while wave action is moving soil material off of shoreline areas. The shoreline banks in these areas are generally lower and more gradual than those on the eastern and northwestern shores, making them slightly less susceptible to wave scouring and recession processes.

Rate And Longevity Of Trend

(1) The high water years of the early 1970s appear to have accelerated the scouring of the underlying glacial till and the exposure of the coarse tephra above it. Dry ravel of the coarse tephra above it probably occurred at a steady rate during the relatively dry period lasting until 1996, which has lead to the current bank angles and edge recession. The high water of levels of 1996 and 1997 have returned wave scouring to the bank slope itself and could lead to extensive erosion if these levels are maintained for an extended portion of the calendar year. This is likely to occur if precipitation levels within the watershed and the region of irrigation use remain above average.

(2) Compaction of the soil resource has been occurring within and adjacent to the developed campgrounds for many years. Developed campgrounds have seen more use in the last ten years, increasing foot traffic between campsites and the lakeshore. Until traffic patterns within the campgrounds are altered, this trend will continue to maintain the denuded conditions present in these areas and may increase the area affected by these mechanisms.

LANDSCAPE AREA E

Trend Causes

The primary causes for altered soil quality within Landscape Area E have been identified as (1) past vegetative management and (2) private land use and development. Vegetative management has occurred on federal lands within this landscape area for approximately forty years, while private forestry activities and grazing have been present for as much as eighty years.

Extent of Impacts

(1) Ground-based harvest and yarding operations have occurred on approximately 40% of the federal acres present within this landscape area. The majority of this activity has occurred on upland soil types, with some activity occurring within riparian soil types. The prescriptions and harvest systems utilized for vegetative management have been shown to incur detrimental compaction on the soil resource, as well as disrupting the natural horizonation of the soil profile and altering the organic matter levels on the soil surface (Soils Monitoring Reports 1992-1996). Soil functions affected by compaction and horizon mixing, such as moisture regimes, nutrient cycling and mycorrhizal activity, are directly related to the productivity of a given site (Graham et al. 1994). Although none of these areas has been degraded to a point where it cannot support vegetation, sites have lost some elements that contribute to soil formation and productivity.

Road building to support vegetative management has also incurred impacts to the soil resource, essentially dedicating these areas to a non-productive state. This landscape area has the greatest number of artificial and natural surface road miles within the watershed. An additional 8% of the federal land in this landscape area is estimated to be in skid trails and landings that are also in a state of degradation unlikely to support natural rates of vegetative growth.

(2) Private land use and development within this landscape area has primarily focused on grazing and forest resource extraction. A ranch within this landscape area has grazed cattle for many years, impacting primarily the riparian areas present because of the low availability of

upland forage within the pumice soils of the watershed. Grazing can alter the strength, infiltration rate and vegetative composition of a soil profiles in either upland or riparian systems (Reed and Peterson 1961), (Belsky and Blumenthal 1995). The extent of grazing impacts within riparian areas on private lands within this landscape area appears to be moderate.

Forest resource extraction has occurred on private land within this landscape area for up to 80 years. Gilchrist Corporation managed the private land for many years on a sustained yield basis, incurring relatively low total impacts to the soil resource. Activity on these acres increased in the last five years under management by the Crown Pacific Corporation, increasing the amount of impact to the soil resource on the upland areas. An estimated 50% of the acreage under private ownership appears to have detrimental impacts to the soil resource covering over 20% of the ground (photo interpretation 1997).

Rate And Longevity Of Trend

(1) Vegetative management on federal lands within the watershed has decreased over the past five years. Approximately 114 acres of stands on upland soil types are currently under contract for silvicultural treatment within this landscape area, an additional 2100 acres in the next five years are scheduled for treatment as a result of the Seven Buttes Environmental Assessment. Implementation of Deschutes LRMP and Northwest Forest Plan standards and guidelines has changed the rate and type of vegetative treatments within the watershed. These, in turn, have reduced overall detrimental impacts to the soil resource within harvest units on the Deschutes National Forest, although impacts within units continue to occur on an average of 30% of unit areas prior to mitigation measures such as subsoiling.

The longevity of altered soil quality in areas of vegetative management is likely to continue within this landscape area as stand density and forest health problems are addressed. Areas of compaction, displacement or organic matter reduction do not naturally re-establish themselves at a significant rate, continuing to reduce the productivity of the soil profile present.

(2) Vegetative management on private lands owned by Crown Pacific will probably decrease over time as commercial trees are removed. Current soil conditions are likely to persist into the future unless compaction studies influence land managers to aggressively rehabilitate compacted areas with a subsoiler. Long-term rotations in ponderosa pine and mixed conifer plant associations most likely will limit ground-based entries until the commercial value returns to the stands.

Grazing on private lands within this landscape area is foreseen to continue into the near future at existing levels. Federal and State regulations may reduce the amount of grazing that occurs in the near future in response to the level of stream and riparian degradation that is assessed for a given watershed.

LANDSCAPE AREA D

The causes, rate and longevity of this trend in Landscape Area D are similar to those described for Landscape Area E, with the exception of private development. The extent of this trend for federal forest lands is less than in Landscape Area E since a smaller percentage of the area has been entered in the past for vegetative management. Grazing use and impacts on private land are similar to those described under Landscape Area E.

Private development has been more extensive within this landscape area than any other area in the watershed. This development continues to dedicate more of the soil resource to roads, structures and septic systems. The full extent and rate of this trend within this landscape area is

limited to some degree by high water tables that reduce the amount of septic development that can occur on private land.

LANDSCAPE AREAS A, C AND F

Altered soil quality within these landscape areas has been identified as a green flag trend due primarily to the Wilderness and OCRA management allocations. Limited harvest and grazing within these areas has reduced the extent of impacts incurred to the soil resource. While not extensive in terms of acreage, recreation use has led to areas of impact along trails and around water-bodies, many of which are adjacent to streams and lakes that may be degraded by sedimentation or loss of vegetative cover.

Fire suppression throughout the plant associations present in these landscape areas has allowed litter and duff layers to build up above historic levels in some areas. This trend may actually have a positive effect on soil moisture and nutrient availability during the growing season, while at the same time increasing the possibility of longer duration temperatures at the soil surface during wildfire events.

SOCIAL (Trend 8)

Current soil conditions at Spring Campground and Contorta Point, in particular, would limit the ability for transplanted vegetation to survive due to compaction and long-term disruption of nutrient cycling within the soil. Decompacting and possibly fertilizing selected areas would help ensure survival of native plantings, providing screening, shade and long-term health of large vegetation.

Commercial use of the forest can also have detrimental effects on soil quality due to soil displacement, compaction, and future erosion. The cost of soil conservation or restoration activities affects the overall cost and feasibility of some commercial uses such as timber sales and grazing. The short-term costs and long-term benefits of soil conservation should be evaluated when planning future commercial projects.

Trend 9 - Commercial use is increasing - requests to extract commodities and commercially utilize resources within the watershed are increasing and diversifying.

SOCIAL (trend 9)

This trend is best illustrated by the recent commercial interest in the matsutake mushroom. Since 1989, commercial use of the matsutake mushroom has generated an estimated 10.2 million dollars within a year and attracted nearly 1,400 transient mushroom pickers to an industrial campground located within the Big Marsh Watershed (Bisbee 1997) (See figure 19 for camp location). In addition to the matsutake mushroom phenomena, other requests for commercial uses have occurred, while the traditional commercial uses and commodities extracted from the watershed such as timber, water, and minerals have continued.

The root of many of these requests is that more people are relocating to the rural environment and depending on the National Forest as a basis for a new business. The local economies are transitioning from a timber-based to a tourism/recreation-based economy. Other reasons for requests may be: 1) the reality that most of the affected communities are surrounded by federal land; 2) the occurrence of technological changes (i.e. cellular telephones), 3) the continual need for gravel sources; and 4) new trends in outdoor recreation such as eco-tourism. The following addresses known commercial uses and commodities within each landscape area.

LANDSCAPE AREAS A, C, and F

The commercial uses of these landscape areas are limited by legislation such as the Wilderness Act. Commercial use of Landscape Area A is the most restricted. At this time, no guided tours or commercial use of resources within the Diamond Peak Wilderness such as the collection of matsutake mushrooms is allowed. However, the wilderness does affect the local economy by attracting tourism to the area.

Commercial use in Landscape Areas C and F is not as restrictive. Portions of the area contribute timber to the wood products industry. However, the matsutake mushroom is probably the most harvested commodity. Because most of the area is located within the OCRA, the Forest Service has received several applications to permit professional guided tours for activities such as big game hunting and snowmobiling. The desire to utilize the recreational settings within this area for profit will probably only increase with time.

Other potential commercial uses of this area that are worth noting include mineral claims, utilities, and grazing. There is a known claim to minerals above Big Marsh, however, very little is known about the history of the claim and its potential effect to the watershed. In the Forest Plan, Windigo Pass is identified as a potential utility corridor connecting the east and west sides of the Cascade Mountains. There are no known proposals for utility installment at this time.

LANDSCAPE AREA B

The first development company to claim rights to stored water at Crescent Lake was J. E. Morson's Walker Basin Land and Irrigation Company on May 6, 1901. The Walker Basin Company intended to sell the water in Crescent Lake and Crescent Creek with lands on both sides of the Deschutes in the vicinity of present-day communities LaPine and Crescent. In 1921 the directors of the Tumalo Irrigation District purchased the storage rights at Crescent Lake from the Walker Basin Co. which had gone into receivership and never recovered. Since then, rights to the water stored at Crescent Lake have been sold with agricultural land in Tumalo, Oregon located 45 miles north and 31 miles east of Crescent Lake. The water is connected by 114 miles

of stream via Crescent Creek, the Little Deschutes River, and Deschutes River. Water can flow from Crescent Lake to Bend in four days (Winch 1985).

The history of the Tumalo Irrigation District is complex, and well documented in several articles published in the Oregon Historical Quarterly. As early as 1946, the Tumalo Irrigation District had asked the U.S. Bureau of Reclamation (BOR) to inspect the log crib dam at Crescent Lake. The dam was described as virtually useless in 1953. Construction of the existing dam by the BOR began on April 13, 1955 and was completed by October 24, 1956 (Winch 1986).

By 1960, the use of Crescent Lake for recreation versus irrigation had become a persistent issue. By 1967, when the numbers of Tumalo water users had increased from 92 to 147, the Forest Service had built four campgrounds around the lake and issued permits to about 70 summer homes, a small resort and two organization camps, mostly benefiting residents of Lane County. Consequently, the irrigation district, BOR, Forest Service, State Engineer, and the licensees and regulars at the lake became embroiled in a dispute over rights, responsibilities, and jurisdiction (Winch 1986).

In November 1966, the Tumalo Irrigation District sponsored a picnic and meeting at the resort, and invited the permitees, eight governmental agencies, eleven public officials, five newspapers, and seven chambers of commerce including Lane County, Eugene, and Oakridge. Several months later during the summer of 1967, an agreement was finally reached, whereby the irrigation district would clear the timber off the land that had been killed by flooding the 21 mile shoreline to the elevation of 4839.5. They also agreed to compensate the Forest Service for relocating its facilities (Winch 1986).

Presently, recreational use of Crescent Lake continues to be the primary competing need for the water in Crescent Lake. The Community Action Team for the community of Crescent Lake Junction identified the reversal of the drawdown at Crescent Lake as one of its top priority action items in their 1994 Community Action Plan. The commercial businesses in the vicinity of Crescent Lake depend on the retention of water to attract tourists and provide them with quality facilities and services. At this time, there is no one conveying the concerns of their community to the Tumalo Irrigation District or Bureau of Reclamation. The water level at the lake affects a community that includes but is not limited to the recreation residents, Boy Scout Camp, the Forest Service, Crescent Lake Junction businesses, Crescent Lake Resort, and campground concessionaires.

LANDSCAPE AREAS D and E

Landscape Areas D and E are probably the most commercially used areas within the Big Marsh Watershed. A large component of private land located within each landscape area has been managed to maximize commercial use and commodity extraction such as the land owned by Crown Pacific. The community of Crescent Lake Junction is located entirely within Landscape Area D. This service-oriented community has a motel, restaurants, a bar, gas stations, general stores, and RV parks. This area is also used as a market area during the matsutake mushroom season.

The Forest Service has permitted rural type facilities such as a state airstrip and located a new sno-park adjacent to the community. These amenities both serve the public and benefit the community. A new industrial camp for commercial mushroom pickers was developed last year near Little Odell Butte located at the south end of Landscape Area D. Mushroom permits are sold from Sept. 1-Oct. 30, with permittees required to camp in this area if not otherwise housed. This 605 acre area has a 1,000 person capacity. Future desires for this camp include a water well and possible construction of fee booths at each end of the 5814 road. Dust tends to be a problem as Forest Road 5814 which services this camp is a native surface road. The proximity

of the camp to the community promotes a safe environment for residents and a profitable environment for local businesses.

Another commercial use with Landscape Area D is cattle grazing. Grazing occurs along Big Marsh Creek near its confluence with Crescent Creek. Records for this small On/Off allotment are vague. The allotment has not been used in two years by the current permitee. However, unauthorized use by cattle from private pastures on the Little Deschutes Cattle Allotment has been a problem for the watershed from Big Marsh north to Highway 58. Between Road 6020 north to the private land boundary has been the largest problem area in the recent past (McGranahan 1997).

Other commercial uses within the area include: firewood collection; cinder pits; matsutake mushroom collection; timber; Christmas trees; boughs; communication towers on Odell Butte; and the railroad. All of these uses are managed by the Forest Service through a permit system or contracted sale. At this time, the Southern Pacific Railroad may be changing ownership. Rumors of reestablishing a stop at Crescent Lake Junction have been circulating, but have never been confirmed. If the stop is reestablished, it would have an impact on the use of the area in terms of recreation, tourism, services, and waste disposal.

(See discussion in Chapter 2 on additional social implications and uses throughout the watershed).

WILDLIFE (trend 9)

Increasing demand for mushrooms by the public may create a decline in this food source for small mammals including squirrels, chipmunks, voles, and other species such as deer and elk. Loss of this important fall forage component may stress the animals listed above during harsh weather periods, which could have an indirect impact on predators that utilize these species such as spotted owls. In addition, disturbance from pickers could impact fall migration routes. Illegal picking is occurring in the Wilderness on what is thought to be a small scale, however, this activity may impact species highly susceptible to human disturbance such as the wolverine.

The increased demand for forest wood products due to the declining availability of timber has impacted late successional and old growth stands and the species dependent on them. Personal use firewood collection removes pockets of dead and down material that are important foraging and nesting habitat for primary and secondary cavity nesting species including birds and small mammals. Prey base habitat for marten, fisher and goshawk may also be reduced with the removal of firewood. See Trends 1 and 2 for additional information.

BOTANY (trend 9)

With commercial uses increasing, there is an increased potential for the introduction and spread of noxious weeds and other non-natives by commercial users and their vehicles. These vehicles would include wood cutters, mushroom pickers, fire suppression personnel, and commercial logging vehicles. New clauses in timber sale contracts will require logging equipment to be cleaned of weed seed before beginning any project on the Forest.

There is potential for impacts to native species from the collection of such commercial forest products as mushrooms, bulrush, prince's pine, and others. Collection of these items is prohibited in the Wilderness, however, some of the most suitable habitat for these species is located there, and collection of mushrooms in Diamond Peak is known to occur.

Commercial harvesting of mushrooms has greatly increased in recent years, creating potential impacts on species populations and habitats. For instance, the matsutake mushroom is a fungal

associate of *Allotropa virgata* (ALVI), a species listed in Appendix J2 of the NWFP and in Appendix C of this document. The harvest of fungi may affect species viability by potentially decreasing distribution, frequency, reproduction, productivity, and genetic variability of species. Currently, most species that are commercially harvested are not considered to be at risk, but future impacts may affect their viability (USFS Appendix J2 1994).

SOILS (trend 9)

LANDSCAPE AREAS D, E AND F

Extent Of Trend

The extent of impact to the soil resource from this trend is not easily quantifiable due to the diversity of forest products and removal techniques currently employed. Impacts associated with commercial timber operations in these areas are discussed under Trend 8. The extent of impacts to the soil resource from firewood cutting, mushroom harvesting and other special uses are moderate to low at current use levels.

Specific impacts to the soil resource from firewood cutting are similar to those incurred from commercial timber operations including compaction, displacement of mineral soil, disruption of natural horizonation, and alteration of organic matter components on the soil surface.

Impacts incurred from mushroom harvest include compaction of the soil in camping areas and displacement of the litter and duff layer in the foraging areas.

Rate And Longevity

While commercial use of the forest for special forest products has increased in the last five years, designated firewood cutting and mushroom camping areas have been put in place to reduce the amount of area affected by these types of operations. The elimination of litter and duff raking for mushroom harvest reduces the amount of disturbance in areas of collection.

Trend 10 - Recreational use is increasing. The demand for public lands to provide a diversity of outdoor recreation settings is increasing with an emphasis on access to primitive and semi-primitive settings that accommodate popular dispersed activities. The need for public education on forest land and resource management is increasing.

SOCIAL (trend 10)

This social trend is validated by findings documented in the Oregon Outdoor Recreation Plan 1994-1999 which was prepared as a statewide comprehensive outdoor recreation plan (SCORP) by the Oregon Parks and Recreation Department. A representative of the U.S. Forest Service served on the SCORP's advisory committee. The findings in this plan that are pertinent to the Big Marsh Watershed include the following:

The demand for outdoor recreation in Oregon has grown steadily over the past 20 years. A growing, and an increasingly urban, in-state population is turning more and more to the out of doors for relaxation and education. Additionally, Oregon's economic strategy for the future includes a major focus on recreation and tourism.

While demand has grown, the supply of public land available for recreation has remained static. The supply of available private land is decreasing due to development and the concerns of private owners. More people sharing a static resource is leading to increasing user conflicts. These conflicts arise from sheer user numbers, different perceptions of what is an appropriate setting, user etiquette and user impacts on the recreation resource.

There is a pronounced preference for more semi-primitive and primitive settings among survey respondents, especially for dispersed activities. This supports findings from the 1988 SCORP which also determined substantial shortages of these settings to meet future demand on U.S. Forest lands.

The most popular dispersed activities are: sight seeing and driving for pleasure; swimming/wading at the ocean, lakes, or rivers; boat fishing; tent camping; and, nature study and wildlife viewing. Significant numbers of survey respondents would like to participate in non-motorized boating, horseback riding on trails, cross country skiing, hiking and backpacking on trails, and nature and wildlife viewing." (SCORP 1994).

These findings in the SCORP are validated within the Big Marsh Watershed. The slow increase and diversification of human use has led to a sprawl of developed Forest settings and resource damage in high use areas. Maintenance and law enforcement needs are increasing as well. There are more conflicts between forest users such as motorized versus non-motorized winter recreationists as well as mushroom pickers versus hunters. These are just a few of the obvious consequences of increased recreational use.

While the demand for recreational settings has increased, government is downsizing and becoming more collaborative in order to keep existing public facilities useful and safe. User fee programs are now being implemented on the Deschutes National Forest and throughout the National Forest system to generate on-site funds for on-site maintenance. Campgrounds are being managed by private concessionaires. Recreation facilities are being maintained and constructed only through partnerships with agencies such as the Oregon State Marine Board and Oregon Department of Transportation. Face to face contact between the public and the USFS personnel is decreasing.

The reality of increased recreational use and lower budgets has an impact on the current and future management of outdoor recreation settings within Big Marsh watershed. Presently, recreation settings and their associated facilities, access routes, scenic vegetation, information services, and riparian interface need to become self-sustaining and low maintenance due to the lack of money available for repairs and upkeep.

(See discussion in Chapter 2 for additional information on social concerns and recreation.)

WILDLIFE (trend 10)

GENERAL

Increased disturbance to wildlife by forest users (mushroom pickers, other forest product gatherers, recreationists, recreational vehicle traffic, and hunters) affects an animal's fitness depending on how it responds to human disturbance. Species that demonstrate a moderate sensitivity to human activity, (tolerate low levels of activity but react to high levels) include: bald eagle, boreal owl, elk, golden eagle, marten, merlin, mountain lion, northern goshawk, and Cooper's, red-tailed, rough-legged, and sharp-shinned hawks, among others. Species that demonstrate a high sensitivity to human activity, (react to both low and high levels of human activity) include: sandhill crane, big brown and silver-haired bats, numerous myotis species, and wolverine, among others.

Depending on the extent, frequency, and duration of disturbance, it may affect the animal's ability to survive during stressful periods, cause abandonment of young, and/or abandonment of habitats. Vehicular traffic on roads, whether it be cars, trucks, motorcycles, ATV's, snowmobiles, or mountain bikes, all contribute to the disturbance of wildlife.

Increases in the number of forest users have favored some wildlife species. Species that show a positive correlation to human activity are the American crow, barn owl, European starling, golden-mantled ground squirrel, gray jay, Townsend's chipmunk, and yellow-pine chipmunk.

Recreation can adversely impact riparian habitat and the species associated with it. This includes dispersed camping along lakes and associated damage to riparian vegetation; trail/stream crossings; and other impacts around lakes.

See Trend 2 for additional information on loss of connectivity and fragmentation.

LANDSCAPE AREAS A AND C

Impacts from recreation on wildlife include disturbance and potential barriers from trails and roads. Recreational use and boating at Summit Lake could impact wildlife species. Substantial recreation use occurs in the fall during hunting season, and impacts the movement of species, especially big game.

LANDSCAPE AREA B

Crescent Lake is an Intensive Recreation Management Area. Bald Eagle Management Areas border the Intensive Recreation areas on the northwest and southeast sides of the lake. The lake is virtually surrounded by numerous campgrounds and summer homes, a resort, Boy Scout Camp, roads and trails. See Figure 1 - 27. As a result of these facilities and the associated human use they receive, impacts to wildlife species and habitat occur.

Recreation use of the area may increase in the near future as a result of the Junction Snopark, the construction of which will be completed in 1997. The Snopark is located in Landscape Area

D, however, impacts will occur in the adjacent landscape areas that contain snowmobile trails and other winter recreation opportunities. Impacts will occur to species using Crescent Lake in the winter, including eagles, waterfowl, marten, and otter among others. There is also a proposal for Camp Makualla to expand its facilities and extend the seasons of use to include winter. There is prime bald eagle winter roosting and potential nest habitat around the camp.

The recreation residences border the Bald Eagle Management Area and are actually included within the Crescent Lake Late Successional Reserve. They are located in the mixed conifer dry PAG which provides suitable nesting habitat for the bald eagle and nesting, roosting, and foraging habitat for the spotted owl. Some disturbances to the species occur as a result of the location of the homes within suitable habitat.

One bald eagle nest is located in the vicinity of Crescent Lake and suitable habitat exists for another pair in the vicinity, however, no nest site has yet been established.

LANDSCAPE AREAS D AND E

As discussed under Landscape Area B, the Junction Snopark will be located within this area and will result in increased numbers of winter recreation users.

Development of private lands continues with the increase of populations near the watershed. Development of private land adversely affects wildlife species by displacing them to less optimal habitat. This is especially occurring in streamside riparian habitats; examples include Crescent Creek and Big Marsh subdivisions.

LANDSCAPE AREA F

Species that are susceptible to human disturbance are located within this landscape area and include the sandhill crane. Disturbance during the spring and summer months could adversely impact nesting bird species. Big Marsh usually remains very wet during the spring and early summer months and the mosquito population is a nuisance, which discourages recreational use.

Big Marsh is a popular area for fly-fishing, bird watching, dispersed camping, and canoeing during the summer, which cause some disturbance to wildlife. Key elk habitat is located within this landscape area and recreation in the spring and summer could impact elk cows and calves.

Big Marsh is an extremely popular recreation area in the fall during archery and rifle deer and elk hunting seasons. Dispersed campsites are located around the marsh, especially on the south end. These activities impact wildlife movement, especially of big game. Waterfowl hunting also occurs to some extent within the marsh, but bird numbers are limited by the lack of open water.

Wildlife has been identified as one of the Outstandingly Remarkable Values for the Big Marsh Wild and Scenic River. Recreational use has the potential to further impact wildlife in the area, if it continues to increase and diversify.

FISHERIES (trend 10)

LANDSCAPE AREA A

The increased demand for recreational opportunities may promote further introductions of non-native fish into the wilderness lakes. This would impact the native flora and fauna of those water bodies. These lakes and streams are not highly productive and increased fishing pressure could reduce the quality of the fisheries which have been developed there. Riparian communities will experience greater damage and erosion, and water quality issues will arise.

LANDSCAPE AREA B

Crescent Lake is now open to year-round fishing. This will increase the pressures upon the riparian community, water quality, fisheries, and the threat of introduction of new exotics, both plant and animal.

LANDSCAPE AREA C

The concerns for this landscape area are the same as for area A. Summit Lake is located within this landscape area and its fishery is under increasing threat from introduced exotics. Again, the quality of the fisheries may suffer from increased pressure.

LANDSCAPE AREA D

The opportunity for fisheries education is high in this hub area of human activity. Again, low productivity of this region will not support large increases in fishing pressure without a decrease in quality.

LANDSCAPE AREA E

Increased use and take of the fisheries in this area will reduce the quality of the resource. If further degradation of the habitat occurs through higher use, the trend towards non-native fish replacing and out-competing native fish will continue. Private lands may actually serve as a buffer safety zone for the fisheries should recreational use increase on public lands to the point that it is impacting the resource.

LANDSCAPE AREA F

Greatly increased recreational use in this area will negatively impact the fishing activities in this area, both in the catch rates and the outdoor experience. Many people fish in the Big Marsh area because of its natural beauty and primitive qualities, regardless of the size or numbers of the fish they catch. These qualities would be lost with a large increase in recreation use.

BOTANY **(trend 10)**

Noxious weeds threaten recreational values by: invading suitable areas to dock boats, picnic, and camp; invading trails traversed by campers, hikers, mountain bikers, and horseback riders; spreading through native plant communities in wilderness area, detracting from wilderness adventures, and outcompeting native wildflowers, eliminating photographic and viewing opportunities.

Increased recreation use also increases the potential for the introduction and spread of noxious weeds and non-native plants. Recreation use can also cause adverse impacts to native plants and sensitive species.

SOILS (trend 10)

LANDSCAPE AREAS A AND C

Extent Of Trend

The extent of impacts to the soil resource from recreational use within these two landscape areas is discussed under Trend 8.

Rate And Longevity

The increased use of these areas by the public will continue to put pressure on the soil resource along trails and around water bodies. Identification of problem areas should allow for rehabilitation and changes in use patterns to reduce the amount of area impacted over time. The higher elevation setting of much of these landscape areas reduces the amount of natural recovery of compacted areas and vegetation that would occur without intervention.

LANDSCAPE AREAS D, E AND F

Extent Of Trend

The extent of recreational impacts within these landscape areas is relatively low when considered as an acreage percentage of the area. In areas of repeated use, the soil resource is compacted and altered from its inherent state.

Rate And Longevity

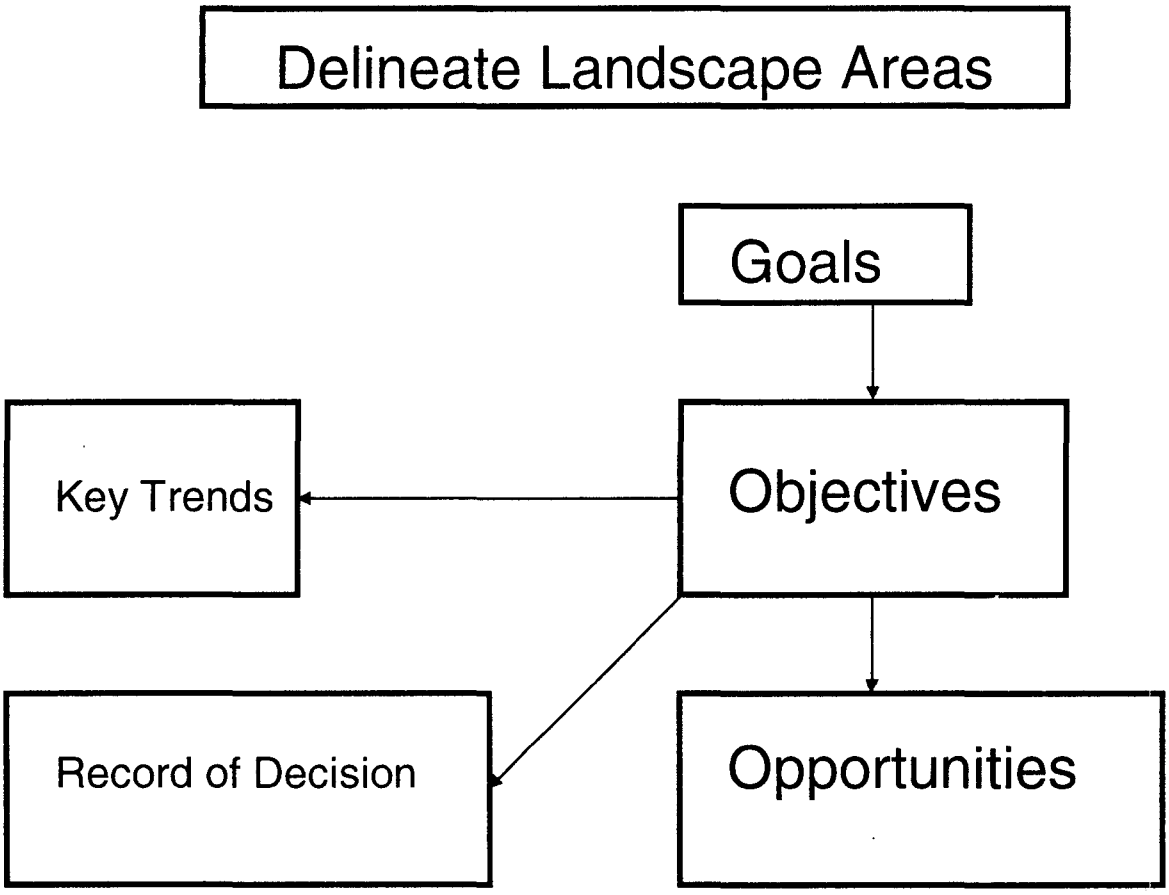
There are many areas of established recreation use that will most likely have the soil resource maintained in a somewhat degraded state. An increase in use in some areas, especially Big Marsh, may increase the amount of the soil resource impacted from recreational activities if use areas are not designated or properly located.

CHAPTER 5

LANDSCAPE GOALS AND OPPORTUNITIES

PHASE E PROCESS

Big Marsh Watershed Analysis



Fiscal Year Program of Work

&

Restoration
Projects

LANDSCAPE AREA GOALS AND OPPORTUNITIES

LANDSCAPE AREA A - Diamond Peak Wilderness

Goal

Protect and enhance the pristine quality of this area including opportunities for solitude, primitive non-motorized settings, mental and physical challenge, a distinct experience in a wilderness environment and maintaining the wilderness characteristics of the lands -- including wildlife habitat for species preferring isolation from human disturbance (e.g. fisher, wolverine), or undisturbed mature forest for old growth associated species (LRMP 4-103). Natural processes are the dominant feature that shape the landscape and include fire, insects and disease.

Objectives

A. Allow fire to play a more natural role in this landscape area, especially in the mountain hemlock zone. Historically, this zone probably had more pockets of early seral stands from low intensity fires, and possibly larger areas of younger stands from high intensity, stand replacement fires. (Trend 3)

B. Evaluate new construction of trails or dispersed sites to determine if it would negatively affect or be a barrier to connective habitat between large blocks of late and old structured (LOS) stands for species such as marten, fisher, and wolverine. (Trends 1, 2)

C. Eradicate or control the spread of noxious weeds and non-natives. Determine the impacts of planted non-native fish to native invertebrates, aquatic insects, fish, and plants. Reduce the impacts if they are negative. Assess effects of other non-native species on the ecosystem. (Trend 4)

D. Maintain the health and integrity of riparian areas especially in high disturbance areas such as trail crossings and dispersed campsites along lakes. Prevent the degradation and reduction of instream flows. (Trends 5, 6, 7)

E. Maintain the existing natural soil condition in upland areas. Reduce erosion and sedimentation from trail/stream crossings and trails that are parallel to streams. Reduce soil compaction around heavily used lakes and the resulting runoff. (Trends 6, 8)

F. Reduce sanitation disposal problems around lakes. (Trend 6)

G. Continue to prohibit commercial use in the wilderness.

H. Maintain compliance with the Wilderness Act, the Deschutes Land and Resource Management Plan (LRMP) and the Northwest Forest Plan. (Trend 10)

I. Enhance education opportunities. (Trend 10)

J. Reduce or eliminate illegal mushroom picking and mountain biking through planning, coordination, law enforcement, and education. (Trend 10)

Opportunities

1. Develop a Prescribed Natural Fire (PNF) plan for the Diamond Peak Wilderness in conjunction with the Willamette National Forest to allow fire to play a natural role in the

ecosystem. A mosaic of stand structures and a reduction in the risk of large scale high intensity fire may result across the landscape. (Objective A)

2. Survey for spotted owls in wilderness areas adjacent to the Crescent LSR with suitable habitat. (Objective, B,H)

3. Identify bald eagle nesting habitat within wilderness areas on the northwest side of Crescent Lake. (Objective, H)

4. Coordinate with the Oregon Department of Fish and Wildlife to determine which of the currently stocked high-elevation lakes should continue to be stocked with non-native fish and which should not due to resource concerns and impacts to native species. Consider the consequent recreation use when making recommendations. (Objective, C)

5. Improve trail and stream crossings and dispersed recreation sites, examples include: trail crossings with Mountain Creek, e.g. Pacific Crest Trail and Snell Lake Trail; Whitefish Trail; Fawn Lake Trail; and dispersed recreation sites at Fawn Lake, among others. (Objective, D,E)

6. Increase law enforcement in the Wilderness to ensure compliance with the prohibition of commercial uses such as mushroom picking and mountain bike riding and to reduce user conflicts. (Objective. H, J)

7. Coordinate educational opportunities with Resort owners and other businesses to provide information about appropriate wilderness uses and methods to help minimize damage to the wilderness through human use. This could include information such as: providing methods to minimize meadow damage from horse use, the use of weed free feed for horses to reduce the spread of noxious weeds, increasing public perception about the role of fire in the wilderness, and educating the public about appropriate sanitation disposal methods in the wilderness. (Objective, I)

8. Determine the numbers of visitors the Wilderness can sustain. If necessary reduce the current number and size of the trailheads to reduce and/or manage use. (Objective, B, F)

9. Determine if there is high potential for suitable habitat for fisher and wolverine. If so, evaluate impacts on the species if new trail construction is planned. [LRMP Appendix 4-9 & 10] (Objective, B)

10. Gather baseline data on stream conditions. (Objective, D)

Monitoring

a. If a large wildfire escapes suppression efforts, monitor to determine the effects on other resource areas. (Would occur before PNF plan is completed) (Opportunity, 1)

b. Monitor the reproductive status of the spotted owl. (Opportunity, 2)

c. Continue to monitor air quality. (Opportunity,1)

d. Continue to monitor the number of users within the Wilderness. Monitor levels of human use at sensitive areas such as lakes. (Opportunity, 8)

e. Continue to complete lake surveys, including the collection of baseline data on species composition of fish, plankton, and amphibians; water quality; lichen monitoring; and lakeside vegetation. (Opportunity, 4, 5)

LANDSCAPE AREA B - Crescent Lake Area

Goal

Provide for recreational use that is both appropriate and diverse by providing a wide spectrum of quality outdoor settings that range from semi-primitive to developed. Maintain and enhance water quality, fisheries and wildlife habitat, riparian integrity, soil productivity, large tree dominance, sensitive plants and special uses while protecting cultural resources and native plant and animal species.

Objectives

A. Maintain or improve the health of the existing late and old structured (LOS) stands. Manage to provide a succession of LOS across the landscape and appropriate levels of snags and down woody debris. Increase the number of stands in the open condition within the ponderosa pine and mixed conifer PAGs (Trends 1, 2, 3)

B. Encourage LOS to improve/enhance suitability of habitat for LOS species such as northern spotted owl, bald eagle, northern goshawk, black-backed woodpecker, pileated woodpecker, great gray owl, and pygmy owl ***within the LSR and BEMA areas.*** Large trees with defects or flat tops should be maintained for nesting and roosting trees when possible . Maintain and enhance connective habitat between large blocks of LOS stands ***especially within the LSR and BEMA areas*** by reducing road densities. Emphasize recreation use in developed recreation areas as opposed to the LSR and BEMAs. (Trends 1, 2)

C. Use silvicultural treatments to protect and enhance the aesthetic large-tree character within the mixed conifer dry PAGs within developed recreation sites to enhance wildlife habitat and scenic quality along roads, trails and campsites. (Trends 1, 2, 10)

D. Control the spread of noxious weeds and non-natives. Determine the impacts of planted non-native fish to native invertebrates, aquatic insects, fish, and plants. Consult with ODFW and USFS to reduce the impacts if they are negative. Assess effects of other non-native species on the ecosystem. (Trend 4)

E. Use prescribed fire in ponderosa pine and mixed conifer dry PAGs as a vegetative manipulation tool and as a method to simplify fuel beds in order to effectively reduce the risk of stand replacement fire. Prescribed underburning can also be used to meet the management objectives for this area. (Trends 1,3)

F. Maintain or enhance the current fishery population. (Trends 4, 5, 6, 7)

G. Reduce the fluctuation of water in Crescent Lake as much as possible, while maintaining downstream flows. Emphasize non-degradation of the steam channels and riparian areas. Reducing the water fluctuation will reduce shoreline erosion and improve riparian edge habitat. (Trends 5, 6, 7)

H. Meet State and Federal water quality laws such as the Clean Water Act. (Trend 6)

I. Retain or enhance the integrity of the existing riparian areas and their buffers and restore normal hydrologic function (e.g. spruce bog by Camp Makualla, Kaboom Creek, and Whitefish Creek). (Trend 7)

J. Assess effects of soil compaction in and around developed recreation sites and the possibility of resulting runoff problems. (Trends 6, 8)

K. Improve amphibian habitat. (Trend 7)

L. Focus commercial use at the Crescent Lake Resort and Camp Makualla. (Trend 9)

M. Limit resource damage from human use trends while protecting the uniqueness of the recreation settings. (Trends 9, 10)

N. Improve the quality and function of existing recreation sites before constructing new ones. (Trend 10)

O. Identify the desired outdoor settings which range from semi-primitive to developed, and the appropriate linkages between them, to attain the desired use. Delineate settings to minimize conflicts among users and between users and wildlife. (Trend 10)

P. Enhance education opportunities via Crescent Lake lodge, campground concessionaires, Willamette Pass Visitor Center, local schools and Central Oregon Community College. (Trend 10)

Q. Develop fuel reduction strategy, especially near summer homes along Crescent Lake and the boy scout camp.

R. Maximize educational opportunities and participation with rural planning groups and private forest users (e.g. fire protection agreements with Crescent Lake Junction rural fire department, and Community Action Team participation). (Trend 10)

S. Enhance waterfowl nesting habitat by providing nesting platforms, vegetation mats, and improved lakeshore and riparian habitat. (Trend 2,7)

T. Replace current vault toilet at Contorta Point with new pre-cast vault in the same location as the current toilet. Present toilet vault has failed and may be causing water contamination. (Trend 6)

Opportunities

1. Stands containing immature and mature trees which could be managed to produce suitable replacement trees for the bald eagle while meeting the habitat needs of other wildlife species should be identified. Management of these stands could include understory thinning, prescribed low intensity fires, creation of small openings for regeneration, and designated removal of some trees to reduce competition and stress. (Objective, B)

2. Emphasize management of regenerated stands to accelerate growth as a means to return to LOS and create bald eagle habitat more quickly. Favor species such as ponderosa pine and Douglas-fir during precommercial thinning. (Objective, A,B,C)

3. Maximize the number of snags in undeveloped areas within suitable bald eagle habitat. (Objective, A,B)

4. Complete an LSR Assessment for the Crescent LSR which recommends management options for vegetation and fuel reduction along the summer homes tract. Include considerations for forest health, scenery, and bald eagle habitat. In areas where snags are absent, utilize nest boxes where appropriate for the affected recreational setting. (Objective, O)

5. Initiate stocking level control for large, multi-storied stands. Thin from below to reduce stand density and maintain health of the stands. Include regeneration stands in stocking level control management. Use prescribed fire when possible. (Objective, A,B)

6. Complete a recreation plan for Crescent Lake that incorporates all resource areas and evaluates the area as a complex with Odell Lake. New development or improvements to existing recreation sites at Crescent Lake should complement the exiting recreation opportunities at the lake and other nearby lakes including Odell, Davis , Summit , and Waldo Lakes. The plan should include protection of recreation settings and wildlife habitat. (Objective, O,L)

7. Develop a holistic, comprehensive bald eagle plan for Crescent Lake, including the areas outside the BEMAs. Evaluate the BEMA boundaries and recommend changes if necessary. (Objective, O)

8. Reduce road densities to meet LRMP guidelines; decrease fragmentation, erosion and sedimentation; eliminate parallel or redundant roads; and/or increase the quality of habitat for wildlife and the undeveloped recreation experience. Areas to concentrate road density reduction include the east side of Crescent Lake, Crescent Lake Sno-park and Simax area. (Objective, I,J,M)

9. Accomplish fuel reduction around the summer homes, in the vicinity of Camp Makualla, and the developed campgrounds. Develop a slash removal and reduction strategy in pre-commercial thinning units. (Objective, Q)

10. Coordinate cooperative fire suppression with the Crescent Lake Junction Rural Fire District. (Objective, Q,R)

11. Educate the public about the role of fire in the ecosystem. (Objective, P)

12. Address the issue of water extraction from the lake by homeowners. Resolve the issue of water rights. Work towards compliance with the water quality laws (summer homes) as special use permits are renewed. Develop a long-term strategy with the Department of Environmental Quality to deal with these water quality issues. (Objective, H,M)

13. Maximize the recreation opportunities in areas that are already developed. (Objective, N)

14. Stabilize banks and promote shoreline vegetation along the Crescent Lake shoreline, especially along the summer home tract and between the mouth of Whitefish Creek and the 60 Road. Create deeper pools and add large woody debris and gravel where appropriate in Whitefish Creek. (Objective, F.I.J,K)

15. Explore possibilities of placing a vortex weir structure at the mouth of Whitefish Creek to keep the pumice bar from building up. Further studies need to be done to determine the feasibility of such a structure. (Objective, I)

16. Work with the Tumalo Irrigation District and the Forest Hydrologist to modify the fluctuation in Crescent Lake and stabilize stream flows in Crescent Creek. National Forest lands are being damaged by the fluctuations and rapid release of water in the creek. (Objective,F,G)

17. Designate and construct long-term boat ramps in coordination with the Oregon State Marine Board that will maximize access during all seasonal use periods. Add filter or absorbent to the dam intake to reduce the risk of fuel spills from boats potentially impacting Crescent Creek. (Objective, H,I,J)

18. Continue the development of Crescent Lake Sno-park for information dissemination or explore the possibility of utilizing the Crescent Guard Station for the same purpose. (Objective, P)

19. Assess need and, if necessary, construct waterfowl enhancement structures. (Objective, S)

20. Educate homeowners and concessionaires about the threat of noxious weeds and benefits of their assistance in controlling the spread. The public could also be made aware of the problem by teaching weed identification and encouraged to help where possible, by pulling weeds and/or notifying the Forest Service of the location of problem areas. (Objective, D,P)

21. Develop a Watchable Wildlife education program and a campground interpretive program. (Objective, P)

22. Obtain baseline water quality information. (Objective, F,H,I)

Monitoring

a. Monitor bald eagle nest productivity and use of winter roosting areas. (Opportunity, 1,2,3)

b. Monitor waterfowl population densities and nesting success. (Opportunity, 8)

c. Monitor aquatic organisms. (Opportunity, 14)

d. Monitor fish utilization of Whitefish Creek if Opportunity 15 is accomplished. (Opportunity,15)

e. Continue redd surveys. (Opportunity,8,14)

f. Monitor water quality in Crescent Lake. (Opportunity, 6)

g. Monitor the introduction and spread of noxious weeds and undesirable non-native species and any efforts to control or eradicate them. (Opportunity, 20)

h. Monitor the number and types of recreation users. (Opportunity, 6)

i. Monitor the incidence of Off-Highway-Vehicle (OHV) use. (Opportunity, 6)

j. For prescribed underburning, monitor the effectiveness of the burn, smoke emissions, mortality, fuel reduction and vegetation response. (Opportunity, 1,4)

k. Monitor sensitive plant sites. (Opportunity 20)

LANDSCAPE AREA C - Oregon Cascades Recreation Area

Goal

Conserve, protect and manage in a substantially undeveloped condition the unique values associated with the Oregon Cascades Recreation Area (OCRA), while allowing the continuation

and conservation of natural processes. Continue to provide and enhance the semi-primitive motorized settings that provide use of dispersed commercial, recreational and educational uses.

Objectives

A. Allow fire to play a more natural role in this landscape area, especially in the mountain hemlock zone. Historically, this zone probably had more pockets of early seral stands from low intensity fires, and possibly larger areas of younger stands from high intensity, stand replacement fires. (Trend 3)

B. Reduce fuel buildup in more fire frequent regimes, such as the mixed conifer dry and lodgepole pine PAGs. Historically, frequent, low intensity fires kept fuel accumulations low, and allowed for more open stands. (Trend 3)

C. Encourage late and old structured (LOS) stands to improve/enhance suitability of habitat for LOS associated species such as northern spotted owl, bald eagle, northern goshawk, black-backed woodpecker, great gray owl, and pygmy owl as well as lichens, bryophytes, fungi, and LOS associated vascular plants. Large trees 30" or larger with defects or flat tops should be maintained for nesting and roosting trees where appropriate. Maintain or improve nesting, roosting, and foraging habitat for the spotted owl. Down woody debris should be maintained for prey base habitat. Maintain and enhance connective habitat between large blocks of LOS stands. (Trends 1, 2)

D. Evaluate new construction of trails to determine if they would negatively affect or be a barrier to connective habitat between large blocks of late and old structured (LOS) stands for species such as marten, fisher, and wolverine. (Trends 1, 2)

E. Eradicate and control the spread of noxious weeds and non-natives. Determine the impacts of planted non-native fish to native invertebrates, aquatic insects, fish, and plants. Assess effects of other non-native species on the ecosystem. (Trend 4)

F. Maintain and enhance the health of riparian areas at trail crossings and dispersed campsites along lakes. Prevent the degradation and reduction of instream flows. No diversions will be constructed. (Trends 5, 6, 7)

G. Maintain the existing natural soil condition in upland areas. Reduce erosion and sedimentation from trail/stream crossings and trails that are parallel to streams. Reduce soil compaction around heavily used lakes and the resulting runoff. (Trends 6, 8)

H. Reduce sanitation disposal problems around lakes. (Trend 6)

I. Develop a comprehensive plan including all resource areas for Summit Lake that addresses both the dispersed and developed sites. The plan should direct recreation use to appropriate areas. Limit boat access to small boat and canoe use on Summit Lake. (Trend 10)

J. Examine methods to reduce user conflicts between mountain bikers, hikers, mushroom pickers and hunters, through planning, coordination, and education. (Trends 9, 10)

K. Maintain existing winter motorized through-traffic routes in the area. (Trend 10)

L. Maintain compliance with direction set forth in the Oregon Cascades Recreation Plan in the LRMP Appendix 4.

M. Utilize businesses, resorts and the Willamette Pass Visitor center to enhance education opportunities in the OCRA. (Trend 10)

Opportunities

1. Assess the impacts of commercial uses on other users and the resources -- determine the carrying capacity for such uses, including mushroom harvesting. (Objective I)

2. Develop a management plan and Prescribed Natural Fire (PNF) plan for the Oregon Cascades Recreation Area in conjunction with the Winema, Umpqua, and Willamette National Forests. Include in the management plan an assessment of current trail conditions and needed construction/reconstruction. Allow fire to play a natural role in the ecosystem. A mosaic of stand structures may result across the landscape as well as a reduction in the risk of large scale high intensity fire. (Objective A)

3. Coordinate with the Oregon Department of Fish and Wildlife to determine which high-elevation lakes should continue to be stocked with non-native fish and which should not due to resource concerns and impacts to native species. Consider the consequent recreation use when making recommendations. (Objective E, F)

4. Coordinate educational opportunities with Odell Lake Lodge and other businesses to provide information and education about the OCRA. This could include information about the role of fire in the ecosystem, noxious weed identification, promoting the use of weed-seed-free-feed and highlighting the importance of maintaining the integrity of riparian areas. (Objective M)

5. Provide education about appropriate sanitation disposal methods in the OCRA and provide toilet facilities where needed and appropriate. (Objective M)

6. Evaluate recreation areas with soil problems to potentially alter use patterns and rehabilitate areas that are heavily impacted. Concentrate dispersed use in designated areas. (Objective F, G, I)

7. Improve trail, trail and stream crossings and dispersed recreation sites, examples include: Windy Lakes Trail (reduce grade and/or relocate) and dispersed recreation sites at the Windy Lakes and Summit Lake plus additional areas where damage is occurring. (Objective F, G, I)

8. Determine the carrying capacity of the OCRA. If necessary, reduce the current number and size of the trailheads to reduce and/or manage use. (Objective I, J, L)

9. Survey for spotted owls in areas with suitable habitat. (Objective C)

10. Determine if there is high potential for suitable habitat for fisher and wolverine in all or parts of this landscape area. If so, evaluate impacts on the species if new trail construction is planned. [LRMP Appendix 4-9&10] (Objective D)

11. Gather baseline data on stream conditions. (Objective F)

12. Explore the possibility of a canoe trail at Summit Lake. (Objective I)

13. Encourage the use of prescribed fire to reduce stand density in the mixed conifer, lodgepole and mountain hemlock PAGs. (Objective A)

14. Evaluate and survey the Tuck Lake area for additional populations of the sensitive plant, *Lycopodiella inundata,* bog clubmoss. (Objective E)

15. Conduct a species inventory at Summit Lake, in conjunction with a recreation plan for the area is completed. (Objective I)

16. Design trails and roads for appropriate use, i.e. bike trails need to be designed to a different standard than hiking trails. (Objective D)

Monitoring

a. Monitor the *Lycopodiella inundata* (ORNHP List 2, TNC Rank G5/S2) sites in the OCRA. (Opportunity 14)

b. Monitor the amount of mushroom picking that occurs in the area and any associate damage to vegetation and soils. (Opportunity 1)

c. Continue the monitoring project at Bingham Lakes which is researching the effects of stocking non-native fish species in naturally fishless lakes. The effects to other organisms are being compared between stocked and unstocked lakes. (Opportunity 3)

d. Monitor effects of any large wildfires that may occur in the OCRA, monitor to determine the effects on other resources. (Opportunity 2)

e. Monitor air quality. (Opportunity 2)

f. Monitor the number and types of users and their route of access to the OCRA (east side or west side). Monitor levels of human use at sensitive areas such as lakes. (Opportunity 4, 8)

g. Continue to complete lake surveys, including the collection of data on species composition of fish, plankton, and amphibians; water quality; lichen monitoring; and lakeside vegetation. (Opportunity 3, 8)

LANDSCAPE AREA D - Crescent Lake Junction Area

Goal

Provide year-round instream flows in Crescent Creek at more natural levels by reducing extreme fluctuations caused by water releases (or lack of) from the dam. Accommodate increased commercial, residential, and recreational use by providing a wide spectrum of quality outdoor settings, while maintaining water quality, soil productivity, wildlife habitat and connectivity corridors, riparian integrity, and public safety. Optimize use of private land for services such as restaurants, service stations, groceries, etc.

Objectives

A. Maintain or improve the health of the existing late and old structured (LOS) stands. Manage to provide a succession of LOS across the landscape and appropriate levels of snags and down woody debris. Increase the number of stands in the open condition where feasible within the ponderosa pine and mixed conifer dry PAGs. (Trends 1, 2)

B. Reduce fragmentation and disturbance to wildlife by decreasing road density where appropriate. Maintain access for fire management, administrative use, hunting, and general sightseeing. A reduction in fragmentation could also be achieved by managing regenerated stands to accelerated growth as a means to return to mature forest more rapidly. (Trend 2)

C. Utilize prescribed fire and mechanical fuel reduction to reduce fuel loading in urban interface areas, ponderosa pine, lodgepole pine, and mixed conifer dry PAGs. (Trend 3)

D. Eradicate and control the spread of noxious weeds and non-natives species. Determine the impacts of planted non-native fish to native invertebrates, fish, aquatic insects, and plants. Reduce the impacts if they are negative. (Trend 4)

E. Reduce stream-side erosion by limiting the extreme fluctuation of water in Crescent Creek, while still maintaining downstream flows. (Trends 5, 6)

F. Develop partnerships with the Oregon Department of Environmental Quality (DEQ) and other state and county agencies to assure compliance with clean water laws and to work toward developing a long-term waste-water treatment plan. (Trend 6)

G. Reduce compaction and displacement from vegetation management activities. Reduce runoff associated with soil compaction from harvest and roads. (Trends 6, 7, 8)

H. Consolidate most urban and rural services into this landscape area, including services such as food, fuel, lodging and the industrial mushroom camp. (Trend 9)

I. Maximize educational opportunities and participation with rural planning groups and private forest users (e.g. fire protection agreements with Crescent Lake Junction rural fire department, and Community Action Team participation). (Trend 10)
J. Identify and sustain wildlife corridors consisting of live forests with a balance of dead and dying trees, especially around private land, as potential dispersal habitat for the great gray owl, American marten, northern goshawk, and big game. (Trend 2)

K. Evaluate future proposals for management in and around Big Marsh and Crescent Creeks using the standards and guidelines listed for the Northwest Forest Plan - Aquatic Conservation Strategy, Riparian Reserves, Key Watersheds, Late Successional Reserves and Wild and Scenic River Plans; standards and guidelines for General Forest in the LRMP, and the specific goals for this landscape area. (All Trends)

Opportunities

1. Reduce road densities to meet LRMP guidelines; decrease fragmentation, erosion and sedimentation; eliminate parallel or redundant roads; and/or increase the quality of habitat for wildlife and the dispersed recreation experience. Maintain access to private land, but eliminate multiple access routes to the same piece of land whenever possible. Reconstruction work is needed on 60-100 road to armor the wet areas in the road. (Objective B, K)

2. Work with private landowners to 1) increase overhead cover in riparian areas to help provide fisheries habitat and reduce stream temperatures; 2) adjust grazing practices to assure compliance with applicable federal, state, and county clean water laws; 3) accomplish fuel reduction around homes; and 4) prevent the spread of noxious weeds and non-native species onto Federal land. (Objective F)

3. Work with the Department of Environmental Quality and Klamath County to monitor water quality concerns. (Objective F)

4. Clean up and remove railroad contamination sites. (Objective F)

5. Evaluate the use of the On-Off Grazing Allotment. Determine acceptable utilization standards. (Objective K, F)

6. Maintain or enhance sandhill crane nesting habitat on the Forest Service portion of the On-Off Grazing Allotment. (Objective K)

7. Utilize the Governor's Initiative for Stream Restoration to assist and support the state agencies responsible for the enforcement of riparian and water quality regulations on private land. (Objective F)

8. Determine Standards and Guidelines for the Crescent and Big Marsh Creek Wild and Scenic River Plans which maintain or enhance the Outstandingly Remarkable Values for each. Determine the Proper Functioning Condition of those riparian areas. (Objective K)

9. Rehabilitate areas of soil damage and excessive compaction from past harvest activities and grazing, both in riparian areas and in the uplands (See Figure 30). (Objective G)

10. Increase public education concerning the natural role of fire in the ecosystem. (Objective I, C)

11. Coordinate cooperative fire suppression with the Crescent and Odell Rural Fire Protection District and Walker Range. (Objective I)

12. Manage lodgepole to provide a diversity of age and size structure across the landscape. Utilize regeneration treatments, uneven-aged management, commercial and precommercial thinning, and prescribed fire. Develop a slash removal or reduction strategy in units that are pre-commercially thinned. (Objective A, C)

13. Evaluate and improve control of illegal dumping on Forest Service land. Educate the public about the prevalence of this problem and ask for their assistance in controlling it. (Objective I)

14. Utilize personal use firewood gathering, especially near urban interface areas, to reduce fuel loading. (Objective C)

15. Improve the fisheries habitat along Crescent Creek by: 1) decreasing the width:depth ratios of the creek below the dam; 2) deepening the pools; and 3) introducing large woody material. (Objective D)

16. Work with the Oregon Department of Transportation to complete thinning along Highway 58 to reduce ice on the road.

17. Evaluate the removal of the spring house at the head of Cold Creek.

18. Evaluate the benefits and effects of installing a well at the industrial mushroom camp. Examine the possibility of authorizing other uses at this site after the big game calving/fawning season ends. (Objective H)

19. Retain the fence line between the private and Forest Service land on the On-Off Grazing Allotment to reduce or eliminate illegal grazing. (Objective K, F)

20. Maintain and enhance the park-to-park trail as a recreation corridor.

Monitoring

a. Monitor the influence on water quality from private land and homes with help from the DEQ *and Klamath County.* (Opportunity 3

b. Monitor grazing to determine the impacts to riparian habitat and to ensure that illegal grazing on Federal land does not occur. (Opportunity 5, 7)

c. Continue to monitor the proper functioning condition of the riparian areas. (Opportunity 7)

d. Monitor stream temperatures and sedimentation below the dam, upstream of the private land on Big Marsh Creek and downstream of the confluence of Crescent and Big Marsh Creeks. (Opportunity 8, 15)

e. Monitor fish utilization and numbers below the dam before and after reduction of the extreme water fluctuations. (Opportunity 15)

f. Monitor sensitive plant sites.

LANDSCAPE AREA E - Mixed Use, Crescent Creek Area

Goal

Encourage riparian and upland vegetation toward historic ranges in pattern, disturbance, structure and seral stage in order to sustain late and old structure related species while maintaining soil quality. Within the Davis LSR, maintain a sustainable amount of multi-storied, forested condition identified as nesting, roosting and foraging habitat for the northern spotted owl.

Objectives

A. Maintain or improve the health of the existing late and old structured (LOS) stands. Manage to provide a succession of LOS across the landscape and appropriate levels of snags and down woody debris. Increase the number of stands in the open condition within the ponderosa pine and mixed conifer PAGs outside the Davis LSR. (Trends 1, 2)

B. Encourage late and old size structure though the use of vegetative manipulation which will improve the foreground scenic quality and enhance the suitability of habitat for late successional wildlife species such as northern spotted owl, northern goshawk, great gray owl, black-backed woodpecker, and marten. Large ponderosa pine and Douglas-fir trees at least 30" in diameter should be maintained for nesting and roosting habitat of many species. (Trends 1, 2)

C. A variety of vegetative management tools and techniques should be used across the landscape. Manage areas for increased resistance to insects, disease and fire, which can be achieved, in part, by maintaining multiple stand structures and seral conditions. Prescribed fire could be used as a method to simplify fuel beds in order to effectively reduce the risk of stand replacement fires. (Trends 1, 3)

D. Reduce fragmentation by decreasing road density and maintaining adequate access for appropriate fire management, administrative use, private land access and recreation. Decreasing motorized vehicle access will also reduce disturbance to wildlife. A reduction in fragmentation could also be achieved by managing regenerated stands to accelerate growth as a means to return to mature forest more rapidly. (Trend 2)

E. Maintain or enhance habitat for wildlife species. Vegetative treatments, such as salvage or firewood cutting could be designed to enhance foraging, roosting, and nesting needs of the black-backed woodpecker. Maintain some component of dead and dying trees, since they are utilized by a variety of species including: black-backed woodpecker, other associated woodpeckers, secondary cavity nesters, ruffed grouse, marten, and fisher. In addition, maintain down woody material since it supports a prey base for goshawk, great gray owl, spotted owl, marten, and fisher. Down woody debris is also important for some species of fungi, bryophytes, lichen, and certain species of vascular plants. Within lodgepole pine maintain a portion of standing dead trees as structural components within goshawk and great gray owl habitat. Harvest access, layout, and design should consider travelways as well as additional habitat needs for goshawks and other species. (Trends 1, 2)

F. Follow guidelines for the LSR established in the Davis LSR Assessment (1996) for areas within LSR boundaries. (Trends 1, 2)

G. Utilize prescribed fire and mechanical fuel reduction to reduce fuel loading in ponderosa pine, lodgepole pine and mixed conifer dry plant association groups. (Trend 3)

H. Enhance education opportunities and coordination between private landowners, other organizations and groups. (Trend 10)

I. Eradicate and control the spread of noxious weeds and non-natives. Determine the impacts of planted non-native fish to native invertebrates, fish, aquatic insects, and plants. (Trend 4)

J. Reduce the fluctuation of instream flows as much as possible, while maintaining adequate downstream flows. Work with private landowners to resolve any illegal water diversions in the watershed. (Trend 5)

K. Reduce compaction and displacement from vegetation management activities and grazing. Reduce runoff associated with soil compaction from harvest and roads. (Trends 6, 7, 8)

L. Seek opportunities to provide commercial commodities (i.e., timber, mushrooms, firewood) while moving the area towards the desired condition, e.g. by thinning from below, we can provide commodities while improving the health of a stand. (Trend 9)

M. Allow mushroom picking in designated areas outside the Davis LSR. Consider low levels of monitored harvest within the LSR as long as effects of harvest are considered at least neutral toward LOS species (Trend 9).

N. Maintain or enhance the scenic quality and recreational opportunities along the Scenic Byway. This includes sustaining the characteristic big-tree component in the ponderosa pine areas and protecting the background views of Odell Butte as well as presenting information and direction to visitors for recreational use. The forthcoming Wild and Scenic River Plan should address the desired and appropriate recreational uses.

O. Provide for connectivity through the Wild and Scenic River Corridor for big game, northern goshawk, and American marten. (Trend 2)

P. Work with private landowners to 1) increase overhead cover in riparian areas to help provide fisheries habitat and reduce stream temperatures; 2) adjust grazing practices to assure compliance with applicable federal, state, and county clean water laws; 3) accomplish fuel reduction around homes; and 4) prevent the spread of noxious weeds and non-native species onto Federal land.

Opportunities

1. Work with private landowners to 1) increase overhead cover in riparian areas to help provide fisheries habitat and reduce stream temperatures and 2) adjust grazing practices to assure compliance with applicable federal, state, and county clean water laws. (Objective, P)

2. Rehabilitate areas with existing soil damage such as harvested areas with excess compaction. (Objective K)

3. Stands containing immature and mature trees which could be managed to produce suitable replacement trees for LOS dependent species should be identified. Management of these stands could include thinning, prescribed low intensity fires, creation of small openings for regeneration, and designated removal of some trees to reduce competition and stress. (Objective B)

4. Reintroduction of fire in the ponderosa pine and mixed conifer dry and lodgepole plant associations could be used as a vegetative manipulation tool and as a method to simplify fuel beds in order to effectively reduce the risk of stand replacement fires. (Objective C, G)

5. Reduce road densities to meet LRMP guidelines; decrease fragmentation, erosion and sedimentation; eliminate parallel or redundant roads; and/or increase the quality of habitat for wildlife and the undeveloped recreation experience. (Objective K)

6. Seek opportunities to utilize Crescent Creek Campground as a parking area for the Wild and Scenic River access and to develop a trail on the north side of the river corridor. (Objective N)

7. Develop standards and guidelines and a comprehensive plan for Crescent Creek Wild and Scenic River Corridor that retain or enhance the Outstandingly Remarkable Value (scenery) associated with comprehensive standards and guides and recreation opportunities for Crescent Creek Wild and Scenic River Corridor. Establish a riparian corridor width for the Crescent Creek Wild and Scenic River, evaluate matching the corridor to the Old Growth Management Area boundary. Within the ponderosa pine PAG along the Wild and Scenic River Corridor manage to maintain or enhance LOS including retaining a more open canopy. (Objective N)

8. Restore and rehabilitate the hazardous waste site near Dell Springs, rehabilitate road access to the area, and encourage dispersed use in areas away from a sensitive amphibian nursery near the springs.

9. Develop education and recreational opportunities along the Scenic Byway and Crescent Creek Campground, including highlighting the natural processes of a healthy ecosystem, including fire, insects and disease; providing information on the historic Wagon Road that passed through this area; and explaining the geologic processes that resulted in the formation of the lava flows. (Objective H)

10. Refer to the Davis LSR Assessment for Management Options listed under Management Strategy Areas T and BB which fall within this Landscape Area. (Objective F)

11. Mixed conifer, ponderosa pine and lodgepole pine associated type wildlife movement corridors could be re-established to benefit species such as the northern spotted owl and other species that utilize LOS stands. (Objective E, O)

12. Develop strategy for control and reduction of spread of noxious weeds.

Monitoring

a. Monitor temperatures and sediment loads in Crescent Creek at the junction of Roads 61 and 62. (Opportunity 1, 2)

b. Monitor and eradicate *Isatis tinctoria,* Dyers woad, on Highway 58. (Opportunity 12)

c. Monitor the roadsides along the 46 and 61 Roads, where the recent road reconstruction occurred, to determine if the noxious weeds are returning, if so, aggressively eradicate. (Opportunity 12)

d. Continue monitoring plots of *Allotropa virgata.* (Opportunity 12)

e. Monitor wildlife movement patterns within Crescent Creek wild and scenic corridor to gather baseline data to determine affects of proposed trail placement in the corridor. (Opportunity 7)

LANDSCAPE AREA F - Big Marsh and OCRA

Goal

Protect and enhance this area for the present and future benefit of riparian dependent species and species associated with late and old structured stands by allowing the continuation and conservation of natural processes. Protect and enhance the semi-primitive motorized settings that provide opportunities for dispersed commercial, recreational and educational uses.

Objectives

A. Maintain or improve the health of the existing late and old structured stands (LOS) stands to improve/enhance suitability of habitat for LOS species such as northern spotted owl, bald eagle, northern goshawk, black-backed woodpecker, great gray owl, and pygmy owl. Manage to provide a succession of LOS across the landscape and appropriate levels of snags and down woody debris. Increase the number of stands in the open condition within the ponderosa pine and mixed conifer PAGs outside the Big Marsh LSRs. (Trends 1, 2, 3)

B. Maintain or enhance LOS species in lodgepole inside the Big Marsh LSRs. Retain large diameter trees for cavity nesting species and pockets of regeneration for long-term sustainability and continuity. Utilize adjacent stands to augment LSR stands. (Trends 1, 2)

C. A variety of management tools and techniques should be used across the landscape. Manage areas for increased resistance to insects, disease and fire, which can be achieved, in part, by maintaining multiple stand structures and seral conditions, which benefit wildlife species. Prescribed fire could be used as a method to simplify fuel beds in order to effectively reduce the risk of stand replacement fires. Within OCRA, utilize vegetation management in the event of catastrophic situations, for wildlife habitat improvement, to enhance recreation opportunities, and protect areas from the risk of fire. (Trends 1,3)

D. Maintain or enhance connective habitat through riparian areas and edge habitat around Big Marsh proper, which provides hiding cover and an important travel corridor. (Trend 2)

E. Utilize prescribed fire to restore the marsh and uplands to a more natural status. Reduce fuel loading in ponderosa pine, lodgepole, and mixed conifer dry plant association groups. (Trend 3)

F. Eradicate and control the spread of noxious weeds and non-natives. Determine the impacts of planted non-native fish to native invertebrates, aquatic insects, fish, and plants. Assess effects of non-native species on the ecosystem. (Trend 4)

G. Continue re-directing Big Marsh Creek into the natural stream channel in order to facilitate the restoration of those wetlands to a more natural functioning system and to minimize erosion and sedimentation. Increase thermal cover along stream banks in Big Marsh where it has been depleted due to past grazing practices, to decrease water temperatures and increase hiding cover and nesting opportunities for aquatic and aquatic-associated species. Restore natural habitat to springs located on the west side of Big Marsh. (Trends 5, 6, 7)

H. Reduce compaction and displacement from vegetation management activities, especially within the riparian buffers of old harvest units. (Trends 7, 8)

I. Develop partnerships with the Department of Environmental Quality, state and county agencies to assure compliance with applicable clean water laws. (Trends 6, 7)

J. Allow mushroom picking only within the boundaries of logically designated areas using roads or other topographical features where possible. (Trend 9)

K. Seek opportunities to provide commercial commodities (i.e., timber, mushrooms, firewood) while moving the area towards the desired condition, e.g. by thinning from below, we can provide commodities while improving the health of a stand. (Trend 9)

L. Encourage recreation-oriented commercial uses, e.g. outfitters, guides, and eco-tours, in other landscape areas where it is more consistent with the goal. (Trends 2, 9)

M. Concentrate recreation opportunities, including wildlife viewing, on the east side of the marsh and orient toward wildlife viewing, interpretation, and the geologic evolution of the marsh. Designate and design long-term access sites near the marsh for dispersed recreation and include improved sanitation facilities. Maintain viewpoints on the 5825 road above the marsh. (Trend 10)

N. Maintain motorized winter through traffic on designated snowmobile trails to provide connections to adjacent recreation areas. (Trend 10)

O. Reduce road densities by closing and obliterating roads or transforming roads to trails where possible to enhance wildlife habitat and the semi-primitive character of the marsh. Retain fire access roads where determined necessary. (Trend 2)
P. Evaluate future proposals for management in and around Big Marsh using the standards and guidelines listed for the Northwest Forest Plan - Aquatic Conservation Strategy, Riparian Reserves, Key Watersheds, and Late Successional Reserves; standards and guidelines for OCRA in the LRMP, and the specific goals for this landscape area. (All Trends)

Q. Protect and enhance habitat for species of concern in Big Marsh proper, e.g. sandhill crane and yellow rail. (Trend 2)

R. Maintain water levels for marsh-related species, such as the spotted frog and green heron. (Trend 5)

S. Enhance education opportunities via Crescent Lake lodge, campground concessionaires, Willamette Pass Visitor Center, local schools and Central Oregon Community College. (Trend 10)

Opportunities

1. Identify wildlife utilization around the edge of Big Marsh. (Objective A,B,Q)

2. Prepare and develop an OCRA management plan in conjunction with the Umpqua, Willamette, and Winema National Forests. Determine appropriate management options. (Objective P)

3. Inventory species associated with springs on the west side of Big Marsh, including invertebrates and bryophytes, and restore the natural functioning of the springs. (Objective G)

4. Where appropriate, increase thermal cover along Big Marsh Creek and introduce large woody debris into the creek. Study the possibility of willow re-introduction in Big Marsh Creek.

5. Develop a long-term motorized and non-motorized access strategy for the east side of Big Marsh. The strategy should consider access for fire, wildlife, recreation, and restoration management. Possible options include the following: Obliterate road 5825-540 from the trailhead to the south end; Consider options to gate road 5825-541 at both ends to retain fire access yet close the road to the general public. Road 5825-541 would need maintenance to use as a fire access road. Closing these roads will reduce erosion, sedimentation and fragmentation along the edge of the marsh as well as reduce disturbance to wildlife and eliminate parallel roads. Utilization of these roads as hiking/interpretive trails could extend the trail system and increase wildlife viewing opportunities along the edge of the marsh. Delineate a trailhead, parking area, and vehicle turn-around site on the east side of the marsh. Install or construct sanitation facilities and an informational kiosk near the trailhead. Obliterate the dispersed campsite currently located near the existing trailhead. Sign the area for day use only. Encourage dispersed camping elsewhere. Promote wildlife viewing near the looped trail. Research trail construction techniques that will withstand periodic flooding. (Objective M, P)

6. Rehabilitate areas with existing soil damage such as harvested areas with excess compaction. (Objective O)

7. Explore the possibility of additional breaching of ditches and construction of check dams in Big Marsh to facilitate more natural conditions by moving the water into the marsh. (Objective G)

8. Explore the possibility of educational partnerships and cooperative agreements with universities and conservation groups to assist in research and species identification. (Objective S)

9. Assess need and, if necessary, construct waterfowl enhancement structures. (Objective B)

10. Develop standards and guidelines and a comprehensive plan for the Big Marsh Wild and Scenic River Corridor that retain or enhance the Outstandingly Remarkable Values associated with Big Marsh Creek, including wildlife, scenery and geology. Maximize the width of the Wild and Scenic Corridor through Big Marsh proper. (Objective P)

11. Re-build snowmobile bridges and culvert on Road 6020 to reduce resource damage. Prior to reconstruction of the bridge on the 6020-340 road, evaluate the potential spread of reed canary grass. Assess impacts from canoe put-in and take-out locations and rehabilitate, if necessary. (Objective M)

12. Design access and parking near snowmobile bridge. (Objective M)

13. Prepare a plan for the restoration of Big Marsh that incorporates all resource areas. Develop a hydrologic map of the marsh. Assess the results from the restoration efforts that have occurred since 1989. (Objective P)

14. Utilize prescribed fire in lodgepole stands to diversify structure. Evaluate lodgepole encroachment in Big Marsh and the appropriate management tools to reduce it, e.g. prescribed fire, mechanical methods, or flooding. (Objective E)

15. Within the two Big Marsh Late Successional Reserves, determine what vegetative treatments, if any, are needed to obtain LSR objectives. (Objective A, B, C)

16. Utilize vegetation treatment methods to meet management goals such as reducing stand density. Management options include among others understory thinning, precommercial thinning, and prescribed fire outside of OCRA. In addition, reduce fuel loading and thinning slash. (Objective C)

17. Gather and compile information on human use patterns and activities throughout the marsh area. (Objective P)

18. Continue to examine methods to reduce user conflicts, especially between hunters and mushroom pickers through planning, coordination, and education. (Objective J)

19. Avoid promoting Big Marsh as a canoeing destination; locating a canoe trail through the marsh is inconsistent with standards and guidelines listed in the Northwest Forest Plan. If recommendations to the contrary are made, restrictions on canoe use including limiting seasons of access, identifying off-limit areas, and designating specific put-in and take-out locations are recommended. (Objective P, M)

Monitoring

a. Monitor temperatures in Big Marsh Creek above and below the confluence with Crescent Creek. (Opportunity 4)

b. Monitor sedimentation above and below the Marsh, especially during any restoration activities. (Objective 6)

c. Monitor utilization of the creek and ditches in Big Marsh by fish and amphibians. Identify locations where populations are centered. (Objective 3)

d. Monitor use of the marsh by canoeists, assess resource impacts. (Objective 17, 19)

e. Monitor 1992 meadow burn (Rocky Mountain Elk Foundation). (Objective 16)

f. Monitor planned marsh restoration.

g. Develop monitoring plan for reed canary grass utilizing the plots established in 1996.

h. Monitor lodgepole encroachment in Big Marsh using the photo points established in 1996.

i. Determine status of bullfrog presence in Big Marsh.

j. Monitor the presence and reproductive status of yellow rails and sandhill cranes in Big Marsh.

MONITORING AND INVENTORY

The Following Opportunities Are Relevant To All Landscape Areas:

Underburning.

Monitor introduction and spread of non-native species and noxious weeds.

Monitor recreation use numbers, and verify types of activities taking place in the watershed.

Meet state water quality standards in all water bodies.

Monitor resource conditions in areas of activity, i.e. harvest, recreation, restoration and planting.

Monitor insect damage to forest through aerial surveys.

Monitor stand conditions through stand exams especially for the risk of catastrophic loss and long term resilience and sustainability.

Monitor air quality in the watershed.

Continue bird, plant and amphibian surveys.

Inventory lakes and streams that have not been surveyed. Monitor those that have been surveyed.

Develop partnerships with groups, universities, birding groups, Ducks unlimited, Taking Wing, Rocky Mountain Elk foundation, ODFW and others that helped with the previous Big Marsh EA, to help with surveys and monitoring.

Monitor big game corridors and their functioning in OCRA/Wilderness.

Complete surveys for northern spotted owl, great gray owl, flammulated owl, marten, wolverine and fisher.

Complete soil surveys in the wilderness and other areas where initial surveys were non-existent or cursory.

Monitor Proper Functioning Condition on all streams, especially in areas where grazing occurs on private land. (Need district training in PFC)

Monitor riparian reserve and buffer functioning.

Update Historic Range of Variability models.

Monitor gravel pit and mining claim activities and the amount of material left.

Monitor lichens, bryophytes, fungi, and vascular plants.

CUMULATIVE EFFECTS

The following is a list to consider and address when completing NEPA analysis

Recreational use.

Spotted owl habitat.

Water quality and quantity including downstream demands on water.

Air quality.

The spread of non-native species and their effects.

Bald eagle habitat.

Big game and forest carnivores -- corridors and connectivity.

Plant species of concern - survey and manage and sensitive plants.

Fragmentation -- amount and size of LOS and the distribution of it.

Structural stage diversity within PAGs.

Fuel buildup and fire occurrence.

Risk of catastrophic loss due to insects, disease, or fire.

Road density.

Disturbance patterns -- fire, insect and disease -- considerations for underburning.

Human disturbance levels.

Effects on redband and bull trout.

Monitor total outputs from the district -- firewood, pounds of mushrooms harvested, board feet of timber, special forest products, water output.

EDUCATIONAL OPPORTUNITIES

The following list should be considered when considering educational opportunities associated with any proposed project in the watershed.

Noxious weed education.

Native vegetation.

Wildlife interpretation.

Explore partnerships with other groups for educational purposes, i.e. Audubon Society, COCC, schools, and other outdoor schools.

Hydrology session in Bend by Dave Rosgin may use Big Marsh as a field trip.

Wilderness training session.

Educational opportunities with the homeowners, Boy Scouts, and resorts.

Campfire talks and interpretive programs.

Programs and brochures to explain some of the forest health issues that will be happening on the forest as part of BMW and Seven Buttes.

Education of and from the Tumalo Irrigation District.

AQUATIC CONSERVATION STRATEGY

INTRODUCTION

The President's Forest Plan developed a strategy for the protection and restoration of aquatic/riparian ecosystems for Forest Service administered lands within the range of the Northern Spotted Owl. The President's Forest Plan identified nine objectives for the Aquatic Conservation Strategy. These objectives can be summarized as follows: Ensure protection of aquatic systems, maintain connectivity, maintain water quality, maintain water and sediment storage and transport regimes, maintain and restore fish, wildlife, and plant populations and diversity. There are four components of the strategy: Riparian Reserves, Key Watersheds, Watershed Analysis, and Watershed Restoration.

The President's Forest Plan identified Big Marsh Creek as a Key Watershed (Tier 1) This watershed is to provide a refugia for management and recovery of at-risk fish species (redband rainbow trout) and to provide high quality water. Watershed Analysis is a planning tool which ensures the above objectives are considered and incorporated in all management decisions. Implementation occurs through watershed restoration and the following special standards, guidelines, and recommended riparian reserves. The interim riparian reserves as defined in the President's Forest Plan are shown in Figure 29.

RIPARIAN RESERVES

Resource Considerations For Setting Riparian Reserves

Processes which drive the dynamics of the floodplain and channel are paramount considerations for setting Riparian Reserve widths and conditions. The width of the channel and floodplain and flow regime characteristics dictate the minimum size of the trees needed to provide effective, instream wood. The presence of LWM within a stream channel is critical to maintaining the integrity of the system, in fact, there cannot be an overabundance of LWM. This wood plays an active role in the storage of sediment in the channel. The general rule is, the larger the tree, the more stable it will be in the floodplain, and the more stream shade it will provide while it is alive. Natural sediment storage in the uplands results from woody material that accumulates on the forest floor and impedes its movement downslope.

The floodplain vegetation is important in resisting the erosive forces of flood events. These zones are very important filters of sediment and nutrients; the thick vegetation creates an extreme roughness which inhibits water movement through and over it.

Riparian areas provide a moist zone for amphibians and other wildlife species to travel and reside in. Ungulates use the riparian areas disproportionately more than terrestrial areas for fawning and calving, and lactating females take advantage of the improved cover and succulent vegetation. Nearly 80% of the terrestrial wildlife species are either directly or indirectly dependent upon riparian areas for meeting their habitat needs.

Riparian Reserves provide important wildlife habitat, which justifies the heavy loading of LWM in the creeks and the floodplains. Refer to Chapter 4, Trend 2 and Trend 7 for additional information on riparian habitats. In the Riparian Reserves (particularly in the Lodgepole Pine Plant Association Group), it is desirable to maintain healthy forest stands over the long-term, while maintaining high snag densities and green tree replacements. Wildlife, water quality, and stand health should dictate stand treatment needs within the Riparian Reserves. It is recognized that the Reserves constitute an area where higher risks are taken (including reduced fire suppression efforts) in order to allow natural processes to occur and continue without human

intervention. Agee (1990) reports that by far the greatest disturbance factor for riparian zones is flood events, not fire.

RIPARIAN RESERVE WIDTHS AND MANAGEMENT REQUIREMENTS

The Riparian Reserves, as described in the President's Forest Plan and Record of Decision (ROD) have been adapted (USDA, USDI, 1994) for the Big Marsh Watershed. These Riparian Reserves will be managed as special management areas, utilizing the sideboards listed below in addition to the Standards and Guidelines in the ROD. Site specific conditions and mitigation will be developed in the project Environmental Assessments (EA).

The Big Marsh Interdisciplinary Team recommends that the Riparian reserve widths described in the ROD be adopted in all areas. Additional Reserve widths will be extended in areas identified as having wet or riparian soil types in excess of the standard buffers in the ROD. These soil types were identified by the Forest Soil Scientist and are identified in the Deschutes soil database as soil types, 2, 5, 8, 43, 44, WG and WH (See figure 31). Most of the identified riparian soil types are along the lodgepole flats of Big Marsh and Crescent Creek. Other areas are identified in Figure 30.

The Big Marsh drainage is a wide glaciated valley that has filled with riverine, volcanic tephra and glacial deposits. The stratification and gradation of these materials combine to create a subsurface layer across the entire valley that is a barrier to downward movement of water and is the source for the high water table levels present today. These conditions have created extensive areas of riparian or seasonally wet soil types across the entire valley (Sussmann, 1997).

The Riparian Reserve Widths Identified In The ROD Are As Follows:

Fish Bearing Streams - From the edges of the active stream channel to the top of the inner gorge, or the outer edges of the 100-year floodplain, or to the outer edges of riparian vegetation, or to a distance equal to the height of two site potential trees, or 300 feet slope distance (600 feet total, including both sides of the stream channel), whichever is greatest.

Permanently flowing nonfish-bearing streams - From the edges of the active stream channel to the top of the inner gorge, or to the outer edges of the 100-year floodplain, or to the outer edges of riparian vegetation, or to a distance equal to the height of on site-potential tree, or 150 feet slope distance (300 feet total), whichever is greatest.

Constructed ponds and reservoirs, and wetlands greater than one acre - Riparian Reserves consist of the body of water or wetland and: the area to the outer edges of the riparian vegetation, or to the extent of seasonally saturated soil, or the extent of unstable and potentially unstable areas, or to a distance equal to the height of one site-potential tree, or 150 feet slope distance from the edge of the wetland greater than one acre or to the maximum pool elevation of constructed ponds and reservoirs, whichever is greatest.

Lakes and natural ponds - Riparian Reserves consist of the body of water and: the area to the outer edges of the riparian vegetation, or to the extent of seasonally saturated soil, or to the extent of unstable and potentially unstable areas, or to a distance equal to the height of two site-potential trees, or a 300 feet slope distance, whichever is greatest.

Seasonally flowing or intermittent streams, wetlands less than one acre, and unstable and potentially unstable areas - This category applies to features with high variability in size and site-specific characteristics. At a minimum, the Riparian Reserves must include:

The extent unstable and potentially unstable areas (including earthflows),

The stream channel and extend to the top of the inner gorge,

The stream channel or wetland and the area from the edges of the stream channel or wetland to the outer edges of the riparian vegetation, and

Extension from the edges of the stream channel to a distance equal to the height of one site-potential tree, or 100 feet slope distance, whichever is greatest.

A site-potential tree is height is the average maximum height of the tallest dominant trees for a given site class.

Intermittent streams are defined as any nonpermanent flowing drainage feature having a definable and evidence of annual scour or deposition. This includes what are sometimes referred to as ephemeral streams if they meet these two physical criteria.

Vegetation

In the Eastern Cascades it is recognized that fire played an important role in shaping the vegetative pattern across the landscape. A combination of salvage, thinnings, and fire can be used as tools to create small openings in the riparian zone. No large trees that have the potential to provide shade (within the distance equal to the height of two site-potential trees) or LWM to the creek will be disturbed. Wildlife needs will dictate the remaining condition of the patches to be created. The fuel loading in the Reserves will be greater than that in the surrounding uplands except within established facilities (campgrounds, summer home tracts, etc.). Operations within the Reserves will result in less than 2% compaction spatially over the length of a mile.

Roads, Grazing and Minerals Management

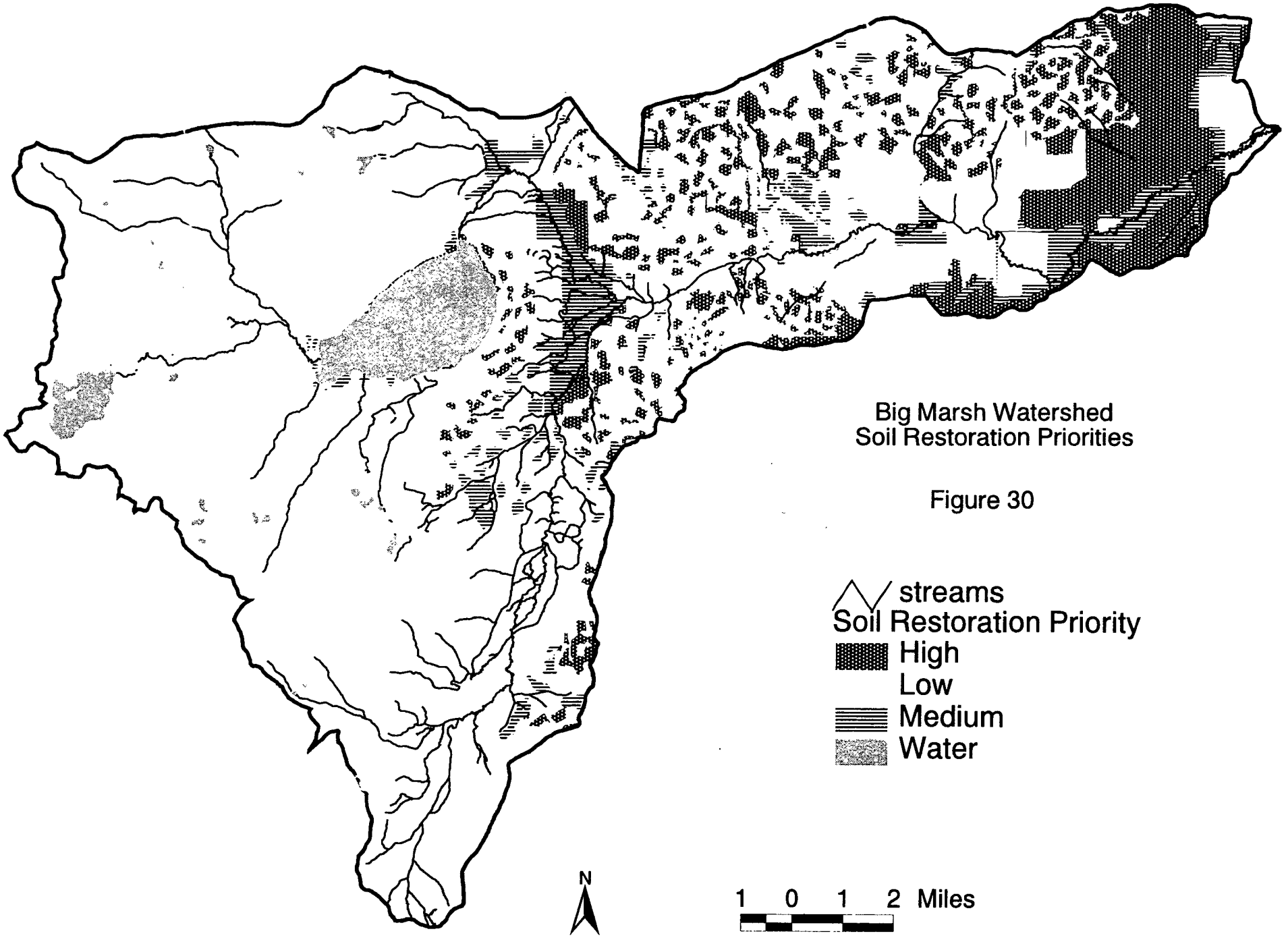
As per the ROD. Site specific conditions and mitigation will be developed in the project EA. No net increase in roads will occur.

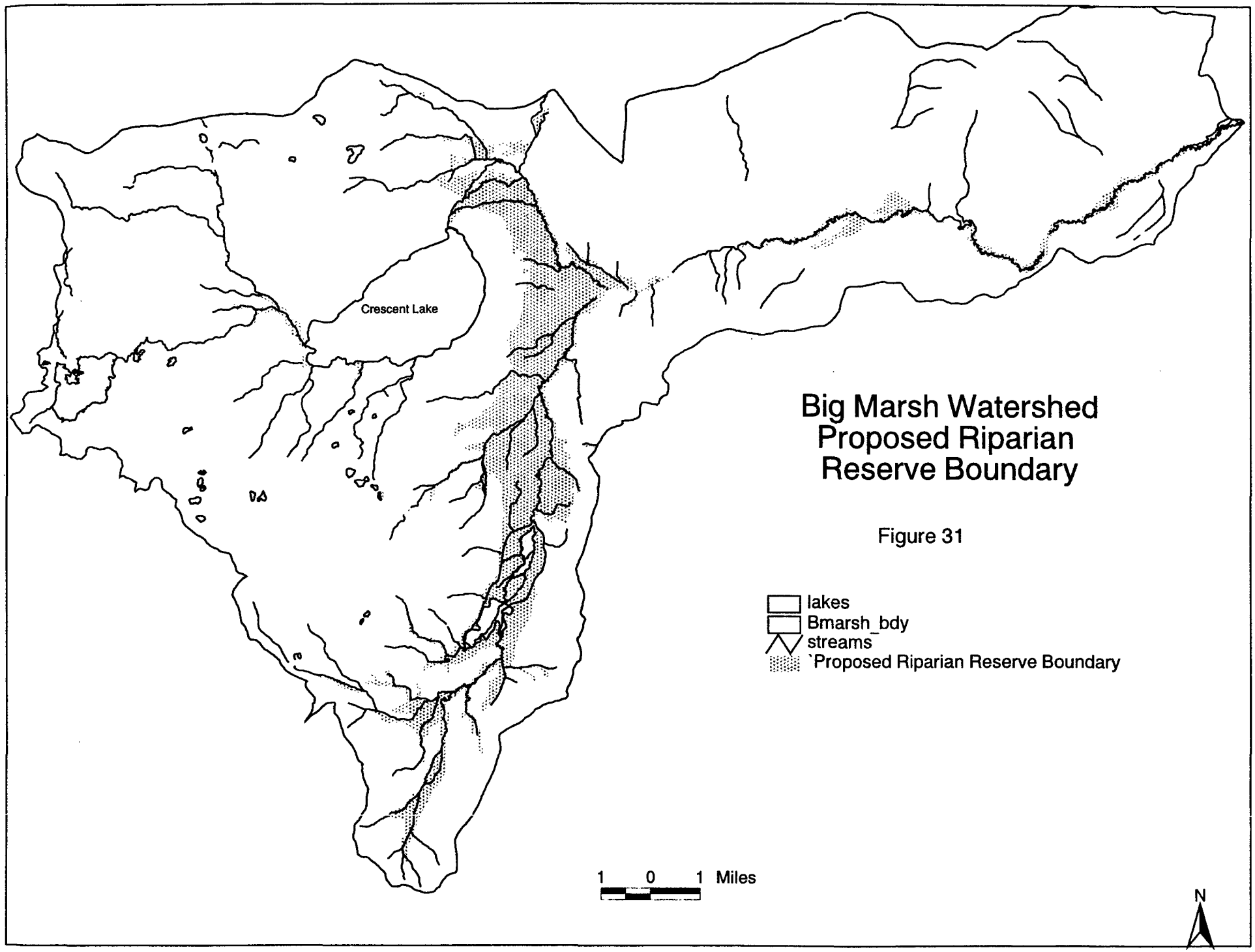
Recreation Management

No new campgrounds will be developed within the distance equal to the height of two site-potential trees of any water body. It is recognized that picnic areas can be developed within that zone if the soils are coarse and riparian vegetation is not trampled or destroyed such that sediment has the potential to wash into the waterbody. Use vegetative buffers to contain any sediment in the uplands. Techniques which are desirable to use are designated trails, hardening sites or creating causeways across sensitive areas. Any existing campsites that are closer than 50 feet to the water (fire ring or picnic bench) will be relocated at a greater distance from the water.

Fire/Fuels Management

Develop a fire management strategy for the Riparian Reserves within five years that will allow for fire by prescription (both natural and human caused ignitions). The intent is for heavy loading of down fuels in the Reserves to result, however, some openings can be created in order to provide a diversity of habitats and to reduce encroachment of conifers in the wetlands.


Big Marsh Watershed
Soil Restoration Priorities
Figure 30
streams
Soil Restoration Priority
High
Low
Medium
Water
N
1 0 1 2 Miles


Crescent Lake
Big Marsh Watershed
Proposed Riparian
Reserve Boundary
Figure 31
lakes
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streams
`Proposed Riparian Reserve Boundary
1 0 1 Miles
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APPENDIX A

FUEL MODEL DESCRIPTIONS

Fuel models are simply tools to help the user realistically estimate fire behavior. Fuelload conditions are described for grass (model 1-3), shrub (model 4-7), timber (model 8-10) and slash fuel complexes (model 11-13), and the user attempts to compare the modeling descriptors to the actual fuel situation being examined. The criteria is based on the fuel stratum that will carry a wildfire and will yield flame length and rate-of-spread information for the purpose of fire behavior prediction and fuels planning.

MODEL 0: No fire behavior is expected in these areas. Usually represented by water, roads, lava flows, gravel pits, rocky alpine peaks and developed land.

MODEL 1: Used for Big Marsh proper, areas adjacent to Crescent Creek and higher elevation meadows.

MODEL 2: Ponderosa Pine areas where wild fire or underburning has occurred, allowing re-establishment of native grasses.

MODEL 3: Also used mostly in describing Big Marsh Proper, a model for grasses averaging 3 feet in height with flame lengths up to 12 feet.

MODEL 5: Higher elevation huckleberry brush under mixed conifer overstory, riparian area with willow, aspen shoots, and grasses.

MODEL 6: Describes fairly volatile shrubs averaging 2.5 feet in height that will yield 6 foot flame lengths but are generally in need of moderate winds (greater than 8 mph at mid-flame height) to carry the fire through the shrub layer. Shrub types in this watershed include greenleaf manzanita, bitterbrush, and ceonothus. Bitterbrush may push flame lengths to 20 feet under certain weather conditions. Fire will drop to the ground at low wind speeds or at openings in the stand.

MODEL 8: Describes slow-burning ground fires with low flame lengths, although the fire may encounter an occasional "jackpot" or heavy fuel concentration that can flare up. Only under severe weather conditions involving high temperatures, low humidities, and high winds do the fuels exhibit more active fire behaviors. The fine fuel load (0-3") for this model would be less than 5 tons/acre and generally this model could not be used for blowdown situations as the deadfall and crown weight would support a more volatile condition.

MODEL 9: Describes conifer needlecast which will yield 2-3 foot flame lengths as fire moves through the surface litter. This is really a combination of fuel model 6 in ponderosa pine on the Crescent Ranger District. Concentrations of dead down woody material will contribute to possible torching out of trees, spotting and crowning.

MODEL 10: Describes fires that burn in the surface and ground fuels with greater intensity than the other timber litter models. Dead-down fuels include greater quantities of 3-inch or larger limbwood resulting from overmaturity or natural events that create a large load of dead material on the forest floor. Crowning out, spotting and torching of individual trees are more frequent in this fuel situation, leading to potential fire control difficulties. Any forest type may be considered if heavy down material is present; examples are insect or disease-ridden stands, wind-thrown stands (blowdown), overmature situations with deadfall, and aged light thinning or partial-cut

slash. Model 10 fires are at the upper limit of control by direct attack and could lead to an escaped fire. Flame lengths could exceed 8 feet under summer conditions.

MODEL 11: The main use of this model is to reflect the more open and/or collapsing lodgepole pine, areas of past harvest where fuels treatment has not occurred, and areas where fuels have accumulated on the ground over time. This makes the fuel load heavier than a fuel model 8, but lighter than fuel model 10, and units thinned within the last 5 years with light fuel loading.

MODEL 12: Describes rapidly spreading fires with high intensities capable of generating firebrands and when an ignition occurs the fire is generally sustained until a fuel break or change in fuels is encountered. It is in this type of fuel situation the fire behavior will present real concerns to all involved in suppression efforts and with flame lengths exceeding 12 feet, any suppression effort by crews or dozers can be extremely hazardous and will likely fail

FIRE ECOLOGY AND FIRE EFFECTS

PONDEROSA PINE

Pinus ponderosa - Fire Ecology

Ponderosa pine is a fire dependent species which requires frequent surface fires in order to maintain stand health and stability. As a result, ponderosa pine communities have evolved flammable properties to encourage recurrent, low intensity burning; resinous pine needles provide an abundant, annual source of highly flammable fuel with yearly accumulations in dense stands. Despite such characteristics, fire frequencies for ponderosa pine under natural fire regimes vary greatly according

To survive within such a fire dominated environment, ponderosa pine has developed a number of fire adaptive traits which help to minimize fire damage to tissues. Whereas seedlings are readily killed by low intensity fires, thick, exfoliating bark and a deep rooting habit make larger trees quite tolerant of most ground fires. The potential for crown fires is lessened in mature individuals due to a tendency to self-prune lower branches, thereby spatially separating foliage from burning ground fuels. Propagation of flames into the crown is further discouraged by long needles which are loosely arranged within an open structured crown; in addition, the foliar moisture content of this species is relatively high (28 to 36%. Trees subjected to dormant season burning are often able to survive extensive crown scorch damage since buds are large and enclosed within thin, insulative bud scales.

Fire plays a crucial role in the regeneration of ponderosa pine by exposing bare mineral soil and removing competing vegetation. Although these conditions are considered optimal for the germination and establishment of ponderosa pine, Postburn establishment is largely successful only when a good seed crop coincides with above average rainfall. Assuming the above conditions are met, seedbed continuity determines whether regeneration appears as dense stands, separated thickets or scattered individuals. Recurrent underburning acts to maintain a very open stocking of trees by periodic thinning; this includes reducing numbers of seedlings, removing dense understories of sapling or pole-sized stands, and thinning low vigor overstory trees.

Fire Effects

The effect of fire on ponderosa pine is generally related to tree size, fire intensity and tree density. Low intensity fires readily kill seedlings less than 12 inches in height. Perhaps because of their inherent ability to withstand high soil surface temperatures, larger ponderosa pine seedlings can sometimes survive heat generated by low intensity surface fires. In addition, seedlings frequently escape ground fires by virtue of their establishment in areas where fuels are discontinuous; ground fuel buildups in seedling stands are typically unable to carry fire until trees are 6 to 8 years old. Trees within the young age classes (i.e., larger seedlings, saplings and poles) are only damaged by low intensity fires which generally act to thin regeneration stands of both low vigor trees and also shade tolerant species. Pine saplings are more fire

resistant than comparatively aged Douglas-fir saplings due such attributes as larger buds, thicker twigs, and the early development of an outer layer of corky bark. In Oregon, Ecologist Fred Hall (1976) found a layer of dead bark .12 to .25 inches thick in trees only 2 inches in diameter. Although low intensity fires may leave pines 6 to 8 feet tall unharmed, prescribed burning is not usually recommended as a means of precommercially thinning regeneration stands where trees are less than 10 to 12 feet in height. Beyond the pole stage, ponderosa pine is quite resistant to the majority of ground fires.

WHITE BARK PINE
Pinus albicaulis - Fire Ecology

The vulnerability of whitebark pine to fire is reduced by the open structure of its stands and the dry, exposed habitats with meager undergrowth in which it grows. Whitebark pine is favored by severe, stand-replacing fires which burn shade-tolerant associated trees. Where succession to shade-tolerant species is relatively rapid, fires are important in moist sites for whitebark pine perpetuation.

Evidence from palynological and firescar studies shows that fires were infrequent (fire intervals from 50 to 300 years) in whitebark pine communities from the last Ice Age glaciation to the early 1900's. Since 1965 only a few thousand acres of seral whitebark pine have burned. Largely due to fire suppression, less than 1 percent of the seral whitebark habitat types have burned since then. At this rate the "average" stand would burn every 3,000 years or longer.

Fire Effects

The moderately fire-resistant whitebark pine is favored by both creeping surface or ground fires and severe fires. Both types of fire kill more shade-tolerant and fire-sensitive associate species of whitebark pine, such as subalpine fir. Hot surface fires that heat the cambium cause fire injury or death to these thin-barked trees. Fires of low to moderate severity can climb into trees if fuel ladders and downfall are present, thus increasing the potential of torching. Most fires occurring where whitebark pines grow are ignited by lightning and do not spread very rapidly or cause severe tree injury.

DOUGLAS-FIR
Pseudotsuga menziesii - Fire Ecology

Plant adaptations to fire: Douglas-fir is more fire resistant than many of its associates and can survive moderately intense fires. Thick, corky bark on the lower bole and roots protects the cambium from heat damage. In addition, the tall trees have their foliage concentrated on the upper bole, which makes it difficult for fire to reach the crown; however, it should be noted that trees are typically not free of lower branches up to a height of 33 feet until they are more than 100 years old.

When trees are killed, Douglas-fir relies on wind-dispersed seed off-site trees to colonize the burned area. If catastrophic fires are extensive, a seed source may be limited due to the lack of seed trees. Under these circumstances, seeds come from mature trees which survive fire, survivors in small unburned pockets, or from trees adjacent to the burned area. Where seed trees are scarce, it may take 100 years or more for Douglas-fir to restock the burned area. On the other extreme, when fires do not kill all the trees in a stand, seedling establishment may begin within a year or two after burning. Mineral soils exposed by fire are generally considered favorable seedbeds.
Fire effects

Crown fires commonly kill all trees over extensive areas. Hot ground fires that scorch tree crowns and char tree boles kill variable proportions of Douglas-fir. Rapidly spreading ground fires tend to inflict more damage to Douglas-fir crowns, while slow spreading ground fires are damaging to the bole and can kill trees through cambial heating. Crown scorching from summer fires is more damaging than
late summer or fall fires because more buds are killed. During late summer the buds are set and subsequent-year needles are well protected. Seedlings and saplings are susceptible to and may be killed by even low-intensity ground fires.

Temperatures in excess of 140 degrees F (60 C) are lethal to Douglas-fir seeds. Thus most seeds on the forest floor will be destroyed by fire. Crown fires will kill seeds in green cones; however, green cones are relatively good insulators and are not highly flammable, and fires that not excessively hot often only scorch the cones. Seeds can mature in scorched cones on fire-killed trees, and later disperse onto the burned area.

MOUNTAIN HEMLOCK
Tsuga mertensia - Fire Ecology

Mountain hemlock is not well adapted to fire. Fire resistance of mountain hemlock has been rated as low. Its relatively thick bark provides some protection, but low hanging branches, highly flammable foliage, and a tendency to grow in dense groups make it very susceptible to fire injury.

Mountain hemlock sites are typically moist with average precipitation over 50 inches, making fire occurrence low (400-800 years). Fuel loading in these sites is often low. In the Pacific Northwest, the estimated Pre-logging fire regime in mountain hemlock forest types is 611 years.

Fire Effects

Mountain hemlock is easily killed by fire. The most common method of killing is root charring and crown scorching. Mountain hemlock is generally slow to regenerate after fire. Tree establishment in burned areas is higher during normal to wet growing seasons. Fire injury makes mountain hemlock very susceptible to insects and disease. Old growth mountain hemlock stands are very susceptible to stand-replacing fires.(Temsky, J.L. 1992; The Fire Effects Information System)

WHITE FIR
Abies Concolor - Fire Ecology

White fir saplings and pole-sized white fir are fire sensitive. Trees of this size have smooth, thin, resinous bark and low-growing branches which easily ignite from burning undergrowth. As the bark thickens and lower branches drop due to self pruning, trees progressively become more fire resistant.

In mixed-conifer forests of the southern Cascades and Sierra Nevada, fire frequency during pre-settlement times was from 6 to 20 years. These frequently occurring fires were generally low in intensity because the short time span between fires resulted in low accumulations of dead and down fuels. As a result of fire suppression, white fir density has greatly increased in mixed-conifer forests, increasing the probabilities for stand replacing fires.

Fire effects

Sapling and pole-sized white fir have thin bark that provides little insulation for the cambium, and shallow roots which are susceptible to soil heating. Because of its shade tolerance, white fir is slow to self prune lower branches. These low growing branches, which have slender twigs and

finely divided foliage, easily ignite from burning undergrowth and provide a fuel ladder to the upper crown. Consequently, young white fir are often killed even by low-intensity surface fires.(Uchytil, R.J., 1991; The Fire Effects Information System.)

LODGEPOLE PINE
Pinus Contorta - Fire Ecology

Lodgepole pine bears both open and closed conned trees. This allows for lodgepole pine to regenerate following both low and high intensity fire. Serotinous cones are advantageous for regeneration following high intensity fires because the heat opens the cones and then releases the seeds. Sometimes, 10 years of annual seed production area stored in Serotinous lodgepole pine cones. This huge seed reserve blankets the exposed forest floor within 3 years after a fire and can explain heavy concentrations of seedling and sapling trees as found in Plot 12. Conversely, ground fires generate insufficient heat to open Serotinous cones. Following this type of fire, seed for regeneration must come from surviving, non-Serotinous conned trees.

Fire regimes in lodgepole pine dominated communities vary, but in areas having dry summers, low to medium intensity ground fires occurred at intervals of 25 to 50 years. In areas with moist summers, sparse understories and slow fuel build up result in less frequent but more intense fires. Fires can smolder in duff for extended periods or can develop into rapidly spreading wildfires. Smoldering fire are common in lodgepole forests because understory fuels are sparse. Fire spread to the crowns is difficult because they are well elevated above the forest floor. However, lodgepole pine stands become more flammable as they age because dead woody fuels accumulate on the forest floor. These fuels result in past fires, insect and disease outbreaks and over maturity.

Fire effects

Lodgepole pine is more damaged by ground fires than thicker barked species such as ponderosa pine or Douglas fir. Because its thin bark has poor insulation properties, many trees are killed from ground fires as a result of cambial heating. However, some trees survive and in general, low intensity ground fires thin lodgepole pine stands.

Although lodgepole pine trees are killed by all but light ground fires, postfire recovery tends to be rapid as new stands quickly establish from seed released from Serotinous cones. (Uchytil, R.J.; 1992 ; The Fire Effects Information System)

ENGLEMAN SPRUCE
Picea Englemani - Fire Ecology

This plant species is very fire sensitive and is generally killed even by low-intensity fires. Postfire re-establishment is via wind-dispersed seeds which readily germinate on fire prepared seed beds. Larger trees occasionally survive light fires. Scattered individuals or pockets of ENGLEMAN spruce trees commonly escape burning because they occur in wet locations where fire spread is hampered. ENGLEMAN spruce usually develop in cool, moist locations and experience fire-free intervals averaging 150 years or more. Many Egleman spruce stands are even aged, suggesting they developed after a fire. The needles on this spruce are small and fine, and form a compact fuel bed in which fire spreads slowly. These concentrated, slow-burning fuels commonly produce flames high enough to reach the low-growing, lichen draped branches and start crown fires.

Fire effects

Egleman spruce is easily killed by fire. It is very susceptible to fire because it has a thin bark that provides little insulation for the cambium. There is a moderate amount of resin in the bark which ignites readily and the tree has shallow roots, low branches, grows in dense stands, and has moderately flammable foliage.

Crown fires typically kill Egleman spruce trees. ENGLEMAN spruce is also very susceptible to surface fires which burn slowly and girdle thin barked boles and chars root structures. Some large ENGLEMAN spruce may survive light, surface fires but these often die later due to infection by wood rotting fungi that enter through fire scars. (Uchytil, R.J.; 1991; The Fire Effects Information System).

SHASTA RED FIR

Abies Magnifica - Fire Ecology

The fire interval for Shasta red fir is 70 to 130 years. Fires are usually patchy and of low severity. Stand replacing fires are rare. Shasta red fir can tolerate occasional light fires. Shasta red fir retains its lower branches when not shaded out, which increases the risk of crown fires. Shasta red fir sheds its needles and naturally prunes its branches where mountain hemlock is the successional climax. Fuel accumulation varies, but decomposition and drying are slow.

Fire effects

Seedlings of California red fir are easily killed by fire. Seedlings and saplings are killed by relatively low intensity fires, but few older California red fir are affected.

Shasta red fir sustains moderate damage from light severity fires, but is often killed by moderate severity fires. (Cope, A.B., 1993; The Fire Effects Information System.)

APPENDIX B

WILDLIFE HABITAT NEEDS

PETS OR SELECTED SPECIES

Aquatic Species Habitat Needs

The spotted frog is a federal candidate species (category 2). It is found in or near a perennial water body such as a spring, pond, lake or sluggish stream associated with marshes or wet meadows without shrubs (Leonard 1993). Habitat may exist in the Odell Creek/marsh complex, however, surveys for spotted frogs have not as yet been conducted.

The Cascades frog is a federal candidate species (category 2) and is found in small pools adjacent to streams flowing through subalpine meadows; also located in sphagnum bogs and fens; seasonally-flooded, forested swamps; and small lakes, ponds and marshy areas adjacent to streams (Leonard 1993). Cascade frogs are known to occur within the Odell Watershed and are likely to inhabit the high elevation wilderness lakes, Bobby Lake, Rosary Lakes and along Odell Creek.

Northern Spotted Owl Habitat Needs

The spotted owl is federally listed as a threatened species. Spotted owls are associated with mature dense mixed conifer forests (preferred nesting, roosting and foraging habitat). These habitats usually consist of an overstory, comprised of large trees with at least one other canopy layer present that creates a dense, closed canopy forested condition. Components within spotted owl habitat include: abundance of dead or defective standing trees and abundance of dead and down woody material.

Spotted owl habitat, and therefore, most likely dispersal corridors, occur along the mid-elevational mixed conifer zone within the Big Marsh Watershed. This corridor, or band of suitable habitat, ties together the small mountains and buttes where the spotted owl nest sites and activity centers occur. This key corridor runs predominately north along the Cascades crest and ties o the Davis Late Successional Reserve area. Corridors are also likely across the crest to the southwest for dispersal of owls to the western slopes of the Cascades.

Bald Eagle Habitat Needs

The bald eagle is federally listed as a threatened species. Key habitat requirements for bald eagles are: secure nest sites, adequate food supply, and minimal disturbance during courtship, nesting, and fledging (Hall and LeGrand 1989).

Eagle nests are almost always located along a shoreline or within two miles of a body of water (Grub et al. 1991). Typical nest sites are in large conifer or hardwood trees that offer a clear flight path and good visibility of the surrounding terrain. Nests are usually located 35-130 feet above the ground (Bowerman and Giesy 1991). Both living and dead trees are used for nesting, but they must be sturdy enough to support the weight of nesting material which may accumulate for many years. Mature ponderosa pine trees that are larger than 32 inches in diameter at breast height (DBH) are the preferred nest site location. Large DBH Douglas-fir (*Pseudotsuga menziesii*) with open large limb structure are also suitable nest trees. Eagles show strong

attachment to old nesting territories and nest sites. If a nest is destroyed, they often rebuild nearby (Broley 1947, Hall and LeGrand 1989).

Eagles require a reliable food supply, usually in the form of live 10-20 inch fish. They will also consume waterfowl and other birds, mammals up to approximately rabbit size, and a variety of carrion (Brewer et al. 1991). Eagles will also prey upon ducks, geese, and other waterfowl, especially during the winter months when these species are concentrated (Hall and LeGrand 1989, Brewer et al 1991).

Peregrine Falcon Habitat Needs

The peregrine falcon, a federally listed endangered species, inhabits open country near cliffs and canyons which provide an unlimited vista of the area. Its nesting habitat includes bluffs and steep escarpments in forested or non-forested environments. Nests are often made on broad cliffs which have more potholes and cracks for food caches than narrow cliffs. Preferred cliffs are usually 100 meters or higher with suitable ledges for nesting that are inaccessible to predators. Peregrine falcons migrate to Central and South America during the winter months and migrate to North America during the breeding season.

Western Snowy Plover Habitat Needs

The western snowy plover is a federally listed threatened species. It utilizes barren sand beaches and mud flats associated with rivers, ponds, marshes, interior lake basins, and alkali ponds.

Northern Goshawk Habitat Needs

The goshawk is listed as a state sensitive species. Habitat is typically characterized by older and mature forests types having a high degree of canopy cover and/or dense overhead foliage, with limited understory vegetation. The presence of riparian areas also contributes to habitat suitability. Nest trees are frequently the largest tree in the stand and are near small breaks in the canopy (Marshall 1992a). Goshawk nests are typically built within the lower one-third of the crown (Hayward, Holland, and Escano 1990). Stands suitable for nesting range from those containing few mature trees but numerous smaller understory conifers to those with containing mature canopies and few understory trees. Some nesting goshawks may utilize lodgepole pine or lodgepole dominated stands having a relatively open canopy (166 trees/ha, 38% canopy closure), uniform tree heights, and single-layered structure (Reynolds et al. 1982). It is suspected that goshawks utilize the watershed throughout the year, however, it is suspected that their winter distribution is limited to the lower elevations due to a potential lack of prey. Goshawks prey below the canopy on a variety of birds and mammals including jays, woodpeckers, quail, grouse, robin, tree and ground squirrels, hares and rabbits. Home ranges are generally around 6,800 acres per pair and distance between nests averaged 3.4 miles (Marshall 1992a).

Wolverine, Fisher and Marten Habitat Needs

The wolverine, a federal candidate species (category 2), is usually associated with remote, high-elevation, subalpine and alpine areas. Wolverine habitat can be found at elevations ranging from 6,000 feet to above timberline. Dominant tree species in this area include white barked pine (*Pinus albicaulis*), mountain hemlock (*Tsuga mertensiana*), and subalpine fir (*Abies*

lasiocarpa). During the winter, wolverine move to lower elevations where the habitat is comprised of mixed conifer and lodgepole pine. Wolverine may defend territories from 10 to 80 square miles and are generally associated with pristine and/or undisturbed areas. However, the wolverine's home range may be from 77 to 163 square miles. Male wolverines often have larger home ranges than females. Depending on habitat a male's home range can be as long as 60 miles and a female's may be 25 miles long (Strickland and Douglas 1987). Wolverine prefer timbered areas and avoid large openings (Ingram 1973). Habitat typically includes a mosaic of mixed conifer and small grassland openings. Wolverine often den in rock crevices or beneath talus.

The wolverine is a species for which little habitat or population specific information is available. There have been only a handful of sightings in the Central Oregon Cascades in the last few decades, of which several sightings occurred within the Odell Watershed.

Marten, a state listed sensitive species, inhabits mature lodgepole pine, subalpine, and mixed conifer forests in the Pacific Northwest (Ingles 1965). Marten prefer mixed or mature conifer forests, but will tolerate a wide variety of habitats if food and cover are available. The marten needs at least 50 percent crown closure and a heavy dead and down component. Conifer or mixed hardwood/conifer travel corridors are also necessary between areas of suitable habitat.

The male marten has a home range that averages about 1.2 square miles, while the female averages approximately 0.4 square miles. Juvenile marten, when searching for a territory, may travel as far as 25 miles (Strickland and Douglas 1987).

The marten is an opportunistic feeder and its diet includes a wide variety of animal and plant material. There is much seasonal variation in the diet. During the summer mice, voles, and shrews constitute an important part of the animal's diet. During the winter the marten concentrates on larger prey items such as the snowshoe hare, Douglas' squirrel, and ruffed grouse. The marten also consumes birds and their eggs, chipmunks, reptiles and amphibians, as well as fruit, insects, nuts, and berries when in season. Historically, marten were probably very common throughout the watershed.

The fisher, a federal candidate species (category 2), is usually found in mixed forests containing a diversity of tree species and ages. Selection of habitat is determined mostly by food availability, but is also influenced by the presence of continuous overhead cover, the proximity to denning sites, and a heavy dead and down component. Optimal conditions for the fisher include a canopy closure of 50% or greater, average tree diameter of ten inches or larger, two or more stories in the tree canopy, and an overstory comprised of at least 50% deciduous trees (Douglas and Strickland 1987).

The male fisher has an average home range of eight square miles, juvenile males average ten square miles, while the female's range is approximately six square miles. Home ranges of the fisher often overlap, although it is usually only the ranges of members of the opposite sex that do.

The fisher is an opportunistic feeder. They frequently prey on porcupines, an animal for which they have almost no competition. A staple in the fisher's diet is the snowshoe hare, while mice, squirrels, and birds can also comprise a large portion of it. Reptiles, amphibians, bird eggs, fish, and insects are also eaten. During the summer months, 30% of the animal's diet can consist of fruit and mast (Douglas and Strickland 1987).

Preble's Shrew Habitat Needs

The Preble's shrew is a federal candidate species (category 2). Habitat for this small insectivorous mammal includes moist fields, marshes, and riparian areas with willows (*Salix species*) at moderate to high elevations. Dead and down logs are an important habitat component for cover, feeding, and breeding.

Long-billed Curlew Habitat Needs

Long-billed curlews are federal candidate species (category 3) Non-breeding habitat can be found in upland and aquatic areas, ranging from moist meadows to very dry prairies, and also including marshes, beaches, mud flats, and grassy meadows near water. Nesting habitat for this species includes meadows and pastures. Nests are constructed of grasses and forbs and built in hollows in the ground.

Black-Backed Woodpecker Habitat Needs

The black-backed woodpecker is listed as a sensitive species in the critical category by the ODFW. The black-backed woodpecker prefers lodgepole pine and mixed conifer forests. The species tends to select for mature lodgepole and ponderosa pine trees as nest trees with a mean next tree DBH of 11". Primary forage species are bark beetles which have been and still are prolific across the forest due to the recent epidemic of the mountain pine beetle. Other preferred habitat includes areas that are frequently burned over and contain fire-killed trees that are infested with bark beetles. The black-backed woodpecker forages on the dead conifers by flaking away large patches of loose bark rather than drilling into it, in search of larvae and insects. Trees used for foraging have generally been dead three years or less. The estimated home range for a pair of black-backed woodpeckers is 956 acres (individuals-430 acres) during bark beetle epidemics; larger areas are needed after the epidemic subsides. The black-backed woodpecker is known to summer roost in defective lodgepole pines having concave western gall rust cankers, mistletoe clumps, and other deformities. (Marshall 1992b).

Great Gray Owl Habitat Needs

The great gray owl is listed as a sensitive species in the vulnerable category by the Oregon Department of Fish and Wildlife (ODFW). Great gray owls inhabit open forest or forest with adjoining deep-soiled meadows. Appropriate habitat is provided by lodgepole pine or mixed lodgepole/ponderosa pine forests of mid to late structural stages (lodgepole over 70 years of age, ponderosa over 200 years of age). The majority of great gray owl nest sites are within 0.2 miles of a meadow. The owl will utilize vacant goshawk or red-tailed hawk nests in large trees or snags adjacent to meadows, and cavities, natural platforms formed by dwarf mistletoe infections, artificial platforms or broken-topped dead trees. Owlets leave the nest before they can fly, so an important habitat component includes dense cover or leaning trees to allow owlets to climb to perches above-ground. Average home range size is 30 square miles and over 60 square miles for first year juveniles (Marshall 1992a).

Flammulated Owl Habitat Needs

The flammulated owl is listed as a sensitive species in the critical category by the ODFW. The flammulated owl nests in cavities in open-canopied mature ponderosa pine and mixed conifer dry stands, and roosts in dense mixed conifer dry stands which afford protection from avian predators. Foraging occurs in forest openings and open-canopied stands (in ponderosa pine, mixed conifer dry and grassland-forest edge). Flammulated owls feed on insects such as

grasshoppers and moths. Studies have found that nest trees have an average DBH of 11.8-22.8" with a canopy closure less than 50%. It was also found that 80% of the nests were located within 90 feet of a forest opening. The nest is typically constructed in a vacated woodpecker cavity. Home range sizes vary from incubation to fledging, and are 48 to 14 acres, respectively (average 25.5 acres) (Marshall 1992a).

Greater Sandhill Crane Habitat Needs

The greater sandhill crane is listed as a sensitive species in the vulnerable category by the ODFW. The sandhill crane is associated with wet meadows, shallow marshes, shallow wetlands and dry fields which contain a high diversity of plant life. Nests usually consist of a hay-like mound made of grasses and sedges. The most successful nests are constructed in deeper water where plants such as hardstem bulrush (*Scirpus acutus*) are present, but the typical nesting habitat consists of meadows. Breeding density is estimated at one pair per 180 acres or larger.

American White Pelican Habitat Needs

The American white pelican is listed as a sensitive species in the vulnerable category by the ODFW. Pelicans occur in shallow-water areas and marshes. Nests are on areas of bare soil or low grasses, but also nest on dense bulrush mats where available. Pelicans nest colonially on islands that are free of human disturbance and mammalian predators. Pelicans forage mostly on fish, and occasionally on salamanders and crayfish. Nesting success is dependent upon a satisfactory food supply; feeding areas can be 60+ miles from the breeding island (Marshall 1992a).

White-Headed Woodpecker Habitat Needs

The white-headed woodpecker is listed as a sensitive species in the critical category by the ODFW. White-headed woodpecker habitat occurs mainly in open-canopied ponderosa pine (generally greater than 20" DBH) and mixed ponderosa pine forests. Stand characteristics include at least ten trees per acre greater than 21" DBH or two trees per acre greater than 31" DBH, multiple understory layers and at least one snag per acre (Blair 1993). The species forages primarily on the trunks of living trees for insects and in the crowns of conifers for seeds with ponderosa pine seeds most desirable. A foraging preference was shown in Central Oregon for trees exceeding 20" DBH. Most foraging for insects occurs near the ground since insect populations are most abundant in the deepest bark furrows and cracks. Nest cavities are usually within 15 feet of the ground in dead trees having heart rot. Nest are located in or on the edges of forest openings or clearings. Cavities are also used for roosting (Marshall 1992a). Home ranges vary from 146 to 477 acres in fragmented stands. Average home range in fragmented areas are 1094 acres (ranging from 121 to 1890 acres) (Blair 1993).

Pileated Woodpecker Habitat Needs

The pileated woodpecker is listed as a sensitive species in the critical category by the ODFW. Habitat is typically found within the mixed conifer associations and predominately on the Deschutes National Forest in those areas containing a high component of mature white fir. Pileated woodpeckers tend to inhabit old-growth and mature stands in Oregon, and older forests on the eastside of the Cascades. Their preferred foraging substrates include large diameter (live and dead) trees and dead and down woody material (Carpenter ants and woodboring beetle

larvae). The birds forage by excavating into wood and scaling or chipping bark. Pileated woodpeckers excavate a new cavity nest each year in trees exceeding 21" DBH. Nest cavity size averages 8" wide by 22" deep and is 20 to 80 feet off the ground. Roost cavities are typically located in live or dead trees greater than 20" DBH. Average home range per pair is 543 acres (Marshall 1992a).

Aquatic Species Habitat Needs

Long-toed salamander (*Ambystoma macrodactylum*)
Northwestern salamander (*Ambystoma gracile)*
Pacific giant salamander (*Dicamptodon tenebrosus*)
Rough-skinned newt (*Taricha granulosa*)
Pacific tree frog (*Pseudacris regilla*)
Tailed frog (*Ascaphus truei*)
Red-legged frog (*Rana aurora)*
Western toad (*Bufo boreas*)
Cascades frog (*Rana cascadae*)
Spotted frog (*Rana pretiosa*)

Amphibian species likely to be found in this watershed are predominantly associated with aquatic and riparian habitats. Some species may migrate overland, but they typically accomplish this during moist or wet conditions, i.e. the rainy season. All amphibian species use aquatic habitats for reproduction.

Landscape corridors between ponds, lakes and key streams allow amphibian migration between and within watersheds, thus enhancing gene pool exchange and the potential for re-colonization of historic habitats. The corridors identified would link key aquatic and riparian areas within the watershed and provide connections between watersheds including those on the west side of the Cascades.

The Diamond Peak Wilderness Area, given its abundance of "potholes," may be a reservoir of native amphibians at endemic levels where recreational use and fish stocking have not disrupted their life history, habitat or predator/prey relationships. This entire area provides a link to the north where additional pothole lakes can be found. Trapper Creek is likely an important corridor linking Odell Lake to the north of the watershed. Odell Lake (particularly the southeastern shore) may be a central draw for amphibians and provides connections from the wilderness southeast, Willamette Pass to the northwest, and Odell Creek northeast to Davis Lake.

Odell and Davis Creeks are the major amphibian waterways which connect Odell Lake and Wickiup Reservoir. Although Davis Creek does not connect Davis Lake to Wickiup Reservoir overground, it is speculated that during the wet season, when amphibians are migrating, that the meadows adjacent to the lava flow would serve as suitable dispersal habitat between Davis Lake and Davis Creek. Ranger, Maklaks and Odell Creeks are cold perennial streams within the watershed that are surrounded by essentially undisturbed meadows. Amphibians are likely to occur at high species densities and diversity within this area. During wet springs, Moore Creek will periodically connect Davis Lake to Bobby Lake which then provides a corridor from low elevation to high elevation, up and over the Cascades Crest towards the Gold Lake Bog and Waldo Lake area.

Terrestrial or Avian Species Associated with the Following Habitats.

Lodgepole Pine (Dry & Wet)
Ponderosa Pine

Mixed Conifer (Dry & Wet)
Lodgepole Pine Dry/Mountain Hemlock
Mountain Hemlock
Meadows (includes Wet Meadows, Moist (hairgrass) Meadows, and Dry Meadows)

Wildlife species need a variety of habitats for a healthy ecosystem. Some species specialize and may only inhabit one or two seral/structure stages within one plant association group, while other species may use several seral/structure stages and several plant association groups. A few species have the adaptability to utilize all stages and all seral stages. All species need access to water. A few small mammal species are able to access water through the dew on the vegetation or the moisture contained in the vegetation. Some species require special habitats such as large trees, snags, down logs, talus, cliffs, lava, fens, small ponds, aspen groves, hardwoods, caves, etc.

There is an estimated 268 species of mammals and birds that are known or suspected to occur within the watershed habitats. Of these, 32 species utilize all the PAG's, either for breeding, feeding, and/or resting.

The following is a breakdown of the number of species that utilize each PAG.

Lodgepole Pine (Dry & Wet)-Seral/Structural Stages

There are 84 species that are known or suspected to utilize the habitats within these two PAGs. Only two species utilize the lodgepole dry and not the lodgepole wet habitat, they are the hermit thrush and golden-crowned sparrow. The varied thrush is the only species found in the lodgepole wet and not the lodgepole dry. The following eleven species require one or two specific structural stages for their primary breeding, feeding, and/or resting habitat:

Early - Anna's hummingbird
Mid/Late - Cooper's hawk and great gray owl
Late/Old - evening grosbeak, Hammond's flycatcher, merlin, northern goshawk, osprey, red crossbill, ruby-crowned kinglet, and white-winged crossbill.

Thirty-six other species use three or more structural stages, and five species use these PAG's for secondary breeding, feeding, and/or resting habitat. All other species use the area for non-breeding purposes.

Ponderosa Pine-Seral/Structural Stages

Within this PAG there are 120 species that are known or suspected to use these habitats. Thirty-three species require one or two specific structural stages for their primary breeding, feeding, and/or resting habitat, they are:

Early - rock wren
Early/Mid - mountain quail, Trowbridge's shrew, ruffed grouse, and western spotted skunk.
Early/Old - turkey vulture
Mid - northern flying squirrel
Mid/Late - Cooper's hawk
Late/Old - ash-throated flycatcher, bald eagle, barn owl, big brown bat, black-headed grosbeak, brown creeper, California myotis, evening grosbeak, golden eagle, Hammond's flycatcher, long-eared myotis, long-legged myotis, northern goshawk, northern saw-whet owl, osprey, pygmy nuthatch, red crossbill, red-tailed hawk, silver-haired bat, white-breasted nuthatch, white-headed woodpecker and Williamson's sapsucker.

Fifty-six species use three or more structural stages, and five species use this PAG for secondary breeding, feeding, and/or resting habitat. All other species use the area for non-breeding purposes.

Mixed Conifer (Dry & Wet)-Seral/Structural Stages

Dry

Within this PAG there are 133 species that are known or suspected to use these habitats. Forty-one species require one or two specific structural stages for their primary breeding, feeding, and/or resting habitat, they are:

Early - Anna's hummingbird, Nashville warbler, and rock wren.
Early/Mid - Calliope hummingbird, ruffed grouse, Trowbridge's shrew, and western spotted skunk.
Early/Old - common raven
Mid/Late - Cooper's hawk
Late/Old - bald eagle, barn owl, barred owl, big brown bat, black-headed grosbeak, California myotis, common poorwill, evening grosbeak, fisher, golden eagle, Hammond's flycatcher, little brown myotis, long-eared myotis, long-legged myotis, marten, northern goshawk, northern saw-whet owl, pileated woodpecker, pygmy nuthatch, red crossbill, red-tailed hawk, ruby-crowned kinglet, silver-haired bat, spotted owl, Townsend's warbler, Vaux's swift, white-breasted nuthatch, white-headed woodpecker, white-winged crossbill, and Williamson's sapsucker.

Sixty-six species in the mixed conifer dry PAG use three or more structural stages, and seven species use this PAG for secondary breeding, feeding, and/or resting habitat. All other species use the area for non-breeding purposes.

Wet

Within this PAG there are 135 species that are known or suspected to use these habitats. The same forty-one species that require one or two specific structural stages for their primary breeding, feeding, and/or resting habitat in the mixed conifer dry also use the mixed conifer wet PAG.

Seventy species in the mixed conifer wet use three or more structural stages, and eight species use this PAG for secondary breeding, feeding, and/or resting habitat. All other species use the area for non-breeding purposes.

Comparison - the dusky flycatcher and pygmy nuthatch utilize mixed conifer dry habitats but may not use mixed conifer wet while the barred owl, shrew-mole, Townsend's chipmunk and Wilson's warbler are identified as using mixed conifer wet, but not dry habitats.

Lodgepole Pine Dry/Mountain Hemlock-Seral/Structural Stages

Within this PAG there are 98 species that are known or suspected to use these habitats. The following eighteen species require one or two specific structural stages for their primary breeding, feeding, and/or resting habitat:

Early/Mid - Calliope hummingbird
Early/Old - common raven
Mid/Late - Cooper's Hawk

Late/Old - black-headed grosbeak, boreal owl, Clark's nutcracker, evening grosbeak, fisher, Hammond's flycatcher, little brown myotis, long-legged myotis, marten, merlin, northern goshawk, northern saw-whet owl, red crossbill, ruby-crowned kinglet, Townsend's warbler, and white-winged crossbill.

Forty-eight species use three or more structural stages, and eight species use this PAG for secondary breeding, feeding, and/or resting habitat. All other species use the area for non-breeding purposes.

Mountain Hemlock-Seral/Structural Stages

Within this PAG there are 97 species that are known or suspected to use these habitats. The following twenty species require one or two specific structural stages for their primary breeding, feeding, and/or resting habitat:

Early/Mid - Calliope hummingbird
Early/Old - common raven
Mid/Late - Cooper's hawk
Late/Old - black-headed grosbeak, boreal owl, Clark's nutcracker, evening grosbeak, fisher, Hammond's flycatcher, little brown myotis, long-legged myotis, marten, merlin, northern goshawk, northern saw-whet owl, red crossbill, ruby-crowned kinglet, Townsend's warbler, white-winged crossbill, and Williamson's sapsucker.

Forty-eight species use three or more structural stages, and eight species use this PAG for secondary breeding, feeding, and/or resting habitat. All other species use the area for non-breeding purposes.

Meadows (includes Wet Meadows, Moist (hairgrass) Meadows, and Dry Meadows)

Within this PAG there are 133 species that are known or suspected to use these habitats. The following eight species require one specific type of meadow for their primary breeding, feeding, and/or resting habitat:

Wet meadow - elk, red fox, and red-winged blackbird.
Dry meadow - common nighthawk, golden-mantled ground squirrel, rock wren, and yellow-bellied marmot.

Twenty-seven other species use two or more meadow types, and one species, the deer mouse uses the dry meadow for secondary breeding, feeding, and/or resting habitat. All other species use the area for non-breeding purposes.

At a landscape level many of the neotropical migratory birds (NTMB's) migrate from Central or South America each spring to breed and feed within the watershed. Other birds including waterfowl, raptors, and larger birds migrate from the southern United States to habitats in Canada and Alaska for breeding, but stop within the Odell Watershed to feed and rest. Many year-round avian and mammalian residents travel in and out of the watershed to seek mates, for juvenile dispersal, or due to displacement caused by the loss of habitat. Most species have unidentifiable routes out of the watershed to other watersheds.

Deer and elk tend to migrate through the valleys between the buttes and as well as south of Odell Lake, to and from summer to winter range. The watershed provides summer range for deer and elk. These ungulates also cross over the Cascade Crest from east to west which results in mule and black-tailed deer crosses. These crosses probably occur north of Odell Lake (Willamette Pass) and north of Davis Lake. During the winter migration deer move to the Silver

Lake and Fort Rock wintering areas. The elk move into the LaPine area or some move over the Cascade Crest to winter on the westside. Elk that cross over to the westside may remain there for the winter or the remainder of their life cycle. This migration has led to crosses between Roosevelt and Rocky Mountain elk. Typically, most elk are classified as Rocky Mountain.

SPECIAL HABITATS

Many species utilize special habitats within the PAG's, in fact, some wildlife species may utilize more than one special areas for primary habitat. Listed are species known or suspected to be within the watershed. The following habitats are known to occur within the watershed, however, inventories have not been conducted to map or quantify these special habitats. Caves are not listed as a special habitat, since to date, none have been located within the area, the likelihood of existence is moderate. Edge habitats are identified as grass-shrub, shrub-forest, grass-forest, water-grass, water-shrub, and water-forest. Large trees may include trees with hollows that support a bat colony. Snags including those that are either hard and soft are used by primary and secondary excavators and users.

Down Logs - 18 species; including bushy-tailed wood rat, common poorwill, dark-eyed junco, ermine, black bear, ruffed grouse, pileated woodpecker, fisher, golden-mantled ground squirrel, long-tailed vole, long-tailed weasel, marten, snowshoe hare, Townsend's chipmunk, western jumping mouse, wolverine, and yellow-pine chipmunk.

Large Trees - 22 species; including bald eagle, Clark's nutcracker, common raven, Douglas' squirrel, flammulated owl, golden eagle, great blue heron, great gray owl, great horned owl, merlin, northern flying squirrel, northern goshawk, northern saw-whet owl, osprey, pileated woodpecker, red-breasted sapsucker, red-tailed hawk, spotted owl, tree swallow, western gray squirrel, white-headed woodpecker, and Williamson's sapsucker.

Snags - 51 species; including many of the large tree species users and the hoary bat, little brown myotis, long-eared myotis, long-legged myotis, red-breasted nuthatch, pygmy nuthatch, mountain bluebird, wood duck, Barrow's goldeneye, bufflehead, common goldeneye, and common merganser.

Edge - 14 species; including American kestrel, Anna's hummingbird, barn owl, black-chinned hummingbird, bushy-tailed wood rat, Calliope hummingbird, chipping sparrow, long-eared owl, red-tailed hawk, ruffed grouse, snowshoe hare, tree swallow, western spotted skunk, and Yuma myotis.

Cliffs - 21 species; including American dipper, barn owl, belted kingfisher, black bear, black rosy finch, bobcat, bushy-tailed wood rat, California myotis, common raven, golden eagle, little brown myotis, long-eared myotis, long-tailed vole, merlin, mountain lion, peregrine falcon, pika, red-tailed hawk, rock wren, and Yuma myotis.

Duff Litter - 8 species; including common nighthawk, common poorwill, dark-eyed junco, long-tailed vole, long-toed salamander, northwestern salamander, shrew-mole, and Trowbridge's shrew.

Talus/Lava Flows - 13 species; including badger, black bear, black rosy finch, bobcat, bushy-tailed wood rat, California myotis, little brown myotis, long-eared myotis, long-tailed vole, pika, rock wren, yellow-bellied marmot, and yellow-pine chipmunk.

NON-NATIVE SPECIES

Aquatic Species Habitat Needs

Bullfrog (Rana catesbeiana)

Inhabits shorelines of lakes, ponds, sloughs, and reservoirs. This species is highly aquatic and seldom ventures far from the vegetated banks of a body of permanent standing water. Adult bullfrogs will eat nearly any creature they can swallow, including insects, fish, amphibians, reptiles, small mammals, and birds as large as robins. Bullfrogs are extremely wary and difficult to approach during daylight (Leonard 1993).

Terrestrial or Avian Species Habitat Needs

House sparrow (*Passer domesticus*)
Brown-headed cowbird (*Molothrus ater*)
European starling (*Sturnus vulgaris*)
Barred owl (*Strix varia*)

House sparrows utilize forest edges and areas around human habitation.

Brown-headed cowbirds utilize forests (especially deciduous forests), forest edges, and grasslands. Within the watershed cowbirds utilize ponderosa pine, mixed conifer, and riparian areas throughout the plant association groups.

European starling is a habitat generalist which utilizes most habitats, except interior forest.

Barred owls utilize dense conifer and mixed conifer/deciduous forests and their associated riparian areas.

Big Marsh Watershed Species List
Known or Suspected

Species Common Name	Scientific Name
American bittern	*Botaurus lentiginosus*
American coot	*Fulica americana*
American crow	*Corvus brachyrhynchos*
American dipper	*Cinclus mexicanus*
American kestrel	*Falco sparverius*
American pipit (water)	*Anthus spinoletta*
American robin	*Turdus migratorius*
American white pelican	*Pelecanus erythrorhynchos*
American wigeon	*Anas americana*
Anna's hummingbird	*Calypte anna*
Arctic loon (Pacific)	*Gavia pacifica*
Ash-throated flycatcher	*Myiarchus cinerascens*
Badger	*Taxidea taxus*
Bald eagle	*Haliaeetus leucocephalus*
Bank swallow	*Riparia riparia*
Barn owl	*Tyto alba*

Barn swallow	*Hirundo rustica*
Barred owl	*Strix varia*
Barrow's goldeneye	*Bucephala islandica*
Beaver	*Castor canadensis*
Belted kingfisher	*Ceryle alcyon*
Big brown bat	*Eptesicus fuscus*
Black bear	*Ursus americanus*
Black rosy finch	*Leucosticte arctoa• • (atrata)*
Black tern	*Chlidonias niger*
Black-backed woodpecker	*Picoides arcticus*
Black-chinned hummingbird	*Archilochus alexandri*
Black-crowned night-heron	*Nycticorax nycticorax*
Black-headed grosbeak	*Pheucticus melanocephalus*
Black-necked stilt	*Himantopus mexicanus*
Black-throated gray warbler	*Dendroica nigrescens*
Blue grouse	*Dendragapus obscurus*
Blue-winged teal	*Anas discors*
Bobcat	*Felis rufus*
Bonaparte's gull	*Larus philadelphia*
Boreal owl	*Aegolius funereus*
Brewer's blackbird	*Euphagus cyanocephalus*
Broad-footed mole	*Scapanus latimanus*
Brown creeper	*Certhia americana*
Brown-headed cowbird	*Molothrus ater*
Bufflehead	*Bucephala albeola*
Bushtit	*Psaltriparus minimus*
Bushy-tailed woodrat	*Neotoma cinerea*
California gull	*Larus californicus*
California myotis	*Myotis californicus*
Calliope hummingbird	*Stellula calliope*
Canada goose	*Branta canadensis*
Canvasback	*Aythya valisineria*
Cascades frog	*Rana cascadae*
Caspian tern	*Sterna caspia*
Cassin's finch	*Carpodacus cassinii*
Chipping sparrow	*Spizella passerina*
Cinnamon teal	*Anas cyanoptera*
Clark's nutcracker	*Nucifraga columbiana*
Coast mole	*Scapanus orarius*
Common garter snake	*Thamnophis sirtalis*
Common goldeneye	*Bucephala clangula*
Common loon	*Gavia immer*
Common merganser	*Mergus merganser*
Common nighthawk	*Chordeiles minor*
Common poorwill	*Phalaenoptilus nuttallii*
Common raven	*Corvus corax*
Common snipe	*Gallinago gallinago*
Common yellowthroat	*Geothlypis trichas*
Cooper's hawk	*Accipiter cooperii*
Coyote	*Canis latrans*
Dark-eyed junco	*Junco hyemalis*
Deer mouse	*Peromyscus maniculatus*
Double-crested cormorant	*Phalacrocorax auritus*
Douglas' squirrel	*Tamiasciurus douglasii*

Downy woodpecker	*Picoides pubescens*
Dunlin	*Calidris alpina*
Dusky flycatcher	*Empidonax oberholseri*
Eared grebe	*Podiceps nigricollis*
Elk	*Cervus elaphus*
Ermine	*Mustela erminea*
Eurasian widgeon	*Anas penelope*
European starling	*Sturnus vulgaris*
Evening grosbeak	*Coccothraustes vespertinus*
Ferruginous hawk	*Buteo regalis*
Fisher	*Martes pennanti*
Flammulated owl	*Otus flammeolus*
Forster's tern	*Sterna forsteri*
Fox sparrow	*Passerella iliaca*
Franklin's gull	*Larus pipixcan*
Gadwall	*Anas strepera*
Golden eagle	*Aquila chrysaetos*
Golden-crowned kinglet	*Regulus satrapa*
Golden-crowned sparrow	*Zonotrichia atricapilla*
Golden-mantled ground squirrel	*Spermophilus lateralis*
Gopher snake	*Pituophis catenifer*
Gray jay	*Perisoreus canadensis*
Great blue heron	*Ardea herodias*
Great egret	*Casmerodius albus*
Great gray owl	*Strix nebulosa*
Great horned owl	*Bubo virginianus*
Greater scaup	*Aythya marila*
Greater white-fronted goose	*Anwer albifrons*
Greater yellowlegs	*Tringa melanoleuca*
Green-backed heron	*Butorides striatus*
Green-winged teal	*Anas crecca*
Hairy woodpecker	*Picoides villosus*
Hammond's flycatcher	*Empidonax hammondii*
Harlequin duck	*Histrionicus histrionicus*
Heather vole	*Phenacomys intermedius*
Hermit thrush	*Catharus guttatus*
Hermit warbler	*Dendroica occidentalis*
Herring gull	*Larus argentatus*
Hoary bat	*Lasiurus cinereus*
Hooded merganser	*Lophodytes cucullatus*
Horned grebe	*Podiceps auritus*
Horned lark	*Eremophila alpestris*
House finch	*Carpodacus mexicanus*
House mouse	*Mus musculus*
House sparrow	*Passer domesticus*
House wren	*Troglodytes aedon*
Killdeer	*Charadrius vociferus*
Lapland longspur	*Calcarius lapponicus*
Lark sparrow	*Chondestes grammacus*
Least bittern	*Ixobrychus exilis*
Least sandpiper	*Calidris minutilla*
Lesser scaup	*Aythya affinis*
Lewis's woodpecker	*Melanerpes lewis*
Little brown myotis	*Myotis lucifugus*

Long-billed curlew	*Numenius americanus*
Long-billed dowitcher	*Limnodromus scolopaceus*
Long-eared myotis	*Myotis evotis*
Long-eared owl	*Asio otus*
Long-legged myotis	*Myotis volans*
Long-tailed vole	*Microtus Longicaudus*
Long-tailed weasel	*Mustela frenata*
Long-toed salamander	*Ambystoma macrodactylum*
MacGillivray's warbler	*Oporornis tolmiei*
Mallard	*Anas platyrhynchos*
Marbled godwit	*Limosa fedoa*
Marsh wren	*Cistothorus palustris*
Marten	*Martes americana*
Merlin	*Falco columbarius*
Mink	*Mustela vison*
Montane vole	*Microtus montanus*
Mountain bluebird	*Sialia currucoides*
Mountain chickadee	*Parus gambeli*
Mountain lion	*Felis concolor*
Mountain quail	*Oreortyx pictus*
Mourning dove	*Zenaida macroura*
Mule deer	*Odocoileus hemionus*
Muskrat	*Ondatra zibethicus*
Mute swan	*Cygnus olor*
Nashville warbler	*Vermivora ruficapilla*
Northern alligator lizard	*Elgaria coerulea*
Northern flicker	*Colaptes auratus*
Northern flying squirrel	*Glaucomys sabrinus*
Northern goshawk	*Accipiter gentilis*
Northern harrier	*Circus cyaneus*
Northern oriole	*Icterus galbula*
Northern pintail	*Anas acuta*
Northern pocket gopher	*Thomomys talpoides*
Northern pygmy-owl	*Glaucidium gnoma*
Northern saw-whet owl	*Aegolius acadicus*
Northern shoveler	*Anas Clypeata*
Northwestern salamander	*Ambystoma gracile*
Norway rat	*Rattus Norvegicus*
Olive-sided flycatcher	*Contopus borealis*
Osprey	*Pandion haliaetus*
Pacific treefrog (chorus)	*Pseudacris regilla*
Peregrine falcon	*Falco peregrinus*
Pied-billed grebe	*Podilymbus podiceps*
Pika	*Ochotona princeps*
Pileated woodpecker	*Dryocopus pileatus*
Pine siskin	*Carduelis pinus*
Porcupine	*Erethizon dorsatum*
Prairie falcon	*Falco mexicanus*
Preble's shrew	*Sorex preblei*
Purple finch	*Carpodacus purpureus*
Purple martin	*Progne subis*
Pygmy nuthatch	*Sitta pygmaea*
Raccoon	*Procyon lotor*
Red crossbill	*Loxia curvirostra*

Red fox	*Vulpes vulpes*
Red-breasted merganser	*Mergus serrator*
Red-breasted nuthatch	*Sitta canadensis*
Red-breasted sapsucker	*Sphyrapicus ruber*
Red-eyed vireo	*Vireo olivaceus*
Red-necked grebe	*Podiceps grisegena*
Red-necked phalarope	*Phalaropus lobatus*
Red-tailed hawk	*Bureo jamaicensis*
Red-winged blackbird	*Agelaius phoeniceus*
Redhead	*Aythya americana*
Ring-billed gull	*Larus delawarensis*
Ring-necked duck	*Aythya collaris*
River otter	*Lutra canadensis*
Rock wren	*Salpinctes obsoletus*
Ross' goose	*Chen rossii*
Rough-legged hawk	*Butreo lagopus*
Rough-skinned newt	*Taricha granulosa*
Rubber boa	*Charina bottae*
Ruby-crowned kinglet	*Regulus calendula*
Ruddy duck	*Oxyura jamaicensis*
Ruffed grouse	*Bonasa umbellus*
Rufous hummingbird	*Selasphorus rufus*
Rufous-sided towhee	*Pipilo erythrophthalmus*
Sandhill crane	*Grus canadensis*
Semipalmated plover	*Charadrius semipalmatus*
Sharp-shinned hawk	*Accipiter striatus*
Shrew-mole	*Neurotrichus gibbsii*
Silver-haired bat	*Lasionycteris noctivagans*
Snow goose	*Chen caerulescens*
Snowshoe hare	*Lepus americanus*
Snowy egret	*Egretta thula*
Solitary vireo	*Vireo solitarius*
Song sparrow	*Melospiza melodia*
Sora	*Porzana carolina*
Spotted frog	*Rana pretiosa*
Spotted owl (northern)	*Strix occidentalis*
Spotted sandpiper	*Actitis macularia*
Steller's jay	*Cyanocitta stelleri*
Swainson's hawk	*Buteo swainsoli*
Swainson's thrush	*Catharus ustulatus*
ŠTailed frog	*Ascaphus truei*
Three-toed woodpecker (northern)	*Picoides tridac.ylus*
Townsend's big-eared bat	*Plecotus townsendii*
Townsend's chipmunk	*Tamias townsendii*
Townsend's warbler	*Dendroica townsendi*
Tree swallow	*Tachycineta bicolor*
Trowbridge's shrew	*Sorex trowbridgii*
Trumpeter swan	*Cygnus buccinator*
Tundra swan (whistling)	*Cygnus columbianus*
Turkey vulture	*Cathartes aura*
Vagrant shrew	*Sorex vagranx*
Varied thrush	*Ixoreus naevius*
Vaux's swift	*Chaetura vauxi*

Virginia rail	*Rallus limicola*
Warbling vireo	*Vireo gilvus*
Water shrew	*Sorex palustris*
Western flycatcher (Pacific-slope)	*Empidonax difficilis*
Western gray squirrel	*Sciurus griseus*
Western grebe	*Aechmophorus occidentalis*
Western jumping mouse	*Zapus princeps*
Western kingbird	*Tyrannus verticalis*
Western pocket gopher	*Thomomys mazama*
Western red-backed vole	*Clethrionomys californicus*
Western sandpiper	*Calidris mauri*
Western spotted skunk	*Spilogale gracilis*
Western tanager	*Piranga ludoviciana*
Western terrestrial garter snake	*Thamnophis elegans*
Western toad	*Bufo boreas*
Western wood-pewee	*Contopus sordidulus*
White-breasted nuthatch	*Sitta carolinensis*
White-crowned sparrow	*Zonotrichia leucophrys*
White-faced ibis	*Plegadis chihi*
White-headed woodpecker	*Picoides albolarvatus*
White-throated swift	*Aeronautes saxatalis*
White-winged crossbill	*Loxia leucoptera*
Willet	*Catoptrophorus semipalmatus*
Williamson's sapsucker	*Sphyrapicus thyroideus*
Willow flycatcher	*Empidonax traillii*
Wilson's phalarope	*Phalaropus tricolor*
Wilson's warbler	*Wilsonia pusilla*
Winter wren	*Troglodytes troglodytes*
Wolverine	*Gulo gulo*
Woodduck	*Aix sponsa*
Yellow warbler	*Dendroica petechia*
Yellow-bellied marmot	• *Marmota flaviventris*
Yellow-breasted chat	*Icteria virens*
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*
Yellow-pine chipmunk	*Tamias amoenus*
Yellow-rumped warbler	*Dendroica coronata*
Yuma myotis	*Myotis yumanensis*

APPENDIX C - PLANT LISTS

HABITAT DESCRIPTIONS FOR SENSITIVE PLANT SPECIES

Habitat descriptions for all PETS plant species known or suspected to occur on the Crescent Ranger District, Deschutes National Forest. All species are on the Regional Forester's Sensitive Species List (FSM 2670.44, Region Six Directive No. 90-1, March 11, 1991).

Agoseris elata, Tall agoseris (Documented; ORNHP List 2; TNC Rank G4S2)

> Found in non-forest areas and openings in ponderosa pine and rarely lodgepole pine (3000'-4800' elevation). Habitat includes dry edges of moist ecotones adjacent to moist meadows, lakes, stream courses, and riverbanks. The closest known sighting is on the Sisters Ranger District.

Allium campanulatum, Sierra onion (Documented; ORNHP List 4; TNC Rank G4S3)

> Found in exposed and sparsely vegetated forest openings, open forest, balds, ridges, rock outcrops, slopes, and benches (4800'-8000' elevation). It tends to occur in moist soil which dries out as the season progresses and is usually in open areas. It is rarely found on shady slopes in conifer forest at higher elevations. Soils are generally shallow gravel, gravelly loams, or more rarely, sandy loams. The closest known sighting is on the Sisters Ranger District.

Arnica viscosa, Shasta arnica (Documented; ORNHP List 2; TNC Rank G4S2)

> Found in non-forest and openings in subalpine mixed conifer forest on exposed and sparsely vegetated rocky sites, relatively steep scree, and talus slopes near or above timberline (6500'-9200' elevation). The closest known sighting is on the Bend Ranger District.

Artemisia ludoviciana ssp. *estesii*, Este's artemisia (Documented; Federal Species of Concern; ORNHP List 1; TNC Rank G5T2S2)

> Found in non-forested areas within river floodplains occurring amidst sparse vegetation in sandy pockets among rocks and river gravel (2000'-5200' elevation). Associates may include willows. Nearest known sighting to Crescent Ranger District is on private lan ' on the Little Deschutes River southwest of LaPine.

Aster gormanii, Gorman's aster (Suspected; Federal Species of Concern; ORNHP List 1; TNC Rank G3S3)

> Found in non-forest and forest openings in subalpine and alpine areas btween 3800' and 6200' elevation. Often found on dry SW,S,SE,ESE,E exposures, open rocky slopes, rocky outcrops or ridges, steep rocky washes or fine gravelly andesitic scree. The closest known sighting is in the Mt. Jefferson Wilderness, on the Willamette National Forest.

Astragalus peckii, Peck's milk-vetch (Documented; Federal Species of Concern; State Threatened; ORNHP List 1; TNC Rank G3S3)

Found in non-forest openings, forest openings, and open forest in juniper woodlands and lodgepole pine occurring between 3000' and 5000' elevation. It is associated with dry sites with loose, deep pumice, loamy sand, or sand soils on flat to very gentle slopes. Often found in or along dry watercourses, old lakebeds, barren flats, and other natural openings.

Botrychium pumicola, Pumice grape-fern (Documented; Federal Species of Concern; State Threatened; ORNHP List 1; TNC Rank G3S3)

Found in seasonally moist to dry, harsh microclimate areas (4500'-9000' elevation). In alpine areas, found on fine to coarse pumice gravel, raw pale yellow pumice (sometimes red pumice) on open wind-swept pumice fields and treeless ridges to gently rolling, convex slopes. May occur in openings of alpine and subapline communities usually surrounded by *Pinus albicaulis* (Whitebark pine).

In montane areas, found in lodgepole pine basins containing frost pockets, pumice flat openings, or open lodgepole forest. Soils include fine to coarse pumice with coarse pumice sand rooting zone. Light needle litter rare. Sparsely vegetated sites, generally free of any recent soil disturbance. Soil surface very flat and even. Plants are most often located at edge of the frost pocket where the microclimate may be somewhat modified by the forest canopy and increased bitterbrush cover.

Calamagrostis breweri, Brewer's reedgrass (Suspected; ORNHP List 2; TNC Rank G4S2)

Found in non-forest, moist-to-dry subalpine and alpine meadows, open slopes, lake margins, and streambanks (4600'-6000' elevation).

Calochortus longebarbatus ssp. *longebarbatus*, Long-bearded mariposa lily (Suspected; Federal Species of Concern; ORNHP List 1; TNC Rank G3T3S3)

Found in vernally moist grassy meadows, openings, and forest edges of ponerosa pine, lodgepole pine, and juniper woodlands (1800'-3600'). Also found occasionally along seasonal streams.

Campanula scabrella, Rough harebell (Suspected; State Considered but rejected - not documented in Oregon)

Found on talus slopes, moraines, limestone cliffs, or other rocky places above timberline on high Cascade peaks (7000'-9000' elevation).

Carex livida, Pale sedge (Suspected; ORNHP List 2; TNC Rank G5S2)

Restricted to sites where water tables are above ground level for the majority of the growing season (2000' -8000' elevation). It occurs primarily in peatlands, growing in wet depressions of the peat surface.

Castilleja chlorotica, Green-tinged paintbrush (Documented; Federal Species of Concern; ORNHP List 1; TNC Rank G3S3)

Found in open areas and forested openings in ponderosa pine, lodgepole pine, and mixed conifer zones (4300'-8200' elevation). Soils vary from sandy soils over basalt, sandy loam with pumice,to shallow sands with coarse fragments. Characteristics common to most sites are openings with very poor to moderately productive soils. Most

openings are dominated by sage brush, but bitterbrush is a shrub associated on the Deschutes National Forest.

Cymopterus nivalis (= *C bipinnatus*), Hayden's cymopterus (Suspected; ORNHP List 2; TNC Rank G5S2)

Found in non-forested scablands and other open, often rocky ridges and talus slopes, from foothills to above timberline (4900'-9500' elevation). Also known from volcanic gravels in *Artemesia tridentata / Bromus tectorum* type.

Gentiana newberryi, Newberry's gentian (Documented; ORNHP List 2; TNC Rank G4S2)

Associated with forest openings and meadows that are wet to dry in the alpine, subalpine, and montane mixed conifer zones (4800'-8700'). It is sometimes found adjacent to springs, streams, or lakes and is commonly associated with *Deschampsia cespitosa*, tufted hairgrass.

Hieracium bolanderi, Bolander's hawkweed (Documented; ORNHP List 2; TNC Rank G4S2)

Found in mixed conifer and non-forested areas in open, exposed sites (sometimes in filtered light) from montane foothills to alpine reaches of the southern Cascades (1100'-8700' elevation). Habitats include: unstable substrates including serpentine soils, rock crevices, rocky ridgetops and slopes, and road cuts; dry,well-drained sites in the 40-80" precipitation zone. Closest known sighting is in the Diamond Peak Wilderness.

Lobelia dortmanna, Water lobelia (Documented; ORNHP List 2; TNC Rank G4S1)

Found in shallow water at the margins of lakes, ponds, and rivers or in standing water of bogs and wet meadows (2700' elevation). The closest known sighting is on the Sisters Ranger District.

Lycopodiella inundata, bog clubmoss (Documented; ORNHP List 2; TNC Rank G5S2)

Terrestrial in bogs, on shores of ponds, streambanks, and in meadows, in peaty, sandy, or occasionally clayey, highly acid soils that sometimes are periodically inundated. The closest known sighting is on Crescent Ranger District.

Lycopodium complanatum, Ground cedar (Suspected; ORNHP List 2; TNC Rank G5S2)

Found along the margins of streams, lakes, ponds, wet meadows, bogs, and fens in mixed conifer; generally in the ecotone where shrubs and coniferous trees meet. Its microhabitat is moist to wet (may be found next to springs) with an overstory canopy closure of about 50% or greater; most often with *Sphagnum sp.* at 3000'-6000' elevation. The closest known sighting is on the Mount Hood National Forest.

Mimulus jepsonii, Jepson's monkey-flower (Documented; ORNHP List 2; TNC Rank G4S3)

Found in dry, open forest or forest openings, with bare or light pine needle litter, on sand, loamy sand, or sandy loam soils on flat to 5% slopes (4400' - 7300' elevation). Most common at the base of steeper slopes or buttes where colluvial materials have been deposited and where seasonal moisture may be available for seed germination.

Many populations observed adjacent to log catchments on gentle slopes. It is an early seral species that may occur along trails, roads, burn bays, and skid trails.

Ophioglossum pusillum, Adder's-tongue (Suspected; ORNHP List 2; TNC Rank G5S1)

This plant is associated with perennial aquatic systems, moist to wet meadows among low shrubs, sedges and grape ferns; highly scattered plants (5'-5500'). Nearest known sightning is on the Willamette National Forest.

Penstemon peckii, Peck's penstemon (Documented; Federal Species of Concern; ORNHP List 1; TNC Rank G3S3)

Associated with openings and open forest (2600'-4400' elevation). Recovering fluvial surfaces (streambanks, overflow channels, inactive floodplains), seeps, springs, vernal ponds (drying edges), draws, rills, ditches, skid trails, dry or intermittent stream channels, and moist to wet meadows. Dry to seasonally moist or subirrigated sandy loam, loamy sand, or pumicious loamy sand soils. Litter generally absent or light; but plants can be found in heavy pine needle litter.

HABITAT DESCRIPTIONS FOR NOXIOUS WEEDS OF BIG MARSH

The noxious weeds that are known to occur in the Big Marsh Watershed are:

Diffuse and spotted knapweeds -- *Centaurea diffusa* and *C. maculosa* -- Knapweeds were introduced from Eurasia in the early 1900s, perhaps in alfalfa seeds. They establish readily in disturbed soil and spread into and reduce desirable native plant communities. Knapweeds are highly successful competitors for soil moisture and nutrients. They also release chemical substances which inhibit the growth of surrounding vegetation.

Canada thistle -- *Cirsium arvense* -- Canadian thistle was introduced from Eurasia into the United States and southern Canada, where it invades fields, pastures, and various waste places. This aggressive perennial weed spreads from deep, extensive rhizomes to form dense persistent populations. It is difficult to eradicate by mechanical or physical methods.

Bull thistle -- *Cirsium vulgare* -- This native of Eurasia has established itself throughout North America. Bull thistle is a biennial with a short, fleshy taproot that reproduces by seeds that ride the wind beneath a parachute-like pappus, finding their way to waste areas, roadsides, fields, and pastures where it is highly competitive with native vegetation. On the Crescent Ranger District, bull thistle occurs mostly along roadsides and in clearcuts.

Scot's or Scotch broom -- *Cytisus scoparius* -- Scot's broom was introduced into Oregon and California as an ornamental in the last century, and since then has spread north into Canada. This extremely aggressive weed invades non-wooded areas throughout its range. The seeds remain viable in the soil seed bank for up to 50 years. It is a widespread pest, especially west of the Cascade crest to the coast.

St. Johnswort -- *Hypericum perforatum* -- St. Johnswort was imported from Europe and now ranges over much of North America. It is one of the most aggressive and noxious weeds in the northwest. St. Johnswort is most conspicuous along roadsides, but regularly invades prairies, meadows, and pastures where it successfully competes with more desirable native plants.

Dyer's woad -- *Isatis tinctoria* -- Dyer's woad is a European import originally cultivated for a blue dye in its leaves. It is a winter annual, biennial, or short-lived perennial with a thick taproot which may exceed five feet in length. It threatens native plant communities.

Dalmatian and common toadflax -- *Linaria dalmatica* and *Linaria vulgaris* -- Both species of toadflax were introduced from Europe as ornamentals. They invade along roadsides and in waste places. Both of these toadflax species have extensive, deep root systems that make control difficult.

Reed canarygrass -- *Phalaris arundinacea* -- Reed canarygrass is an introduced (probably from Eurasia) perennial that is common on disturbed sites along muddy shores and in shallow waters of ponds, lakes, sloughs, ditches, and streams. It is an aggressive cultivar that was introduced for wetland forage and erosion control. It aggressively outcompetes other more desirable native plant species in wetlands and is difficult to eradicate. It provides food, cover, and nesting habitat for waterfowl, marsh birds, and small animals, however, so do the native plants that it displaces. It is rated as good early forage for cattle, horses, sheep, and big game.

Other non-native species of concern in Big Marsh are meadow foxtail (*Alopecurus pratensis*), Kentucky bluegrass (*Poa pratensis*), and white clover (*Trifolium repens*). These species dominate much of the area in the mesic meadows and moist lodgepole pine communities and have dramatically altered these areas. Common timothy (*Phleum pratense*), creeping bentgrass (*Agrostis stolonifera*), fowl bluegrass (*Poa palustris*), birds-foot trefoil (*Lotus corniculatus*), sticky chickweed (*Cerastium viscosum*), sheep sorrel (*Rumex acetosella*), dandelion (*Taraxacum officinale*), and common vetch (*Vicia sativa*) are common but not dominant.

LICHENS OF BIG MARSH WATERSHED ANALYSIS AREA

(incomplete list)

Scientific Name	Common Name
Alectoria imshaugi	Imshaug's witch's hair lichen
Alectoria sarmentosa	witch's hair lichen
Bryoria abbreviata	abbreviated horsehair lichen
Bryoria fremontii	Fremont's horsehair lichen
Bryoria fuscescens	horsehair lichen
Bryoria pseudofuscescens	horsehair lichen
Cetraria canadensis	Canadian tuckermannopsis lichen
Cetraria merrillii	Merrill's tuckermannopsis lichen
Hypocenomyce scalaris	cockleshell lichen
Hypogymnia imshaugii	Imshaug's tube lichen
Hypogymnia tubulosa	tube lichen
Letharia columbiana	wolf lichen
Letharia vulpina	wolf lichen
Parmeliopsis ambigua	ambiguous bran lichen
Parmeliopsis hyperopta	bran lichen

RARE, THREATENED or SENSITIVE BRYOPHYTES

WITH POTENTIAL HABITAT in the BIG MARSH WATERSHED ANALYSIS AREA

LIVERWORTS

Species	Common name	Status
Anastrophyllum minutum	Little darkstar	ONHP List 3
Calypogeja sphagnicola	Bog pouchwort	ONHP List 2
Cephaloziella spinigera	Toothed tinythread	ONHP List 3
Haplomitrium hookeri	Ancestorwort	ONHP List 3
Harpanthus flotovianus	Brown fenwort	ONHP List 3
Jamesoniella autumnalis	Waldo Lake liverwort	ONHP List 3
*var. _heterostipa_*		
Lophozia laxa	Bog palewort	ONHP List 2
Marsupella emarginata	Stream ladderwort	ROD Table C-3
*var. _aquatica_*		ONHP List 3
Nardia japonica	Pacific spikewort	ONHP List 3
Preissia quadrata	Blister ribbon	ONHP List 3
Scapania obscura	Scorched spadewort	ONHP List 3
Schofieldia monticola	Alpine masterwort	ONHP List 3
Tritomaria exsectiformis	Forest brownwort	ONHP List 2
		ROD Table C-3

MOSSES

Andreaea schofieldiana	Broad-leaved lantern moss	ONHP List 2
Antitrichia curtipendula	Hanging moss	ROD Table C-3
Bartramiopsis lescurii	False apple moss	ROD Table C-3
Bruchia bolanderi	Bolander's candle moss	ONHP List 3
Buxbaumia piperi	Piper's bug moss	SAT and FEMAT Lists
Buxbaumia viridis	Green bug moss	SAT and FEMAT Lists
Calliergon trifarium	Blunt water moss	ONHP List 2
Conostomum tetragonum	Ribbed mountain moss	ONHP List 3
*Encalypta_ _brevicola_*	Crum's extinguisher moss	ROD Table C-3
var. _crumiana		ONHP List 1
Encalypta brevipes	Stubby extiguisher moss	ONHP List 2
Funaria muhlenbergii	Western pinwheel moss	ONHP List 2
Helodium blandowii	Blandow's feather moss	ONHP List 2
Pohlia sphaginicola	Sparse hummock moss	ONHP List 2
Polytrichum sphaerothecium	Dwarf rock haircap	ONHP List 3
Polytrichum strictum	Hummock haircap	ONHP List 2
Racomitrium aquaticum	Awnless wet wavy-cell moss	ROD Table C-3
Racomitrium acificum	Awnless smooth dry wavy-cell	ONHP List 2
Rhizomnium nudum	Naked round moss	SAT and FEMAT Lists
Rhytidium rugosum	Crumpled-leaf moss	ONHP List 3
Schistostega pennata	Luminous moss	SAT and FEMAT Lists
Scouleria marginata	Margined black knotmoss	ROD Table C-3
Splachnum ampullaceum	Purple-vased stink moss	ONHP List 2
Tayloria serrata	Broad leaved stink moss	ONHP List 2
Tetraphis geniculata	Bent-kneed four-tooth moss	ROD Table C-3
Tetraplodon mnioides	Black-fruited stink moss	ONHP List 2
Trematodon boasii	Boas' long-necked moss	ONHP List 3

Ulota megalospora	Giant-spored tree moss	SAT and FEMAT Lists

HABITAT DESCRIPTIONS FOR SENSITIVE PLANT SPECIES

Habitat descriptions for all PETS plant species known or suspected to occur on the Crescent Ranger District, Deschutes National Forest. All species are on the Regional Forester's Sensitive Species List (FSM 2670.44, Region Six Directive No. 90-1, March 11, 1991).

Agoseris elata, Tall agoseris (Documented; ORNHP List 2; TNC Rank G4S2)

> Found in non-forest areas and openings in ponderosa pine and rarely lodgepole pine (3000'-4800' elevation). Habitat includes dry edges of moist ecotones adjacent to moist meadows, lakes, stream courses, and riverbanks. The closest known sighting is on the Sisters Ranger District.

Allium campanulatum, Sierra onion (Documented; ORNHP List 4; TNC Rank G4S3)

> Found in exposed and sparsely vegetated forest openings, open forest, balds, ridges, rock outcrops, slopes, and benches (4800'-8000' elevation). It tends to occur in moist soil which dries out as the season progresses and is usually in open areas. It is rarely found on shady slopes in conifer forest at higher elevations. Soils are generally shallow gravel, gravelly loams, or more rarely, sandy loams. The closest known sighting is on the Sisters Ranger District.

Arnica viscosa, Shasta arnica (Documented; ORNHP List 2; TNC Rank G4S2)

> Found in non-forest and openings in subalpine mixed conifer forest on exposed and sparsely vegetated rocky sites, relatively steep scree, and talus slopes near or above timberline (6500'-9200' elevation). The closest known sighting is on the Bend Ranger District.

Artemisia ludoviciana ssp. *estesii*, Este's artemisia (Documented; Federal Species of Concern; ORNHP List 1; TNC Rank G5T2S2)

> Found in non-forested areas within river floodplains occurring amidst sparse vegetation in sandy pockets among rocks and river gravel (2000'-5200' elevation). Associates may include willows. Nearest known sighting to Crescent Ranger District is on private land on the Little Deschutes River southwest of LaPine.

Aster gormanii, Gorman's aster (Suspected; Federal Species of Concern; ORNHP List 1; TNC Rank G3S3)

> Found in non-forest and forest openings in subalpine and alpine areas btween 3800' and 6200' elevation. Often found on dry SW,S,SE,ESE,E exposures, open rocky slopes, rocky outcrops or ridges, steep rocky washes or fine gravelly andesitic scree. The closest known sighting is in the Mt. Jefferson Wilderness, on the Willamette National Forest.

Astragalus peckii, Peck's milk-vetch (Documented; Federal Species of Concern; State Threatened; ORNHP List 1; TNC Rank G3S3)

> Found in non-forest openings, forest openings, and open forest in juniper woodlands and lodgepole pine occurring between 3000' and 5000' elevation. It is associated with dry sites with loose, deep pumice, loamy sand, or sand soils on flat to very gentle slopes.

Often found in or along dry watercourses, old lakebeds, barren flats, and other natural openings.

Botrychium pumicola, Pumice grape-fern (Documented; Federal Species of Concern; State Threatened; ORNHP List 1; TNC Rank G3S3)

Found in seasonally moist to dry, harsh microclimate areas (4500'-9000' elevation). In alpine areas, found on fine to coarse pumice gravel, raw pale yellow pumice (sometimes red pumice) on open wind-swept pumice fields and treeless ridges to gently rolling, convex slopes. May occur in openings of alpine and subapline communities usually surrounded by *Pinus albicaulis* (Whitebark pine).

In montane areas, found in lodgepole pine basins containing frost pockets, pumice flat openings, or open lodgepole forest. Soils include fine to coarse pumice with coarse pumice sand rooting zone. Light needle litter rare. Sparsely vegetated sites, generally free of any recent soil disturbance. Soil surface very flat and even. Plants are most often located at edge of the frost pocket where the microclimate may be somewhat modified by the forest canopy and increased bitterbrush cover.

Calamagrostis breweri, Brewer's reedgrass (Suspected; ORNHP List 2; TNC Rank G4S2)

Found in non-forest, moist-to-dry subalpine and alpine meadows, open slopes, lake margins, and streambanks (4600'-6000' elevation).

Calochortus longebarbatus ssp. *longebarbatus*, Long-bearded mariposa lily (Suspected; Federal Species of Concern; ORNHP List 1; TNC Rank G3T3S3)

Found in vernally moist grassy meadows, openings, and forest edges of ponerosa pine, lodgepole pine, and juniper woodlands (1800'-3600'). Also found occasionally along seasonal streams.

Campanula scabrella, Rough harebell (Suspected; State Considered but rejected - not documented in Oregon)

Found on talus slopes, moraines, limestone cliffs, or other rocky places above timberline on high Cascade peaks (7000'-9000' elevation).

Carex livida, Pale sedge (Suspected; ORNHP List 2; TNC Rank G5S2)

Restricted to sites where water tables are above ground level for the majority of the growing season (2000' -8000' elevation). It occurs primarily in peatlands, growing in wet depressions of the peat surface.

Castilleja chlorotica, Green-tinged paintbrush (Documented; Federal Species of Concern; ORNHP List 1; TNC Rank G3S3)

Found in open areas and forested openings in ponderosa pine, lodgepole pine, and mixed conifer zones (4300'-8200' elevation). Soils vary from sandy soils over basalt, sandy loam with pumice,to shallow sands with coarse fragments. Characteristics common to most sites are openings with very poor to moderately productive soils. Most openings are dominated by sage brush, but bitterbrush is a shrub associated on the Deschutes National Forest.

Cymopterus nivalis (= *C bipinnatus*), Hayden's cymopterus (Suspected; ORNHP List 2; TNC Rank G5S2)

Found in non-forested scablands and other open, often rocky ridges and talus slopes, from foothills to above timberline (4900'-9500' elevation). Also known from volcanic gravels in *Artemesia tridentata / Bromus tectorum* type.

Gentiana newberryi, Newberry's gentian (Documented; ORNHP List 2; TNC Rank G4S2)

Associated with forest openings and meadows that are wet to dry in the alpine, subalpine, and montane mixed conifer zones (4800'-8700'). It is sometimes found adjacent to springs, streams, or lakes and is commonly associated with *Deschampsia cespitosa*, tufted hairgrass.

Hieracium bolanderi, Bolander's hawkweed (Documented; ORNHP List 2; TNC Rank G4S2)

Found in mixed conifer and non-forested areas in open, exposed sites (sometimes in filtered light) from montane foothills to alpine reaches of the southern Cascades (1100'-8700' elevation). Habitats include: unstable substrates including serpentine soils, rock crevices, rocky ridgetops and slopes, and road cuts; dry,well-drained sites in the 40-80" precipitation zone. Closest known sighting is in the Diamond Peak Wilderness.

Lobelia dortmanna, Water lobelia (Documented; ORNHP List 2; TNC Rank G4S1)

Found in shallow water at the margins of lakes, ponds, and rivers or in standing water of bogs and wet meadows (2700' elevation). The closest known sighting is on the Sisters Ranger District.

Lycopodiella inundata, bog clubmoss (Documented; ORNHP List 2; TNC Rank G5S2)

Terrestrial in bogs, on shores of ponds, streambanks, and in meadows, in peaty, sandy, or occasionally clayey, highly acid soils that sometimes are periodically inundated. The closest known sighting is on Crescent Ranger District.

Lycopodium complanatum, Ground cedar (Suspected; ORNHP List 2; TNC Rank G5S2)

Found along the margins of streams, lakes, ponds, wet meadows, bogs, and fens in mixed conifer; generally in the ecotone where shrubs and coniferous trees meet. Its microhabitat is moist to wet (may be found next to springs) with an overstory canopy closure of about 50% or greater; most often with *Sphagnum sp.* at 3000'-6000' elevation. The closest known sighting is on the Mount Hood National Forest.

Mimulus jepsonii, Jepson's monkey-flower (Documented; ORNHP List 2; TNC Rank G4S3)

Found in dry, open forest or forest openings, with bare or light pine needle litter, on sand, loamy sand, or sandy loam soils on flat to 5% slopes (4400' - 7300' elevation). Most common at the base of steeper slopes or buttes where colluvial materials have been deposited and where seasonal moisture may be available for seed germination. Many populations observed adjacent to log catchments on gentle slopes. It is an early seral species that may occur along trails, roads, burn bays, and skid trails.

Ophioglossum pusillum, Adder's-tongue (Suspected; ORNHP List 2; TNC Rank G5S1)

This plant is associated with perennial aquatic systems, moist to wet meadows among low shrubs, sedges and grape ferns; highly scattered plants (5'-5500'). Nearest known sightning is on the Willamette National Forest.

Penstemon peckii, Peck's penstemon (Documented; Federal Species of Concern; ORNHP List 1; TNC Rank G3S3)

Associated with openings and open forest (2600'-4400' elevation). Recovering fluvial surfaces (streambanks, overflow channels, inactive floodplains), seeps, springs, vernal ponds (drying edges), draws, rills, ditches, skid trails, dry or intermittent stream channels, and moist to wet meadows. Dry to seasonally moist or subirrigated sandy loam, loamy sand, or pumicious loamy sand soils. Litter generally absent or light; but plants can be found in heavy pine needle litter.

LICHENS OF BIG MARSH WATERSHED ANALYSIS AREA

(incomplete list)

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Bryoria fremontii	Fremont's horsehair lichen
Bryoria fuscescens	horsehair lichen
Bryoria pseudofuscescens	horsehair lichen
Cetraria canadensis	Canadian tuckermannopsis lichen
Cetraria merrillii Merrill's	tuckermannopsis lichen
Hypocenomyce scalaris	cockleshell lichen
Hypogymnia imshaugii	Imshaug's tube lichen
Hypogymnia tubulosa	tube lichen
Letharia columbiana	wolf lichen
Letharia vulpina	wolf lichen
Parmeliopsis ambigua	ambiguous bran lichen
Parmeliopsis hyperopta	bran lichen

RARE, THREATENED or SENSITIVE BRYOPHYTES WITH POTENTIAL HABITAT in the BIG MARSH WATERSHED ANALYSIS AREA

LIVERWORTS

Species	Common name	Status
Anastrophyllum minutum	Little darkstar	ONHP List 3
Calypogeja sphagnicola	Bog pouchwort	ONHP List 2

Cephaloziella spinigera	Toothed tinythread	ONHP List 3
Haplomitrium hookeri	Ancestorwort	ONHP List 3
Harpanthus flotovianus	Brown fenwort	ONHP List 3
*Jamesoniella autumnalis var. _heterostipa_*	Waldo Lake liverwort	ONHP List 3
Lophozia laxa	Bog palewort	ONHP List 2
*Marsupella emarginata var. _aquatica_*	Stream ladderwort	ROD Table C-3 ONHP List 3
Nardia japonica	Pacific spikewort	ONHP List 3
Preissia quadrata	Blister ribbon	ONHP List 3
Scapania obscura	Scorched spadewort	ONHP List 3
Schofieldia monticola	Alpine masterwort	ONHP List 3
Tritomaria exsectiformis	Forest brownwort	ONHP List 2 ROD Table C-3

MOSSES

Andreaea schofieldiana	Broad-leaved lantern moss	ONHP List 2
Antitrichia curtipendula	Hanging moss	ROD Table C-3
Bartramiopsis lescurii	False apple moss	ROD Table C-3
Bruchia bolanderi	Bolander's candle moss	ONHP List 3
Buxbaumia piperi	Piper's bug moss	SAT and FEMAT Lists
Buxbaumia viridis	Green bug moss	SAT and FEMAT Lists
Calliergon trifarium	Blunt water moss	ONHP List 2
Conostomum tetragonum	Ribbed mountain moss	ONHP List 3
Encalypta_ _brevicola_ var. _crumiana	Crum's extinguisher moss	ROD Table C-3 ONHP List 1
Encalypta brevipes	Stubby extiguisher moss	ONHP List 2
Funaria muhlenbergii	Western pinwheel moss	ONHP List 2
Helodium blandowii	Blandow's feather moss	ONHP List 2
Pohlia sphaginicola	Sparse hummock moss	ONHP List 2
Polytrichum sphaerothecium	Dwarf rock haircap	ONHP List 3
Polytrichum strictum	Hummock haircap	ONHP List 2
Racomitrium aquaticum	Awnless wet wavy-cell moss	ROD Table C-3
Racomitrium acificum	Awnless smooth dry wavy-cell	ONHP List 2
Rhizomnium nudum	Naked round moss	SAT and FEMAT Lists
Rhytidium rugosum	Crumpled-leaf moss	ONHP List 3
Schistostega pennata	Luminous moss	SAT and FEMAT Lists
Scouleria marginata	Margined black knotmoss	ROD Table C-3
Splachnum ampullaceum	Purple-vased stink moss	ONHP List 2
Tayloria serrata	Broad leaved stink moss	ONHP List 2
Tetraphis geniculata	Bent-kneed four-tooth moss	ROD Table C-3
Tetraplodon mnioides	Black-fruited stink moss	ONHP List 2
Trematodon boasii	Boas' long-necked moss	ONHP List 3
Ulota megalospora	Giant-spored tree moss	SAT and FEMAT Lists

Big Marsh Watershed Species List
Known or Suspected

Species Common Name	Scientific Name

American bittern	*Botaurus lentiginosus*
American coot	*Fulica americana*
American crow	*Corvus brachyrhynchos*
American dipper	*Cinclus mexicanus*
American kestrel	*Falco sparverius*
American pipit (water)	*Anthus spinoletta*
American robin	*Turdus migratorius*
American white pelican	*Pelecanus erythrorhynchos*
American wigeon	*Anas americana*
Anna's hummingbird	*Calypte anna*
Arctic loon (Pacific)	*Gavia pacifica*
Ash-throated flycatcher	*Myiarchus cinerascens*
Badger	*Taxidea taxus*
Bald eagle	*Haliaeetus leucocephalus*
Bank swallow	*Riparia riparia*
Barn owl	*Tyto alba*
Barn swallow	*Hirundo rustica*
Barred owl	*Strix varia*
Barrow's goldeneye	*Bucephala islandica*
Beaver	*Castor canadensis*
Belted kingfisher	*Ceryle alcyon*
Big brown bat	*Eptesicus fuscus*
Black bear	*Ursus americanus*
Black rosy finch	*Leucosticte arctoa• • (atrata)*
Black tern	*Chlidonias niger*
Black-backed woodpecker	*Picoides arcticus*
Black-chinned hummingbird	*Archilochus alexandri*
Black-crowned night-heron	*Nycticorax nycticorax*
Black-headed grosbeak	*Pheucticus melanocephalus*
Black-necked stilt	*Himantopus mexicanus*
Black-throated gray warbler	*Dendroica nigrescens*
Blue grouse	*Dendragapus obscurus*
Blue-winged teal	*Anas discors*
Bobcat	*Felis rufus*
Bonaparte's gull	*Larus philadelphia*
Boreal owl	*Aegolius funereus*
Brewer's blackbird	*Euphagus cyanocephalus*
Broad-footed mole	*Scapanus latimanus*
Brown creeper	*Certhia americana*
Brown-headed cowbird	*Molothrus ater*
Bufflehead	*Bucephala albeola*
Bushtit	*Psaltriparus minimus*
Bushy-tailed woodrat	*Neotoma cinerea*
California gull	*Larus californicus*
California myotis	*Myotis californicus*
Calliope hummingbird	*Stellula calliope*
Canada goose	*Branta canadensis*
Canvasback	*Aythya valisineria*
Cascades frog	*Rana cascadae*
Caspian tern	*Sterna caspia*
Cassin's finch	*Carpodacus cassinii*
Chipping sparrow	*Spizella passerina*
Cinnamon teal	*Anas cyanoptera*
Clark's nutcracker	*Nucifraga columbiana*

Coast mole	*Scapanus orarius*
Common garter snake	*Thamnophis sirtalis*
Common goldeneye	*Bucephala clangula*
Common loon	*Gavia immer*
Common merganser	*Mergus merganser*
Common nighthawk	*Chordeiles minor*
Common poorwill	*Phalaenoptilus nuttallii*
Common raven	*Corvus corax*
Common snipe	*Gallinago gallinago*
Common yellowthroat	*Geothlypis trichas*
Cooper's hawk	*Accipiter cooperii*
Coyote	*Canis latrans*
Dark-eyed junco	*Junco hyemalis*
Deer mouse	*Peromyscus maniculatus*
Double-crested cormorant	*Phalacrocorax auritus*
Douglas' squirrel	*Tamiasciurus douglasii*
Downy woodpecker	*Picoides pubescens*
Dunlin	*Calidris alpina*
Dusky flycatcher	*Empidonax oberholseri*
Eared grebe	*Podiceps nigricollis*
Elk	*Cervus elaphus*
Ermine	*Mustela erminea*
Eurasian widgeon	*Anas penelope*
European starling	*Sturnus vulgaris*
Evening grosbeak	*Coccothraustes vespertinus*
Ferruginous hawk	*Buteo regalis*
Fisher	*Martes pennanti*
Flammulated owl	*Otus flammeolus*
Forster's tern	*Sterna forsteri*
Fox sparrow	*Passerella iliaca*
Franklin's gull	*Larus pipixcan*
Gadwall	*Anas strepera*
Golden eagle	*Aquila chrysaetos*
Golden-crowned kinglet	*Regulus satrapa*
Golden-crowned sparrow	*Zonotrichia atricapilla*
Golden-mantled ground squirrel	*Spermophilus lateralis*
Gopher snake	*Pituophis catenifer*
Gray jay	*Perisoreus canadensis*
Great blue heron	*Ardea herodias*
Great egret	*Casmerodius albus*
Great gray owl	*Strix nebulosa*
Great horned owl	*Bubo virginianus*
Greater scaup	*Aythya marila*
Greater white-fronted goose	*Anwer albifrons*
Greater yellowlegs	*Tringa melanoleuca*
Green-backed heron	*Butorides striatus*
Green-winged teal	*Anas crecca*
Hairy woodpecker	*Picoides villosus*
Hammond's flycatcher	*Empidonax hammondii*
Harlequin duck	*Histrionicus histrionicus*
Heather vole	*Phenacomys intermedius*
Hermit thrush	*Catharus guttatus*
Hermit warbler	*Dendroica occidentalis*
Herring gull	*Larus argentatus*

Hoary bat	*Lasiurus cinereus*
Hooded merganser	*Lophodytes cucullatus*
Horned grebe	*Podiceps auritus*
Horned lark	*Eremophila alpestris*
House finch	*Carpodacus mexicanus*
House mouse	*Mus musculus*
House sparrow	*Passer domesticus*
House wren	*Troglodytes aedon*
Killdeer	*Charadrius vociferus*
Lapland longspur	*Calcarius lapponicus*
Lark sparrow	*Chondestes grammacus*
Least bittern	*Ixobrychus exilis*
Least sandpiper	*Calidris minutilla*
Lesser scaup	*Aythya affinis*
Lewis's woodpecker	*Melanerpes lewis*
Little brown myotis	*Myotis lucifugus*
Long-billed curlew	*Numenius americanus*
Long-billed dowitcher	*Limnodromus scolopaceus*
Long-eared myotis	*Myotis evotis*
Long-eared owl	*Asio otus*
Long-legged myotis	*Myotis volans*
Long-tailed vole	*Microtus Longicaudus*
Long-tailed weasel	*Mustela frenata*
Long-toed salamander	*Ambystoma macrodactylum*
MacGillivray's warbler	*Oporornis tolmiei*
Mallard	*Anas platyrhynchos*
Marbled godwit	*Limosa fedoa*
Marsh wren	*Cistothorus palustris*
Marten	*Martes americana*
Merlin	*Falco columbarius*
Mink	*Mustela vison*
Montane vole	*Microtus montanus*
Mountain bluebird	*Sialia currucoides*
Mountain chickadee	*Parus gambeli*
Mountain lion	*Felis concolor*
Mountain quail	*Oreortyx pictus*
Mourning dove	*Zenaida macroura*
Mule deer	*Odocoileus hemionus*
Muskrat	*Ondatra zibethicus*
Mute swan	*Cygnus olor*
Nashville warbler	*Vermivora ruficapilla*
Northern alligator lizard	*Elgaria coerulea*
Northern flicker	*Colaptes auratus*
Northern flying squirrel	*Glaucomys sabrinus*
Northern goshawk	*Accipiter gentilis*
Northern harrier	*Circus cyaneus*
Northern oriole	*Icterus galbula*
Northern pintail	*Anas acuta*
Northern pocket gopher	*Thomomys talpoides*
Northern pygmy-owl	*Glaucidium gnoma*
Northern saw-whet owl	*Aegolius acadicus*
Northern shoveler	*Anas Clypeata*
Northwestern salamander	*Ambystoma gracile*
Norway rat	*Rattus Norvegicus*

Olive-sided flycatcher	*Contopus borealis*
Osprey	*Pandion haliaetus*
Pacific treefrog (chorus)	*Pseudacris regilla*
Peregrine falcon	*Falco peregrinus*
Pied-billed grebe	*Podilymbus podiceps*
Pika	*Ochotona princeps*
Pileated woodpecker	*Dryocopus pileatus*
Pine siskin	*Carduelis pinus*
Porcupine	*Erethizon dorsatum*
Prairie falcon	*Falco mexicanus*
Preble's shrew	*Sorex preblei*
Purple finch	*Carpodacus purpureus*
Purple martin	*Progne subis*
Pygmy nuthatch	*Sitta pygmaea*
Raccoon	*Procyon lotor*
Red crossbill	*Loxia curvirostra*
Red fox	*Vulpes vulpes*
Red-breasted merganser	*Mergus serrator*
Red-breasted nuthatch	*Sitta canadensis*
Red-breasted sapsucker	*Sphyrapicus ruber*
Red-eyed vireo	*Vireo olivaceus*
Red-necked grebe	*Podiceps grisegena*
Red-necked phalarope	*Phalaropus lobatus*
Red-tailed hawk	*Bureo jamaicensis*
Red-winged blackbird	*Agelaius phoeniceus*
Redhead	*Aythya americana*
Ring-billed gull	*Larus delawarensis*
Ring-necked duck	*Aythya collaris*
River otter	*Lutra canadensis*
Rock wren	*Salpinctes obsoletus*
Ross' goose	*Chen rossii*
Rough-legged hawk	*Butreo lagopus*
Rough-skinned newt	*Taricha granulosa*
Rubber boa	*Charina bottae*
Ruby-crowned kinglet	*Regulus calendula*
Ruddy duck	*Oxyura jamaicensis*
Ruffed grouse	*Bonasa umbellus*
Rufous hummingbird	*Selasphorus rufus*
Rufous-sided towhee	*Pipilo erythrophthalmus*
Sandhill crane	*Grus canadensis*
Semipalmated plover	*Charadrius semipalmatus*
Sharp-shinned hawk	*Accipiter striatus*
Shrew-mole	*Neurotrichus gibbsii*
Silver-haired bat	*Lasionycteris noctivagans*
Snow goose	*Chen caerulescens*
Snowshoe hare	*Lepus americanus*
Snowy egret	*Egretta thula*
Solitary vireo	*Vireo solitarius*
Song sparrow	*Melospiza melodia*
Sora	*Porzana carolina*
Spotted frog	*Rana pretiosa*
Spotted owl (northern)	*Strix occidentalis*
Spotted sandpiper	*Actitis macularia*
Steller's jay	*Cyanocitta stelleri*

Swainson's hawk	*Buteo swainsoli*
Swainson's thrush	*Catharus ustulatus*
ŠTailed frog	*Ascaphus truei*
Three-toed woodpecker (northern)	*Picoides tridactylus*
Townsend's big-eared bat	*Plecotus townsendii*
Townsend's chipmunk	*Tamias townsendii*
Townsend's warbler	*Dendroica townsendi*
Tree swallow	*Tachycineta bicolor*
Trowbridge's shrew	*Sorex trowbridgii*
Trumpeter swan	*Cygnus buccinator*
Tundra swan (whistling)	*Cygnus columbianus*
Turkey vulture	*Cathartes aura*
Vagrant shrew	*Sorex vagranx*
Varied thrush	*Ixoreus naevius*
Vaux's swift	*Chaetura vauxi*
Virginia rail	*Rallus limicola*
Warbling vireo	*Vireo gilvus*
Water shrew	*Sorex palustris*
Western flycatcher (Pacific-slope)	*Empidonax difficilis*
Western gray squirrel	*Sciurus griseus*
Western grebe	*Aechmophorus occidentalis*
Western jumping mouse	*Zapus princeps*
Western kingbird	*Tyrannus verticalis*
Western pocket gopher	*Thomomys mazama*
Western red-backed vole	*Clethrionomys californicus*
Western sandpiper	*Calidris mauri*
Western spotted skunk	*Spilogale gracilis*
Western tanager	*Piranga ludoviciana*
Western terrestrial garter snake	*Thamnophis elegans*
Western toad	*Bufo boreas*
Western wood-pewee	*Contopus sordidulus*
White-breasted nuthatch	*Sitta carolinensis*
White-crowned sparrow	*Zonotrichia leucophrys*
White-faced ibis	*Plegadis chihi*
White-headed woodpecker	*Picoides albolarvatus*
White-throated swift	*Aeronautes saxatalis*
White-winged crossbill	*Loxia leucoptera*
Willet	*Catoptrophorus semipalmatus*
Williamson's sapsucker	*Sphyrapicus thyroideus*
Willow flycatcher	*Empidonax traillii*
Wilson's phalarope	*Phalaropus tricolor*
Wilson's warbler	*Wilsonia pusilla*
Winter wren	*Troglodytes troglodytes*
Wolverine	*Gulo gulo*
Woodduck	*Aix sponsa*
Yellow warbler	*Dendroica petechia*
Yellow-bellied marmot	• *Marmota flaviventris*
Yellow-breasted chat	*Icteria virens*
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*
Yellow-pine chipmunk	*Tamias amoenus*
Yellow-rumped warbler	*Dendroica coronata*
Yuma myotis	*Myotis yumanensis*

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Fuel loading -- The weight of fuel present at a given site; usually expressed in tons per acre. This value generally refers to the fuel that would typically be available for consumption by fire. Fuel loading varies as a result of disturbance (including human activities), the magnitude of that disturbance, the successional stage of the vegetation, and other conditions of the site.

Habitat -- The area where a plant or animal lives and grows under natural conditions. Habitat consists of living and non-living attributes, and provides all requirements for food and shelter.

Habitat fragmentation -- The splitting or isolating of patches of similar habitat, typically forest cover (but could also apply to grass fields, shrub patches, and other habitats); habitat can be fragmented from natural conditions, such as thin or variable soils, or from forest management activities, such as clear-cut logging.

Habitat type -- The land area capable of supporting a single plant association.

Harvest -- Felling and removal of tree stems from the forest for the manufacture of forest products.

Healthy ecosystem -- An ecosystem in which structure and functions allow the maintenance of biological diversity, biotic integrity, and ecological processes over time.

High intensity fire -- A fire with the capability to be stand replacing or to cause excessive damage to late successional forest characteristics.

High severity fire -- A wildfire event with acute ecological impacts; usually, but not always of high intensity.

Imminent Susceptibility -- A situation where the conditions are such that it is very likely there will be significant change in structure or character of forest stands on a large scale as a result of insect attack and/or fire within the next 10 years.

Impact -- An environmental change that negatively affects a beneficial use or value. The value judgment of "negative" is generally construed to mean that conditions or processes are moving away from desired states.

Interdisciplinary team -- A group of individuals with varying areas of specialty assembled to solve a problem or perform a task. The team is assembled out of recognition that no one scientific discipline is sufficiently broad enough to adequately analyze the problem and propose action.

Landscape -- A heterogeneous land area with interacting ecosystems that are repeated in a similar form throughout.

Large-scale fire -- A very large-sized fire compared to the natural range of fire sizes of the fire regime in the geographic area considered. Fires that greatly exceed the typical fire size are often of high intensity and may cause profound fire effects.

Late-successional reserve -- A forest in its mature and/or old-growth stages that has been reserved under the ROD.

Long-term soil productivity -- The capability of soil to sustain inherent, natural growth potential of plants and plant communities over time.

Management activity -- An activity undertaken for the purpose of harvesting, traversing, transporting, protecting, changing, replenishing, or otherwise using resources.

Matrix -- Federal lands outside of reserves, withdrawn areas, and Managed Late-Successional areas.

Multistoried -- Forest stands that contain trees of various heights and diameter classes and therefore support foliage at various heights in the vertical profile of the stand.

National Environmental Policy Act (NEPA) -- An Act passed in 1969 to declare a national policy that encourages productive and enjoyable harmony between humankind and the environment, promotes efforts that prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of humanity, enriches the understanding of the ecological systems and natural resources important to the nation, and establishes a Council on Environmental Quality (The Principal Laws Relating to Forest Service Activities, Agric. Handb. 453 USDA Forest Service, 359 p.).

Nesting, roosting, and foraging habitat -- The forest vegetation with the age class, species of trees, structure, sufficient area, and adequate food source to meet some or all of the life needs of the northern spotted owl.

Northwest Forest Plan -- Alternative 9 and the preferred alternative of the 1994 Final Supplemental Environmental Impact Statement on Management of Habitat for Late-Successional and Old-growth Forest Related Species Within the Range of the Northern Spotted Owl. This plan amends the 1990 Deschutes National Forest Land and Resource Management Plan.

Old growth -- A forest stand usually at least 180-220 years old with moderate to high canopy closure; a multilayered, multispecies canopy dominated by large overstory trees; high incidence of large trees, some with broken tops and other indications of old and decaying wood (decadence); numerous large snags; and heavy accumulations of wood, including large logs on the ground.

Old-growth associated species -- Plant and animal species that exhibit a strong association with old-growth forests.

Overstory -- Trees that provide the uppermost layer of foliage in a forest with more than one roughly horizontal layer of foliage.

Park-like stands -- Stands having scattered, large, seral overstory trees and open growing conditions usually maintained by frequent ground fires.

Plant Association -- The distinctive combination of trees, shrubs, grasses, and herbs occurring in a theoretical terminal or climax community or a series of communities.

Population viability -- Probability that a population will persist for a specified period across its range despite normal fluctuations in population and environmental conditions.

Precommercial thinning -- The practice of removing some of the trees less than merchantable size from a stand so that remaining trees will grow faster.

Prescribed fire -- A fire burning within an approved, pre-defined and planned prescription. The fire may result from either a planned or natural ignition. When a prescribed fire exceeds the prescription and/or planned perimeter, it may be declared a wildfire.

Range of the northern spotted owl -- The range of the northern spotted owl in the United States is generally comprised of land in western Washington and Oregon, and northern California.

Reforestation -- The natural or artificial restocking of an area with forest trees; most commonly used in reference to artificial stocking.

Restoration -- Actions taken to return an ecosystem in whole or in part to a desired condition.

Riparian area -- A geographic area containing an aquatic ecosystem and adjacent upland areas that directly affect it. This includes floodplain, woodlands, and all areas within a horizontal distance of approximately 100 feet from the normal line of high water of a stream channel or from the shoreline of a standing body of water.

Riparian reserves -- The area adjacent to streams, lakes and wetlands which is designed to protect aquatic and riparian functions and values.

Roost -- The resting behavior of an animal.

Shelterwood -- A regeneration method under an even-aged silvicultural system. A portion of the mature stand is retained as a source of seed and/or protection during the period of regeneration. The mature stand is removed in two or more cuttings.

Silvicultural prescription -- A professional plan for controlling the establishment, composition, constitution and growth of forests.

Snag -- A standing dead tree.

Stand -- Vegetation occupying a specific area that is sufficiently uniform in composition, size, arrangement, structure, and condition as to be distinguished from the vegetation in adjoining areas.

Standards and guidelines -- The rules and limits governing actions, and the principles specifying the environmental conditions or levels to be achieved and maintained.

Structure -- The physical organization and arrangement of vegetation; the size and arrangement (both vertical and horizontal) of trees and tree parts.

Structural diversity -- The diversity of forest structure, both vertical and horizontal, that provides for a variety of forest habitats for plants and animals. The variety results from layering or tiering of the canopy and the die-back, death and ultimate decay of trees. In aquatic habitats, the presence of a variety of structural features such as logs and boulders create a variety of habitat.

Surface fire -- A fire burning along the surface without significant movement into the understory or overstory, usually flame lengths are less than one meter in size.

Sustainability -- The ability of an ecosystem to maintain its organization and autonomy over time including but not limited to maintenance of ecological processes, biological diversity and productivity.

Threatened species -- Those plant or animal species likely to become endangered throughout all or a significant portion of their range within the foreseeable future. A plant or animal identified and defined in accordance with the 1973 Endangered Species Act and published in the Federal Register.

Underburning -- Prescribed burning of the forest floor or understory for botanical or wildlife habitat objectives, hazard reduction, or silvicultural objectives.

Understory -- The trees and other woody species growing under the canopies of larger adjacent trees and other woody growth.

Uneven-aged management -- A combination of actions that simultaneously maintains continuous tall forest cover, recurring regeneration of desirable species, and the orderly growth and development of trees through a range of diameter or age classes. Cutting methods that develop and maintain uneven-aged stands are single-tree selection and group selection.

Upper Management Zone (UMZ) -- This represents the point at which tree mortality begins to occur due to competition for site resources. This is the site-specific density level of trees at which a suppressed class of trees develops. (Cochran et al 1994)

Viability -- The ability of a wildlife or plant population to maintain sufficient size so that it persists over time in spite of normal fluctuations in numbers; usually expressed as a probability of maintaining a certain population for a specified period.

Viable population -- A wildlife or plant population that contains an adequate number of reproductive individuals appropriately distributed on the planning area to ensure the long-term existence of the species.

Watershed -- The drainage basin contributing water, organic matter, dissolved nutrients and sediments to a stream or lake.

Wildfire -- Any wildland fire that does not meet management objectives, thus requiring a fire suppression response. Once declared a wildfire, the fire can no longer be declared a prescribed fire.

APPENDIX F

COMMON ACRONYMS

ACS: Aquatic Conservation Strategy

BEMA: Bald Eagle Management Area

BLM: Bureau of Land Management

CCC: Civilian Conservation Corp

CCS: Challenge Cost Share

DBH: Diameter at Breast Height

DEQ: Department of Environmental Quality

DSEIS: Draft Supplemental Environmental Impact Statemen

DWD: Down Woody Debris

EA: Environmental Assessment

EPA: Environmental Protection Agency

FEMAT: Forest Ecosystem Management Assesment Team

FS: Forest Service

FSEIS: Final Supplemental Environmental Impact Statement

FSM: Forest Service Manual

FWS: Fish and Wildlife Service

GIS: Geographical Information Systems

HRV: Historic Range of Variability

IDT: Interdisciplinary Team

KCDH: Klamath County Department of Health

LP: Lodgepole

LPD: Lodgepole Dry

LPH: Lodgepole with Mountain Hemlock

LPW: Lodgepole Wet

LRMP: Land and Resource Management Plan

LSR: Late Successional Reserve

LWM: Large Woody Material

MCD: Mixed Conifer Dry

MCW: Mixed Conifer Wet

MH: Mountain Hemlock

MIS: Management Indicator Species

NEPA: National Environmental Protection Act

NF: National Forest

NFMA: National Forest Management Act

NFP: Northwest Forest Plan

NRF: Nesting, Roosting, and Foraging

NTMB: Neotropical Migratory Bird

ODFW: Oregon Department of Fish and Wildlife

ODOT: Oregon Department of Transportation

OHV: Off Highway Vehicle

ORV: Off Road Vehicle

OSU: Oregon State University

PAG: Plant Association Group

PC: Personal Computer

PCT: Pacific Crest Trail

PETS: Potential Endangered, Threatened, or Sensitive (Species)

PFP: President's Forest Plan

PMR: Pacific Meridian Resources

PNW: Pacific Northwest

PP: Ponderposa Pine

ROD: Record of Decision

ROS: Recreational Opportunity Spectrum

SRI: Soil Resource Inventory

USDA: United States Department of Agriculture

USDI: United States Department of the Interior

USFS: United States Forest Service

USGS: United States Geological Survey

WEAVE: Watershed Evaluation and Analysis for Viable Ecosystems

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Fuel loading -- The weight of fuel present at a given site; usually expressed in tons per acre. This value generally refers to the fuel that would typically be available for consumption by fire. Fuel loading varies as a result of disturbance (including human activities), the magnitude of that disturbance, the successional stage of the vegetation, and other conditions of the site.

Habitat -- The area where a plant or animal lives and grows under natural conditions. Habitat consists of living and non-living attributes, and provides all requirements for food and shelter.

Habitat fragmentation -- The splitting or isolating of patches of similar habitat, typically forest cover (but could also apply to grass fields, shrub patches, and other habitats); habitat can be fragmented from natural conditions, such as thin or variable soils, or from forest management activities, such as clear-cut logging.

Habitat type -- The land area capable of supporting a single plant association.

Harvest -- Felling and removal of tree stems from the forest for the manufacture of forest products.

Healthy ecosystem -- An ecosystem in which structure and functions allow the maintenance of biological diversity, biotic integrity, and ecological processes over time.

High intensity fire -- A fire with the capability to be stand replacing or to cause excessive damage to late successional forest characteristics.

High severity fire -- A wildfire event with acute ecological impacts; usually, but not always of high intensity.

Imminent Susceptibility -- A situation where the conditions are such that it is very likely there will be significant change in structure or character of forest stands on a large scale as a result of insect attack and/or fire within the next 10 years.

Impact -- An environmental change that negatively affects a beneficial use or value. The value judgment of "negative" is generally construed to mean that conditions or processes are moving away from desired states.

Interdisciplinary team -- A group of individuals with varying areas of specialty assembled to solve a problem or perform a task. The team is assembled out of recognition that no one scientific discipline is sufficiently broad enough to adequately analyze the problem and propose action.

Landscape -- A heterogeneous land area with interacting ecosystems that are repeated in a similar form throughout.

Large-scale fire -- A very large-sized fire compared to the natural range of fire sizes of the fire regime in the geographic area considered. Fires that greatly exceed the typical fire size are often of high intensity and may cause profound fire effects.

Late-successional reserve -- A forest in its mature and/or old-growth stages that has been reserved under the ROD.

Long-term soil productivity -- The capability of soil to sustain inherent, natural growth potential of plants and plant communities over time.

Management activity -- An activity undertaken for the purpose of harvesting, traversing, transporting, protecting, changing, replenishing, or otherwise using resources.

Matrix -- Federal lands outside of reserves, withdrawn areas, and Managed Late-Successional areas.

Multistoried -- Forest stands that contain trees of various heights and diameter classes and therefore support foliage at various heights in the vertical profile of the stand.

National Environmental Policy Act (NEPA) -- An Act passed in 1969 to declare a national policy that encourages productive and enjoyable harmony between humankind and the environment, promotes efforts that prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of humanity, enriches the understanding of the ecological systems and natural resources important to the nation, and establishes a Council on Environmental Quality (The Principal Laws Relating to Forest Service Activities, Agric. Handb. 453 USDA Forest Service, 359 p.).

Nesting, roosting, and foraging habitat -- The forest vegetation with the age class, species of trees, structure, sufficient area, and adequate food source to meet some or all of the life needs of the northern spotted owl.

Northwest Forest Plan -- Alternative 9 and the preferred alternative of the 1994 Final Supplemental Environmental Impact Statement on Management of Habitat for Late-Successional and Old-growth Forest Related Species Within the Range of the Northern Spotted Owl. This plan amends the 1990 Deschutes National Forest Land and Resource Management Plan.

Old growth -- A forest stand usually at least 180-220 years old with moderate to high canopy closure; a multilayered, multispecies canopy dominated by large overstory trees; high incidence of large trees, some with broken tops and other indications of old and decaying wood (decadence); numerous large snags; and heavy accumulations of wood, including large logs on the ground.

Old-growth associated species -- Plant and animal species that exhibit a strong association with old-growth forests.

Overstory -- Trees that provide the uppermost layer of foliage in a forest with more than one roughly horizontal layer of foliage.

Park-like stands -- Stands having scattered, large, seral overstory trees and open growing conditions usually maintained by frequent ground fires.

Plant Association -- The distinctive combination of trees, shrubs, grasses, and herbs occurring in a theoretical terminal or climax community or a series of communities.

Population viability -- Probability that a population will persist for a specified period across its range despite normal fluctuations in population and environmental conditions.

Precommercial thinning -- The practice of removing some of the trees less than merchantable size from a stand so that remaining trees will grow faster.

Prescribed fire -- A fire burning within an approved, pre-defined and planned prescription. The fire may result from either a planned or natural ignition. When a prescribed fire exceeds the prescription and/or planned perimeter, it may be declared a wildfire.

Range of the northern spotted owl -- The range of the northern spotted owl in the United States is generally comprised of land in western Washington and Oregon, and northern California.

Reforestation -- The natural or artificial restocking of an area with forest trees; most commonly used in reference to artificial stocking.

Restoration -- Actions taken to return an ecosystem in whole or in part to a desired condition.

Riparian area -- A geographic area containing an aquatic ecosystem and adjacent upland areas that directly affect it. This includes floodplain, woodlands, and all areas within a horizontal distance of approximately 100 feet from the normal line of high water of a stream channel or from the shoreline of a standing body of water.

Riparian reserves -- The area adjacent to streams, lakes and wetlands which is designed to protect aquatic and riparian functions and values.

Roost -- The resting behavior of an animal.

Shelterwood -- A regeneration method under an even-aged silvicultural system. A portion of the mature stand is retained as a source of seed and/or protection during the period of regeneration. The mature stand is removed in two or more cuttings.

Silvicultural prescription -- A professional plan for controlling the establishment, composition, constitution and growth of forests.

Snag -- A standing dead tree.

Stand -- Vegetation occupying a specific area that is sufficiently uniform in composition, size, arrangement, structure, and condition as to be distinguished from the vegetation in adjoining areas.

Standards and guidelines -- The rules and limits governing actions, and the principles specifying the environmental conditions or levels to be achieved and maintained.

Structure -- The physical organization and arrangement of vegetation; the size and arrangement (both vertical and horizontal) of trees and tree parts.

Structural diversity -- The diversity of forest structure, both vertical and horizontal, that provides for a variety of forest habitats for plants and animals. The variety results from layering or tiering of the canopy and the die-back, death and ultimate decay of trees. In aquatic habitats, the presence of a variety of structural features such as logs and boulders create a variety of habitat.

Surface fire -- A fire burning along the surface without significant movement into the understory or overstory, usually flame lengths are less than one meter in size.

Sustainability -- The ability of an ecosystem to maintain its organization and autonomy over time including but not limited to maintenance of ecological processes, biological diversity and productivity.

Threatened species -- Those plant or animal species likely to become endangered throughout all or a significant portion of their range within the foreseeable future. A plant or animal identified and defined in accordance with the 1973 Endangered Species Act and published in the Federal Register.

Underburning -- Prescribed burning of the forest floor or understory for botanical or wildlife habitat objectives, hazard reduction, or silvicultural objectives.

Understory -- The trees and other woody species growing under the canopies of larger adjacent trees and other woody growth.

Uneven-aged management -- A combination of actions that simultaneously maintains continuous tall forest cover, recurring regeneration of desirable species, and the orderly growth and development of trees through a range of diameter or age classes. Cutting methods that develop and maintain uneven-aged stands are single-tree selection and group selection.

Upper Management Zone (UMZ) -- This represents the point at which tree mortality begins to occur due to competition for site resources. This is the site-specific density level of trees at which a suppressed class of trees develops. (Cochran et al 1994)

Viability -- The ability of a wildlife or plant population to maintain sufficient size so that it persists over time in spite of normal fluctuations in numbers; usually expressed as a probability of maintaining a certain population for a specified period.

Viable population -- A wildlife or plant population that contains an adequate number of reproductive individuals appropriately distributed on the planning area to ensure the long-term existence of the species.

Watershed -- The drainage basin contributing water, organic matter, dissolved nutrients and sediments to a stream or lake.

Wildfire -- Any wildland fire that does not meet management objectives, thus requiring a fire suppression response. Once declared a wildfire, the fire can no longer be declared a prescribed fire.