

CHAPTER 4

LANDFORM BLOCK ANALYSIS

INTRODUCTION

Wilson's 1981 "Landforms of the McKenzie River Basin" was the basis for most of the geomorphology interpretation of this watershed. His study divided the area into ten "Land Systems," which delineated landforms based on geological origin and process.

For the purposes of the Upper McKenzie analysis, the watershed was stratified into Landform Blocks similar to Wilson's system. The WA stratification went beyond hydrologic and geologic characterizations, however, to include vegetation patterns, fire behavior, valley segment types, and fish and wildlife habitats (Figure 4-1). The stratification allowed for more detailed discussion of the resources at a smaller scale. The following chapter discusses resources within each landform block.

LANDFORM BLOCK 1:

MCKENZIE BRIDGE GLACIAL VALLEY (Glacial Valley System of Wilson 1981)

Introduction

The western-most portion of the Upper McKenzie Watershed is confined by two east-west trending ridges. The Lookout ridge lava flows to the north, which are 6.3 to 8.8 million years old (Avramenko 1981, Preist et al. 1988) are part of the Early High Cascade ridge-capping basalts overlaying the Western Cascade slopes. Foley Ridge to the south is 2.1 to 4.0 million years old (Flaherty 1981) and is composed of younger, Late High Cascade lava flows. Foley Ridge represents inverted topography, whereby eruptions from early High Cascade volcanoes filled the ancient valley. The valley was subsequently eroded by glaciation and fluvial action, leaving the "intracanyon" lava flows perched on the base rock of the Western Cascades as ridge-capping basalts (Van Dusen 1962, Jan 1967).

This reach of the mainstem McKenzie is the point at which the river course changes from north-south to east-west. It is also where the ancestral McKenzie breached the High Cascade fault escarpment and lost elevation near Belknap Hot Springs. These hot springs lie in a north-south trending position along the North Santiam fault zone with other structurally controlled Cascade hot springs such as Foley, Cougar, McCredie, and Bagby hot springs (Figure 4-2).

Figure 4-1. Landform Blocks & Streams

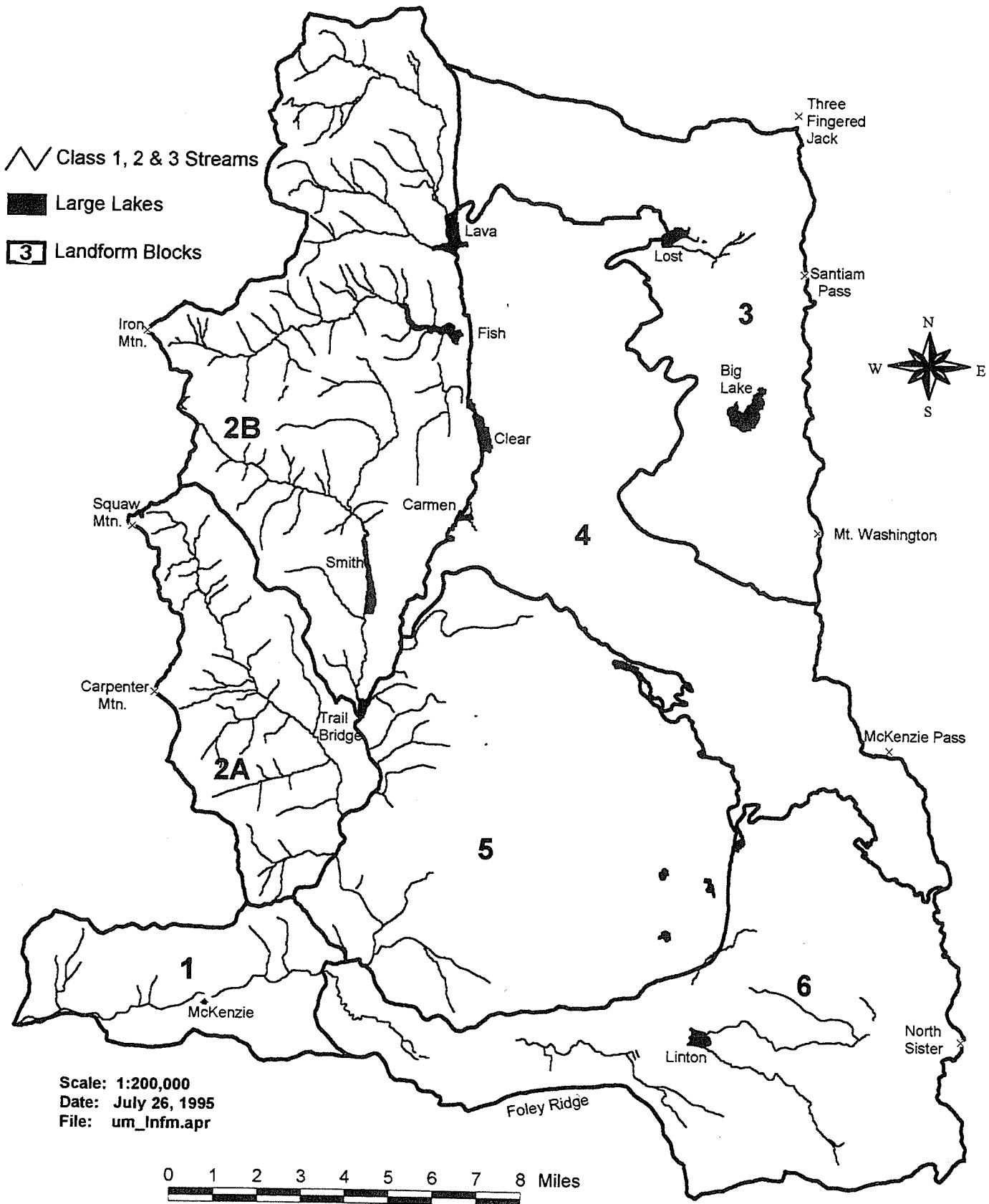




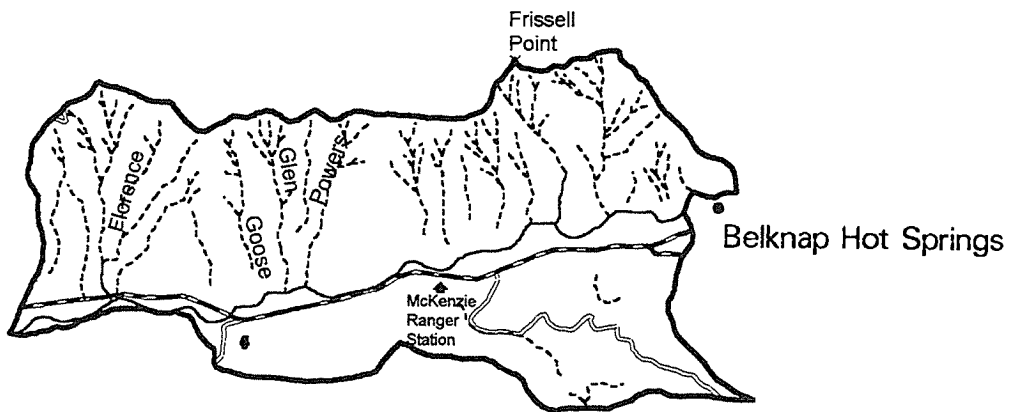
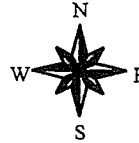
Figure 4-2: Landform Block 1 Locator Map

 Arterials
 Collectors

 Class 1 & 2 Streams

 Class 3 & 4 Streams

 Lakes



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Disturbance History - Mass Wasting

The typical U-shaped valley of post-glacial landforms is not entirely evident in this section. Mass wasting and fluvial processes have re-filled the valley through valley side-slope stress relief failures, debris avalanches, and glacial-fluvial terrace deposits (Williamson 1987).

Landform Block 1 is susceptible to natural failures because upslope streams saturate the glacial terraces on the north side by the upslope streams. There is also high debris avalanche potential on Lookout Ridge (above the glacial terraces) and on the south side Foley Ridge because of the steep slope angles. Debris failure transport occurs over a long segment of this stream because most of the 4th order streams confluence at an angle greater than 70 degrees. Active landslides are obvious, and the area contains two of the road related slope failures in the watershed (Figure 4-3 and 4-4).

Landform block 1 contains SRI Units 3 and 235 potentially on all slopes; and Units 16, 301, 310U, 610U, and 71 on slopes greater than 70%.

Disturbance History: Fire and Vegetation Patterns

The forested vegetation of this block is mostly Douglas-fir (PSME) and western hemlock (TSHE) plant series. For further discussion of the associated plants, stand development pattern, and ecology of these series, see the Upland Vegetation section of Chapter 3.

The typical wind pattern in this block is westerly, up slope, and up canyon. The wind is predictably erratic at the east end of the block where Lost Creek joins the McKenzie River. The landform channels the east winds, resulting in a stronger flow above 2000'. Historically fires were medium-sized, moderate-intensity, and fairly frequent. Large-sized, high-intensity, stand-replacing fires of intermediate frequency also occurred. These historical disturbances resulted in a forested landscape comprised of a mosaic of medium and large-sized patches. The majority of the forested stands are currently less than 200 years, with trees less than 150 years old common. Fires appeared to have often originated on ridgetops, moving down and across the slope.

The topography of the block greatly influences the flow of fire and the subsequent vegetation patterns. The south aspect of the block is a long rise that extends from the river valley to the ridge top (Lookout Ridge to Frissell Point). The face is dissected by both dry and wet drainages. This type of topography typically promotes large-sized fire. The north aspect of the block along Foley Ridge receives less direct sunlight, staying damper than the area north of the river. This results in lower intensity fires and smaller patches sizes.

Figure 4-3. Landform Block 1 Unstable & Potentially Unstable Areas

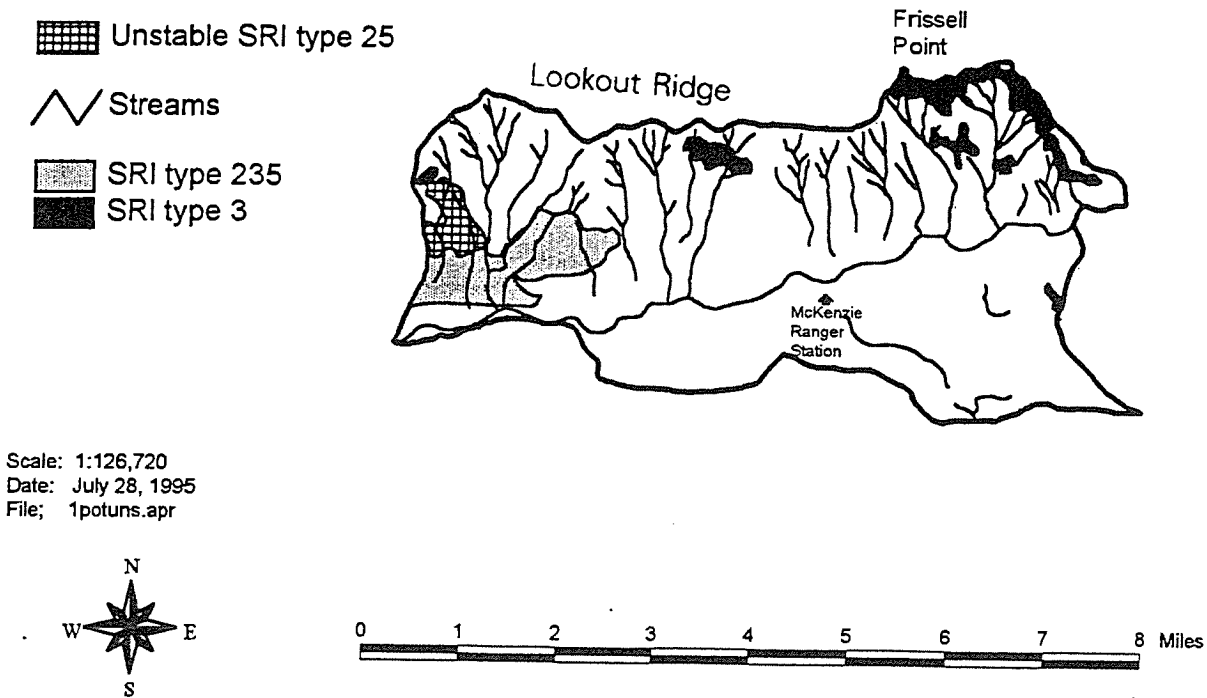
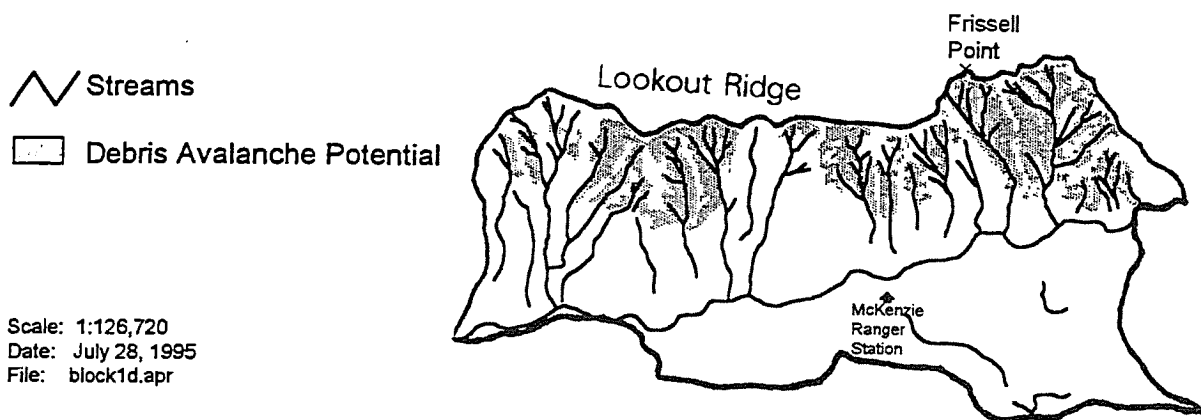


Figure 4-4. Landform Block 1 Debris Avalanche Potential



The forest patches in this block are currently a mix of predominantly even-aged stands. There may have been a fire event as often as every 40 years which helps to explain why there is such a mix of tree ages across the block. The average size of the forested patches is small, about 45 acres. This is significantly smaller than the 1900 average patch size of about 120 acres. A Shannon diversity index indicates a 12% reduction in patch-type diversity between 1900 and 1995 (from 1.63 to 1.43 1900 and 1995, respectively). This reduction is related to the loss of fire disturbance in this block. Fires historically resulted in a highly diverse mosaic of patch types on this landform.

Tree regeneration following fire events was probably slow on the warm and droughty south aspects and on the thin, rocky soils of the upper slopes.

Unique Habitats

Table 4-1 and Figure 4-5 displays the non-forested habitats located within this landform block. The prominent habitat feature of this landform block is rock outcrops and cliffs that run west from Frissel Point to Lookout Ridge. These south-facing habitats support herbs and grass species that have adapted to these harsh sites. The cliffs are providing low to moderate quality habitat for peregrine falcons. No verified sitings have been recorded.

Table 4-1: Non-forested habitats within Landform block 1.

Habitat Feature	Acres
Wet meadow	3.76
Dry meadows	31.76
Herb/forb meadow	30.70
Shrub communities	55.84
Hardwood/shrub community	7.18
Rock talus	9.55
Rock outcrops	504.81
Lakes	3.82

A unique marsh/wet meadow habitat occurs on a private parcel on the valley floor. Pond Turtles, band-tailed pigeons, and wood ducks inhabit the area, as well as abundant elk.

The wetland is within a half mile of another wet meadow outside the watershed which has a known population *Ophioglossum pusillum*, a sensitive plant. The potential for *O. pusillum* to occur in this area is high. The area appears to be stable, and there are no known threats. The marsh should be a high priority to assess for a potential land exchange.

Figure 4-5. Landform Block 1 Special Habitats

-  Class 1 & 2 Streams
-  Class 3 & 4 Streams
-  Lakes
-  Grasslands
-  Hardwoods
-  Lava Flows, Rock & Cinders
-  Wetlands
-  Shrublands
-  Herblands



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Special Habitats were identified through photo interpretation.



High quality, late successional riparian habitat is limited along this section of the McKenzie River. Most of the older forest in the riparian reserve has been harvested on private lands. The riparian zone and associated upland vegetation provide habitat for five sensitive plants to occur in this landform block. A pristine example of late seral riparian habitat still exists, however, at Paradise Campground. Mature big leaf maple trees provide habitat for an abundance of bryophytes and lichens. This plant community will gradually change over time due to the presence of the laminated root-rot *Phellinus weirii*. This disease kills Douglas-fir trees. As the forest canopy opens, hardwoods and western hemlock more resistant to the disease will replace the Douglas-fir.

Noxious Weeds

Extensive populations of spotted knapweed, a noxious weed, has established along Highway 126 in this block. The Department of Transportation (ODOT) is responsible for mowing the plants before they set seed. Although this practice reduces the expansion of the weed, the plants continue to grow and persist in the environment. Plants missed by the reach of the mower continue to disperse seeds.

Last fall approximately one acre adjacent to the highway was planted with two species of grass seed in an attempt to out-compete noxious weeds. Germination was poor this spring, and spotted knapweed continues to dominate the site. The non-native weedy plant oxeye daisy (*Chrysanthemum leucanthemum*), common in the Willamette Valley, has become more prevalent along Highway 126. This species occurs in patches, but should be eradicated before it becomes established. Oxeye daisy is a perennial that can quickly invade meadows and aggressively out-compete with native vegetation.

The EWEB powerline runs west through the landform block. The dominant vegetation growing in the powerline corridor is the noxious weed Scotch broom. Further expansion is limited as it does not grow well in dense shade under crown closure. However, seeds of Scotch broom can remain viable for sixty years in the soil (Miller 1994). No current eradication program exists for the removal of Scotch broom under the powerlines. A TES plant and weed survey is being completed for the corridor in FY95.

Channel Condition and Aquatic Habitat

The streams of Landform Block 1 are steep in gradient and flow south off the ridge of the Western Cascades. They generally disappear subsurface when they encounter the glacial deposits within the McKenzie River glacial valley. Debris torrents and debris avalanches are common in the steep, upper portions of the streams. In the past, intensive, large fires on the steep slopes probably introduced large amounts of sediment onto the flats of the valley glacial

deposits, with a majority of the slide material eventually making its way to the McKenzie River. Many of the streams are incised into the glacial material where debris torrents have cut through the deposits.

The landform block is located within the McKenzie Bridge subwatershed. Approximately 15% of its area has been harvested and roaded (Table 4-2 and 4-3).

Table 4-2: Percent area harvested within McKenzie Bridge Subdrainage.

SUB-WATERSHED #	SUB-WATERSHED NAME	PERCENT HARVESTED	PERCENT ROADED	TOTAL PERCENT MANAGED	ROAD DENSITY (miles/square mile)
07-1	McKenzie Bridge	13.0	2.0	15.0	3.1
07-2	Lost Cr/Wh. Branch	4.0	0.5	4.5	3.5
07-3	Boulder/Frissel	24.0	2.0	26.0	3.2
07-4	Kink/Inland Basin	5.0	0.5	5.5	0.7
07-5	Hackleman	14.0	2.0	16.0	2.4
07-6	Smith River	25.0	2.0	27.0	2.5
07-7	Deer Cr.	36.0	3.0	39.0	3.8
07-8	Park Cr.	11.0	2.0	13.0	2.3

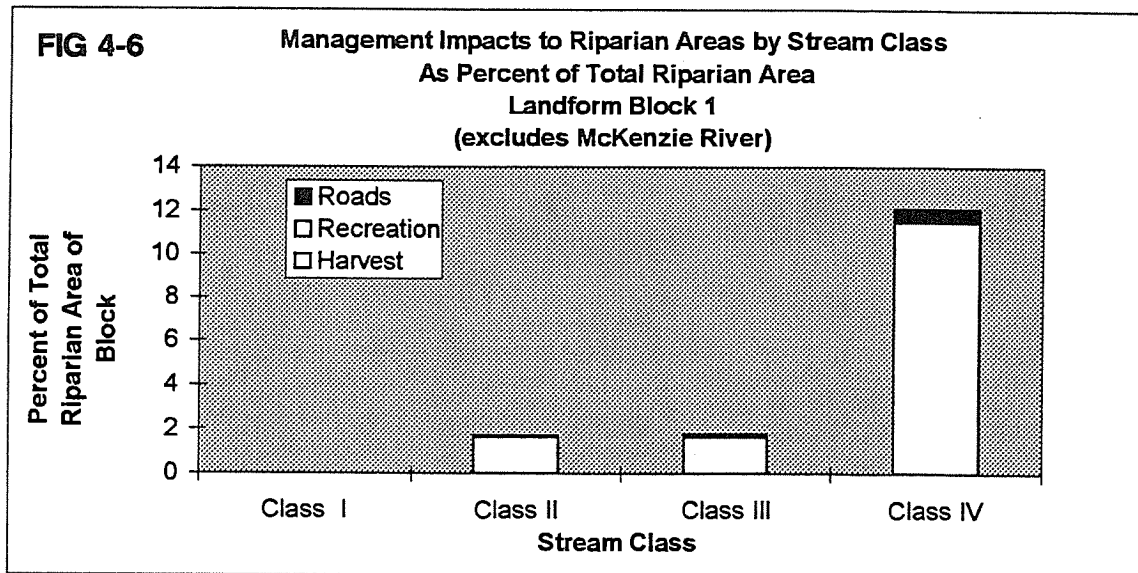
Table 4-3: Percent area harvested and roaded within each drainage.

SUB-WATERSHED NAME	DRAINAGE NAME	PERCENT HARVESTED	PERCENT ROADED	TOTAL % MANAGED	ROAD DENSITY (miles per square mile)
Boulder/ Frissel	Boulder	20.0	2.0	22.0	2.4
	Frissel	15.0	1.0	16.0	1.6*
	Scott	29.0	3.0	32.0	4.4
	Sprngs Cmx	24.0	2.0	26.0	2.9
	Twisty	44.0	4.0	48.0	5.1
Kink/Inland Basin	Kink	19.0	2.0	21.0	2.3
	Sweetwater	30.0	3.0	33.0	4.5
Hackleman	Hackleman	24.0	2.0	26.0	3.0

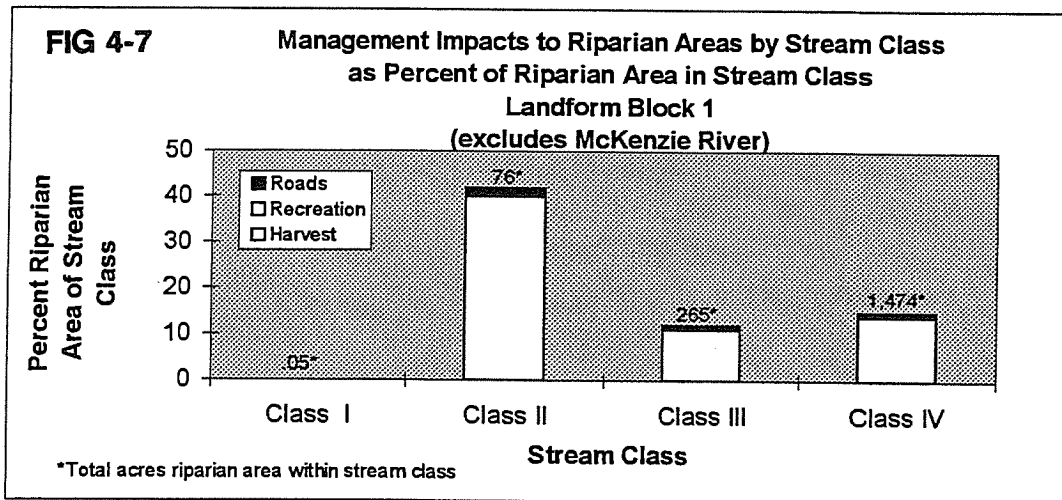
Table 4-3 continued

SUB-WATERSHED NAME	DRAINAGE NAME	PERCENT HARVESTED	PERCENT ROADED	TOTAL % MANAGED	ROAD DENSITY (miles per square mile)
Smith River	Browder	25.0	1.0	26.0	2.0
	Bunchgrass	30.0	3.0	33.0	3.7
	Smith	27.0	2.0	29.0	2.6
Deer Cr.	Budworm	13.0	2.0	15.0	2.3
	Cadenza Cm	44.0	14.0	58.0	4.7
	Carpenter	41.0	3.0	44.0	3.9
	County	35.0	2.0	37.0	3.6
	Fritz	43.0	3.0	46.0	4.3
	Sluice	42.0	3.0	45.0	4.0
	Deer Cmpx	38.0	3.0	41.0	3.8
Park Cr.	Upper Deer	40.0	3.0	43.0	4.2
	Crescent	22.0	2.0	24.0	3.5
	Danny	68.0	3.0	71.0	4.7
	Maude	0.6	0.7	1.0	1.1
	Park	26.0	2.0	28.0	2.8

Of the total riparian area within the block, 12% of the area harvested and roaded has occurred in Class IV riparian areas (Fig. 4-6).



However, of the 76 acres of riparian area associated with Class II streams, over 40% of the area has been harvested and roaded (Fig. 4-7). Harvest and roading in the Class II portion of Florence Cr. accounts for the entire 40%.



The low gradient, lower reach of Florence Cr. and an unnamed tributary across from Paradise Campground both provide perennial flow and habitat for cutthroat trout. The most recent survey of streams in this landform were conducted in 1975. Most channels draining the steep side slopes were found to flow subsurface after reaching low gradient glacial deposits. Those channels with year-round flow provided habitat for cutthroat trout and were expected to provide refuge from high McKenzie River flows. Seasonal refuge during high flows is also available in intermittent channels draining directly into the McKenzie River.

Human Disturbances And Effects - Campsites

Dispersed Campsites: All of the dispersed campsites in this block that were inventoried in the summer of 1988 fall within the McKenzie River riparian reserve. Therefore, those sites are discussed under the Mainstem McKenzie landform block.

Developed Recreation Facilities: The following developed recreation facilities are located within this block. Developed facilities include: McKenzie Bridge Campground/Picnic Area and Boat Launch; Paradise Campground/Picnic Area and Boat Launch; and McKenzie River Trailhead Boat Launch.

Administrative and Recreational Special Use Permit Areas: McKenzie Ranger Station compound and Horse Creek Work Center are located in this block. The facilities consist of an office building, warehouse, two bunkhouses, storage yard, tree cooler, and large parking lots. Horse Creek Work Center consists of five permanent residence homes, two large storage buildings, three mobile homes

and pads for two more, a large grass ball-field, parking lot, and covered storage areas.

LANDFORM BLOCK 2A:

DEER CREEK CIRQUE-RIDGE

(Western Cascade Cirque Ridge System of Wilson 1981)

Introduction

This landform block is dominated by the southeast-trending Deer Creek drainage, which originates near Squaw Mountain in the north, and near Wolf Meadow/Carpenter Mountain/Lookout Ridge in the west and south. Streams traverse only one bedrock unit, the Western Cascades, and therefore have a relatively consistent gradient and incision rate (Avramenko 1981). The landforms in this area are a product of alpine glaciation and subsequent valley filling processes such as glacial outwash and moraine deposits. The on-going fluvial processes have provided a mechanism for large mass wasting and erosion events involving side slope and toe slope deposits (Figure 4-8). The majority of mass wasting events in the watershed are located within this landform block.

Disturbance History - Mass Wasting

Landform Block 2A contains 9 of the 19 road-related failures in the watershed. Large, unstable landslows are located in the County Creek and Conroy Creek areas. Although this block is more susceptible to rotational and earthflow-type failures, it is less susceptible to debris avalanche transport over long stream reaches. An exception to this is in the Frissel-Carpenter area because of the "trellis-like" development of the fourth and third order streams and their angle of intersections being less than 70 degrees. Post-harvest debris avalanches and erosion are evident in both County and Conroy Creek drainages (Figure 4-9,10).

Landform block 2A contains SRI Units 3, 233, and 235 potentially on all slopes; and Units 13, 16, 21, 301, and 310U on slopes greater than 70%.

Disturbance History - Fire and Vegetation Patterns

The vegetation of this block is mostly western hemlock (TSHE) and Pacific silver fir (ABAM) plant series in the higher elevations. The block also contains two small pockets of Douglas-fir (PSME) plant series. For further discussion of the associated plants, stand development pattern, and ecology of these plant series, see the Upland Vegetation section of Chapter 3.

Figure 4-8. Landform Block 2a Locator Map

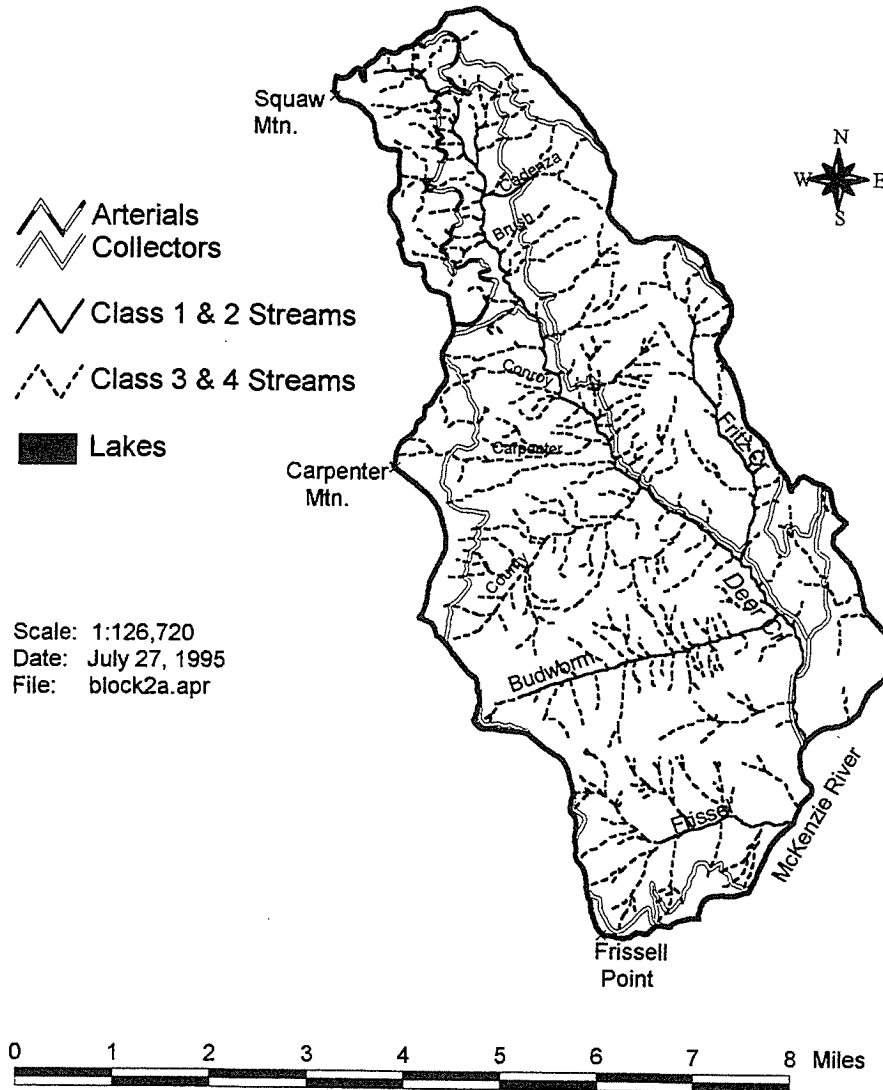


Figure 4-9. Landform Block 2a Unstable & Potentially Unstable Areas

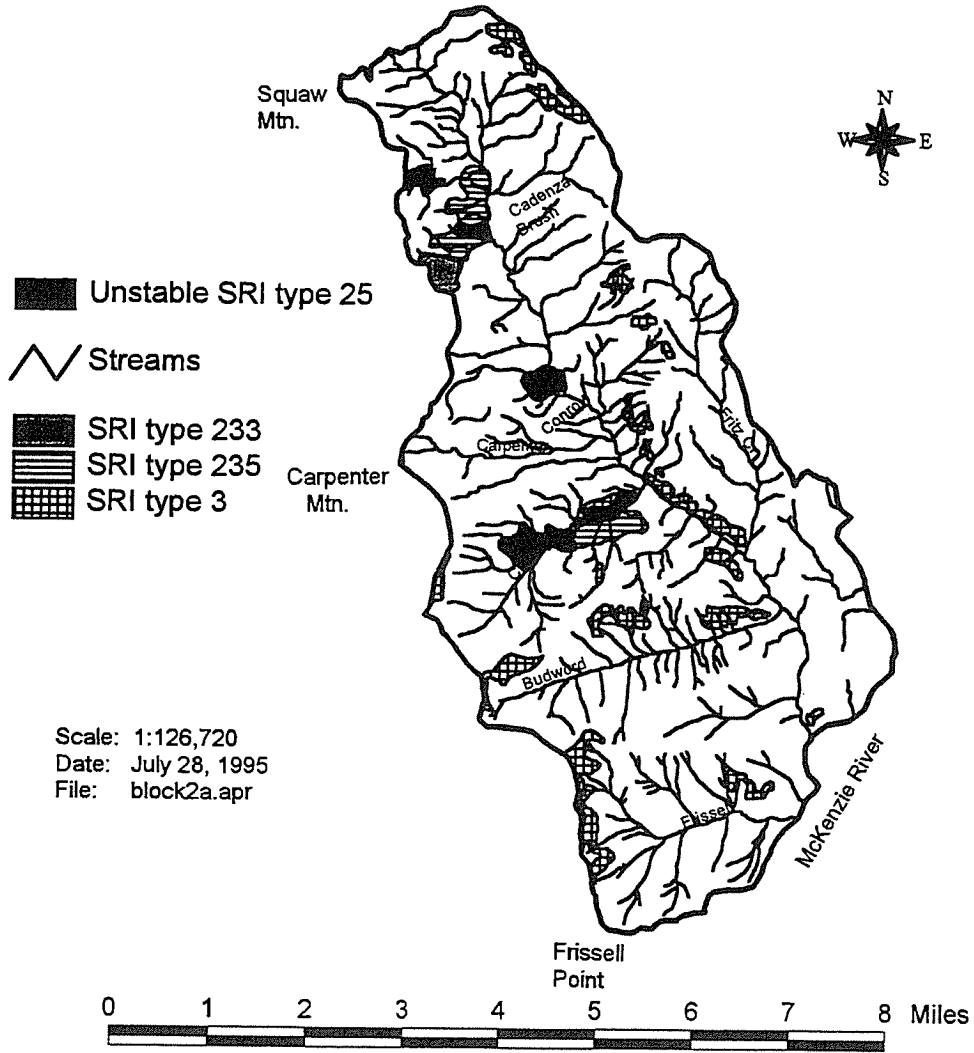
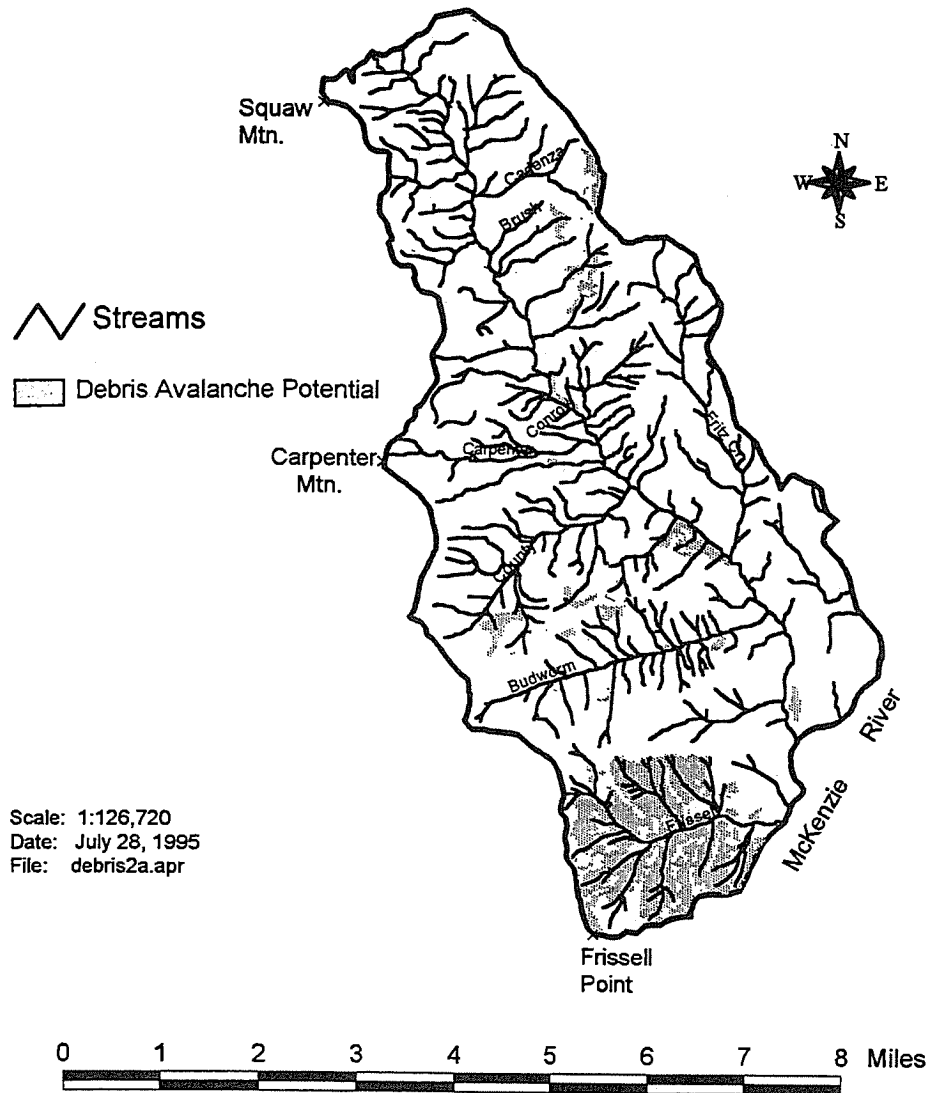


Figure 4-10. Landform Block 2a Debris Avalanche Potential



Typical daily west or southwest wind flows in this area are modified by the topography of Wolf Rock and Carpenter Mt. The wind channels up Blue River, flows through a low pass, then a portion of the wind turns southeast in response to Bunchgrass Mt. The southeast direction of this flow is down-canyon along Deer Creek. This is contrary to the normal up-slope, up-canyon winds expected. The effect is most noted in the upper portions of the Conroy, Carpenter, and County Creek areas. In other areas of the block, the wind is up-slope and up-canyon. On the ridges, the wind is west or southwest.

During periods of east wind, the wind is strongest in the upper portions of Budworm, Frissell, Carpenter, and County Creeks. Other areas, except the ridges, are less exposed to the east wind but are subject to frequent wind shifts and eddies.

Most of the area, except in the Douglas-fir stands, is composed of stands created by small-sized, intermediate to frequent return interval, stand replacement fires. The expected final fire size is a result of the steep north and south aspects associated with the east-running creeks. East winds funnel up the creek drainage and push fires into natural barriers such as rocky ridge tops and less favorable aspects.

The forest patches in this block are a mix of even-aged and multi-aged stands. The average size of the patches is currently small: about 31 acres. This is smaller than the 1900 average patch size of 82 acres. A Shannon diversity index indicated a 35% increase in diversity from 1900 to 1995. The index changed from 1.40 to 1.89 in 1900 and 1995, respectively. This increase reflects an increase in small early and mid seral patches caused by clearcutting over the past 40 years.

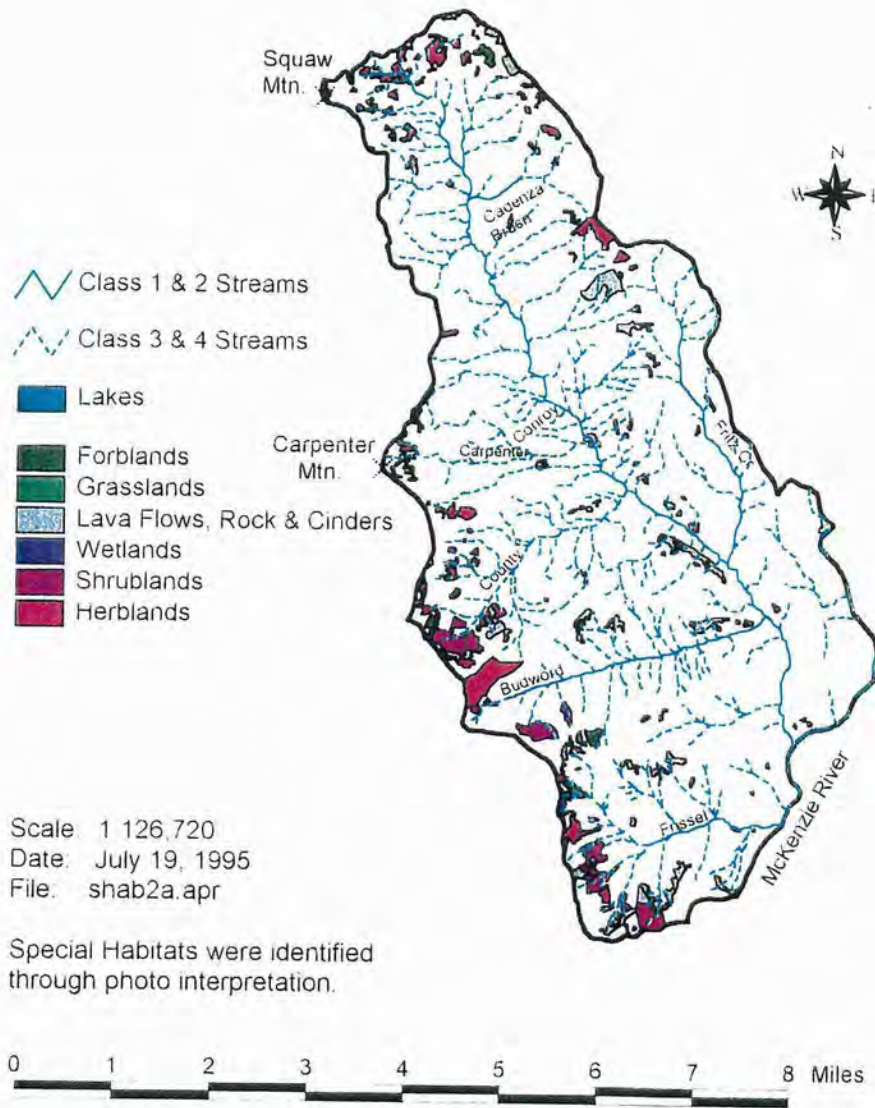
Unique Habitats

Table 4-4 and Figure 4-11 displays unique habitats within this landform block. Most of the special habitats occur along the ridgeline of Frissell Point north to Carpenter Mountain.

Table 4-4: Unique habitats within Landform Block 2A.

Habitat Feature	Acres
Wet meadow	26.62
Dry meadow	64.66
Herb/forb meadow	460.29
Shrub communities	244.77
Dry Rock Gardens	7.92
Rock outcrops	332.36
Lakes	.58

Figure 4-11. Landform Block 2a Special Habitats



Moderately high elevation Sitka alder thickets and vine maple plant associations are found at the headwalls of Frissell, Budworm and County creeks. Beargrass meadows occur on the cold, dry, flat areas along the ridgeline. Old growth riparian vegetation and its associated upland vegetation is lacking along upper reaches of Deer Creek, limiting habitat for many of the ROD Table C-3 species to occur.

This landblock contains high quality cliff habitat for peregrine falcons. Sitings have been recorded. Meadow complexes in this area include Bunchgrass Mtn Special Wildlife Habitat Area (SWHA) and Upper Deer Cr. SWHA. Wetland areas include Cadenza Cr. SWHA. Maintenance of water quality, hydrological processes, and riparian/meadow vegetation are critical for these habitats to continue to function. The majority of these areas are protected from threats through Special Wildlife Habitat Area LMP designations. These habitats are not currently being threatened with the exception of Bunchgrass Mtn., which is being encroached by conifers from lack of fire disturbance.

Sensitive Plant Species

Habitat for five sensitive plant species is found within this landform block (Table 4-5). The sensitive plant species Thompson’s mistmaiden (*Romanzoffia thompsonii*) is found in a seepy area on a steep road cut bank. Road cuts often produce rock faces with seeps which can develop into moist habitat for pioneer bryophyte species and other plant species. The Thompson’s mistmaiden population is stable with no current threats. *Allotropa virgata* (candystick), a ROD Table C-3 survey and manage species, has been found in two separate western hemlock sites within this block. These sites should be re-surveyed to determine the current status of the species.

Table 4-5: Sensitive Plants Located in Landform Block 2A.

Species	Status	Number of pups
<i>Romanzoffia thompsonii</i> - Thompson’s mist maiden	Sensitive	1
Region 6 Sensitive Plant List; Review List and the Watch List are maintained by the Oregon Natural Heritage Program. The Willamette National Forest maintains a Concern List for locally rare species not included in the first three lists.		

Noxious Weeds

Noxious weeds are being treated with biological control agents and manual removal in this landform block.

Channel Condition and Aquatic Habitat

Historically, the erosion rates within the geologically uplifted block of western cascade strata has been high relative to the other landform blocks of the

watershed. The deeply dissected landscape and steep side slope tributaries in this landform have historically carried heavy bedloads to Deer Cr. that were then delivered to the upper McKenzie River.

The Frissell and Budworm drainages are steeply dissected with debris flows being the major form of sediment delivery to the streams and to Deer Cr. Bank cutting was not uncommon. This landscape erodes at a faster rate than the more resistant High Cascades. In contrast, the earthflow terrain of County, Conroy, Carpenter, Cadenza, and Brush drainages generally provide large quantities of sediment to the system as stream courses cut the toe slopes. Fritz Cr. drainage is the most stable of the landform block. It drains through glaciated lava flows. Steep tributary channels of first, second, and third order streams store sediments behind debris jams of large wood. The wood was often recruited from windthrow or failed slopes, and it accumulated during high flow events. Deer Cr. drainage was historically a large source of sediment and debris to the upper McKenzie River. Elsewhere within the watershed, such as in the Smith River drainage with Western Cascades geology, similar drainage size and orientation contributed large quantities of debris and sediment to the Upper McKenzie River.

Moderate to high intensity fires occurred within a significant portion of this landform block, and these small to medium-sized fires introduced a large amount of sediment to Deer Cr. and the McKenzie River approximately every 130-190 years. Input of sediment from mass wasting processes resulted in additional sediment of all sizes, including small to large boulders and whole trees that provided LWD and structure to the channels.

Historic disturbances that have influenced this landscape include a large stand replacing fire in the early 1900's that burned about 1,000 acres on Carpenter Mountain and the headwaters of Carpenter Creek. Similar disturbances have been shown to influence erosion and failure rates, stream temperatures, and nutrient supply. The portions of the landscape that burned reduced the local recruitment supply of in-stream wood until future conifer regeneration matured to replenish the supply. No other major fire disturbance has been recorded in this landform block since the early 1900's.

Major floods also significantly shaped this landscape. Floods and debris torrents changed aquatic habitat by: altering pool:riffle ratios by filling and scouring pools; transporting and concentrating large woody debris into jams; modifying the active channel and off-channel habitats by creating new and abandoning old channels; and sorting and silting spawning gravels. Flows of record in excess of 15 year recurrence intervals occurred in water years 1946, 1953, 1956 and 1965. Reconstruction of roads and salvage of the Deer Cr. channel and flood plain followed the 1965 120-year event.

The unconfined and cobble/gravel-rich lower reach of Deer Cr. is important to chinook salmon. They use the lower 1.5 miles of Deer Cr. as spawning and rearing habitat. Bull trout subadults have been observed rearing, and adults likely forage, in lower Deer Cr. Rainbow/steelhead trout are known to migrate 5.0 miles up Deer Cr. to the base of a 60 foot falls to spawn. Cutthroat trout are found below and above the falls to Deer Cr. headwaters and within major tributaries of Deer Cr. (Fritz, Budworm, and lower Carpenter Cr.). Frissell Cr., a tributary to the McKenzie River downstream of the confluence of Deer Cr., is included in this landform block.

Deer Creek Aquatic Habitat Condition

Since the early 1960's, road building within block 2A has caused debris flow failures, and fire suppression has reduced failures associated with fires. Therefore, total sediment production within the system may not have increased, but the character of the material was different than the sediment added from non-road related failures. The size of material added to the system from the road related failures has been confined to sediment used in construction of fill slopes and lacks the various-sized material. In addition, road fills generally have stumps from large trees, but do not contribute large wood with root wads upon failure that historically provided valuable structure to the channel.

Channel conditions within the drainages of Deer Cr. reflect the intensity of management within this landform block. Tables 4-2 and 4-3 outlines the road density, total harvest, and percent harvest of the Deer Cr. subwatershed (see Figures 3-17 and 3-17a for subwatershed and drainage locations and names). With 36% of the subwatershed in a harvested or roaded condition, this subwatershed is the most heavily managed in the Upper McKenzie watershed. Table 4-3 also displays the percent harvest and roaded, and road density for selected drainages within the Deer Cr. subwatershed. Note that nearly all of the drainages within the Deer Cr. subwatershed have 35% or more of the drainages in a managed condition except for Budworm drainage.

Additionally, almost the entire west facing (east side) of the Deer Cr. watershed is located within high potential contribution to rain-on-snow, including Brush and Cadenza drainages (Figure 3-17a). The ARP value for the Deer Cr. subwatershed is one of the lowest values for the watershed at 73, with many of the ARP values in the Deer subwatershed ranging from 50-78. Although some of the drainages appear to be relatively recovered hydrologically, such as Upper Deer and Deer Complex, they are still likely experiencing increased peak flows. As discovered in a small basin study by Jones and Grant (in review 1994b), peak flow discharges increased by more than 25% for as long as 25 years after the drainage had been harvested and roaded. Channel bank cutting, high bedload transport, and wide, shallow channels indicate that removal of wood and high

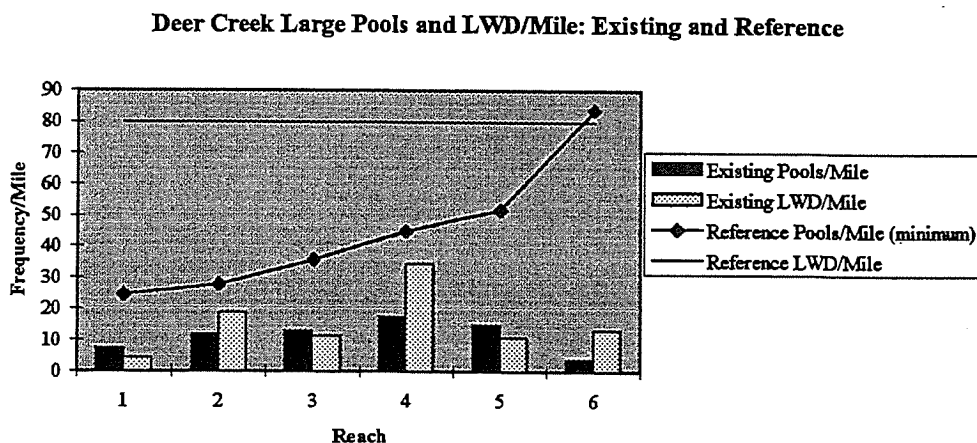
stream flows in Deer Cr., Carpenter Cr., County Cr., and Fritz Cr. have altered channel features.

Timber harvest on the earthflow complex in the Conroy Cr. drainage many years ago triggered a large landslide, leaving an escarpment over 100 ft. high. The resultant sediment and slide material never reached Deer Cr. due to the large bench below the slide area.

Stream surveys from the early 1990's reflect the instability and a wide range of channel conditions observed in this Landform Block. Some tributary channels currently contain over 300 pieces of large diameter wood per mile, present as debris jams or windthrow patches. As in Carpenter Cr., high winds from the southwest can funnel through the northeast trending tributaries and knock over stream buffers or edges of timber stands. Less managed tributaries such as Budworm Cr. have LWD counts more closely representing regional historic volumes of in-stream wood. Pool frequency drops significantly in low gradient reaches (<10%) including Deer Cr., reflecting high volume sediment transport and pool filling.

Pool frequency and volume of in-stream large wood in Deer Cr. are lower than reference conditions representative of Cascade streams (Figure 4-12). The low proportion of pool-to-riffle habitat (1:6.7) and high bankfull width-to-depth ratio (25:1) in lower Deer Cr. are also indications of channel simplification.

Figure 4-12



From USDA Forest Service Level II Deer Cr. survey, 1994. Appendix 4 describes habitat evaluation criteria.

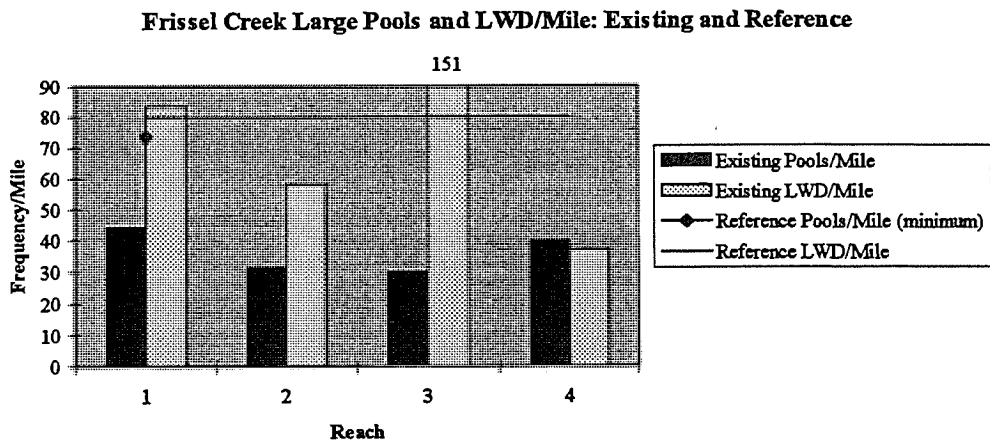
Past habitat enhancement projects in lower Deer Cr. (1988) sought to improve low pool frequency and side channel habitat, and to improve volume of in-stream wood. Boulders and large wood were placed in the lower mile, resulting in an increase in pocket-pool area and available cover. A deflector dam directs

Deer Cr. flow into 100 feet of side channel habitat. An additional 300 feet of side channel habitat was restored in the lower mile by excavating and armoring side channel inlets. Lower Deer Cr. continues to be characterized by low quantities of structure to deflect flows, abandonment of side channels, and low LWD recruitment potential, factors contributing to simplification of the channel (USDA Forest Service EA 1994).

Frissell Creek Aquatic Habitat Condition

Frissell Cr. aquatic habitat condition reflects recent disturbance. A bedload with high percentage fines and embedded cobbles reflect frequent road-related failures within the drainage. A 1985, large slope failure near the confluence with the McKenzie River contributed to higher bankfull width-to-depth ratio (10) in Reach 1 as compared to upper reaches (5-3). A 1993 road decommission of 5 miles along Frissell Ridge seeks to reduce the frequency of slope failure. Six road related failures have been recorded in the Frissell drainage. Slope failures, hardwood dominated regeneration and harvest units across the channel contribute poor LWD recruitment potential. Current LWD counts meet reference condition in Reach 1 and 3 (Figure 4-13). Reach 1 LWD is found concentrated in debris jams.

Figure 4-13



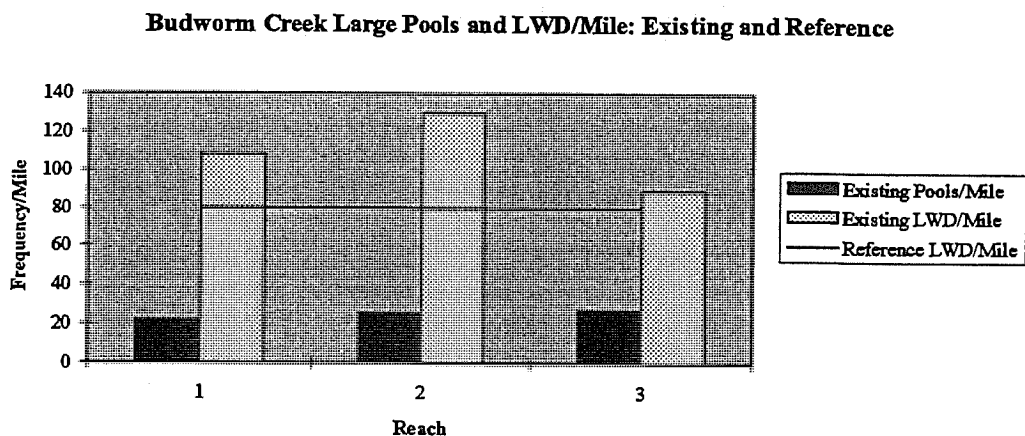
From USDA Forest Service Level II Frissell Cr. survey, 1992. The Fisheries Appendix describes habitat evaluation criteria. Reference pool frequency, based upon active channel width, is not estimated for channel gradients >10% as in Reach 2, 3, and 4. Reach 3 is a large tributary draining Frissell Creek's south-facing slope.

Recent slope failure, channel aggradation, and pool filling by fines are factors influencing lowered pool frequency in Reach 1. The 1992 biological survey of Frissell Cr. found a population of cutthroat trout along the lower 2.0 miles and fingerling chinook salmon rearing in the lower tributary. Stream temperatures recorded by surveyors did not exceed 14 deg. C for the period of July 6-20, 1992.

Budworm Creek Aquatic Habitat Condition

Budworm Cr. supports a population of cutthroat trout in its lower two miles. Rainbow/steelhead juveniles have been observed in Budworm's lower reach. Channel condition in lower Budworm Cr. represents a "least managed" condition of tributaries in this Landform block.. Although approximately 25% of the upper half of the tributary has been clear-cut during the 1980's, habitat conditions in the channel remain good. Road density is lower in the Budworm/Frissell block compared to adjacent drainages, averaging about 2.3 miles/mile². Reference levels of large wood are present, well distributed within the channel (Figure 4-14). Recruitment potential of large diameter LWD is excellent in the lower 1.5 mile.

Figure 4-14



From USDA Forest Service Level II Budworm Cr. survey, 1992. The Fisheries Appendix describes habitat evaluation criteria. Reference pool frequency, based upon active channel width, is not estimated for Budworm Cr. reaches as channel gradients exceed 10%.

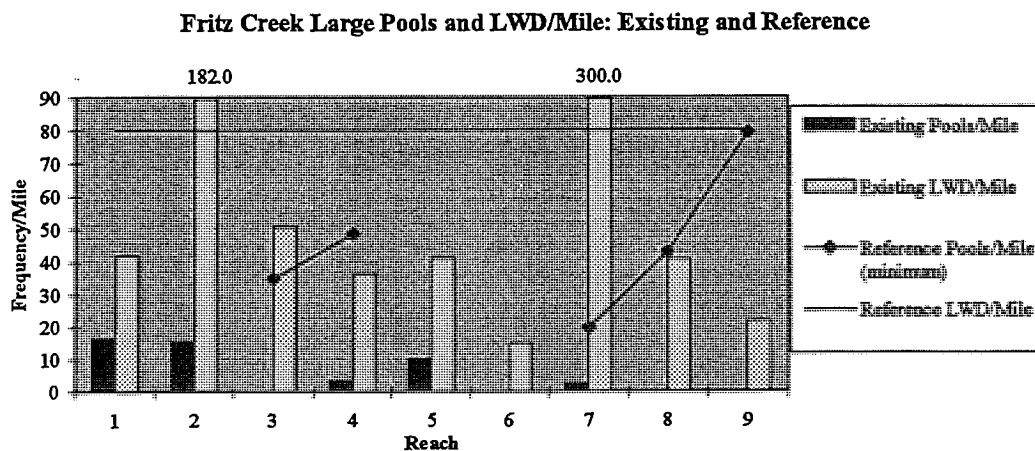
Pool frequency is good with 22 to 28 large pools/mile and pocket pools occupy 10-25% of riffle area. Management activity in the drainage is comparatively lower than adjacent Deer Cr. tributaries. Cobbles are embedded in Reach 2 and 3, however average pool depths (1.9 and 1.6 ft., respectively) and bankfull width-to-depth ratios (6 and 5, respectively) remain good. Stream temperatures meet the proposed average 7-day maximum ODEQ standard of 17.7 deg. C for perennial streams.

Fritz Creek Aquatic Habitat Condition

The moderate reach gradients found in Fritz Cr. provide habitat for a population of cutthroat trout in its lower 3.0 miles. A January 1990 windstorm leveled buffer trees in Unit 197 and account for high LWD counts in Reach 7 (Figure 4-14). Low pool frequency and shallow pool depths are consistent with frequent

bank failure and high bedload transport observed in the 1990 survey. Similar to Deer Cr., pool frequency drops significantly in low gradient reaches (<10%), reflecting high volume sediment transport and low quantities of in-stream wood.

Figure 4-15



From USDA Forest Service Level II Fritz Cr. survey, 1990. Fisheries Appendix describes habitat evaluation criteria. Reference pool frequency, based upon active channel width, is not estimated for channel gradients >10% as in Reach 1,2,5 and 6.

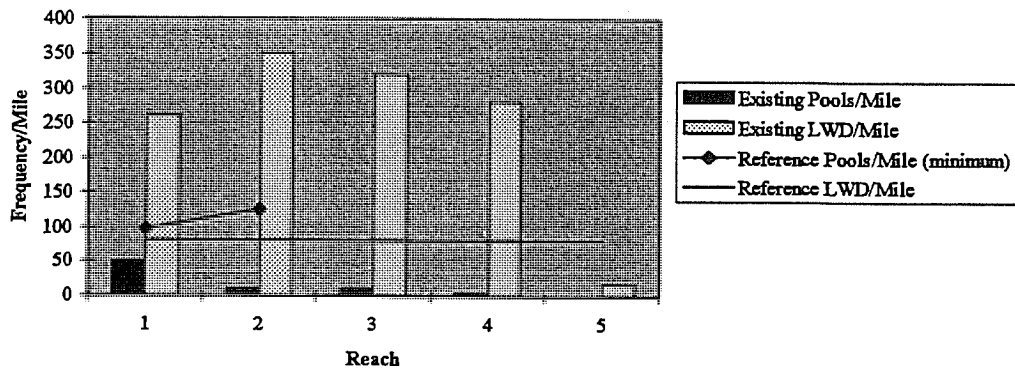
Large sediment storage areas occur behind several debris jams. The volume of in-stream large wood in Fritz Cr. is generally lower than reference conditions representative of Cascade streams. Salvage of in-stream LWD may account for low volume. A culvert passage barrier restricts upstream fish migration in Fritz Cr. above Forest Road 2654. A second culvert passage barrier exists one mile upstream, also restricting upstream fish migration beneath Forest Road 2655-503.

Carpenter Creek Aquatic Habitat Condition

Mass bedload transport characterizes the lower four reaches in Carpenter Creek. Accumulation of sediments in the channel from the drainages' highly erodable soil originated from slope and bank failures, bank cutting, and windthrown trees. The high volume of LWD observed in the first four reaches came from a combination windthrow and slope/bank failure (Figure 4-16). With high winds from the southwest funneling down the northeast trending channel, buffers or unit boundaries were subject to blowdown. High flow events have recently recruited bank trees in this deeply dissected drainage and concentrated wood into debris jams. The current channel is a stair-step of well embedded debris jams and stored sediments. Future recruitment potential of LWD is poor as a result of recent stream adjacent conifer harvest.

Figure 4-16

Carpenter Creek Large Pools and LWD/Mile: Existing and Reference

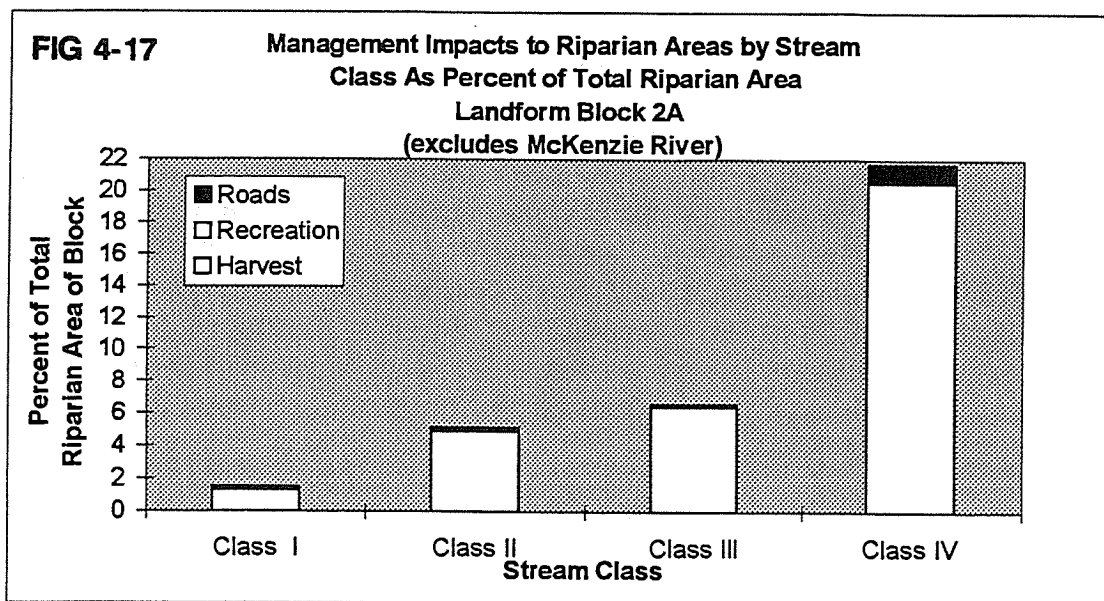


From USDA Forest Service Level II Carpenter Cr. survey, 1990. The Fisheries Appendix describes habitat evaluation criteria. Reference pool frequency, based upon active channel width, is not estimated for channel gradients >10% as in Reach 3, 4, and 5.

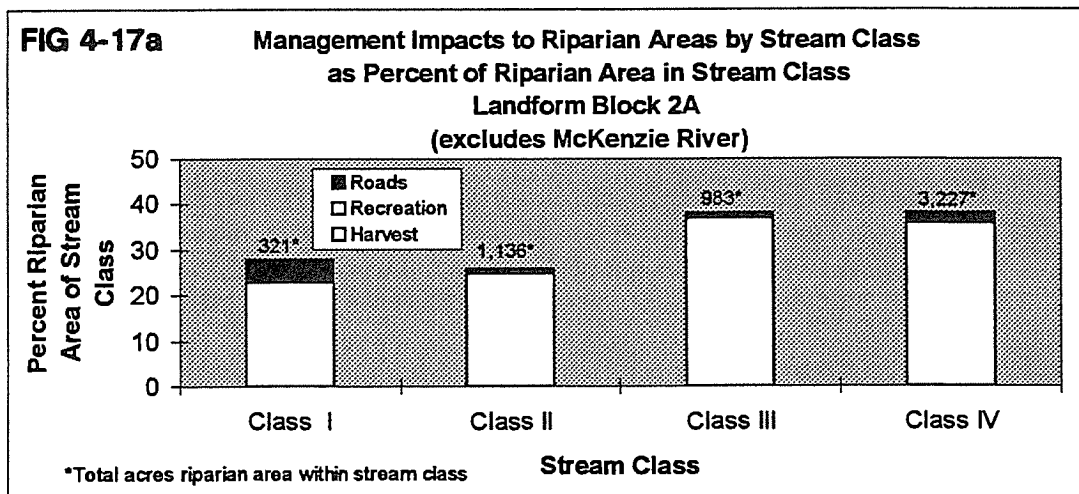
Cutthroat trout may have been present throughout Carpenter Creek's moderate channel gradient, but past disturbance (debris torrents) and current passage barrier jams may restrict their current range to the lower portion of Reach 1.

RIPARIAN VEGETATION

Of the total riparian area located within this landform block, Class IV streams are by far the most heavily altered, with nearly 22% of the riparian area harvested and roaded (See Figure 4-17).



Although it appears as though Class I, II, and III riparian areas are only slightly altered with 1-7% disturbance of the total riparian area, they are actually affected by 26-38% when looked at on a percentage of the riparian area for the given stream class (Figure 4-17a). Twenty-eight percent of the riparian area along the Class I stream of Deer Cr. has been harvested or roaded; 26% of the riparian area along the Class II stream (mainly Deer Cr., Fritz Cr., and some of Budworm) has been harvested or roaded; and 38% of the riparian area along Class III streams of the entire Block 2A have been harvested or roaded. The effects of these impacts range from increased stream temperatures due to lack of shading on the perennial streams (Class I, II, and III); reduced amount of LWD input important for channel stability and aquatic habitat; and reduced nutrient input to the stream.

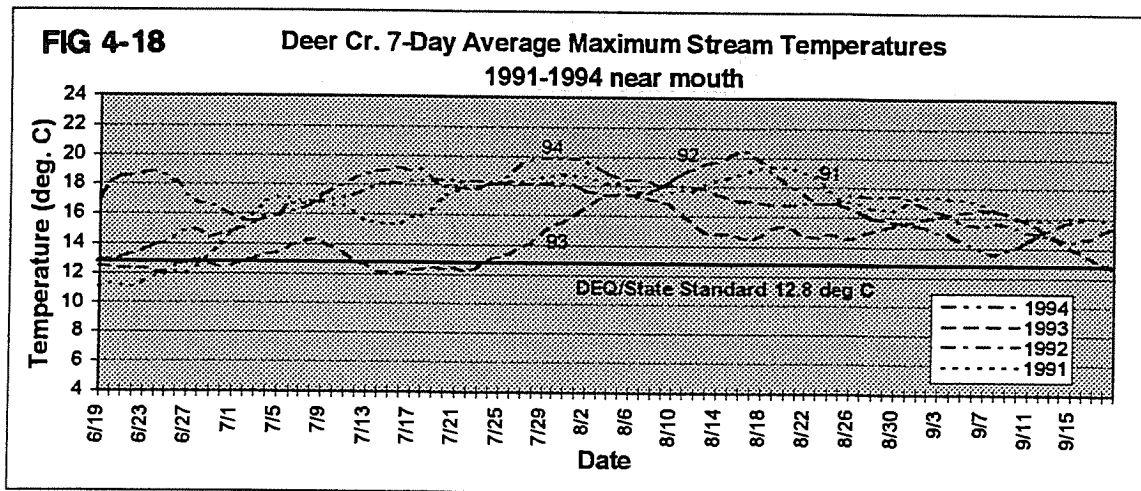


STREAM TEMPERATURE

Stream temperatures within this landform block are considered to be the most problematic of the entire watershed. Specifically, Deer Cr. has very high summer stream temperatures, and excessive temperatures is one of the possible reasons that spawning by adult chinook salmon is limited. Salmon and trout have evolved to the temperature patterns of the subbasin and deviations may adversely affect their survival. Warming of spawning and rearing tributaries can significantly diminish survival by altering migration timing and accelerating maturation, incubation and emergence timing. Spring chinook optimal spawning temperatures range from 5.6-13.9 deg. C (beyond which mortality increases) and optimal incubation temperatures range from 5.0-14.4 deg. C (Bjornn and Reiser 1991).

The apparent minimal use of lower Deer Cr. by spawning and rearing spring chinook and foraging bull trout likely reflects habitat degradation, including elevated stream temperature, beyond those species tolerance. Water quality standards established by the state and published by the Oregon Department of

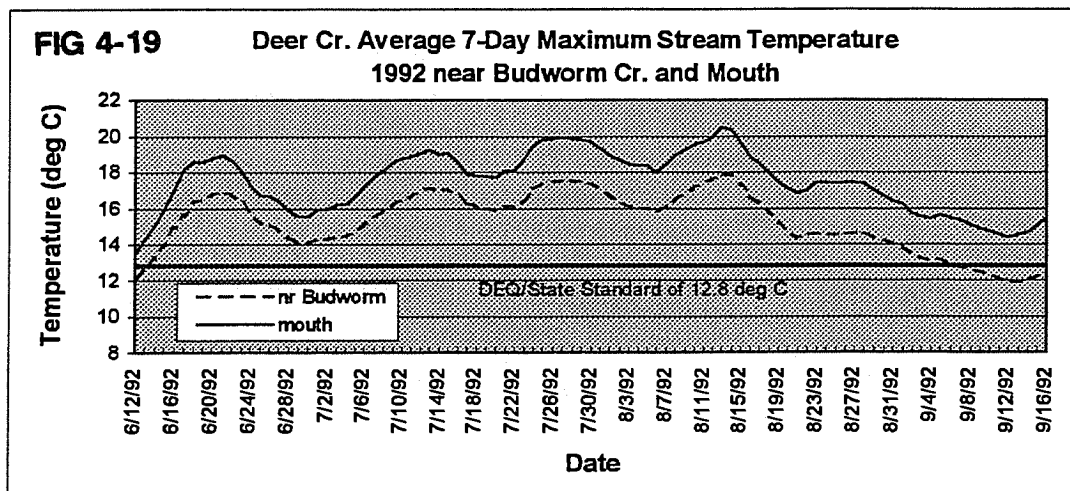
Environmental Quality have recently been reassessed for stream temperatures. New standards, which are not yet published, require that the moving average of the 7-day maximum stream temperature not exceed 55 deg. F. (12.8 deg. C) for anadromous spawning and rearing streams such as the lower 1.5 miles of Deer Cr. (DEQ 1994). Figure 4-18 display the 7-Day average maximum stream temperatures for 1991 through 1994 at the mouth of Deer Cr. Note that all years exceed state standards, and there does not appear to be a declining trend.



An analysis of stream temperatures for Deer Cr. was done for the Clipper EA in 1992 by the district hydrologist. In that report, data collected by the District Biologist in 1984 was analyzed and it was determined that the majority of heating occurred in the mainstem of the creek, while most of the tributaries contributed to cooling of the mainstem. Though no data exists prior to timber harvest within the Deer Cr. subwatershed, indications from the 1984 data are that much of the heating source is within the mainstem below Brush Cr. for approximately one mile downstream, where harvest of riparian vegetation that took place 26-32 years ago has not yet recovered to the point of providing adequate shading.

Another major source of heating is also within the mainstem near the mouth of Deer Creek. The EWEB powerline is located directly in the floodplain and crosses the creek at an obtuse angle in three separate locations. Construction of the powerline required removing the tall, coniferous riparian vegetation which has been replaced by small, deciduous trees and shrubs for approximately one mile of stream length. Additionally, the main road access into the subwatershed runs directly up the floodplain, also reducing the potential area that could be vegetated. As a result, the current riparian vegetation is inadequate to shade the stream channel from incoming solar radiation. Figure 4-19 displays the average 7-day maximum stream temperature for 1992 at the mouth of Deer Cr. and at a location upstream from the influence of the powerline corridor and road (near

the mouth of Budworm Cr.). Note that in the distance of one mile traveled, stream temperatures increase by as much as 5.4 deg F (3 deg C.) and range from 2.5 to 5.4 deg. F. (1.4 - 3.0 deg C).

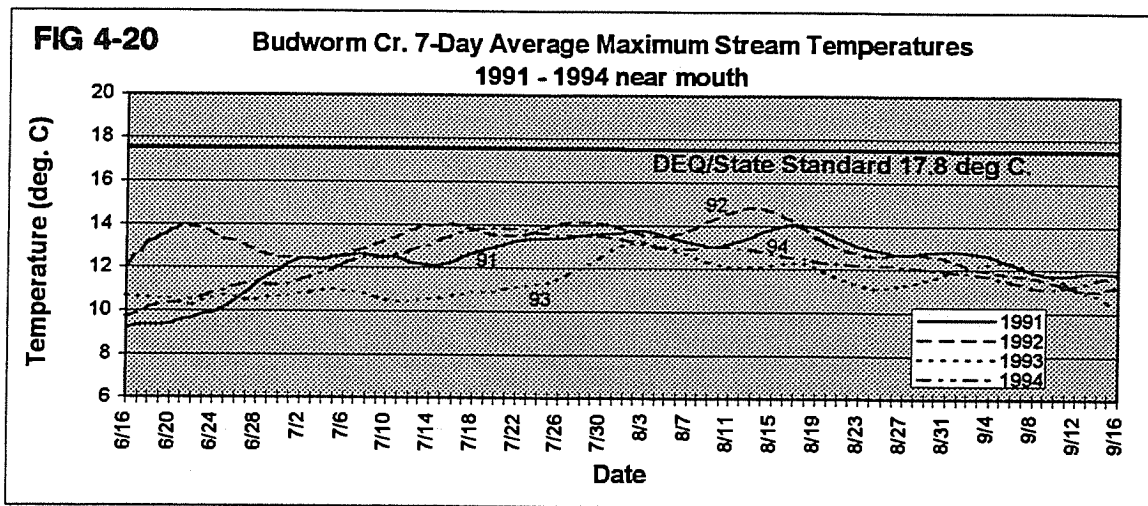


Existing high stream temperatures likely limit current spring chinook and bull trout use within this landform. Current spring chinook spawning use of Deer Cr. is extremely limited (one redd in 1993), and some chinook juveniles entering from main stem McKenzie to rear in lower Deer Cr. margins and side channels.

A tributary to Deer Cr., Budworm Cr., also has been monitored for summer stream temperatures near its mouth from 1991 through 1994. State standards for maximum stream temperatures which were reassessed and are not yet published require that the 7-Day average maximum stream temperature not exceed 64 deg. F. (17.8 deg. C). Budworm Cr. is considered to be in a fairly unaltered state from management. Where limited harvest activities have occurred, no-harvest riparian buffers were left along Budworm Cr. to ensure stream temperatures would be maintained. Note that for all four years, summer stream temperatures met state standards (Figure 20).

Comparing the stream temperatures at the mouth of Deer Cr. to those temperatures measured in Budworm Cr., one would not expect to find Deer Cr. stream temperatures to be cooler than Budworm. The best we could expect for summer stream temperatures at the mouth of Deer Cr. would be temperatures found in Budworm Cr. And yet, even the temperatures in Budworm Cr. exceeded state standards set for Deer Cr. of 55 deg. F. (12.8 deg. C). In conclusion, although stream temperatures are acknowledged to be elevated in Deer Cr., the standard set by the state and DEQ may not be achievable for Deer Cr., even given ideal conditions.

Maintenance of roads and utility corridors continue to restrict long term sources of in-stream large wood and stream shade (USDA Forest Service EA 1994).



High stream temperatures recorded in lower Deer Cr. in recent years are a result of decreased stream shade, particularly downstream of Budworm confluence; Deer Cr. channel's south flowing orientation; and probable warmed tributary contribution from the harvested upper landform.

Human Disturbances and Effects - Campsites

Dispersed Campsites, Developed Recreation Facilities and Administrative Sites: Block 2A is unique in that it has no inventoried dispersed campsites; no developed recreation sites such as campgrounds, picnic areas or boat launches; no wilderness; and no administrative sites or recreational special use permit areas. It is a roaded area with fairly heavy timber harvest in the past. However, this area does lend itself to some recreational activities. Huckleberries and blackberries are gathered here late in the summer, as are Christmas trees if snow allows winter access. Forest visitors who enjoy driving backcountry routes will often drive through this area on the way to Wolf Rock, a local landmark located adjacent to the landform block's boundary.

LANDFORM BLOCK 2B:

WESTERN-HIGH CASCADE TRANSITION ZONE

(Western Cascade Cirque Ridge, Plio Cascade and High Cascade Platform Systems of Wilson 1981)

Introduction

This landform block is characterized by west-east flowing streams (Park Creek, Hackleman Creek, Browder Creek and Bunchgrass Creek) that originate in glacially carved valleys of the Western Cascades. The exception is northeast trending Ikenick Creek, which flows into Clear Lake. The valley segments through these stream reaches are steeply incised and prone to mass wasting. This is due to the older, lower strength bedrock of the Western Cascade formation being more susceptible to erosion and slope failure. Incision rates have been higher in the geologic past in the Western Cascades due to stream gradients being twice as high as present during the Western Cascade uplift (Long 1991).

As the west-east streams cross the north-south trending contact between the older Western Cascades and younger High Cascade platform lava, the valleys broaden into meadows. More resistant and younger basalts and andesites are encountered. The streams finally confluence with north-south flowing, fault-controlled McKenzie and Smith rivers. Debris avalanche tracks are evident in the Hackleman Creek area (Figure 4-21).

Disturbance History - Mass Wasting

Landform Block 2B contains 5 of the 19 road related failures in the watershed. Debris avalanche potential exists in the upper elevations of Hackleman, Bunchgrass, Browder, Park and Crescent Creek drainages. A large Quaternary landslide has been mapped by the U.S. Geological Survey 2 miles northeast of Crescent Mountain. No recent movement could be discerned from the air photo surveys (Figure 4-22, 4-23))

Landform block 2B contains SRI Unit 3 potentially on all slopes; and Units 13, 16, 301, 610, 610U, 614, and 71 on slopes greater than 70%.

Figure 4-21. Landform Block 2b Locator Map

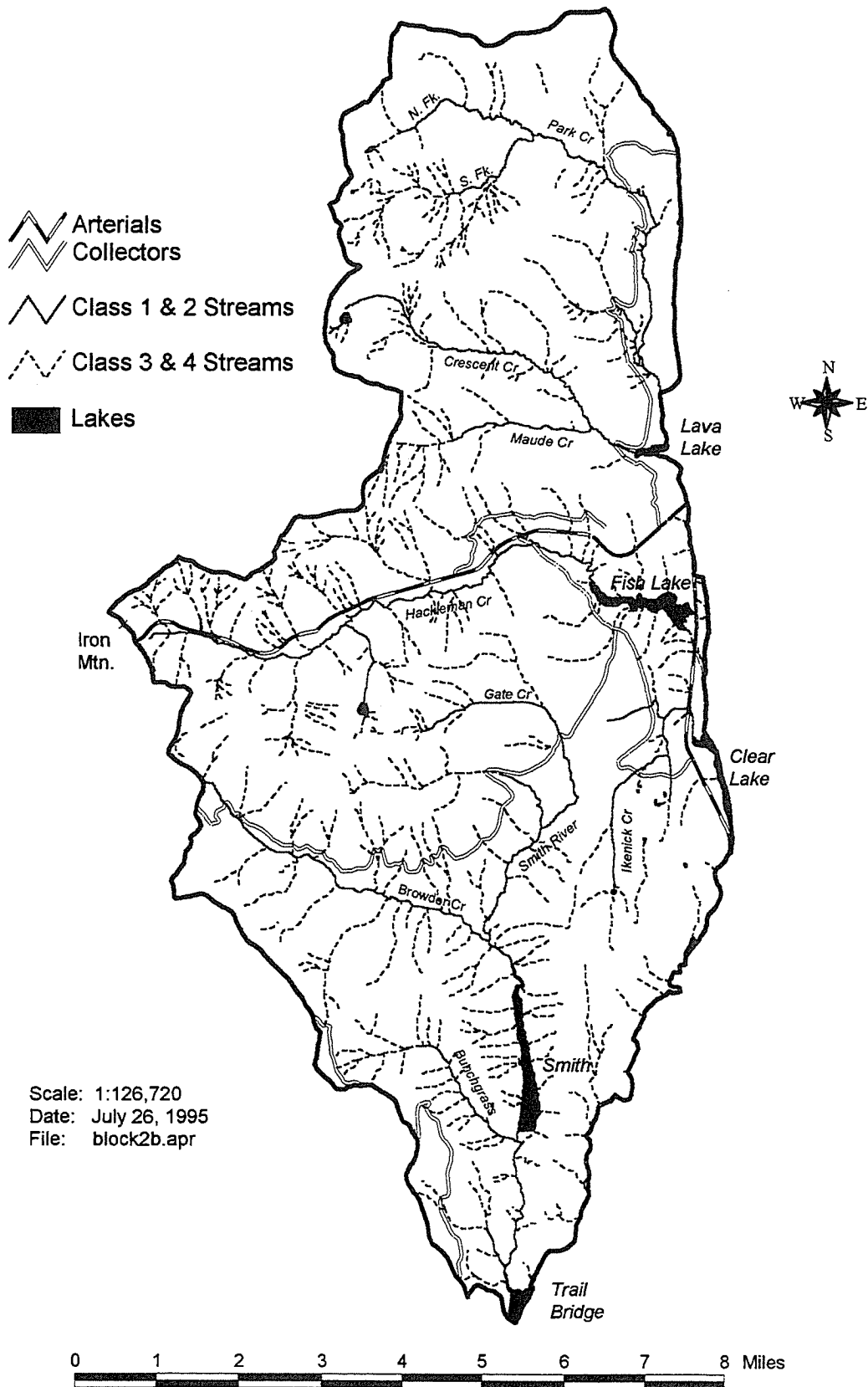


Figure 4-22. Landform Block 2b Potentially Unstable Areas

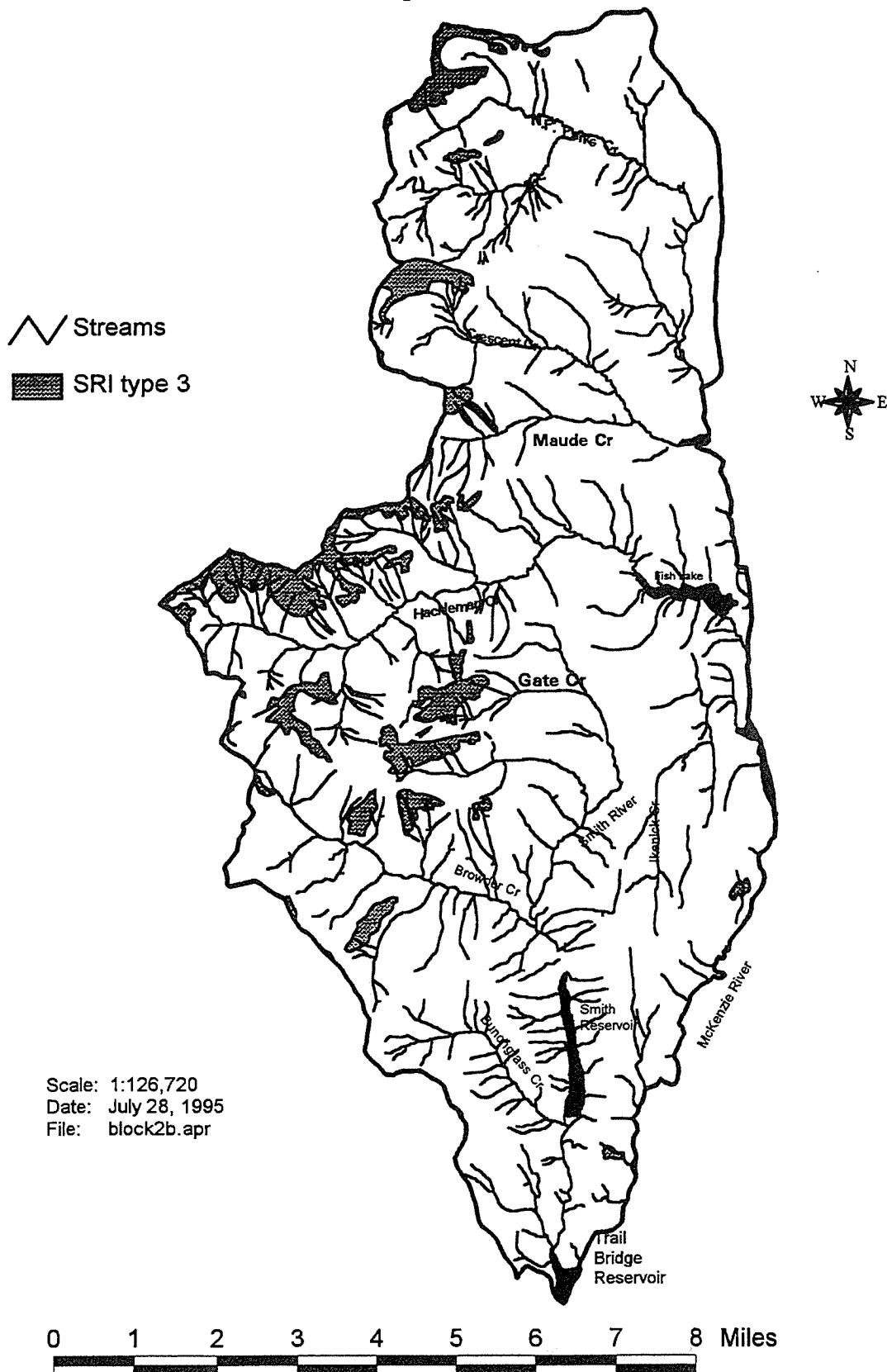
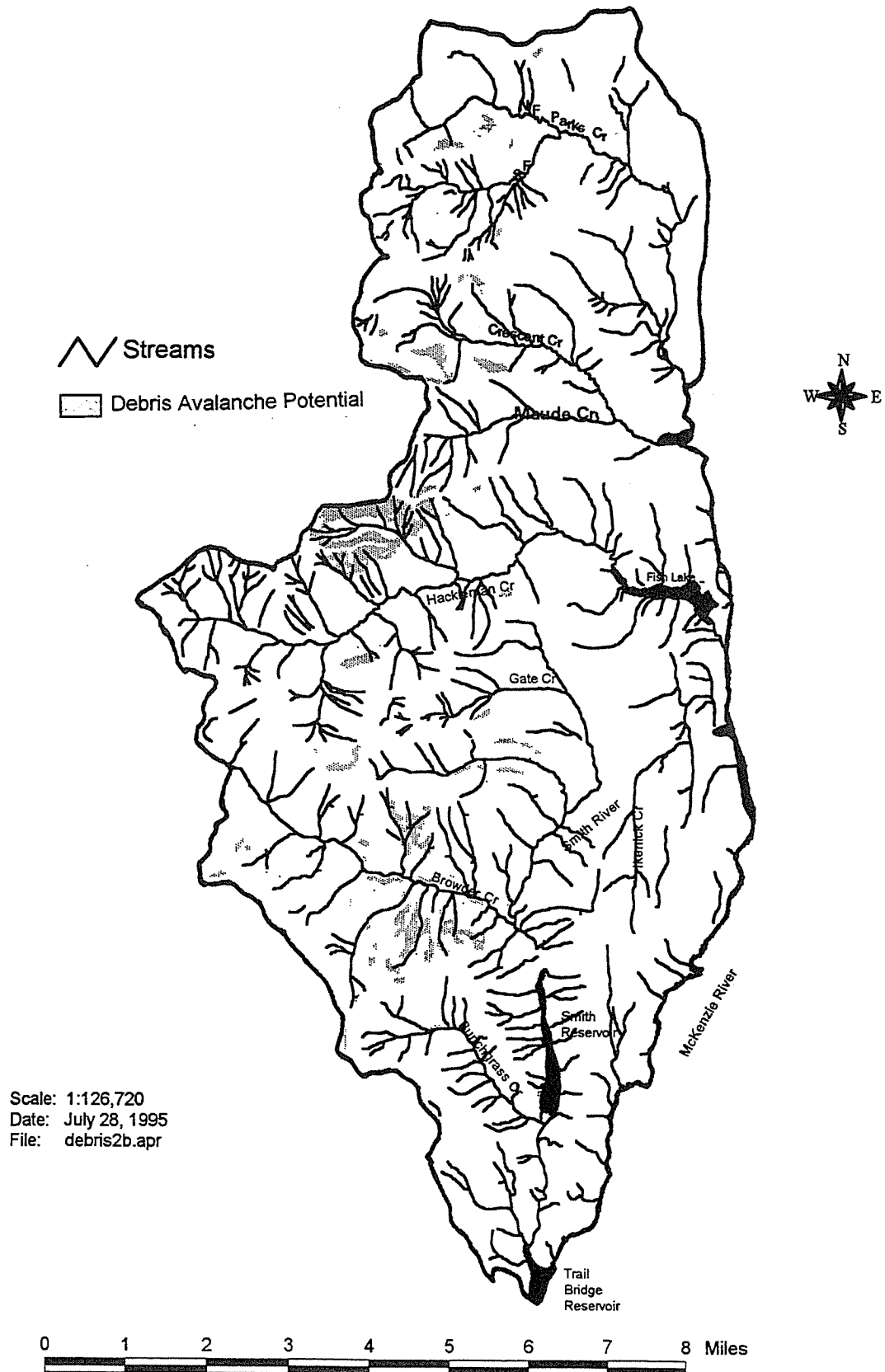


Figure 4-23. Landform Block 2b Debris Avalanche Potential



Disturbance History - Fire and Vegetation Patterns

The vegetation of this block is mostly Pacific silver fir (ABAM) and western hemlock (TSHE) plant series. For further discussion of the associated plants, stand development pattern, and ecology of these plant series, see the Upland Vegetation section of Chapter 3.

Strong east and west winds in this area are channeled between Wildcat Mt. and Browder Ridge; Browder Ridge and Iron Mt.; and between Echo Mt. and Crescent Mt. Other areas, with the exception of the ridgetops, are subject to the normal up-slope and up-valley daytime winds.

The forested stands in this block were formed by medium-sized, intermediate-frequency, stand-replacing fires. Small-sized, relatively frequent, and low-intensity lightning fires also occurred in this block, resulting in a high level of patch diversity. Fire influences have been complicated in this area by the presence of current and traditional human travel-ways. Portions of the block that contain these corridors have experienced a significant number of human-caused fires.

Some of the mountain tops and ridge tops have had large areas that frequently burned, either by lightning or by human fire use. Certain creek bottoms in this area apparently have been favored areas for historic summer camping, as evidenced by the open stands of timber. These openings appear to have been maintained over time by the users of the area.

The forest patches in this block are a mix of even-aged and multi-aged stands. The average size of the patches is moderate: 61 acres. This is smaller than the average patch size in 1900, which was 123 acres. A Shannon diversity index for this area indicates a 6% increase in diversity between 1900 and 1995. The index increased from 1.20 in 1900 to 1.27 in 1995. This is a reflection of the increased availability of small, early seral patches on the landscape from clearcutting.

Unique Habitats

Table 4-6 and Figure 4-24 display the unique habitats present in this landform block. This area has the largest concentration and greatest diversity of non-forested plant habitats within the watershed. These habitats and associated plant communities are rich in floristic biodiversity.

Table 4-6: Unique habitats within landform block 2A.

Habitat Feature	Acres
Wet meadow	402.4
Dry meadow	17.51
Mesic meadows	3.67
Herb/Forb meadow	1529.8
Shrub communities	2.78
Shrub lava	55.73
Lava	272.93
Rock outcrops	343.66
Lakes	.58

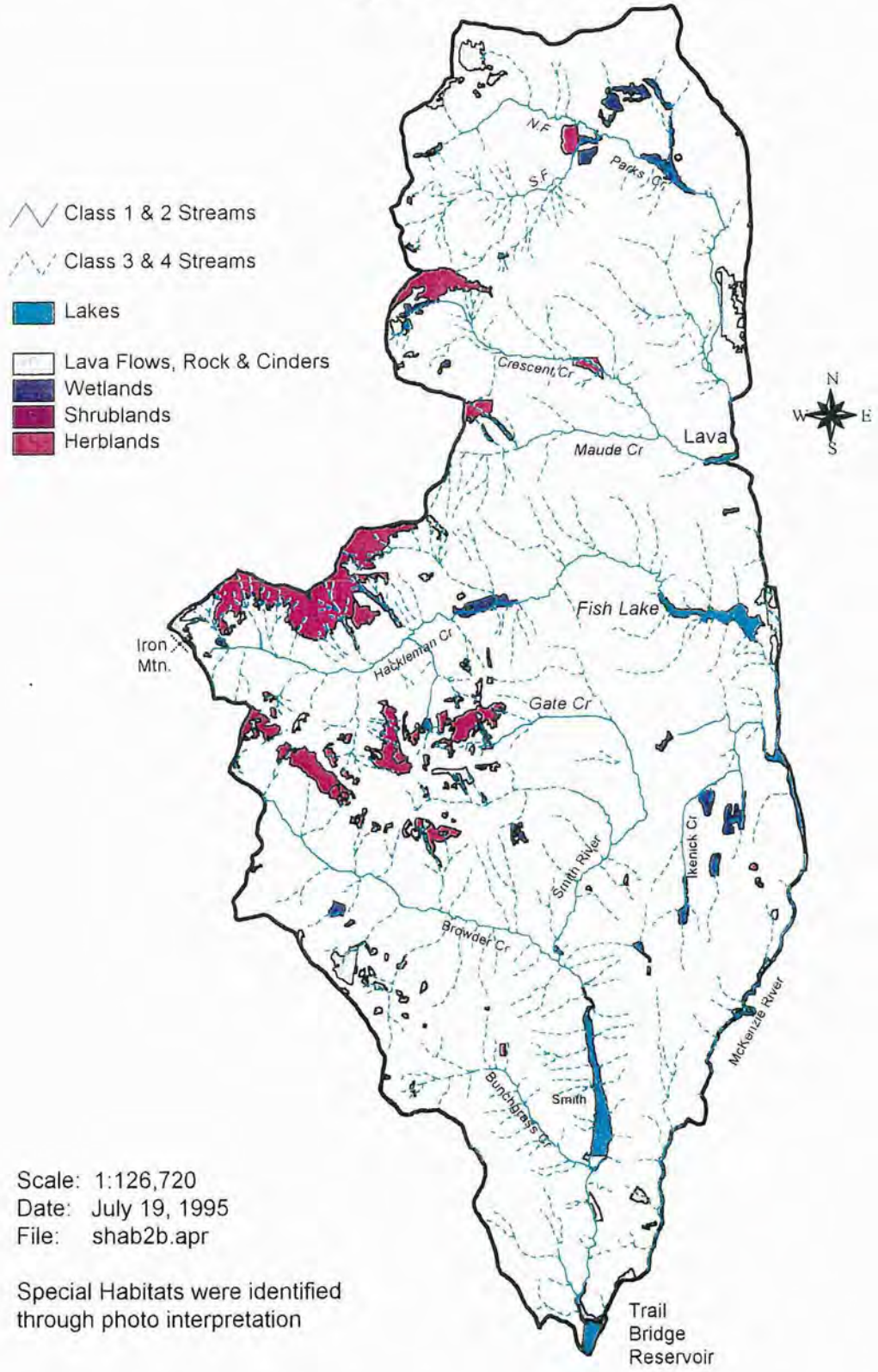
The prominent non-forested habitat type in this landform block is meadow communities, particularly along Browder Ridge. Dry meadows occupy the south-facing mountain slopes. Typically these meadows develop in shallower soils than the adjacent forested areas. These meadows have evolved with recurring periodic fires. Wildfire suppression activities have removed the role fire once had on the maintenance of the native vegetation. The periodic burning of meadow vegetation stimulates vigorous new growth, consumes dead and dying plants and reduces shrub and tree invasion. Bunchgrass Meadow is planned to be burned to reduce conifer encroachment. There are several other meadow communities that would benefit from a light surface burn.

Large wet plant communities are found at Smith Bog, Fish Lake and the wet meadows associated with the Parks Creek area to the north of the watershed. Smith Bog and Fish Lake are very resilient plant communities. Smith Bog and Parks Creek have populations of beavers. Beaver activities are known to alter plant composition and structure. Although livestock have been grazing at Fish Lake since the early 1900's, species' composition of the sedge meadow has not been severely impacted.

Smaller wetlands within and near harvest units have been impacted by past logging practices. The removal of the overstory canopy or adjacent forested areas alters the hydrology of these habitats. Changes in the hydrology of these communities alter plant species composition and succession, which may have impacts to the wildlife species that use these habitats.

Wet and dry rock gardens are scattered across the older Cascade peaks. Many of these habitats have been impacted by the removal of adjacent forested stands and the subsequent change in the microclimate. An increase in solar exposure increases the air and soil temperatures which can alter the vegetation composition of these habitats. Rock gardens adjacent to hiking trails are impacted from soil disturbances. Soil disturbance provides noxious weeds and other non-native plants the opportunity to become established. The noxious

Figure 4-24. Landform Block 2b Special Habitats



weed St. John's wort is a serious threat to the integrity of the plant communities on Iron Mountain.

Two rare forested plant associations (PSME/HODI/GRASS and ABGR/BENE) are found in this landform block. The Pacific silver fir/devil's club plant association occurs frequently in this landform block where soils are deep and drainage is impeded or near streams. These sites have high wildlife values. Remnant patches of Alaska yellow cedar (*Chamaecyparis nootkaensis*) are found in avalanche chutes, and swampy wet areas. These uncommon forest types contribute to the biodiversity of forested plant communities.

This landblock contains high quality cliff habitat for peregrine falcons. Sightings have been recorded. Fish and Lava lakes are providing high quality habitat for many wildlife species, including several threatened and sensitive species such as bald eagle and sandhill cranes. Meadow complexes in this area include Smith Prairie, Crescent Mtn., South Pyramid, Wildcat RNA, and Fish Lake (during summer months). Wetland areas include Smith Ridge SWHA and Lava Lake. Maintenance of water quality, hydrological processes, and riparian/meadow vegetation are critical for these habitats to continue to function. The majority of these areas are protected from threats through Special Wildlife Habitat Area or Research Natural Area LMP designations. These habitats are not currently being threatened with the exception of Fish Lake. Though grazing is occurring at Fish Lake, high quality habitat is still being provided for several sensitive species.

Sensitive Plants

Potential habitat for sixteen sensitive plant species occurs within the landform block. Three sensitive plant species and numerous other species of concern have been documented (Table 4-7). The population center for the sensitive species Thompson's mistmaiden (*Romanzoffia thompsonii*) is located along the rocky, south-facing slopes of Iron Mountain, Cone Peak, and Browder Ridge. Gorman's aster (*Aster gormanii*) is a species proposed to be listed as Threatened by the U.S. Fish and Wildlife Service. Both of these species are locally endemic and found only within a narrow geographical range on the west side of the Cascades. Threats to these sensitive species are disturbances to populations growing close to hiking trails and the invasion of noxious weeds, particularly St. John's wort.

The third sensitive species documented here is the reclusive mountain grapefern (*Botrychium montanum*). This is the only known sighting on the Willamette National Forest. There were no known collections of *B. montanum* in the Northwest prior to 1976 (Wagner 1983). Botrychiums are not 'true ferns' because their sporangia (spore sacs) are borne in clusters on a naked stalk, instead of on leaves as in true ferns. The clusters of sporangia are thought to look like

bunches of grapes. The mountain grape-fern is unique from most other sensitive plant species as it occurs in forested plant communities. It is associated with western red cedar growing on stream terraces. This species is to be considered in altering riparian reserve widths. Threats to this population are loss of shade from the removal of overstory trees and shrubs and damage from ungulate browse.

Table 4-7: Sensitive and Rare Plants Located in the Upper McKenzie Watershed.

Species	Status	Number of pops
<i>Aster gormanii</i> -Gorman's aster	S	2
<i>Botrychium montanum</i> - mountain grape-fern	S	1
<i>Romanzoffia thompsonii</i> - Thompson's mist maiden	S	>6
<i>Castilleja rupicola</i> - cliff paintbrush	R	2
<i>Douglasia laevigata</i> - Smooth douglasia	R	3
<i>Epilobrum luteum</i> - yellow willow-herb	R	2
<i>Hemicarpha occidentalis</i> - western hemicarpha	R	1
<i>Martensia bella</i> - Oregon bluebells	R	1
<i>Tholurna dissimilis</i> - lichen	R	1
<i>Sidalcea cusickii</i> - Cusick's mallow	W	1
<i>Asplenium trichomanes</i> - maidenhair spleenwort	C	1
<i>Botrychium simplex</i> - little grape-fern	C	2
<i>Heuchera chlorantha</i> - meadow alumroot	C	1
<i>Isoetes spp.</i> - quillworts	C	1
<i>Ploystichum lonchitis</i> - mountain holly-fern	C	1
<i>Viburnum edule</i> - squashberry	C	1
The Region 6 Sensitive (S) Plant List; Review (R) List and the Watch (W) List are maintained by the Oregon Natural Heritage Program. The Willamette National Forest maintains a Concern (C) List for locally rare species not included in the first three lists.		

In addition to *B. montanum*, several other species listed in the ROD Table C-3 are found in this landform block. A rare leafy arboreal lichen, *Tholurna dissimilis*, is found growing in the upper canopy of old growth Douglas-fir trees on Iron Mountain. This site is the only known location in Oregon. A rare endemic nitrogen fixing lichen, *Nephroma occultan*, is reported to occur in the canopy of old growth trees along Fish Lake Creek. Of the five known sites of this species

in Oregon, four occur on the Willamette National Forest. Three species of rare and false truffles are found within the Wildcat Research Natural Area (RNA) and one species (*Alpova* sp. 1690) at Hackleman Creek. The extensive timber harvest in the Hackleman Creek area may have removed much of the mature forest near the site where the fungus was discovered. These species of fungi are rare, local endemics known only from these sites. The Wildcat RNA is recommended as a Mycological Special Interest Area (Holthausen, et al. 1994). *Allotropia virgata* is found in a western hemlock stand within this landform block.

Noxious Weeds

Control methods used in this block are manual, biological control agents, and the selected use of rodeo. Spotted knapweed growing along the road should of Hwy. 126 and an isolated population of dalmation toadflax were treated with Rodeo in FY95. Manual removal and the use of biological control agents have been unsuccessful on these species. The toadflax site is the only know location on the Willamette National Forest.

CHANNEL CONDITION AND AQUATIC HABITAT

Sediment production in this landform block was historically high, similar to landform block 2A. However, the large-sized and high-intensity fires that affected this block possibly make this area the highest producer of sediment in the watershed due to the unstable nature of the terrain. This would be particularly true for Browder Creek, Smith River, Bunchgrass Creek, and Hackleman Creek, where the majority of stream length flows through the steeper, more unstable Western Cascades geology. Prior to construction of Smith Reservoir and Trailbridge Dam, the major contributors of sediment to the main McKenzie River in the watershed were likely Smith River, Browder Creek, and Bunchgrass Creek. Although Hackleman Creek produced and transported large quantities of sediment, the change in geology to the low gradient, relatively stable terrain of the high cascades provided depositional, response reaches. As the high gradient reaches of the Western Cascades transported material down Hackelman Cr., the coarser sediments such as boulders, cobbles and some gravels deposited soon after traversing from the high gradient western cascades to the low gradient high cascades. The finer materials of sands, silts, and some gravels were carried further down the channel, depositing at the lakes' edge, into the meadow system, and into Fish Lake.

Fish Lake drains during the summer via an intermittent channel to Clear Lake. Fish Lake Cr. transports very small quantities of fine sediment into Clear Lake. Drainage of the lake also occurs through two drain holes in the center of the lake, which are part of a series of lava tubes connecting to Clear Lake. Fine

sediments that might be transported into these drain holes would be quickly filtered by the porous lava enroute to Clear Lake.

The upper headwaters of Park Creek, Crescent Creek, and Maude Creek, located in the western cascades geology, historically had sediment production rates similar to Browder Creek, Smith River, Bunchgrass Creek, and Hackleman Creek. Large amounts of sediment were produced as debris avalanches and slides resulted from the high intensity fires were quickly transported downstream to the lower gradient, non-transport response reaches within the high cascades geology. Like Hackleman Cr., deposition within the lower gradient, high cascades geology has formed meadow systems through which Park, Crescent, and Maude meander. These low gradient channels were characterized by high pool frequencies. However, unlike Hackleman Cr., a large proportion of their stream lengths is located within the lower gradient, meadow systems. Also like Hackleman Cr., these streams flow into a lake with no outlet that had been dammed by lava flows (Lava Lake). It also drains subsurface through lava tubes to feed Clear Lake and the McKenzie River.

Ikenick Cr. is the only major stream within the landform block that flows entirely within the low gradient, stable terrain of the High Cascades. Historically, sediment production within the Ikenick drainage has been low even though very large, high intensity fires occur within this drainage. All of the streams within this block that flow within the High Cascades had very large, high intensity fires. Fine sediments such as sands, silts and clays may have been transported from these meadow systems down into Lava Lake, Fish Lake, or in the case of Ikenick Cr., into Clear Lake following an intense, large burn.

Historic disturbances that have influenced this landscape include a large, stand-replacing fire prior to 1901 that burned a large area between Squaw and Bunchgrass Mountain to the south to Cone Peak to the north. This large burn would have influenced the unstable slopes of Smith and upper Hackleman Cr. drainages. Fire disturbance has been shown to influence the erosion rates, stream temperatures and nutrient supply. The portions of the landscape that burned reduced the local recruitment supply of in-stream wood until conifer regeneration matured and replenished the supply. No other major fire disturbance has been recorded in this landform since the early 1900's. A 64 acre fire burned near the headwaters of Browder Cr. in 1919.

Major floods also significantly shaped this landscape. Floods and debris torrents changed aquatic habitat by altering pool:riffle ratios (filling and scouring pools); transporting and concentrating large woody debris into jams; modifying the active channel and off-channel habitats by creating new and abandoning old channels; and sorting and silting spawning gravels. Evidence of debris torrents is present in bedrock scoured channels in the Smith River drainage. Flows of

record in excess of 15 year recurrence intervals occurred in water years 1946, 1953, 1956 and 1965.

The source of the McKenzie River's perennial surface flow is Clear Lake. The lava flow that formed Clear Lake isolated a population of cutthroat trout above, while creating natural barriers to upstream migration. Clear Lake is fed mainly by subsurface flow. The largest flows are from springs on the lake's north and east shores. Fish Lake Cr. and Ikenick Cr. supply Clear Lake with surface flow on the north shore. This low production lake never stratifies and has Secchi disk depth in excess of 100 feet. The recent volcanism that created Clear Lake also dammed the Hackleman, Parks, and Lost Lake drainages, restricting flow from these drainages to subsurface routes to reach Clear Lake below. The isolation of those drainages about 4,000 years ago isolated resident cutthroat trout in their headwater tributaries. Seasonal lakes (Fish, Lava, and Lost Lakes) are present during periods of high flow in winter and spring when basins provide enough flow to exceed seepage through lava. Spring runoff leaving Hackleman Cr./Fish Lake is great enough to flow seasonally over Fish Lake Cr. bed into Clear Lake and provides a corridor for upstream migrating cutthroat trout from Clear Lake. The lake beds of Fish and Lava Lake become meadow during summer and fall as subsurface percolation exceeds basin supply. These lake's long period of isolation is thought to provide the opportunity for genetically unique cutthroat trout population(s).

The high quantities of cold, spring-fed surface water in this high elevation landform provide habitat for unique aquatic macroinvertebrates. Within Landform 2b are found specialized caddisfly whose range is limited to habitat similar to upper Hackleman Creek. Tombstone Prairie Farulan Caddisfly is known from three locations throughout Oregon, including the high elevations of Hackleman Creek's Tombstone Prairie (Schmidt 1968). Occurrences of this species have been in high gradient streams adjacent to old-growth coniferous forest or open road cut areas. Stream channels contained large amounts of woody debris and aquatic mosses. Another aquatic macroinvertebrate, the Tombstone Prairie Oligophlebodes Caddisfly has only been found in Hackleman Creek (Anderson 1976). Both Tombstone Prairie caddisfly are considered Region 6 sensitive species.

Because of fire suppression efforts in the last 50 years, the main cause of mass wasting and sediment production has shifted to road-related failures. As in Landform Block 2A, the quantity of sediment transported from hillslope and into the channels within this Landform may have actually decreased since historic times. However, the character of the sediment probably has changed. Whereas mass wasting from fires or floods would incorporate large trees and various sized sediment, road related failures would generally entrain materials cobble sized and smaller along with some tree stumps. Also, source areas that

historically provided sediment to the McKenzie River have had the supply interrupted by construction of Smith Reservoir.

The streams within this landblock have likely experienced increased peak flows as a result of harvest and roads, though not to the extent of streams in Landform Block 2A. Table 4-3 displays the percent area harvest with roads for subwatersheds Park, Hackleman, and Smith in which Block 2B lies (See Figure 3-17 and 3-17a for subwatershed and drainage boundaries and locations). The area managed for the Park and Hackleman subwatersheds is relatively low, however, the area managed in Smith subwatershed is fairly high and exceeded only by the Deer subwatershed. Indeed, the ARP values for Smith and Hackleman are 82 and 96, respectively, with no value for Park as the entire subwatershed is located in the permanent snow zone and not in the transient snow zone. These high values for hydrologic recovery are due mainly to the small area considered to be within the transient snow zone, because the harvest within the subwatersheds is located within the permanent snow zone, not the transient snow zone. The low percent area managed for the Park and Hackleman subwatersheds is due to the boundaries of these subwatershed encompassing large areas of wilderness and/or new lava flows. When focused down on a smaller scale, it is obvious that drainages within the Park and Hackleman subwatersheds have been extensively managed, with increased peak flows a likely result in Hackleman Cr., Browder Cr., Bunchgrass Cr., Smith River, Danny Cr., and Park Cr. (Table 4-3).

This conclusion is based on data analyzed in a large basin study by Jones and Grant (see Chapt. 3 Overview of Stream/Aquatic Processes for this discussion), and a small basin study by Jones and Grant (see Chapt. 4, Block 2A Streams and Channel Conditions and Aquatic Habitat peak flow discussion). The increases in peak flows result almost entirely from rain events, while rain-on-snow events probably do not contribute to higher flows within this landform block. Figure 3-17b, Potential Contribution to Rain-On-Snow Events, depicts the area east of Smith Reservoir and Smith River below the reservoir as the only high contributing area in the block.

Crescent and Parks Creek and Lava Lake Aquatic Habitat Condition

Crescent and Parks Cr. flow into Lava Lake basin, which flows subsurface to the McKenzie River. Lava Lake bed has been used for domestic grazing since the early 1900's. After the lake bed dried in summer, horses were brought in from 1911-1930, sheep from 1930-1942, horses again from 1945-1966, and cattle from 1967 to present. The animals remained on the lakebed until September (USDA EA 1993[a]). Stream banks within the lake bed meadow are characterized as severely eroded and unstable with little vegetation due to overgrazing. Eighty plus head of elk are observed grazing in the lake bed each spring. The elk leave as livestock are brought onto the allotment. Water quality concerns include

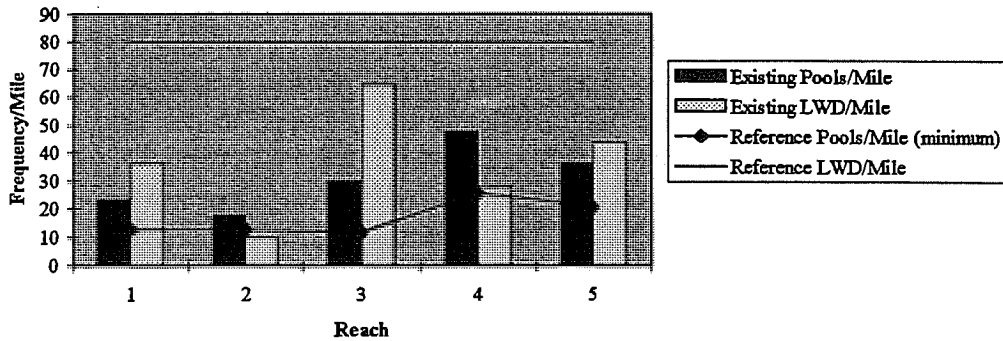
sedimentation and enrichment of surface flow. Fencing to exclude cattle use of portions of Parks Cr. in 1992 resulted in stabilized stream banks and willow survival. In 1993, Sweet Home Ranger District recommended cessation of grazing to improve water quality, riparian and aquatic condition, recreation opportunities, and wildlife habitat. The grazing permit is scheduled to end after the 1995 season.

Fish sampling in 1981 by ODFW biologists found cutthroat distribution throughout Parks Cr., Crescent Cr., and their tributaries. Brook trout established in upper Parks Cr. Brook trout appear to have displaced cutthroat along 3 miles of low gradient pool habitat above and below the confluence of N.F. and S.F. Parks Creek. Cutthroat trout in 1981 were found distributed above brook trout in higher gradient reaches of upper N.F. and S.F. Parks Creek. Both species were found in Brook Trout Cr., a tributary to Parks Creek. It is not known when brook trout were introduced into the Lava Lake system. Brook trout are similarly displacing native cutthroat in Hackleman Cr./Fish Lake system. Monitoring during the past decade by ODFW in Hackleman Cr. saw an increase in proportion of brook trout to cutthroat population. The Parks/Crescent Cr. composition in 1981 was 95.6% cutthroat and 4.4% brook trout.

Low gradients provide for high pool frequency in the Parks Cr. (Figure 4-25) and Crescent Cr. channels. Beaver dams are common. Habitat conditions within regional reference conditions exist for pool habitat, although LWD/mile is present below reference conditions. Certain reaches are deficient of wood due to a natural low density of conifers adjacent to meadows. Elsewhere, recent harvest of conifers in a checkerboard of private ownership provides a poor recruitment source of future in-stream wood as in Reach 2. A 25 acre fire burned an area adjacent to N.F. Parks Cr. in 1973.

Figure 4-25

Parks Creek Large Pools and LWD/Mile: Existing and Reference



From USDA Forest Service Level II Parks Cr. survey, 1993. The Fisheries Appendix describes habitat evaluation criteria. Reference pool frequency is based upon active channel width and channel gradient.

Only cutthroat (no brook trout) were found in the Crescent/Maude Cr., Twelve/Danny Cr. tributaries of Parks Cr in 1981. A potential passage barrier to upstream fish migration in Twelve Cr. may exist beneath FS Rd 2067.

Hackleman Creek and Fish Lake Aquatic Habitat Condition

No current stream survey has been conducted on Hackleman Creek. A 1964 Oregon Game Commission/Forest Service survey found good habitat conditions in Hackleman Creek. Frequent debris jams contributed to a high pool:riffle ratio of 47:53, however much of the wood was subsequently salvaged in efforts to improve fish passage and reduce bank erosion. Approximately 5 miles of Hackleman Cr. and seasonally available Fish Lake and Fish Lake Cr. are currently used by native cutthroat.

A transport corridor for LWD has been interrupted by Hwy 126 over Fish Lake Creek. Large wood historically moved into Clear Lake from the Hackleman Cr. drainage via Fish Lake Cr. is no longer able to continue beyond a highway culvert. Debris from this uppermost part of the McKenzie subbasin historically found its way to the main stem river below.

Fish Lake is an intermittent lake, filling with snowmelt runoff from Hackleman Cr. in the spring, then drying to a sedge meadow in the summer and fall. The lake drains internally through what is believed to be a subsurface lava tube in the center of the lake, and also by surface flow through Fish Lake Cr. into Clear Lake. The lakebed of Fish Lake, when drained to a meadow condition, is approximately 120 acres in size and contains 3.7 miles of winding and interconnected stream channels of Hackleman Cr. and approximately five

permanent ponds. The sedge meadow and streams provide unique habitat to numerous species of wildlife and fish, including the Hackleman cutthroat trout, indigenous to Hackleman Cr.

Historically, the meadow has been grazed by livestock during the summer months, and manipulation of willows (chemical and mechanical removal) and stream channels (rerouting and channelizing) has occurred to increase forage production. As a result of these past management practices, most of the stream miles within the meadow are in poor condition. The streams are downcut into the meadow, are extremely wide and shallow, have very low sinuosity (straight channels that do not meander), and have no overhanging banks. All of these conditions provide poor fish habitat. Both willow and sedge are important to wildlife by providing cover, forage, and structural diversity. Some of the wildlife that use the lakebed include bald eagles, waterfowl, great blue herons, beaver, and osprey.

Stream-side vegetation is important because it builds stream banks by catching sediments; it decreases the erosive force of the creek by dissipating stream energy; and it reinforces banks through its root network. Stream bank stability is reduced within the grazed area due to grazing of vegetation and trampling resulting in stream channel widening, downcutting, and reduced sinuosity. This causes the channel to become very simple in structure with little channel complexity. Vegetation overhang provides cover and food for fish and anchoring sites and food for aquatic macroinvertebrates. Vegetation overhang also protects stream banks from erosion. Stream side willows can shade the stream, act as better bank reinforcement than sedges, and add small wood and nutrients to the stream.

Because of the inherent lack of large wood to this part of Hackleman Creek, undercut banks play an important role as cover for fish. Reduced bank stability due to a lack of stream bank vegetation and grazing early in the year (trampled wet banks) has had an impact upon the amount of bank undercut. Without cover, fish become easy prey for the numerous aerial predators which utilize the lake.

Livestock trampling, stream bank erosion, channel downcutting, and a change in channel shape to a wide, shallow condition, has caused an increase in the amount of stream substrate fine sediment content. As sand and silt content increases in the stream substrate, spawning habitat and cover for fish, and cover and anchor sites for macroinvertebrates decrease.

Approximately eight years ago, 71 acres of the western-most portion of the meadow (59% of the entire meadow) was excluded from grazing. The excluded area contained 1.71 miles, or 63%, of all perennial stream courses in the meadow, and three of the five permanent ponds. Recovery of channel conditions in the

excluded area has been slow, but the gullied stream is showing signs of rebuilding stable streambanks, increasing sinuosity, and providing lush, overhanging vegetation within its newly formed floodplain. Channel shape has recovered enough to allow transport of fine sediment from the bottom of the channels, exposing the cobbles and gravels. Building of the floodplain up from the gullied situation will take many decades.

Two years ago, a management plan was adopted within the Fish Lake meadow to provide for recovery of all perennial streams and lakes. Implementation of the plan began in 1993, with full implementation of a management alternative occurring in 1994. The plan required exclusion of livestock from an additional 23 acres of critical habitat which contained the remaining 1.0 mile of perennial streams, and 0.4 miles (40%) of intermittent streams. An additional 6 acres of non-critical area (containing no perennial streams) was added to the acreage to be grazed located on the eastern boundary of the meadow. With current practices, 33 acres, or 27%, of the entire meadow is grazed during the summer months, and contains 0.6 miles (60%) of all intermittent streams.

Visual estimates of meadow and stream condition since the change in management practices in 1993 indicate an upward trend in channel condition. Monitoring data collected the summer of 1994 will continue throughout the coming years to track condition of the stream channels and riparian vegetation.

Hackleman cutthroat are thought to be a unique population due to their geographic and temporal isolation and have been identified by ODFW as a Category 2, Stock of Concern. Hackleman Cr. has been closed to angling since 1922. Brook trout, established in Hackleman Cr. and Fish Lake, are believed to have migrated downstream after introduction into Heart Lake in 1949. Brook trout were first noted in Hackleman Cr. in 1989. Continuing monitoring by ODFW biologists reveal an increasing proportion of brook trout to cutthroat trout in annual trapping of Hackleman Creek. The potential for extirpation of Hackleman cutthroat from this drainage by competition from brook trout or exposure to disease appears to be a real danger. In 1994, an annual effort to trap Hackleman cutthroat as hatchery brood stock yielded no schools of cutthroat as are usually encountered. Trapping effort in spring 1995 have found Hackleman cutthroat.

Ikenick Creek Existing Aquatic Habitat Condition

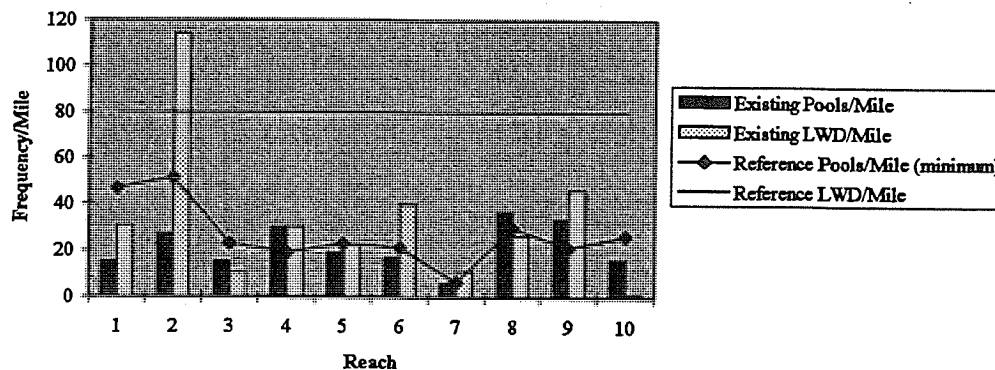
Ikenick Cr. drains Smith Prairie into Clear Lake. The construction of Carmen-Smith-Trail Bridge complex in the early 1960's may have significantly altered groundwater storage and flow regime on Smith Prairie.

Brook trout residing in lower Ikenick Cr. originated from introduction into Clear Lake and now appear to be limited to Ikenick Creek's lower 0.2 mile. The low gradient habitat found above on Smith Prairie would likely provide ideal brook

trout habitat if not for a passage barrier culvert beneath Hwy 126 and steeper gradients of Reach 2. This barrier to upstream migration appears beneficial because it prohibits brook trout from expanding their range into upper Ikenick Creek. Native cutthroat trout are found throughout Ikenick Cr., with brook trout only found in Reach 1 up to Hwy 126 culvert. Low volumes of in-stream wood characterizes most Ikenick Cr. reaches (Figure 4-26). The stream channel and tributaries are adjacent to roads and have been salvaged in the past. Several reaches are deficient of wood due to a natural low density of conifers adjacent to meadows. Reach 2's higher volume of in-stream wood was provided by windthrown buffer of stream adjacent conifers and bank failure.

Figure 4-26

Ikenick Creek Large Pools and LWD/Mile: Existing and Reference



From USDA Forest Service Level II Ikenick Cr. survey, 1993. The Fisheries Appendix describes habitat evaluation criteria. Reference pool frequency is based upon active channel width and channel gradient.

The channel condition is generally characterized as possessing low stream canopy density due to recently managed stands or meadows. Stream banks are often unstable, and bank cutting/failure is common. Low quantities of large diameter in-stream wood are not available to provide cover and a source of pool scour. Several reaches with stream adjacent conifers have poor recruitment potential due to young seral classes. The lack of stream canopy in Ikenick Cr. may warm water temperatures beyond the historic range. A survey of the stream in late June 1993 found temperatures to 18 deg. C.

Pool habitat is near regional reference levels, sometimes exceeding reference minimums. High pool frequency and deep pool depth are common in Ikenick Cr. low gradients. Beaver dams are common. A 15-30 foot wide zone of vine maple and alder hardwoods is characteristic of most reaches.

Clear Lake Aquatic Habitat Condition

A variety of game species have been stocked in Clear Lake since the early 1900's, including non-native cutthroat stocks. It is unknown if native cutthroat remain genetically distinct. Brook trout were introduced in the early 1960's, and they now reproduce naturally. Continued natural reproduction of brook trout is expected to limit survival of juvenile cutthroat trout in Clear Lake (ODFW 1990). Periodic sampling of the lake reveals brook trout comprise about 75% of the lake's fish population. Rainbow trout are the only species currently stocked and do not appear to reproduce naturally in Clear Lake or its tributaries.

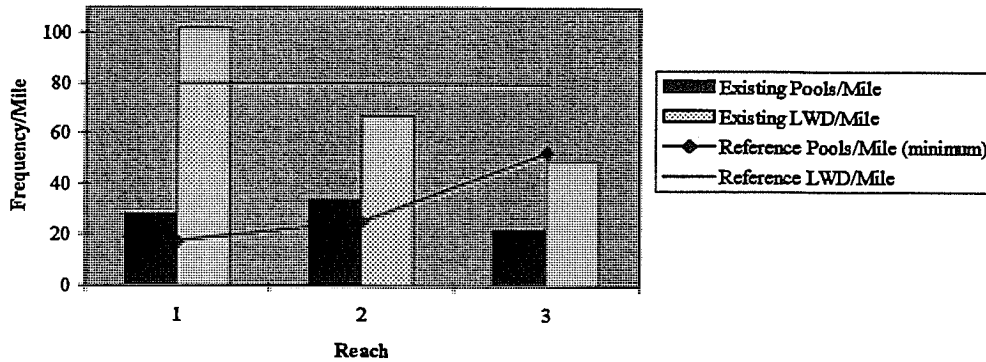
Smith River, Bunchgrass and Browder Creeks Aquatic Habitat Condition

Recent surveys have been conducted on Bunchgrass and Browder Cr. Older surveys (1975 and 1977) are available for Smith River, Gate, Bunchgrass, and Browder Creeks. Twenty years ago, Smith River was characterized as having a wide channel with few pools. Pool depths were shallow and bedrock exposure in the channel was common, suggesting debris torrents had scoured away portions of bedload. Numerous log jams of natural origin (windthrow and bank failure) with stored sediments were common in Smith River upper reaches. The Western Cascade geology is evident with steep side slopes and highly erodable soils. Bunchgrass Cr. typifies larger tributaries with common bank failure, frequent stored sediments behind debris accumulations, and many alluvial bars. Smith River and its tributaries have had their substrate and debris transport intercepted by Smith and Trail Bridge dams. LWD collected behind each dam is removed from the channel to avoid damage to utility equipment.

A recent survey in Browder Cr. reflects Smith drainage's current general condition. In-stream wood is present in fair numbers, but the recruitment potential is poor due to recent harvest activity (Figure 4-27). Pool frequency is best where in-stream wood continues to influence the channel. The upper reach of Browder Cr. (Reach 3) contains fewer pieces LWD, which is lower than reference pool frequency, and poor recruitment potential of large diameter wood.

Figure 4-27

Browder Creek Large Pools and LWD/Mile: Existing and Reference



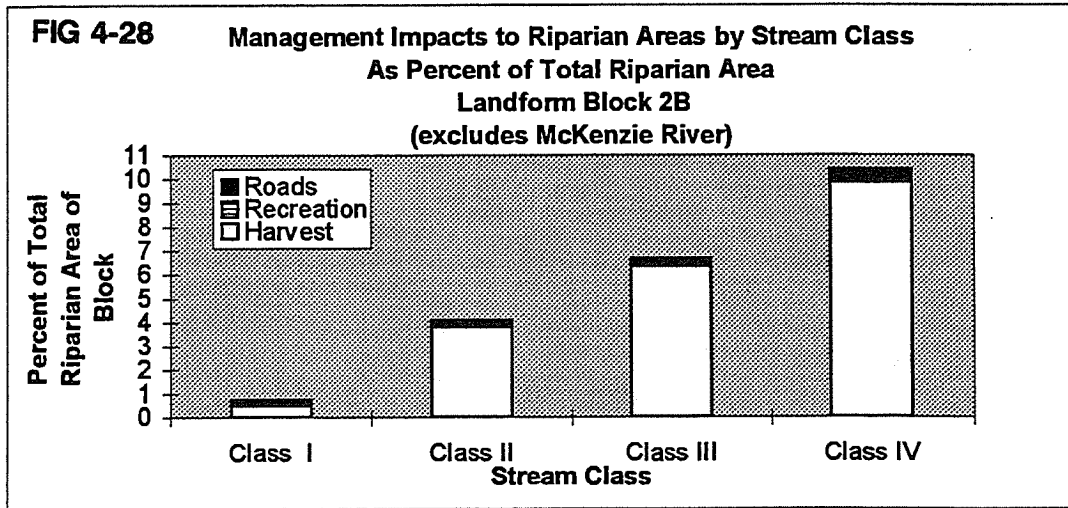
From USDA Forest Service Level II Browder Cr. survey, 1992. The Fisheries Appendix describes habitat evaluation criteria. Reference pool frequency is based upon active channel width and channel gradient.

Similar to Browder Cr., high quantities of LWD are present in lower Bunchgrass Cr., and pool frequencies meet reference conditions.

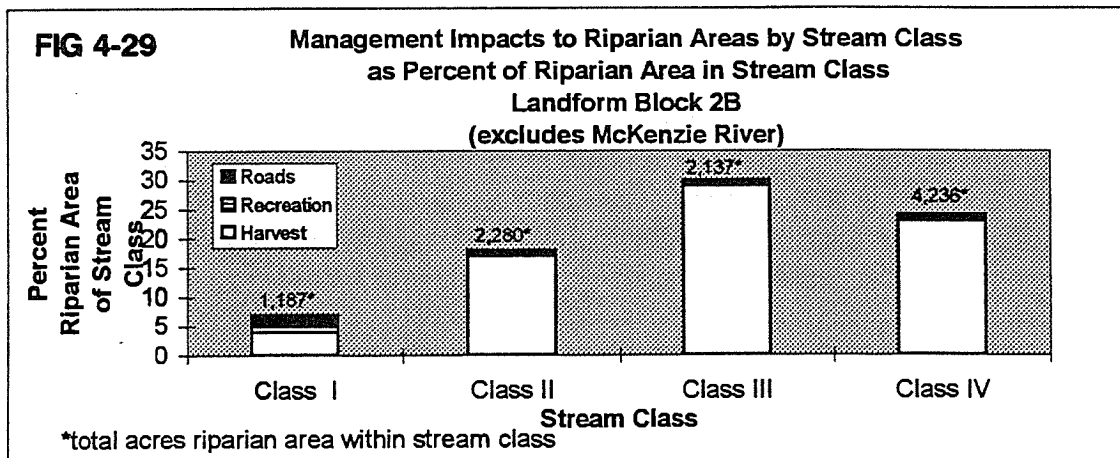
Cutthroat trout are currently the most prevalent fish species. They are found throughout Smith River and its tributaries. Previous surveys found a few rainbow trout in lower Smith River and lower Browder Creek. Rainbow trout are stocked in Smith reservoir throughout summer. A naturally reproducing population of brook trout are found in Smith Reservoir, likely utilizing lower Smith River as spawning habitat. Bull trout were reportedly caught for several years following impoundment of Smith reservoir, apparently trapped upstream of Smith dam as they utilized Smith drainage as foraging habitat. No suitable bull trout spawning and rearing habitat has been found above Smith dam to support an isolated population in Smith reservoir. Two potential barriers to cutthroat upstream migration are present in Smith drainage: a barrier culvert on upper Gate Cr. beneath FS Rd 1598 and a barrier culvert on upper Browder Cr. beneath FS Rd 1598.

Riparian Vegetation

Landform Block 2B has approximately 22% of the total riparian reserves for the block in a harvested or roaded condition (Fig. 4-28).



Class IV streams are the most altered, with approximately 10% of the total riparian vegetation impacted. However, of the total acres in Class II and III riparian reserves, 18% and 30%, respectively, have been roaded or harvested (Fig. 4-29).



Of the Class II riparian areas, Smith River, Browder Cr., and Crescent Cr. are the most heavily impacted. The total miles of Class II stream riparian reserves in an altered condition is approximately 9 miles. The 30% of Class III riparian reserves impacted are mainly located in Hackleman Cr., Crescent Cr., and Park Cr. (including Danny Cr.). This figure is particularly troublesome as it represents nearly 30 miles of Class III stream riparian reserves that have been manipulated. Four percent of the Class I riparian reserves have been harvested,

while approximately 1% is in a recreation site (Lake's End Campground and part of Trailbridge Campground), and 2% is roaded.

Human Disturbances and Effects: Campsites

Dispersed Campsites: The 1988 inventory by Troy Hall, using Limits of Acceptable Change (LAC) data forms, showed that this landform block has 49 dispersed camp sites located on McKenzie Ranger District. In 1990, Sweet Home Ranger District conducted a dispersed campsite inventory that collected information on somewhat different data. For those 33 dispersed sites, information on the total campsite area was not gathered; barren core measurement were not collected for eight of the thirty-three; and distance to water was not specifically measured for any. Inference can be made as to whether these are riparian sites, as a data entry for water on/off site was gathered. The analysis for these 33 sites will be discussed separately below. The 82 dispersed sites in this block represent 25% of the total 333 sites in the watershed.

Riparian: McKenzie--Thirty-one sites (or 38%) are in a riparian reserve, with 25 of these sites concentrated in the Fish Lake dispersed area. There are 2 riparian sites on Hackleman Creek Road and 4 on the road to Smith Reservoir. Vehicles can access all but 2 of the riparian camp sites. The 31 riparian dispersed sites have a total of 55,825 sq ft, or 1.28 acres of total campsite area. The barren core of these sites equals 24,550 sq ft or 0.56 acres. That averages to 44% of the riparian camp areas as barren, a figure that may be misleading due to a few sites with very large core areas.

Riparian: Sweet Home--Six of the inventoried sites are riparian. Three are on the 2067 Rd, and two are on the 2672 Rd. That equates to 7% of the 82 sites. Four of the six sites did not collect barren core data. All of these sites are accessible by vehicle.

Non-Riparian: McKenzie--Eighteen of the dispersed campsites are not close enough to water to be considered within a riparian reserve. These 18 sites have a total area of 40,145 sq ft, or 0.92 acres. Of this area, 21,195 sq ft or 0.49 acres is considered barren core. That averages 53% of core within these sites. All of these dispersed camps are accessible by vehicle.

Non-Riparian: Sweet Home--Twenty-seven of the sites are not in a riparian buffer. The barren core data collected included two huge measurements (500x500 and 500x1000) that skew data to the point that, compounded by missing barren core measurements for three sites, an "average barren core"

would be meaningless. Separating out those five sites, the remaining twenty-two sites have a barren core of 2770 sq ft, or 0.64 acres. All of these dispersed sites are accessible by vehicle.

Developed Recreation Facilities: Campground recreational facilities typically consist of Forest Service provided tables, fire rings, vault or flush toilets, and parking spurs. They may have water systems and garbage service. The Recreation Resource Information System (RRIS) lists the condition of facilities. Boat launch facilities usually are graveled ramps accessing lakes or reservoirs. The river launches sometimes have log skids to help drift boats and rafts access the river.

The following developed recreation facilities are located within landform Block 2B:

Campgrounds: Trailbridge Campground—There are 28 designated camp units in this campground. Trailbridge "Flats" refers to the rocky, open area near the shore of the reservoir, outside of the forested developed campsites. Undesignated camping is allowed in this area, with 49% of the total campground area within the riparian reserve of the Trailbridge Reservoir. Lake's End Campground—There are 17 camp units in this campground, located at the end of Smith Reservoir. Eighty-three percent of the campground is within the riparian reserve. Fish Lake Campground—There are 10 camp units in this campground, and 93% of the campground is within the riparian reserve of Fish Lake. Lost Prairie Campground—There are 10 camp units in the campground with 100% falling within the riparian reserve.

Boat Launches: Trailbridge, Carmen, and Smith Reservoirs all have boat launches with simple ramps. Vault toilets are located at Carmen and Smith, with seasonal placement of portable toilets at Trailbridge. All of these boat launches are located within the riparian reserves.

Picnic/Day Use: Clear Lake Day Use Area consists of 8 picnic sites and a historic covered picnic shelter. It covers 40 acres of which 43% falls in riparian reserve.

Sno-Parks: Ikenick, Lost Prairie, Big Springs, Lava Lake, and Tombstone Pass sno-parks are in this landform block. The only facilities connected with these areas are signs, plowed parking, and winter-accessible composting toilets at Lava Lake and Big Springs. Ikenick, Big Springs, Lava Lake sno-parks cover over 7 acres and none are in riparian reserves. Lost Prairie and Tombstone Pass sno-parks are entirely in riparian reserves.

Administrative or Recreation Special Use Permit Areas: Fish Lake Remount Station is located in this block. It consists of three historic cabins, a large barn and corral, a pioneer grave interpretive site, and a modern-day bunkhouse duplex with the historic Santiam Wagon Road running through the complex. Clear Lake Resort consists of small rental cabins, vault toilets, a restaurant/store with floating boat dock, a gravel parking lot and a boat ramp. This permit area covers 11.87 acres of which 99% falls within the riparian reserve of Clear Lake.

LANDFORM BLOCK 3

HIGH CASCADE PLATFORM

(Hoodoo, High Cascade Plateau systems of Wilson 1981)

Introduction

This Landform Block is characterized by broad, flat, glacially scoured rock plains (Davie 1981) interrupted by volcanic cinder cones (Hoodoo Butte), residual volcanic plug domes (Hayrick Butte and Hogg Rock), shield volcanoes (Maxwell Butte), glacial lakes (Big Lake), glaciated ridges (Potato Hill), and High Cascade composite volcanoes (Mt. Washington). Relief in the area is between 0 and 20% except near or on the side-slope of cinder cones. The soils in this area are largely a result of wind-blown and glacial-lake silt deposits; volcanic ash and cinder fall from the Sand Mountain cinder cones; and large deposits of free draining and granular of glacial moraine in the Santiam Pass area (Figure 4-30).

Disturbance History - Mass Wasting

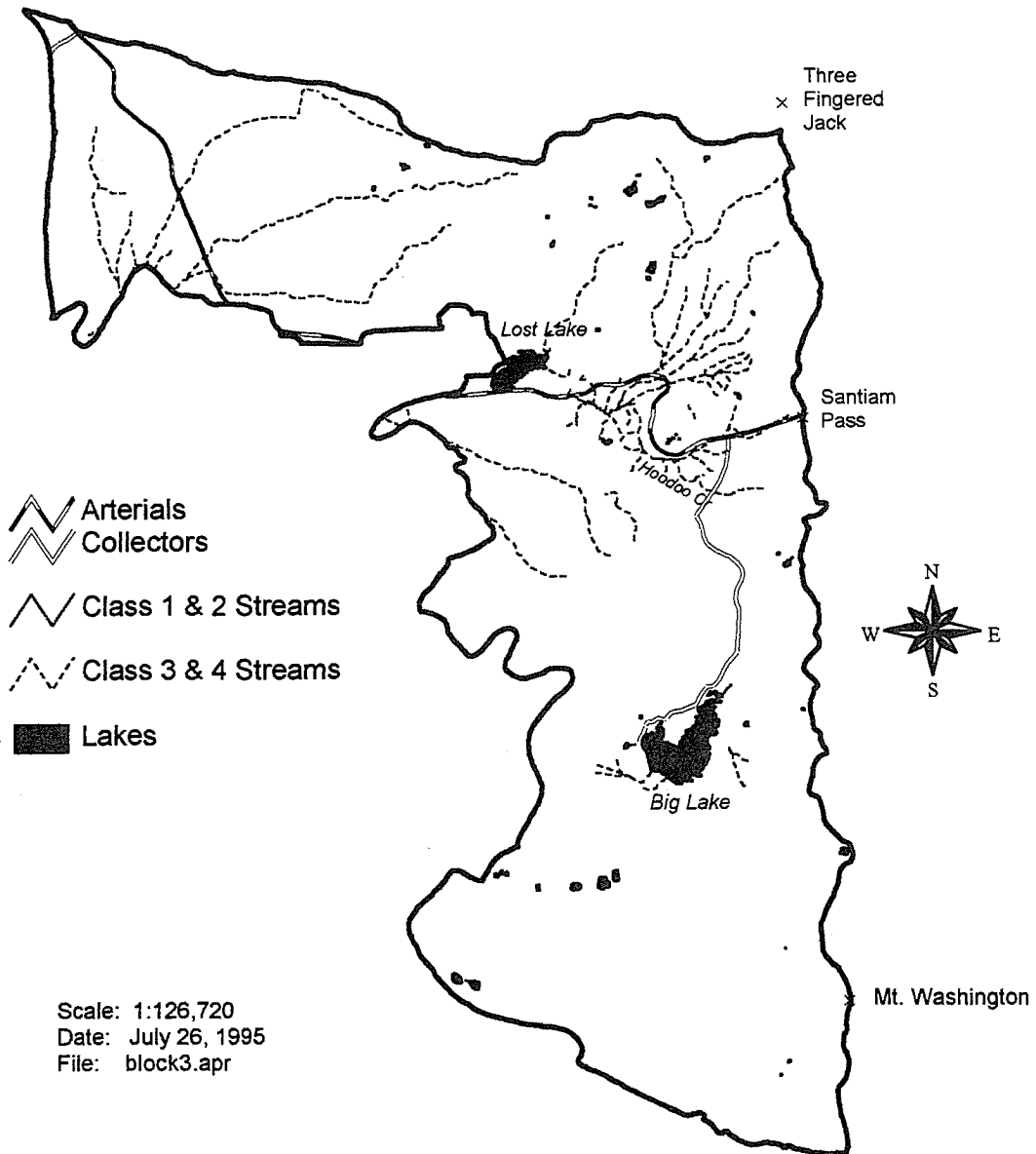
Landform Block 3 is located on the High Cascade platform with low relief. Any unstable potential in this area is confined to the rock cuts on the main arterial highways (See Mainstem McKenzie landform block discussion) and on the flanks of cinder cones (Figure 4-31).

Landform block 3 contains SRI Unit 3 potentially on all slopes.

Disturbance History: Fire and Vegetation Patterns

The vegetation of this block is mostly Pacific silver fir (ABAM), Grand fir (ABGR) and mountain hemlock (TSME) plant series. For further discussion of the associated plants, stand development pattern, and ecology of these plant series, see the Upland Vegetation section of Chapter 3.

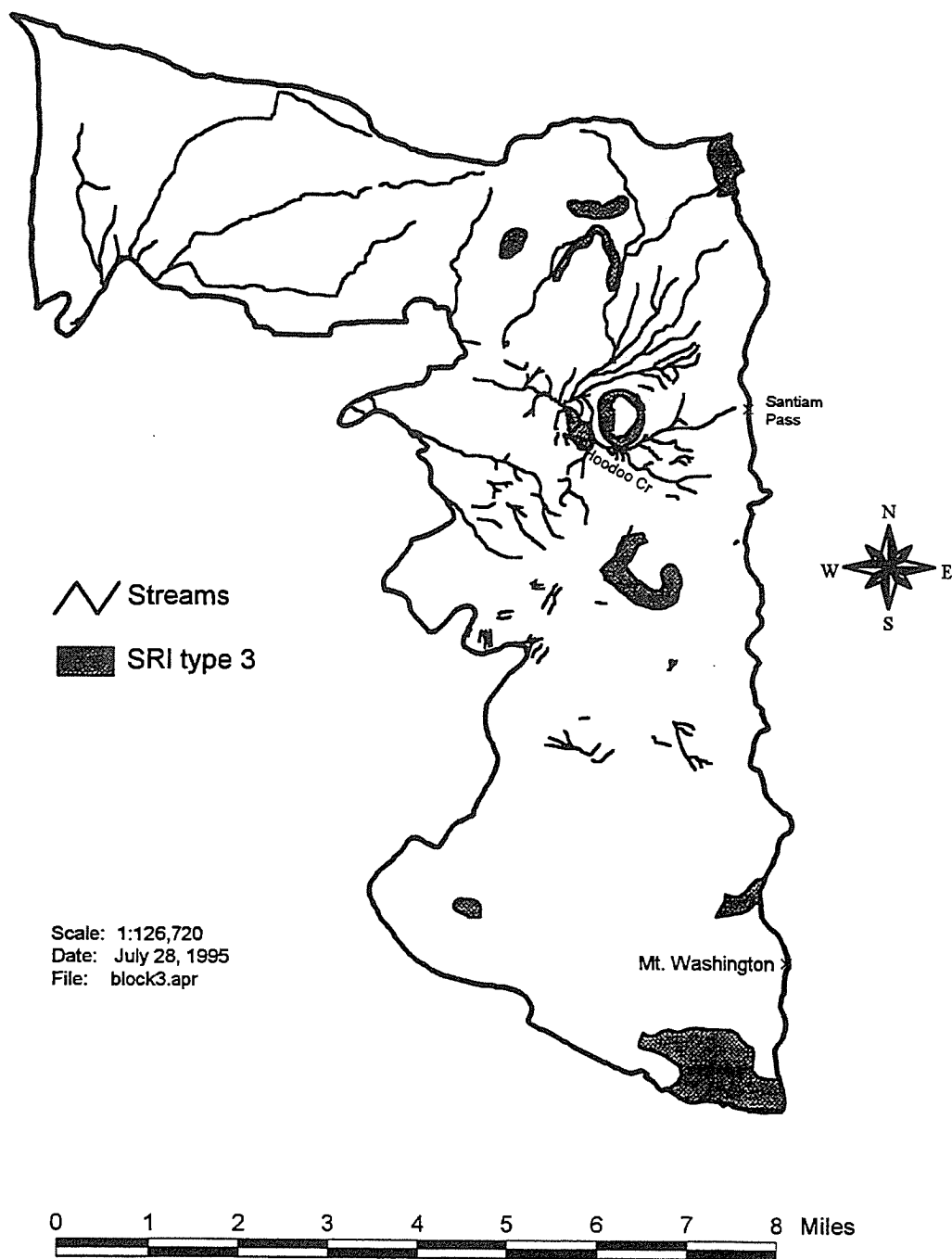
Figure 4-30. Landform Block 3 Locator Map



Scale: 1:126,720
Date: July 26, 1995
File: block3.apr

0 1 2 3 4 5 6 7 8 Miles

Figure 4-31. Landform Block 3 Potentially Unstable Areas



Wind flow in and around this area predominately occurs from two directions: southwest and east. The majority of the time, wind blows from these directions with little to no effect. Depending on the time of year and atmospheric condition, both wind directions can occur on a daily basis. This is caused by the difference in the intensity of heating on the east side and west side of the Cascade crest. When the heating is stronger on the east side, an easterly wind passes a few miles over the crest.

Most of the stands have been created by small-sized, low to medium-intensity, relatively frequent fires. Large-sized, high-intensity fires of intermediate frequency also occurred on the more southerly, lower aspects in this block.

The two most recent outbreaks of western spruce budworm (*Choristoneura occidentalis*) within block 3 coincided with regional outbreaks along the east slope of the Cascades and in the Blue Mountains of northeastern Oregon. Defoliation in the Santiam Pass area was recorded from 1949 to 1953 and from 1986 to 1993. In the absence of fire, the number of shade tolerant, budworm-host trees increased in many of these stands. The effects of the budworm defoliation on these stands may have been more severe than would have been under an uncontrolled fire regime

The effects of budworm outbreaks within the Santiam Pass area depend largely on the availability of suitable forest habitat. The amount of suitable habitat is influenced by the exclusion of fire which results in the development of multi-storied stands of fire susceptible true fir.

The forest patches in this block are mostly even-aged stands. The average size of the patches is small: about 70 acres. This is smaller than the average patch size in 1900, which was about 118 acres. A Shannon diversity index indicates that a 14% increase in diversity has occurred from 1900 to 1996. The index changed from 1.50 in 1900 to 1.71 in 1995. This increase reflects an increase in small, early seral patches in this landform block from clearcutting.

Unique Habitats

Table 4-8 and Figure 4-32 displays the unique habitats that occur in this landform block. The Cascade range functions as barrier for plant movement from east to west. Some movement does occur at Santiam Pass and few eastside plant species have adapted to this area. This ecotonal affect adds to the biodiversity of the area.

A variety of atypical non-forested habitats and associated plant communities occur in this landform block. Many of these special habitats were created from past volcanic activity, including lava flows, talus, sand blowouts, cone rims, and

rock gardens. Off-road vehicles and the introduction and establishment of noxious weeds and other non-native plant species are the major threats to these habitats. Lava and talus are stable with no known threats. Talus habitat occurs around Hayrick, Hoodoo, and Hogg Rock and at the headwaters of Lost Lake.

Due to the porous nature of the soils, the hydrologic regime determines the types of meadows that are scattered throughout this area. Meadows range from very wet sedge or shrub communities to very dry grass meadows. Hydrologic disturbances can alter plant species composition and structure. Many of these meadows have evolved with fire. Suppression activities have disrupted the ecological role fire once had in maintaining the plant growth and vigor of these communities. Several grass meadows have been identified as seed collection sites for restoration projects.

Table 4-8: Unique habitats within Landform block 3.

Habitat Feature	Acres
Wet meadow	124.17
Sedge Meadow	47.72
Herb/forb meadows	808.52
Vine Maple talus	19.56
Shrub communities	270.48
Dry Rock garden	28.41
Sand blowouts	25.05
Cone rims	1.00
Talus	385.29
Lava	89.05
Rock	675.66
Lakes	3.77

Lost Lake, Big Lake, Mosquito Lake, Patjens Lakes, and Washington Ponds are providing low to high quality wildlife habitat within this block. High levels of motorized boat traffic on Big Lake reduce its quality for wildlife many species. Mosquito and Lost lake are suffering from off road vehicle traffic on their banks. Hogg Rock, Hayrick Butte, and Hoodoo Butte are providing low quality cliff habitat. Because of the low potential for these outcrops to have caves or ledges, they are not considered high quality habitat for most species. Enhancement efforts would probably be best spent elsewhere because of the high levels of human use in this area.

Sensitive Plants

Potential habitat for seven sensitive plant species is found within this landform block (Table 4-9). Two C-3 species are known to occur in this block: *Thaxterogaster pingue*, a rare false truffle found in a conifer stand at Lost Lake, and *Allotropa virgata*, which occurs in two grand fir stands.

Figure 4-32. Landform Block 3 Special Habitats

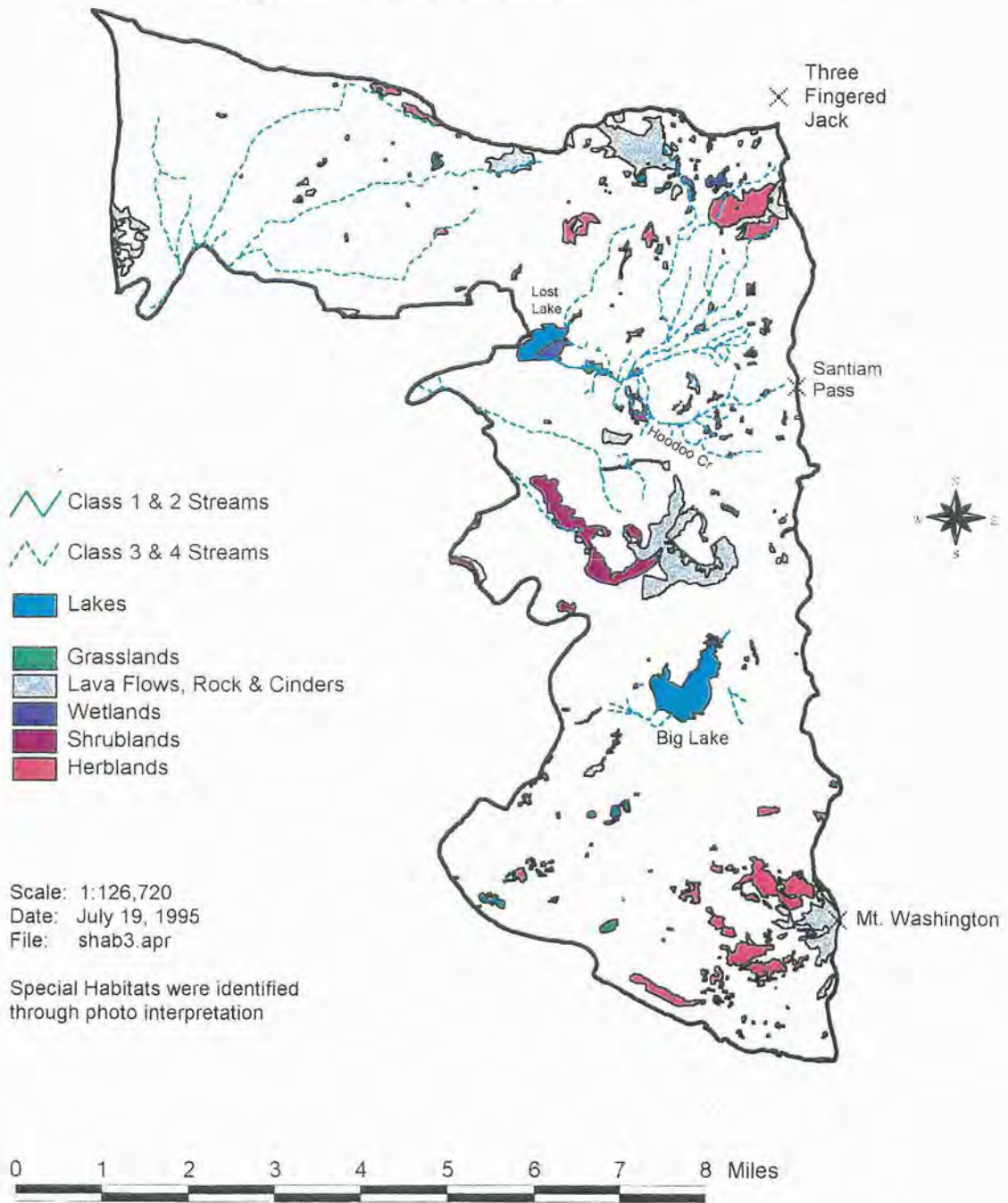


Table 4-9: Sensitive and Rare Plants Located in Landform Block 3.

Species	Status	Number of pops
<i>Botrychium simplex</i> - little grape-fern	Concern	1
<i>Botrychium virginianum</i> - rattlesnake fern	Concern	2
<i>Viburnum edule</i> - squashberry	Concern	1
The Region 6 Sensitive (S) Plant List; Review (R) List and the Watch (W) List are maintained by the Oregon Natural Heritage Program. The Willamette National Forest maintains a Concern (C) List for locally rare species not included in the first three list.		

CHANNEL CONDITION AND AQUATIC HABITAT

Block 3 is located within portions of the Park and Kink/Inland Basin subwatersheds, and it is within the permanent snow zone. Lost Cr., a class II, is the only major stream within this block. This subwatershed has very little of its drainage area harvested and roaded (Table 4-3). Like Landform Block 5, the porous glacial deposits and high storage capacity of the lava aquifers result in a large network of Class IV streams and channels that are not subject to high peak flows.

Landform Block 3 contains low quantities of water and riparian habitat. Although intensive, large to medium fires burned here historically, sediment production was minimal due to the general stability of the area and the flat terrain. In wilderness, Craig and Berley Lakes (Mt. Jefferson Wilderness) occupy 12 acres and Patjen Lakes (Mt. Washington Wilderness) occupy 9 acres (Fisheries Appendix). Big Lake and Lost Lake, the largest lakes within Landform 3 occupy 238 and 50 acres, respectively. All lakes are believed to have been barren of fish with the exception of Lost Lake. Anecdotal accounts describe a cutthroat population residing in Lost Lake. If cutthroat once inhabited Lost Lake, they would have behaved much like Fish Lake and Lava Lake populations and migrated up tributaries as the lake bed dried in summer. Lost Lake Cr. would have provided cutthroat with spawning and rearing habitat. Early 1900's accounts also describe Lost Lake as drying entirely, which would have forced aquatic inhabitants to seek refuge in Lost Lake Creek or two short spring-fed tributaries. Unique habitat exists for specialized macroinvertebrates with cold (4° C), spring-fed tributaries feeding Lost Lake, similar to Hackleman Creek. No surface outlet drains Lost or Big Lake.

Disturbance of record in this landform include the 9,000 acre Big Lake burn in 1967, the largest fire recorded in the analysis area since the early 1900's. A large earthflow of unknown date originated from the flanks of Hogg Rock and

contains large quantities of fine sediment (glacial sand?). Lost Lake Cr. now incises the earthflow, and its lower gradient reaches are dominated by sand.

Lost Lake, Lost Lake Creek and Big Lake Aquatic Habitat Condition

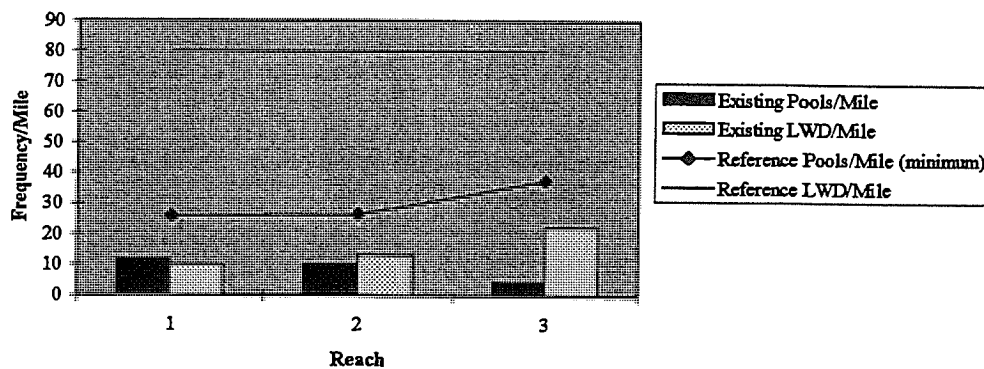
Lost Lake dries during drought years, most recently drying in the early summer of 1992. Lost Lake Cr. provides important refuge for aquatic organisms when the lake bed goes dry. Brook trout have established a naturally reproducing population in Lost Lake and Lost Lake Cr. sometime before records began to be kept in 1950. Currently rainbow trout and Atlantic salmon are stocked in Lost Lake for a popular fly fishing fishery. An idea of how tenuous Lost Lakes' water storage ability is came from recent efforts to provide holding pools for potentially stranded fish. Excavation of tens of cubic feet in the lake bed resulted in more rapid subsurface loss through the lava bed and seasonal drying. Filling in the excavated pools slowed the flow.. The water storage, geology, and subsurface outflow of Lost Lake appear quite similar to Lava and Fish Lake (Landform 2b) and vary only in rate of water percolation. Lava and Fish Lake, with significantly larger catchment basins, are supplied with far greater volumes of water than Lost Lake, but difference in their subsurface flow routes allows them to drain every season.

Heavy recreational use and vehicle access to the lake bed have impacted Lost Lake shoreline and aquatic habitat quality. Soil compaction, vegetation removal and unstable banks have resulted from the heavy use. Aquatic plants adapted to inundation and drying are removed or not allowed to establish in concentrated-use areas. Downed woody material in or near water have been removed.

As described earlier, Lost Lake Cr. has a primary fine sediment supply from an earthflow near its headwaters. Much of the fine material has transported from above and deposited in lower gradient Reach 2, Lost Lake Cr. meadows, adjacent to Hwy 126. The low volume of LWD observed in the 1993 survey is likely a result of broad hardwood riparian zones (Reach 1), or meadows (Reach 2) (Figure 4-33) or the proximity of Hwy 126 to the channel. Smaller diameter wood is present in good quantities in the channel. Smaller diameter true fir and Douglas-fir are characteristic of this high elevation (3,900 ft. or more) and the reference levels of in-stream LWD need adjustment for diameter. Previous management activity does not appear to have reduced the supply of large wood available to the channel. Recent insect infestation and disease have entered the high elevation stands of Douglas-fir, true fir and mountain hemlock. Anticipated rates of LWD input are expected to accelerate, then lull following loss of riparian tree density.

Figure 4-33

Lost Lake Creek Large Pools and LWD/Mile: Existing and Reference



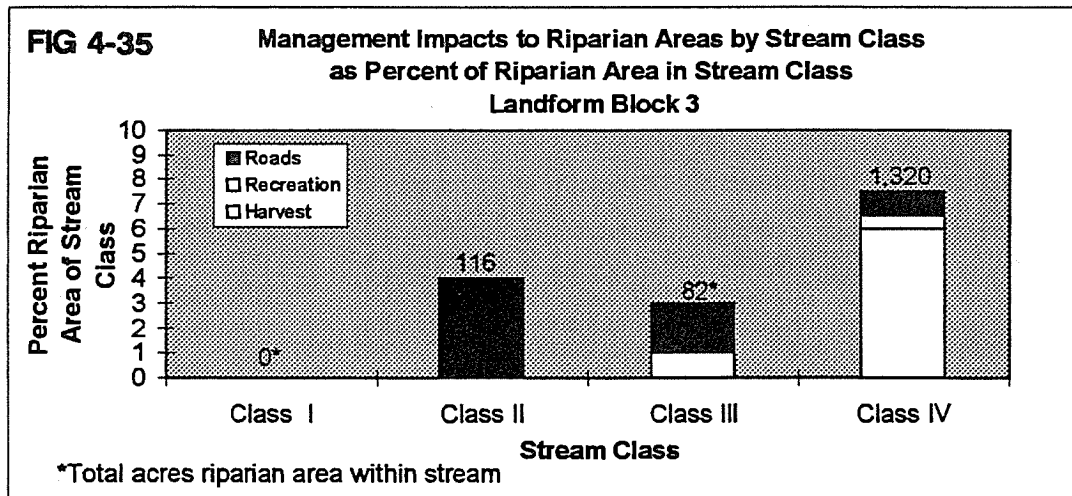
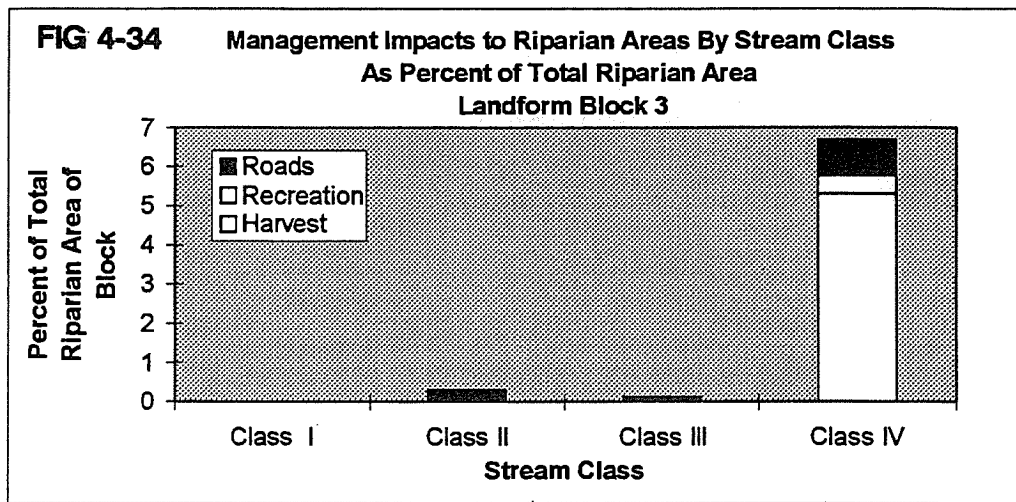
From USDA Forest Service Level II Lost Lake Cr. survey, 1993. The Fisheries Appendix describes habitat evaluation criteria. Reference pool frequency is based upon active channel width and channel gradient.

The highly sinuous channel creates pools by lateral scour or by scouring around in-stream wood. However, low quantities of pools are present in Lost Lake Cr. compared to reference levels, possibly due to large quantities of sand filling pools and lowering pool frequency. Aquatic macroinvertebrate sampling in 1993 collected numerous caddisfly species with various tolerances to sedimentation. Species diversity (18 different species identified) had high to moderate tolerance to sedimentation, with none present with low tolerance to sedimentation (USDA 1993[c]), reflecting the quantity of fine sediment observed in bedloads. Sedimentation appears to be the result of natural disturbance. Human alteration of physical habitat has occurred where the channel nears Hwy 126 and large quantities of red scoria, used by ODOT to sand winter roads, has washed into and accumulated in the channel. Surveyors in 1993 saw concentrations of juvenile brook trout near beds of scoria, suggesting brook trout have found it suitable spawning substrate.

Big Lake, formed by glacial scouring, was barren of fish life until introduction of a variety of salmonids beginning in the 1920's. Big Lake has two Class IV inlets and no outlet. Current stocking occurs annually with various numbers of four species: brook trout, rainbow, cutthroat and kokanee (Fisheries Appendix). Big Lake retains its low level of production despite continued heavy recreation use. Impacts to the lake margin are soil compaction, vegetation and downed woody debris removal, and bank erosion. A portion of youth camp property and Forest Service campground is rip-rapped to protect eroding banks.

Data indicates that of the total riparian reserves within the block, Class IV streams are the most impacted with almost 7% of their areas harvested, roaded,

and containing recreation or administrative sites (Fig. 4-34). And although less than 0.5% of the Class II riparian area (Lost Cr.) is roaded on the basis of the total riparian area within the block, it is interesting to note that based on the percentage of the riparian reserve along Class II streams, 4% of the riparian reserve along the Class II portion of Lost Lk. Cr. is within a roaded condition (Fig. 4-35).



It may not seem as though 4% is much of an impact, however, roads are linear features and tend to impact more stream length given the same percent area impact than other kinds of disturbances. This is concept is portrayed well for Lost Cr., where although only 4% of the riparian reserve is impacted, the length of the impact runs for 60% of the entire length of the Class II portion of the creek. This may have created wider, more negative impacts than a disturbance that runs for a lesser distance along the length of the channel. Shading and LWD input may be reduced where length of stream impacted is great.

Human Disturbances and Effects: Campsites

Dispersed Campsites: The 1988 inventory by Troy Hall, using Limits of Acceptable Change (LAC) data forms, showed that this landform block has 69 dispersed recreation sites. That is 21% of the total 333 dispersed sites in this watershed.

Riparian: Forty-four sites (or 64% of those in this block) are in a riparian reserve, with 38 of these sites concentrated in the Lost Lake dispersed area. The remaining 6 riparian sites are located at Big Lake on the Santiam Wagon Road. Vehicles can access all of the riparian camp sites. The 44 riparian dispersed sites have 213,242 sq ft, or 4.98 acres of campsite area. The barren core of these sites equals 147,560 sq ft or 3.39 acres. That averages to 69% of the riparian camp areas as barren, a figure that may be misleading due to a few sites with very large core areas.

Non-Riparian: Twenty-five of the dispersed campsites in this landform block are not close enough to water to be considered within a riparian reserve. Fifteen of these sites are located at Cayuse Horse Camp. The remaining 10 are along the Santiam Wagon Road. These 25 sites have a total area of 62,580 sq ft, or 1.44 acres. Of this area, 8,325 sq ft or .19 acres, is considered barren core. That averages 13% of core. All of these dispersed camps are accessible by vehicle.

Developed Recreation Facilities: Campground recreational facilities typically consist of Forest Service-provided tables, fire rings, vault or flush toilets, and parking spurs. Some may have water systems and garbage service. This narrative will identify campgrounds that do not have gray water disposal sumps. Boat launch facilities usually are graveled ramps accessing lakes or reservoirs. The river launches sometimes have log skids to help drift boats and rafts access the river. The following developed recreation facilities are located within landform block 3:

Campgrounds: Big Lake Campground--There are 49 designated camp units in this campground. 86% of the campground falls within the riparian reserve of Big Lake. Big Lake West Campground--There are 11 camp units in this campground. All of the campground falls within the riparian reserve of Big Lake.

Picnic/Day Use Area: Big Lake Campground has 3 picnic sites near the boat ramp: all are within riparian reserve.

Boat Ramps: Big Lake Campground has a paved boat ramp and parking for approximately 15 vehicles. All of this boat ramp is located within the riparian reserve.

Sno-Parks: Ray Benson Sno-Park and Santiam Sno-play are in this landform block. The facilities connected with these areas are plowed parking, a winter accessible vaults toilet at both. Sixty-three percent of Ray Benson and 72% of Santiam sno-park fall into a riparian reserve.

Administrative or Recreation Special Use Permit Areas: Hoodoo Ski Area is in landform block 3. It covers 879 acres; has a lodge, lifts, X-country ski trails, and large plowed parking areas. Class IV streams are located in the northern part of the permit area, with winter cross country ski trails crossing in several locations. A new Hoodoo Master Plan is currently being developed, with riparian influences being analyzed in that document. Thirteen Special Use Permit Recreation Residences covering 14 acres are located near Hoodoo. Fifteen percent of the area is in riparian reserve. Big Lake Youth Camp, covering 24 acres, is operated on the east shore of Big Lake. Eighty percent of it falls within the riparian reserve of Big Lake. The facilities consist of many small cabins, dining hall, storage buildings, a floating dock with boat moorage, a stable and corral, and a year round residence. A historic structure, Santiam Lodge is located within this block. It is an unused structure, with its status and future undetermined.

Human Disturbance and Effects: Rooding

The "Airstrip Burn" occurred in 1967 and is still a recognizable feature defined by old fire lines. Many current trails and roads (some of which were originally fire lines) are not surfaced. There are approximately 39 miles of existing Forest Service system roads within the area of the burn, of which 34 miles are unsurfaced and considered primitive in nature. Vehicles may easily stray off these roads. Vegetation along roadsides does not usually restrain vehicle traffic from driving off road. Some travel-ways were created by recreationists, never intended or designed for long term use by the Forest Service. The area does not have designated Off Road Vehicle (ORV) routes for the road system. As designated forest roads, many ORV users do not realize that they must be both a licensed driver and their vehicles must also be "street legal" to operate.

There are approximately 4 miles of trail being used for ORV, motorcycle, and limited mountain bike use. Some of these trails have become brushed in, but they are still listed as Forest Service system roads. The 34 miles of primitive road varies from two wheel drive vehicles to four wheel drive, and they are being used by all types of vehicles. ORV's, motorcycles, mountain bikes, and horses. A portion of the above is also used by cross-country skiers and snow-mobilers in the winter season. The Pacific Crest Trail has multiple ORV crossings, which conflicts with trail management goals.

There are various segments of the primitive roads and trails which have minor to heavy ditch and wheel rut-type erosion. Minor erosion is defined as mostly wheel rutting within the road prism, ruts no more than 3" deep, and no off-site damage caused by sedimentation. There are approximately 5.3 miles of this minor erosion.

Moderate erosion is defined as wheel rutting within the road prism that is forming a water channel. This type of erosion can involve ditch erosion, which carries sedimentation for short distances. In most cases it is not causing off site damage (beyond the road prism). There is 2.6 miles of moderate erosion present. There are 1.3 miles of heavy erosion. Heavy erosion is defined as damage occurring from wheel rutting and ditch erosion. Deep wheel rutting may be causing vehicles to avoid the ruts, which causes damage outside of the road prism. It may also be causing boulders to protrude. Ditch erosion may be carrying sediment off-site in some cases, and it also can cause vehicles to go completely around the area extending the damage.

During the months of May through August 1994, seasonal fire patrol Jim Denney collected data on use, type of Off Road Vehicles (OHVs) encountered, and locations of encounters while on his normal patrol. On days following the encounters, Jim would use his own motorcycle to initiate public contact with OHV users. A chart following this narrative provides a summary by month on numbers of users and type of vehicles in various locations. The types of Off Highway Vehicles encountered in the Big Lake area were Motorcross Competition on Motorcycles, Three Wheelers, Quad Cycles, Dual Sport/Street Legal, Trials/Competition Motorcycles. Also encountered were two dune buggies used by hunters, several trail bikes, and small cc Honda 90s. The report's text is as follows:

User conflicts in or about Big Lake Campground: mainly complaints about noise from OHVs. No complaints from horse users. Some remarks regarding dust. Resource damage is occurring in areas where user trails have been developed, especially between Road 2690 and Road 810 as well as the area directly south of Cayuse Horse Camp and the horse camp itself. Damage is taking the form of deeply rutted trails in soft soil as well as damage to vegetation. Significant public comment was received expressing concern about vehicle use in the Sand Pits below Sand Mountain. Also concern was expressed by some users about encounters between OHV's and other vehicles on the road up Sand Mountain to the lookout parking lot. Comments were received from OHV users during the Endurance Horse Ride staged from Cayuse Horse Camp concerning horse event "taking over" the area. User trails into Mosquito Lake area is well established and the lake (pond) bed shows considerable impacts from OHVs. There are continued signs that OHVs are crossing the wilderness boundary to the south of Sand Mountain as well as entering the same area

from access point off the Santiam Wagon Road to the north of Sand Mountain. A problem still exists with OHVs getting on the Pacific Crest Trail to the east of the PCT trail head at Big Lake. The Patjens Lake Trail was also illegally accessed several times by motorcycles. Some complaints were received from people camping next to the PCT trailhead at Big Lake concerning dust and noise from OHVs. OHVs users expressed concern on several occasions about lack of maps, signage, information about the area. Confusion about the different land use classifications between the Deschutes and the Willamette National Forests in the Santiam Pass area.

From informal questions posed to people encountered, it appears that roughly 40% of the OHV users were from Eugene/Springfield, 40% from Salem/Albany/Highway 20 corridor, 10% Bend, and the remainder from Portland, Southern Washington, or the Oregon Coast.

Days OHV's users were encountered included May: Sunday 15th, Sunday 22nd, Monday 23rd, Sunday 29th; June: Saturday 4th, Wednesday 8th, Sunday 12th, Friday 17th, Mon 20th, Sat 25; July: Saturday 2nd, Sunday 3rd, Friday 8th, Saturday 9th. Fire restrictions started by mid-July, with road closures in effect by August 12.

LANDFORM BLOCK 4

RECENT HIGH CASCADES LAVA

(Belknap-Sand Mountain system of Wilson 1981)

This unit consists of the most recent lava flows and pyroclastic ash deposits in the watershed that were erupted from north-south trending cinder cones of the Lost Lake/Sand Mountain Chain and Belknap Crater less than 12,000 years ago (Holocene). This young geomorphic unit was deposited after the last glacial retreat, and it covers the central third of the High Cascades Plateau between 4,000 and 6,000 feet elevation with relatively low relief and few erosional features. (Taylor 1979, Avramenko 1981)

The lava flows covered the pre-existing topography of the Older High Cascades and surficial glacial deposits. Due to the high vertical and horizontal hydraulic conductivity of these recent lava flows, they provide a pathway for water migration through the basalts and underlying glacial deposits which discharges as springs and underground flow in the McKenzie valley. These flows also produced geomorphic features such as lava-dammed lakes (Clear Lake, Lava Lake) interrupted drainage features, and islands or "kipukas" of older landforms as the lava flowed around them. In areas that were associated with final eruptions of ash, or those areas older than 6,000 years that have deposits of Mazama ash, the permeability of the lava may have been reduced enough to prevent complete percolation of the winter snow pack in closed contour depressions, leaving year-round wet meadows (Figure 4-36).

Disturbance History - Mass Wasting

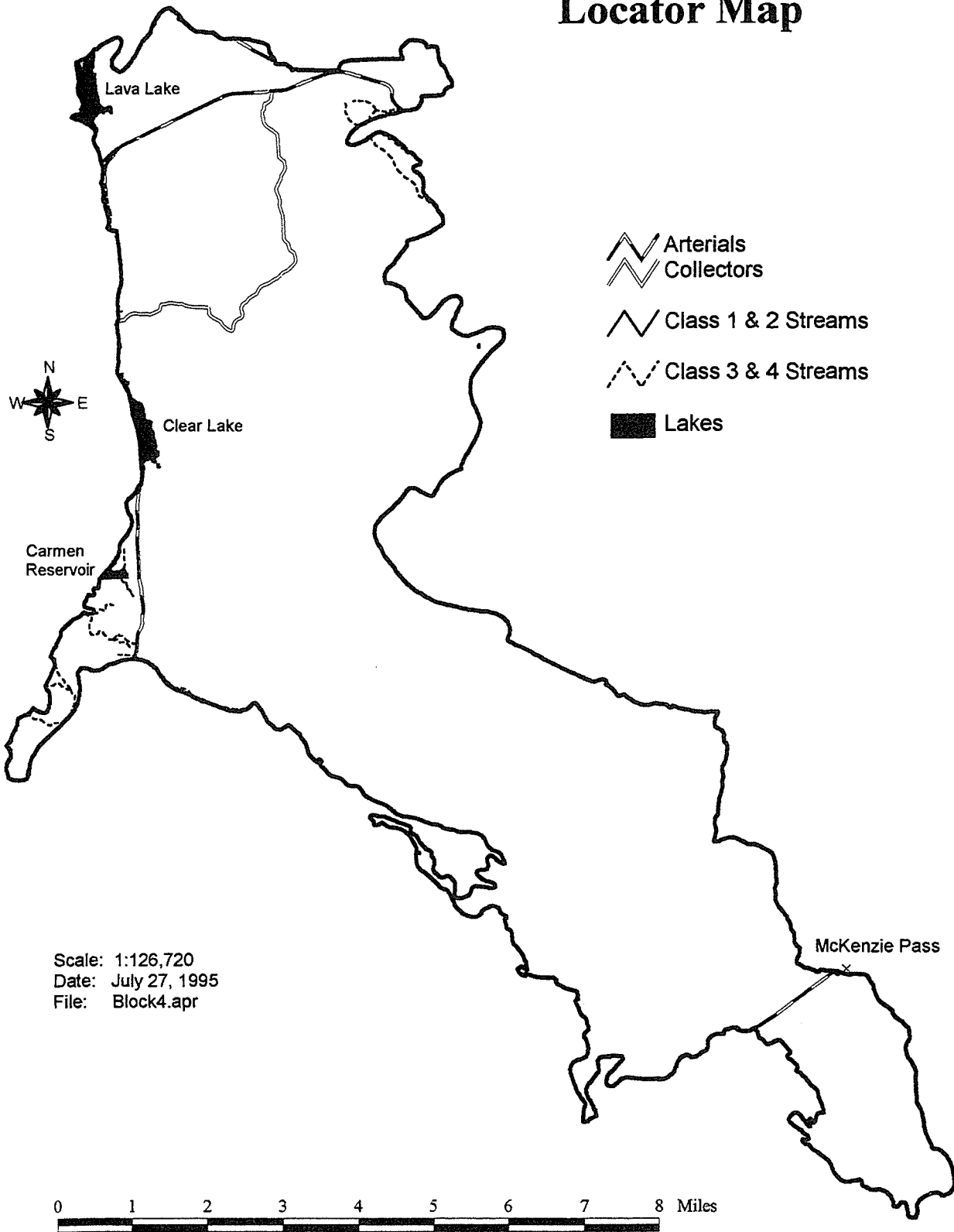
The only potential for mass wasting in this Landblock is on sideslopes of cindercones, and on the major volcanoes and active glaciers.

Disturbance History - Fire and Vegetation Patterns

The vegetation of this block is mostly Pacific silver fir (ABAM), Grand fir (ABGR) and mountain hemlock (TSME) plant series. The mountain hemlock portions contain pockets of subalpine fir (ABLA) series. For further discussion of the associated plants, stand development pattern, and ecology of these plant series, see the Upland Vegetation section of Chapter 3.

This area is composed of lava fields, pumice cones, and sand from relatively recent geological events. Vegetation is sparse because the soil in this block is not

Figure 4-36. Landform Block 4 Locator Map



as old as the others. The block is high in elevation, rather flat, and exposed to both typical westerly and easterly winds.

Fire is relatively frequent and normally of low intensity due to the lack of available fuel to burn. Even though the fuel is sparse, the area does experience stand-replacing fires and partial stand-replacing fires as evidenced by the 700 acre Lava Flow fire of 1967 and the more recent 13 acre Clear fire. Strong east winds drove both these fires.

Block 4 has changed the least of all the blocks in the Upper McKenzie watershed over the past 100 years. The average patch size had declined from 40 acres to 36, and the diversity index has not changed from the value in 1900. Fire has continued to influence on the vegetation patterns in this block.

Unique Habitats

Table 4-10 and Figure 4-37 display the acres of unique habitats within this area. Lava is the dominate landscape feature. Talus occurs where andesite and basalt boulders have weathered and soil has accumulated to support vegetation. A variety of cryptogram species grow on the lava.

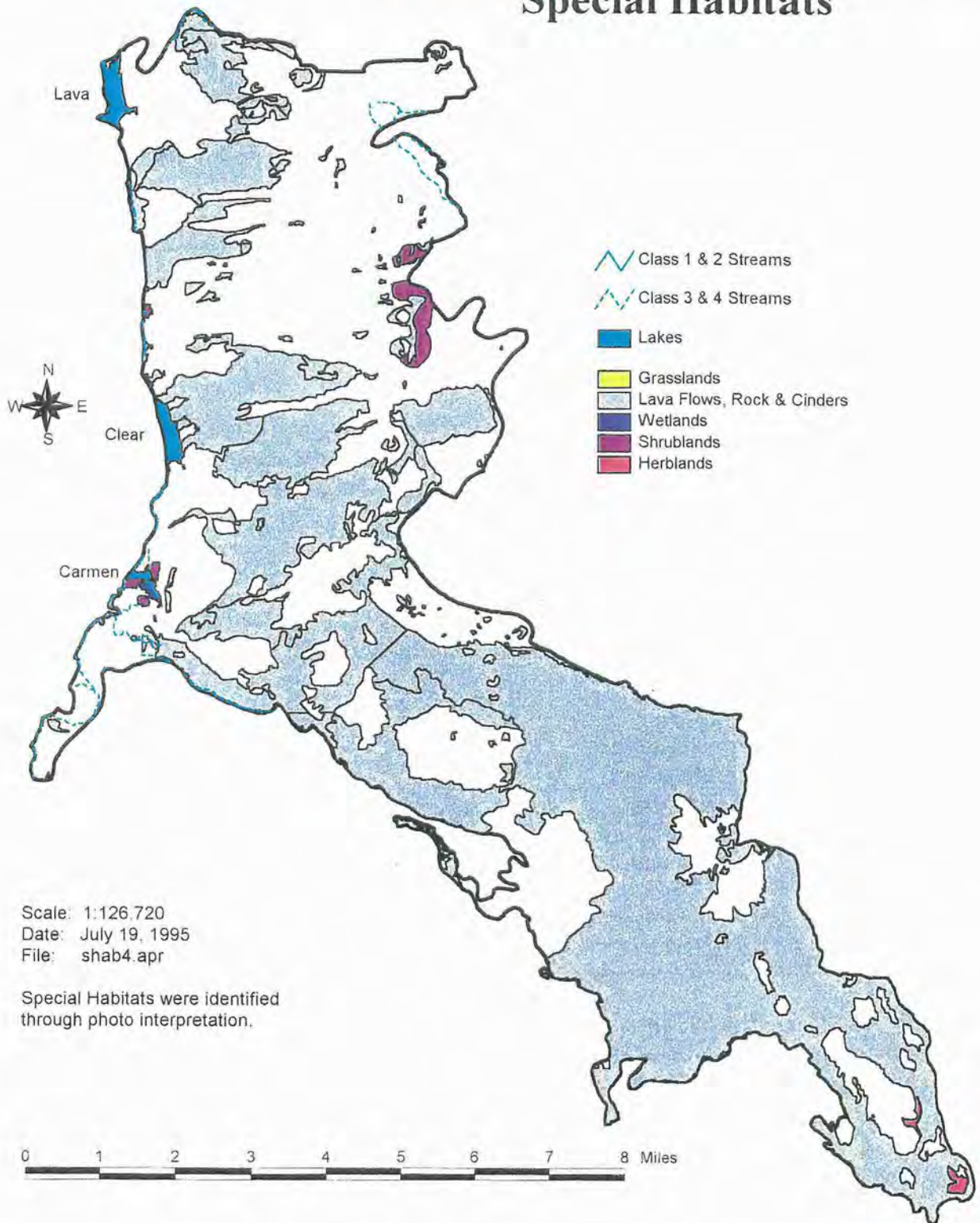
Table 4-10: Unique Habitats within Landform block 4.

Habitat Feature	Acres
Wet meadow	27.55
Mesic meadows	8.37
Dry meadows	4.50
Herb/forb meadows	92.38
Shrub communities	269.61
Dry rock gardens	13.36
Sand blowouts	1528.96
Cone rims	163.15
Shrub lava	1249.72
Lava	21,412.99
Lakes	237.25
Reservoirs	20.86

Livestock grazing at Lava Lake has severely degraded the native vegetation. In some areas it is so complete that noxious weeds and other non-native species dominant. The current allotment expires at the end of 1995. Based upon the Environmental Assessment for Lava Lake future grazing will be prohibited.

Beaver Marsh and the surrounding plant community provide potential habitat for several sensitive plant and Table C-3 species. These wetlands are protected by a Special Wildlife Habitat LMP designation. This area is an excellent candidate for an interpretive site. A rare nitrogen-fixing lichen,

Figure 4-37. Landform Block 4 Special Habitats



Pseudocryphellaria rainierensis, occurs at Koosah Falls. This species is to be protected and managed under survey strategy 1. This lichen is known only from five sites in Oregon, of which four are located on the Willamette National Forest. All of these sites are old growth forest approximately 400 years of age (Neitlich et al. 1993, Neitlich 1993). *Allotropa virgata* is documented in three grand fir stands in the block. Sahalie and Koosah Falls and the forested area surrounding Clear Lake may provide habitat for additional Table C-3 species.

Huckleberry Lake, Clear Lake, and Carmen Reservoir are providing moderate to high quality wildlife habitat within this block. Human use at Clear Lake and Carmen may be reducing their potential for some species. Abundant lava fields across the Santiam Pass area are providing high quality, stable habitat. There are no known threats. Tamolitch and Sahalie falls are providing high quality habitats, and they are currently protected from threats. Sawyer's Ice Cave is providing habitat for bats and other animals. Its quality is deteriorating because of human use and vandalism.

Sensitive Plants

Habitat for seven sensitive plant species is found in this landform block.

Noxious Weeds

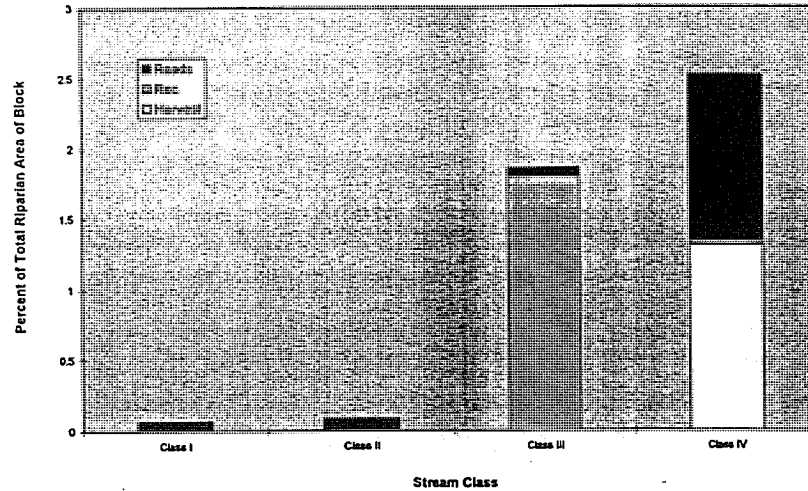
The introduction and establishment of noxious weeds and other non-native plant species is the major threat to this area. Extensive populations of the noxious weed spotted knapweed have easily become established in the cinder material along the road shoulders of Highway 126 and 20. In FY95, isolated populations of spotted knapweed along the road shoulder will be treated with the herbicide Rodeo. Removal of these weeds by either manual or biological control agents has been unsuccessful.

CHANNEL CONDITION AND AQUATIC HABITAT:

Perennial streams are virtually non-existent in this block, and Class IV and ephemeral streams are scarce. Drainage networks within the new lava flows have not yet formed, and precipitation within this block drains directly into subsurface aquifers. Because of the mostly lava terrain, vegetation is limited and harvest is precluded. This landblock falls within the Hackleman, Kink/Inland Basin, and Park subwatersheds. Since peak flows were not of concern within this block, smaller drainages were not analyzed. The minimal harvest within this block is obvious from Fig. 4-38, which shows that of the total riparian area within the block, less than 3% of harvest and roading occurred with Class IV riparian areas.

Management Impacts to Riparian Area
as Percent of Total Riparian Area
Landform Block 4

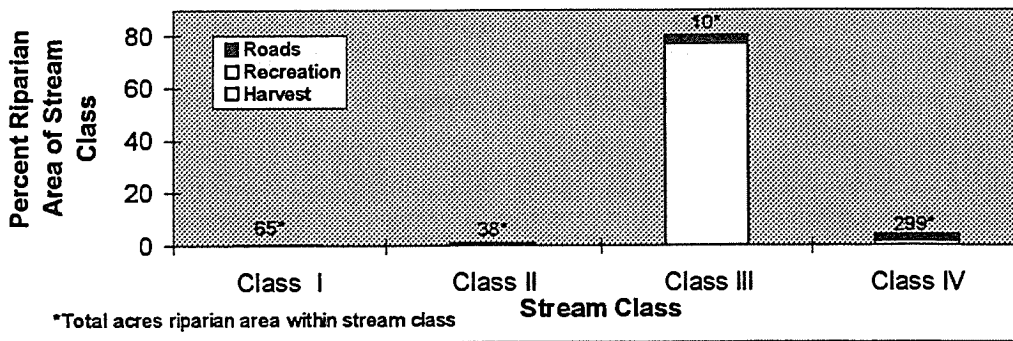
FIG 4-38



Data indicates that of the 10 acres of riparian area along Class III streams, almost all of the area (80%) has a recreation site (Icecap Campground) and is roaded. The small percentage of the Class I stream shown as roaded is along Fish Lake Cr. just north of Clear Lake (Figure 4-39).

FIG 4-39

Management Impacts to Riparian Areas by Stream Class
as Percent of Riparian Area in Stream Class
Landform Block 4
(excludes McKenzie River and Clear Lake)



Human Disturbances and Effects: Campsites

Dispersed Campsites: The 1988 inventory by Troy Hall, using Limits of Acceptable Change (LAC) data forms, showed that block 4 has 37 dispersed camping sites. That is 11% of the total 333 dispersed sites in this watershed.

Riparian: Twenty-one sites (or 57% of those in this block) are in a riparian reserve, with 20 of these sites concentrated in the Huckleberry Lake, Craig Lake, or Clear Lake Trail areas. Huckleberry Lake is 1 acre, at the 5250 foot elevation. Craig Lake is 2 acres, located at the 5100 foot elevation. Vehicles can access 8 of

the riparian camp sites, with 13 sites at Huckleberry Lake accessible on a closed road by foot only. The 21 riparian dispersed sites have a total of 24,225 sq ft, or 0.56 acres of total campsite area. The barren core of these sites equals 3,130 sq ft or 0.07 acres. That averages to 13% of the riparian camp areas as barren, a figure that may be misleading due to a few sites with very small core areas.

Non-Riparian: Sixteen of the dispersed campsites in this landform block are not close enough to water to be considered within a riparian reserve. These sites are near Huckleberry Lake, McKenzie Pass, and the Pacific Crest Trailhead area along Highway 242. These 16 sites are 12,525 sq ft in area, or 0.29 acres. Of this area, 7,645 sq ft or 0.29 acres is considered barren core. That averages 61% of core within these site areas. Twelve of these dispersed camps are accessible by vehicle. The remaining four by Huckleberry Lake are accessible by foot only.

Developed Recreation Facilities: Campground recreational facilities typically consist of Forest Service-provided tables, fire rings, vault or flush toilets, and parking spurs. They may have water systems and garbage service. Boat ramp facilities usually are graveled ramps accessing lakes or reservoirs. The river launches sometimes have log skids to help drift boats and rafts access the river. The following developed recreation facilities are located within landform block 4:

Campgrounds: Ice Cap Campground—There are 22 designated camp units in this campground. Seventy percent of these campgrounds is within a riparian reserve. Due to the elevation differences between the river and the campground facilities, this reserve location needs to be ground-verified. Cold Water Cove Campground—There are 35 camp units in this campground. Fifty-four percent of this campground is within the riparian reserve of Clear Lake. Due to the elevation differences between the lake and the campground facilities, this reserve location should be ground-verified.

Picnic/Day Use Area: Ice Cap Campground has 2 picnic sites near the entrance to the campground.

Boat Ramps: Cold Water Cove Campground has a paved boat ramp and parking for approximately 15 vehicles. There are also long wooden pole "skids" to help slide canoes and boats into the lake. All of this boat ramp is located within the riparian reserve of Clear Lake.

Sno-Parks: Potato Hill and Little Nash Sno-parks are in this landform block. The facilities connected with these areas are plowed parking and bulletin boards. Potato Hill covers 0.55 acres, with 44% falling into a riparian reserve. Little Nash covers 2.15 acres and is not in a reserve.

Viewpoints: Sahalie Falls and Koosah Falls Viewpoints are partly in this block. Mapping indicates that 94% of Sahalie Viewpoint and 100% of Koosah Falls Viewpoint fall into a riparian reserve of the McKenzie River. Due to the elevation differences between the river and the viewpoint facilities, these reserve locations should be ground-verified.

Administrative or Recreation Special Use Permit Areas: This block does not have any administrative or recreational special use permits within it.

Wilderness: Within this landform block are 24,090 acres of Wilderness which is 59% of the block. Most of those acres are within the Mt. Washington Wilderness, which in this landform is almost entirely inaccessible lava flow. The only trails located here are a mile of Pacific Crest Trail (PCT) near Little Belknap and another short section of the PCT as it crosses Highway 242 south into the Three Sisters Wilderness. Approximately 2500 acres of this landform are within the Three Sisters Wilderness. Due to the rough terrain, lack of water and trails, very little if any campsites would be expected to be found within this block. Stock use is restricted to the Pacific Crest Trail, and no grazing opportunities are apparent.

LANDFORM BLOCK 5

SCOTT MOUNTAIN GLACIAL PLATEAU AND VALLEYS

(Glacial Lakes, High Cascade Platform, Glacial Valley, and Yapoah-Anderson Creek systems of Wilson 1981)

Introduction

This Landform Block is influenced by the development of valley systems of Scott, Boulder, Twisty, Ollalie, Anderson, and Kink Creeks. It is primarily controlled by the previous topography of the Scott Mountain cinder cone and the westward glacial advance from the High Cascade Platform. Surficial deposits of glacial till cover most of the area, with the exception of Anderson and Ollalie Creeks that contain recent High Cascade intracanyon flows that mask the previous topography. Unlike the northern Early High Cascade Platform (Landform Block 3) which was partially covered by the recent High Cascade lavas, the eastern portion of Landform Block 5, above the headwalls of the lower valleys, contains the majority of the High Cascade glacial lakes in the watershed (Figure 4-40).

Disturbance History - Mass Wasting

Valley sideslopes in lower portions of Scott and Boulder Creeks are susceptible to glacial terrace ravel and valley stress relief failure. This Landform Block contains 3 of the 19 road related failures in the watershed, confined to the lower Frissel and Scott Creek drainages in Western Cascade volcanics (Figure 4-41 and 4-42).






Landform block 5 contains SRI Units 3 and 235 potentially on all slopes; and Units 16, 301, 610, 610U, 614, and 71 on slopes greater than 70%.

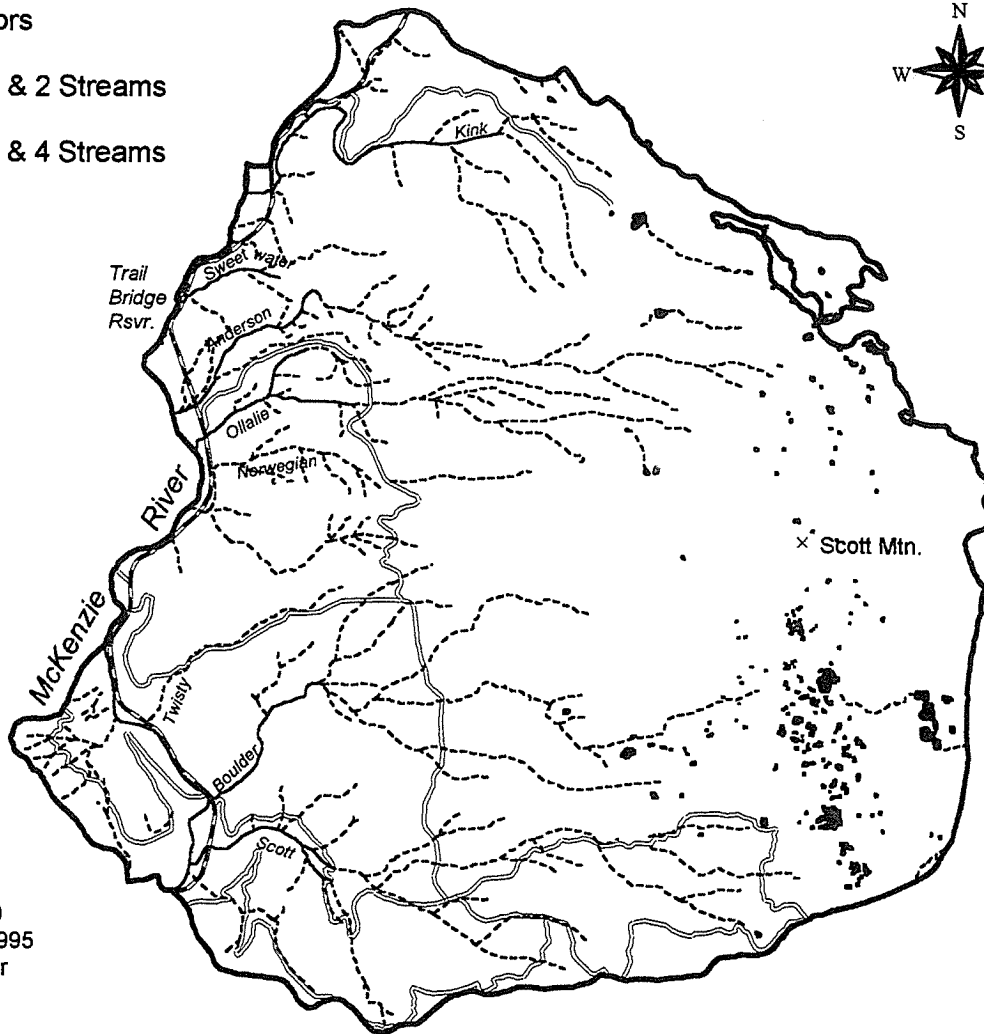
Disturbance History - Fire and Vegetation Patterns

The vegetation of this block is mostly Pacific silver fir (ABAM), western hemlock (TSHE) and mountain hemlock (TSME) plant series. The block contains small pockets of Douglas-fir (PSME) plant series. For further discussion of the associated plants, stand development pattern, and ecology of these plant series, see the Upland Vegetation section of Chapter 3.

The typical wind is from the west or southwest, blowing up-slope in this block. The east wind flows across the surface through most of this block. The

Figure 4-40. Landform Block 5 Locator Map

-  Arterials
-  Collectors
-  Class 1 & 2 Streams
-  Class 3 & 4 Streams
-  Lakes



Scale: 1:126,720
Date: July 27, 1995
File: Block5.apr



Figure 4-41. Landform Block 5 Potentially Unstable Areas

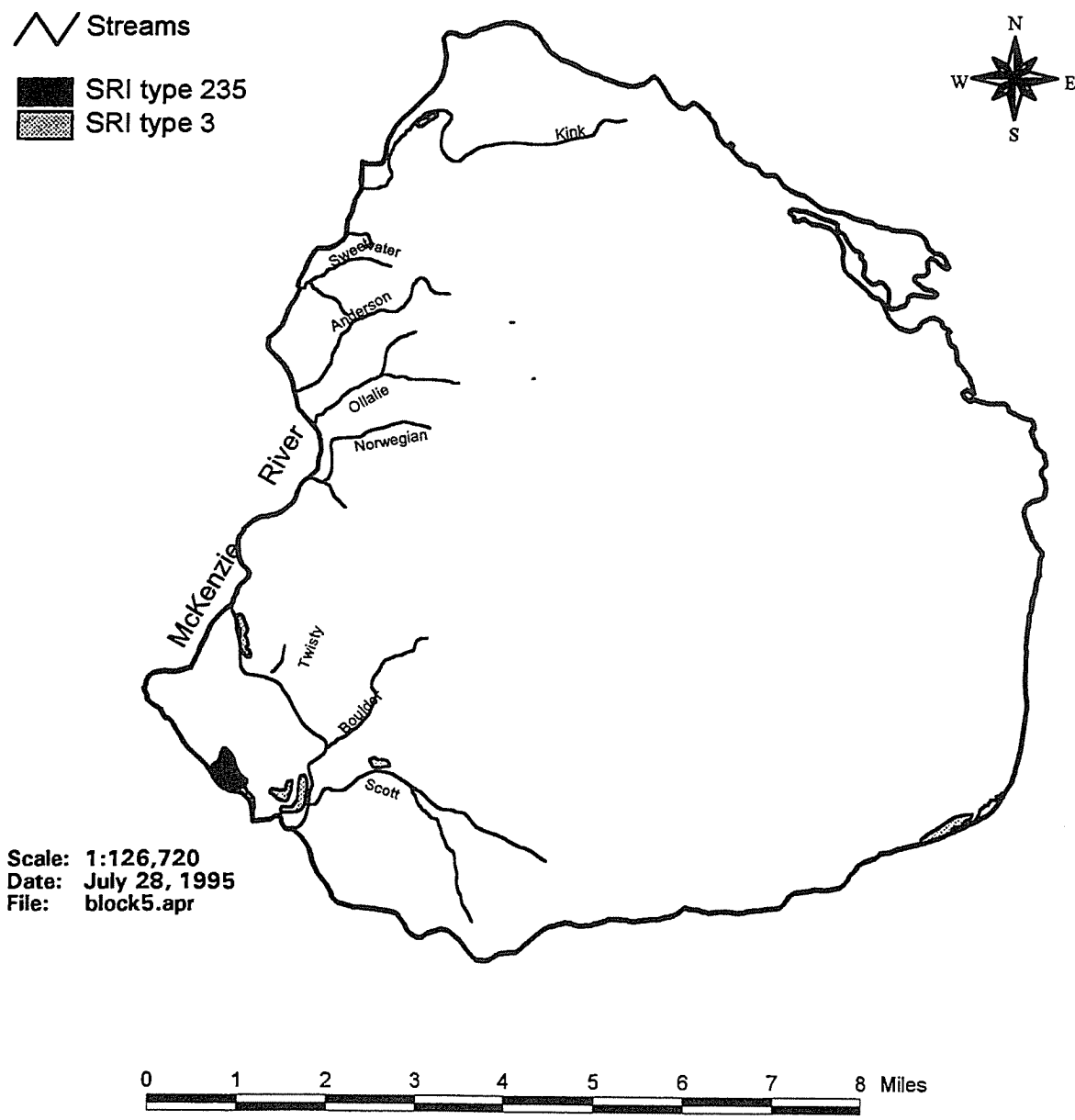
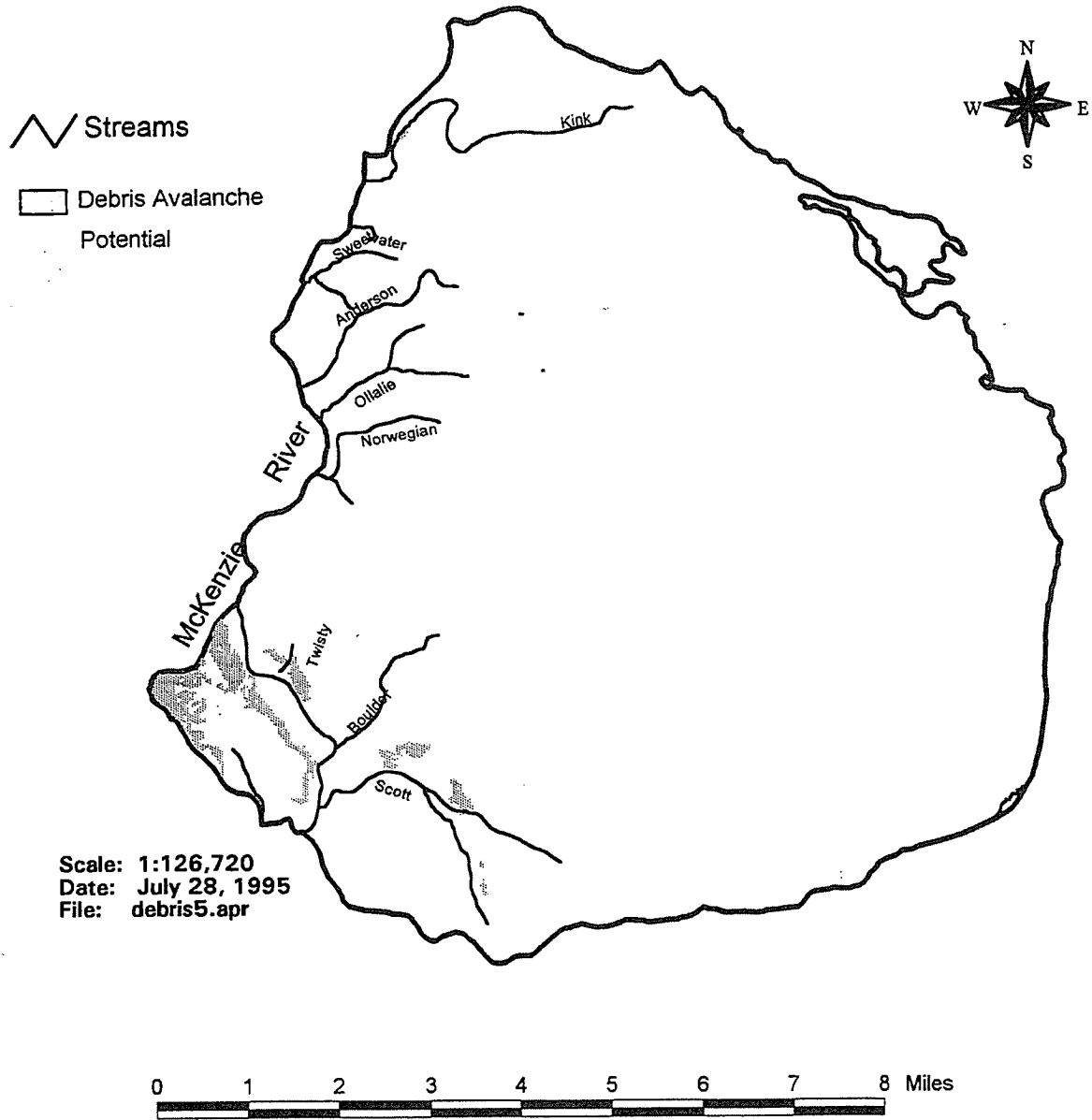


Figure 4-42. Landform Block 5 Debris Avalanche Potential



surface wind is channeled and strengthened by the gaps between Bunchgrass Ridge and Scott Mt.; Scott Mt. and Two Buttes; and Two Buttes and Deer Butte.

The area has a history of small-sized, frequent, low to moderate-intensity fires coupled with large-sized, high-intensity, relatively frequent, stand-replacing fires. The stand-replacing fires have a longer fire return interval than those of any of the other landform blocks. The area also has high meadows that burned rather frequently. These areas are currently being invaded by young trees.

Many high elevation meadows and huckleberry fields occur within this area. The areas surrounding these meadows and fields may have been influenced by sheep herders burning meadows in the late 1800's, and before then, by aboriginal burns to enhance berry productivity.

The forest patches in this block are mostly even-aged stands. The average size of the patches is small: about 61 acres. This is significantly smaller than the average patch size in 1900, which was about 261 acres. A Shannon diversity index indicates 5% increase in diversity from 1900 to 1995. The index shifted from 1.90 in 1900 to 2.00 in 1995. This shift reflects the increase in small patches created through clearcutting over the past 40 years.

Unique Habitats

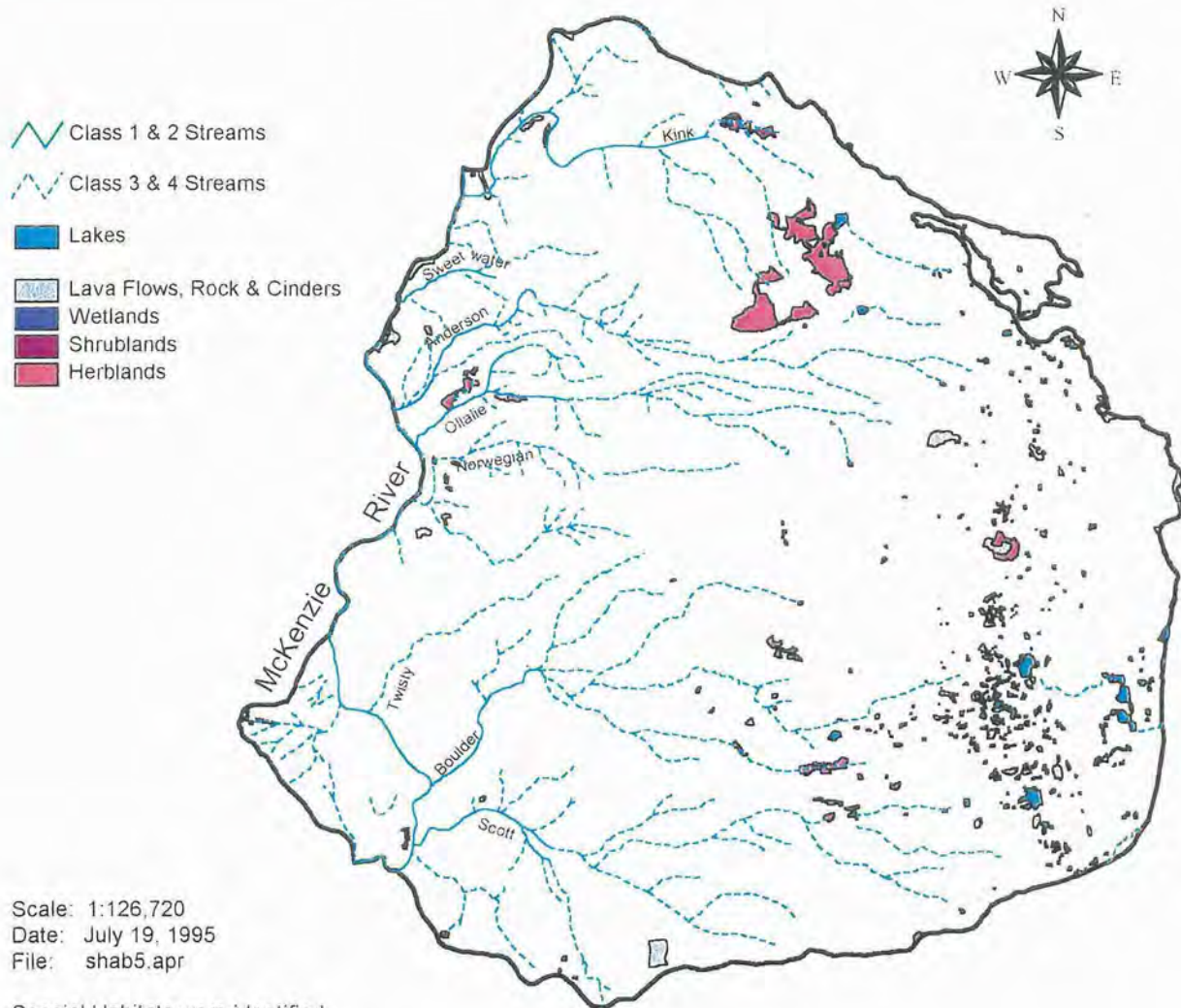
Table 4-11 and Figure 4-43 display the unique habitats that occur within this landform block. The predominant unique habitats are lava and talus.

Table 4-11: Unique Habitats within Landform block 5.

Habitat Feature	Acres
Bog	3.45
Wet meadow	30.04
Mesic meadows	47.34
Dry meadows	333.67
Herb/forb meadows	121.74
Shrub communities	14.08
Rock outcrop	9.13
Talus	380.48
Lava	660.78
Lakes	208.80
Reservoirs	9.32

Lakes, wet, mesic and dry meadows occur in small openings that are scattered throughout the dense stands of trees in this block. The majority of meadows are located in the wilderness. Wildfire, ignited either by lightning or Native Americans, was a natural element of the ecology of the high Cascades (Franklin

Figure 4-43. Landform Block 5 Special Habitats



Special Habitats were identified through photo interpretation.

and Dryness 1973). Fire suppression activities in this century have probably interrupted the natural fire frequency in much of the High Cascades (Franklin and Dryness 1973)

An area west of the wilderness is a large glacial deposit. The soils covering the glacial material have little water holding capacity and quickly dry out. Three meadows located in this area are Fingerboard, Bunchgrass, and Buttercup. Bunchgrass and small isolated areas of Fingerboard Meadow have had recent man-caused fires. No change in species composition has been noted in these meadows as a result of the fire. These meadows have been identified as seed collection sites for revegetation projects.

There are abundant high quality lakes in the wilderness area of this landform block that are providing high quality habitat for many wildlife species. They have generally not been inventoried, so the extent of their biota is unknown. Threats to the wildlife may include introduced stocks of fish that consume native amphibians. Fingerboard Prairie SWHA, Bunchgrass SWHA, and Buttercup SWHA are all providing high quality meadow habitat for wildlife, and they are protected by SWHA LMP allocations. Fingerboard Prairie is the site of a Migratory Bird Monitoring station, and abundant information is available on the bird species that utilize that area. Anderson Spring SWHA and Kink Creek SWHA are providing high quality habitat, also protected by SWHA designation. There are currently no threats to these habitats, with the exception of Fingerboard Prairie. Conifer invasion from lack of fire is reducing the available meadow habitat. Reintroduction of fire is being tested.

Sensitive Plants

Two sensitive plants and 3 species of concern occur in this landform block (Table 4-12). Both populations are stable at this time. Potential habitat for 15 sensitive plant species is found in this landform block. Table C-3 species present are a false truffle, *Thaxterogaster pingue*, located at Scott Lake; and *Allotropa virgata*. *A. virgata* is documented in six western hemlock stands, three of these sites occur in an uncommon western hemlock/rhododendron-salal plant association.

Noxious Weeds

Many non-native plants occur in the meadow complex that make up Fingerboard Prairie. These species are most likely a result of past livestock grazing that historically occurred in the meadows. The prevalence of noxious weeds and other non-native plants in these meadows is competing with the native vegetation. The reintroduction of fire in these meadows may reduce the presence of these introduced species.

Table 4-12: Sensitive and Rare Plants Located in Landform Block 5.

Landform Block 5	Status	Number of pops
<i>Romanzoffia thompsonii</i> - Thomson's mist maiden	S	1
<i>Carex atrata</i> var. <i>atrosquama</i> - blackened sedge	S	1
<i>Sidalcea cusickii</i> - Cusick's mallow	W	2
<i>Botrychium virginianum</i> - rattlesnake fern	C	1
<i>Corallorhiza trifida</i> - yellow coral-root	C	1
The Region 6 Sensitive (S) Plant List; Review (R) List and the Watch (W) List are maintained by the Oregon Natural Heritage Program. The Willamette National Forest maintains a Concern (C) List for locally rare species not included in the first three lists.		

Biological control and manual removal are the treatment methods used in this landform block for noxious weeds. Beneficial insects feed on the seed heads and roots of selected weed species. Over time, the insects reduce the growth and expansion of the weeds.

CHANNEL CONDITION AND AQUATIC HABITAT

Streams draining the relatively flat slopes of the high cascades and glacial deposits within this landform block are similar to the streams of Block 3 with relatively low channel incision. This reflects both the youngness of the channel and the porosity and storage capacity of the surrounding geologic material. The exception is the lower 2 miles of Scott Cr. and Boulder Cr., where the channels run through Western Cascades geology and into the McKenzie River glacial trough, resulting in more steeply incised, higher gradient streams. The streams within this block tend to be somewhat immune to large storm events, likely due to the porosity of the glacial deposits and the large storage capacity of the underlying lava flows. This is reflected in much of the drainage network consisting of Class IV stream channels. There is just not an extensive area of perennial flow. Whereas streams in the Western Cascades tend to be "flashy," the streams within the High Cascades have flows metered out on a more uniform basis. This is particularly true for the spring-fed systems of Ollalie, Sweetwater, and Anderson Creeks that flow from springs originating from the contact between the old High Cascades, and the new High Cascades lava flows.

Sediment production within this block was historically moderate. The area typically burned intensively throughout large areas. However the flat terrain and generally stable ground probably did not result in an extremely high sediment yield.

The recent High Cascade lava flow (<12,000 years old) across the early High Cascade lavas (12,000-4 million years old) provides the cold, spring-fed flow that currently supports spawning and rearing habitat for bull trout. Sweetwater, Anderson, and Olallie Creeks each flow across porous young lava flows and provide much colder water temperatures (2-6° C) than adjacent streams flowing across early High Cascade lavas (6-13° C). Although more deeply incised due to their longer period of existence, streams draining the early high Cascades in Landform 5 (Kink, Twisty, Boulder, and Scott Cr.) are less accessible to upstream migrating fish due to their channel's steep gradients over glaciated valley walls and low surface flow over incised glacial till. The channels of Sweetwater, Anderson, and Olallie Creeks do not possess the obstacle of steep glacial walls. Rather the recent lava flow inundated the steep valley walls and provided low gradient access to their spring-fed headwaters. This gradual toe of lava also determines bull trout stream geomorphology of shallow to moderately incised channel and gentle, rolling side slopes resistant to failure. Low levels of fine sedimentation are characteristic of bull trout streams, as well as undercut banks, high quantities of LWD, abundant margin habitat, and high channel complexity. The even flow of these spring-fed streams provide for a high level of channel stability. Frequent forb vegetated islands, that would be subject to annual rearrangement in adjacent flashy streams, persist for decades in Sweetwater, Anderson, and Olallie Creek. The spring-fed nature of the channel dampens rain-on-snow events and does not appear to allow transport of larger diameter LWD. Large wood found in-stream shows little sign of movement, often decomposing where it falls. Other bull trout stream characteristics include high levels of input and retention of fine organic matter. Large volumes of in-stream wood and a mature conifer canopy provide significant quantities of detritus with which bull trout juveniles are often associated (Goetz 1994). Low velocity habitats have deep beds of detritus that juvenile bull trout use as cover and foraging grounds for aquatic insects. Bull trout association with wood in these streams continues through adulthood, when they return to spawn and seek cover under large in-stream wood.

Historic bull trout use of subbasin tributaries has likely shifted to include these fairly recent sources of cold water. Bull trout are believed to be "glacial relicts," present during the retreating ice age and adapted to cold water habitats. As conditions of the landscape changed with volcanic activity and warming climate, bull trout use of tributary streams shifted. This may help explain current bull trout distribution. Bull trout specific requirements for spawning and rearing habitat are not currently met by Scott or nearby Lost Cr. (Landform Block 6), but may have been in the past. If habitat requirements were met, such as low temperatures and low levels of fine sedimentation, bull trout may have spawned and reared in streams adjacent to Sweetwater, Anderson, and Olallie Creeks.

Elsewhere in Landform 5, Twisty and Kink Creeks flow across the early High Cascade plateau before dropping steeply over the McKenzie's glaciated valley rim. Soils made up in large part of glacial till deposits characterize Landform 5 which possess large water storage capacity. Low gradient, uniform flow streams do not provide adequate energy to transport debris or sediment as compared to Western Cascade tributaries. Boulder and Scott Cr., each with their lower two miles incised in Western Cascades geology, possess more variable flow regimes and the ability to transport greater quantities of debris and sediment.

Recent disturbance in this landform include a large stand-replacing fire of unknown acreage prior to 1901 in the vicinity of Olallie Creek. In the mid-1980's, disappearance of surface water flow occurred on Olallie Creek near its headwaters. Large springs dried as the surface water found an alternate route. It is believed the upper springs found a subsurface route, through the porous lavas, to emerge downstream and abandon the former channel (near the junction of FS Rd 2657 and Rd 830). This unusual form of habitat disturbance may occur as spring-fed channels cut through their porous parent material.

The majority of the 349 lakes and ponds found within the watershed are located in Landform 5. Many are located on the glaciated flanks of Scott Mtn. Few of these lakes have inlets or outlets. Generally if surface flow is present, it is as a springtime, ephemeral inlet. Most high elevation lakes can be classified as at a very low level of productivity (low trophic status - ultraoligotrophic) and originally barren of fish life. No lakes in Landform 5 are expected to have been inhabited with fish historically (Fisheries Appendix). Rates of lake succession and enrichment by surrounding vegetation is very slow due to high lake elevation and parent geology. Although not recently surveyed, most lakes can be expected to continue to be classified as ultraoligotrophic. The native fauna of High Cascade lakes includes numerous bottom-dwelling caddisfly, mayfly, amphipods, and water beetles. Zooplankton communities are present in low productivity lakes. Amphibians include Cascade, red-legged and spotted frogs, western toads, Northwestern salamanders, and Pacific giant salamanders.

Landform Block 5 falls within the Boulder/Frissell subwatershed, and it is one of the three most heavily managed subwatershed in the Upper McKenzie Watershed (Deer subwatershed is more heavily managed, and Smith subwatershed has almost the same percent of its subwatershed managed as Boulder/Frissell) (Table 4-3). Smaller drainages within the Boulder/Frissell subwatershed have had up to 44% of their drainages harvested and roaded as in the case of Twisty drainage (Table 4-3). Scott Cr. drainage has also been intensely managed with 32% of the drainage harvested and roaded. Kink Cr. drainage is also located within this block, and has 21% of its area roaded and harvested. What this heavy management means to the stream systems is unclear. Much of this landform block has area located within the permanent snow pack, and the porous volcanic rocks probably act as moisture reservoirs

making it a low and moderate contributor to rain-on-snow events (Fig. 3-17b). For these reasons, the streams may not experience increased peak flows to the extent streams do that are located in the western cascade province. This is truly the case for the springfed streams of Ollalie, Anderson, and Sweetwater Creeks. For example, Sweetwater Cr. has 33% of its drainage roaded and harvested, with a road density of 4.5 mi/sq. mi, and yet the channel is in good condition (Table 3-3). The same is true for the non-springfed streams of Block 5 such as Boulder, Scott, Kink, and Twisty, whose channels are all pretty well intact.

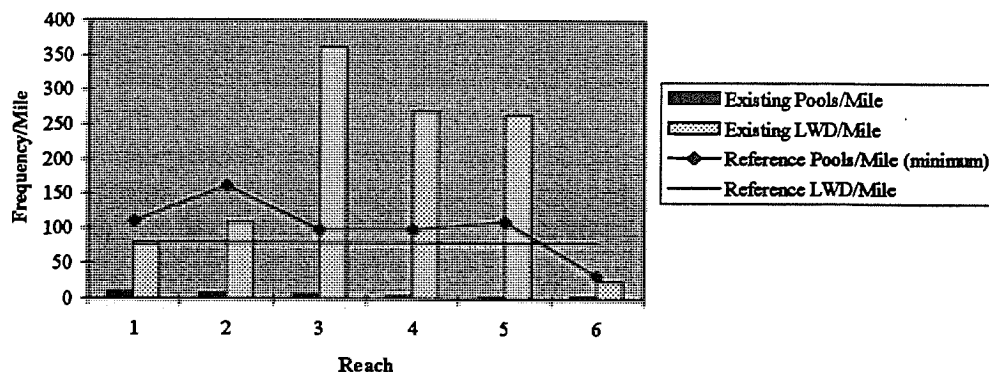
Kink and Twisty Creek Habitat Condition

On each side of the recent high Cascade lava flow, two creeks are located: Kink Creek to the north and Twisty Creek to the south. Both have similar channel geomorphology and aquatic habitat characteristics. Both stream channels travel across early High Cascade formations and drop over the steep glaciated valley walls to enter the McKenzie River flood plain. Both channels behave similarly, going seasonally dry as they traverse the McKenzie River's coarse glacial till. This seasonal barrier prohibits fish migration during summer and fall months.

Large volumes of LWD are present in Kink Cr. channel (Figure 4-44). An old-growth dominated riparian area contributes large diameter Douglas-fir to the channel, most often from windthrow. Few debris jams of large material are present suggesting high flows are rarely capable of transporting whole large diameter trees.

Figure 4-44

Kink Creek Large Pools and LWD/Mile: Existing and Reference



From USDA Forest Service Level II Kink Cr. survey, 1990. The Fisheries Appendix describes habitat evaluation criteria. Reference pool frequency is based upon active channel width and channel gradient.

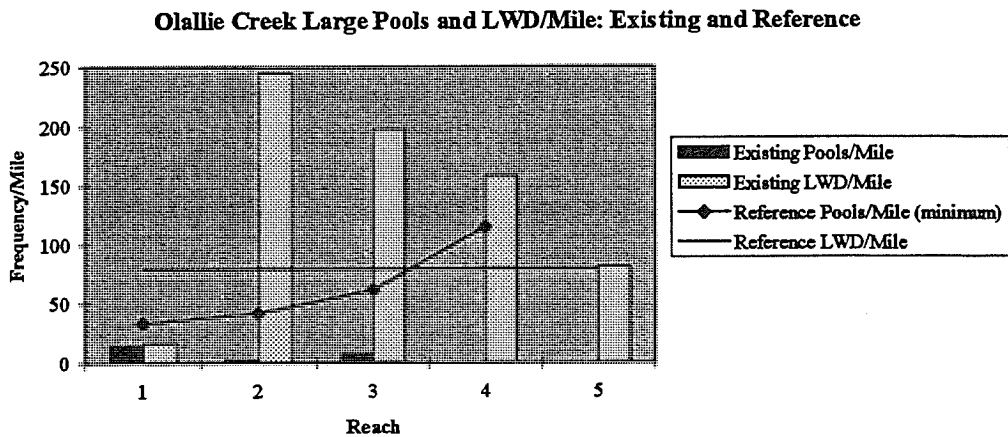
Old-growth riparian areas and buffer strips provide good recruitment potential to Kink Creek. Twisty Creek has far less volume of in-stream wood (Table x) and poor recruitment potential due to harvest activity near the channel. Pool

frequency on both Kink and Twisty Cr. is low. Low recorded large pool frequency is typical of habitat complexes found in Kink and Twisty Creek. Both streams may be characterized as boulder/plunge pool habitat complexes, where large pools are infrequent and pocket pools are common. A cutthroat population resides throughout Kink Cr.; no fish were found in a recent survey of Twisty Creek.

Sweetwater, Anderson and Olallie Creek Aquatic Habitat Condition

Large volumes of in-stream wood characterize Olallie Cr. (Figure 4-45) and Sweetwater and Anderson Cr., although diameters of in-stream wood in Anderson Cr. are smaller, averaging less than 24 inches. All three streams retain their LWD due to even spring-fed flow, rather than transporting wood to the McKenzie River.

Figure 4-45



From USDA Forest Service Level II Olallie Cr. survey, 1992. The Fisheries Appendix describes habitat evaluation criteria. Reference pool frequency, based upon active channel width, is not estimated for channel gradients >10% as in Reach 5.

Recruitment potential of large wood to the channel is good to excellent in all three streams. Several clearcuts adjacent to streams will delay natural rates of input. Stream bank stability is a concern where buffers have or are subject to blow down. Bull trout have been found to be particularly sensitive to land management activity with a low tolerance of increases in sediment level in spawning gravels. Significant reduction in survival of incubating eggs occurs with increases in fine sediment levels. Weaver and Fraley (1991) found increases in fine sediment composition beyond 35% of spawning substrate, decreased egg to emergent fry survival.

Large pool frequency does not reflect the high quantity of smaller pool area available in these streams. Due to the broad channel width and low gradient, large channel spanning pools are infrequent in these three streams. For this

reason, meeting reference conditions for typical Western Cascade streams may be unrealistic. Anderson Cr. survey, conducted by ODFW in 1991, may represent similar to reference conditions with pool:riffle ratios of about 1:4 for these stream types, although some habitat alteration may have occurred with moderate levels of management disturbance.

Bull trout production in the Upper McKenzie subbasin may be suppressed by limited rearing area in Anderson Creek. Recent monitoring of emerging fry migration in Anderson Creek suggests the stream does not have rearing habitat area sufficient for its fry production. Out-migrating fry likely suffer high percentage mortality once they reach the main stem McKenzie River. A recent study of habitat enhancement in Anderson Creek (USDA Forest Service 1993[d]) found addition of margin habitat resulted in increased use by juvenile bull trout. Competition for rearing space in Anderson Cr. may be verified by trapping at the confluence with the McKenzie River.

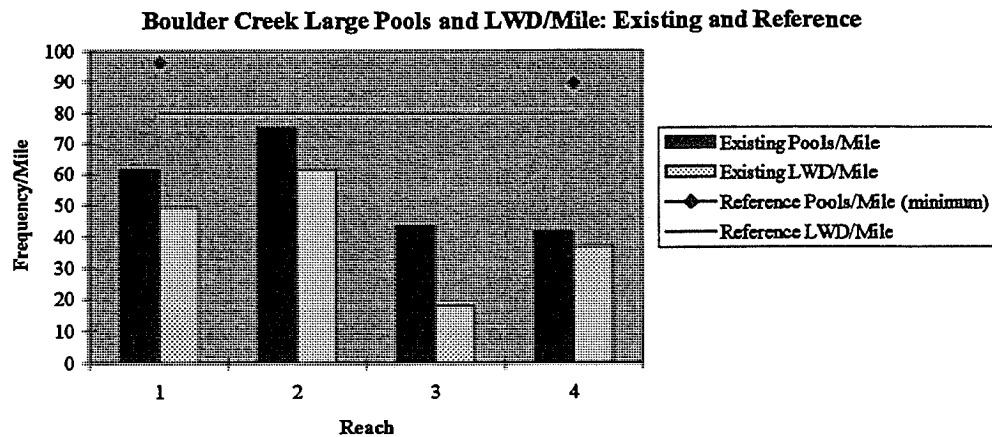
Olallie Cr. culvert beneath Hwy 126 is a passage barrier and will be treated during summer 1995. A parallel passage culvert will provide upstream migration for cutthroat, rainbow, and bull trout and spring chinook salmon to about 1.5 mile of historic spawning and rearing habitat.

The small geographical area of bull trout spawning and rearing streams, all located within a one mile radius, subjects the population to significant loss from disturbance. Additional protection of this important habitat will be necessary for higher probability disturbance such as wildfire, poaching, chemical spill, and sediment input.

Boulder and Scott Creek Aquatic Habitat Condition

Both Boulder and Scott Cr. are more deeply incised channels, characteristic of Western Cascade streams. Each streams' lower two miles have cut the Pleistocene high Cascade lavas and now incise underlying Western Cascades and McKenzie River glacial deposits. Their headwaters lie in the early high Cascades and glacial deposits. Their flow regime has a greater range of variability than adjacent Landform 5 streams. Boulder (Figure 4-46) and Scott Cr. each generally possess lower than reference levels of in-stream LWD. Both channels have poor recruitment potential of LWD due to previous harvest activity along some stream segments.

Figure 4-46



From USDA Forest Service Level II Boulder Cr. survey, 1992. The Fisheries Appendix describes habitat evaluation criteria. Reference pool frequency, based upon active channel width, is not estimated for channel gradients >10% as in Reach 2 and 3.

Buffer windthrow and bank cutting is common along both streams. Pools/mile are present in fair numbers, although below reference minimums. Lowered pool numbers reflect transport or salvage of LWD from channels, increases in peak flows and bedload deposition (pool filling). Debris jams are more frequent in Boulder and Scott Cr. as compared to other Landform Block 5 streams.

Both streams are occupied by resident cutthroat trout and sculpin. It is likely rainbow trout utilize both streams as spawning and rearing habitat. Spring chinook fry have been found in Scott Cr., likely moving from the main stem McKenzie to rear in low gradient portions of lower Scott Creek. Lower reaches of both streams are probable foraging areas for bull trout. Unlike Kink and Twisty Cr., these streams do not flow intermittently over McKenzie flood plain glacial till, but flow year round to the McKenzie River. An isolated population of cutthroat exist above a 9 foot falls at Scott Creek's rivermile 1.1.

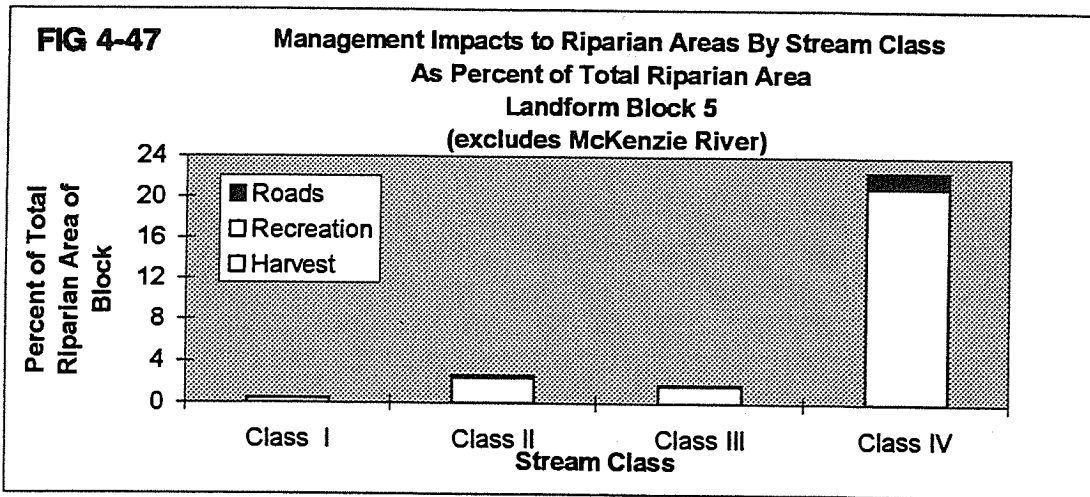
High Lakes Aquatic Habitat Condition

The Fisheries Appendix lists a portion of the lakes within Landform 5 and most of the lakes currently managed. By area, about 70% of wilderness lakes are stocked with non-native trout. All lakes in Landform 5 are believed to have been barren prior to introduction of trout in the early 1900's. No natural reproduction by fish occurs in this landform's lakes, and rainbow, cutthroat and/or brook trout are restocked every 1 to 4 years. Generally, larger and deeper lakes are planted to allow carry over of stocked fish and avoid mortality in shallow lakes freezing through. The impacts to native fauna from introduced species may be significant in these lakes. Introduced trout prey upon native aquatic insects and amphibians that have adapted to an environment free of an

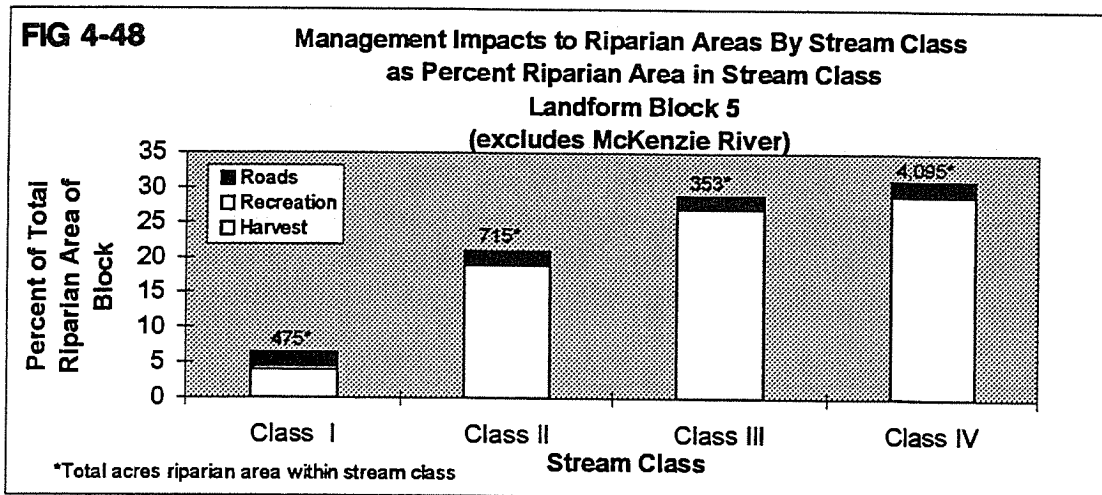
efficient aquatic predator. Human and stock impacts to wilderness lakes may significantly impact native fauna. Degradation of lake margins and riparian habitat consists of vegetation and LWD removal, barren banks, and potential impacts to water quality by enrichment. High impact lakes are generally easier access lakes with a popular fishery.

RIPARIAN RESERVES

Of the total riparian area within landform block 5, the area associated with Class IV stream channels has been the most heavily harvested and roaded (Fig. 4-47)



This is not surprising since much of the channel network is composed of Class IV streams. However, 21% and 29% of the riparian area of Class II and III streams, respectively, have been impacted when looked at as a percentage of riparian area along a given stream class (Fig. 4-48).



Boulder and Scott Creeks have the portions of Class II streams that are most impacted, and Anderson, Scott, and Twisty Creeks are the riparian areas associated with Class III's that most are affected. The 6% of the Class I riparian reserve impacted includes harvest in Sweetwater and Anderson Creeks riparian areas, and a small portion of Ollalie riparian reserve impacted by Ollalie Campground.

Human Disturbance and Effects: Campsites

Dispersed Campsites: The 1988 inventory by Troy Hall, using Limits of Acceptable Change (LAC) data forms, showed that this landform block has 80 dispersed camping sites. This is 24% of the 333 dispersed sites in this watershed.

Riparian: Forty-six sites (or 58% of those in this block) are in a riparian reserve, with 33 of these sites concentrated in the Scott Lake area. Twenty-nine of these sites are accessible by foot only on a closed road. The remaining dispersed riparian sites are on Olallie, Anderson and Boulder Creeks, Irish Camp Lake, and Robinson Lake. The 46 riparian dispersed sites have 94,186 sq ft, or 2.16 acres of campsite area. The barren core of these sites equals 53,163 sq ft or 1.22 acres. That averages to 56% of the riparian camp areas as barren, a figure that may be misleading due to a few sites with very large core areas.

Non-Riparian: Thirty-four of the dispersed campsites in this landform block are not close enough to water to be considered within a riparian reserve. These sites are near Trailbridge Reservoir, Olallie Creek, Foley Ridge Road, Hand Lake area, and Robinson Lake Road. These 34 sites have an area of 45,883 sq ft, or 1.05 acres. Of this area, 3,990 sq ft or 0.09 acres is considered barren core. That averages 9% of core within these site areas. Five of these dispersed camps located in the Hand Lake area are accessible by foot only.

Developed Recreation Facilities: Campground recreational facilities typically consist of Forest Service-provided tables, fire rings, vault or flush toilets, and parking spurs. They may have water systems and garbage service. Boat ramp facilities usually are graveled ramps accessing lakes or reservoirs. The river launches sometimes have log skids to help drift boats and rafts access the river. The following developed recreation facilities are located within landform block 5:

Campgrounds: Olallie Campground--This campground is described under the mainstem McKenzie corridor.

Picnic/Day-Use Area--There are no day-use areas within this block.

Boat Ramps: None of the boat launches are in this block.

Sno-Parks: No sno-parks are in this landform block.

Administrative or Recreation Special Use Permit Areas: This block contains Camp Melakwa, a Boy Scout Camp operated under Special Use Permit. The facilities consist of wooden tent platforms, cabins, a piped water system, mess hall, covering 55 acres. All these areas fall within the riparian buffer of Melakwa Lake.

Wilderness: Landform block 5 has 10,016 acres, or 22% in Wilderness. This area is relatively accessible by trail, containing destinations such as Kuitan Lake, Scott Mountain, Texas Lakes, Benson Lake. The landform boundary follows the foot of the lava flows, placing the flows in block 4, and leaving the gentler terrain in this block 5. Wilderness permit data shows this area is lightly traveled by recreational stock users.

LANDFORM BLOCK 6

LOST CREEK GLACIAL TROUGH

(Yapoah-Anderson Creek system of Wilson 1981)

Introduction

The Lost Creek/White Branch drainage represents three episodes of geologic formation. The original valley was deeply incised in Older High Cascades volcanics during uplift of the Central Cascade Range. Subsequently, the valley was filled by later "intracanyon" lava flows about 4 million years ago. Stream erosion at the margins of these flows and subsequent valley erosion by several events of glacial advance and retreat have left these older intracanyon flows perched above the valley as Foley Ridge (Flaherty 1981).






The valley glacial events were followed by two new episodes of intracanyon basalt flows from Younger High Cascade cinder cones; one about 7,500 years ago which erupted from Sims Butte and reached a point near the confluence with the main-stem of the McKenzie; and one from Collier Cone about 2,500 years ago which side-lapped the Sims Butte flow (Lund 1977). These flows were associated with pyroclastic ash eruptions which account for some of the sediment source for the watershed. Because of this and the much lower stream velocity in the Lost Creek drainage, the gradation of the sediments are much finer than those in the main-stem of the McKenzie.

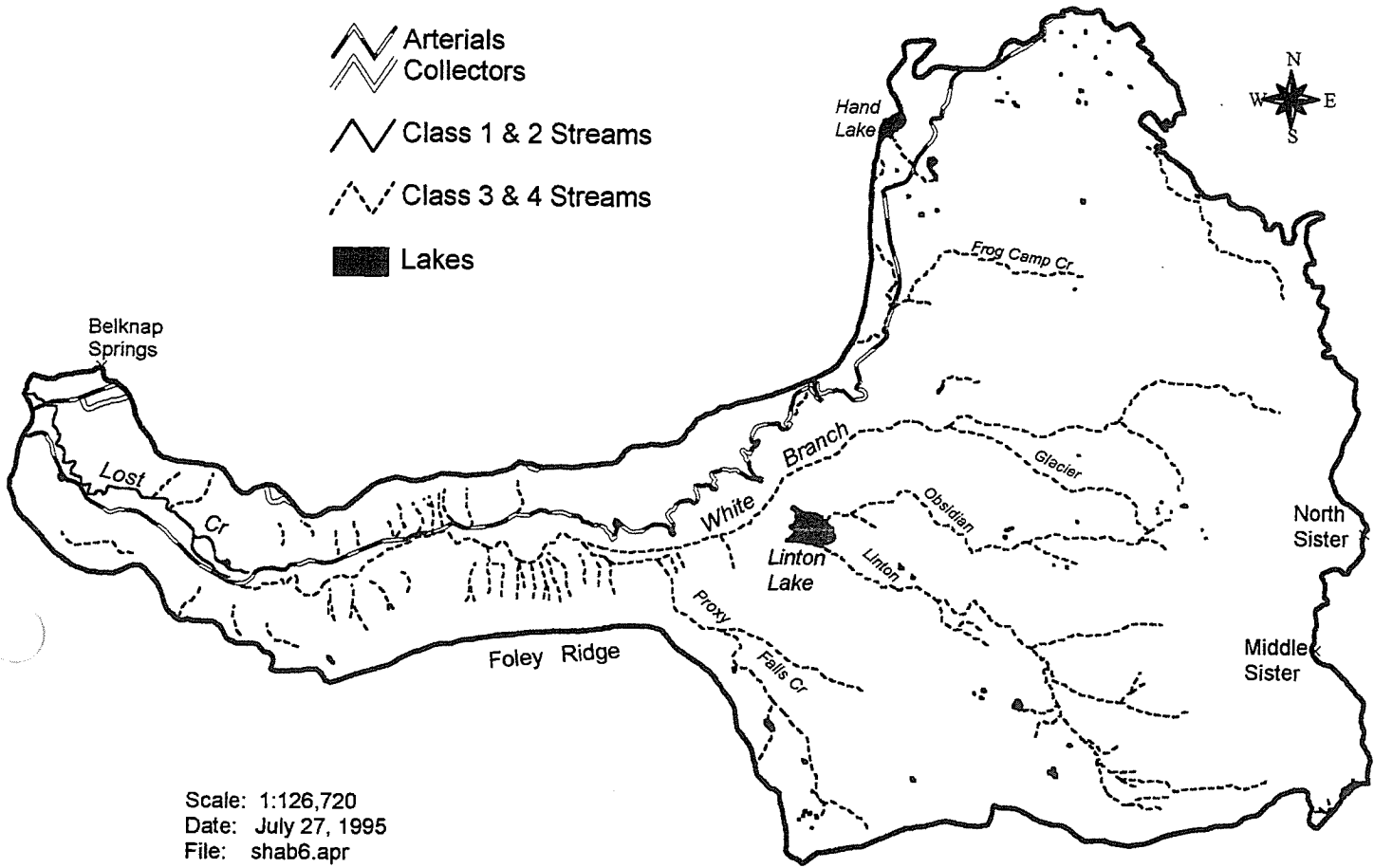
Similar to the Recent High Cascades landform block, these younger, more permeable lava flows overlying glacial deposits provide for subsurface water flow, which originates from Collier Glacier, and emerges as springs in the lower valley such as Alder, Butte, and Payne Springs (Figure 4-49).

Disturbance History - Mass Wasting

Mass wasting in Landform Block 6 has been a result of differential weathering at the base of the Simms and Collier Butte flows on the sideslopes of Lost Creek (between Payne Springs and Cupola Rock). This created debris avalanches that were transported to the valley floor of Lost Creek due to the lack of sinuosity of the fourth order streams. Landslide and debris avalanche events also occur on the sideslopes of the cinder cones and volcanoes in the upper portions of the Landform Block, and potential exists for events to occur as a result of alpine glacial melting (Fig. 4-50 and 4-51).

Figure 4-49. Block 6 Locator Map

-  Arterials
-  Collectors
-  Class 1 & 2 Streams
-  Class 3 & 4 Streams
-  Lakes



Scale: 1:126,720
Date: July 27, 1995
File: shab6.apr



Figure 4-50. Landform Block 6 Potentially Unstable Areas

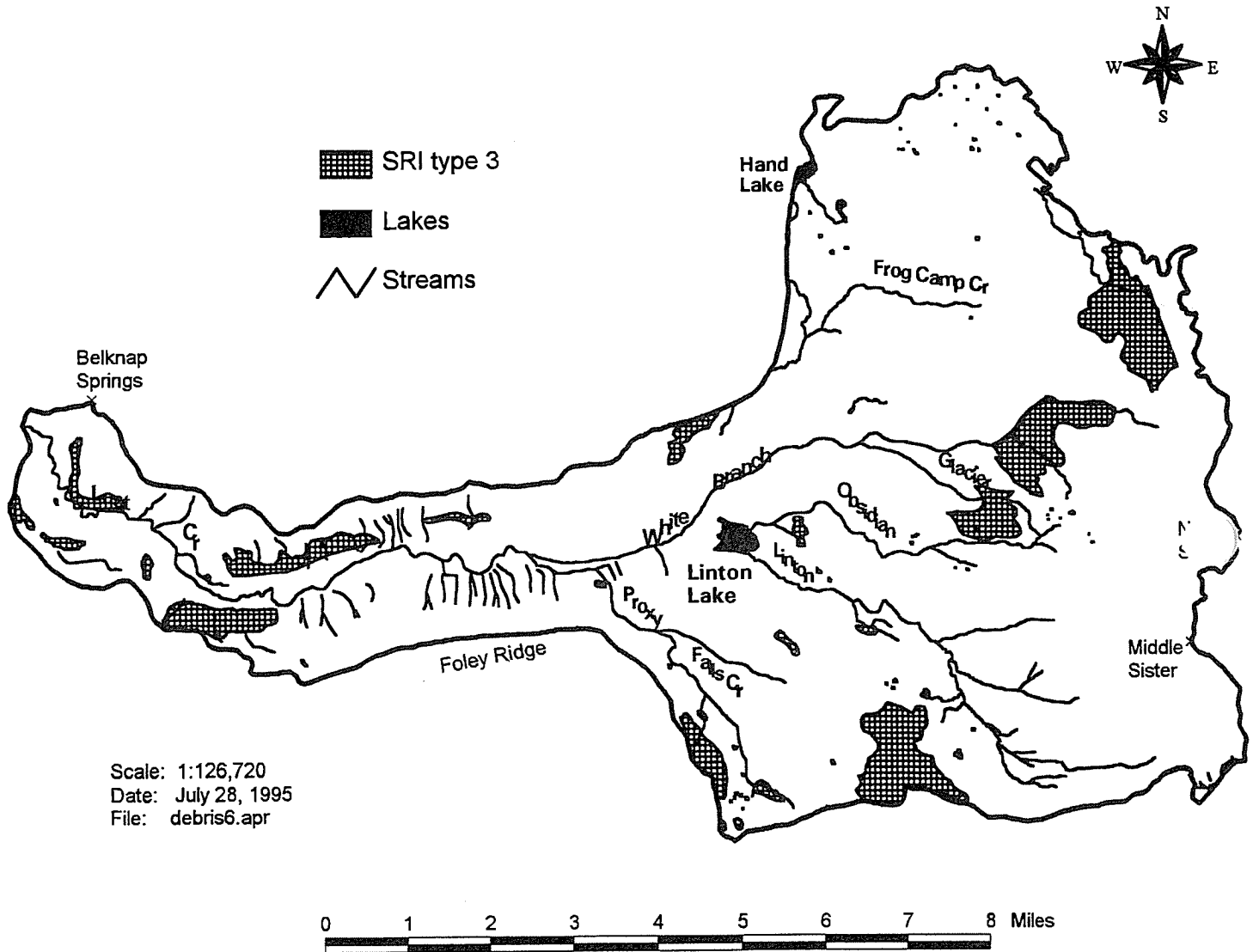
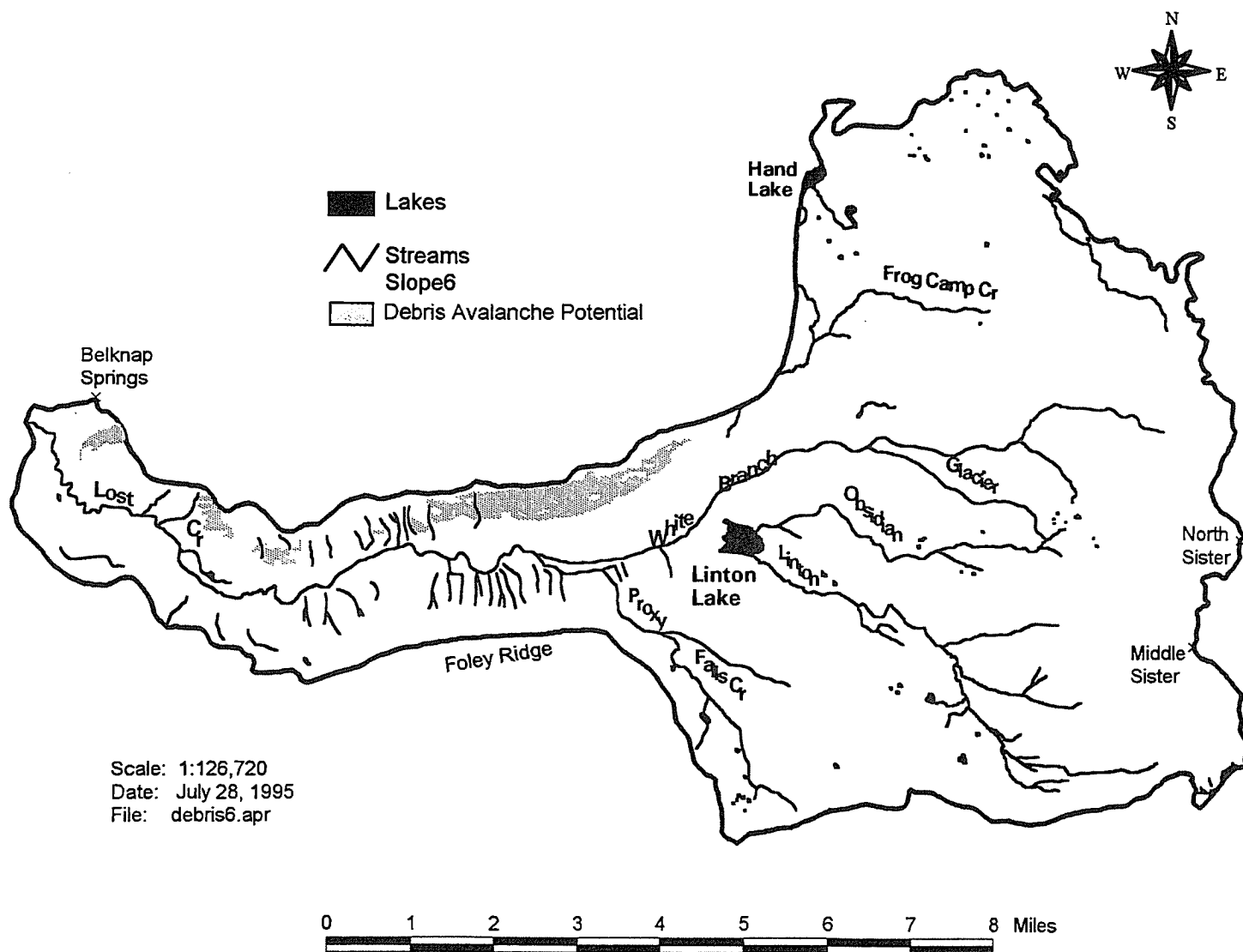


Figure 4-51. Landform Block 6 Debris Avalanche Potential



Landform block 6 contains SRI Unit 3 potentially on all slopes; and Units 61, 610, 610U, 614, and 71 on slopes greater than 70%.

Disturbance History: Fire and Vegetation Patterns

The vegetation of this block is mostly Pacific silver fir (ABAM), western hemlock (TSHE), mountain hemlock (TSME) plant series, and Douglas-fir (PSME) plant series. For further discussion of the associated plants, stand development pattern, and ecology of these plant series, see the Upland Vegetation section of Chapter 3.

The typical winds in this area are from the west, blowing up-slope and up-canyon. The east winds blow across the surface on most of this block. That surface wind is channeled and strengthened by the gap between Black Crater and North Sister (Faith 1990). This same stream of wind slips down into the White Branch drainage to approximately 2500 feet elevation.

The area has a history of fairly frequent fires of varying intensity and varying sizes. This block is capable of producing large final fire sizes. Currently, average patch size is larger here than anywhere in the watershed. This is consistent with the amount of wilderness, the plant series, the stand density of this block, and long topography.


Along the ridgelines, lightning ignitions play an important role in the ecological process within this block, but fires here have been relatively small in extent due to the nature of fuel packing and abundance, and moisture at these sites. The area also has high meadows that are being invaded by young trees.

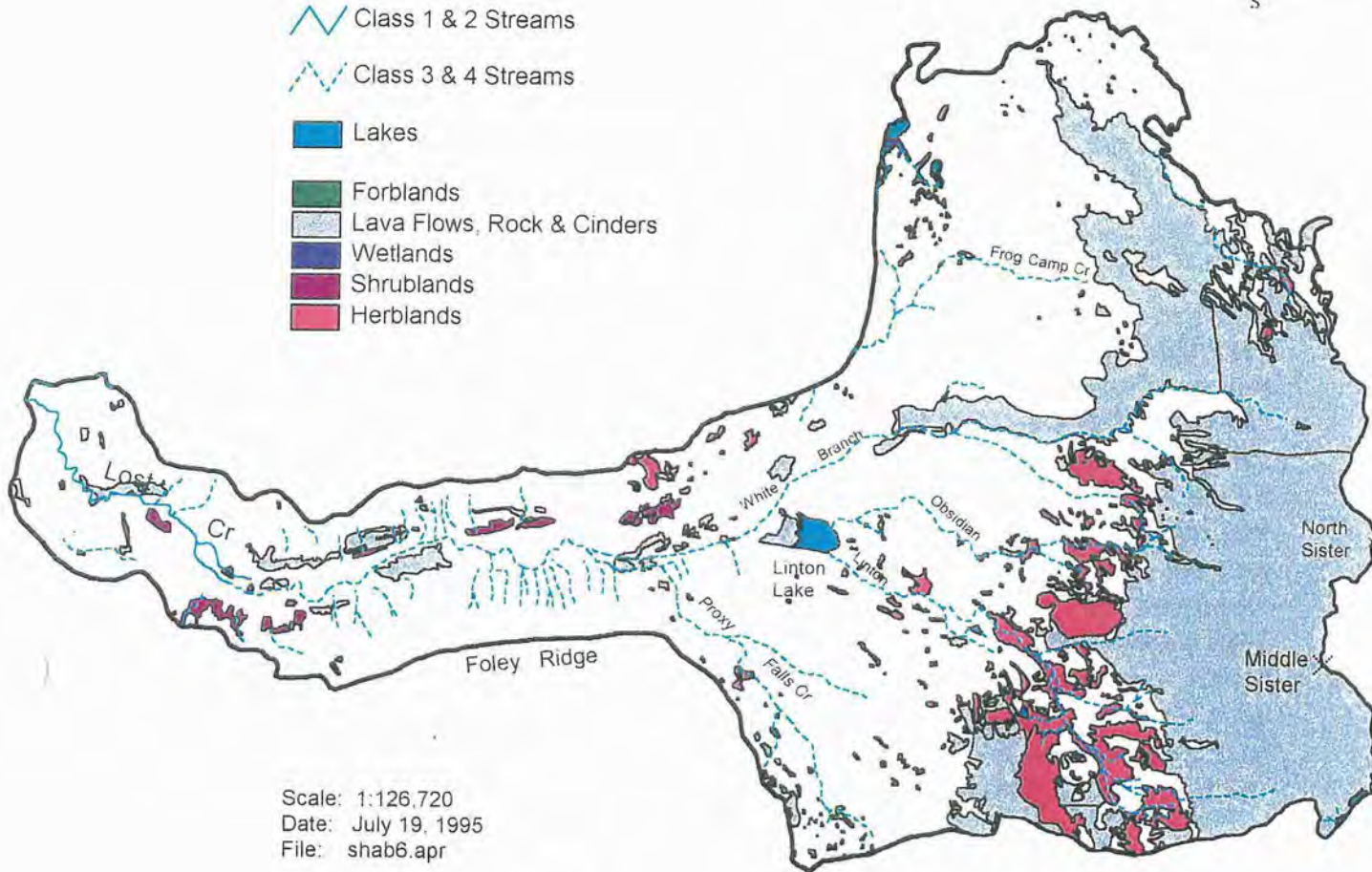
The forest patches in this block are a mix of even-aged stands and multi-aged stands. The multi-aged stands are located in the lower elevations of the block. The average size of the patches is small: about 74 acres. This is smaller than the average patch size in 1900, which was about 90 acres. A Shannon diversity index analysis indicates a 3% decrease in diversity between 1900 and 1995. The index changed from 1.90 in 1900 to 1.85 in 1995. The decrease is mostly related to fire suppression in the wilderness portions of the block that has created a more homogeneous landscape.

Unique Habitats

Table 4-13 and Figure 4-52 display the unique habitats within this landform block. The most dominant non-forest habitats are meadows and lava.

Figure 4-52. Block 6 Special Habitats

-  Class 1 & 2 Streams
-  Class 3 & 4 Streams
-  Lakes
-  Forblands
-  Lava Flows, Rock & Cinders
-  Wetlands
-  Shrublands
-  Herblands



Scale: 1:126,720
Date: July 19, 1995
File: shab6.apr

Special Habitats were identified through photo interpretation.



Table 4-13: Unique Habitats within Landform block 6.

Habitat Feature	Acres
Wet meadow	53.90
Mesic meadows	12.90
Dry meadows	21.25
Herb/forb meadows	1,743.53
Shrub communities	220.77
Shrub lava	96.22
Rock outcrop	4.55
Talus	124.44
Lava	4,463.57
Lakes	60.30

This landform block is unique because of the variety of non-forested habitats that are found and a range in elevation from approximately 1600 feet to over 9000 feet at the top of the Middle Sister. Much of the wilderness area is open subalpine parkland vegetation. Extensive huckleberry fields are found as well as many lakes and ponds with associated sedge vegetation are present. Plant associations of wet to dry habitats ranging from subalpine to low elevation meadows are scattered throughout the landform block. Threats to these meadows are a result of soil disturbances from recreationalists and grazing by pack animals. Many of these meadows tend to have fragile plant communities which are easily impacted by continual disturbance. These meadows may provide habitat for sensitive and other rare plant species. This summer, selected meadows will be field inventoried to assess the impacts from recreational use. Many of the subalpine plant communities have not been classified.

Cliff habitat in this landform block is providing high quality peregrine falcon habitat.

A unique feature of this area is the ecotone that exists between the younger unvegetated lava flow and the older vegetated flow that surrounds it.

Sensitive Species

Potential habitat for 15 sensitive plant species is present (Table 4-14). Three sensitive plant species and 3 species of concern have been located. Newberry's gentian (*Gentiana newberryi*) is the only known location on the Willamette National Forest. Newberry's gentian is a low growing alpine perennial found in moist meadows. Threats to this population are from hiking trails located in close proximity to these populations. The second sensitive species is the Northern bog clubmoss, found in open sphagnum bogs. Sighting information for this species is from an historical report; the area needs to be re-surveyed to determine current status of the species.

Table 4-14: Sensitive and Rare Plants Located in Landform block 6.

Landform Block 6	Status	Number of pops
<i>Gentiana newberryi</i> - Newberry's gentian	S	1
<i>Lycopodiella inundata</i> - bog clubmoss	S	1
<i>Utricularia minor</i> - lesser bladderwort	S	1
<i>Draba aureola</i> - golden alpine draba	W	5
<i>Lycopodium annotinum</i> - stiff clubmoss	W	2
<i>Oxypolis occidentalis</i> western cow-bane	W	1
<i>Botrychium simplex</i> little grape-fern	C	1
<i>Corallorhiza trifida</i> - yellow coral-root	C	2
<i>Isoetes spp.</i> - quilworts	C	1
The Region 6 Sensitive (S) Plant List; Review (R) List and the Watch (W) List are maintained by the Oregon Natural Heritage Program. The Willamette National Forest maintains a Concern (C) List for locally rare species not included in the first three lists.		

Table C-3 plant species that are found in this landform block are: *Gautieria magnicellaris* a rare mycorrhizal false truffle associated with high elevation old growth mountain hemlock and true fir conifers in the Mt. Washington Wilderness Area; *Thaxterogaster pingue* a false truffle found in a conifer stand adjacent to Huckleberry Lake and *Allotropia virgata* in two conifer stands (Botany Appendix). Additional habitat for many Table C-3 species occurs within this landform block.

CHANNEL CONDITION AND AQUATIC HABITAT:

Like Landform Block 5, much of this subwatershed drains gently sloping terrain of the High Cascades province and has new and old lava flows that have large water storage capacity. The nature of the springfed stream of Lost Cr., coupled with the storage capacity of the drainage area, determine the stable, even flows of the creek.

These conditions create stream habitat very similar to Landform 5's Sweetwater/Anderson/Olallie Creeks. The recent high Cascade lava flow upon which Lost Cr. flows overlies glacial deposits and older Pleistocene lavas. Cold water supplied by spring-fed flow originates from the western flanks of Middle and South Sister. The high water storage capacity of deep glacial deposits and

porous lavas provide for evenly supplied flow to Lost Creek. Changes in flow routes are a potential within this drainage, as observed recently in White Branch tributary with loss of surface flow as subsurface routes were apparently encountered by the channel. Disturbance in the past carried potential of massive debris torrents originating from glacial lakes at Lost Cr. headwaters. A similar torrent originating from nearby Skinner glacier flowed down Separation and Horse Cr. in 1933. Fire disturbance includes a large stand replacing fire along the south facing slope above Lost Cr. sometime before 1901. Fire in the Simms Butte vicinity was recorded in 1925 (480 acres) and 1935 (1,715 acres).

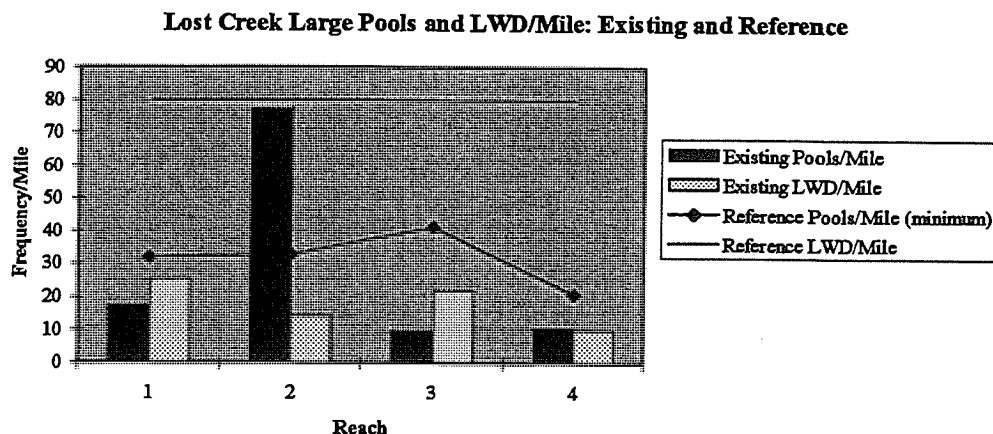
Lost Creek is an important spring chinook spawning and rearing stream. Cutthroat, rainbow and sculpin are known to inhabit the stream. It appears bull trout only use the stream currently as foraging habitat, entering its low gradient reaches to prey on abundant resident fish species and floating eggs of chinook salmon. Historic use of Lost Cr. by fish species may include spawning and rearing bull trout. Why bull trout do not currently use Lost Cr. as spawning and rearing habitat is not known. Theories include high concentrations of fine ash sediment in most habitats that does not allow optimal survival during incubation. All other habitat requirements of bull trout are apparently met by Lost Creek. The supply of ash to the channel comes from interception of ash layers adjacent to the channel supplied by steep side slope tributaries. If ash presence has not been continuous, perhaps bull trout used this stream as spawning and rearing habitat.

Similar to Landform Block 5, most lakes located in this landform are glacial scour lakes and were historically barren of fish. Linton Lake, isolated by a lava dam, may have had a native population of cutthroat in its past.

Lost Creek Aquatic Habitat Condition

Abundant LWD is present in Lost Cr. channel despite a large fire in the past century that burned stream adjacent conifers along most of its length. Although large diameter wood is present in low numbers (Figure 4-53), diameters smaller than 24 inches have been supplied to the channel.

Figure 4-53



From ODFW Level II Lost Cr. survey, 1991. The Fisheries Appendix describes habitat evaluation criteria. Reference pool frequency is based upon active channel width and channel gradient.

Highly complex habitat exists in Lost Creek, in part due to its uniform flow and stable channel. Habitat conditions similar to Sweetwater/Anderson/Olallie Cr. are abundant side channel habitat in low gradients, stable islands and in-stream wood, and undercut banks. Large pool habitat does not meet references levels in Reach 1, 3 and 4 due to the broad, unconstrained channel. Large channel spanning pools are infrequent, except in Reach 2 with a steeper, constrained channel. Active beaver colonies utilize a broad, inner hardwood riparian zone in Reach 2 and 3. Large wood in the channel appears to remain where it falls in unconstrained reaches. Recruitment potential is good for large diameter wood along Lost Creek.

Larger high lakes in this landform (Fisheries Appendix) previously barren of fish life, are currently stocked every 1-4 years. Self-reproducing populations of brook trout are found in Spring Lake and brook and brown trout are found in Linton Lake.

RIPARIAN RESERVES

Data indicates that approximately 7% of the entire riparian area within the block has been roaded, harvested, or has an administrative or recreation site. Of the total riparian area within the block, Class IV riparian areas have been the most impacted (<4%) (Figure 4-54).

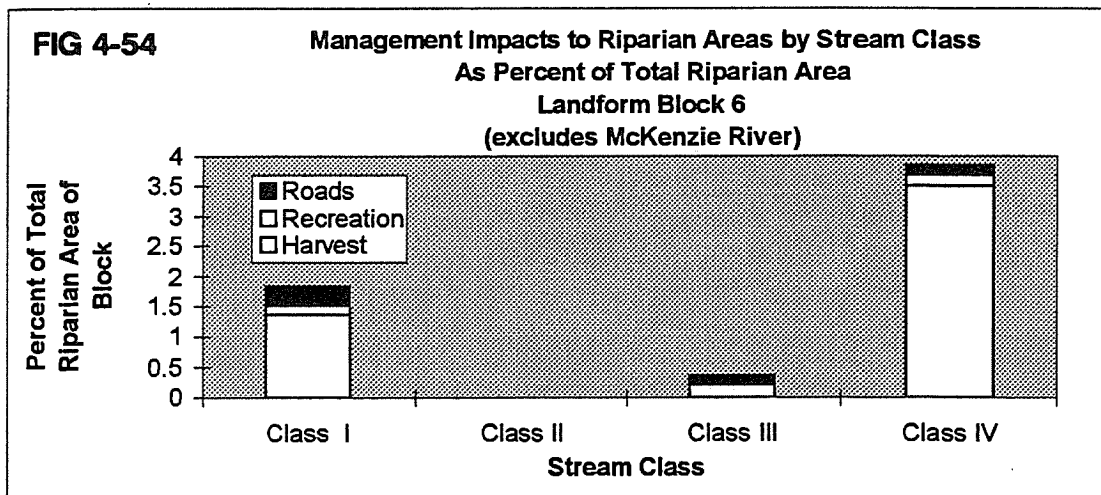
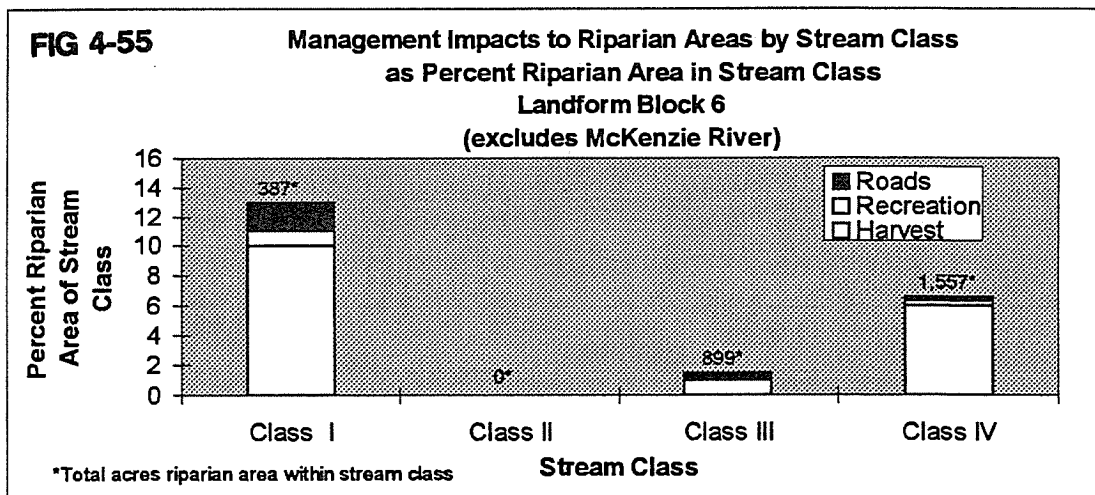


Figure 4-55 shows that Lost Cr. (Class I) has had nearly 13% of the riparian area impacted when considered as a percentage of the total riparian area for the Class I stream.



Harvest has occurred within 10% of the riparian reserve of Lost Cr., while Limberlost Campground accounts for 1% impact, and roads 2% impact to the Lost Cr. This combined encroachment into 13% of the riparian reserves probably has little to no effect on the channel function and water quality of Lost Cr., but may begin to contribute to decreased LWD in the channel, affecting habitat.

Human Disturbances and Effects: Campsites

Dispersed Campsites: The 1988 inventory by Troy Hall, using Limits of Acceptable Change (LAC) data forms, showed that this landform block has 31 dispersed recreation sites. That is 9% of the 333 dispersed sites in this watershed.

Riparian: Thirteen sites (or 42% of those in this block) are in a riparian reserve, with 5 of these sites located at Camper's Lake and 8 along Highway 242 in the vicinity of Limberlost Campground. Ten of the 13 sites are accessible by foot only; four accessible on a closed road off Highway 242, and six at Camper's Lake. The 13 riparian dispersed sites have a total of 12,516 sq ft, or 0.29 acres of campsite area. The barren core of these sites equals 1,410 sq ft or 0.03 acres. That averages to 11% of the riparian camp areas as barren, a figure that may be misleading due to a few sites with very small core areas.

Non-Riparian: Eighteen of the dispersed campsites in this landform block are not close enough to water to be considered within a riparian reserve. These sites are all off Highway 242. These 18 sites have an area of 17,290 sq ft, or 0.40 acres. Of this area 978 sq ft or 0.02 acres is considered barren core. That averages 6% of core within these site areas. Five of these dispersed camps are accessible by foot, the remaining 13 by vehicle.

Developed Recreation Facilities: Campground recreational facilities typically consist of Forest Service-provided tables, fire rings, vault or flush toilets, and parking spurs. Some have water systems and garbage service. Boat ramp facilities usually are graveled ramps accessing lakes or reservoirs. The river launches sometimes have log skids to help drift boats and rafts access the river. The following developed recreation facilities are located within landform block 6:

Campgrounds: Limberlost Campground--There are 12 designated camp units in this campground. All of the campground falls within a riparian reserve. Alder Springs Campground--There are 6 camp units in this campground. None of this campground falls within a riparian reserve.

Picnic/Day Use Area--No Day Use Areas are within this landform block.

Boat Ramps: No boat ramps are within this landform block.

Sno-Parks: No sno-parks are within this landform block.

Administrative or Recreation Special Use Permit Areas: This block contains White Branch Youth Camp, under Special Use Permit to the Churches of God of

Oregon. The facilities consist of cabins, dining hall and kitchen, lodge building, swimming pool, a hill for winter tubing. This facility covers 41 acres of which 30% falls within a riparian reserve.

Wilderness: Block 6 contains 29,791 acres of the Three Sisters Wilderness, which is 75% of this total area. Access to most of this area is off of Highway 242, which is closed in the late fall and opens again in early summer. The non-wilderness acres are in a narrow band of land following Highway 242 down from McKenzie Pass to its junction with Highway 126. This portion of the Three Sisters contains some of the most heavily traveled trails and destinations, including Linton Meadows, Proxy Falls, Obsidian, and the Middle Sister. These wilderness acres include three destinations which receive relatively high recreational stock use when compared with rest of the westside of the wilderness:

Trail # 26 Foley Ridge Trail is on the boundary of the watershed, but perhaps 75% of all the stock users on that trail go to Linton Meadows, which is within this block; **Trail #29** Obsidian Trail has stock users that either stay around Obsidian Creek or again continue to Linton Meadows. **Trail #30** Scott Trail leads through a meadow area near Four in One Cone that receives some grazing use by recreational stock.

MAINSTEM MCKENZIE

Introduction

The mainstem of the McKenzie traverses through Landform Blocks 4, 2B, 2A, 5 and 1. It winds its way along the North Santiam Fault Zone, which controls the North-South direction of the river. Just south of Belknap Hot Springs, the river changes course to a westerly direction as it breaches the ancient High Cascade escarpment and flows into the McKenzie Bridge-Blue River glacial valley. Through this area, the valley is wider due to glacial scouring. Through time, the river has generally been incising except during those periods of glaciation when the glacial outwash of sediment during glacial retreat overwhelmed the sediment transport capacity of the river. The result was aggradation of the streambed and floodplain. Since the time of glacial advances, the sediment supply has reduced and the river has downcut into the glacial deposits, creating terraces (Ligon 1991) (Figure 4-55a).

Disturbance History - Mass Wasting

Mass wasting along the mainstem corridor is mainly a function of the slopes adjacent to the river and State Highway 126. The Oregon Department of Transportation routinely inspects the cutslopes and monitors them for any change in frequency or size of rockfall occurrence. The following are the areas of greatest frequency:

Highway 126: Belknap Springs to Clear Lake:

M.P. 5.43 to 5.53
6.36 to 6.70
8.81 to 9.29
11.16 to 11.40

Santiam Highway :

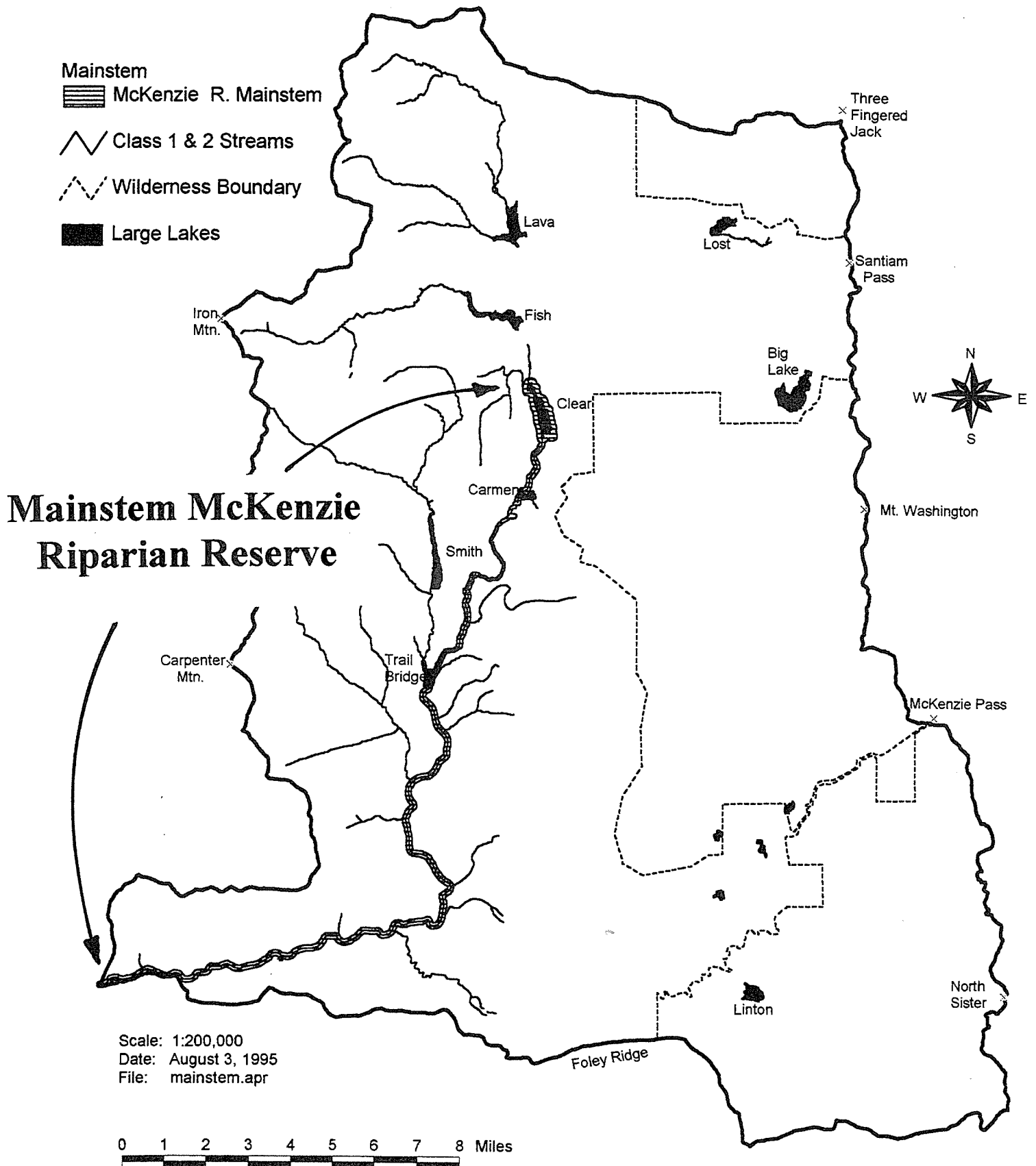
M.P. 71.23 to 71.31
78.41 to 78.47
78.75 to 79.46
84.93 to 85.20
85.83 to 85.85

CHANNEL CONDITION AND AQUATIC HABITAT

Introduction

The geomorphic and hydrologic processes described earlier in this document shape the landscape of this watershed. The valley and flood plain width, vegetation, and dimensions of the channel are products of the geology, climate, flow regime, and erosion in the subbasin. The aquatic habitat in a Cascade river or tributary is similarly a product of continual recruitment, storage and transport of bedload, erosion of banks, deposition on floodplains at high flow, and supply

Figure 4-55a. Mainstem McKenzie Riparian Reserve



of organic debris and nutrients. The degree to which conditions in aquatic habitat vary as a result of natural disturbance is the range of conditions to which communities have adapted. Natural disturbance include flood, fire, mass failure/debris flow, disease and insect infestation, wind throw, and climactic change (Swanson 1991). Beyond this background level of aquatic habitat variability, human influence can disrupt natural processes and drastically alter habitat condition, possibly beyond organism ability to adapt. Human alteration of aquatic habitat may result from dam building, timber harvest, fire suppression, road building, channelization, salvage of in-stream wood, or alteration of riparian vegetation.

Important Fish Habitats

Habitats essential to spring chinook within the analysis area include the main stem McKenzie River and Lost Creek (Figure 4-55a). Extraordinary holding periods for adult chinook require they hold through summer in deep pool habitats, primarily, but not limited to lower McKenzie reaches. Spawning habitats utilized by spring chinook are cobble and gravel rich low gradient riffles and pool tail-outs. Rearing habitats and winter refuge consist of side channels, river margins and lower tributaries. Recent efforts to restore rearing habitat in a side channel of the upper McKenzie have resulted in an encouraging increase in side channel utilization by rearing chinook salmon (USDA Forest Service 1994). After enhancement of flow and in-stream LWD of a McKenzie River side channel, a two-fold increase in the number of juveniles was observed by comparing pre- and post-project monitoring. Although additional monitoring will be necessary to extract conclusive evidence, early indications suggest rearing habitat is a factor limiting spring chinook production in the upper McKenzie subbasin. In addition to numerous rearing chinook in the restored side channel, were juvenile bull trout, attracted to a concentrated prey source. The side channel's recruitment of rearing chinook attracted predatory bull trout where there had been none prior to enhancement.

The main stem McKenzie River provides essential foraging and rearing habitat for bull trout. The main stem river used by bull trout above Trail Bridge Dam includes Trail Bridge pool and main stem McKenzie River above to Tamolitch pool. Adults and subadults utilize all habitats in the main stem while foraging. Their distribution (other than during spawning season) is determined by distribution and behavior of prey species. Adult bull trout are most often observed in deep pools utilizing available wood or undercut banks as cover. Main stem rearing habitats and winter refuge consist of side channels, river margins and tributary junctions. No evidence to date has been found of bull trout spawning in the main stem McKenzie below Trail Bridge dam. Spawning habitat appears to be limited to spring-fed tributaries. Above Trail Bridge dam, the main stem McKenzie River, with relatively lower flow, has been used as spawning habitat by the Trail Bridge population.

McKenzie Aquatic Habitat and Channel Condition

The main stem McKenzie River above Belknap Springs is somewhat constrained and travels through deep glacial deposits of cobble, rubble and boulders. The McKenzie River has been eroding relatively young mountains and, therefore, is very steep relative to its discharge. As a result, the river has a very high boundary shear stress and sediment transport capacity which exceeds its natural sediment supply. Most sediment entering the system is quickly transported out, resulting in an actively incising stream that has relatively small quantities of in-channel sediment and a coarse, armored bed. This process of downcutting and substrate coarsening may be accelerated with the presence of the Carmen, Smith, and Trailbridge dams, which cut off sediment supply to the river below these impoundments. Capturing of sediment upstream of the dams will cause scour below the dams immediately following dam closure. Erosion below the dam will continue until the gradient is reduced and/or the bed coarsens to a bed roughness that reduces the velocity below the threshold for the sediment transport (Petts 1979). Evidence of down cutting may exist in the change through time of number and length of side channels in the upper river. From Belknap Springs to Trail Bridge, the number of side channels dropped from 10 to 3 (1,039 meters to 669 meters) between 1949 and 1986, indicating possible channel down cutting and abandonment of side channels (Minear 1994, Table 5). Minear's study of the McKenzie River noted changes in channel and riparian condition by comparing aerial photos from 1949 and 1986 (Tables 4-15 and 4-16). Data collected included wetted channel area, side channels, large woody debris, exposed gravel bars, roads and dominant vegetation seral stage.

Table 4-15: Channel characteristics, side channel number and length, and exposed gravel bar area in the Upper McKenzie River in 1949 and 1986.

Reach	year	Channel Sinuosity	Channel Area (ha)	Number of Side Channels	Side Channel Length (m)	Gravel Bar Area (m ²)
Belknap Springs to Trail Bridge	1949	1.36	35	10	1,039	0
	1986	1.36	30	03	669	0
McKenzie Bridge to Belknap Springs	1949	1.14	38	07	998	165
	1986	1.14	33	11	1,263	6,457

from Minear 1994.

Table 4-16: Percent of riparian area by vegetation classes in the Upper McKenzie Watershed in 1949 and 1986. (Riparian area was defined as the area within 90m of active channels, plus floodplains)

Reach	year	% Riparian Resid/ Develop	% Riparian In roads	% Riparian <20 yr hwds	% Riparian 20-100 yr hwds	% Riparian <20 yr conifer	% Riparian 20-100yr conifer	% Riparian >100yr conifer
Belknap Springs to Trail Bridge	1949	0	1	0	0	0	35	62
	1986	0	5	1	2	3	49	39
McKenzie Bridge to Belknap Springs from Minear 1994	1949	1	1	1	1	14	61	20
	1986	3	3	1	6	0	60	27

The uppermost reach in Minear's study (Reach 1) examined the river from Belknap Springs to Trail Bridge. Reach 2 is an examination of river from Belknap Springs to McKenzie Bridge, allowing use of her analysis to characterize historic and existing channel and riparian condition of the McKenzie River within the analysis area. This portion of the river remained mostly intact in the 1949 photos, the riparian area consisting of mostly conifer forest under federal ownership. The upper, less accessible reaches of the McKenzie, particularly above Belknap Springs, were developed or harvested relatively recently. In the 1986 aerial photos, Minear found significant changes in riparian and channel condition.

Minear (1994) found no significant change in channel area or sinuosity from McKenzie Bridge to Trail Bridge between 1949 and 1986. There are indications of channel down cutting and/or bedload coarsening in Minear's and similar studies. Changes in observed bedload composition between 1937 and 1991 indicate larger substrates are currently more abundant (Sedell et al. 1992). Table 4-17 depicts changes in pool frequency and substrate composition in the upper McKenzie River. This observation is consistent with other dammed rivers. The supply of sediment upstream of the Carmen-Smith-Trail Bridge dams has been intercepted by the dam and starves the river below of historic levels of sediment. The supply of in-stream wood upstream of diversions has also been intercepted, and with their absence is lost a source of scour, flow deflection and sediment storage for the river below.

Table 4-17. Changes in large pool frequency and percent bottom by substrate size for the Upper McKenzie River, 1937-1991 (Large pools are those greater than 20 meters² and deeper than 1 meter).

Reach	Year	Large Pools/ Mile	% Bottom Large Rubble (>150mm)	% Bottom Medium Rubble (75-150 mm)	% Bottom Small Rubble (6-75 mm)	% Bottom Fine Sediment (<6 mm)
Belknap Springs to Smith River Bridge	1937-	18.7	43	40	17	1
	38 1991	11.1	84	09	05	2
McKenzie Bridge to Belknap Springs	1937-	7.3	57	26	16	1
	38 1991	8.8	79	15	06	0

from Sedell et al 1991.

The results of Minear's analysis of 1949 and 1986 aerial photos indicated significant straightening of unconstrained reaches lower in the McKenzie River. The simplification of the lower main stem channel over the course of 37 years was attributed to reduction of peak flows (by Cougar and Blue River impoundments), lack of in-stream structure (LWD) to deflect flow, channelization by rip-rap, roads, and alteration of riparian vegetation. Although no straightening of the more constrained upper reaches was observed, low quantities of in-stream LWD, placement of channel constraining road fill and rip-rap, alteration of riparian composition, a coarsening bedload, and side channel abandonment indicate channel simplification has occurred in the Upper McKenzie River.

Channel complexity is reduced where bank erosion is eliminated by rip-rap. Rip-rap causes the channel to deepen and narrow as it scours holes against the hardened bank. This stabilizes the channel location which leads to a reduction in the formation of mid channel bars and islands (Ligon 1991). Places where this is apparent on the McKenzie River is the lower section of the watershed beginning at Belknap downstream to the downstream boundary. The rip-rap is discontinuous and is first noted at Belknap Hotsprings, then again at Paradise Campground downstream. Approaching the town of McKenzie Bridge, riprapping of the river increases dramatically as the number of houses located on the river banks increases. Boulder placement on the banks is particularly heavy beginning upstream of an old, large island with residences and a church located on the river banks. As the river periodically shifts the location of the dominant channel from one side of the island to the other, it shifts the location of maximum erosion from one bank to the other (Ligon 1991). Hardening of the banks with riprap opposite from the island is likely causing the channel to scour and fix its location, leading to an eventual elimination of one of the two channels. If there are no major flows in the near future to shift the dominant channel from the right side of the island to the left (as one looks downstream), it appears as though the left side of the island would be the channel to be dewatered.

There is one section located downstream from the mouth of Frissell Cr. where the highway impinges on the river and riprap has been placed to protect the road. In this location, the riprap has effectively caused channel constriction, resulting in channel widening and the formation of a mid channel bar directly upstream of the constriction.

A recent survey of large woody debris (LWD) in the active channel of the McKenzie River from Trail Bridge Dam to Scott Creek found about 18 pieces/mile measuring 24 inches in diameter or greater by 50 feet or longer (USDA Forest Service 1992). Historic levels of in-stream wood are greater but are not quantified. Extensive salvage of in-stream wood occurred in the reach from Belknap Springs to Trail Bridge Dam following the 1964 and 1972 floods (Sedell op. cit.). Further reduction of in-stream wood continues following completion of Carmen-Smith-Trail Bridge Complex and interception of recruited wood from Smith River drainage, Hackleman Cr., and main stem McKenzie River above the dams. Historically, LWD likely consisted of greater numbers of off-bank and bank parallel whole trees (Paula Minear, pers. comm.) although not typically channel spanning. Frequent log jams were located at the head of islands and side channels. Channel spanning accumulations were only occasional and consisted of jams on large boulders. In-stream wood perceived as flood hazards or of commercial value have been removed historically. In recent history the channel has been maintained for boat and raft navigation below Olallie Campground where boaters have removed in-stream wood perceived as navigation hazards. Today, although present in reduced numbers, in-stream wood is accumulated at the head of islands, on rocks, and at side channel inlets. Off-bank and parallel to the bank large wood is most typical of debris that remains in the channel.

ODOT uses 40 to 50 thousand cubic yards of volcanic cinders in the Santiam Pass area each year. About 40% of that amount is distributed within the Upper McKenzie Watershed. Ten to 15% of the cinders spread on the highways are recovered and reused. The cinders generally fall within 100 feet of the highway edge. About 50% of the zone of cinder influence is also within a riparian area.

The influence of cinders in the riparian area is nominal. The cinders have neutral pH so the acidity of the soil is not altered. The bulk density of the soil adjacent to the highway may be somewhat lowered. The cinders occasionally fall into the McKenzie River and its side channels. The cinders in the water have slightly increased the available spawning habitat by raising in-stream gravel levels. The cinder gravel mostly provides habitat for fish requiring smaller substrate, such as cutthroat, rainbow, and brook trout.

Deicers have not been used on the roadways within this watershed. ODOT is considering use of a deicer composed of calcium-magnesium-acetate. The chemical compound is benign and tests have shown no impacts to riparian areas.

Riparian vegetation is removed when the culverts and ditches adjacent to the highways are cleared. This results in a temporary increase in surface erosion. However, the maintenance of the drainage system reduces overall chances of a large failure. In the past, material cleared from the highway ditch line was dumped over the sideslope, impacting riparian vegetation. This practice displaced and killed riparian vegetation. The practice was discontinued about 10 years ago.

Streamflows and Aquatic Habitat

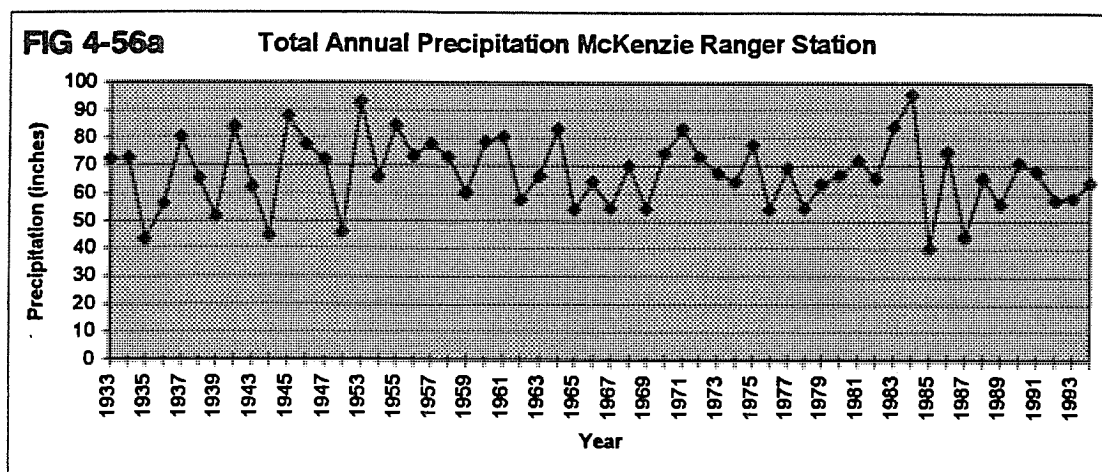
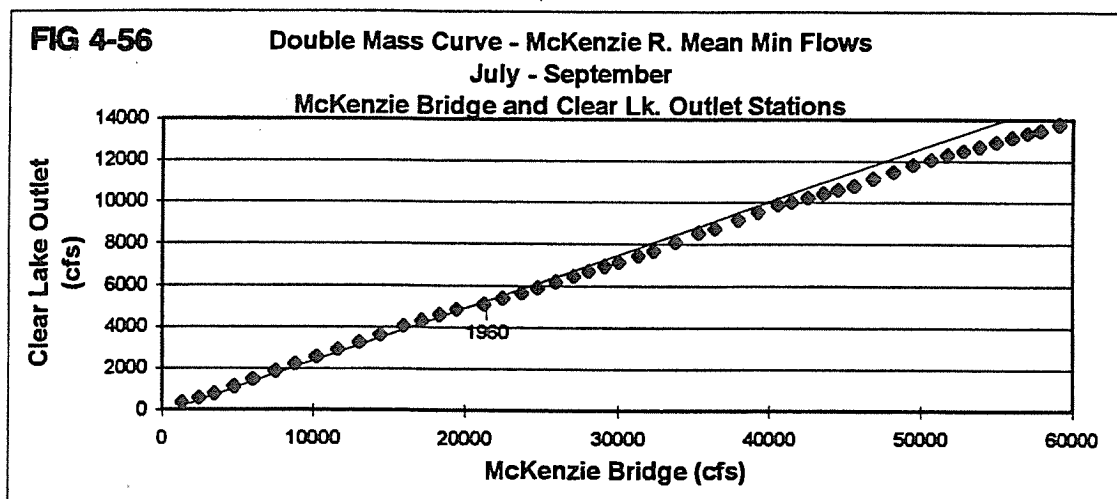
Analysis of streamflows on the McKenzie River were conducted to determine if changes in flows had occurred resulting from construction and operation of the Carmen-Smith Project. The project includes three dams, one located on Smith River known as Smith Reservoir, and two located on the main McKenzie River known as Carmen Dam and Trailbridge Dam. Carmen dam serves as a diversion reservoir, supplying water through a tunnel to Smith River reservoir. Water is then diverted from Smith Reservoir to Trailbridge Reservoir where power is generated. The project was completed in 1963. Analysis of discharge data described below indicates that there has been a decrease in summer low flows and no change in peak flows following construction of the Carmen Smith project.

At the time of exploratory work in the late 1950's, the idea of constructing one large dam at the Carmen site and omitting Smith Reservoir was quickly abandoned when many large holes in the Beaver Marsh area were discovered to drain water from the McKenzie River into lava tubes. In addition, the extremely fractured and porous nature of the basalt that would form the abutment of the west side of Carmen dam face would make it difficult to hold water within the reservoir (Progress Report 1959). Therefore, the decision was made to go with a minimum diversion requirement for diverting the McKenzie River to Smith Reservoir.

A double-mass curve of annual maximum mean flows from the McKenzie Bridge and Clear Lake outlet USGS gaging stations was used to determine if a shift in flows had occurred at the McKenzie Bridge Station relative to the Clear Lake outlet station. A shift in the data was not noticeable for flows from 1948-1993, indicating that annual maximum mean flows did not change as a result of the Carmen Project. Indeed, a t-test on the data supports the double-mass curve analysis, with no significant difference in the means before and after construction of the Carmen Project (0.95 confidence level). A t-test performed on

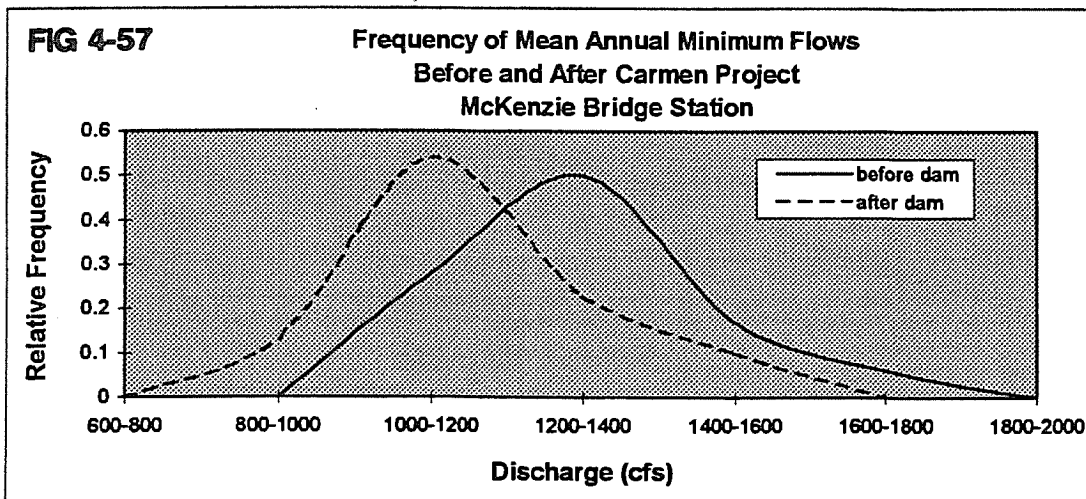
instantaneous peak flows also resulted in no significant difference in means before and after construction of the Carmen Project (0.95 confidence level).

Analysis of summer low flows has caused some sleepless nights and frustrating days. A double mass curve of mean minimum flows for July-September for USGS gaging stations at McKenzie Bridge and Clear Lake Outlet for the years 1913-1915 and 1948-1993 is displayed in Fig. 4-56. The curve reveals that summer low flows increased at the McKenzie Bridge station relative to the station at the Clear Lake outlet beginning in water year 1960. A look at the total annual precipitation as recorded at the McKenzie Ranger District since 1933 yielded no significant difference in precipitation before and after construction of the Carmen Project (t-test confidence interval = 0.95) (Fig. 4-56a).



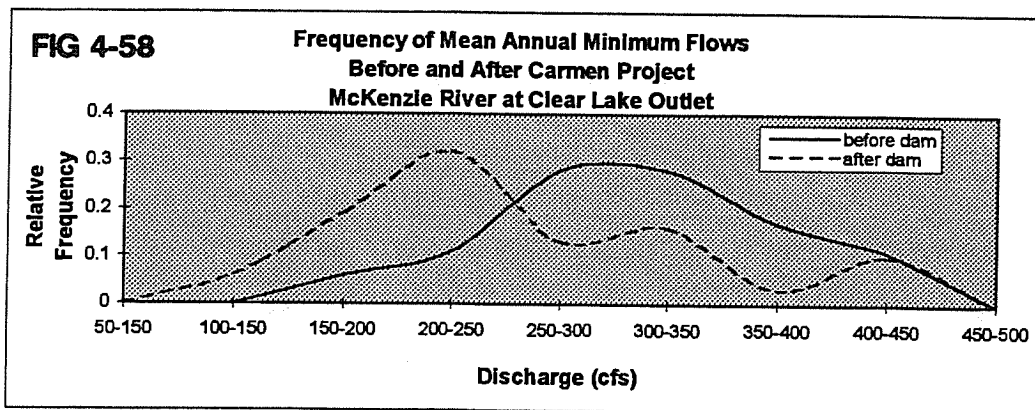
Streamflows during summer months have been noted to increase following logging activities due to reduced evapotranspiration and greater soil moisture levels (Harr, et al. 1979; Klock and Lopushinsky 1980; Cheng 1989; Bartos 1989; and Keppeler and Ziemer 1990). Increases in summer streamflows were also documented in the H.J. Andrews Experimental Forest near Blue River, Oregon (Rothacher 1971). Extensive logging began in 1960 to clear the reservoir (Place pers. comm.), and has continued since that time with a peak in the 1980's.

To determine the magnitude of change and to test for significance of the change in summer low flows at the McKenzie Bridge station, a t-test was performed on the data and a graph constructed of the relative frequency of flows before and after construction of the Carmen Project. The t-test and the relative frequency graph both showed changes in low flows before and after the Carmen project, but surprisingly, the change was to lower flows following construction of the project (Fig. 4-57).



This was contradictory to the double-mass curve which showed an increase in low flows beginning in 1960.

To resolve this discrepancy, a t-test was performed and frequency plot constructed of summer low flow data for the Clear Lake outlet station. This data also showed a reduction in low flows following construction of the Carmen Project (confidence interval = 0.95) (Fig. 4-58).

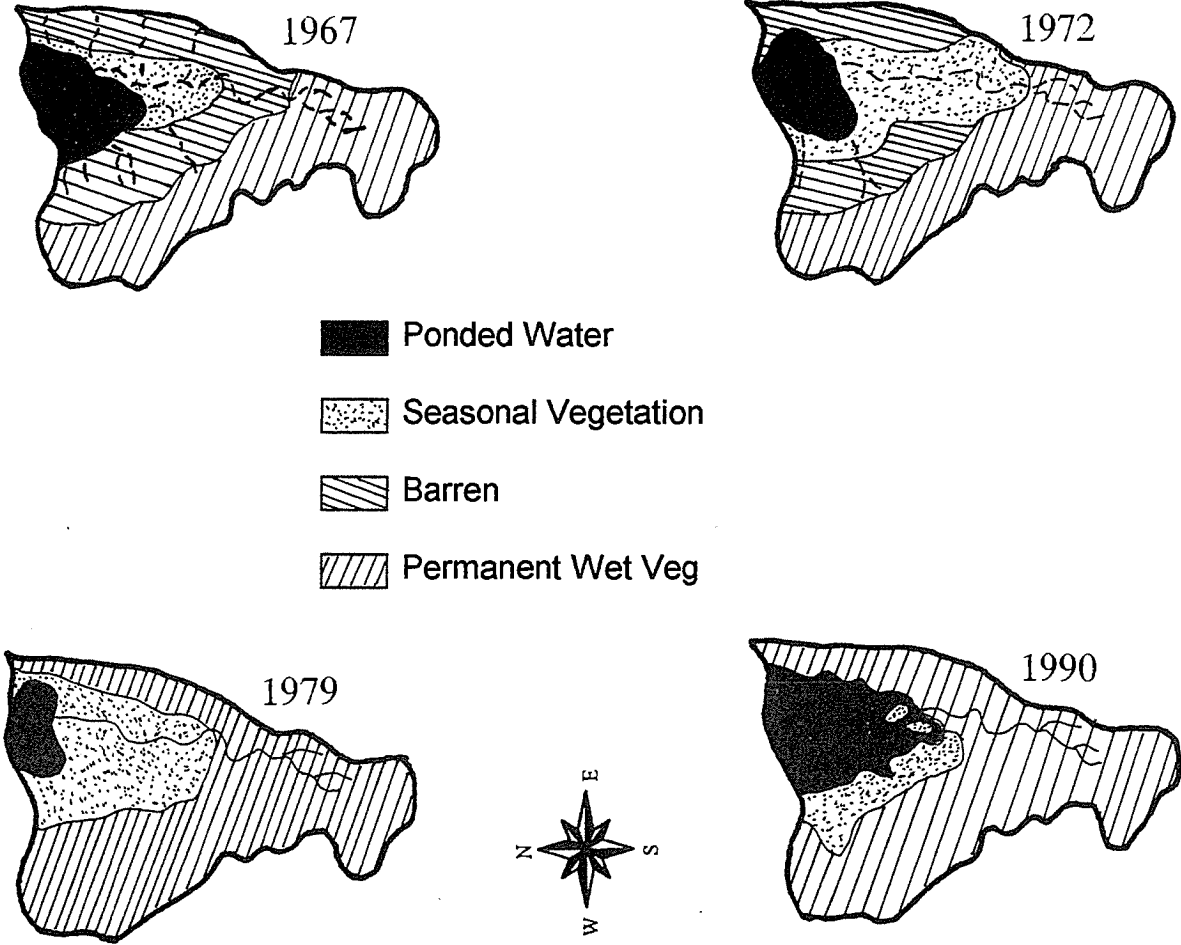


Both McKenzie Bridge and Clear Lake outlet stations had lost water during July, August, and September, but more water was lost at the Clear Lake outlet relative to the McKenzie Bridge station (difference in mean annual minimum flows before and after Carmen Project are 173 cfs and 54 cfs for McKenzie Bridge and Carmen Outlet, respectively).

A possible scenario for the changes in flow is as follows: during construction of the tunnel between Carmen Reservoir and Smith Reservoir, a fault system was encountered that allowed water to come gushing into the tunnel (Staples, pers. comm). As much as 10,500 gallons/minute (23 cfs) came pouring into the tunnel, requiring the tunnel drivers to work in wetsuits for the remainder of the project. The source of the water is more than likely from the Ikenick drainage, which is located directly above the tunnel, and which also flows directly into Clear Lake. Water from the Ikenick drainage was intercepted in the fault and redirected into the Carmen Project.

Figure 4-59 is a time-series drawing of the pond near the headwaters of Ikenick Cr. The four year series of 1967, 1972, 1979, and 1990 show a progressive depletion of the area of long-term ponding of water as indicated by the change in vegetation. The actual area of ponded water would not provide an accurate picture of long-term changes in water availability, as the area of actual ponded water would change depending on the amount of precipitation for the given year and the time of year the photo was taken. In 1967, the actual area of ponded water is small, however, the area of barren ground attests to a large area that, on a year-to-year basis, holds water long enough to preclude any kind of permanent, wet vegetation. Moving through the photo series, the area of barren ground continues to decline, while the area of seasonal vegetation continues to increase, followed by an increase in area of permanent, wet vegetation. Although changes such as this could be due to beaver activity in the area, it verifies that there has been a progressive depletion in the quantity of water once ponded in the Ikenick headwaters. This trend cannot be explained by precipitation changes, since there has not been trend of decreasing precipitation since 1967 (with the exception of years prior to the 1990 photo for the years 1987-1989).

Figure 4-59. Vegetative Changes of Ikenick Pond



Scale approx. 1:3200 Ikenick Pond located T14S,R7E,Sec.18

Theoretically, the water from the fault is captured through drain valves and incorporated into the flow to Smith Reservoir. However, the first 1,500 ft. of the tunnel is composed of extremely porous, volcanic rock (Core, pers. comm.) that the water from the fault could easily flow into, thus capturing and redirecting the water into another part of the groundwater aquifer. Additionally, water that is evaporated from the surface of Smith Reservoir, coupled with the possible loss of water through the fractured basalt and porous lava adjacent to the reservoir, could be the cause for reduced summer flows at the McKenzie Bridge station following construction of the Carmen Project.

The overall effect on streamflows at the McKenzie Bridge USGS station is a decrease in summer low flows due to the Carmen Project, but a corresponding increase in summer low flows due to harvest. The net result is reduced streamflows during July, August, and September. However, the magnitude of the decrease is tempered with increased flows resulting from harvest. In other words, low flows may have been lower if it were not for additional water made available from timber harvest.

This reduction in summer low flows following completion of the hydroelectric complex may influence resident and migratory fish populations. Most studies of the effects on fish from changes in flow have been conducted on anadromous fish, where reduction in low flows have been found to affect migration and spawning success (Bjornn and Reiser 1991). Migration routes too shallow for passage are not likely, as the McKenzie continues to retain sufficient depths to provide passage to the Carmen Spawning Channel. The extent to which reduction in low flow has modified spawning beds may be of concern. In combination with a coarsening bedload, lower summer flows may result in lower available spawning bed area. Optimal spawning conditions include ideal discharge and maximum available spawning area (including preferred velocity, depth and substrate composition). Alteration of these components may reduce spring chinook spawning success. The flow regime subsurface and in the river channel below Carmen Dam extending to Trail Bridge Dam has been significantly altered by diversion of McKenzie River flow. This segment of the McKenzie River ran intermittently prior to construction of the Carmen-Smith-Trail Bridge hydroelectric facilities.

Hydroelectric projects may pose a risk to fish in other ways. Two unscreened hydroelectric intakes are present in the upper McKenzie River. The largest, operated by EWEB, draws outlet flow from Trail Bridge pool through a turbine generator and may pose a risk to bull trout and native fish residing above the

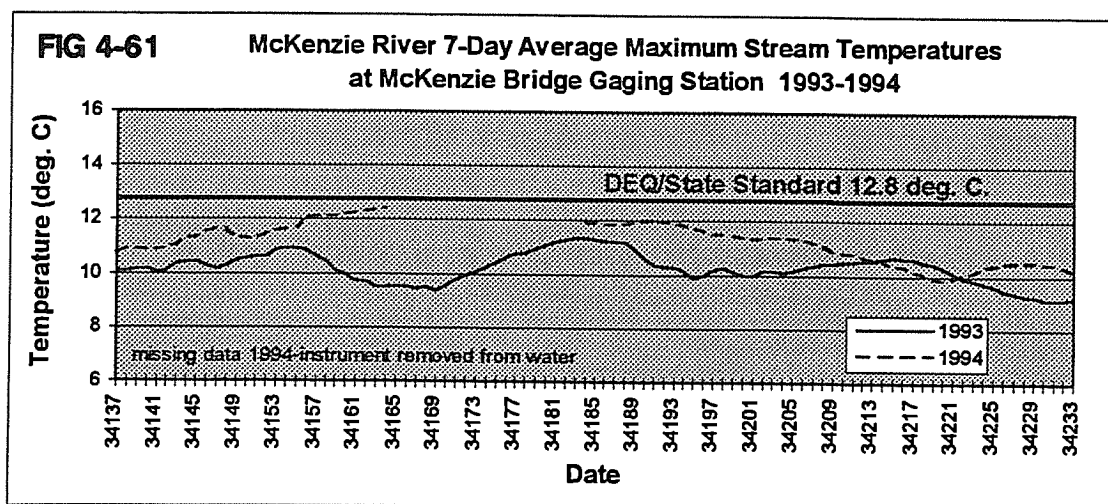
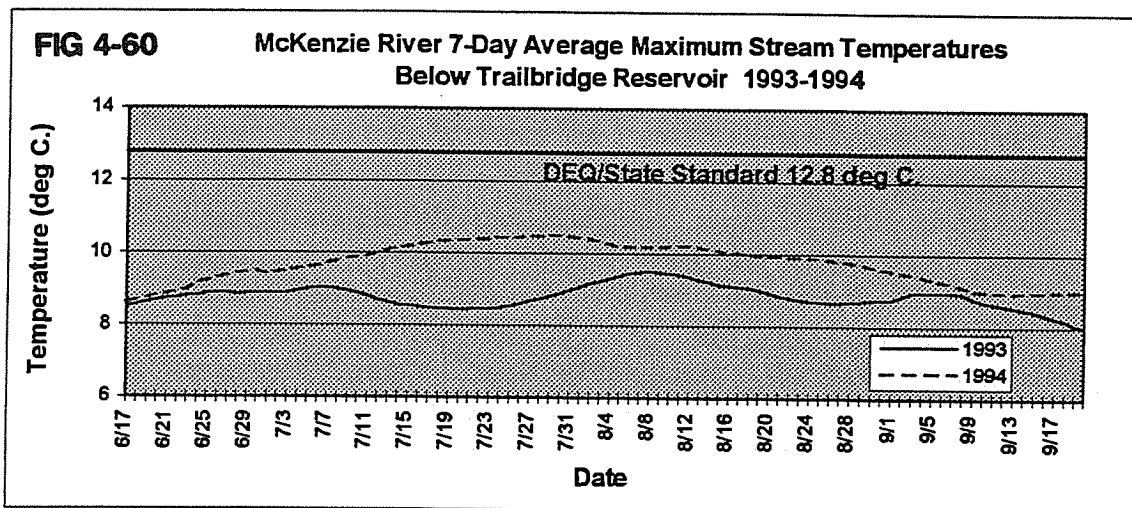
dam. A small, privately owned generator is driven by flow diverted from the main stem McKenzie below Belknap Springs and may pose a risk to spring chinook, bull trout and native fish utilizing side channels as rearing and foraging habitat and to upstream migrating adults. The privately owned generator is currently under FERC review for licensing.

The question was asked during issue identification in this analysis process: Have utility mitigation efforts supplemented loss of spring chinook habitat since dam construction? The Carmen Spawning Channel has operated since 1961, during the construction of the Carmen-Smith-Trail Bridge hydroelectric complex. The spawning channel was designed to replace spawning habitat for 100-200 returning adult chinook. The criteria used to evaluate success of the channel to mitigate for habitat loss was the number of returning adults. The return to the spawning channel has not maintained pre-dam runs, its use paralleling depressed upper river returns and returns to relatively unaltered spawning habitat in Lost Creek. One of the limitations of the spawning channel identified by Smith (1993) is limited rearing area within the mitigation channel itself. Loss of rearing habitat above Trail Bridge dam was not mitigated for and likely represents a factor limiting spring chinook production in the upper McKenzie River. Other sources of loss managed by EWEB utility may reduce chinook use of the upper river and spawning facility. Poor adult fish passage facilities at Leaburg dam and an unscreened water diversion at Walterville canal have been identified as sources of migrant loss and are scheduled for improvement.

Although resident population needs were not identified in original mitigation efforts, EWEB continues to be an active cooperater in bull trout recovery efforts. Restoration of habitat fragmented by construction of Carmen-Smith-Trail Bridge Complex and Hwy 126 has occurred cooperatively between EWEB, management agencies and special interest groups.

Water Temperature

Stream temperature data on the Upper McKenzie River was collected at the gaging station below Trailbridge Dam from 1976-1985, and during the summer of 1993 and 1994. Summer stream temperatures were also recorded at the gaging station at McKenzie Bridge (located across from the McKenzie Ranger Station) during 1993 and 1994. Water quality standards established by the state and published by the Oregon Department of Environmental Quality have recently been reassessed for stream temperatures. New standards, which are not yet published, require that the moving average of the 7-day maximum stream temperature not exceed 55 deg. F. (12.8 deg. C) for anadromous spawning and rearing streams such as the McKenzie River. Figures 4-60 and 4-61 display the 7-day average maximum stream temperatures for 1993 and 1994 at the Trailbridge station and the McKenzie Bridge station.



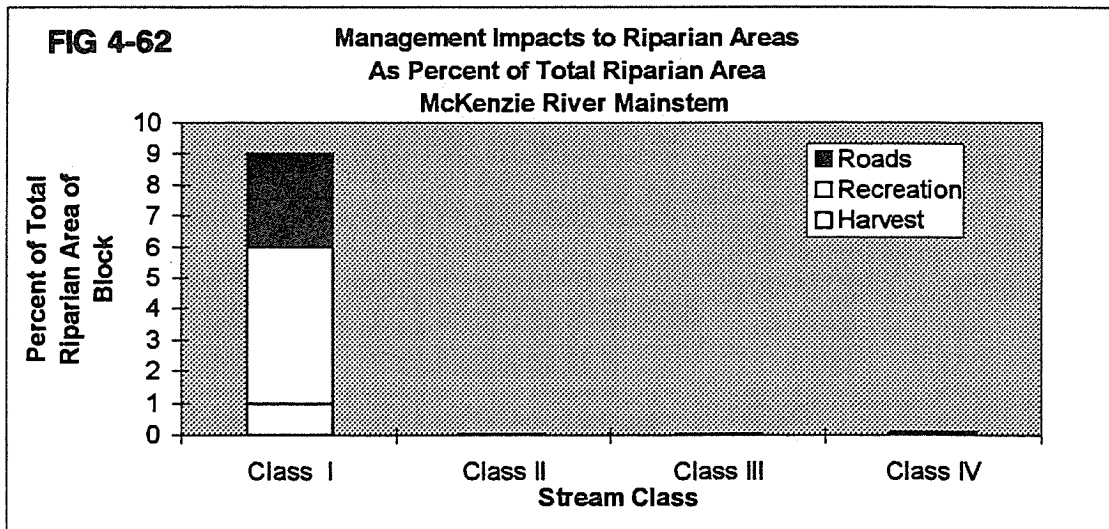
Both graphs indicate that stream temperatures are within State Standards, although the maximum temperatures for the summer of 1994 were not recorded because the instrument had been removed from the water.

Historically, maximum stream temperatures for the McKenzie River near the confluence with the Willamette River ranged from 55.4 deg F (13 deg C.) to 62.6 deg F. (17 deg C.) (USDA Forest Service, Pacific Northwest Region 1993). Although the current mode of the maximum stream temperatures fall within the historic range, current maximum stream temperatures exceed the historic range with temperatures as high as 71.6 deg F. (22 deg C.) at the mouth of the McKenzie River. Although no data exists for historical maximum stream temperatures for the upper McKenzie River watershed, it is likely that maximum stream temperatures have increased at the McKenzie Bridge station as early as 1965 in association with the harvest of riparian vegetation along tributary channels. However, it is also likely that current maximum stream temperatures are returning to historic ranges as riparian vegetation becomes reestablished along tributary streams. The exception may be Deer Cr., a major

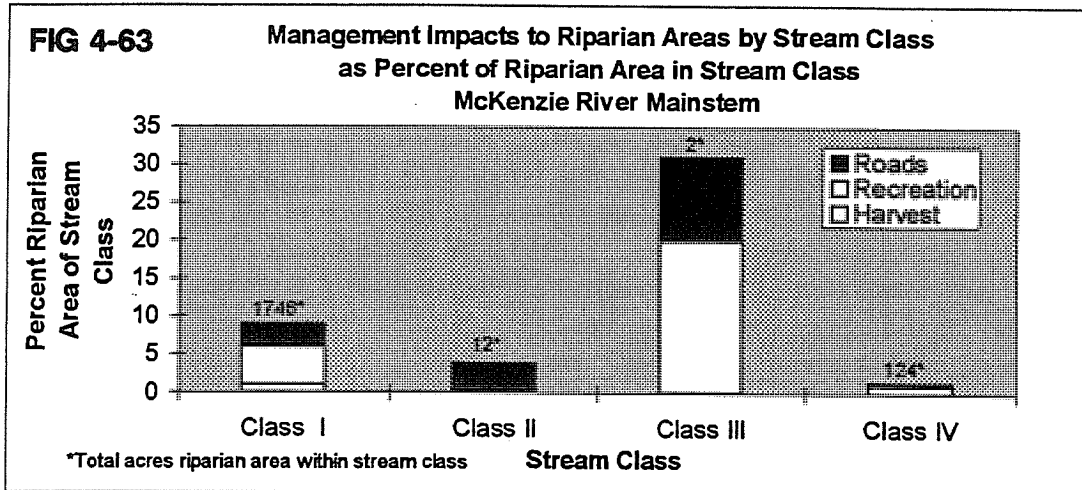
tributary to the McKenzie River whose riparian vegetation is limited due to the presence of a power line (see discussion on Deer Cr. stream temperatures in Landform Block 2a).

Riparian Reserves

In the McKenzie River riparian area, the recruitment source of large wood for the channel and flood plain has been modified from historic levels. Data reflecting relatively recent development (timber harvest, roading) in the upper McKenzie subbasin (as compared to earlier harvest of the lower subbasin) is depicted in Table 4-3. A shift in riparian seral stage occurred between 1949 and 1986 above Belknap Springs. Mature conifers in the riparian area have decreased from 62% to 39%, with a corresponding increase in younger conifers, hardwoods and riparian roads (Minear 1994). Along the mainstem McKenzie River, recreation and administrative sites together with roads, combine to affect the riparian reserve within the corridor (Fig. 4-62).



With approximately 1% of the harvest within the reserve, harvest, recreation/administrative sites, and roads combine to impact a total of 9% of the reserve. Much of this area is located linearly along the length of the river, unlike harvest units that encompass the total width of the reserve. This translates to 8 miles of stream length that is roaded or has a recreation/administrative site along one side of the river. Although this does not significantly alter stream shade, channel stability, or LWD recruitment, this level of impact is approaching a level that could become detrimental to stream channel condition (bank stability; LWD amounts) and water quality (bank stability/sediment input; stream temperature)(Figure 4-63).



Data shows that of the Class III streams entering the McKenzie River corridor, 31% of the riparian reserves are roaded or have recreation/administrative sites within them (note however that the total amount of riparian reserve within Class III streams is only 2 acres, thus, only 0.71 acres are impacted).

Human Disturbances and Effects: Campsites

Dispersed Campsites: The 1988 inventory by Troy Hall, using Limits of Acceptable Change (LAC) data forms, showed that the mainstem McKenzie corridor has 34 dispersed camping sites. That is 10% of the 333 dispersed sites in this watershed.

Riparian: By definition, all of the 34 camp sites are within the riparian reservoir of the McKenzie River. If the sites were further away from the river, they were tallied in the landform block adjacent to the river. The area of these river camp sites equaled 36,835 sq ft or 0.85 acres. The barren cores equaled 25,246 sq ft or 0.58 acres. That averages 69% of the riparian camp areas as barren, a figure that may be misleading due to a few sites with very large core areas. Eighteen of the thirty-four camping sites were accessible by foot, mainly from the McKenzie River Trail. The remaining sixteen sites were accessible by vehicles, seven of those at Deer Creek.

Developed Recreation Facilities: Campground recreational facilities typically consist of Forest Service-provided tables, fire rings, vault or flush toilets and parking spurs. They may have water systems and garbage service. Boat ramp facilities usually are graveled ramps accessing lakes or reservoirs. Launches sometimes have log skids to help drift boats and rafts access the river. The

following developed recreation facilities are located, at least partly, within the mainstem McKenzie River corridor.

Campgrounds: McKenzie Bridge—There are 20 camp units in this campground, covering 41 acres. Forty seven percent fall within the riparian reserve of the McKenzie River. Paradise Campground—There are a total of 64 camp units in this campground, covering 78 acres. Thirty five percent fall within the riparian reserve of the McKenzie River. Olallie Campground—There are 17 designated camp units in this campground, covering 11.5 acres. Eighty five percent fall within the riparian reserve of the McKenzie River.

Picnic/Day Use Areas: McKenzie Bridge—There are 6 picnic sites within McKenzie Bridge Campground, all are within the riparian reserve. Paradise—There are 4 picnic sites within Paradise Campground: all are within the riparian reserve.

Boat Launches: There are five boat launches located on National Forest within the McKenzie corridor. McKenzie Bridge Campground launch is 1 acre. It has a paved loop road, parking for approximately 5 vehicles with boat trailers, a gravel ramp, informational bulletin board displays, and seasonal placement of portable toilets. McKenzie River Trailhead Boat Launch is 0.5 acres. It has a gravel highway edge parking strip for 4 vehicles with boat trailers, a dirt ramp, informational bulletin board displays, and seasonal placement of a portable toilet. Paradise Campground Boat Launch is 0.5 acres. It has a paved loop road, parking for approximately 10 vehicles with boat trailers, a dirt ramp, a graveled raft staging area, informational bulletin board displays, and vault toilets close by. Frissell/Carpenter (aka Buck's Bridge) Boat Launch is 0.8 acres. It has highway pull-off parking for approximately 8 vehicles with boat trailers, a wooden pole skid ramp, informational bulletin board displays, and seasonal placement of a portable toilet. Olallie Boat launch is 1 acre. It has a gravel road, parking for approximately 10 vehicles with boat trailers, a gravel ramp, informational bulletin board displays, and seasonal placement of a portable toilet.

Sno-Parks: No sno-parks are within this riparian corridor.

Viewpoints: Sahalie Falls and Koosah Falls Viewpoints are partly in this corridor, but described under block 4.

Administrative or Recreation Special Use Permit Areas: Eugene Water and Electric Board (EWEB) has offices, shops, and employee homes located here. Those facilities covers approximately 10 acres, with an estimated 75% falling into riparian reserve. Both these figures need to be more accurately measured.

Wilderness: There are no wilderness acres within the mainstem McKenzie riparian buffer.