CHAPTER 4 - PAST, CURRENT AND FUTURE CONDITIONS

This chapter will display the essence of the analysis. The conditions as well as the processes and causal mechanisms will be organized within the same format that was used to display the key questions;

- CONTEXT
- HUMAN/SOCIAL
- SOIL/WATER/FISH
- RIPARIAN VEGETATION
- VEGETATION/WILDLIFE/WILDLIFE HABITAT

Within these five categories a variety of stratifications were used to complete the analyses and display conditions. The discussion on Context used the McKenzie River Subbasin as the unit for analysis and description. Within the Soil/Water/Fish section a combination of individual subwatersheds as well as groups of subwatersheds were used to display the conditions and identify areas of sensitivity. Riparian vegetation is also discussed at the level of subwatersheds.

Vegetation patterns and distribution were analysed on the entire watershed but many patterns were not discernable until the analysis was completed on five stratifications within the watershed. Results are displayed for the whole watershed as well as for these smaller stratifications.

Wildlife habitat is displayed at the level of the watershed using plant series as the stratification. Additional stratifications were used based on individual species.

Each of the stratifications is displayed on maps within the appropriate section of Chapter 4.

CONTEXT

VEGETATION

The following section displays the distribution of the vegetation within the McKenzie River Subbasin and relates how the South Fork compares to the overall story of the McKenzie.

FORESTED LAND DISTRIBUTION, PRODUCTIVITY AND UTILIZATION

Over 90% of the McKenzie River Subbasin is currently in forest uses, with 67% of the land being productive Douglas-fir forest type (Table 2). Industrial forest owners hold almost half of the productive type. Federal lands contain most of the less-productive intermediate and high elevation forested lands. Industrial forest lands are being harvested faster than federal lands in this decade due to changing management emphasis for sustainable ecosystem management on federal lands.

Forested Land Area Within the McKenzie and Ownership by Elevation and Type

	Low Elev Douglas fir/Hemlock	Intermediate Elev Pacific silver fir	High Elev Mountain hemlock	Non Forest
All ownerships	67%	16%	1%	6%
Federal	59%	99%	100%	Most
Industrial Forest	29%	—	—	—

Table 2

STAND STRUCTURE

Information on the stand structure and age of forest land within the entire McKenzie River Subbasin, is from a vegetation map derived from 1988 Landsat Thematic Mapper imagery (Cohen and Spies 1992). Our analysis adapted six categories of that map into four classes (Table 3). There is some error associated with this data. Cohen and others (1994 in prep.) have noted errors primarily assigned to distinguishing between "mature" and "old". While compiling the data for this analysis, a discrepancy between this data and Forest Service data was noted primarily with the "young" and "mature" categories. For example, the French Pete area which is approximately 150 years old is classed in the remotely sensed data as "young" when it should be "mature". The acreage classed as "old" appeared similar between the remotely sensed data and Forest Service data.

Stand Structure/Age Categories

XX	Stand Structure Categories	Grouped for Display
1	Open mixed < 30% canopy closure	Not included in analysis
2	Semi-open mixed 30-85% canopy closure	2 & 3 = Hardwood
3	Closed mixed > 85% canopy closure	
	Closed conifer	
4	Young < 80 years	
5	Mature 80 - 200 years	
6	Old > 200 years	

* mixed = mix of conifer and hardwood

Table 3

Caution in projecting age classes or management history from the remotely sensed data is important. Interpretations made on the basis of the remotely sensed data should be viewed as requiring ground verification. The "open mixed" class may contain some non-forest communities, agricultural fields, and very young clear cuts. Because of this ambiguity, this class (5% of the McKenzie River Subbasin) is not included in the age class summary. The "semi-open mixed" and the "closed mixed" are combined into a single hardwood class (Figure 5). Young managed stands may be underestimated by the amount included in the "open mixed" class, while older plantations in the "young conifer" group may supply volume in commercial thinnings or clearcuts. Some "mature" acres in the lower valley may be on their second rotations, though most "mature" and "old" stands are natural stands.

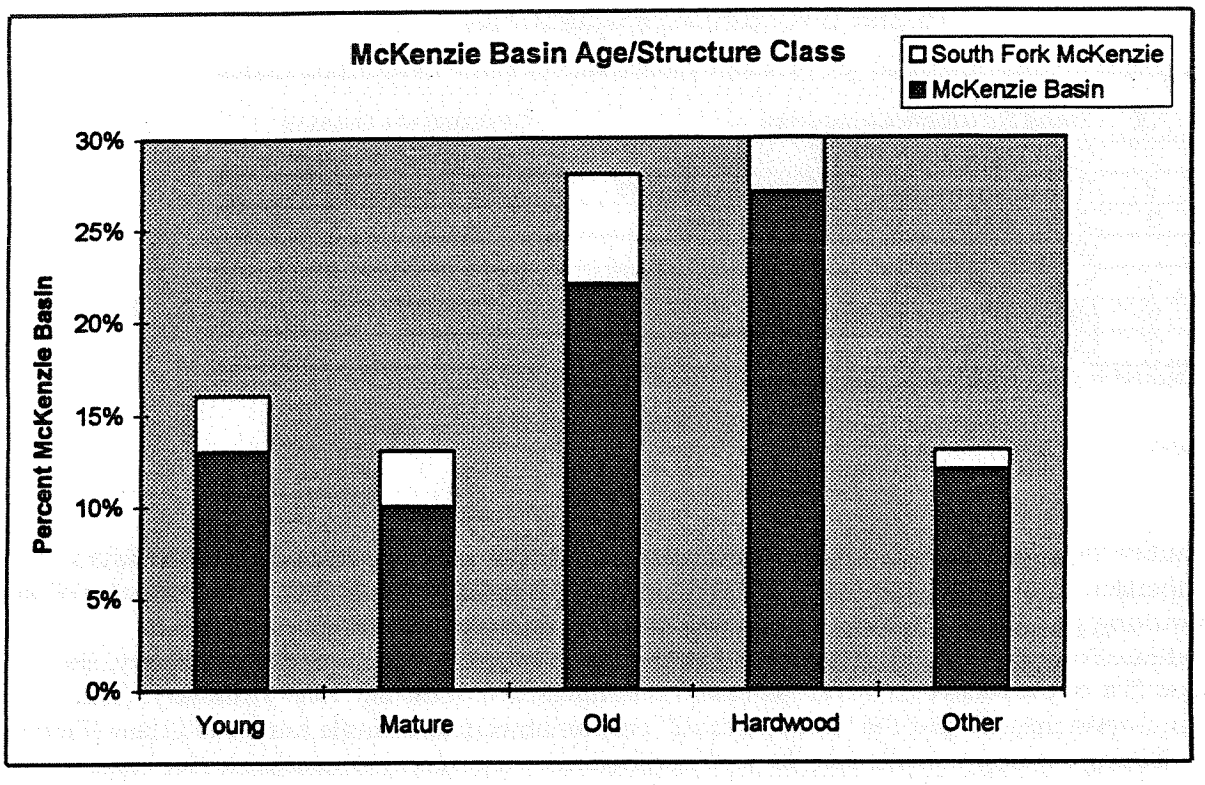


Figure 5

If the mixed hardwood class and young conifer class together are interpreted as an approximation of harvested acres then 46% of the basin has been logged. The percent represents status as of 1988. There were three years of average harvests on Federal land in 1988-1990 which shifted some mature acres into young. Since 1991 there most likely has been an increase in the rate of harvest on private land.

A quarter of industrial forestry land was in the two older age classes, as of 1988, though that may be exaggerated, based on the discrepancy we found when comparing the Landsat data with data on the South Fork.

HOW THE SOUTH FORK FITS

The South Fork holds 20% of the McKenzie River Subbasin old class, and 21% of the mature class (but only 11% of the mixed hardwood/conifer class, primarily due to the Three Sisters Wilderness status of half the watershed). Potential for the South Fork to contribute major volumes of large logs to the local economy is limited in the near-term. Less than a quarter of the South Fork is available for timber production. This reflects the large proportion of the watershed in non-harvest allocations such as Wilderness, Late Successional Reserves, and Riparian Reserves. Concentrated harvest has created a high proportion in early and young stands in the harvestable lands. Discrepancies noted above between USFS databases and the remotely sensed data preclude projecting these figures for reliable current or future timber supply for the McKenzie River Subbasin.

Recent harvest trends on private and public lands in the McKenzie River Subbasin may increase the South Forks percentage of the subbasin's older forests. This may have long term importance for recreation and wildlife habitat distribution along the McKenzie and for the Willamette National Forest.

CURRENT LANDSCAPE PATTERN

Patterns of age class patches in the western non-USFS portion of the McKenzie basin differ from both the Wilderness and non-Wilderness pieces of USFS ownership, as discussed below.

Non Forest Service

The lower basin shows a matrix of semi-open mixed hardwood stands with stringers of the open type in the bottom lands of the Mohawk River, Camp Creek, and the McKenzie up to the town of Leaburg. Large patches of the young conifer class drape the upper slopes of the north-facing ridge bounding the basin from Leaburg east to Vida. Other patches of young conifer are present in the upper slopes on the northwest of the Mohawk drainage and north of Vida near the headwaters of the Mohawk and Mill Creek. The older age classes appear as scattered small nearly homogeneous patches or on the margins of larger patches of young conifer.

Forest Service

Outside of Wilderness, USFS lands show a highly fragmented pattern of small blocks of semi-open mixed hardwood patches set between slightly larger patches of older age classes. Within Wilderness, large patches of older age classes dominate the pattern, with smaller blocks or sweeping patches of younger age classes following topographic features. The distribution of age classes and patch sizes show the majority of the Forest Service lands are small blocks of less than 50 acres (Table 4).

A detailed discussion of the landscape patterns of the South Fork is given in Chapter Four's section on past and current vegetation. The South Fork holds perhaps the largest remaining piece of landscape preserving the unmanaged patterns of age classes connecting the Crest of the Cascades to lower elevation habitat. To the west and south of the South Fork mainstem, the landscape is typical of the highly fragmented USFS lands.

Distribution of Age Classes and Patch Sizes

Large Blocks (>500 acres)

Late	Early	Older Managed
20%	.1%	2%

Small Blocks (<50 acres)

Late	Early	Older Managed

Table 4

Past Patterns

Recent estimates describe the range of natural conditions for early and late seral stages for USFS lands within the McKenzie basin (Siuslaw and Willamette National Forests 1993, unpublished data summarized in USFS Pacific Northwest Region 1993). Over the time period 1600 to 1850, acres in early seral stages ranged from 2 to 20% of the USFS lands; late seral conditions ranged from 20 to 55%.

Near the margins of the Willamette Valley, lightning caused fires as well as Native American activities may have caused fairly frequent low intensity burns and occasional higher intensity events. This fire regime is compatible with a mosaic of patches of old growth stands amid younger, single or multi-storied stands. Frequent low intensity non-stand replacement burns during periods of relatively moist cool weather could have increased proportions in old growth, while more ignitions during warm dry periods would have increased the acres in early seral conditions. It is possible that the range of conditions for the lower valley may have been greater than for the upper valley now managed by the USFS.

The Siuslaw and Willamette National Forests Subregional Ecosystem Assessment (1993 unpublished) estimated typical pre-settlement fire sizes for the USFS lands within the McKenzie basin. For the high elevation mountain hemlock zone, fire boundaries were estimated at 700-1800 acres, while for lower elevation zones, fires ranged from 1500-26000+ acres. Similar fire sizes could be expected for the lower elevation lands outside of USFS ownership.

FISH

Several aquatic and fisheries issues have become prominent and defined at Regional (i.e. Pacific Northwest), and large river basin scales (i.e. the Columbia River Basin), or within the range of Pacific anadromy during the past decade. These include the identification of sensitive, threatened, endangered, and "at-risk" fish stocks; habitat quality for stream species; and habitat quality for riparian dependent species.

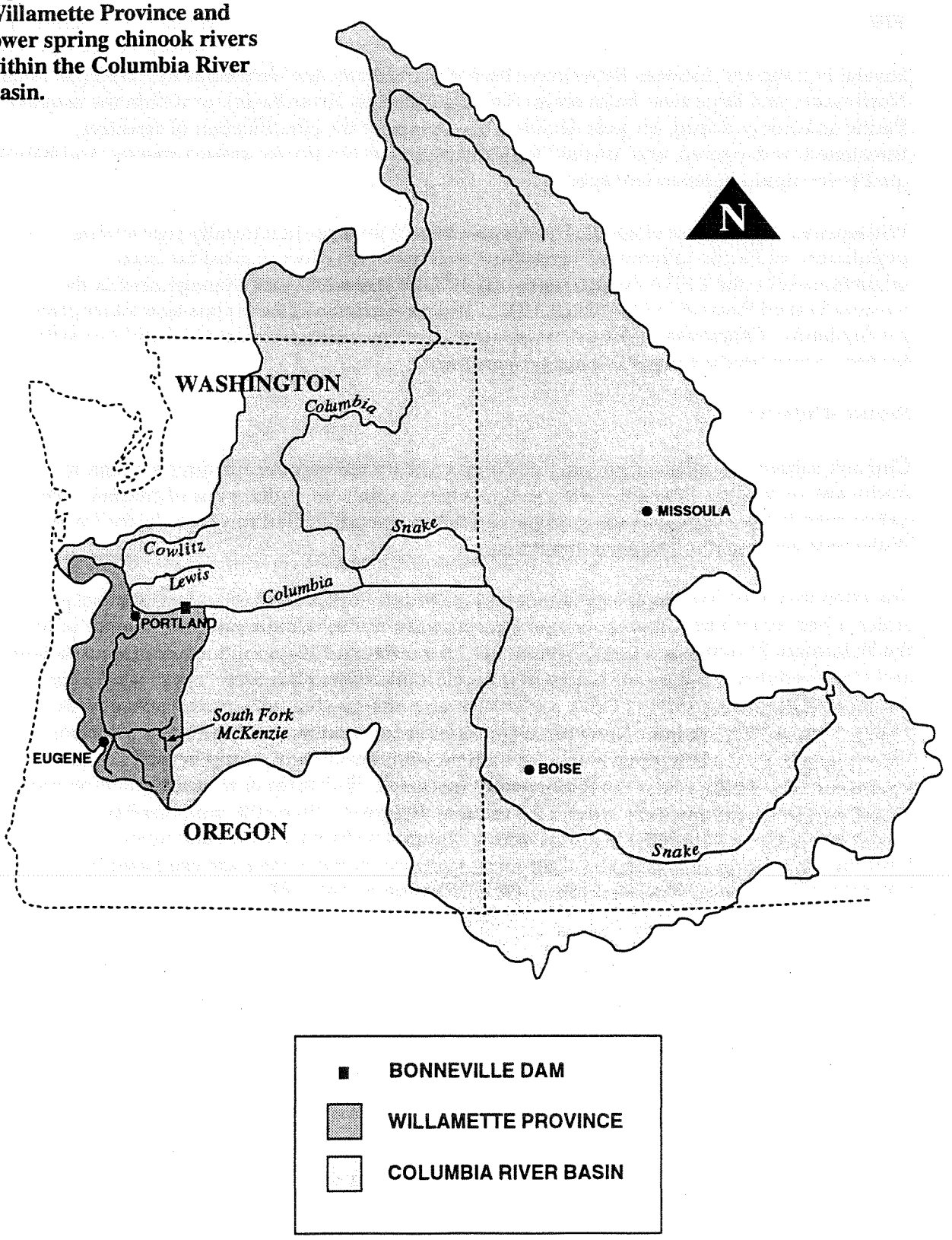
Widespread degradation of aquatic habitat and broad declines in naturally reproducing populations of Pacific salmon and steelhead trout have been documented for lands administered by the USDA Forest Service and USDI Bureau of Land Management in the western United States (USDA/USDI 1994). The degradation of habitat has also taken place on private lands. Other reasons for fish popluation declines include commercial and recreational harvest, ocean productivity and hatchery practices.

SPRING CHINOOK

Chinook salmon have been grouped according to the time they return from the ocean to freshwater as adults. Thus there are spring, summer, fall, and winter runs of chinook. The native runs in the Willamette are spring and fall, however, the fall run occurs in the lower Willamette and will not be considered here.

The relationship of native spring chinook in the South Fork McKenzie to larger landscape scales is best understood by reviewing information from the Columbia River basin, in which the Willamette Province is located (Figure 6). An estimated 10-16 million anadromous salmon and steelhead trout returned to spawn in the Columbia River basin each year prior to Euro-American influences (NPPC 1987), such as harvest of spring chinook which peaked in the 1880's. Over 200 Columbia River basin stocks have been estimated to be extinct, with most of the remaining runs being much smaller than they were historically, and several listed or petitioned for listing under the Endangered Species Act. Run sizes of returning salmon and steelhead in recent times are around 2.5 million, with greater than 90% supported by hatcheries. Considering the historical range of chinook within the four-state region of Washington, Oregon, Idaho, and California, spring and summer runs are estimated to be extinct in 63% of their historical range (The Wilderness Society 1993).

Figure 6. Location of the Willamette Province and lower spring chinook rivers within the Columbia River Basin.



In the context of the Columbia River basin the Willamette spring chinook are considered part of a "lower river" (below Bonneville Dam) spring chinook group (Figure 6). Three river systems dominate lower river production; the Willamette, the Cowlitz, and the Lewis rivers (CBFWA 1991). All three subbasins have been impacted by the construction of high dams which eliminated most of the natural spawning areas for lower river spring chinook. A hatchery program currently maintains the Willamette run of spring chinook, with hatchery stock that is primarily native Willamette fish.

The McKenzie River is the only major natural production area remaining within the lower river systems that is available for spring chinook (CBFWA 1991). In addition to the Clackamas River, a relatively small chinook producer in the Sandy subbasin, these are the only lower river systems where natural productivity is not incidental to artificial productivity. Overall, natural production is estimated to be 5-15% of the lower Columbia River (and Willamette) total spring chinook production, with the remainder from hatcheries. Natural production in the McKenzie is not known because hatchery spring chinook have not been marked. The only year hatchery production was marked was 1993.

PROVINCIAL FACTORS LIMITING SPRING CHINOOK

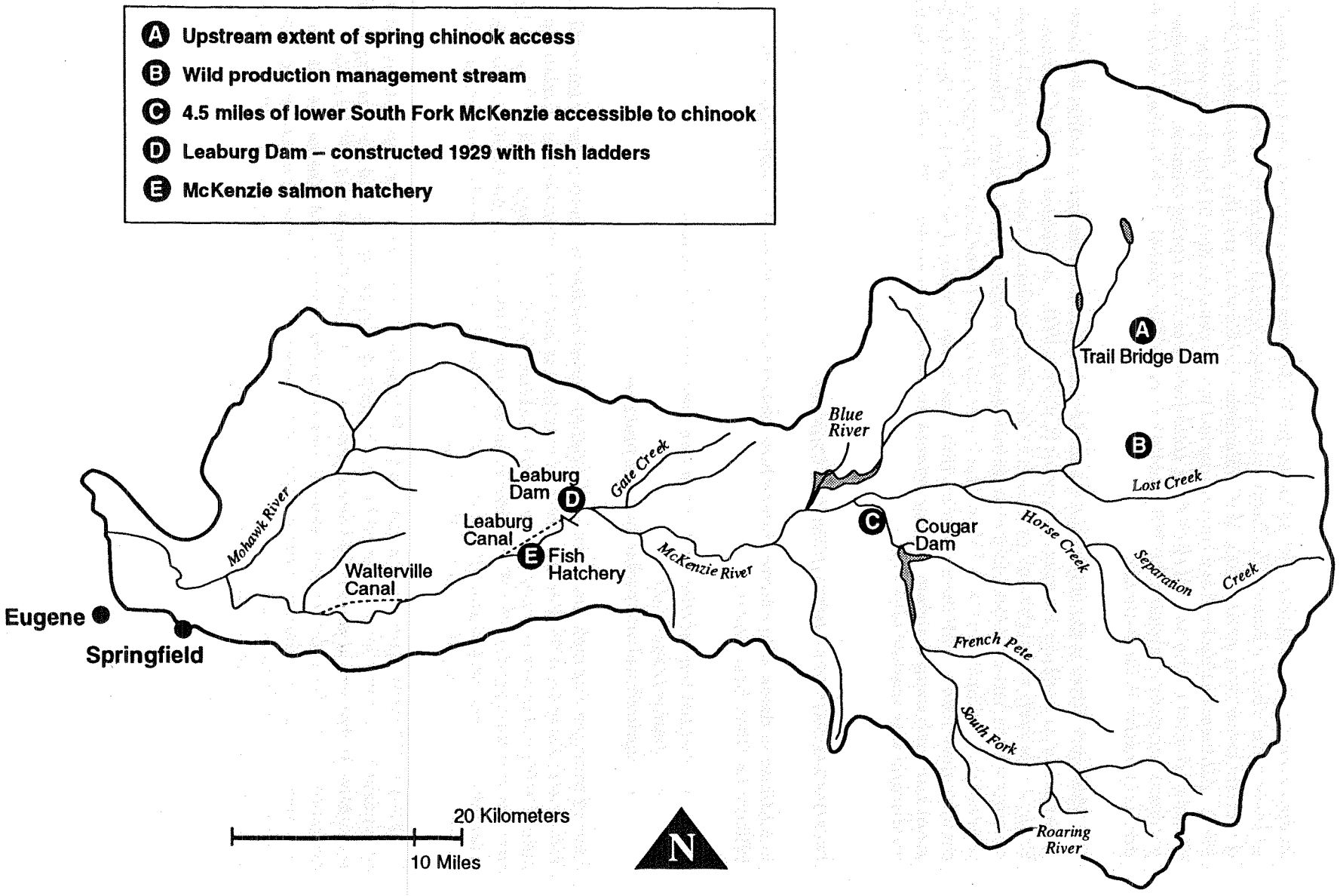
In addition to dams, other factors which have limited spring chinook production in the Willamette River basin include:

- habitat degradation from urban and industrial development;
- channelization; and
- agricultural and timber harvest practices.

Loss of multiple channels, marshes, and riparian forest habitat has been a major impact in the Willamette River from 1870 to the present, resulting in one main channel that is relatively simple with homogeneous aquatic vertebrate habitat (Sedell and Froggatt 1984). Due to these impacts it is thought that the Willamette basin has very little natural production capability remaining, yet the McKenzie still has the best potential for natural production of this species (Smith and Zakel 1981, Max Smith, EWEB, pers. comm.)

In addition to habitat impacts common to the Willamette River basin, the spring chinook in the McKenzie River have been impacted by unscreened diversion canals, and de-watering of the mainstem during use of the EWEB canals (Figure 7). Recent changes to EWEB's canal operations have allowed for more water to remain in the mainstem McKenzie for fish and recreational uses. In addition, Leaburg diversion canals is now screened to juveniles, with Walterville targeted for an adult tail race barrier and juvenile screening when FERC (Federal Energy Regulatory Commission) relicensing occurs in 1995-96.

Figure 7. Map of McKenzie River with reference to spring chinook management.



SPRING CHINOOK STOCK STATUS AND OBJECTIVES

Prior to major development in the Willamette basin, the McKenzie River was thought to be the best spring chinook producer above Willamette Falls, with 39-50% of the run entering the McKenzie to spawn (Mattson 1948, Willis et al. 1960). Within the McKenzie River subbasin, the major remaining spawning areas currently utilized are the mainstem McKenzie, Horse Creek, and Lost Creek. Of major areas formerly accessible, only 4.5 miles of the approximate 25 miles of mainstem South Fork habitat is currently accessible. Gate Creek, which is located downstream on the main McKenzie, was formerly an important chinook producing tributary, but currently is underutilized due to low quality habitat (Figure 7).

Trends of natural spawning in the upper McKenzie River indicate continuing decline of spring chinook salmon production from the 1960's to the late 1980's, at which time, redd counts increased (Figure 8). Based on limited historical information, peak runs of spring chinook in the McKenzie occurred in the mid-late 1920's (Max Smith EWEB, 1994). By the 1940's egg-collection data from hatchery operations at the McKenzie River salmon hatchery indicated serious declines in the natural spawning population (Wallis 1961). Run sizes in the McKenzie from 1945-1960 averaged 18,000 fish . Annual counts of spring chinook passing Leaburg dam from 1970-1993 show no obvious trends, except the late 1980's increase. The total McKenzie run has averaged 6,714 during that period, with an average of 2,910 for Leaburg Dam in that same period (Figure 9).

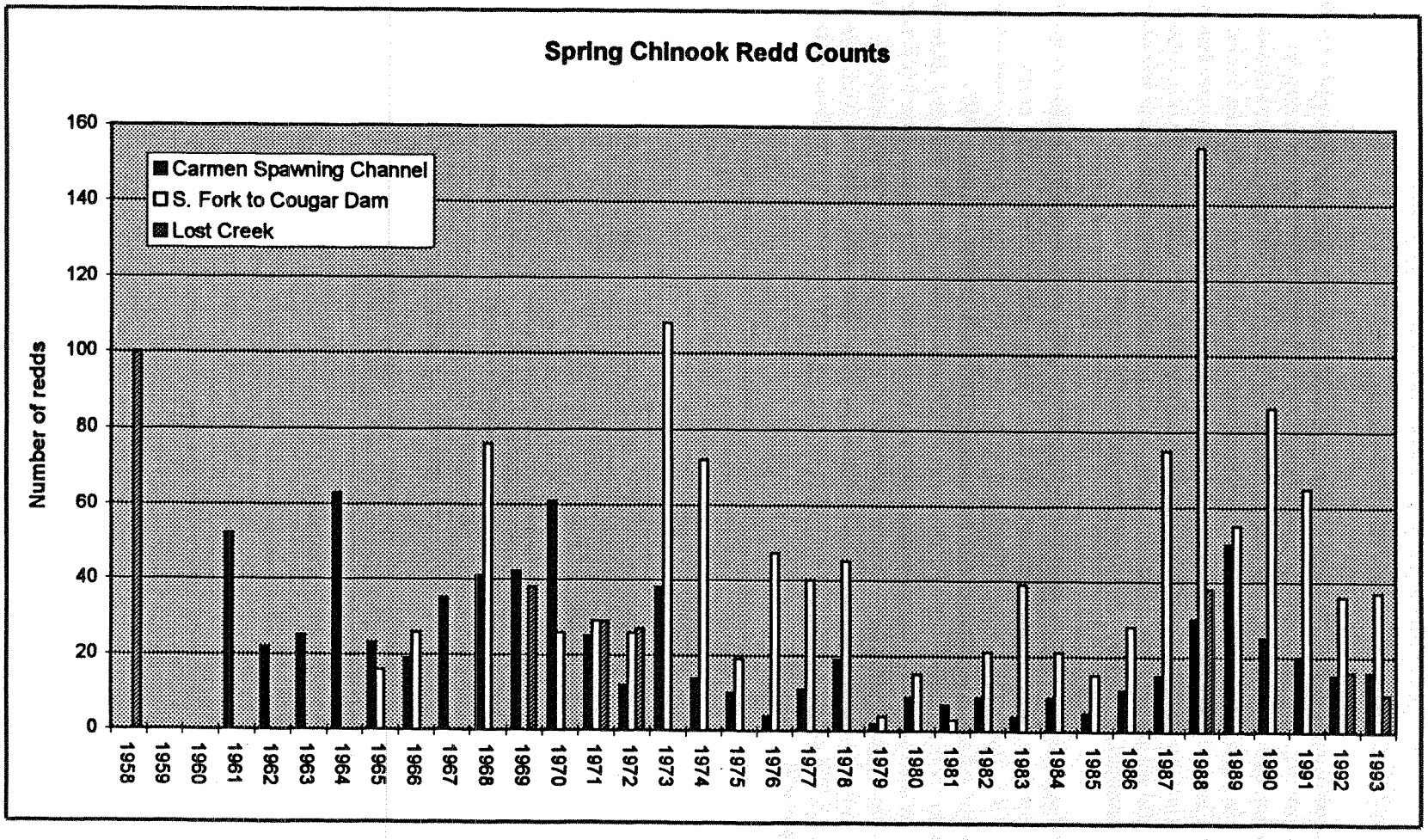

Spring Chinook Redd Counts
Carmen Spawning Channel
S. Fork to Cougar Dam
Lost Creek
Number of redds
0
20
40
60
80
100
120
140
160
1958
1959
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993

Figure 8

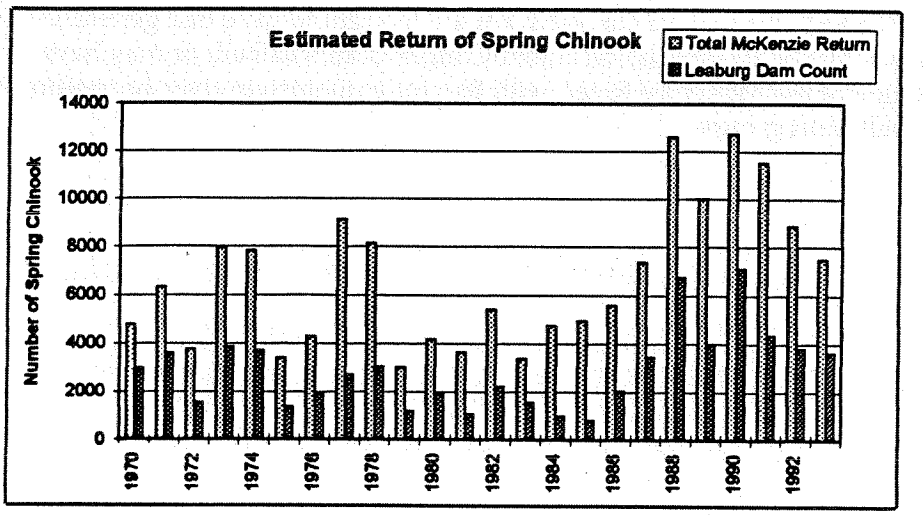


Figure 9

Within the Willamette River basin, the McKenzie River subbasin has been identified as a high priority area for habitat protection for spring chinook (ODFW 1993). The McKenzie is to be managed for production and harvest of wild and hatchery spring chinook, with the river above Leaburg Dam reserved for natural production only (ODFW 1993 p.7). The returning run size objective for the entire McKenzie River is 18,000 spring chinook; 8,000 adults from hatchery smolt releases and 10,000 wild fish.

BULL TROUT STOCK STATUS

Bull trout are an endemic char and share several life history features with species adapted to northern environments, such as the arctic char (*Salvelinus alpinus*).
These features include:

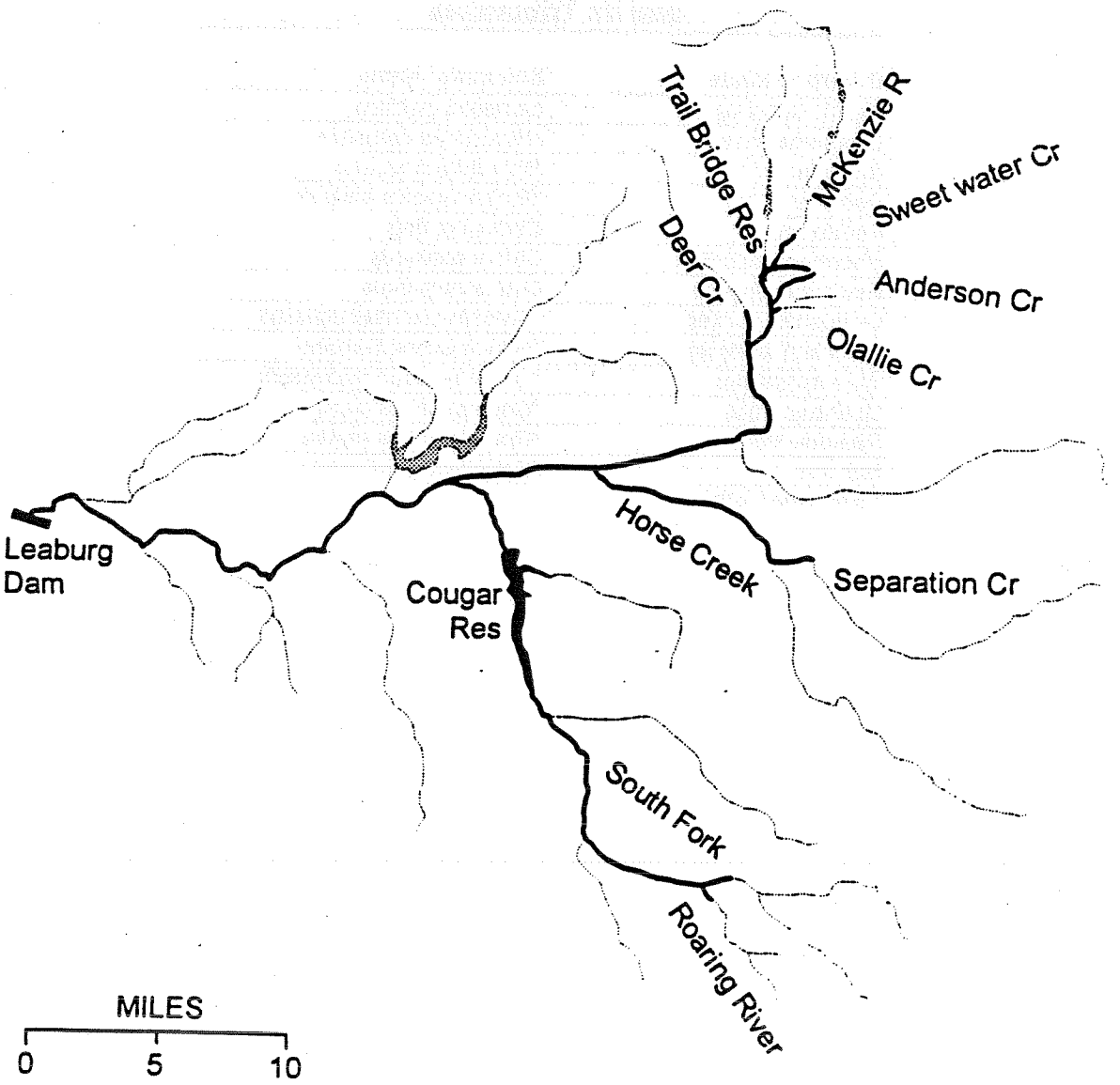
- advanced age at maturity,
- alternate year spawning,
- extensive migrations, and
- separation of juvenile and adult segments of the populations (Thomas 1992).

Bull trout have been eliminated or seriously reduced in abundance throughout most of its range (Meehan and Bjornn 1991). The primary reasons for the reduction are altered habitat due to land management (dams, diversions, timber harvest, and roads), followed by fishing, and interactions with introduced fishes (e.g. brook trout, brown trout, and/or lake trout) (USDA 1994). Bull trout are a Forest Service Sensitive species and have been found eligible for listing by the US Fish and Wildlife Service under the Endangered Species Act. The bull trout in the McKenzie River subbasin (Figure 10) are the only remaining western Cascade population in Oregon that has over 50 adults, although precise numbers are unknown (Ratliff and Howell 1992, USDA Forest Service 1994). Bull trout populations in the Santiam River subbasin are

extinct, and a very small, remnant population is suspected in the Middle Fork Willamette subbasin. The bull trout above Cougar Dam are thought to have had genetic interchange with the mainstem McKenzie population before Cougar Dam was built or may have been a subpopulation of the McKenzie River, with the upper mainstem river supporting the 2nd of two main bull trout groups.

McKenzie River Bull Trout

1994 Distribution



MAP COURTESY OF ODFW

FIGURE 10

OTHER FISH SPECIES

Two native trout species occur in the McKenzie River watershed. They are rainbow trout (*O. mykiss*), which are locally called "redsides", and cutthroat trout (*O. clarki*) (Hutchison 1991). Several other fish species native to the McKenzie River basin also occur in the South Fork McKenzie watershed (Table 5).

Fish Species of the South Fork McKenzie River and its Tributaries

Common Name	Scientific Name
Pacific lamprey	*Lampetra pacifica*
Longnose dace	*Rhinichthys cataracta*
Speckled dace	*Rhinichthys osculus*
Redside shiner	**Richardsonius balteatus*
Paiute sculpin	*Cottus beldingi*
Shorthead sculpin	*Cottus confusus*
Reticulate sculpin	*Cottus perplexus*
Largescale sucker	**Catostomus macrocheilus*
Mountain whitefish	**Prosopium williamsoni*
Chinook salmon	**Oncorhynchus tshawtscha*
Cutthroat trout	**Oncorhynchus clarki*
Rainbow trout	**Oncorhynchus mykiss*
Bull trout	**Salvelinus confluentus*

* confirmed siting

Table 5

HUMAN/SOCIAL

PATTERNS OF USE AND DEVELOPMENT

PREHISTORIC, ETHNOHISTORIC AND HISTORIC USE

Knowledge of prehistoric use of the South Fork watershed is incomplete. Much of the data collected has come from cultural resource surveys conducted prior to ground-disturbing activities. Such surveys have generally been limited to surface examinations of archeological sites, rather than subsurface sampling of cultural deposits.

The early 19th century ethnohistoric period is poorly documented. However, it is known that four aboriginal peoples - the Kalapuya, Molalla, Tenio, and Northern Paiute - frequented places within, or adjacent to, the Willamette National Forest at the time of historic contact. The Central Band of the Molalla Indians were likely the primary inhabitants in and around the Forest, including the South Fork McKenzie River (Minor and Pecor 1977). The Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians categorize the archeological value of the South Fork corridor as "extremely high" considering that the river bed areas were primary village sites.

The later ethnohistoric period is better documented. It is believed that beginning in the early 1860's, equestrian bands of Warm Springs Indians seasonally migrated into the area during late summer/early fall. They hunted, fished, gathered berries, bought/traded raw deer hides and finished goods, and worked as agricultural laborers in the Willamette Valley (primarily as hops pickers). A number of their temporary encampments have been reported along the South Fork and its tributaries.

SETTLERS ARRIVAL

With the arrival of settlers from Europe (and other parts of the world) to the south Willamette Valley came the first intentional settling and development in the area. Most of the available history pertinent to the McKenzie Valley, and areas proximate to the South Fork, is of an anecdotal nature. Much of it is vague, and some of it is conflictive.

All sources note the first presence of non-natives in the early 1800s. It appears that fur trappers and explorers from John Jacob Astor's Pacific Fur Company and the Hudson Bay Company were present in the Willamette Valley just after the turn of the century. The McKenzie River itself was "discovered" and named by a member of Astor's enterprise. Donald Mackenzie, with a party of explorers, came upon the river in about 1810/1812. During the rest of the 1800's the Willamette valley was settled and towards the end of the 1800's exploration pushed up the McKenzie valley.

The South Fork is frequently cited as a premier fishing spot in the late 1800's, and there is evidence to suggest that professional "guides" were used by recreational anglers at that time.

Elk were abundant and were being hunted for sport rather than sustenance by the turn of the century. Two resorts and a summer hotel existed in the upper McKenzie Valley. Foley Springs and Belnap Springs resorts were being served by stagecoach, run by John West Sr., from Eugene. Ranchers and stockmen had also settled in the upper valley. One of the people who came to hunt with the Belknaps was Hiram Terwilliger. Terwilliger is said to have found the Hot Springs which are named for him in the late 1800's.

The Cascade Range Forest Reserve was designated in 1893. Over the next 40 years or so there was a transition from a land of isolated frontier habitations to a series of forest communities, including those nearest the South Fork. Travelways were being improved to expedite the flow of commerce across the Cascades. Upper valley settlers were responding to the influx of recreational users and commercial traffic with entrepreneurial spirit.

Samuel Sparks and his sons laid out and platted the town of Blue River in 1900. Shortly thereafter a new hotel, a livery stable and sawmill were built at the site of present-day Blue River. Other facilities included a Chinese laundry, five saloons and a blacksmith's shop. There were many transient workers in and out of the area due to development of mining projects. Most claims were tapped out by 1912. The community was almost exclusively males.

In 1906, Hiram Terwilliger filed a cinnabar (mercuric sulphide) claim on the hot springs area. This claim was later abandoned.

1908
According to Manena Schwering, long-time resident of Blue River, the establishment of the McKenzie Ranger district had a significant and lasting impact on community development. First ranger Smith L. Taylor served the area for 27 years and came to be regarded as an unofficial spokesman for community projects, school and highway improvement, and later, fought for rural electrification (informal communication). It was during this year that the Cascade Forest was created out of the Cascade Crest Reserve.

During these years and through the 1920's the area continued as a prime fishing spot. In 1920 Hidden Lake is described as an angler's "paradise." The area was reached by a trail from the river. By the 1950's, over fishing had claimed the trout and due to extensive logging, " and the lake had lost most of its pristine beauty."

Grazing sheep in the western Cascades began about 1880 (Colville 1898, Rakestraw 1933). Grazing was prohibited one year after the Cascade Range Forest Reserve was designated and then opened again under permit in 1898. The earliest grazing records for the South Fork begin in 1909, although the area was undoubtedly grazed prior to that. The South Fork had grazing allotments along the ridges on the east and west. A grazing report and history can be found in Appendix Report Veg 1. Sheep grazing continued through the 1940's. Cattle grazed in the Chucksney mountain area until 1976.

1927
Terwilliger Hot Springs Incorporated was formed by a group of Eugeneans, with plans to develop a resort. Forest Service issued permits, but Federal Power Commission had plans for a reservoir. The lease was terminated in 1930.

By this time in the 1930's the lumber industry in the Willamette Valley had made a major shift from private to public lands as a source of timber; many lumber companies went under and others changed ownership; "sustained yield" became a goal of Forest Service management; railroad logging and river drives gave way to tractor logging and truck transportation and, cutting practices changed. Growing timber was now an industrial business.

In 1934 the road down the South Fork was built as part of the Civilian Conservation Corp (CCC) program. There had been a trail down the South Fork which ran the length of the river prior to this. With the construction of the road access to the area was open. Logging began in the mid to late 1940"s.

The 1950"s were years of confidence and growth. However, a near tragic fire and some alleged favoritism in timber sales had created a rift between the residents of the McKenzie Valley near Blue River and the Forest Service in the late fifties. Then district ranger Edward Anderson initiated what might be recognized as the first Natural Resource Education program ever undertaken in an effort to restore confidence in the Forest Service.

The Blue River Ranger District was established through a withdrawal of lands from the McKenzie Ranger District in 1956.

Logging activity in the South Fork increased during the 1950's and 1960's and production peaked in the 1970's and 1980's.

In 1957, the Secretary of Agriculture established the Three Sisters Wilderness, but determined that 57,000 acres of the primitive area had greater public value if managed for multiple uses. Most of the excluded acreage was in the French Pete drainage area of the South Fork. Subsequently, French Pete was dropped from this legislation and controversy over this area began. Early in 1968, plans to harvest timber in French Pete met with public protest. The Save French Pete Creek Committee was formed by people proposing that the area be left in a natural state.

In 1969, the Forest Supervisor appointed an ad hoc committee of 23 people felt to represent the broad spectrum of public interest. The group heard the Forest Supervisor's tentative plan for managing French Pete, which met the specifications of the 1957 decision by the Secretary. The committee supported this plan, and, after further amendments were made to further protect water, recreation and wildlife values, the Supervisor announced his approval of the plan. to manage the French Pete area for multiple uses, including timber harvest.

This announcement effectively ushered in the present era of conflict and controversy that speaks to yet another shift in public values. Controversy around French Pete continued until it was finally added to the Three Sisters Wilderness in 1978. French Pete was followed closely by further conflict around Terwilliger Hot Springs.

1979
Terwilliger Hot Springs Management Plan completed in an effort to address overuse and abuse of the area. Regulations established included: no camping around the springs, dogs required to be on leash, and no camping in parking lots. Forest Service patrols were increased to enforce the new regulations.

1982
A group of concerned citizens representing various outdoor groups formed the South Fork Consensus Group. This group was formed in response to Forest Service proposed logging activities in the area between the river and the wilderness boundary. The group met with the Forest Service over a period of several months and hammered out an alternative for the area. That alternative eventually was incorporated into the 1990 Forest Plan as a Special Interest Area.

1983
The Second Terwilliger Hot Springs Management Plan was signed by District Ranger Jim Caswell. This plan called for the non-profit "Friends of the Springs Trust" to manage the natural mineral springs. Increased use and increased levels of crime prompted this action.

In 1989/1990 a third management plan was developed for Terwilliger Hot Springs. This plan called for night time closure.

1992
South Fork is determined to be eligible for Wild and Scenic River Designation.

Currently, Terwillger Hot Springs area is managed in conjuntion with the Cougar crossing area.

ACCESS AND COMMODITY PRODUCTION

During this time of use and development the predominant human development activities were the building of the dam, road building, timber harvest and the development of recreation sites. The following discussion centers on the road system for access and commodity production.

ACCESS

The original access into the South Fork, Road 19, remains the main access route today. Currently, traffic varies from about 170 vehicles per day during the winter to over 600 vehicles during the summer , with as many as 800 vehicles per day on the weekends. With reduced logging, recreation vehicles account for more than 85 percent of the traffic.

All other roads were built to provide access for timber harvest activities. Today there are approximately 337 miles of road in the watershed . The main access routes are displayed in Figure 11. Dates illustrating the trend in construction are displayed in Figure 12. Of the 337 miles of roads 5 miles are closed year round and fifty-five miles are closed seasonally for wildlife protection (Figure 13).

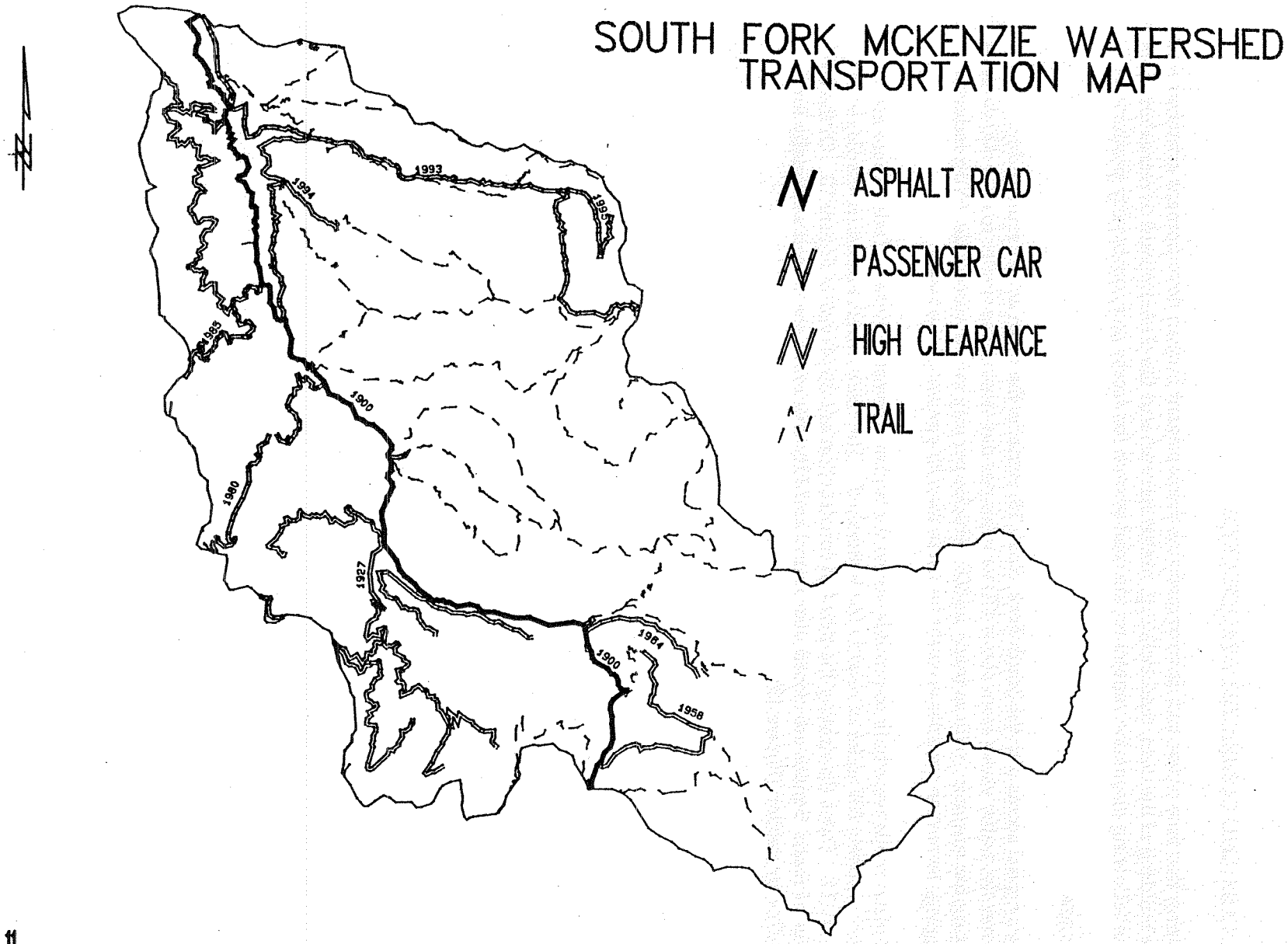

SOUTH FORK MCKENZIE WATERSHED
TRANSPORTATION MAP
ASPHALT ROAD
PASSENGER CAR
HIGH CLEARANCE
TRAIL
1993
1994
1995
1985
1900
1980
1927
1964
1900
1958

FIGURE 11

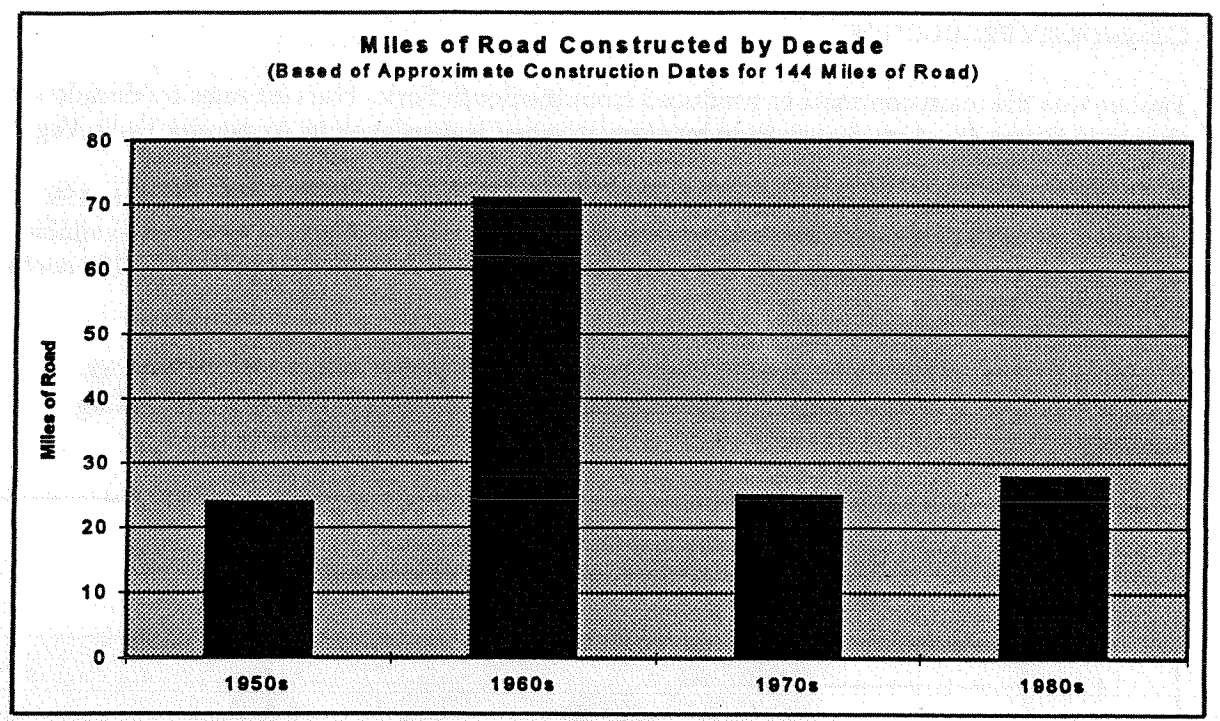


Figure 12

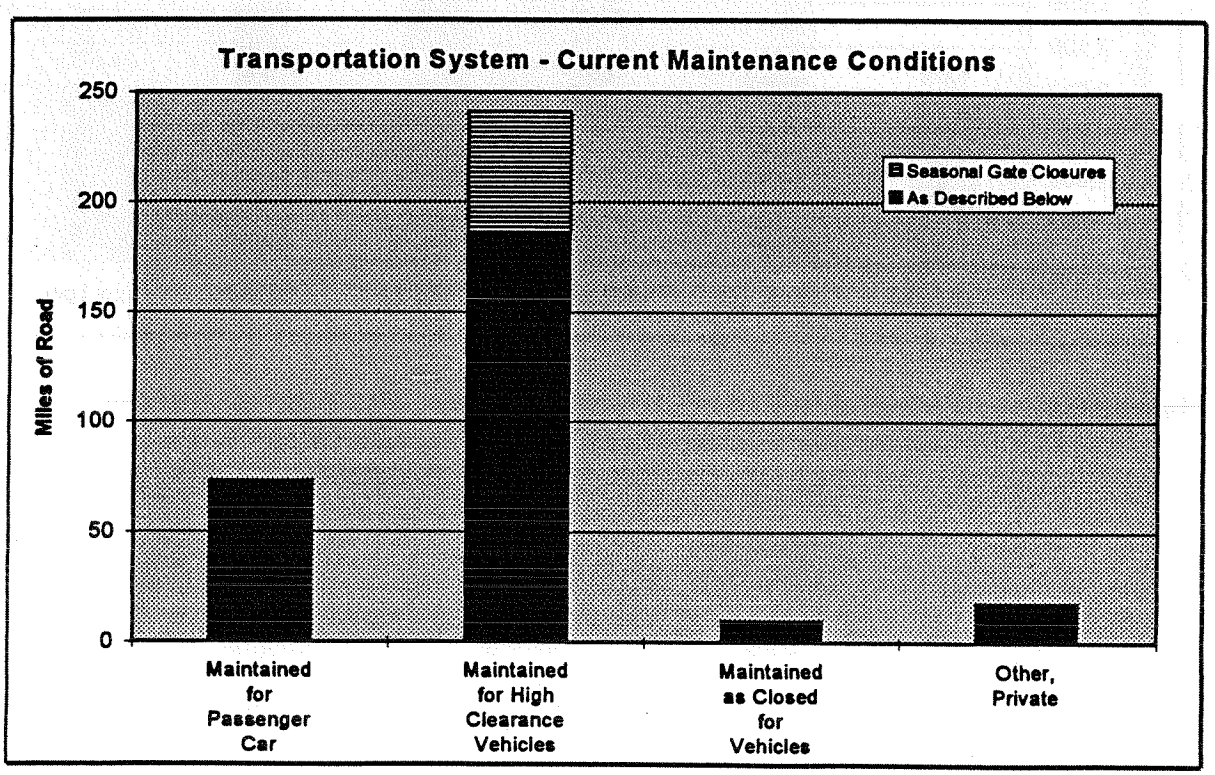


Figure 13

COMMODITY PRODUCTION

Timber was the main commodity produced from the South Fork. Harvest rates by decade are shown in figure 14. Acre distribution by subwatershed is displayed in Appendix Table Veg 2.

Firewood was another commodity produced historically from the South Fork. Prior to 1993 approximately 500 cords of firewood were sold per year. The amounts of firewood available have been steadily decreasing with the reduction in timber harvest. Approximately 100 cords were sold in 1994.

No records were available for special forest products specifically sold on the South Fork. Special forest products are a growing area of use and the demand appears to be heading upward.

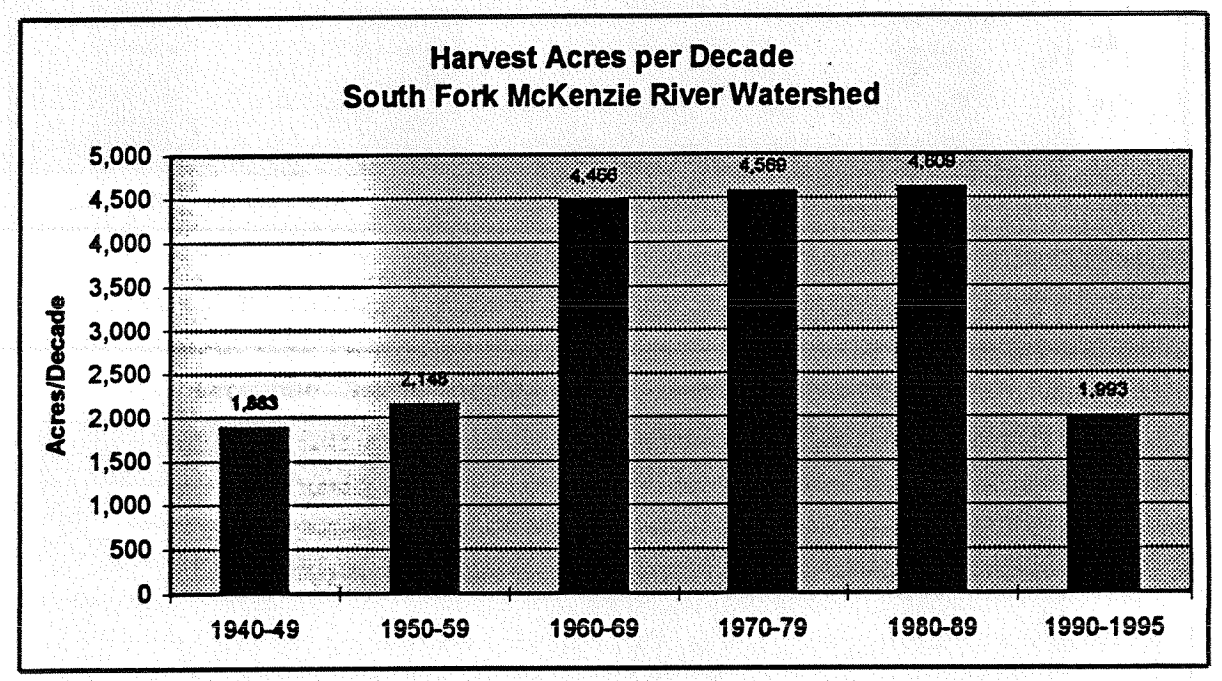


Figure 14

SCENIC

Scenic Past Conditions

Prior to development of road access within the South Fork Watershed the condition of the Scenic Resource landscape was shaped by a long history of natural processes, marked by periodic events of:

- flooding,
- landslides, and
- wildfire.

The basic landscape structure consisted of steep slopes and long ridges covered by a coniferous forest. This landscape was and is punctuated with rock formations and meadow openings, and dissected by numerous streams tributary to the South Fork.

During this period a significant portion of the watershed, 33%, was composed of pole size stands of timber (Appendix Table SR1). One percent of the area was composed of seedlings and saplings size regeneration. Sixty one percent of the watershed was composed of a mix of small, medium, large and old growth trees. With 39% of the area in relatively young age classes, this suggests that large areas had in the recent past experienced some natural conversion process. This condition would be regarded as Natural Appearing considering it is natural in origin and random in size, shape, and distribution; and with only 1% of the area in essentially an open condition.

Around 1950, significant human initiated disturbances within the watershed included Road 19, campgrounds, harvest activities, grazing, and fire lookouts. However, by the mid-1960's significant alterations of the natural appearance of the lower South Fork watershed occurred. These alterations to the landscape were:

- Cougar Dam and reservoir,
- new road construction and reallocations, and
- increased timber harvesting.

Also during this period harvest activities occurred to ready the area for construction of the reservoir facility, including the dam, the reservoir basin, and new roads. These created permanent alterations to the scenic character of the watershed. Most significant of these alterations included: the massive dam structure; the terraced rock slopes; road cuts and fills with attendant clearings; and the raw, stump dotted, barren slopes of the reservoir basin. These alterations are revealed for lengthy periods during drawdown . In addition harvest activities increased in other areas of the watershed and became apparent to casual users from new vantage points within the South Fork. Harvest activities were occurring in the upper East Fork, lower Walker Creek, lower Rebel Creek, and the Skookum Plateau. However, the primary focus of harvest activity was on the western slopes that rise above the reservoir to Indian Ridge. Here the most intensively managed area of the South Fork was evidenced as a mosaic of patch cuts in various stages of regeneration.

At this time 5% of the watershed was composed of pole size stands of timber and 4% was composed of seedlings and saplings size regeneration. (Appendix Table 2), with 87% of the watershed composed of a mix of small, medium, and large/old growth size trees. With 9% of the area in relatively new harvest units and roads, exhibiting the geometric character typical of the period, the lower South Fork would appear as Heavily Altered. At this time extensive harvests had not occurred in the upper reaches of the watershed and thus would be considered Slightly Altered. The cumulative effect of harvest activities and reservoir development were devastating to the scenic quality of the South Fork watershed. Certainly the Scenic Condition of the lower portion of the watershed must be considered Heavily Altered. However the upper reaches of the South Fork, particularly above the reservoir would be considered Slightly Altered.

Scenic Current Conditions

The watershed of today is experienced visually in several distinct segments described below, whether traveling in a northerly or southerly direction through the watershed. The current condition of the Scenic Resource in the watershed is mainly due to the following factors:

- operation of Cougar Dam and it's resulting reservoir;
- relocation of Road 19 from the valley bottom to the side slopes skirting the western edge of the reservoir;
- construction of the East Fork and East Side Roads;
- designation of a significant portion of the watershed as Wilderness; and
- extensive timber harvest and road construction in the western and southwestern portions of the watershed.

The area below the dam is a contained relatively flat space viewed primarily while descending from the dam on Forest Road 19. The most prominent aspects of this view are Castle Rock, Lookout Ridge to the North, Strube Flat, the face of the dam, and the terraced excavations on the eastern slope of the watershed proximate to the dam.

The area surrounding the reservoir is a large space, linear and serpentine in character, formed by steep slopes and ridges along it's eastern and western shores, which narrow to the river valley of the South Fork near the middle of the watershed. The most prominent visual elements within this space are: the steep, forested, rugged slopes surrounding the reservoir; meadows and rock out-cropings on upper south and west facing slopes; distant views to the north and south; the irregular shoreline of the reservoir; the contrast between second growth, mature and old growth stands that surround the reservoir; and the bare, exposed band of soil that surrounds the water surface of the reservoir during drawdown periods.

The upper half of the watershed is a narrow, linear, up and down, often a twisting and turning corridor through the Forest. There are occasional views to the ridges that give it definition. The travelers experience is dominated by a matrix of coniferous and deciduous vegetation. There is a view of large trees and soft ground covers; steep river canyon slopes; refreshing views of the South Fork of the McKenzie River; several tributaries; and the ever present geometric evidence of past timber harvest activities.

Scenic Assessment

The Forest Land Management Plan assigns Scenic Quality Objectives to the South Fork Watershed through a variety of Management Areas. The distribution of Scenic Quality Objectives in the watershed are illustrated in Figure 15. The current status of timber stands within the South Fork watershed by each of these areas is illustrated in Table 6 and their spatial distribution is shown in Figure 16. Although, as illustrated in this table, the existing condition for each management area exceeds it's respective decade harvest rate, in no instance does the condition exceed the Forest Plan standard for maximum disturbance.

Although harvest activities are currently consistent with Forest Plan standards, the sizes, arrangements, and geometric character of treatments over the past thirty years has had a lasting effect on the scenic quality of the area. It is the visibility, distribution, and in some instances the concentration of treatments and their physical attributes in contrast with older un-cut stands that contribute significantly to the current quality of the areas scenic resources. This in addition to the obvious effects of dam construction and reservoir operation, noted above, provide the basis for describing the Existing Visual Condition of the watershed on the whole as being Moderately to Heavily Altered. Clearly the area encompassing: Strube Flat; the dam and reservoir; the western slopes of the watershed that form Indian Ridge; and the East Fork drainage are considered Heavily Altered. The area of the upper South Fork to Box Canyon is considered Moderately Altered to the casual viewer.

Scenic Future Condition

The Future Visual Condition of the watershed is expected to improve over current conditions when considering several developments and trends affecting Forest land management activities. As Forest managers begin to focus more attention on balancing human use and product extraction with management of natural processes the appearance of the watershed, in time, is expected to approach a Visual Condition of Moderately to Slightly Altered.

With the Forest Plan as amended and associated standards for management of scenic resources, including the control of harvest rates, unit sizes, other treatment area attributes, and methods such as thinnings and individual tree selection, the design and distribution of activities within the watershed are expected to be less apparent to the casual viewer. Changes that set aside additional lands for the preservation of Late Successional Reserves, increased the size of riparian reserves, reduced annual harvest rates, and established additional standards for management of a wide range of Forest resources is expected to have a beneficial effect on the ultimate quality of scenic resources in the future.

SOUTH FORK MCKENZIE WATERSHED SCENIC QUALITY OBJECTIVES BY MANAGEMENT AREAS

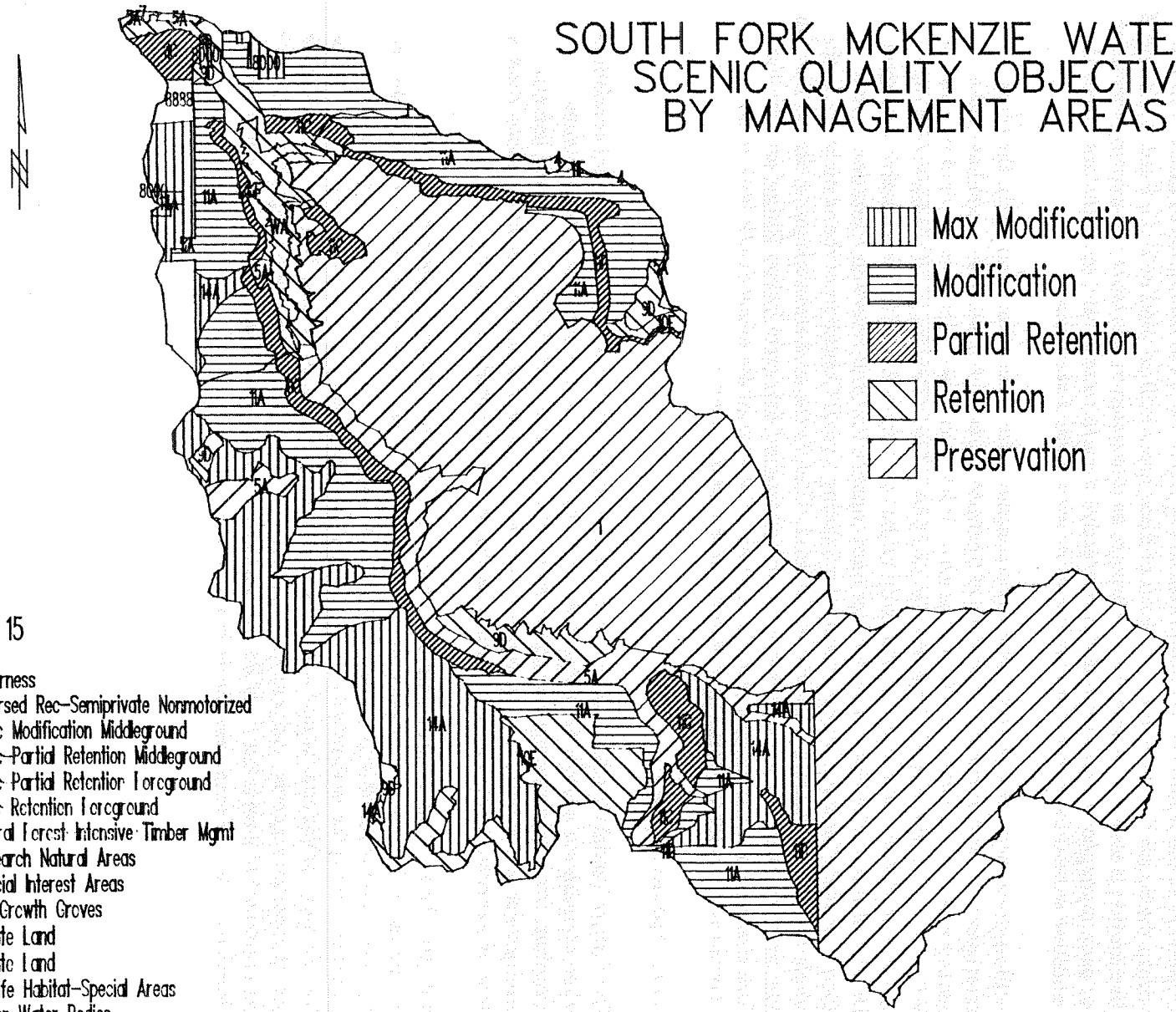


FIGURE 15

1 Wilderness
10E Dispersed Rec–Semiprivate Nonmotorized
11A Scenic Modification Middleground
11C Scenic–Partial Retention Middleground
11D Scenic–Partial Retention Foreground
11I Scenic–Retention Foreground
14A General Forest–Intensive Timber Mgmt
4 Research Natural Areas
5A Special Interest Areas
7 Old Growth Groves
SCCC Private Land
SSSS Private Land
9D Wildlife Habitat–Special Areas
WA Major Water Bodies

Existing Visual Condition Analysis by Management Area

Mgmt Area	HRO	EDC	MDC	Seeds & saps 0-20 yrs	Poles 21-?	Small Trees	Medium Trees	Large/OG Trees	Non-forest	Total Acres
1	0.00	0.00	0.00	0	41	2,672	35,080	26,615	5,109	69,517
10E	0.00	0.00	0.00	0	0	608	995	2,199	393	4,207
11A	0.12	0.18	0.24	3,137	3,311	145	4,024	6,606	326	17,549
11C	0.10	0.13	0.20	620	1,355	57	1,098	1,480	88	4,699
11D	0.07	0.06	0.14	50	0	0	154	682	3	890
11F	0.05	0.02	0.10	55	315	237	265	1,245	541	2,658
14A	0.13	0.18	0.26	3,050	2,432	427	3,636	7,299	523	17,367
5A	0.00	0.04	0.00	259	473	65	1,590	3,424	245	6,055
0.07	0.00	0.00	0.00	0	7	13	0	22	0	42
80	0.88	0.08	1.76	249	1,959	0	380	477	0	3,064
9D	0.00	0.06	0.00	108	311	0	876	356	139	1,790
LSR	0.00	0.19	0.00	1,601	284	160	4,350	1,654	443	8,491
WA	0.00	0.00	0.00	0	0	0	0	3	1,127	1,131
Watershed Totals										
		Acres		9,142	10,488	4,385	52,448	52,061	8,936	137,459
		Percent		7%	8%	3%	38%	38%	6%	100%

HRO = Harvest Rate Objective
EDC = Existing Disturbed Condition
MDC = Maximum Disturbed Condition

Table 6

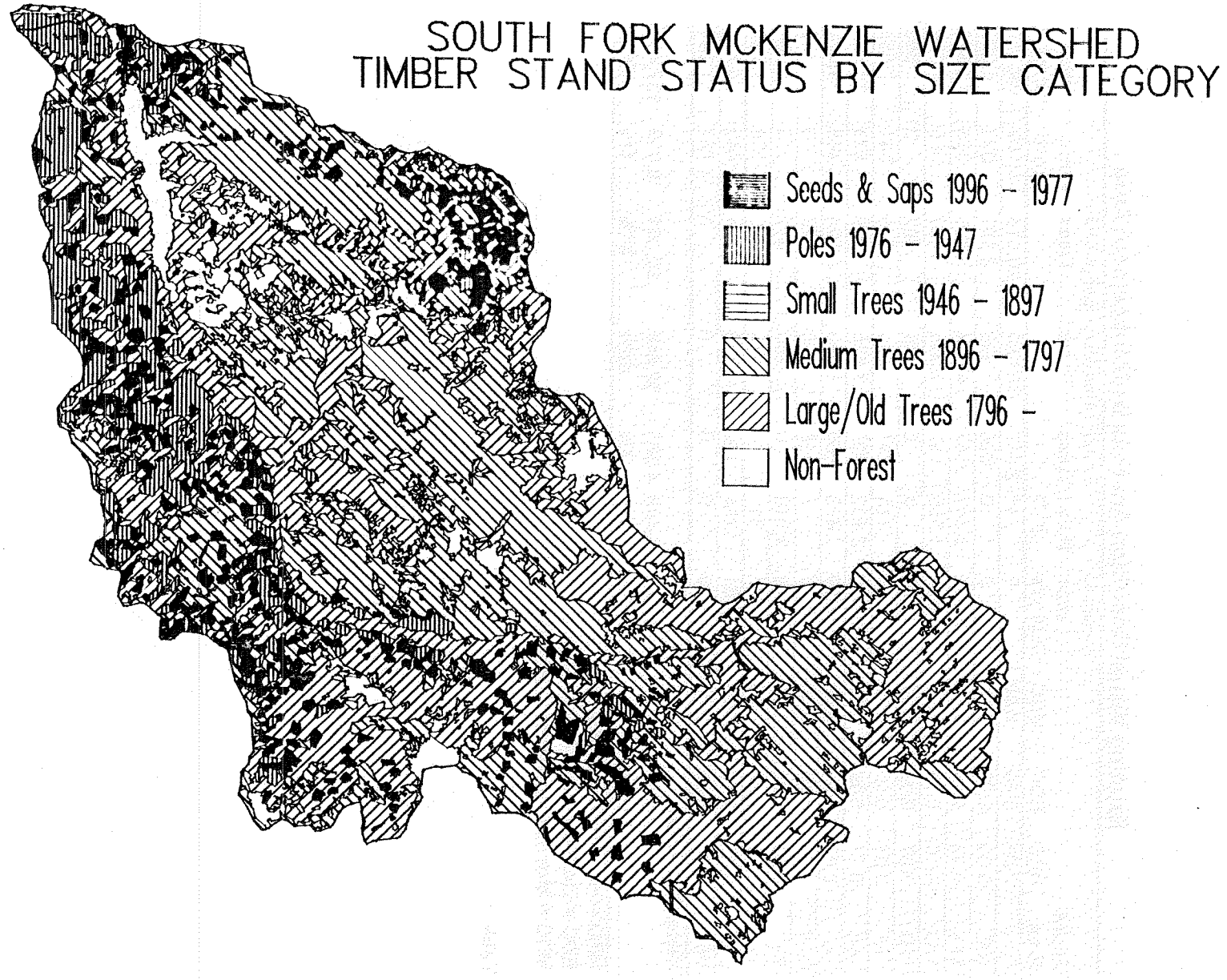

SOUTH FORK MCKENZIE WATERSHED
TIMBER STAND STATUS BY SIZE CATEGORY
Seeds & Saps 1996 - 1977
Poles 1976 - 1947
Small Trees 1946 - 1897
Medium Trees 1896 - 1797
Large/Old Trees 1796 -
Non-Forest

FIGURE 16

RECREATION

Recreation Past Conditions

Around 1900 and before, the South Fork McKenzie watershed was an undeveloped area used more as a source of fish and game and the gathering of other forest products essential to daily life than as a recreational resource, although this was surely an important aspect of the areas use. Not until Road 19 was built in 1934 and several campgrounds were constructed in the upper part of the watershed as CCC projects did the area become a popular recreation destination. In addition Terwilliger Hot Springs became a popular focus of use following it's discovery in 1906.

Following the construction of Cougar Dam, additional recreation sites, and improved access to a wide range of recreation pursuits in the late 50s and early 60s the South Fork began to experience a significant increase in hunting, fishing, camping, and hiking use. In addition to developed campground use, dispersed camping grew steadily where water access was available, particularly in the vicinity of the Westend Bridge area and in the upper South Fork. Terwilliger Hot Springs also increased in popularity as a destination for many visitors to the South Fork watershed. Perhaps the most controversial issue of recreational use during this period involved the French Pete area. This area was a part of the Three Sisters Primitive Area, however, when the Primitive Area was designated Wilderness the area known as French Pete was excluded. This caused a great controversy that raged on until 47,000 acres of the area was finally added to the Three Sisters Wilderness in 1977.

Recreation Current Condition

Present day visitors to the South Fork Watershed are able to participate in a wide variety of recreational activities. To provide recreationists with camping and hiking opportunities, campgrounds and trail facilities have been constructed and the nature, purpose and location of these facilities influence to a large extent the type of activities users pursue. Campgrounds typically provide for concentrated, water associated, day and overnight use, while trails provide access and dispersion of users throughout the watershed for dispersed recreation and wilderness related experiences. Recreation activities typical of the South Fork include, developed and dispersed camping, backpacking, hiking, hunting, fishing, boating and water-skiing, nature study and wildlife viewing, driving and sightseeing, cycling, horseback riding, swimming and gathering forest products.

Developed Recreation Assessment:

In addition to campgrounds, the watershed includes developed sites for boating, swimming, trail access, picnicking, and visitor information and interpretive facilities. Appendix Table SR3 provides a summary of developed recreation use opportunities within the watershed. Nearly all of these sites occur within riparian reserves of the South Fork. Current use of developed recreation sites in the South Fork watershed is estimated at 57,580 recreation visitor days(RVDs) or 66% of available practical use capacity. The area in the riparian reserves dedicated to developed recreation facilities and use is 67 acres.

The condition of developed recreation facilities is assessed annually and documented in the districts' Recreation Resource Information System (RRIS). This assessment documents the specific conditions of all the facilities within a developed site area and identifies and schedules needed maintenance or replacement. The facility condition assessment of individual sites in the South Fork can be obtained from the RRIS files of the Blue River Ranger District.

Developed Recreation Future Conditions

Although future developed recreation use is likely to be affected by changes in a variety of factors, including socioeconomic indicators, the availability of opportunities, technology, and weather conditions, an existing demand for developed recreation opportunities is present that will increase with a growing population that has an expanding awareness and appreciation of recreation values. The historic rate of annual growth for camping activities on the Forest is 3.4%. The Oregon State Comprehensive Outdoor Recreation Plan (SCORP) projects a 3.7% average annual increase in the demand for camping activities for the period 1991-2010. While current capacity is sufficient to accommodate projected amounts of increased use, it may be inadequate to accommodate projected demand during peak periods of seasonal or weekend use.

Dispersed Recreation Assessment

The type of available dispersed recreation experience opportunities, and their respective levels of use in the South Fork are illustrated in Table 7. Dispersed camping use, within some of the areas discussed above, but, primarily along the reservoir and the South Fork of the McKenzie River, occurs where access is relatively easy to level areas near water. In some cases lengthy access "roads" have been developed by the users to reach desirable sites along the river or reservoir. In other cases the access was created to salvage wood and users later took the opportunity to use those roads for dispersed camping. In addition some access points to the river have been developed by users to launch boats in the river below the dam.

Use of dispersed sites is primarily during the summer months with peak periods around the time of the Oregon Country Fair and summer rock concerts held in Eugene.
While this dispersed camping use is concentrated in existing sites within the riparian areas during summer, it is broadly dispersed throughout the upland areas during the fall hunting season.

Dispersed Recreation Opportunities of the South Fork Watershed

Recreation Category	Acres	RVDs	Trail Miles
Wilderness	69,551	3,206	77.5
Dispersed Areas			
Semiprimitive Non-Motor	4,507	6,310	7.3
Roaded Natural	20,150	55,614	22.4
Roaded Modified	40,223	15,285	21.9
Private Land	3,065	-	-
Totals		80,415	129.1

Table 7

An inventory of dispersed sites was completed for the South Fork using the WRS-ROS Evaluation Methodology for dispersed and wilderness campsites. The inventory and sample of dispersed camping revealed 325 site locations scattered throughout the South Fork watershed. Heavy concentrations of dispersed sites were noted at the South end of the reservoir. A significant number of sites were recorded on both sides of the reservoir and river up and down stream from the bridge crossing. High concentrations of sites were also noted along the reservoir north of Slide Creek Campground, at Hidden Lake, and in the upper South Fork drainage near Hardy Creek, and Blue Creek.

Based on observed conditions and a 16.9% (55 sites) sample of inventoried sites it is apparent that the number of user developed sites is increasing and that the distribution of sites within areas of high concentration fluctuates from year to year. Nearly all sites inventoried occur within the riparian zone. As indicated in Appendix Table SR4 dispersed sites average 2,100 sq. ft. in size with an average barren core of 1,400 sq. ft. Dispersed campsites in the South Fork occupy 15.8 acres of which 10.3 acres is considered barren core. The total disturbed area of the riparian reserve attributable to dispersed camp sites is 1%.

The inventory sample of dispersed campsite conditions, as illustrated in Appendix Table SR5, suggest that scenic quality and user experiences at many sites is being affected by use patterns and behaviors that shape the size and condition of sites. The sample shows that: 89% of sites experienced vegetation loss in excess of the norm; 73% of sites experienced tree damage or loss in excess of the norm; and 95% and 65% of sites exceeded the norm for campsite size and barren core area respectively. In addition the proximity of sites to the river accounts for compaction, erosion and vegetation loss along the banks of the South Fork. However, the

disturbance or erosion due to human use of stream banks is not extensive, presumably due to the composition of the river bed and its banks.

Conditions of the most severely impacted sites observed include: compaction, erosion, vegetation loss, and tree damage. These conditions can be attributed in large measure to virtually unlimited vehicular access to the site area and in some cases to the river. Clearly the amount of use many sites receive from season to season, due to their popularity or proximity to specific areas of interest is a contributing factor in the conditions they exhibit. This is extremely obvious in the case of sites at the south end of the reservoir that attract a large number of visitors who frequent Terwilliger Hot Springs.

Terwilliger Hot Springs warrants special note in regard to its use and conditions. The hot springs is a day use site accessible by a highly compacted trail that is about 1/4 mile in length and in need of heavy maintenance. The springs are located within a stand of mature to old growth that has recently experienced some tree loss due to disease. The presence of any plants or animals that may be typical of the micro environment of the hot springs, but unusual in the South Fork drainage have not been documented. They would have been subject to continuous human disturbance since it's discovery in 1906. The site of the springs includes:

- a series of user constructed pools,
- a vacant and deteriorating caretakers cabin, and
- an old composting toilet.

The pools are surround by steep slopes, the lower extents of which are denuded of vegetation, and have severely compacted soils from the use of thousands of annual visitors. The site, including the parking facility on Road 19, has for many years been controversial because of user conflicts, harassment, nudity, sanitation, personal safety, and law enforcement issues.

Beyond site conditions the dispersed recreation setting in the South Fork watershed exhibits other characteristics that are a function of area users and their behaviors. It is typical throughout the watershed that poor sanitation is obvious next to dispersed sites. In addition, often the waste associated with the camping experience is either left behind in plastic bags, piled within the fire pit, or left strewn about the site. In some instances the materials left behind include household furniture, automotive parts, product containers, and camping equipment. In addition these items and more are discarded periodically in upland areas of the watershed.

This residue left by dispersed users is a concern in terms of public health and safety, particularly during periods of peak concentrated use. During this period the presence of human waste and other debris around dispersed camp areas may pose a threat to the health and safety to the users present. However, due to the relative short duration and seasonal nature of this use and the scale of the total watershed, these conditions do not have a measurable effect on downstream water quality.

The presence of human waste and debris, tree damage and loss, and denuded and compacted camp areas, all have an affect on the scenic quality of the area at the site or site complex scale. In addition the large number of sites where the condition norm was exceeded for vegetation loss, camp size, barren core area, tree damage and loss, suggests that both the scenic quality and the intended recreation experience opportunity have been diminished for a significant number of sites in the watershed.

The South Fork attracts a diverse range of users with a wide range of interests, attitudes and opinions regarding management and use of the area. While one segment of the South Fork users would like improvements to facilities, more control over the disruptive behaviors of others, separation of uses, improved sanitation and waste disposal, and improved barrier free access to opportunities, another segment of users would prefer that things stay as they are in respect to camping, and sanitation facilities, and object to the idea of paying for the use of the Forest, the presence of agency personnel, and often view past management actions as misguided or harmful to the South Fork watershed.

Dispersed Recreation Future Conditions

With projections of increased population growth for the Eugene-Springfield metropolitan area, increased recreational use of the South Fork watershed can be expected for a wide range of dispersed recreation activities. With an average annual 2.7% increase in all forms of recreation use on the Forest for the period 1980-1989, and with projections of increased use of 2.0-4.7% for all forms of dispersed recreation including, hunting (2.5%)and fishing (2.5%) by the Oregon State Comprehensive Outdoor Recreation Plan for Region 8 (the area of the Willamette Forest) an increased demand for dispersed camping, fishing, boating, hiking, sightseeing, information, hunting, and horseback riding is anticipated.

This potential demand may place additional pressure on the basic resources and facilities of the South Fork and amplify the need for intensive management of recreational use within the watershed. A response to future use may require new strategies for responding to situations where human use exceeds ROS standards for extended periods of the normal use season. Possibly a change to a management area with standards more closely aligned with the type of use taking place; hardening and development of the area to better accommodate the type and level of use; and/or the use of experimental approaches to address forms of recreational use somewhat divergent from the cultural norm.

Wilderness Assessment

A Limits of Acceptable Change (LAC) inventory and sample of 181 site locations scattered throughout the wilderness portion of the South Fork watershed was examined to assess site conditions and effects to user experiences. A majority (79%) of wilderness sites in the South Fork occur in the Mink Lake and McFarland Lake Basins. The remainder (21%) are located in the French Pete, Walker, and Rebel Creek drainages. Sites in the Mink Lake and McFarland Lake Basins are associated with the riparian areas of lakes, while sites in the French Pete, Walker, and Rebel Creek drainages are associated with trails and streamside riparian areas.

Based on the LAC site inventory a 100% sample indicates the condition norm was exceeded for all sample categories, including vegetation loss, tree damage or loss, camp size and barren core area. The sample shows in Appendix Table SR6 that: 98% of sites experienced vegetation loss in excess of the norm; 73% and 75% of sites respectively had tree damage or loss and camp sizes in excess of the norm; and 33% of sites exceeded the norm for barren core area.

Most sites included in the sample occur within the riparian zone of wilderness lakes and streams. As indicated in Appendix Table SR7 wilderness campsites in the South Fork watershed average 1,900 sq. ft. in size with an average barren core of 700 sq. ft. All wilderness campsites in the South Fork occupy 7.9 acres of land area of which 2.9 acres is considered barren core. The inventory sample of wilderness campsites suggests that scenic quality and user experiences within most Wilderness Resource Spectrum (WRS) settings have been affected by the conditions noted. While wilderness campsite conditions may diminish the intended user experience they represent little or no effect to downstream water quality. However, in high elevation environments, the conditions noted for many of the wilderness campsites may require significant time for recovery of denuded riparian vegetation and compacted soils.

Wilderness Future Conditions

The condition of wilderness resources and associated experiences are expected to improve in the future based on several developments including issuance of wilderness management plans and associated standards and guidelines. Efforts over the past few years to collect use data and monitor use patterns and conditions are directed toward realizing field conditions that are consistent with current management direction. Extensive monitoring through the use of a wilderness use permit system and field surveys are providing new information for making on-site management decisions. In addition a schedule for implementing wilderness management actions has been developed as a tool for moving wilderness site and use conditions closer to current wilderness management direction.

SOIL/WATER/FISH

An effort was made to integrate the upslope and stream channel conditions and processes relative to fish habitat. The display of conditions and processes will, for the most part, be conveyed using groups of subwatersheds (Figure 17). There are eleven groups total; nine are the groups of subwatersheds as shown in Figure 17, the tenth is the mainstem and the eleventh is lakes and ponds.

Prior to the specific subwatershed group discussions will be an overview of the geology, soils, streams, tributary processes and aquatic processes within the entire South Fork.

Following the discussion of the subwatershed groups will be a soils summary and water quality section that will address the entire watershed.

OVERVIEW

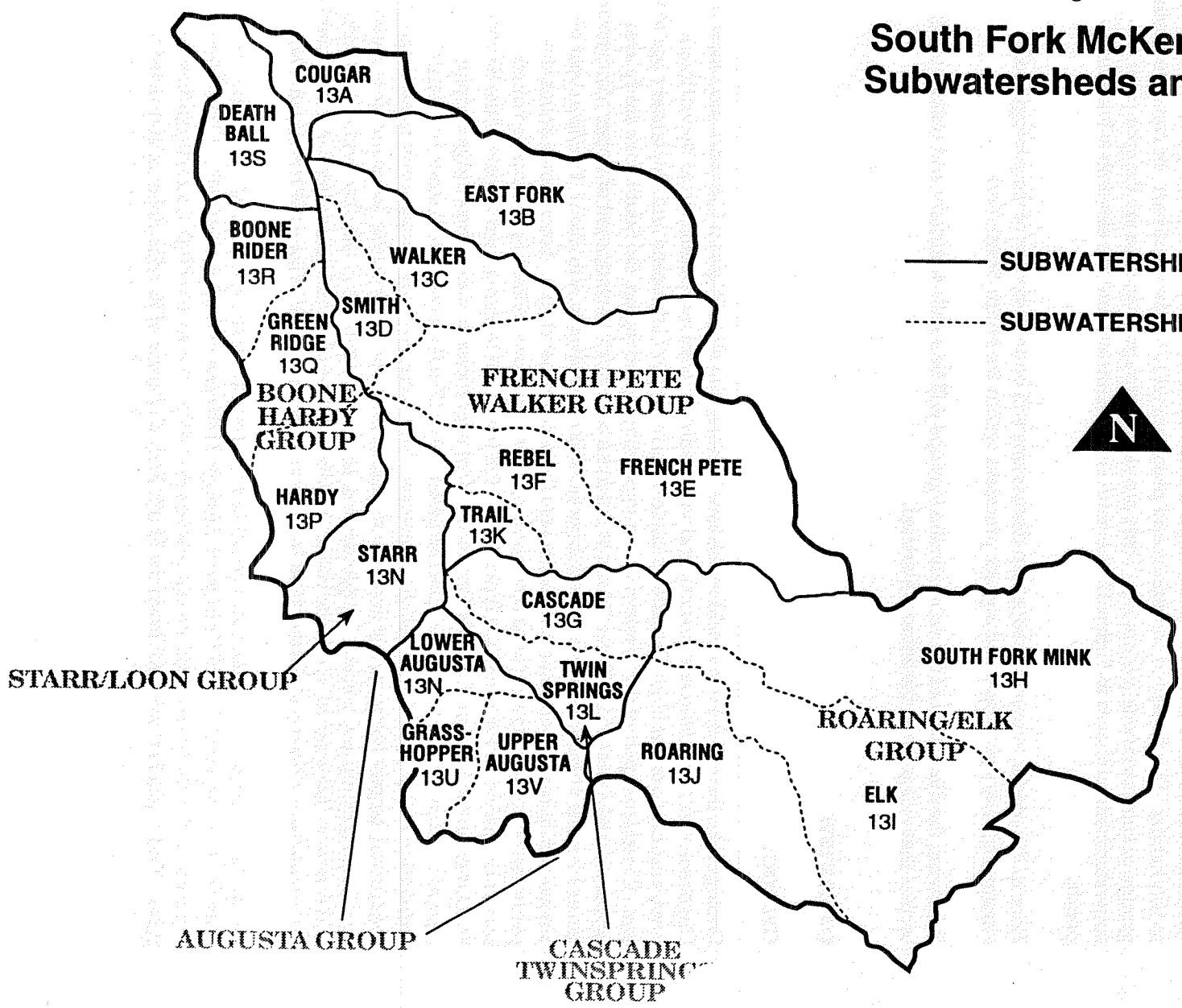
GEOLOGY

Geologically, the South Fork straddles the time between the older Western Cascades sequences of Oligocene and lower Miocene volcanic and volcaniclastic rocks more common to the north and west, and the younger High Cascade volcanic units of Upper Pleistocene and Quaternary age to the east. Considered part of the Western Cascade physiographic region, the South Fork study area (approximately west of the Three Sisters Wilderness boundary) is composed of upper Miocene and lower Pliocene volcanic and volcanicalstic rocks. More specifically, 4 to about 10 million year old olivine basalt, basaltic andesite and dacite lava flows cap most ridges. Some flows of this time period are lithologically similar to flow rocks of the oldest flows of the High Cascade volcanic sequence, and some are more like flows that in the past have been mapped as part of the Sardine Formation in the Western Cascade Province. What ever the case, under these ridge capping deposits rest the upper to middle Miocene (about 10 to 17 million years old) strata that form the foundation of the South Fork geologic sequences. They consist of a heterogeneous assemblage of continental, largely volcanogenic deposits of basaltic andesite and andesite flows and flow breccias, mudflows (lahars), and volcanic conglomerates, and lesser amounts of ash-flow and air-fall tuffs, and coarse to fine grained, epiclasitc volcanic sedimentary rocks, such as sandstones, conglomerates and mudstones (Priest and Others 1988; Walker and Duncan 1989; Wilson 1981; Sharrod 1991).

The surface expression of these rock formations has been extensively modified by erosion since late Miocene time, especially from Pleistocene through Holocene with glacial activity. Glacial forms are common in the study area, and ice cap glaciers probably covered the High Cascade platform many times. Valley glaciers traveled down the South Fork and some of its tributaries as they acted as outlets for excess ice accumulation. Common features from the most recent glaciation are the

Figure 17

South Fork McKenzie River Subwatersheds and Groups



numerous glacial lakes that can be found primarily in the upland areas associated with the Three Sisters Wilderness. As can be seen actively occurring today on the Three Sisters, in the past smaller glaciers carved cirques on the higher peaks at lower elevations. The basic cirque form is a bowl shaped depression, with a sheer to very steep rocky headwall. Examples can be found north of Grasshopper Point, in the headwaters of Augusta Creek as well as north west of Lowell Mountain in Loon and Starr Creeks.

SOIL

This complex geologic history has produced a myriad of diverse landforms and soils (Figure 18). A geomorphically mild to moderately complex terrain exists with a distinctive, but not necessarily diverse topographic expression. Landforms range from: highly glaciated upland benches and flats with extensive ground moraine such as the headwaters of Roaring River; to steep rocky canyons and crags of the East Fork; to the large scale stabilized slump/earthflow complexes and associated glacial deposits of Balm and Bouy Creeks; and to the flat stable river terraces and outwash plains of Cougar Creek and at the confluence of the South Fork with the main McKenzie system. A critical component of each subwatershed inquiry will be sorting out the specific landform history.

As was just discussed, cirque basins, hanging valleys, and assorted morainal deposits all reside on the landscape, but most have been extensively altered by stream erosion and slope instability. Locally, some of the bedrock materials tend to weather to form deep colluvial and residual soils that can give rise to unstable terrain with both rotational and translational failures common. However, the major landflows common to much of the northwestern portion of the study area resulted from failures in outwash material as stream downcutting along the main South Fork Channel removed toe areas. Stabilized slump/landflow features, such as sag ponds, bench and scarp topography, and disrupted drainage, are common in Penny Creek, Balm Creek and Bouy Creek while debris chute prone drainage are located in Rush and Basalt creeks. However, slope instability has not been a significant factor in slope development or stream channel morphology in most areas for several thousands to hundreds of thousands of years.

The principal effort in this analysis process was to assess individual subwatersheds in regards to their natural features and provide a description of the distribution, type and relative importance of the upland environmental processes and time frames in operation. This was a field based effort that looked specifically at the following:

- geomorphic setting,
- landtype distribution,
- soil suitability,
- slope stability, and
- site productivity.

The time frames for certain discussion will generally fall within the last 1000 years and more specifically within the range of the oldest vegetation at about 500 years.

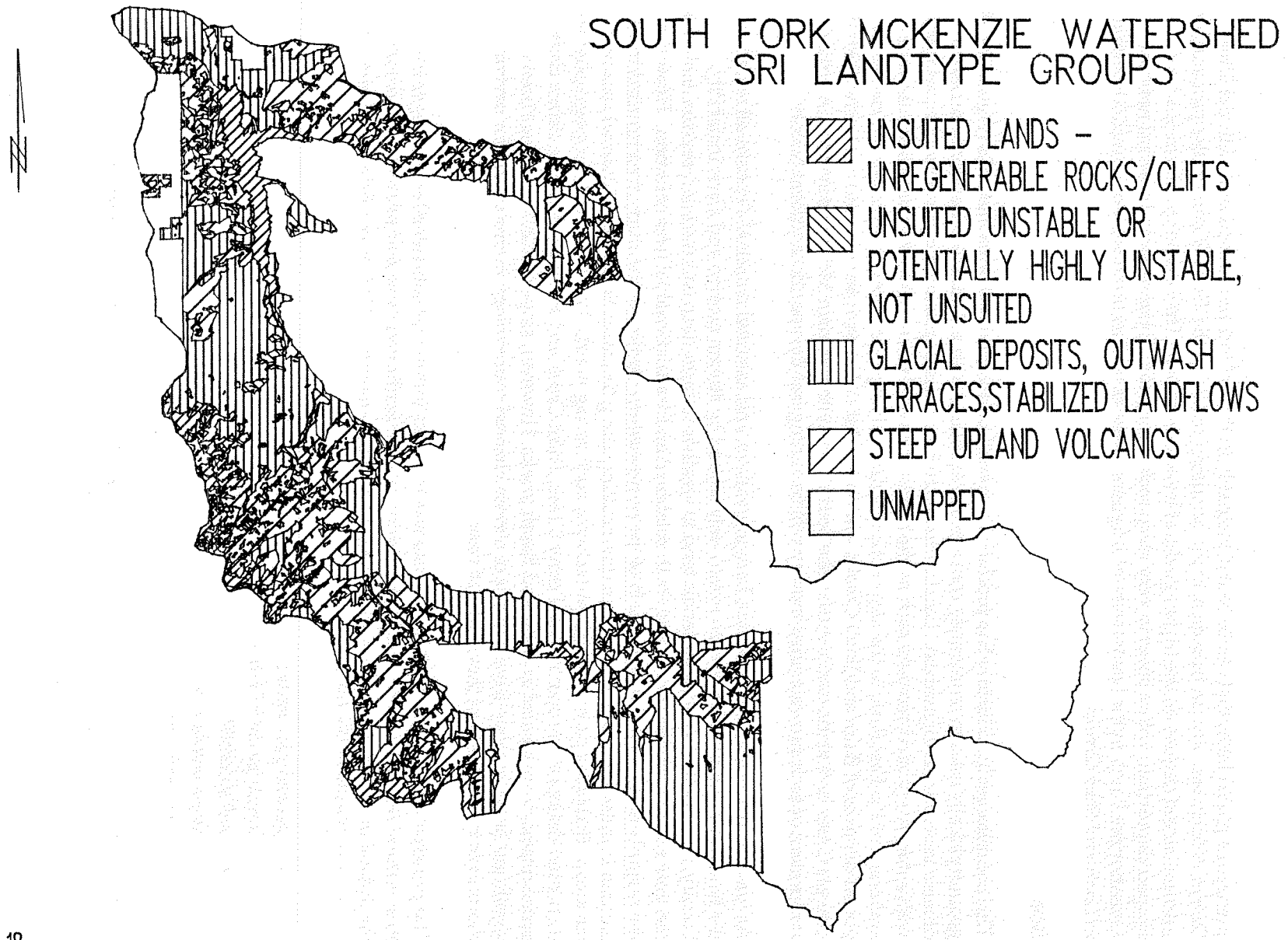

SOUTH FORK MCKENZIE WATERSHED
SRI LANDTYPE GROUPS
UNSUITED LANDS - UNREGENERABLE ROCKS/CLIFFS
UNSUITED UNSTABLE OR POTENTIALLY HIGHLY UNSTABLE, NOT UNSUITED
GLACIAL DEPOSITS, OUTWASH TERRACES,STABILIZED LANDFLOWS
STEEP UPLAND VOLCANICS
UNMAPPED
N

FIGURE 18

STREAMS

The mainstem of the South Fork McKenzie River is a 6th order stream that flows east from its headwaters in the High Cascades Province for approximately 16 miles where it joins with a major spring fed tributary, Roaring River (Figure 19). Three miles downstream from the Roaring River/South Fork confluence, the South Fork begins to turn toward the north flowing another nine miles prior to entering Cougar Reservoir. The reservoir is five miles long, with one major arm extending to the east which is the East Fork of the South Fork McKenzie. The South Fork McKenzie River continues to flow north following discharge from the dam for approximately five more miles prior to entering the mainstem McKenzie River. The total length of the South Fork is about 38 miles. There are hundreds of lakes within the watershed, most of which are located in the wilderness (696 acres of lakes within wilderness, 38 acres outside wilderness). The watershed contains 258 miles of Class I, II, and III streams, and 1,335 miles of Class IV streams, for a total of 1,593 miles of stream. Stream Classes are defined as follows:

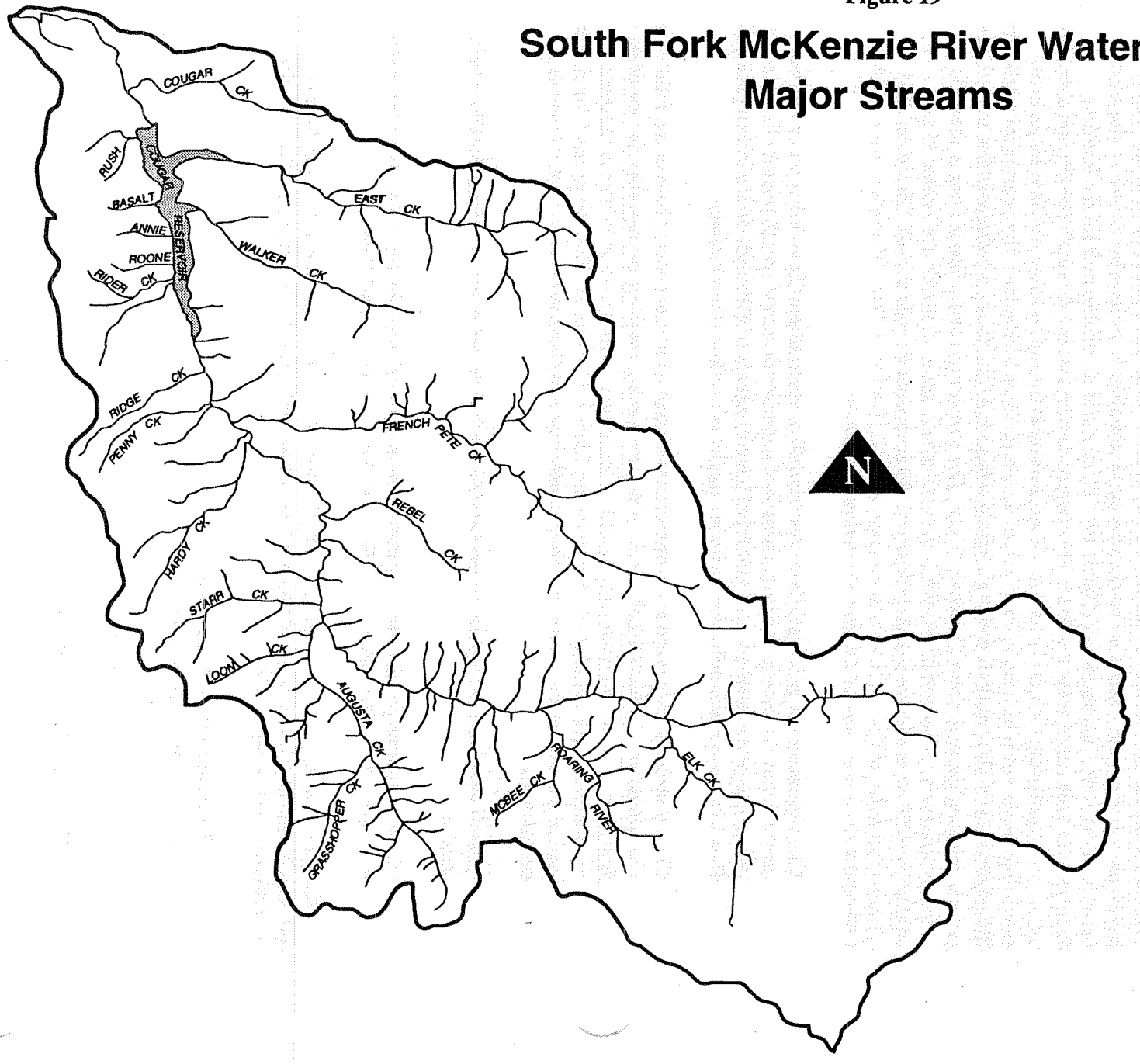
> Class I streams are perennial (flow year round) or intermittent (flow only part of the year) streams that: 1) serve as the direct source of water for domestic use; 2) provide habitats for either spawning, rearing, or migration of large numbers of fish; and/or 3) contain sufficient flow to have a major influence on water quality of another Class I stream.
>
> Class II streams are perennial or intermittent streams that meet one or both of the following characteristics: 1) provide habitats for either spawning, rearing, or migration for moderate though significant numbers of fish; and/or 2) contain sufficient flow to have a moderate influence on water quality of a downstream Class I or II stream. Fish are present for at least part of the year or the stream has the potential for establishment or re-establishment of fish populations.
>
> Class III streams are all other perennial streams that do not meet the criteria for Class I or II streams.
>
> Class IV streams are all other intermittent or ephemeral streams that do not meet the criteria for Class I, II, or III streams (WNF Riparian Management Guide, 1990).

A USGS gaging station located approximately 0.5 miles above the high pool of Cougar Reservoir and one located just downstream of Cougar Dam (data used prior to dam closure) have recorded the following major flood events:

- December 1945 - 25 year event;
- January 1953 - 8 year event;
- December 1955 - 16 year event;
- December 1964 - 130 year event;
- January 1971 - 15 year event; and
- February 1986 - 8 year event.

Figure 19

South Fork McKenzie River Watershed Major Streams



A storm occurring approximately one month after the 130 year event in December, 1964 hit the South Fork watershed with nearly the same ferocity as the 1964 flood itself. The event, which began on January 28, 1965 and continued through January 30th, recorded average daily flows comparable to the average daily flows of the 1964 flood (December, 1964 = 6930 cfs vs. January, 1965 = 6570). However, unlike the 1964 flood which had a heavy snowpack accompanied by intense, warm rain, the event the month following was mainly snowfall and not a rain -on -snow event. The average daily maximum flow, on which return intervals are calculated, was not available for the January flows. Thus, the return interval for the January flows was not calculated. The average daily maximum flow for the December, 1964 flood registered 14,000 cfs.

The McKenzie River Subbasin Surface Water Classification identifies the South Fork McKenzie River and its tributaries for domestic, commercial use for customarily domestic purposes not to exceed 0.01 cfs, livestock and public instream uses. The minimum perennial streamflow sufficient to support aquatic life and minimize pollution is to be maintained at 200 cfs of natural flow, plus up to an additional 230 cfs released from storage (Water Resources Dept., 1994). This additional 230 cfs may be released in average or better water years when there is uncontracted water stored in the reservoir (uncontracted water is that additional water available after uses stated above are satisfied). As requested by the Oregon Dept. of Fish and Wildlife, the additional release of uncontracted water is to be released during the summer with a constant flow of 400 cfs, and flow fluctuations are to be avoided during September and October to maintain constant flow for salmon spawning. After October, a constant flow of 300 cfs is to be maintained, also for constant flow for salmon spawning (Oregon Water Resources Dept., 1992).

SOUTH FORK TRIBUTARIES PROCESSES AND AQUATIC PROCESSES

Tributary streams to the South Fork McKenzie River are moderate to high gradient (>2%), first to fifth order, with a stepped-bed morphology. The stepped-bed morphology occurs in high gradient streams where a high concentration of bed particles creates steps composed of the largest boulders in the stream, alternating with small backwater and plunge pools (Grant and others, 1990). In the tributary streams of the South Fork McKenzie River, individual steps also form over large woody debris which is common in forest mountain streams (Swanson and others, 1976).

LARGE WOODY DEBRIS

The relative importance of instream large woody debris (LWD) within these stepped-bed channel types differs according to substrate size and streambank stability. Reaches that are dominated by large substrate and streambank particle sizes (large and small boulder, bedrock, and to a lesser extent, cobble) are generally less dependent on large quantities of large instream wood to maintain step-pools and cascades, which maintains gradient and stability. Roaring River is a good example of a high velocity, high gradient stream with a dominant substrate of cobble and small boulders, and streambanks composed of boulders and bedrock. Roaring River is dominated by cascade channel units and is very stable even though it lacks LWD. In contrast, stream reaches that are

composed mainly of gravels, cobbles and small boulders, and have streambank particles cobble sized or smaller, generally are areas of deposition with broader floodplains. Without LWD to provide steps and plunge pools, the channel is characterized by high width/depth ratios and long, featureless riffles. This is especially apparent in Rider Creek where some harvested streamside reaches are low in LWD and have a dominant substrate of gravels and cobbles.

Deposition of abundant gravels and cobbles behind large logs and log jams indicates the importance of large wood in retaining organic and inorganic matter, providing stability and biological productivity (Bilby 1984; Speaker et al. 1984). "Of all the ecological functions of riparian areas, the process of woody debris loading into channels, lakes and floodplains requires the longest time for recovery after harvest," (WNF Riparian Management Guide , 1990). As a result, recruitment of LWD into stream channels such as Rider and Hardy at this time and in the near future is low.

In many cases, a few logs trapped by boulders causes deposition of large quantities of sediment within the valley bottom. Aggradation behind the logs, usually a result of mass movement events such as debris flows, may occur in reaches that function as transport reaches as well as within depositional reaches. The accumulation of substrate material behind logs in the higher gradient, more confined reaches allows for the metering out of sediment over long time periods, and provides spawning habitat. It also may prevent extreme aggradation and channel widening within the depositional reaches, particularly near the channel mouths such as in Starr Creek and Augusta Creek.

AQUATIC PROCESSES

One of the methods for assessing management impacts to stream system health is to establish parameters which are indicative of streams which are in equilibrium with the hillslope processes around them. Assessing channel condition and predicting channel response requires identification of functionally similar portions of the channel network (Montgomery and Buffington 1993). The identification of Valley Segment Types is one part of the assessment (USFS 1993). It is assumed that in-channel parameters stated as measurable objectives over a range that occurs naturally in the landscape represent fish habitat conditions necessary to sustain viable populations.

The Willamette National Forest Land and Resource Management Plan (1990) began to establish quantitative parameters for functionally similar channels based on gradient. Further refinement of the qualitative pool objectives has been based on research by Dr. Gordon Grant of the Forest Service Lab of the Pacific Northwest Research Station (PNW). Much of that research has been conducted in the western Cascades, including in the South Fork, and is used here to refine the habitat objectives for both pool quantity and the source and distribution of LWD within these systems. Other parameters have been developed at the Forest or regional scale. For purposes of standardizing and comparing the objectives of pool spacing, Grant's numeric objectives are inverted to "pools/channel width", similar to the Forest Plan. A discussion of the variability observed in the South Fork compared to objectives in Table 8 occurs in Chapter 5.

Objectives for Aquatic Habitat Variables

Habitat Variable	Definition or Range	Objective	Source
Large Pools	0.5-2% gradient	one pool/5-7 channel widths	F-Plan, Grant
Large Pools	0.5-2% gradient	one pool/4-10 channel widths	Grant
Large Pools	2-8% gradient	one pool/3-5 channel widths	F-Plan
Large Pools	2-10% gradient	one pool/2-3 channel widths	Grant
Large Wood	Undefined	80 pieces over 24" dbh & 50' length	CRB Policy (PIG), PACFISH, PNW
Large Wood	Low gradient streams	105 pieces longer than stream width with pieces > 25"	F-Plan Appendix
Large Wood	High gradient streams	50% of channel length should be influenced.	F-Plan Appendix See p. E-8
Width:Depth Ratio	All streams	< 10	PACFISH
Width:Depth Ratio	1-4% gradient 4-10%	> 12 < 12	Refined from PACFISH for WNF
Temperature	Streams	Meet state standards	

Table 8

DESCRIPTION OF SUBWATERSHED GROUPS

The South Fork McKenzie tributaries vary in condition depending on management history, stream type, and landtype through which they flow. Discussions of tributary channel conditions that follows will be based on the stratification of the watershed for soil, water, and fish (Figure 17). Tributaries within a given subwatershed or subwatershed aggregate group are considered to be within a generally common landtype (see Soils discussion). Therefore, differences in channel conditions due to landtype will be emphasized between subwatershed or groups, whereas,

descriptions of channel conditions within a subwatershed or group will hold landtype constant and differences in management history and stream type will be emphasized. Discussions will begin with the Cougar Subwatershed, and continue in a counter-clockwise direction through the succeeding subwatersheds.

1) COUGAR SUBWATERSHED - PSUB 13A

Soils

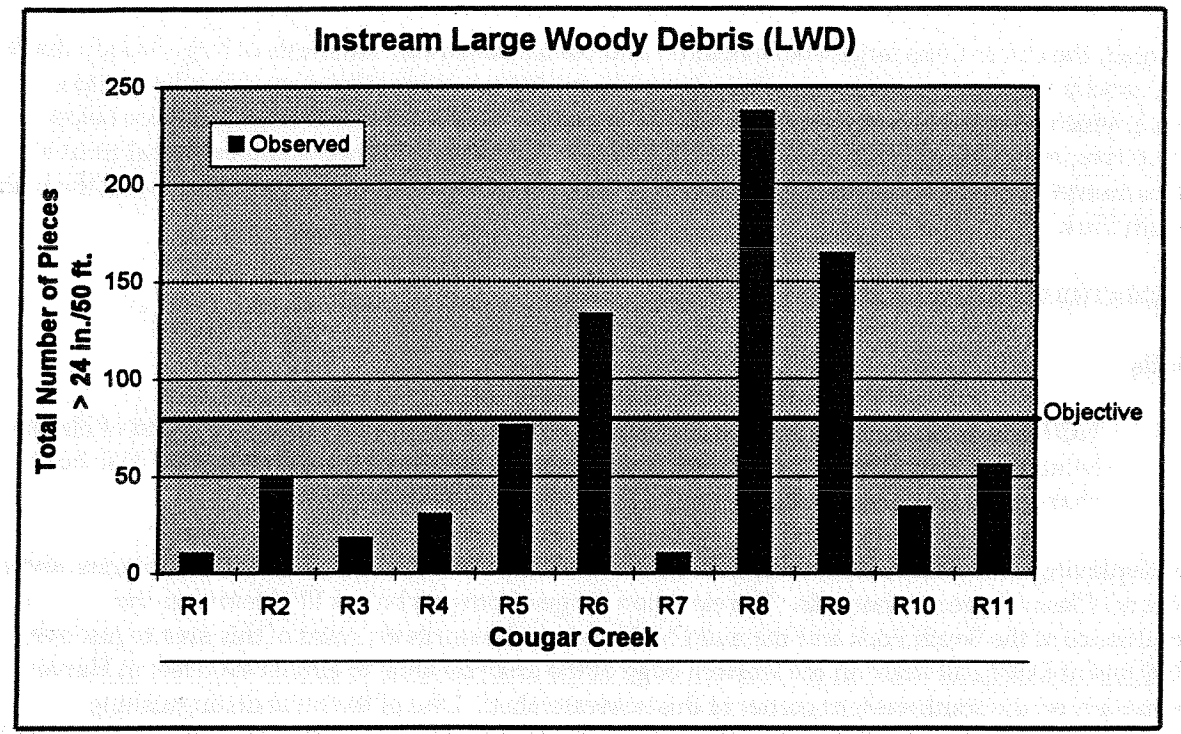
The distinguishing features of this drainage are the extensive stream terrace deposits that probably resulted from mid to early Pleistocene glaciation. The north fork of Cougar Creek developed as a side glacial channel that formed when the main stem McKenzie was filled with at least 1200 feet of ice and morrainal material. Various terrace deposits are located along the entire length of Cougar Creek. Near the main stem confluence for example, over 400 feet in elevation now occurs between the major terrace levels.

Stream downcutting of the volcanic formations that comprise the younger Western Cascade parent materials has been the principal active process in this area for several million years. Although displaying over a half mile of relief, the area is not extensively dissected. The elevation ranges from just below 1100 feet near the confluence of the South Fork with the main McKenzie at the northwest corner of this area to Castle Rock on the north with an elevation of 3308 feet and McLennen Mountain on the extreme eastern tip at over 4960 feet. The uplands above the terraces are relatively uniform sideslopes of 50% to over 100% with numerous rock outcrops in some areas. As would be expected, the soils on the steep sideslopes are colluvial/residual in nature and are described as non plastic, generally tan to light gray brown to yellow brown, gravelly sands to sandy silts. The soils on the glacio-fluvial terraces are distinct in that they commonly have numerous subrounded to rounded gravels and cobbles within a matrix of silty sands.

The principal sediment delivery system in operation is downslope movement of the soil mantel by creep or colluvial connections. This process appears to be accelerated during large scale fire events, and much of this basin had a major fire about 200 years ago (1800). Some localized areas of instability in the form of debris chutes have occurred in the draws, likely after the fire events. Small debris chutes have occurred in the steeper uplands along both the north fork of Cougar Creek as well as the main Cougar channel. In the case of the north fork, many do not reach the stream as they are deposited as fans on the terrace material.

Stream Channel Condition and Fish

The substrate type and quantity of in-stream LWD is a major contributor to the relatively good condition of Cougar Creek, even though the Cougar subwatershed has been extensively managed. Approximately 36% of the streamside vegetation has been harvested along Cougar Creek. Of the reaches with <10% gradient (Appendix FW 6), the two which have the least amount of LWD also have the lowest frequency of large pool habitat (Figure 20). This includes one reach (R7) which has no large pool habitat due to aggradation of gravel among the boulders.



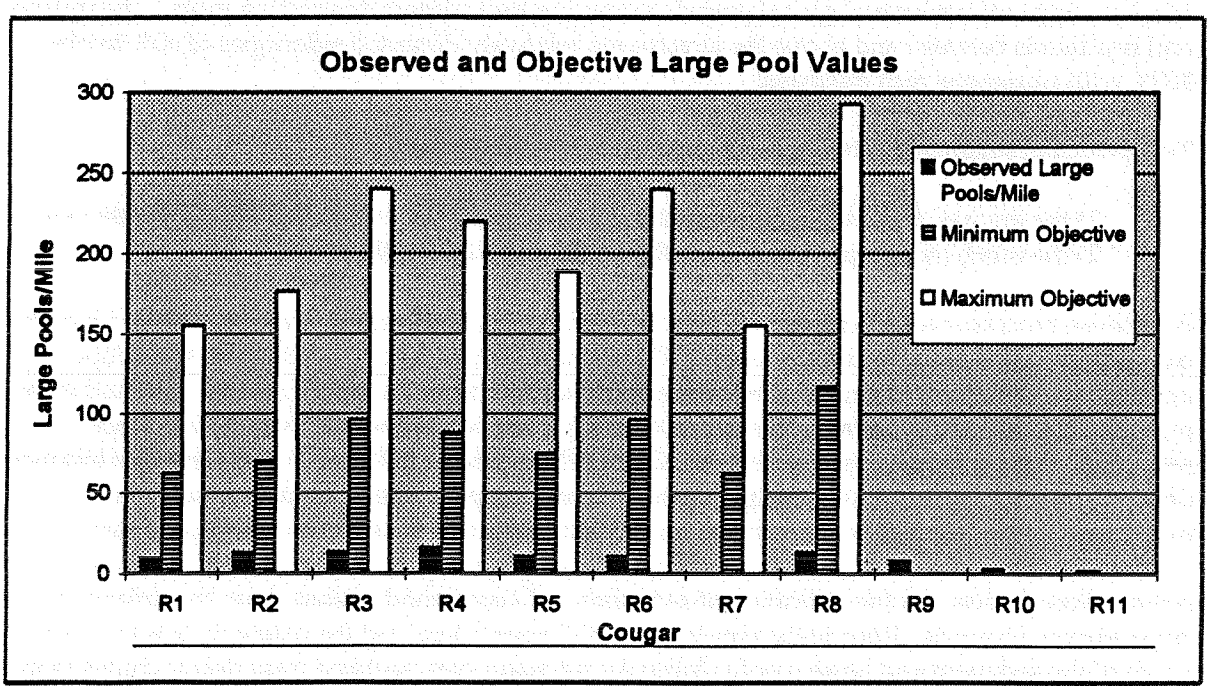


Figure 20. Cougar subwatershed LWD and pool values.

Overall, the channel has large, stable boulder and cobble substrate. Amounts of large woody debris are good to excellent, resulting in relatively stable conditions, except those reaches adjacent to a road, which have the lowest amount of LWD (Appendix FW 2). Levels of large pools are below objectives, even when pocket pool habitat in riffles is considered. Rainbow and cutthroat trout are documented, with fish observed up to Reach 9, which is 2.5 miles from the confluence with the main South Fork.

2) DEATHBALL SUBWATERSHED - PSUB 13S

Soils

> NOTE: The following discussion includes the small drainage of Basalt Creek east of Harvey Mountain. Basalt Creek is currently the northern most stream in Subwatershed 13R, but its characteristics are much similar to the discussion of 13S that is to follow.

In displaying over a half mile of relief, the area is well dissected by Rush Creek, its tributaries, and a host of Class IV stream channels. The elevation ranges from just below 1100 feet near the confluence of the South Fork and the main McKenzie at the northern point of this area to just over 4000 feet at Deathball Rock on the western edge of the analysis area, to almost 4900 feet at Harvey Mountain on the southwestern corner of this subwatershed. One of the most distinguishing features of this drainage is the series of four distinctive fluvio-glacial terraces, that probably resulted from several Pleistocene glacial periods. Located roughly at elevations of 3600 feet, 2800 feet, 1800 feet and 1200 feet – approximately on a line running west to east from Deathball Rock, these benches may indicate several glacial periods extending back almost one million years. The uplands and headlands between and above the terraces are relatively dissected sideslopes of 60% to over 100% with numerous rock outcrops.

Two principal sediment delivery mechanisms are now in operation:

1) the gradual downslope movement of the soil mantel by creep or colluvial process, and
2) the much more rapid translation slope failures or debris chutes.

Both these processes would appear to be accelerated during large scale fire events and much of this basin had major fire events from around 100 to about 200 years ago. Localized areas of slope instability in the form of debris chutes are generally concentrated in specific highly dissected areas of steep sideslopes and shallow, often unstable, soils, or associated with fluvioglacial terrace remnants. These failures appear to be related to the large scale fire/flood events. In other instances, debris chute type failures have resulted from road sidecast problems. In either case, these translational failures result in a complete removal of sediment and debris in the upper channel reaches, and its relocation to small terrace deposits much lower on the slope. Such failures are the principal mechanism for the relocation of sediment and large woody debris from the uplands to the larger stream channels. Prior to the construction of Cougar Dam and the reservoir, it is likely that much of the sediment and large woody debris for the main stem resulted from debris chutes in this area. The likely scenario for sediment movement is one typical of the West Cascades where gradual

creep and colluvial activity fill draws with sediment and debris during periods between fires and/or floods. Large scale stand replacement fires or 100 year flood events (or both) cause debris chute failures to deliver material to the valley floors. This event starts the cycle over again and many years may be required to refill the steep valleys before the next failure.

Stream Channel Condition and Fish

Deathball contains two major tributaries, Rush Creek and Basalt Creek. These streams are exceedingly prone to shallow, rapid failures such as debris flows and debris torrents in both unmanaged settings and due to roads and harvest units. They lack LWD as a result of frequent debris torrents, but also due to a fire approximately 130 years ago that burned about 50% of the upper slopes, killing many of the older trees within the Basalt and Rush Creek subwatersheds. Consequently, there are few large trees incorporated into the stream channels of Rush and Basalt Creeks. Naturally occurring slope failures in Basalt Creek, and natural and management caused failures in Rush Creek have resulted in stream scouring down to bedrock in some cases. The size and number of pieces of wood within these channels are too small to reduce the velocity of the debris flows and to provide enough area for deposition of sediment.

These streams have not been surveyed for fish habitat and populations since 1975. No fish were noted for either of these tributaries, presumably due to small flows (low summer flow was 3 cfs in Basalt Creek and 1.5 cfs in Rush Creek) and habitat dominated by steep gradient (15-20%) cascades, with many falls (Armantrout and Shula 1975).

3) BOONE/HARDY SUBWATERSHEDS - 13R, 13P, AND 13Q

Soils

> NOTE: The following discussion excludes the small drainage of Basalt Creek east of Harvey Mountain. Basalt Creek is currently the northern most stream in Subwatershed 13R, but since its characteristics are much similar to the discussion of 13S, it is include there. Subwatersheds Green/Ridge is 13Q.

Similarity of geomorphic features and geologic history is the principal reason these areas are discussed as a unit. The most distinguishing features include steep rocky headlands in the upper reaches with looming rock scarps and bluffs that give way down valley to extensive slump/earthflow complexes, comprised almost entirely of glacial outwash probably from the early to mid- Pleistocene glacial periods. Most of the large landflows toed out along and within the South Fork channel; these toe zones are now over 400 feet in elevation above the river level as the main stem has downcut through the volcanic rocks to a new base level in the time period of several hundreds of thousands of years. For Boone Rider, the elevation ranges from 1357 feet at the full pool elevation of Cougar Reservoir to almost 4900 feet at Harvey Mountain on the northwestern corner of this subwatershed. For Green Ridge, the elevation ranges from 1357 feet at the full pool elevation of Cougar Reservoir to over 5360 feet on Indian Ridge at the southwestern corner of this subwatershed. For Hardy, the elevation ranges from about 1700 feet at French Pete Campground on the main stem of the South Fork to 5405 feet at the Indian Ridge Lookout, located approximately midway along Indian Ridge at the southwestern boundary of this subwatershed.

Slump earth flows of glacially derived material (fluvioglacial deposits) have been the dominant process in these areas. The slumps probably resulted from stream downcutting of the volcanic formations that comprise the younger Western Cascade parent materials and base level lowering. The process was accelerated with several Pleistocene glaciations as they initially were responsible for the fluvioglacial deposition, and later glaciations accelerated stream downcutting and slope instability. Late Pleistocene glacial ice may have actually occupied the headlands of Hardy Creek on Indian Ridge. Several ice generated rock benches from relatively recent glaciations are present. Whether these formed during the last glaciation or were simply reoccupied is not known. Lulu Lake, for example, appears to be a classic, cirque controlled glacial lake or tarn. Hidden Lake on the other hand clearly resulted from slump activity, probably after Pleistocene glaciation ended.

The principal sediment delivery mechanisms now in operation are the gradual downslope movement of the soil mantel by creep or colluvial process, and the much more rapid rotational and translation slope failures. Areas of active larger scale instability are not common, but do still occur. In a tributary of Penny Creek (13Q), an approximately 50 acre, moderately active, earthflow/debris chute complex is located. To the north in Boone Creek (13R), another moderately active, earthflow/debris chute complex of about the same size can be found. Slope movement in both areas appears to be episodic in nature, and related to, or accelerated by, large scale fire events that occurred in this basin from around 100 to 200 years ago.

Debris chute failures often occur at slope breaks where the more gently sloping upland landflows are perched to drop quickly to the main valley bottoms. This condition resulted from aggressive stream downcutting of the underlying volcanic materials. These types of failures probably continued almost unabated for several thousand years until some equilibrium was established. Such failures were once the principal mechanism for the relocation of sediment and large woody debris from the uplands to the larger stream channels. However, since most of the extensive landflows stabilized many thousands of years ago, this form of slope failure has not been as prevalent as was once likely in these subwatersheds. Creep and colluvial process probably now compete about equally with slope failure systems as the principal sediment delivery mechanism.

Stream Channel Condition and Fish

Major tributaries within the Boone/Hardy group include Annie, Boone, Rider, Ridge, Penny, Horn, Balm, and Hardy Creeks. All of the subwatersheds in this group are located within an old earthflow complex which is generally very stable ground, much of which has been intensively managed.

The exception to stability is the Hardy Creek subwatershed which has unstable glacial deposits high on its southern slope. Hardy Creek has also had 58% of its streamside vegetation harvested and is in poor condition due to the combination of harvest impacts and natural instability. Flood flows within Hardy Creek have caused channel widening, bank failures, downcutting to bedrock, and in some locations, aggradation of the channel bottom with coarse, cobbly material. In some areas, the current channel has downcut through the deposits, forming tall cobble terraces as much as 20 feet above the summer low flow level.

Much of the channel has widened and aggraded as a result of the 1964 flood causing numerous, large bank failures and massive streamside slides due to destabilization of the old earthflow. Since

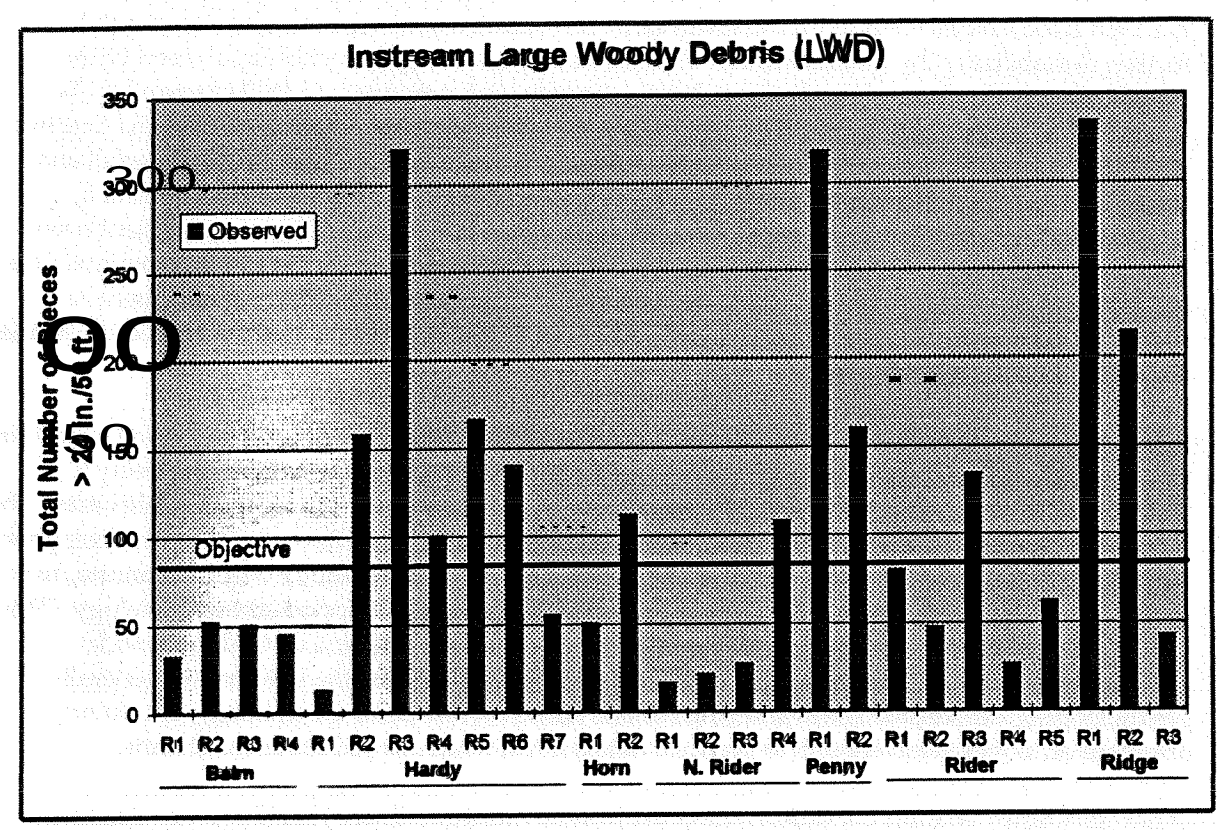
the 1964 flood, debris torrents off the south slope have contributed additional sediment while further destabilizing the channel banks. This has contributed angular rubble and wood to the stream. Several reaches of Hardy Creek have relatively high amounts of LWD (Appendix FW, Table FW2, Figure 21), however the distribution of wood is relatively poor except for the first two miles upstream from the mouth. Much of the wood is located directly below a 40' waterfall and is doing little to a) provide energy dissipation through steps, b) provide sediment storage, or c) provide channel stability. In addition, the high number and frequency of mass movement events translated into a huge volume of sediment that requires massive amounts of LWD to maintain the stepped-bed morphology and complex channel units. Currently, the addition of sediment has caused channel widening, aggradation, and loss of pool habitat, which is directly related to channel instability and poor fish habitat.

Some streams such as Penny Creek, Ridge Creek, and Rider Creek, are in relatively good condition even though intensive management has occurred within their drainages. Although Penny Creek and Ridge Creek have had 38% and 28%, respectively, of their streamside vegetation harvested, the quantity of instream wood and the stable landtype within which they flow contribute to their good condition. In the streams which lack large boulders and have a dominantly cobble substrate, such as Penny and Rider, the large wood serves as the steps to form the stepped-bed morphology. This results in a dissipation of stream energy and maintains channel gradient, as well as provides sediment storage areas, backwater areas, and channel stability. Since the landform is generally gently sloping, streamside slides and small debris slides occur within the drainage, but do not originate on slopes steep enough to produce debris flows which would scour the channel.

Other tributaries' channel condition within the heavily managed Boone/Hardy group depends on the substrate type and quantity of instream large woody debris. Rider Creek has the majority of its stream channel in good condition although 65% of the streamside vegetation has been harvested. The channel has large stable boulder and cobble substrate, as well as good to excellent amounts of large woody debris, resulting in a relatively stable condition. Management related mass wasting was observed during surveys of Penny Creek and Horn Creek, while high silt loads were specifically noted for upper Balm Creek (Reach 4, gradient 25%) and behind debris jams in Ridge Creek.

Although Annie Creek lies within a relatively more stable landtype than Basalt Creek, it is similar to Basalt with evidence of fire that burned approximately 130 years ago, leaving the stream with small amounts and sizes of LWD. Consequently, much of the channel is scoured down to bedrock as there are not enough pieces of LWD to capture and hold sediment within the channel.

Of the surveyed streams in this group, only in Hardy Creek have fish been observed beyond the first reach. The limitation in distribution is due primarily to natural low flow, falls, or steep gradients which are generally greater than 10% (Appendix FW6). Cutthroat trout have been documented in the lower portions of these streams and redside shiner (*Richardsonius balteatus*) were observed in Ridge Creek near the confluence with Cougar Reservoir. The streams in this group are too warm for bull trout, except for possible seasonal use during migration at the lowest portions of the tributaries between the upper South Fork and Cougar Reservoir. Use by rainbow trout, sculpins, and other species is undocumented.



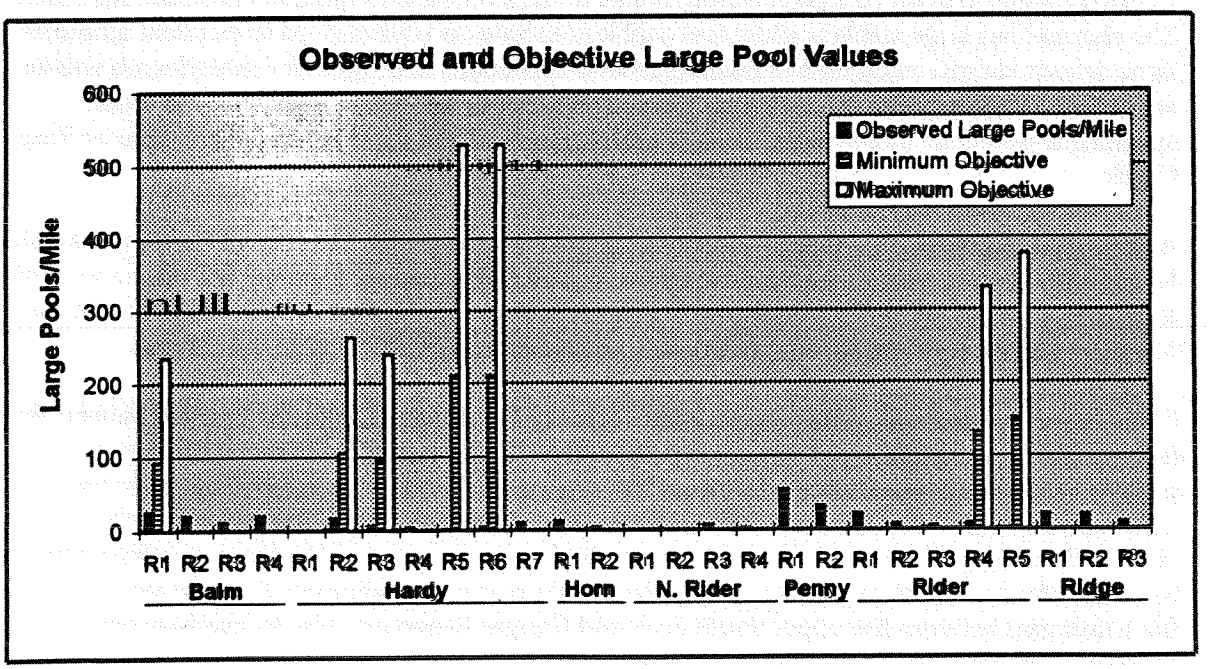


Figure 21 Boone/Hardy subwatershed group LWD and pool values.

4) STARR/LOON SUBWATERSHEDS - 13N AND 13M

Soils

Note: This discussion excludes the portion of 13M which is not tributary to Loon Creek or the drainage immediately to the south of Loon Creek. It will be discussed in the next section as part of Augusta Creek and its tributary system.

In consistently displaying over a half mile of relief (almost 3000 feet in several areas), this subwatershed is extensively dissected by Starr and Loon Creeks, and their host of tributaries. The elevation ranges from around 1800 feet at the northern tip of Starr Subwatershed in the South Fork channel to 5112 feet on Hardy Ridge at the northwestern edge of the project area, to almost 5400 feet on Hiyu Ridge at the southwestern corner of the Loon Creek area. The most distinguishing feature of this drainage (other than the impressive relief) are the series of distinctive U-shaped glaciated valleys that occupy the headwaters of these drainages. Probably resulting from several Pleistocene glacial periods, these northeast trending, glacial troughs likely had small valley glaciers extending part way down canyon in the last glaciation. As was common with other subswatersheds in the South Fork, older glacial periods produced extensive outwash terraces and other fluvio-glacial deposits at the lower elevations along the main South Fork channel. Of some interest, the large scale slump / earthflows that displaced the fluvio-glacial deposits to the north, although still present, are not as extensive in this area. The likely explanation is that the considerable downcutting from base level lowering of the South Fork has not been as developed here as it is in the more northerly reaches. Two principal sediment delivery mechanisms are now in operation:

1) the gradual downslope movement of the soil mantel by creep or colluvial process, and
2) t he much more rapid translation slope failures or debris chutes.

Both these processes would appear to be accelerated during large scale fire events and much of this basin had major fire events from 100 to 200 years ago. Localized areas of slope instability in the form of debris chutes are common throughout the subwatershed, and they are associated with both the highly dissected, shallow, volcanic soils on the steep sideslopes, as well as the deeper soils associated with fluvioglacial terrace remnants or other glacially derived soils that often drape the lower slopes above the terraces. These failures are of natural origin and appear to be related to the large scale fire/flood events. In a few instances, debris chute type failures have resulted from road sidecast problems. In either case, these translational failures result in a complete removal of sediment and debris in the upper channel reaches, and its relocation to small terrace deposits much lower on the slope. Such failures are the principal mechanism for the relocation of sediment and large woody debris from the uplands to the larger stream channels. Direct sediment and LWD input to the main South Fork channel resulted from such slope failures along the north and northeastern edge of Subwatershed Starr.

Stream Channel Condition and Fish

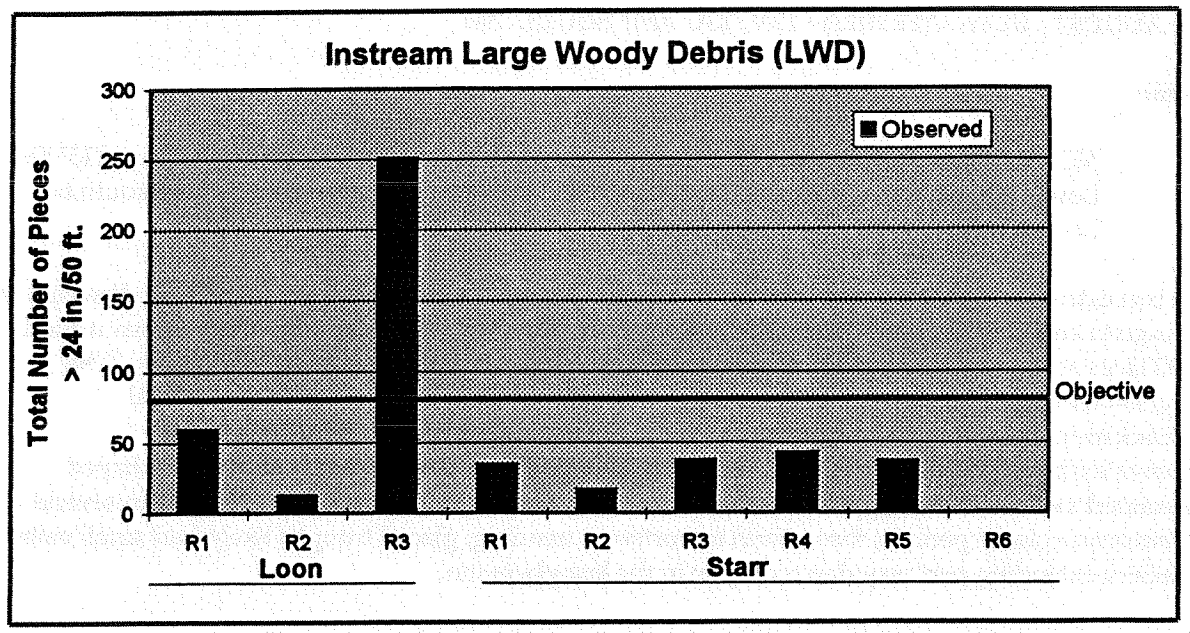
The landtype of the Starr/Loon group is characterized by naturally occurring and frequent debris torrents and debris flows. Much of the wood incorporated within the channels originated high on the hill slopes, transported to the channel as part of the landslides. Starr Creek contains less LWD,

especially in the two smallest size categories (Appendix FW2), than Loon Creek due to fire within its subwatershed approximately 100-150 years ago. Levels of LWD > 24" diameter and 50 feet length are below objectives for both Starr and Loon Creeks, with the exception of Reach 3 in Starr Creek which is bedrock constrained and Reach 3 of Loon Creek which has over 200 pieces of LWD/mile (Figure 22).

Starr Creek lacks a distinctive stepped-bed morphology from its mouth upstream for approximately 1.25 miles due to the lack of large woody debris, and the aggradation and widening of the channel with cobble and small boulders. The aggradation is due to non-management induced debris flows, with a lesser role due to management in the 1950's to 70's which included poorly laid culverts and deposition of fines from side cast road deposits.

Upstream from the aggraded riffle dominated reaches of Starr Creek a change to large boulders and bedrock substrate within a more confined valley results in distinctive steps. These steps were formed where the bedrock and large boulders traps the small boulders, cobbles, and large wood.

Starr and Loon are the primary fish bearing streams in this group. Cutthroat trout were observed in the lower 1.8 miles of Starr Creek. Sculpins are also documented in Starr Creek. Fifteen and twenty foot falls at 1.8 miles, with an upstream gradient of 17%, may limit the fish distribution in Starr Creek, with no fish observed above that point. Although fish were observed in Reach 1 of Loon Creek, several significant falls and sections of steep gradient (Appendix FW, Table FW3), limit migration and fish presence. No fish have been noted in the Reach 2 and 3, however no intensive biological survey has been conducted.



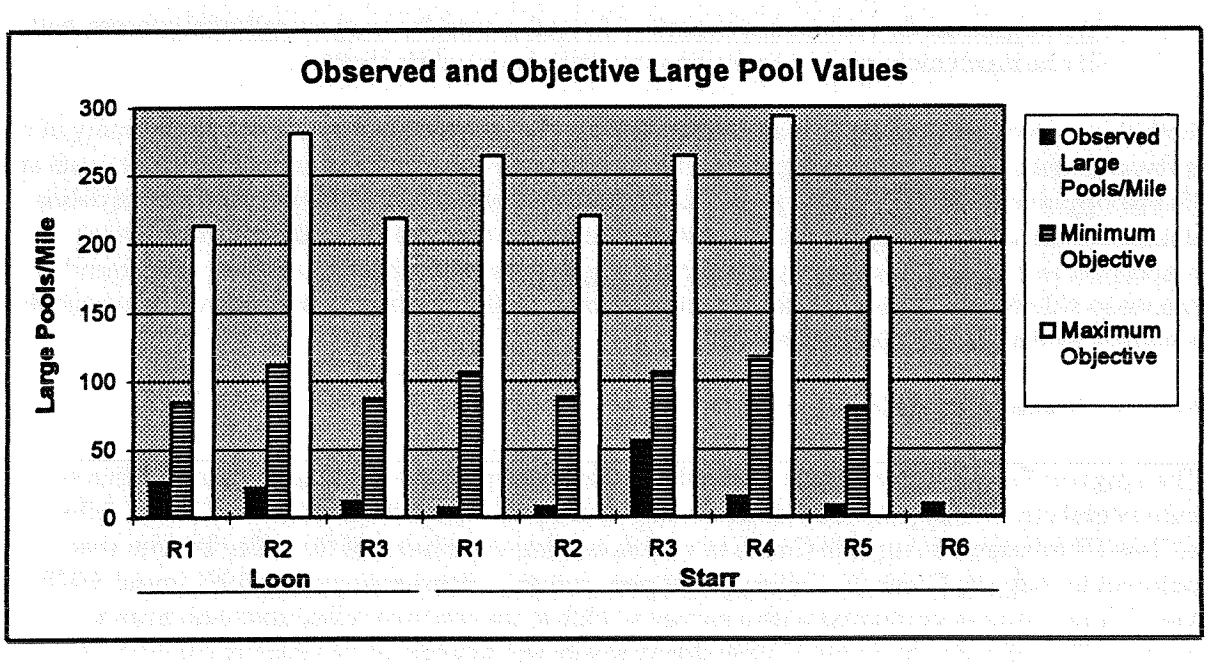


Figure 22. Loon/Starr subwatershed group LWD and pool values.

5) AUGUSTA SUBWATERSHED - 13V, 13U AND SOUTH 13M

Soils

> NOTE: Upper Augusta and Grasshopper, respectively, and the southern portion of 13M is Lower Augusta that excludes Loon Creek and the drainage immediately to the south of Loon Creek.

In consistently displaying over a half mile of relief, these subwatersheds are extensively dissected by Augusta and Grasshooper Creeks and their host of tributaries. The elevation ranges from around 2300 feet at the northern tip of that portion of Lower Augusta included in this discussion. The highest elevations are located at Grasshopper Mountain (5642 feet) on the southwest and Chucksney Mountain (5740 feet) on the east. The most distinguishing features of these subwatersheds (PSUBs), other than the impressive relief, are the series of distinctive U-shaped glaciated valleys that occupy the headwaters of these drainages. Probably resulting from several Pleistocene glacial periods, these north to northeast trending, glacial troughs likely had small valley glaciers extending part way down canyon in the last glaciation.

Two principal sediment delivery mechanisms are now in operation:

1) the gradual downslope movement of the soil mantel by creep or colluvial process, and
2) t he much more rapid translation slope failures or debris chutes.

Both these processes appear to be accelerated during large scale fire events. But, unlike many of the subwatersheds to the north, no significant fire events have occurred in much of Upper Augusta and Grasshopper for several hundred years. Localized areas of slope instability in the form of debris chutes are common throughout these subwatersheds, and they are often (though not always) associated with Class IV stream channels in the highly dissected, shallow, volcanic soils found on the steep sideslopes. Some failures are of natural origin, but the majority are related to management activities associated with timber harvest.

Stream Channel Condition and Fish

The Augusta Group lies within an inherently stable landtype, however, management within the subwatersheds of this group has induced many landslides. The 1964 flood caused a road failure of a Class III tributary to Augusta Creek, as well as causing a wash-out of the valley bottom road adjacent to Augusta Creek (R. Kellison, 1994 pers. comm.). Stream surveys in 1991 found 50-55% loss of large pools as compared with a survey in 1938 in the first two miles upstream from the mouth. The reduction on pools is likely due to severe aggredation of the channel combined with the loss of LWD by direct removal from the channel and by recruitment loss through complete riparian vegetation harvest. Amounts of LWD increase greatly upstream of the lower two miles (Appendix FW2, Figure 23). Rainbow trout densities estimated from snorkel and electroshocking were lowest in the lower two miles, and increased with increasing LWD, until gradient exceeded 10%. Sculpins were noted in the lower three miles and dace in the lowest mile of Augusta Creek.

From 1975-1988 several timber units were harvested adjacent to or on both sides of Grasshopper Creek. In the 1975 survey the stream within a clear cut unit had noticeable pool filling, decreased pool frequency, and complete loss of riparian vegetation, as compared to the stream in unharvested areas above the clearcut (Armantrout and Shula 1975). In the 1991 stream survey, excess fines were noted in all reaches of Grasshopper Creek. Cutthroat trout is the only documented fish in Grasshopper Creek.

6) CASCADE/TWINSPRINGS SUBWATERSHEDS - 13G AND 13L

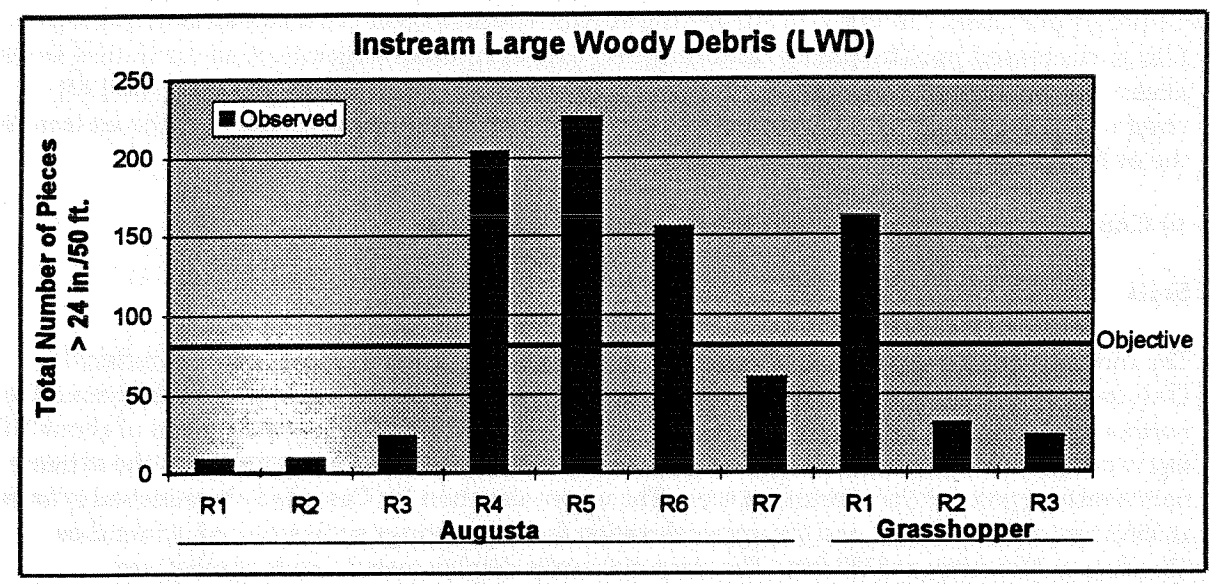
Soils

The most distinguishing feature of these two subwatersheds taken together is the characteristic U-shaped valley that they form for the South Fork drainage. These two subwatersheds contain the north and south sides of the east-west trending South Fork River. The lower elevation of about 2100 feet is common to both subwatersheds and is located at Dutch Oven Campground on the extreme northwestern point of this discussion area. The upper elevation for Cascade Subwatershed is found at 5563 feet on Rebel Rock, and the upper elevation for Twinsprings subwatershed is found on Chucksney Mountain at 5760 feet. The steep side walls display over 0.6 mile of relief, are extensively dissected, and show numerous rock outcrops and cliffs. By comparison, the almost flat lying terrace deposits of the valley bottom are comprised almost entirely of glacial outwash materials.

From a slope failure standpoint, these outwash deposits have almost no evidence of slope failure. This observation completes the mid to late Pleistocene glacial outwash story. In the lower reaches of the South Fork (Hardy, Green Ridge, and Boone Rider), almost all the outwash deposits show large scale slump/earthflow failure regimes. Farther up canyon (Starr and to an extent in Trail, Rebel, Lower Augusta), these terrace deposits show a range of slump activity from extensive to only limited in scope. Finally at these sites, almost no failure evidence is noted. The reason is relatively straight forward - base level lowering of the South Fork by erosion has not progressed up canyon to this point as the terrace deposits are only downcut 50 to 100 feet or so. A rough south to north cross section from west of Chucksney Mountain would show only two terrace levels at this point in the canyon. The upper is located at the 3100 to 3300 level and the lower is 2400 to 2600 feet level, and is often associated with the active channel. The soils on the steep sideslopes are colluvial/residual in nature and are described as non plastic, generally tan to light gray brown to yellow brown, gravelly sands to sandy silts. The soils on the glacio-fluvial terraces are distinct in that they commonly have numerous subrounded to rounded gravels and cobbles within a matrix of silty sands.

Stream Channel Condition and Fish

The two documented fish bearing streams in this subwatershed group are Cascade and Fir Creeks, which were last surveyed in 1975. These are relatively small, short tributaries (approximately two miles each) that contain cutthroat trout spawning and rearing habitat in their lower sections. Portions of Cascade Creek drainage have been harvested, but no specific information exists on stream condition. Cascade Creek is approximately 10% gradient and Fir Creek 5% gradient.



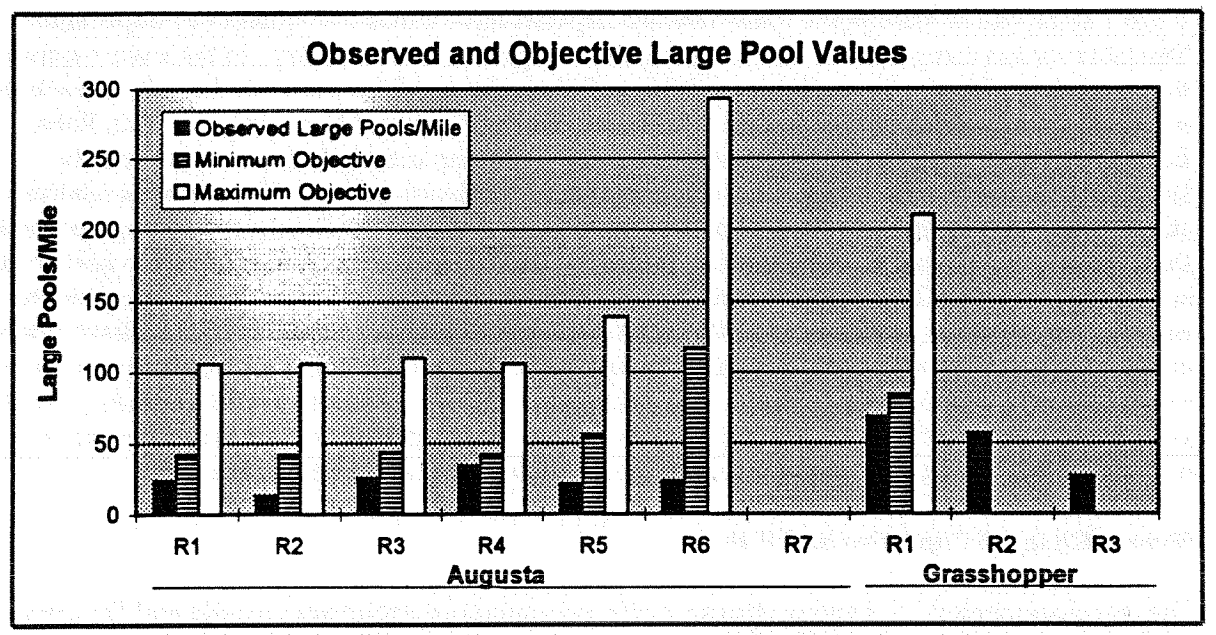


Figure 23. Augusta/Grasshopper subwatershed group LWD and pool values.

7) ROARING/ELK SUBWATERSHED - PSUB 13J, 13I, AND 13H

Soils

NOTE: Subwatershed 13H is South Fork Mink

Just below the Frissel Crossing Campground, these three subwatersheds combine at their lowest and only common point to form the main South Fork channel. Comprised of north/south to east/west trending, U-shaped, glaciated valleys, these drainages once contained the smaller valley glaciers that coalesced to form the main South Fork glacier that extended down canyon for several more miles. The lower common elevation for all the subwatersheds is about 2500 feet. The upper elevation for South Fork Mink and Elk (13H and 13I) is located many miles to the east along the great Cascade Range divide in the High Cascade physiographic province in the heart of the Three Sisters Wilderness. This set of subwatersheds are the first to leave the younger Western Cascade province and extend to the east sufficiently to impinge on the younger Tertiary rocks of the High Cascades.

Excluding the area to the east in the Three Sisters Wilderness, the highest point for South Fork Mink is 5190 feet on the ridge dividing French Pete Creek from the South Fork. For both South Fork Mink and Elk, the highest point on their common eastern boundary is 5654 feet at a common point in the extreme southeast corner of the project area near the wilderness boundary. On its far western boundary, Roaring attains an elevation of 5760 feet at Chucksney Mountain. As was mentioned previously, the most distinguishing features of these three subwatersheds taken together are the characteristic coalescing, U-shaped valleys. The steep side walls only display about 1500 to 2000 feet of relief, but are extensively dissected, show numerous rock outcrops and cliffs, and maintain heavily forested hillsides. By comparison, both the lowland terraces and the plateau like uplands are almost flat lying. The terrace deposits of the valley bottom are comprised almost entirely of glacial outwash materials. The upland deposits are outwash and ground moraine, with an occasional covering of recent volcanic ash deposits from venting to the east. This ash surface component is most common in the Skookum area.

The ;most unique feature found in this section is the extensive springs associated with Roaring River in Roaring Subwatershed. Roaring River has a base flow of over 60 cfs, and most of that flow is generated in two sets of springs about one mile apart. The thunderous outpouring of the spring flow as it exits a rock face in numerous individual outlets and cascades down over the mossy rocks clearly gives rise to the name "Roaring" River.

Stream Channel Condition and Fish

This subwatershed group has the majority of wilderness high lakes and critical cold water stream habitat. The major tributaries are Roaring River, Elk Creek, and Moss Creek (a tributary to Roaring River) all of which occur in a relatively stable landform. Roaring River has been documented as a spawning and rearing area for bull trout. Although the Roaring River subwatershed has been intensively managed, Roaring River remains in good condition due to it's large spring source, relatively intact riparian vegetation, and its streambank and bed composition of bedrock and small boulders. In addition harvest in the Roaring River has left buffers and avoided unstable areas for

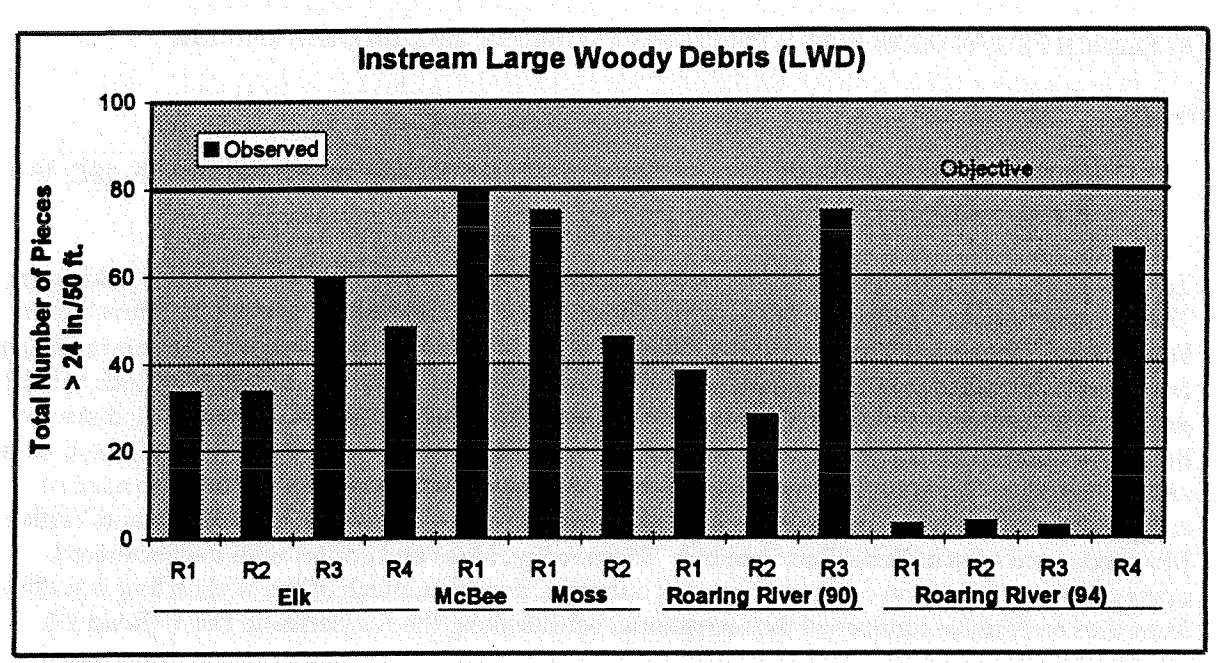
the most part. Low levels of large instream wood and large pools in the lower mile may be due to previous salvage, and the presence of the 19 Road. Low levels of LWD in the upper reaches are likely due to a fire that occurred 100-150 years ago.

Settling of road fill is causing some instability within the riparian area along Roaring River. Located approximately 1.5 miles up from where Road 19 crosses the South Fork McKenzie River, the fill is cracking and forming "piping", where runoff from the road flows into the cracks and erodes "channels" through the fill

An exception to the natural stability of the Roaring/Elk landtype is the Moss Creek subwatershed. Landtype can be the determining factor of channel condition, particularly where management within the drainage has been limited. Moss Creek is an example of a stream that has been impacted by debris flows due to steep, unstable geologic parent material. The debris flows which initiated from rock outcrops in steep, first order headwaters streams have resulted in channel aggradation, channel scour and streambank erosion. The survey information substantiates the condition with low levels of large pool habitat observed in the lower 1.5 miles of Moss Creek (Figure 24).

The channel condition of Elk Creek is relatively poor, particularly for the first 1.5 miles upstream from its mouth due to dominantly cobble sized streambed and banks, lack of LWD and complete harvest of riparian vegetation. The combination of these factors have resulted in downcutting of the stream channel, including exposure of bedrock which consists of indurated green breccia, which produces a fine clay sediment into the stream. The lower portion of Elk Creek is also lacking in large pool habitat, although conditions improve upstream. Remnant old channels, many of which flow during the winter and spring, and pond water in the summer, flow across the old alluvial fan near the stream's mouth.

The upper limit of rainbow trout and historic spring Chinook spawning occur in the main South Fork within this subwatershed group. Cutthroat trout, mountain whitefish, and sculpin species are also present.



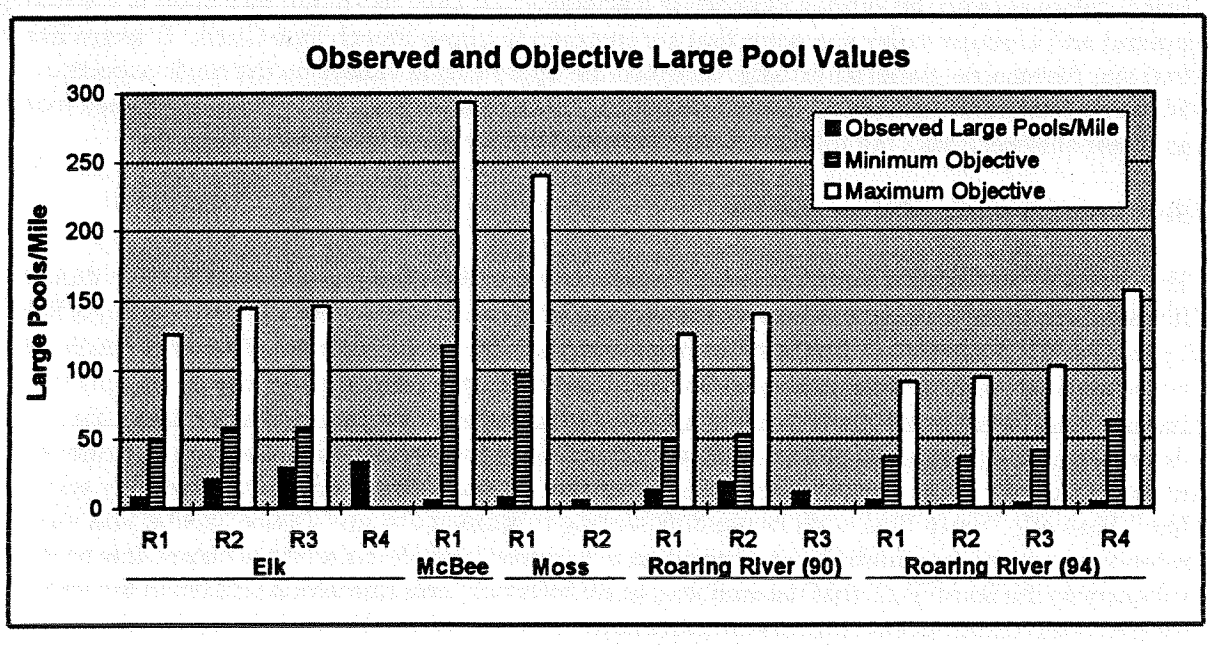


Figure 24. Roaring / Elk subwatershed group LWD and pool values.

8) FRENCH PETE/WALKER SUBWATERSHEDS - PSUBS 13E, 13C, 13D, 13F AND 13K

Soils

NOTE: French Pete, Walker, Smith, Rebel, and Trail (PSUBs respectively are 13E, 13C, 13D, 13F and 13K),

The following discussion is based on photo interpretation and a very limited amount of field work. These subwatersheds comprise primarily the French Pete Wilderness Addition to the Three Sisters Wilderness. The elevation ranges from 1357 feet at the full pool level of Cougar Reservoir to Olallie Mountain in the northeast at 5700 feet, and to the south Pyramid Mountain and Rebel Rock at 5600 and 5583 feet, respectively. In displaying over a half mile of relief, the area is extensively dissected by Walker Creek, French Pete Creek, and Rebel Creek, as well as a host of their tributaries and other smaller streams. The most distinguishing features of these subwatersheds are likely the massive craggy scarps that can be found along Sawtooth Ridge, west and south of Tipsoo Butte and Yankee Mountain, and west of Rebel Rock lookout. These rocky ridges and chutes with their scattered, open grassy meadows on commanding rock outcrops, dominate much of the skyline that is visible from the comfortable confines of the recreational vehicle along the Aufderheide Drive (Road 19).

Stream downcutting of the volcanic formations that comprise the younger Western Cascade parent materials has been the principal active process in this area for several million years. This process was accelerated with the various Pleistocene glaciations that gave rise to the formation of the rolling upland and U-shape valley segments that are common to upper French Pete Creek. It seems likely that late Pleistocene glacial ice actually occupied the upper cirque valleys on the north aspects of Walker Creek (north and east of Tipsoo Butte and Yankee Mountain) and French Pete Creek (north and east of Rebel Rock), but this cannot conclusively be proven at this point.

Stream Channel Condition and Fish

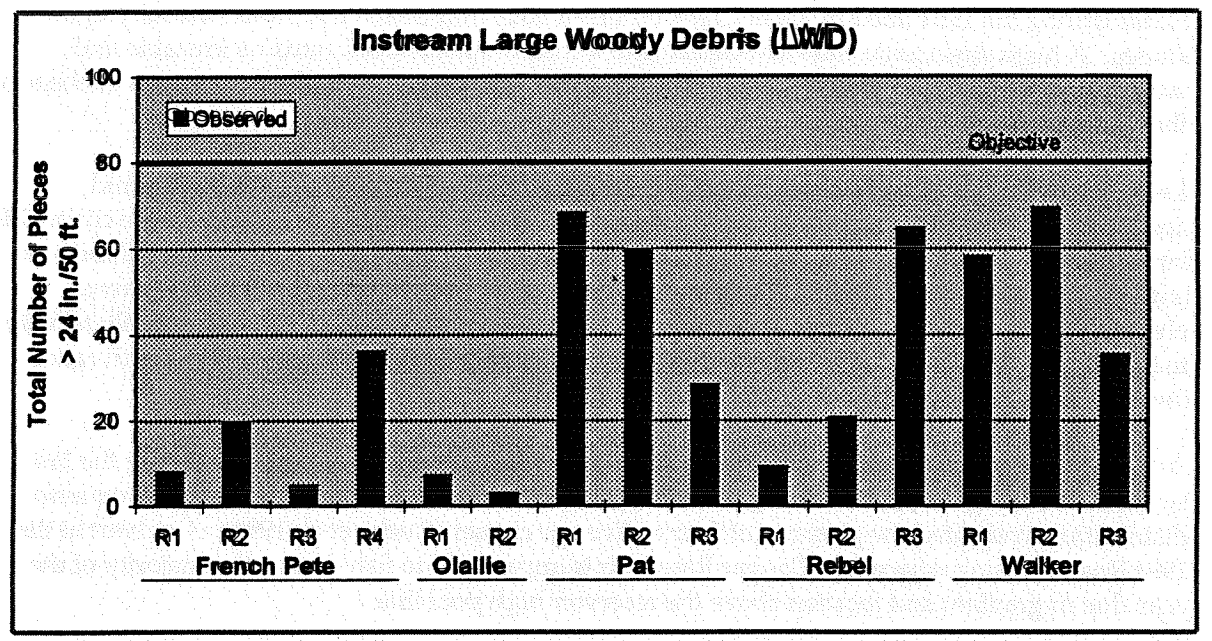
The French Pete/Walker Group contain streams that are in relatively good condition even though floods have caused massive debris torrents and slides. This is true for French Pete Creek and Rebel Creek, which underwent extreme widening during the 1964 flood. Failures within the French Pete subwatershed were generally all associated with naturally unstable, shallow soils. Widening of French Pete Creek is particularly visible on aerial photos due to the relatively large size of the drainage area as compared to other subwatersheds within the South Fork. The shear quantity of water coupled with the large amount of sediment from debris slides resulted in a relatively wide flood channel. French Pete, with its two fish bearing tributaries, Pat and Olallie Creeks, was most recently surveyed for aquatic habitat condition in summer 1994. It is a relatively large, low gradient tributary to the South Fork that has rainbow, adult bulltrout, and numerous suckers in the lower reaches, with cutthroat and sculpins documented in upper reaches. Pat and Olallie Creeks also contain cutthroat trout through the surveyed portions.

Slides during the 1964 flood in Rebel Creek occurred both from roads and from naturally unstable slopes. A huge streamside slide associated with a road in Rebel Creek remains unstable and unvegetated to this day. Rebel Creek is dominated by cutthroat trout, and also contains suckers in the lower portion.

Lack of LWD in the streams of the French Pete/Walker Group is due to a fire that occurred approximately 130 years ago, resulting in streamside trees not old enough to fall into the channel in large numbers, and not large enough to remain in the channel during flood flows even if they did enter the channel. For instance some of the lowest levels of LWD >24" DBH/50' length were observed during surveys in 1994 of Olallie Creek and French Pete (Figure 25), presumably relating to fire history. Storm events and fire may explain some of the relatively high width:depth ratios found in wilderness reaches.

An intensive biological (electroshocking) survey of Walker Creek was conducted during the first two weeks of August 1994. The largest cutthroat sampled was 20 cm (10") and length-frequency distributions indicated the presence of four or five age classes (Cutler et al. 1994). A culvert at the 1994 Road crossing adjacent to Cougar Reservoir is impassable to fish during the majority of the year due to gradient and location above the reservoir high pool line.

Although the majority of these tributaries are located within wilderness, the lower portions of French Pete, Rebel, and Walker, have been subject to some management impact, either from roads or timber harvest where they are not located in wilderness. In both the 1974 and 1994 habitat surveys pool filling by fines was noted in the lower reach of Walker Creek. This was attributed in 1974 to a road and not to harvest units.



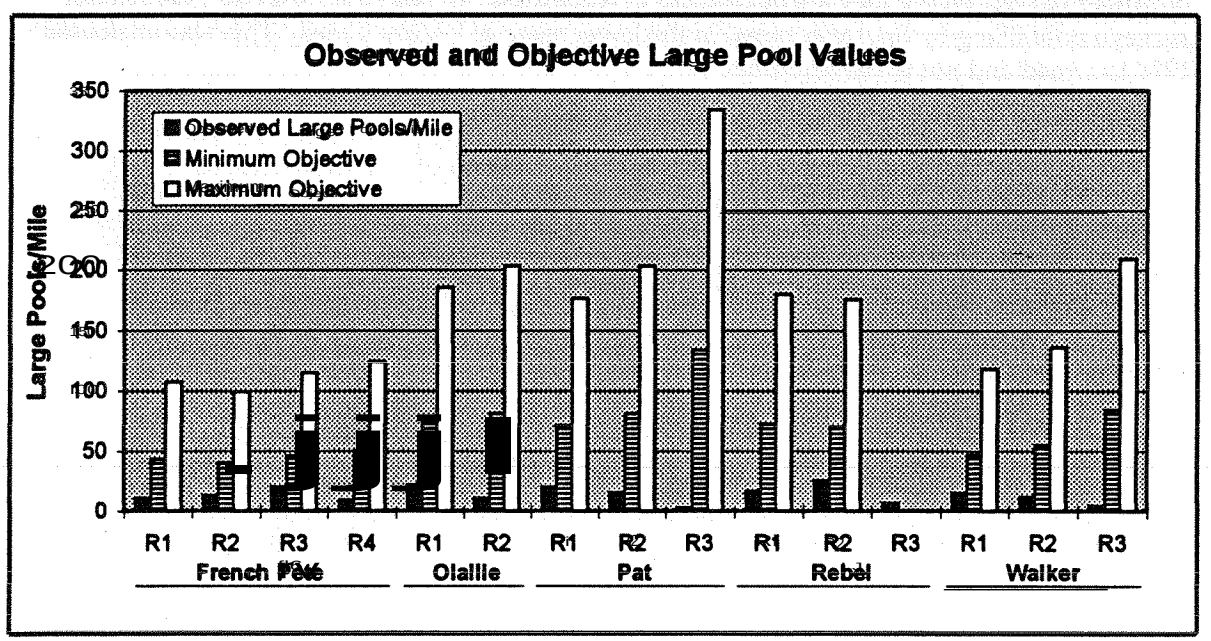


Figure 25. French Pete / Walker subwatershed group LWD and pool values.

9) EAST FORK SUBWATERSHED - PSUB 13B

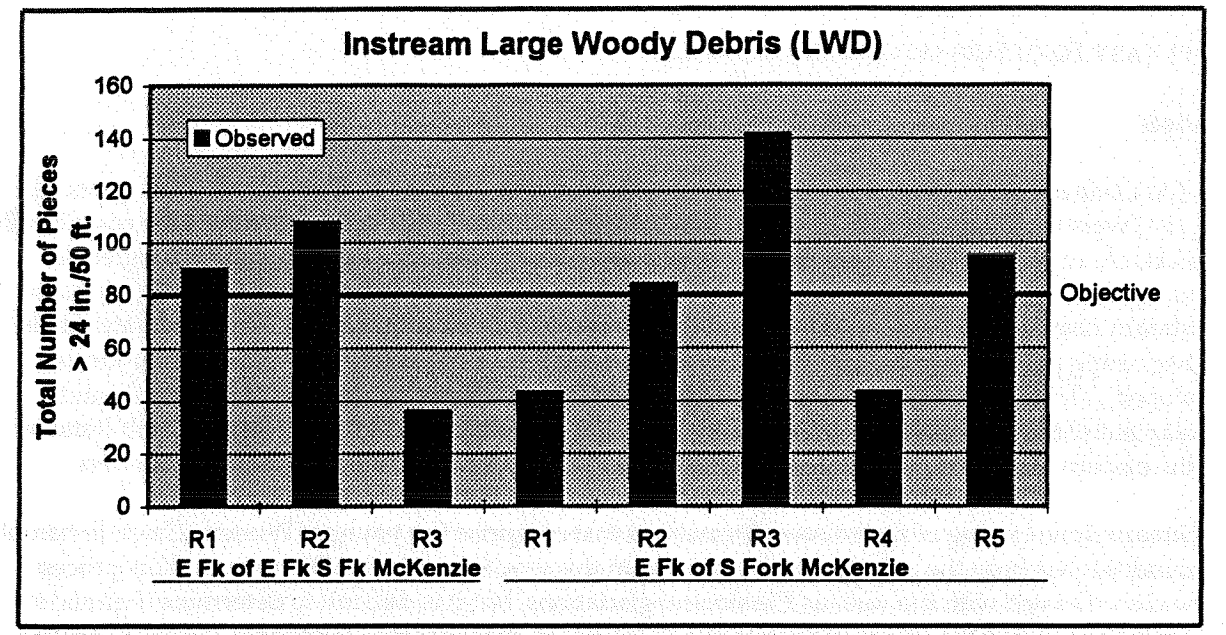
Soil

The drainage's most distinguishing feature is the sharp dog leg jog to the south that the generally east/west trending stream makes near the headwaters. Nearer the confluence with the main South Fork channel, the valleys walls display over a half mile of relief and a corresponding degree of steep, dissected topography. As one moves upstream the relief begins to moderate slightly as the stream rises, and the upland ridges tend to follow the same elevation band. The headwater areas, beginning primarily at the major bend in the drainage are more gently sloping, glacially-formed slopes. The elevation ranges from 1357 feet at the full pool elevation of Cougar Reservoir, and climbs to 5630 feet on the north boundary at O'Leary Mountain, and to 5527 feet at Lamb Butte on the eastern boundary, and ultimately to 5756 feet at French Mountain on the south boundary.

Stream downcutting of the volcanic formations that comprise the younger Western Cascade parent materials has been the principal active process in this area for several million years. This process was accelerated with the various Pleistocene glaciations, but it is difficult to determine if glacial ice actually occupied the upper valleys of the East Fork in more recent glaciations. Late Pleistocene glaciation probably had little direct effect in the area, except perhaps to form ice fields or small glaciers along the north facing slopes of Sawtooth Ridge, French Mountain, or English Mountain. Slope instability has not been a significant factor in shaping the area in more recent times.

Stream Channel Condition and Fish

The East Fork of the South Fork, and its tributary, the "East Fork of the East Fork", are relatively low gradient systems. Survey information from 1991 indicates high quality habitat with some of the highest large pool observations in the South Fork watershed. LWD > 24" DBH/50' length were observed to be at levels which exceed 80 pieces per mile in five out of eight reaches (Figure 26.) In the upper 2.6-3.4 miles side channels are common (Heller and Baker 1974). Embeddedness was noted in the upper two reaches of the East Fork of the East Fork, indicating excess fines in the substrate. The source of the fines is not documented, and is probably related to the geology, since most of the units in the upper East Fork were buffered. The East Fork of the South Fork primarily contains cutthroat trout, with seasonal use of the lower East Fork by rainbow and bulltrout during winter.



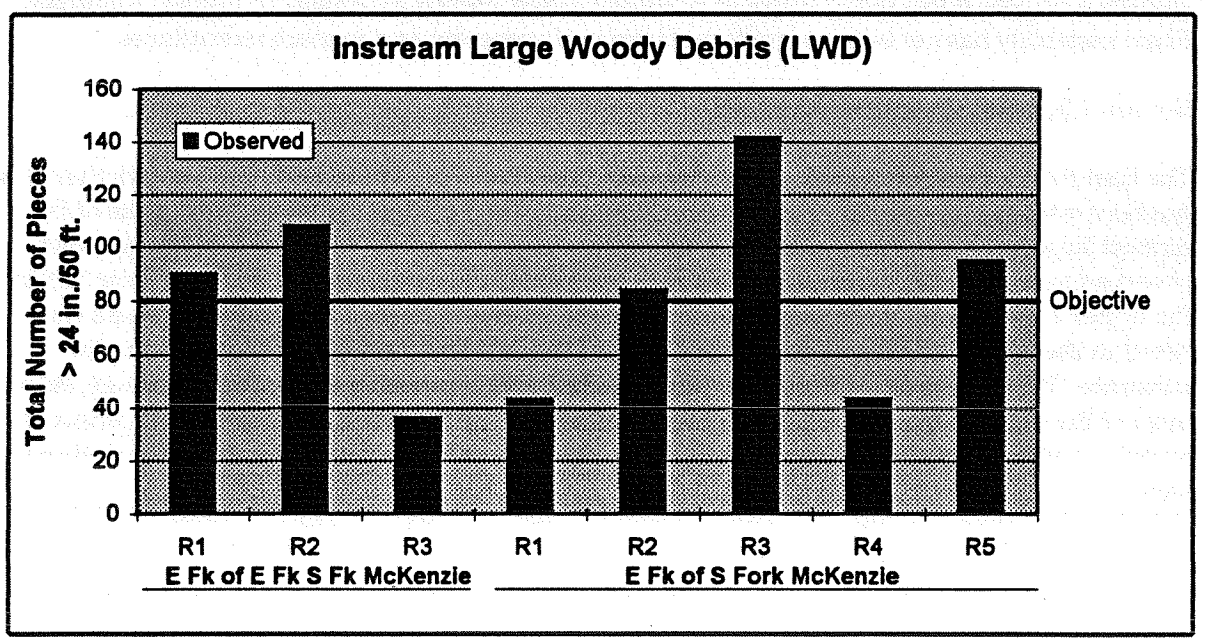


Figure 26. East Fork subwatershed group LWD and pool values.

10) SOUTH FORK MAINSTEM

Soils

The South Fork of the McKenzie River becomes the sum of its parts. Formed 10 to 17 million years ago when thousands of feet of lava flows and ash deposits rained down from numerous volcanoes, the river immediately began to erode these original slopes. Millions of years passed as mountains were worn down and canyons cut, and new lava flows filled in old channels to start the process over. Somewhere around a million years ago the glaciers started. The canyon records several glacial advances and retreats, and it is these glaciations that have left the most pronounced mark on stream morphology. The glacial grinding and scour provided the grist mill for sediment generation on a grand scale. These deposits form the extensive terraces common to much of the River. As the glacial rasp slowed, the river, on its perpetual run to the sea, started downcutting again. As these unconsolidated terrace materials were left hanging on the steeper hillsides, they lost their grip and thousands of cubic yards of material came cascading down into the South Fork as landflows. As it had done with the glacial material before it, the river carried this material farther down canyon to form terraces lower in the valley and on the main McKenzie.

Since deglaciation, smaller scale forces have been at work to alter the landscape. Fires and floods, debris chutes and debris dams, wind storms and disease, have all affected vegetation and soils within the system. Always yielding to gravity's never ending pull, material moved down hill, sometimes catastrophically, more often incrementally, to fill the swales, draws, and streams with wood, rock, and soil. In due course, these materials reach the main stem and provide the building blocks for the river to construct its winding channel. Most recently, man has entered the picture, not as a traveler through the system, but as an agent of change within the system. As the river sees it, the dam has, for the moment, constrained its many forces. In reality, this is only a temporary inconvenience. Nature's forces, landslide, earthquake, fire, and storm, are still at work. It's only a matter of time.

Stream Channel Condition

Analysis of current channel conditions and channel changes through time of the mainstem South Fork McKenzie River was accomplished with the aid of an analytical photogrammetry program called the MDSD computer program. For a complete discussion of analytical processes and techniques used (Appendix FW7).

Six aerial photo series covering 1939, 1953, 1959, 1967, 1979, and 1990 were digitally mapped using the MDSD computer program. Mapping of the South Fork was done in two sections:

1) from the confluence with the McKenzie River up to the dam base - approximately 4.5 miles, and

2) from the tail of the reservoir at high pool up to the confluence with Roaring River - approximately 12 miles.

The exception to the extent mapped apply to the 1939 and 1953 photos whose coverage does not extend up to roaring River., as with the other photos, the 1939 and 1953 photos were mapped from the confluence with the McKenzie River up to the dam base, but the length mapped upstream from the reservoir tail totals approximately 1 mile, or to about the location where French Pete Creek enters the South Fork.

Reach sensitivity was determined by measuring changes in channel sinuosity, amount of exposed cobble and gravel bars, number and length of side channels, active channel width and number and locations of large wood. The 16.5 miles of the South Fork were divided into four reaches based on the valley segment type (Figure 27). Valley segment types are further define and discussed later in this chapter. The four reaches are:

- Below Dam - Lower Reach
- Below Dam - Upper Reach
- Above Dam - Lower Reach
- Above Dam - Upper Reach

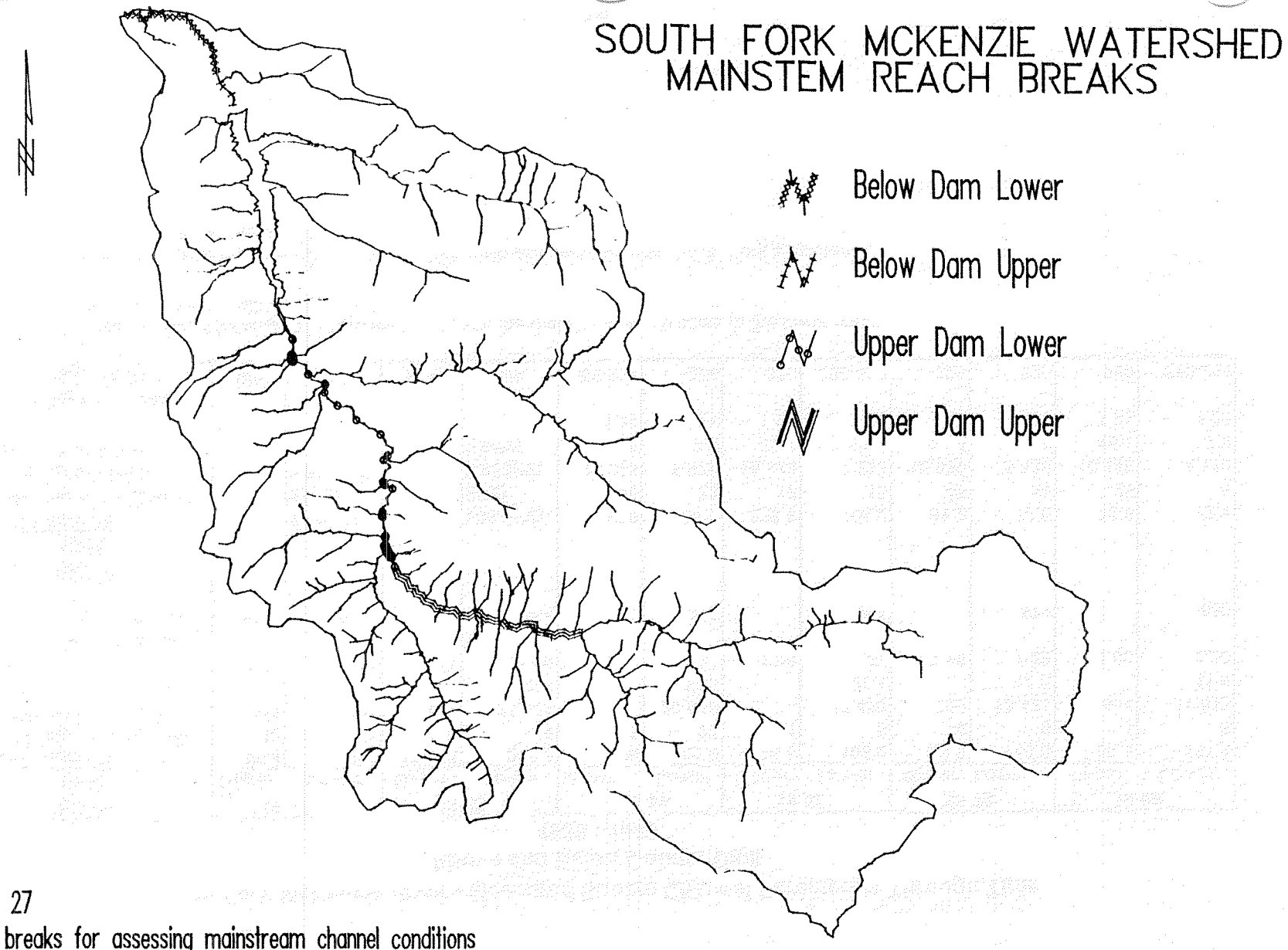


FIGURE 27
Reach breaks for assessing mainstream channel conditions of digitally mapped photo series, 1939 – 1990

South Fork McKenzie River - Measured Stream Channel Parameters Through Time
Above and Below Cougar Dam
1939 - 1990

BELOW DAM	19 39		19 53		19 59		19 67		19 79		19 90	
	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
Channel Width (ft)	96.4	178.8	122.03	216.8	90	209.9	98.6	155.8	90.9	143.8	82.9	131.4
LWD(Number of Locations)	10	28	6	19	3	27	1	9	4	9	1	6
Side Channel Length (ft)	537	23,452	471	21,628		20,542		17,400	580	13,421	694	11,633
Unvegetated bars (acres)				33.3		37.5		21.4		14.9		11.6
Sinuosity	1.11	1.25	1.11	1.29	1.10	1.31	1.08	1.27	1.10	1.29	1.06	1.30
Discharge day photo taken below Cougar Res (cfs) (*1)	N/A	N/A		664		315		299		571		856
ABOVE DAM												
Channel Width (ft)		71.8(*2)		100.9(*2)	56.8	84.7	125.8	104.2	91.2	77.6	75.6	72.4
LWD(Number of Locations)		23(*2)		2(*2)	49	23	17	15	46	14	25	5
Side Channel Length (ft)		3,640(*2)		2,953(*2)	23,393	5,978	16,373	7,237	15,099	5,330	10,348	4,110
Unvegetated bars (acres)				2.9(*2)	4.8	7.9	32.7	23.3	17.8	7.5	15.1	7.9
Sinuosity					1.21	1.24	1.25	1.25	1.20	1.25	1.21	1.25
Discharge day photo taken above Cougar Res (cfs)	N/A	N/A	N/A	N/A	266-274	274	336	336-620	225	225	250	240-250

*(1) Note: Discharge required for analysis of unvegetated bars, the majority of which occur in the lower reach (See Analytic Processes Appendix)

*(2) Note: Includes only a portion of the "upper reach". See main document section "South Fork Mainstem", "Stream Channel Condition"

Table 9

Below Dam - Lower and Upper Reaches

Values for the stream channel parameters measured above and below the Dam are displayed in Table 9.

1939

The year 1939 (with 28 side channels totaling 4.5 miles) was characterized by the highest number and length of side channels when compared to any of the other six photo series analyzed. All but one side channel was located in the lower reach. Through all time periods analyzed, only 2-6% of the total side channel length below the dam was located in the upper, more constrained reach. LWD locations were also at a high, with 38 total locations identified; 10 in the upper reach and 28 in the lower reach. Average channel width was 96.4 ft and 178.8 ft. for the upper and lower reaches, respectively. Interestingly, the sinuosity of the lower reach was at it's lowest at 1.25, and the upper reach at it's highest (but equal to 1953 value) at 1.11. Exposed gravel and cobble bars were not measured as discharge rates were not available on the date of photography for accurate comparisons between years.

1953

In 1953 there was a slight reduction (8%) in side channel length to 4.2 miles, with all the loss occurring in the lower reach. The total number of locations of LWD decreased to 25 (34% reduction). Average channel width increased 27% and 21% for the upper and lower reaches, respectively. Sinuosity in the upper reach remained constant at 1.11 and increased to 1.29 in the lower reach. All of these changes as compared to 1939 parameters, particularly channel widening and loss of LWD locations are likely due to the 25-year flood event (Dec. 1945) that occurred in the intervening years between photo periods.

1959

By 1959 construction of Cougar Dam was well under way, however, the floodplain area downstream of the dam that was used as a construction site known as the Strube Flat area was still intact. Side channels for the upper and lower reaches totaled 21 for a length of 3.9 miles, a 7% reduction as compared to 1953. Number of locations of LWD actually increased by 20%, from 25 in 1953 to 30 in 1959. The increase in LWD was all within the lower reach with a loss actually recorded in the upper reach. Recovery of channel width following the 25-year flood event of 1945 was evident in 1959, with the greatest reduction in width (26%) occurring in the upper reach, and only a 6% reduction in width taking place in the lower reach. It seems the 16-year flood event of Dec., 1955 had little effect on the more confined, higher gradient upper reach other than perhaps transporting some of the LWD down into the lower reach. However, changes were noticeable in the lower reach as reflected in sinuosity increases from 1.29 in 1953 to 1.31 in 1959. Also, it is postulated that channel width in the less confined, lower gradient reach actually decreased around 20-30% in the years after the channel widened in the 1945 flood. The 16-year event then widened it again, but to a lesser extent than the 1945 flood, resulting in a net decrease in channel width of 6% as viewed in the 1959 photos. Sinuosity also remained unaffected in the upper reach with a value of 1.10 as compared to 1.11 in 1953.

1963

The most significant changes that occurred below the dam site took place in the period following dam closure in November of 1963. Comparisons of 1967 photos to 1959 photos reveal a 43% reduction in exposed gravel and cobble bars, 67% reduction in LWD locations, 23% decrease in width in the lower reach and a 9% increase in the upper reach, decreases in sinuosity to 1.08 in the upper reach and 1.27 in the lower reach, and a 15% decrease in side channel length. Reduction of exposed gravel and cobble bars, decreases in sinuosity, and the decrease in channel width in the lower reach are probably direct results of Cougar Dam interrupting sediment transport and regulating peak flows. Minear (1994) attributed an overall decrease in exposed gravel bars in the McKenzie River to a depletion of sediment supply and reduction in peak flows as a result of dams. Reduced peak flows are directly responsible for reduced channel capacity which results in narrowing of the channel (Unknown author, Chapter 5). Decreased channel capacity in the South Fork may also be the result of redistribution of sediment. Petts (1979) found that erosion immediately below dams may be transported to downstream reaches where the sediment deposits as berms or bars, effectively reducing channel capacity and channel width. As seems to be the case in the upper reach below Cougar Dam, Petts (1979) recognized that channel armoring and bed coarsening occurs immediately below dams as a result of channel degradation. Indeed, surveys by district fish biologists found average to poor spawning material within the upper reach and noted "larger substrate lying over small gravel and sand" (Blue River Memo, 1991). Reduction in sinuosity in the upper reach is likely the result of reduction in gradient through degradation immediately below the dam.

The slight increase in width in the upper reach is believed to have occurred through rip-rapping of channel banks immediately below the dam, causing constriction and increased velocities which eroded an alternate bar and increased channel width. The loss of LWD was due to salvage efforts following the 1964 flood, where wood was effectively and consistently removed from the channel. It might be argued that many of these changes were due to the catastrophic flood of 1964, which was a 130-year event on the South Fork above the dam. However, Cougar Dam was in operation one year prior to that event, and flood control is something it did quite well. When return intervals for the 1964 flood are calculated with discharge values below the dam following dam closure (water year 1964-1992), the flows released from the reservoir (6,100 cfs) would equal a 25-year event. However, using discharge measures below the dam prior to dam closure to determine the return interval for the 1964 flood, the amount of water released from the dam was equivalent to less than a two-year event. This discharge of approximately bankfull discharge is hardly enough flow to cause changes of this magnitude.

One of the more interesting stories and puzzles to piece together is that of the channel configuration in the Strube Flat area prior to rearrangement by the Army Corps of Engineers. A map of the area (Figure 28) shows the channel at Strube Flat in 1959 and in 1967. In order to construct a temporary bridge across the channel, the active channel had to be straightened and narrowed. To accomplish this, an area of approximately 2.4 acres was filled, most of it directly into the active channel and a small portion of the vegetated floodplain. This action effectively moved the channel over 170 ft. to the west and deflected flow directly into the north streambank. As a result of cutting off the

meander bend, the flow could not make the turn back to the west, requiring the Corps to construct a new channel to the south. To accomplish this, approximately nine acres of vegetated floodplain was leveled, completely removing the vegetation and pushing the cobbles and gravels out to flatten and reduce the height of the floodplain, effectively creating a braided channel.

1979

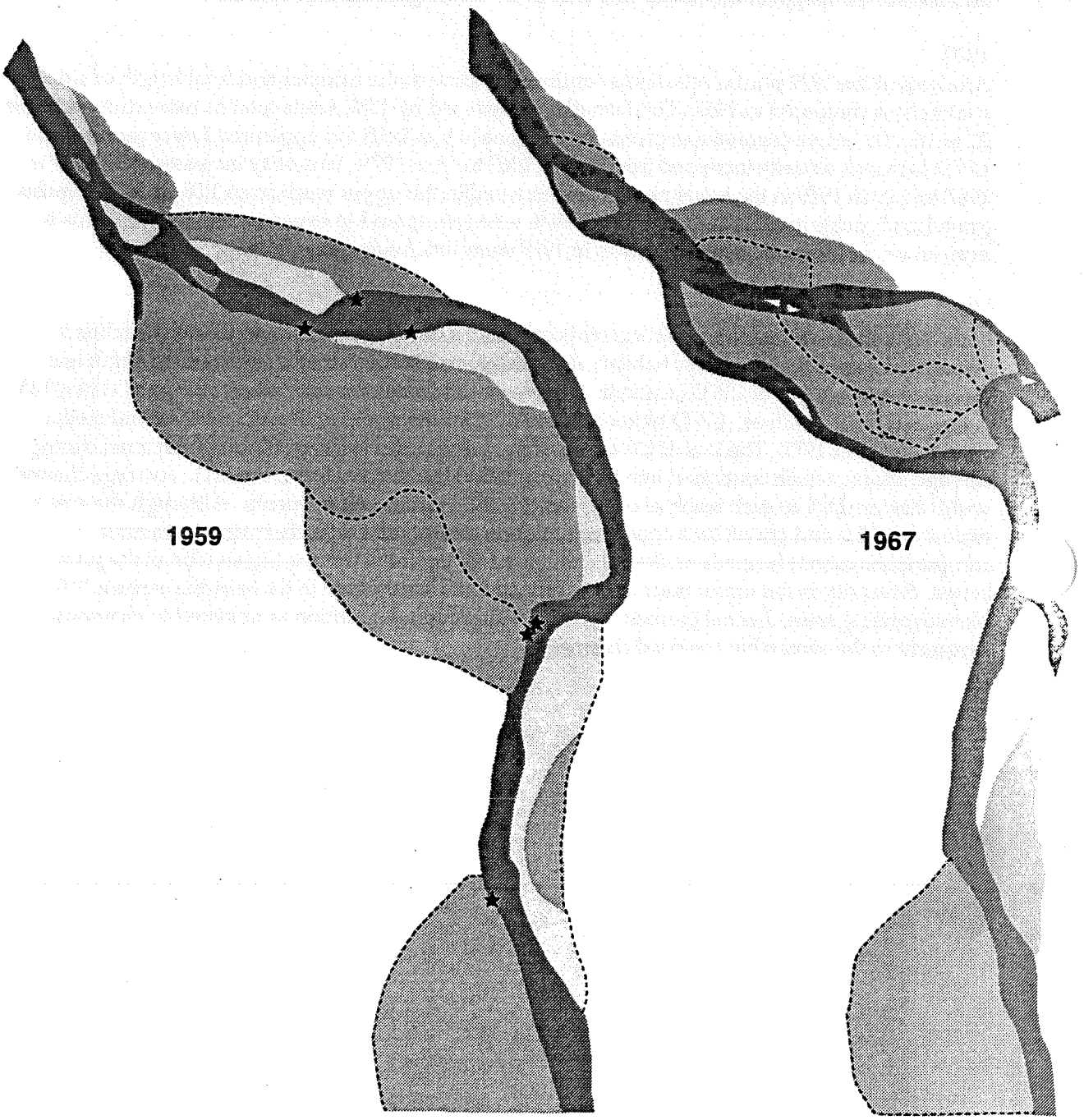
Analysis of the 1979 photos revealed a continued decline in the number and total length of side channels as compared to 1967. Total length was reduced by 18%, while total number dropped from 22 to 16. The active channel narrowed an additional 8% in both the upper and lower reaches, and LWD locations actually increased from ten in 1967 to 13 in 1979. Sinuosity increased from 1.27 in 1967 to 1.29 in 1979 in the lower reach, and increased in the upper reach from 1.08 to 1.10. Exposed gravel and cobble bars declined in area by 55% when compared to exposed area in 1953. This is even more accentuated given that flows in 1979 were 14% lower than in 1953.

1990

The 1990 photos are used to reflect current conditions of 1994 and reveal a continued decline in channel complexity and aquatic habitat. All-time lows had been hit for side channel length and number, and number of LWD locations. There were 14 side channels totaling 2.3 miles, down 14% compared to 1979 values. LWD locations totaled 7 for the upper and lower reaches combined, a drop from 13 in 1979. The loss of LWD was likely due to direct removal from the channel during salvage efforts, which continued into the early 1980's (Leavitt 1994, pers. comm.). Average channel width declined 8% in each reach as compared to 1979 width measurements. Although the area in exposed cobble and gravel bars appeared to decline compared with other years, measured comparisons cannot be made as flows during the 1990 photos were the highest for all the photo series. Sinuosity in the upper reach has declined to its lowest value of the analysis series at 1.06. Not surprising since channel gradient is reduced through degradation as opposed to increasing sinuosity in the somewhat confined channel.

Figure 28

South Fork McKenzie River
Strube Flat below Cougar Reservoir
1959 vs. 1967



Although overall sinuosity in the lower reach appears to be increasing since 1967 due to reduced average annual peaks and sediment, a high probability exists that two chute-cutoffs are in progress across the floodplain of two meander bends. This is caused by the following sequence of events: the channel is unable to transport sediment downstream that it received from the upper reach due to reduced average annual peak flows. In order to increase its ability to transport the sediment, the gradient is increased by continuing to aggrade, causing an increase in slope at the downstream point of aggradation. However, the slope is reduced above the depositional area, causing continued aggradation (Morisawa 1968). The chute-cutoffs are old side channels which are capturing and taking over the main channel flow because the slope is greater in the side channels than in the area of reduced gradient above the aggrading section. Cutting off the meander bend through the chute-cutoff process will reduce the sinuosity from 1.30 to 1.24 and may cause one of two channel responses in an attempt to reduce the channel gradient. The two possible channel responses are:

1) channel scour above the chute-cutoff upstream until the reduction of gradient and/or increase in channel bed roughness reduces the velocity below the threshold for sediment transport; or

2) an increase in sinuosity upstream until gradient is reduced (Unknown Author, Ch.5; Rosgen 1994, pers. comm.)

Above Dam-Lower Reach

Discussion of channel conditions and channel changes for 1939 and 1953 will be confined to the section of river from reservoir high pool to 0.75 mi. upstream of the French Pete tributary area, as these photos do not extend through the remaining lower and upper reaches. Therefore, comparisons of general channel features will be made between the 1939 and 1953 photos, but comparisons will not be made between these two earlier photo sets and the subsequent four series. The exception will be for the description of channel changes around the French Pete alluvial fan, which will be discussed as a separate topic and include all six photo series.

French Pete Alluvial Fan 1939-1990

In 1939, the main South Fork McKenzie River channel was located approximately where it flows today and in the 1990 photos, and the alluvial fan was fully vegetated (Figure 29). In 1953 following the 1945 flood event, the main channel moved to the northeast 430 ft., the mouth of French Pete moved 484 ft. to the east, 3 acres of cobbles and gravels derived from the mainstem and French Pete subwatershed were deposited onto the alluvial fan, and what used to be the mainstem in 1939 became a secondary channel. In the ensuing years between 1953 and 1959, a small change occurs in the secondary channel to the south where the channel captures a small section of side channel, leaving a side channel in place of the secondary channel.

The 1967 photos are the record for effects from the 1964 flood. The flood sent water gushing through a side channel and into the secondary channel to the south, recapturing the old, main channel of 1939. What had been the main channel in the 1953 and 1959 photos became a large side channel or secondary channel. By 1979, the side channel or secondary channel to the north has been abandoned, and sediment deposited onto the alluvial fan during the 1964 flood has become fully vegetated. The main channel maintains its position to the north. The basic pattern remained through 1990 with continued vegetative recovery on the alluvial fan. Comparisons of LWD

locations and side channel lengths in 1990 vs. 1939 within 0.5 miles upstream and downstream of the alluvial fan indicate great reductions. There were nine LWD locations in 1939 as compared with zero in 1990, and side channels are 67% shorter in length in 1990 (0.21 mi) as compared to 1939 (0.64 mi).

1939-1953 Above Dam Lower Reach

Seven side channels totaling 0.7 miles occurred in a short 1.25 mile section above the dam during 1939, but declined by 19% to four channels and 0.56 miles. LWD locations decreased significantly from 23 locations in 1939 to two in 1953. One possibility is that all the LWD was not transported out of the system, but perhaps some single or multiple logs formed into debris jams reducing the number of locations but not the total volume of logs. Active channel width increased 40%, from 71.8 ft. to 100.9 ft. Although discharge was not known for 1939 which makes comparisons of exposed gravel and cobble bars somewhat tenuous, there were no bars viewed at all in 1939, whereas almost three acres were visible in the 1953 photos. All of these changes were likely the direct result of the 1945 flood which was a 25-year event.

1959-1967

Changes through the lower reach during this time period reflect effects from the 1964 flood. Channel width increased 23% and there was almost a 200% increase in exposed cobble and gravel bars, with the majority of deposition taking place on point bars and alternating bars. This is true even though discharge in 1967 was greater than in 1959. There was a major reduction (92%) in vegetated mid channel bars or islands, where two large, stable island complexes with multiple side channels became point bars, with a single threaded channel. Figure 38 illustrates this change to a more simple channel for one area located approximately one mile upstream from Rebel Creek. LWD locations decreased from 23 locations in 1959 to 15 in 1967, a direct result of salvage out of the channel. Side channel length increased 21% although total numbers dropped from 13 to ten. Sinuosity remained relatively constant at 1.24 in 1959 and 1.25 in 1967.

1967-1979

The channel through this time period began its recovery from the 1964 flood and showed no signs of change due to a 15-year event in 1971. The active channel narrowed 25%, and over the 12 year period there was a 68% decline in the exposed unvegetated gravel and cobble bars, most of which became vegetated. Although there was probably additional LWD that entered the channel during this time interval, salvage operations held relatively constant the number of LWD locations at 14 in 1979 (down from 15 in 1967). Side channels continued to be abandoned with a drop from 10 to 7 channels and a 26% loss in total length.

Figure 29

South Fork McKenzie River — French Pete Alluvial Fan 1939-1990

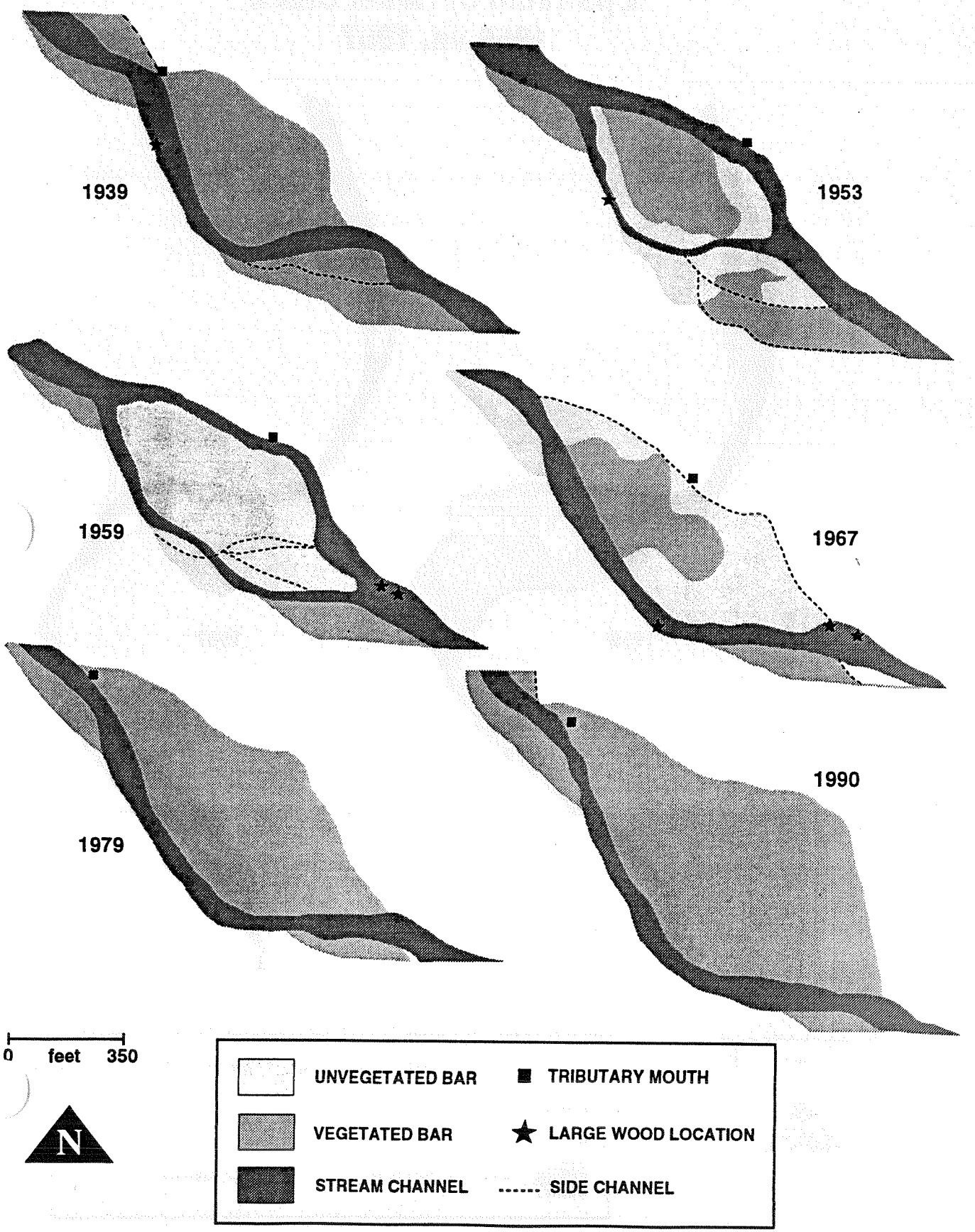
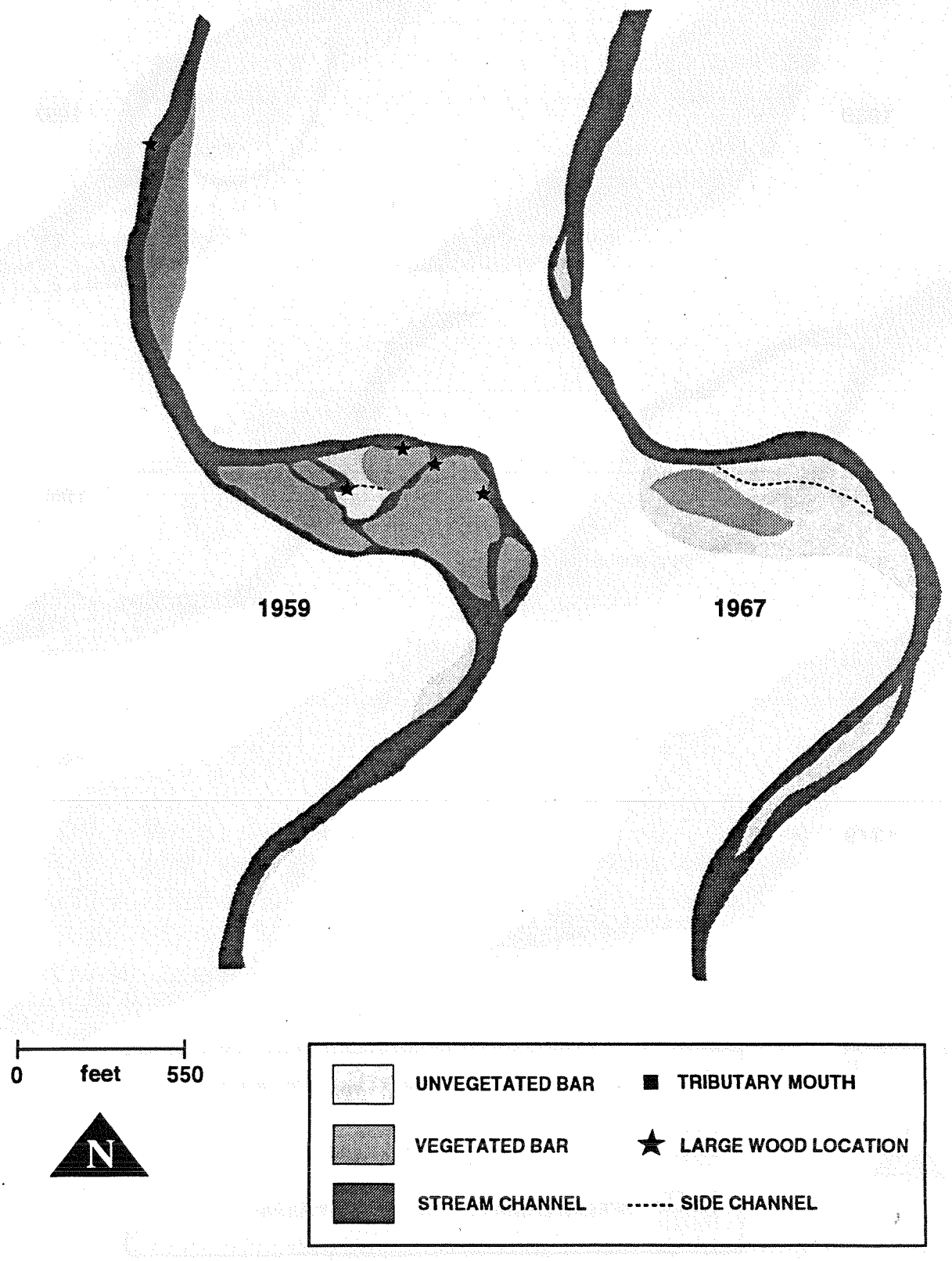


Figure 30

South Fork McKenzie River Upstream of Rebel Creek 1959 vs. 1967



1979-1990
During this eleven year time interval the South Fork McKenzie River stabilized in channel width at an average of 72 ft.. Unfortunately, LWD within its channel plummeted 64% due to salvage, and side channel length took another 23% drop. An 8-year flood event in 1986 did not appear to effect the channel to any measurable degree as unvegetated, exposed cobble and gravel bars became more vegetated. Mid channel bars and islands declined overall as secondary channels were abandoned and the mid channel bars became point-bars. An exception is directly downstream of Hardy Creek where the unvegetated, exposed cobble and gravel bars actually increased in area from about a tenth of an acre to a quarter acre in size. A combination of two factors likely explains this accumulation of sediment. First, the numerous, large bank failures within the earthflow material of Hardy Creek triggered by cutting of the riparian vegetation and the 1964 flood, were still active and slow to heal. In addition, two debris slides from the south slopes of Hardy Creek careened down the slopes and tore along the channel banks of Hardy Creek, exposing more raw, unstable banks. This provided additional sediment to Hardy Creek and was transported down into the South Fork channel. Second, the bridge crossing over the South Fork channel located approximately 500 ft. downstream from the mouth of Hardy Creek acts as a constriction point where the sediment is deposited upstream. Other studies on movement of sediment through channel networks indicate that structural controls such as bridges slows the downstream progression of sediment by impounding material upstream and causing deposition downstream (Beschta 1983, Williams 1978).

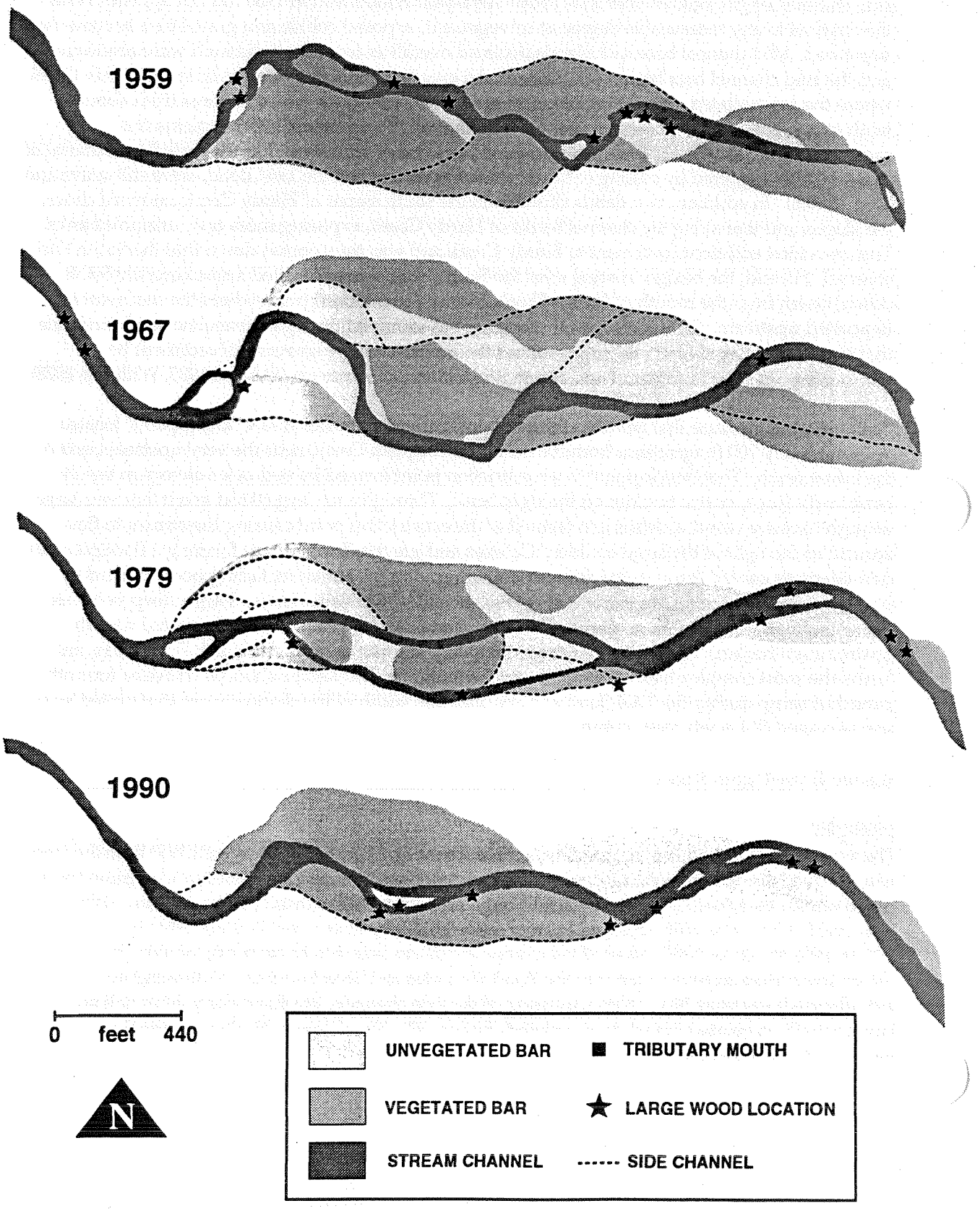
One interesting feature that persisted through all of the photo series was a "knick-point" located approximately 700 ft. upstream from the mouth of Augusta Creek, near the very upstream end of the lower reach. This "knick-point" is a constriction point formed by bedrock outcrop on the left bank and a huge, erratic boulder on the right bank. Through each large flood event that was large enough to move wood, a debris jam formed at the constriction point causing the stream to flow around to the right of the large boulder. Cobbles and gravels dropped out forming a floodplain and side-channels carved through the deposits, creating complex habitat including pools formed by plunge pools over wood, deposition of gravels, and slow backwater areas. Large, deep pools are associated with the log jam and bedrock outcrop, and slower, ponded water is created directly upstream of the jam. This is the only remaining log jam that exists on the South Fork today, and forms the most complex habitat along the entire South Fork McKenzie channel. Three or four other jams that setup during the 1964 flood and spanned the width of the channel were dynamited apart and salvaged (B.Leavitt, pers. comm.).

Above Dam-Upper Reach

1959-1967
The upper reach is by far more sensitive to disturbance by flood and salvage of LWD than the lower reach. The channel within the upper reach is less confined than the lower reach and is more free to move within the broad U-shaped glacial trough and alluviated mountain valley bottom. This is the only reach where sinuosity changed to any measurable degree as a result of the 1964 flood, from 1.21 in 1959 to 1.25 in 1967. Most of the change in pattern was due to capturing of side channels, of which there were numerous prior to the flood (4.4 miles and 38 in number). Following the flood, side channels declined 30%. With capturing of the side channels, the flow was split in half and large, mostly vegetated islands were created (Figure 39). The diagram illustrates where this happened in one small section.

Figure 31

South Fork McKenzie River
Upstream from Homestead Bridge (1/2 mi.)
Channel Changes 1959-1990



Channel width more than doubled from an average of 56.8 ft. to 125 ft. (120% increase!), and unvegetated, exposed gravel and cobble bars increased 600%. The proportion of increased gravel and cobble bars from actual new accumulations vs. older, vegetated bars whose vegetation was devastated during the flood is unknown.

1967-1979
LWD locations took a jump during this 12 year interval from 17 locations in 1967 to 46 in 1979, perhaps due to the 15-year flood event of 1971. Other features reflect recovery from the 1964 flood such as a 28% decline in channel width, and a 45% reduction in exposed cobble and gravel bars. The 45% reduction figure in exposed bars is conservative given that flows in 1979 were 33% lower than in 1967. The main channel began to revert back to a single threaded channel, dropping many of the secondary channels, thereby losing several islands and mid channel bars. The total length of side channels remained about the same, however, the number increased from 27 in 1967 to 35 in 1979, a 30% increase. It's possible that moderately sized flood events such as the 15-year event in 1971 contributes to side channel formation.

1979-1990
An 8-year flood event occurring in 1986 cannot be the cause for the huge reduction in LWD locations in 1990 as compared to 1979. Logs "pulled right out of the gravels" in some cases (B.Leavitt, pers. comm. 1994) contributed to a 46% loss in LWD locations, from 46 in 1979 to 25 in 1990. Channel width continued to narrow (17% reduction), 15% more gravel and cobble bars became vegetated, 17 more side channels were abandoned (49% reduction), and side channel length was shortened 31%. A drought which began in 1986 is possibly, in part, responsible for reductions in channel width, side channel length, and reduced area of exposed bars. Sinuosity was back at its 1959 value of 1.21.

Below Dam - Effects of the Dam on Peak Flows

Measurements of channel width below the dam were made on all six time series photos to determine if changes in peak flows due to controlled release from the reservoir has affected active channel width. Narrowing of the active channel has been found to occur below many dams around the country due to decreased peak flows and mean annual discharge (Williams 1978, Schumm and Meyer 1979, Andrews 1986). Comparisons were made for pre- and post-dam instantaneous peak flows below the dam from water year 1946-1993 (Figure 32). For the six years that both gaging stations ran coincidentally (one above the dam and one below) prior to dam construction, peak flows below the dam were always larger than above the dam. Prior to construction of Cougar Dam, instantaneous peak flows below the dam were 19% greater than above the dam. Following completion of the dam in 1963 (water year 1964), the trend reversed and the average instantaneous peak flow above the dam was 30% greater than below the dam. While channel form is related to bankfull discharge, reductions in peak flow below the dam may be affecting the landscape features and valley form (Anderson 1977; Rosgen pers. comm. 1994). Calculations of average peak discharges revealed a 45% decrease in average peak flows following construction of Cougar Dam, from a mean of 7415 cfs to 4094 cfs. A study performed on the McKenzie River also found a 44% reduction in mean instantaneous peak flows (Minear 1994). Indeed, Figure 33 shows an overall decrease in discharge for a given return interval from pre-dam to post-dam on the South Fork

McKenzie River. A flow that would on average occur once every two years prior to dam construction, now occurs on average once every 50-60 years. At a gaging station location downstream on the McKenzie River near Vida, Lion (1991) found that there have been no floods recorded with a return interval greater than two years since 1965.

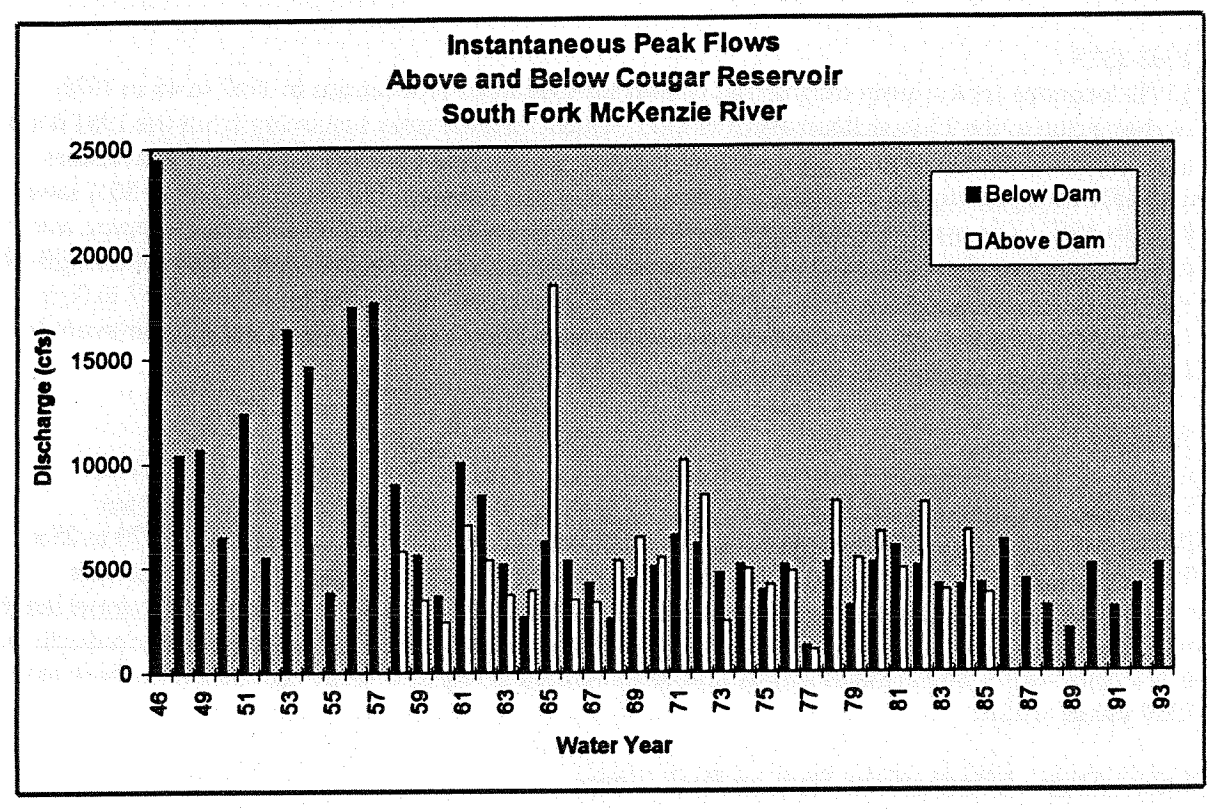


Figure 32.

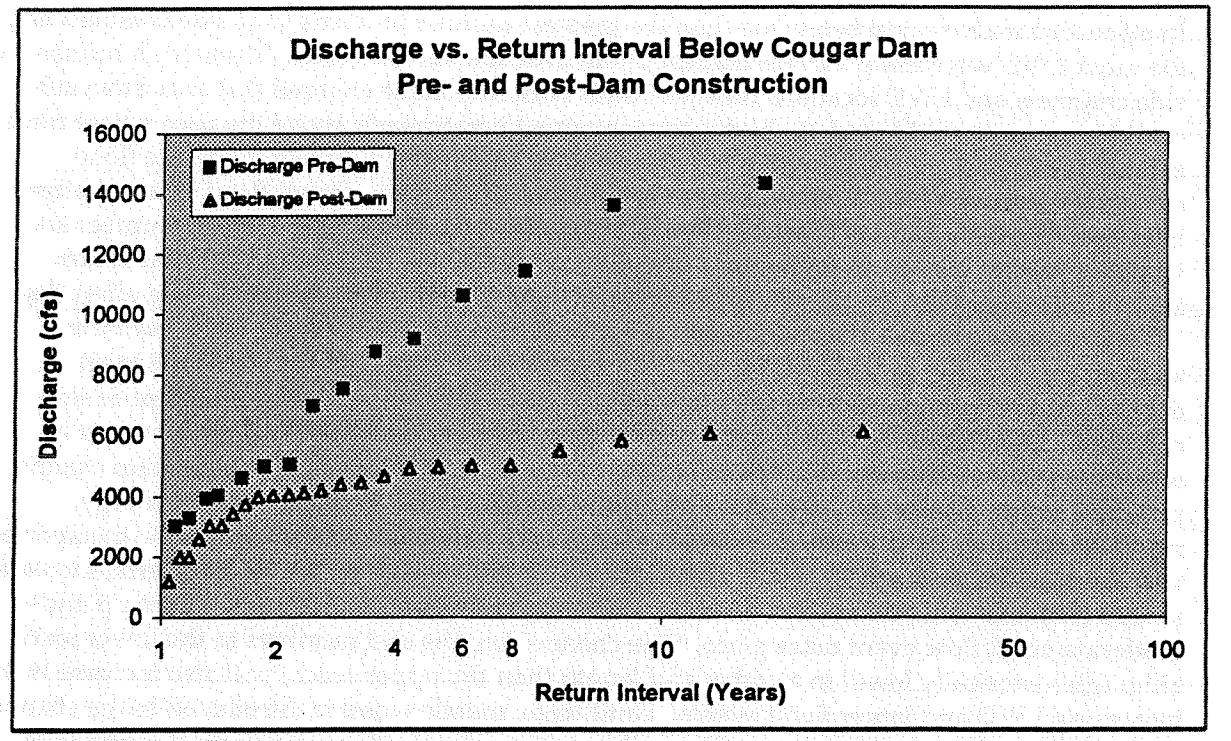


Figure 33

South Fork Mainstem Channel-Summary and Trends

The 1964 flood, not surprisingly, was the major event during the period of analysis whose effects overshadowed and drove generally all channel changes within the watershed. Exceptions to this statement are the effects that the dam had on the reaches below the dam, and the effects of LWD removal on channel complexity in all channel reaches. Based on aerial photo analysis of the six time intervals from 1939-1990, significant increases in channel width and area of exposed cobble and gravel bars were measured results from the 130-year flood event in both reaches above the dam. Because the dam was in operation during the 1964 flood, sediment and flood waters were held back, effectively discharging the equivalent of a 2-year flood flow below the dam. Rather than cobble and gravel bars accumulating and vegetated bars being "set-back" to unvegetated conditions as what occurred above the dam, the area of exposed cobble and gravel bars actually decreased 43% below the dam following the 1964 flood. Recovery from the 1964 flood continued above the dam through all photo series to the final analysis period of 1990, with exposed, unvegetated cobble and gravel bars becoming increasingly vegetated and stable, and active channel width narrowing. The trend of reductions in channel width and area of exposed cobble and gravel bars was slowing by the 1990 analysis, but small reductions may have continued from 1990 to present due to low flows from drought conditions.

Flood sizes, sediment availability and size, and channel stability are all factors that would influence the formation and maintenance of side channels in the South Fork McKenzie River.

In all cases for above and below the dam the greatest number and length of side channels and the most LWD were always in the earliest photo available for the reach. These high numbers of side channels and LWD locations reflect a South Fork McKenzie channel that was extremely complex as compared to today. In the unconstrained upper reach above the dam where most side channels occur, it would seem that side channels are formed during moderate flood events: those with a return interval of approximately 10-20 years. Small flood events (return interval 1-10 years) and very large events (100-year return interval) reduced the number and length of side channels. In the more confined lower reach, the 1964 flood (130-year return interval) increased the length of side channels, but the total number declined. The effect that LWD has on side-channel formation and maintenance could not be determined from this analysis. It is highly probable, however, that aggressive salvage of LWD from the main channel and side channels from 1964 through the early 1980's caused abandonment of side channels. LWD located at the mouths of side channels provide a hard surface for water to scour the channel, keeping the channel entrance clear of sediment. LWD in the main channel provides sediment storage sites and, as a roughness element to dissipate stream energy, provides stability. Results are less stream energy and less sediment available to be transported into the side channels which would close them off from water flow. In the long-term, increases in side channels will occur above the dam in the upper reach when LWD levels are up and a moderate sized flow event takes place. Side channel lengths and numbers in the lower reach, although historically lower in number and length than the upper reach, will also increase with increasing LWD and larger flood events. Until large, mobile wood is introduced to the channel and higher discharge events occur, the number and length of side channels may continue to decline into the near future.

Channel complexity has also been reduced where bank erosion is eliminated by riprap. Riprap 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 South Fork include the Hardy Creek and Homestead bridge (roads 1927 and 1900-430), cobble berms at the Twin Springs campground, and the Frech Pete road 19 old bridge crossing.

Based on field observations, LWD was found to be key in the formation of pools and the deposition of gravels in the upper reach above the dam. Often, long glides would be featureless until a piece of LWD caused scouring of the cobbles and gravels, forming a deep pool. The lower reach, with a more confined valley, higher gradient, and larger substrate of cobbles and small boulders was less dependent on wood for pool formation and sediment storage sites. In the lower reach, large pools were generally associated with bedrock outcrops and riffles contained numerous pocket pools. The majority of smaller sediment, mostly gravels, were generally transported down to the reservoir or accumulated on point bars or islands around the Rebel Creek/French Pete Creek area.

Below the dam, construction of Cougar Dam had profound effects on sediment availability and transport, discharge, channel pattern, and side channel habitat. Since 1953, the area of exposed gravel and cobble bars has continued to decline due to lack of flood waters and loss of sediment source. The reduction in flood flow and extreme loss in LWD have both contributed to a significant drop in side channel length and number.

Although the 1945 flood widened the channel below the dam, the reduced flows have decreased the channel capacity resulting in the channel continuing to narrow. Channel degradation immediately below the dam has caused channel armoring resulting in little gravels available for spawning. As the upper reach degraded, initially providing sediment to the lower reach, the channel pattern responded through a decrease in sinuosity in the lower reach. Since the initial transport of sediment from the upper to the lower reach, sediment availability has declined. The reduction in sediment coupled with lower peak flows has resulted in an increase in sinuosity in the lower reach. In addition, the lower peak flows have reduced the channel competence, causing the channel to aggrade in an attempt to increase gradient in a local section of the lower reach. Decrease in channel gradient immediately upstream of the aggrading reach has led to the formation of two chute-cutoffs which will shorten the channel length and decrease sinuosity. Downcutting through the chute-cutoffs has already commenced, with downcutting up the main channel a likely scenario into the future. The result will be further isolation of currently existing side channels upstream of the chute-cutoffs and downstream transport of smaller sized substrate.

Riparian Vegetation below the Dam

Riparian vegetation patterns along the mainstem South Fork are reacting to the flow and sediment deposition changes since construction of Cougar Dam. Communities once found near secondary channels, on depositional bars, and on floodplains are shifting due to natural successional processes as well as altered disturbance regimes. Decreases in high flows are allowing plants to establish in secondary channels and previously barren bars within the main channel. Many surfaces which experienced periodic flooding and fine sediment deposition are now unlikely to be inundated. Successional pathways for such previously vegetated surfaces differ from those documented for such communities since species respond not only to competition and microclimate shifts but also to soil conditions. In alluvial systems, deposition during flooding plays a significant role in soil development. Hawk and Zobel's work on riparian forests along the McKenzie (1974) established that edaphic factors were the major determinants in distribution and succession . Changes in deposition therefore can be expected to alter typical patterns for vegetated geomorphic surfaces below the dam.

Sediment movement can scour rooting zones and batter plants. However, fine sediment deposits provide fresh rooting media and allow establishment of pioneer species such as red alder, cottonwood, and willows. As sediments accumulate on bars and floodplains, they increase the water and nutrient holding capacity of the soil as they raise the level of the surface above the water table. Species tolerant of dry conditions can grow on old surfaces with coarse substrate (glacial outwash, cobble/boulder deposits), while species requiring moister soil conditions require accumulations of finer soils through flood deposits and incorporation of organic material. Since construction of the dam, area exposed to significant scour or significant new seed beds have

declined. Cobble bars and old channels are moving into shrub and alder types. Older floodplains no longer receive additions to the soil profile, while seedlings intolerant of periodic floods are no longer eliminated.

Data from a 962 foot long transect across the reach suggest trends in vegetation below the dam will be most significantly affected by

1) abandonment of secondary channels;
2) transformation of depositional bars into floodplains; and
3) transformation of old floodplains into terraces.

Decreased soil accretion on the old bars may deflect succession into a different plant association group than would have resulted under the previous regime. The transect crosses a portion of the valley bottom where the main channel has shifted back and forth over the period covered by the historic aerial photo series. Hence it has old channels, side channels, banks, floodplains, and terraces. The terraces show vegetation that Hawk and Zobel assign to the Douglas fir/California hazel-sword fern associations which they consider successional to a western hemlock/sword fern-oxalis type. This type (approximately 30% of the transect) requires fairly deep deposits of alluvium. Communities with similar understory vegetation but without all overstory components accounted for another 13%. Inclusions of conifer/Oregon grape communities were only 10% of the transect. These types tolerate drier, more well drained sites developed over soils with higher percentages of coarse fragments. Approximately a quarter of the transect is now in Hawk and Zobel's cottonwood community, 12% in their red alder type, and 2% in the willow type. Given the current flow regime from the dam, red alder communities can be expected to contract to 3% as areas along abandoned channels succeed to conifer types. In the absence of catastrophic flooding in the basin, little opportunity for cottonwood sites to be renewed or expanded is likely unless rehabilitation reverses the trend for eventual down-cutting and lowering of the water table, combined with limited seed bed availability. For cobble bars now beginning their succession toward conifer communities, it seems possible that they may succeed toward Oregon grape types instead of the more mesic sword fern or oxalis types due to limited soil development. Succession of the Douglas fir/sword fern-oxalis types toward the western hemlock associations may be somewhat retarded by slower rates of soil development on the lower terraces.

Numeric results from a single transect, of course, can not be extrapolated to the entire reach. The trends for the geomorphic surfaces and plant communities, however, may broadly apply to the lower alluvial valley segment of the South Fork.

Main South Fork Fisheries

The main South Fork McKenzie was surveyed in 1937-38 as part of a larger effort by the Bureau of Fisheries (BOF) to document spawning and rearing habitat for salmon and steelhead in the Columbia River Basin. These surveys are the earliest and most comprehensive documentation available of the condition and extent of anadromous fish habitat before hydropower development in the Columbia River Basin (McIntosh et al. 1994).

The methodology for the surveys included field work by foot, by horse or boat. Records were taken at approximately 100-yard intervals, with estimation of distances which were later checked against

maps for accuracy. Width and depth measurements were made with a tape or rule. Stations were designated along the length of the survey, usually at intervals of several miles, where important landmarks existed or stream conditions changed (Rich 1948 in McIntosh et al.). Seven stations were designated for the South Fork, resulting in six sections over 26.4 river miles (RM). Although the data is the most quantitative available for past conditions, there is no way to ascertain the exact quality (accuracy, variability, e.g. conducted on foot or horse). For instance many of the BOF surveys designated pools by six classes (McIntosh et al. 1994) based on area and depth, however only "resting pools" were recorded on the main South Fork survey. Resting pools are defined as pools greater than or equal to 25 square yards in area and > 2 feet depth, with enough area and depth to support adult chinook salmon (Sedell and Everest 1990).

The results of comparing the 1937-38 data with more recent stream survey data indicates an overall significant loss of large pool habitat in the entire main South Fork, excluding the area now inundated by the reservoir (Table 10). These results are similar to findings by Sedell et al. (1992) and Sedell and Everest (1990) of pool losses on the main South Fork between 75%-82%.

Comparison of 1937-38 Stream Survey Data
With OSU (1988) and USFS (1994) data on the South Fork

Reach "station"(1937-38)	Distance	Resting Pools	Pools/ Mile	Reach(1988/94)	Distance (thalweg)	Large Pools	Pools/ Mile	Percent Loss
Mouth to A (Cougar Creek)	3.0 miles	45	15.0	Mouth to Cougar Reservoir	3.0 miles *	17	5.7	62%
A to B (Cougar to Walker Creek)	2.9 miles	170	77.3	Majority inundated by Cougar Reservoir. No comparison possible				
B to C (Walker to French Pete)	5.6 miles	246	48.0	Majority inundated by Cougar Reservoir. No comparison possible				
C to D (French Pete to * Dutch Oven)	4.7 miles	188	38.4	Reservoir to Augusta Creek	6.5 miles	29	4.3	89%
D to E *(Dutch Oven to Frissell Crossing	7.6 miles	199	35.4	Augusta to Elk	9.6 miles	46	4.8	80%
E to F (Frissell Crossing to end of survey)	5.3 miles	45	8.5	Elk to end of R1 (USFS 94)	3.3 miles	15.8	4.8	
D to F	12.9 miles	weighted average	24.3	Augusta to end	12.9 miles		4.8	
GRAND TOTAL	29.1 MILES			GRAND TOTAL	28.4 MILES			

* Dutch Oven is located at approximately Augusta mouth.

Table 10

Spring Chinook - Past Condition

Except for the mainstem McKenzie, the South Fork was identified as the most important spawning tributary within the McKenzie River subbasin. When Cougar Dam was being planned the state of Oregon estimated that the South Fork supported a run of 3,000-4,000 spring chinook. The US Army Corps of Engineers noted a potential run of 6,000 adults (USACE 1956) and in the 1937-38 surveys the Bureau of Commercial Fisheries estimated spawning area available for "at least 13,000 salmon" in the South Fork McKenzie. An appraisal of the Cougar project by the US Fish and Wildlife Service (USFWS 1959) used the Corps' engineering data to look at affects on the fish and wildlife resources. They estimated a run size around 5,360 spring chinook based on redd numbers in 1956 (USFWS 1959). All of these estimates, except in 1938, were based on the spring chinook population in the McKenzie after it had begun to seriously decline in the 1940's (i.e. due to harvest, mainstem Willamette pollution, and other habitat impacts).

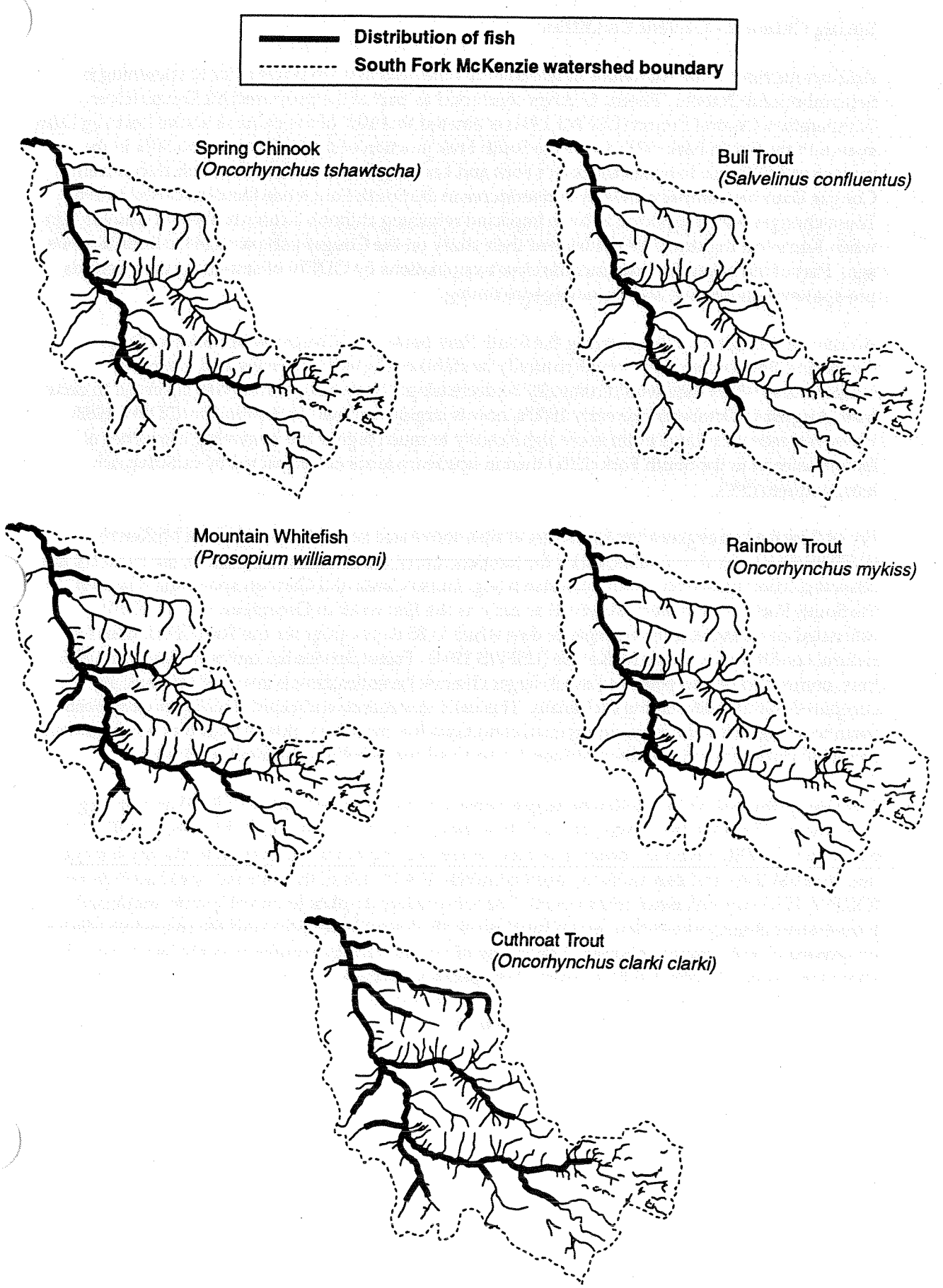
During construction of Cougar Dam (1956-1963) fish passage facilities were designed and added to the project. They consisted of a barrier below the dam to divert upstream migrating adults to an adult fish collector, and a fingerling multilevel bypass facility designed for 300 cfs discharge during the downstream migration period. The fishways were to be evaluated for the first few years Cougar was in operation (USACE 1944). From 1956-1959 the South Fork was unobstructed to fish passage (Ingram and Korn 1969). Projections of adult-to-redd ratios from the evaluation period of 1960-1966 suggested that over 5,200 adults may have returned to the South Fork in 1959 (Ingram and Korn 1969; Max Smith EWEB, 1994). The Corps built the McKenzie salmon hatchery for mitigation of 3,860 adults after the failure of the Cougar fish passage facilities.

Other Fish Species Prior to Cougar Dam Construction

Very little is known about population sizes, movements, or exact limits of upper and lower distributions of other fish species. Thus, the illustrated distribution, although based on field observations, is approximate (Figure 34).

Anecdotal information from local people who fished the South Fork prior to the dam, reveal a "Dolly Varden paradise" with numerous side channels along the South Fork. That the river was "intensively fished" was noted in the 1937-38 surveys, with few "good catches reported". Trail access had existed prior to 1934, but automobile access did not exist until 1934 (see Historical section). The USFWS Fish and Wildlife Coordination Act report (1959) documented all the species currently present in the South Fork (Table 5, page 34), except for lamprey and suckers. They indicated that the suckers might move in with reservoir clearing and changes in the South Fork habitat associated with construction activities. However, suckers were present in the lower section during the 1937-38 survey.

Figure 34. Approximate distribution of Salmonide fishes prior to Euro-American influences in the South Fork McKenzie River watershed, Western Cascades, Oregon.



Spring Chinook - Current Condition

Adults returning to the McKenzie in late-May to June hold in deep pools prior to spawning in September and October. Recent findings conducted as part of the proposed McKenzie River Temperature Control Project (USFWS 1994) estimated that 10% of the chinook above Leaburg Dam spawn in the South Fork, 60% above the South Fork junction of the McKenzie, and 30% in the mainstem McKenzie between the South Fork and Leaburg Dam. Altered flow conditions from Cougar Dam have impacted water temperatures in the South Fork since the dam closed in 1963. These changes were suspected to have impacted returning chinook adult numbers at Cougar Dam when Korn and Ingram (1969) published their study on the Cougar fish passage facilities 28 years ago. Part of the recent findings include close examinations by ODFW of spawning time periods, pre-spawning mortality, and fry emergence timing.

Adults are thought to delay entering the South Fork because of Cougar water releases (e.g. decreasing flows when they would naturally be stable or slightly increasing and warming temperatures when they would naturally be decreasing). Spawning, which was observed to occur from August to October in the early 1900's, now is largely confined to September (ODFW 1988). However, recent findings point more significantly to much higher pre-spawning moralities of female salmon in the South Fork (23%) than in upstream areas not impacted by out-of-synch temperatures (5%).

Fry (< 2 inches) emergence timing differs at sites above and below the South Fork McKenzie (USFWS 1994). At sites unaffected by the temperature of water released by dams, emerged fry are observed from mid-February to mid-March (e.g. Horse Creek and Carmen spawning channel). In the South Fork fry have been observed as early as the first week in December, which ODFW estimated as an average fry emergence date which is 85 days earlier for the South Fork than for natural conditions in upper McKenzie (USFWS 1994). Forest Service biologists (J. Capurso USFS, pers. comm.) have also observed much larger chinook juveniles downstream of the dam, as compared to other sites in the McKenzie. This early emergence and rapid development subjects them to a different suite of environmental conditions (i.e. predation, flows) than they evolved with, probably putting them at a disadvantage for survival compared to historical conditions.

The spring chinook in the McKenzie largely move out of the system as fry (> 90%) and no large movements of smolt-sized spring chinook have been observed in the upper McKenzie (ODFW 1988, Max Smith EWEB, personal communication). Some fish remain in the system to the smolt stage (i.e. one year old fish), but they make up approximately 10% or less of the naturally produced chinook (ODFW, USFS unpublished information). This observation applies to out-migrants unaffected by temperature during incubation, as well as those in the lower South Fork and the mainstem effected by unnatural temperature regimes. The timing of out-migrating juveniles is suspected to have been altered for those fish effected by unnatural temperature changes. Fry seining by ODFW found that a portion of the earlier emerging fry head into the mainstem three months earlier than the fry that emerge in the normal period of February to March.

Other Fish Species - Current Condition

Some of the current fish distribution and presence information wass presented in the Soil/Water/Fish subwatershed group discussions previously in this Chapter) However, additional information is available from biological probes conducted by Blue River Ranger District personnel from 1991 to present (Table 11).

Fish and Crayfish Observed During Biological Probes for Bull trout in the South Fork McKenzie Watershed

Stream	Date	Location from S Fk Confluence	Species Observed
Boone Creek	8/7-8/8/91	0-0.5 miles	cutthroat
Penny Creek	8/8/91	0-0.5 miles	cutthroat
Rider Creek	8/8/91	0-200 meters	cutthroat, crayfish
Ridge Creek	9/13/91	0-0.5 miles	rainbow, sculpin
Elk Creek	7/28/92	0-.10 miles	cutthroat, sculpin
Elk Creek	8/4/92	.25 mi, 1.25 mi, 2.5 mi	cutthroat, sculpin
Cougar Creek	8/12/92	0-200 meters	cutthroat
Walker Creek	8/12/92	Near double culvert at reservoir	suckers, cutthroat, sculpin, crayfish
French Pete Creek	8/25/92	Wilderness boundary upstream .25 miles	suckers, cuttroat, sculpin, crayfish
French Pete Creek	9/8/92	Road 19 bridge upstream 125 meters	suckers, cutthroat, sculpin, crayfish
Rebel Creek	9/8/92	0-300 meters upstream	cutthroat, suckers
Cougar Creek	10/22/92	1.0 mile - 100 meters upstream	rainbow, cutthroat, crayfish
McBee Creek	10/22/92	Roaring confluence - upstream 300 meters	cutthroat
Roaring River	10/22/92	Roaring River Campground	cutthroat, bull trout
Roaring River	10/20/93	0-0.8 miles	cutthroat, rainbow, one bull trout redd
Upper South Fork	7/18/94	Trail #3327 to Elk Cr	cutthroat, whitefish, sculpins
Elk Creek	7/18/94	0-0.2 miles	cuttroat, sculpin
Roaring River	7/20/94	0.0.2 miles	cutthroat, sculpin, whitefish
South Fork above Roaring River	7/20/94	50 meters above confluence w/RR	cutthroat, sculpin, whitefish
McBee Creek	7/21/94	FS Road 1958 crossing	cutthroat
Roaring River (below 4' falls)	7/21/94	Approx. 1.75 miles above mouth	bulltrout, cutthroat
Elk Creek	7/27/94	Wilderness boundary upstream 1,500'	cutthroat, sculpin
Roaring River (above 4' falls)	8/4/94	Approx. 2.0 miles above mouth	cutthroat
Upper South Fork	8/10/94	Trail #3327	cutthroat, sculpin
Upper South Fork	8/18/94	1.0 mi above Trail #3327	cutthroat, sculpin
Upper East Fork of the South Fork	9/1/94	10 miles above confluence w/South Fork	cutthroat

Table 11

Reservoir Operations Compared to Downstream Spring Chinook Life Stages

Based on a graph of the approximate natural hydrogragh (no dam), a comparison is discussed in relation to spring chinook life stages below the dam where the hydrograph has changed.
From December 1 to January 31 the reservoir is held at the minimum flood control level. This is the period when spring chinook eggs and alevins would be in the gravels if they did not hatch and emerge early due to increased water temperatures. Flows below the dam during this period are variable in order to maintain the minimum pool elevation. However, they do not usually fall below 750 cfs in order to maintain firm power generation. They are reduced to 100 cfs if needed to hold back flow for downstream flooding. This period could be the closest to the natural flow regime of those discussed, though it is reduced from pre-dam regimes.

From February 1 to May 10 the reservoir is filled and generally 300 cfs is released from the dam. Prior to the dam this period would be one of increasing flows from February into March with spring melt off, with a decrease into May. The flows would normally be at least four times the 300 cfs release. This is the rearing period and due to early emergence and lack of side channel habitat, fry and juveniles are suspected to leave the poor habitat in the lower South Fork.

From May 11 to November 30 water is released from the reservoir to augment flows in the Willamette Valley. Generally a 200 cfs release occurs from July to November 30, which would normally be a time of slowly decreasing flows, until October rains begin. The furthest departure from natural flows occurs at the end of this period when flows increase to 800 cfs. Temperatures, discussed elsewhere, also plays a large role in chinook behavior during this period. May to July flows are closer to natural flows than July to September when flows from the dam are increasing. Adult holding and spawning behavior is affected during this period.

Bull Trout - Current Condition

The current South Fork population is estimated to number between 150-300 adult spawners (Jeff Ziller ODFW, 1994), based on reports from recreational fishing catches. Recent angling regulations provide for release of all bull trout. There is limited additional information on the bull trout population in the South Fork, although information reported from recreational fishing catches has been compiled (Figure 35). Adult bull trout have been documented in Cougar Reservoir. Both redd and juveniles have been observed in the lower Roaring River (J.Capurso, pers. comm.). During 1994 snorkel surveys of the Roaring River bull trout were observed below a four foot falls around River Mile 2. They were not observed above the falls, however further surveys would be needed to determine if the falls is a true limitation to their distribution in the Roaring River.

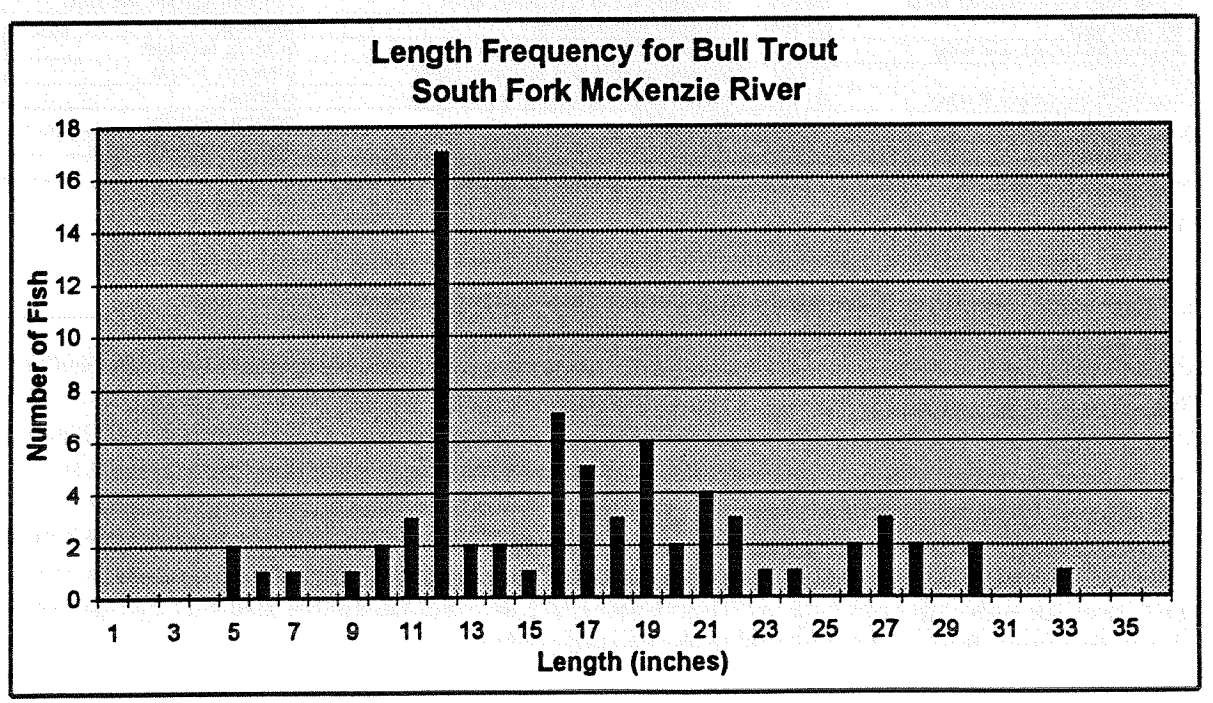


Figure 35.

Searches for bull trout in several other streams of the watershed have not revealed any further documented spawning or rearing of bull trout in tributary streams (Table 11). Observations have occurred in the mouths of streams such as Augusta and French Pete where they are suspected to forage during certain times of the year. There is no further information on population condition such as age class distribution, sex ratios, length/weight indices, or specific knowledge on the timing or extent of their movements in the South Fork watershed.

Aquatic Macroinvertebrates

The production of aquatic insects in the McKenzie River subbasin is considered to be abundant and diverse. Major groups include caddis, mayflies, stoneflies, and chironomid midges (ODFW 1988). With a few exceptions, invertebrate populations and their diversity in the South Fork McKenzie watershed have not been well documented. Research on cutthroat trout fry use and ecology of lateral stream habitats in three 3rd order streams in the McKenzie watershed, including a portion of Grasshopper Creek (tributary to Augusta Creek) has documented a relatively high abundance of chironomids (e.g. 30,000/sq. meter). In addition, other insects found are oligochates, hydracarinid mites, ostracods, and harpacticoid copepods (Moore and Gregory 1988). Collector-gatherer and shredder functional groups dominated in the detritus reach lateral habitats (Moore 1987). The downstream effects of Cougar Dam (temperature, discharge, and sediment/bedload impacts discussed elsewhere) to invertebrate production and diversity in the lower South Fork are not well documented. A decrease in diversity of invertebrates has been noted below dams in similar cases (Cushman 1985, Hunter 1992).

11) LAKES AND PONDS

Hundreds of lakes lie within the watershed, most of which occur in the wilderness area. There are 626 acres of lakes in the wilderness; 37 acres outside of wilderness. The formation of the lakes are by two processes: glacial scour or earthflows. The glacially scoured lakes generally are located within the wilderness (Roaring/Elk Subwatershed), and those formed by earthflows are found in the Ridge/Boone Subwatershed. All the lakes within the watershed are fed by groundwater and snowmelt. Many of the wilderness lakes are stocked with hatchery fish every few years. The primary species are book trout and rainbow trout.

Conditions

Based on surveys performed on three wilderness lakes within the South Fork Watershed (Mink, Mac, and Porky) and other surveys performed on other glacial lakes within the wilderness but outside of the watershed, the lakes trophic status is either ultraoligotrophic or oligotrophic. These classifications mean that the lakes are very unproductive, or have low organic production as determined by low concentrations of phosphorus, chlorophyll, and phytoplankton. These lakes are typically characterized by very clear water and low rates of primary productivity. A survey performed on Hidden Lake, the largest of the earthflow formed lakes, indicates that the trophic status is oligotrophic based on concentrations of chlorophyll and phytoplankton. Nitrate concentrations were low in all lakes, however, the total phosphorous concentration was high (16 ug/L) in Hidden Lake compared with the other lakes (Mink 3 ug/L; Porky 9 ug/L; and

Mac 7 ug/L). In addition, analysis of zooplankton diversity and densities can be an indicator of lake health. While Mink, Mac, and Porky were all determined to be stable based on zooplankton species diversity and sizes, Hidden Lake appeared to be stressed. The low diversity of zooplankton in Hidden Lake is likely a result of high predation by fish. Although Hidden Lake is considered to be oligotrophic, zooplankton numbers and phosphorous concentrations indicate that the lake is potentially in transition toward mesotrophic trophic status due to external impacts.

PROCESSES AT WATERSHED LEVEL

WATER

Peak Flows and Determination of Relative Contributing Areas

To determine the relative contribution of the South Fork watershed to a potential rain-on-snow event, three factors were considered:

- snow accumulation,
- snow-melt rate, and
- groundwater storage capacity.

Snow accumulation zones were determined from the potential vegetation layer which is a function of elevation and aspect. Three zones of snow accumulation were identified: High - the ABAM and TSME zone (true fir and mountain hemlock); Moderate - the TSHE zone (Douglas-fir and western hemlock); Low - the PSME (climax Douglas-fir).

Elevation (based on the potential vegetation groupings) and aspect were the two parameters used to model the potential snowmelt rate that might result from a storm event with high winds and high air temperatures. Since these type of storm events typically approach from the southwest, areas of high elevation and a north or northeast aspect were considered to have a "low" snow-melt rate. In contrast, areas of low elevation and a south or southwest aspect were rated as having a "high" snow-melt rate. Using these basic principles of increasing melt rates with decreasing elevation and more southerly aspects, and decreasing melt rates with increasing elevation and more northerly aspects, GIS was used to model and produce a map of potential event-driven snow melt rates.

Groundwater storage capacity is directly related to soil depth. Therefore, soil depth was used to assign a "high", "moderate", or "low" value to the soils' ability to hold water. Where soils were deep, storage was rated as "high", and shallow soils were rated as "low". Those soils with "low" values and little storage capacity would be the greatest contributors to rain-on-snow events. The combination of all three factors, snow accumulation, snow melt rate, and groundwater storage resulted in Figure 43. Note that most of the watershed rated as having "high" contribution potential is located in the wilderness on the north and east side of the South Fork McKenzie River due to the south and southwest aspects. Other areas within the watershed that are potential contributors to rain-on-snow events are Augusta, Loon, Starr, and Hardy subwatersheds. These areas are rated as "high" potential contributors due to their elevation range, aspects of south, southeast, southwest, and northwest, and shallow soils. Although some of the area in the Rider subwatershed is classified as "high", it would more accurate to label the "high" areas as "moderate" due to the very deep soils.

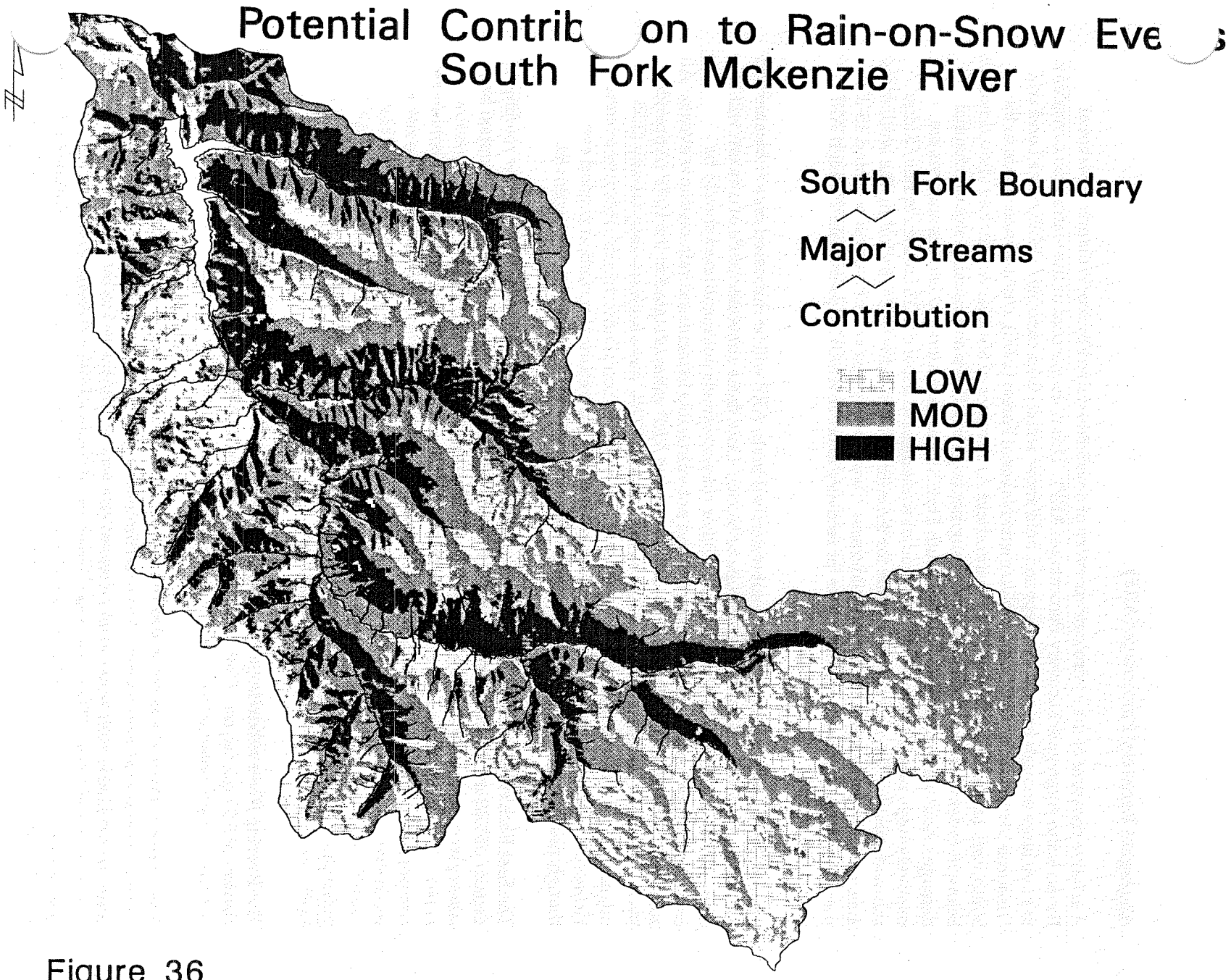

Potential Contrib on to Rain-on-Snow Eve s
South Fork Mckenzie River
South Fork Boundary
Major Streams
Contribution
LOW
MOD
HIGH

Figure 36

Aggregate Recovery Percentage (ARP)

A relative measure of the hydrologic recovery of a watershed used by the Willamette National Forest is the Aggregate Recovery Percentage (ARP). This is the percent of the watershed considered to have large enough trees to intercept and hold snow within their canopies. Within the Land and Resource Management Plan for the Willamette National Forest (1990), the subwatersheds in the South Fork (excluding wilderness) have threshold ARP values of 65-80%, which they should not fall below in order to reduce the possibility of augmenting peak flows and causing stream channel damage. ARP values calculated for the South Fork McKenzie watershed for this analysis are relatively high, ranging from 99% recovered in wilderness to a low of 72% in the Penney/Ridge sub-watersheds. The average ARP value for the entire watershed is 87.2% including the wilderness area, and 82% for the area excluding wilderness. Since the highest rate of harvest occurred 15-25 years ago, there has been sufficient time for recovery to occur which helps explain the high ARP values (Figure 14).

Since ARP values are calculated on a subwatershed basis, ARP will be discussed on a subwatershed basis rather than by subwatershed groups or blocks. Only those subwatersheds of concern will be discussed in the next several paragraphs. Other subwatersheds not mentioned should be considered to be hydrologically recovered and not vulnerable to increased rain-on-snow events. All subwatersheds are currently above the recommended ARP value as stated in the LMP (Appendix FW4). Cougar Creek subwatershed has an ARP value of 77%, has a high roading density (3.58 mi/sq.mi.), and has its south facing slope as a potential high contributor to rain-on-snow events. However, due to the large substrate and amount of LWD, the channel condition is good even though peak flows have possibly increased within this subwatershed due to management.

The East Fork subwatershed currently has a relatively high ARP value of 88% and a low roading density of 1.49 mi/sq.mi. However, all of the harvest that has occurred within this watershed has taken place on the south facing slopes that have high potential for contributing to rain-on-snow events. The entire north facing slope is within wilderness. Since the channel banks and bottom are composed of cobble, small boulders, and bedrock, and the amounts of LWD are good, the risk is moderate to low of severe impacts to the East Fork of the South Fork channel as a result of high peak flows. It should be recognized that augmentation of peak flows within this subwatershed is potentially high, and that concentration of harvest units on the south facing slopes may reflect a higher concern than the ARP value indicates.

The Roaring River subdrainage has a high ARP value of 84%, but has a moderately-high roading density of 3.25 mi./sq.mi. Due to the deep soils and more northerly aspects, the subwatershed does not have a high potential for contribution to rain-on-snow peak flow events.

Road density was not a factor in determining the relative contribution of the watershed for potential contribution to peak flow events. Snow accumulation and melt rates were a factor, but the ability to route any available melt water at an increased rate was not considered in building the "contribution to rain-on-snow" map. Therefore, road density must be an additional consideration when determining possible sources for increased peak flows. Although road densities within the Roaring River subdrainage is high, most are concentrated in the flat, southeast area know as "Skookum".

The majority of the roads in the Skookum area are dirt spurs that are located on deep soils with high infiltration rates. Thus, most roads do not have ditchlines or ditch relief culverts that could transport water more quickly.

High potential for increased flows exist from the southwest facing aspect adjacent to Roaring River from its mouth up to the junction with McBee Creek Although the channel is very stable with small boulder, cobble, and bedrock bottoms and banks, potential does exist of augmenting flows through extensive harvest of this southwest facing slope.

Peak flows within lower Augusta Creek may have increased due to roading and harvest. The ARP value for the lower Augusta and Loon Creek subwatersheds is 73%, and the roading density is 3.75 mi./sq.mi. Many of the harvest units and roads within the lower Augusta subwatershed are located within the area that has high potential contribution to rain-on-snow events.

Starr Creek subwatershed and Hardy Creek subwatershed have moderate ARP values of 79% and 81%, respectively. Both have high roading densities at 3.13 miles per square mile for Starr, and 4.62 miles per square mile for Hardy. Management activities on the south facing slope within Starr Creek subwatershed, including road building and harvest, occur within areas of high potential rain-on-snow contribution. The location of harvest units coupled with the high road density, may have caused increased flows within the Starr Creek channel. The west and northwest facing slopes within Hardy Creek subwatershed are the areas of high rain-on-snow potential, and contain roads and harvest units. Increased peak flows within the Hardy Creek subwatershed are suspected due to the high road density, and are of particular concern due to the nature of the channel banks and the poor channel condition. The earthflow on the north side of the channel impinges on the channel making the channel very susceptible to massive bank failures resulting from high flows.

The Penny/Ridge subwatershed has an ARP value of 72% and a road density of 4.87 mi./sq.mi, the highest road density in the South Fork watershed. Due to the deep soils and more easterly aspects, the subwatershed does not have a high potential for contribution to rain-on-snow peak flow events. However, the same argument outlined in the Roaring River subwatershed discussion concerning roads applies in the Penny/Ridge subwatershed. Road density was not a factor in determining the relative contribution of the watershed for potential contribution to peak flow events, but the high road density may increase the rate at which available melt water is routed to the channel. Therefore, it is possible that peak flows may have increased within Penny Creek and Ridge Creek due to rapid routing of melt-water. Penny Creek and Ridge Creek are very susceptible to large streamside bank failures because of their location within an old landflow. Good amounts of LWD have helped to keep them in relatively good condition, but high flow events can easily trigger bank failures. The result is mass wasting and sedimentation of the channel, as has been observed near the mouth of Penny Creek.

Deathball subwatershed has a high ARP value of 83%, but the road density is relatively high with 3.81 mi./sq.mi. Potential exists for rapid routing of melt-water from the roads to the stream channel, causing increased peak flows. However, nearly all the road miles are located down on the flat near the South Fork McKenzie River channel where interception of melt-water and increased routing rates would not occur. Even so, an increase in melt-water resulting from that small of an area would not cause a measurable increase in peak flows within the South Fork McKenzie River.

Although the Grasshopper subwatershed has a high ARP value of 83%, the road density is 3.81 mi./sq.mi, a value that could potentially be contributing to higher peak discharges in Grasshopper Creek Some of the roads and harvest units also lay within areas determined to be high potential contributors to peak rain-on-snow events.

Summer Base Flows

Potential for a reduction in streamflow within the South Fork watershed during summer months was not considered an issue. The quantity of surface flow is generally adequate for aquatic life, with subsurface flow occurring very rarely and only in the mouth of Starr Creek In fact, many studies in the past have indicated that stream flows increase during the summer months following timber harvest as a result of 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). However, a study in the Bull Run Watershed (Portland, OR) has documented a decrease in streamflow as a result of reduced fog drip (Harr, 1982; Ingwersen, 1985). In this same study, the effect of decreased streamflow is apparent only during early summer, and the reduction in fog drip recovers 5 or 6 years following harvest.

To determine the relative contribution of the South Fork watershed to summer base flow, three factors were considered:

- snow accumulation,
- seasonal snow-melt rate, and
- groundwater storage.

The same snow accumulation and groundwater storage maps used for developing the rain-on-snow potential map were used in determining the contributing zones to summer base flows. Snowpacks at the higher elevations which persist into the late summer months were considered to be the source for summer base flows. Melt rates for the summer months are driven by "non-event" weather, where southeast-southwest aspects at low elevations are the earliest to melt. Increasingly higher elevations and more northerly aspects will experience later snow melt. Combining the snow accumulation map, snow-melt rate map, and groundwater storage map yielded a map entitled "Estimated Contribution to Summer Base Flow", Figure 45. Areas of "high" snow accumulation, "low" snow-melt rate, and "high" groundwater storage resulted in areas within the watershed with "high" potential to contribute to summer base flow. With diminishing snow accumulation and groundwater storage, and increasingly higher snow-melt rates, the area within the watershed potentially contributing to summer base flow decreased. Naturally, the high

elevation areas with northerly aspects, especially in the Roaring River and Elk Creek subwatersheds, and Mink Lake Basin, are high contributors to summer base flows. Other high contributors are located throughout the basin at the higher elevations and northerly aspects, particularly in the wilderness area and the headwaters of Augusta, Loon, Hardy, and Penny subwatersheds. At moderate elevations, deeper soils coupled with northerly aspects in the earthflow group (Boone/Hardy group) are potentially high contributors to summer low flows. Another potential high contributor to summer base flows is on the flat but slightly north facing ground in the Deathball subwatershed. The deep soils within this area provides good groundwater storage for contribution to summer flows.

Estimated Contribution to Summer Base Flows
South Fork McKenzie River

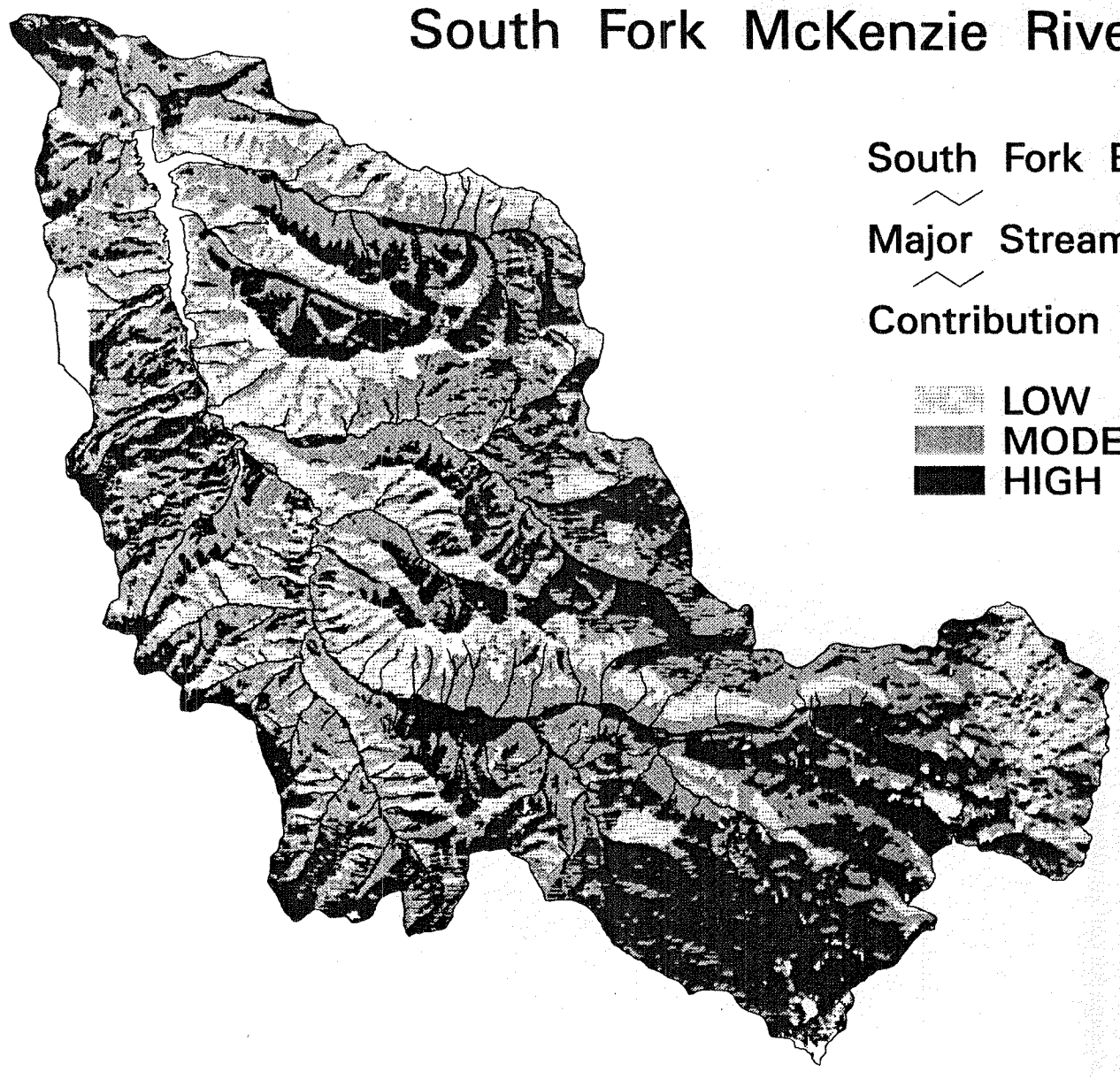


Figure 37

Water Quality - Stream Temperature

Stream temperature data on the South Fork McKenzie River is available at the gaging station above the reservoir from water year 1958-1987, and below the reservoir from 1947-present, with several years of missing records within that period. Water quality standards established by the state and published by the Oregon Department of Environmental Quality require that for stream temperature in the Willamette Basin "no measurable increases shall be allowed outside of the assigned mixing zone, as measured relative to a control point immediately upstream from a discharge when stream temperatures are 58 °Fahrenheit (F.) or greater; or more than 0.5 °F. increase due to a single-source discharge when receiving water temperatures are 57.5 °F. or less; or more than 2 °F. increase due to all sources combined when stream temperatures are 56 °F. or less, except for specifically limited duration activities which may be authorized by DEQ..." (Dept. of Environmental Quality, 1992).

Since no measurable increases are allowed when stream temperatures are 58 °F. or greater, the number of days that stream temperature exceeded 58 °F. was plotted (Figure 46). Data used for the plot was collected by the USGS from the gaging station above the dam. Note that for above the dam, the temperature was exceeded for eleven of the 14 years for which data was available. Where only partial data was available for stream temperature, no average was calculated. Another way to look at stream temperature is to view the number of consecutive days on an annual basis that stream temperature exceeds 58 °F (Figure 47). This figure displays the number of consecutive days that stream temperatures exceeded 58 °F for a given year. The size of each "block" within a column represents the number of consecutive days temperatures exceeded 58 ° prior to a cooling trend. A large "block" within a column means there were several consecutive days that temperatures were high. The number of days that warm stream temperatures are sustained day after day can help determine the stress put on aquatic organisms. One day of 60 degree water temperature is not as detrimental as five or six days in a row. Note that although 1967 has many total days that temperatures exceed 58 °. F., the number of consecutive days that these temperatures were sustained is relatively low compared to other years with high total number of consecutive days.

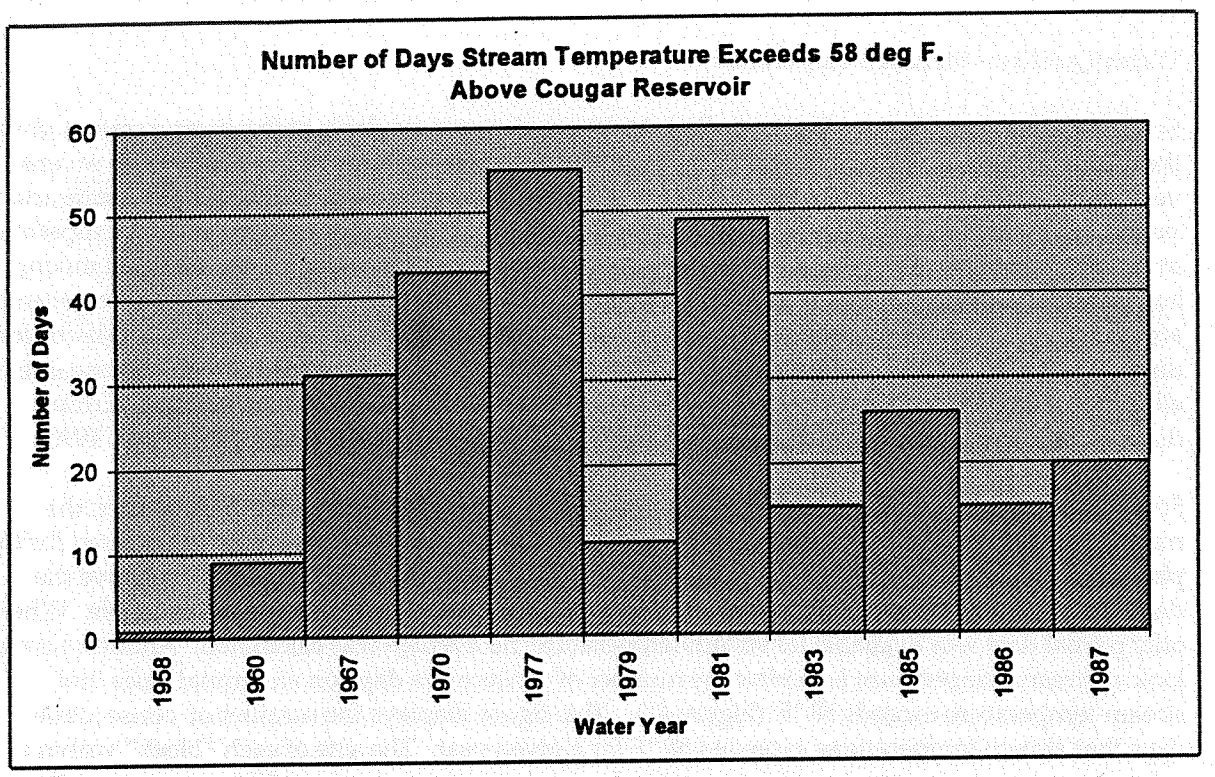


Figure 38

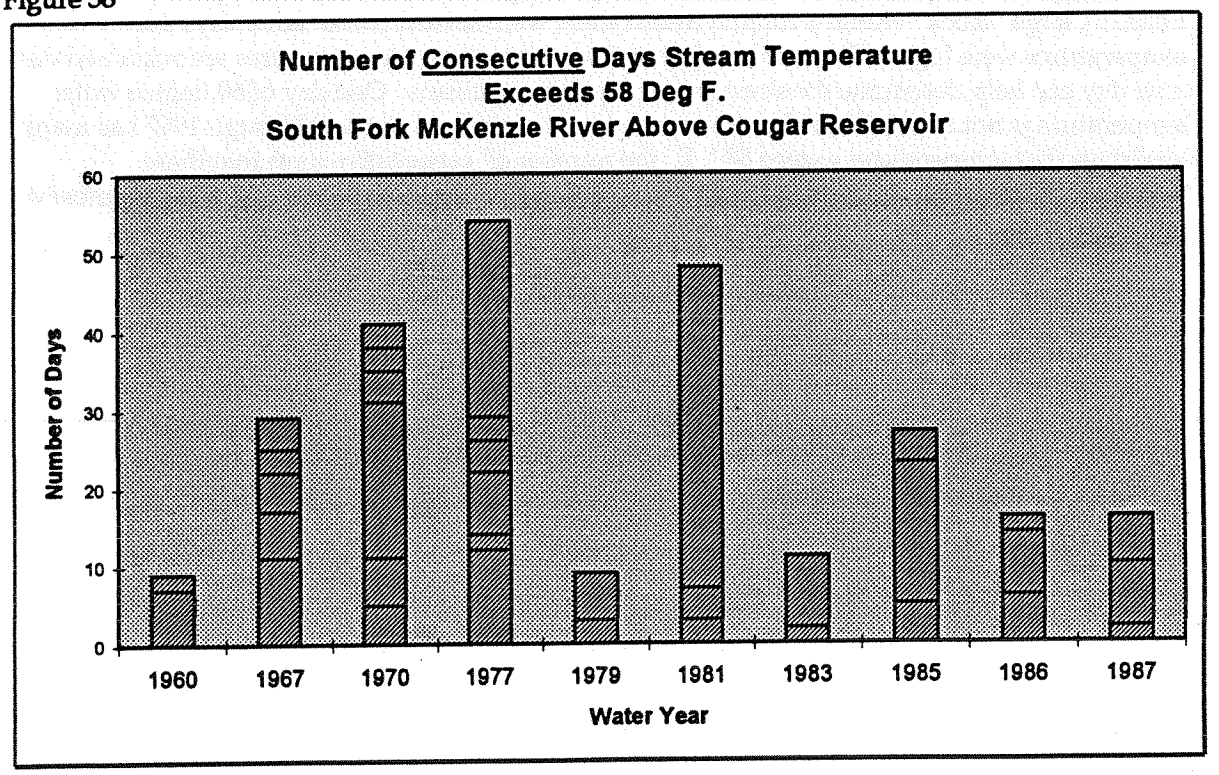


Figure 39

To help explain the stream temperatures in excess of 58 °F., comparisons were made between average maximum stream temperature and average minimum discharge for July and August (Figure 40). Although low stream discharge is a contributing factor to the higher stream temperatures such as in 1977 and 1981, discharge is not the only variable explaining higher or lower stream temperatures. Other environmental factors such as cool or cloudy weather would contribute to stream temperatures.

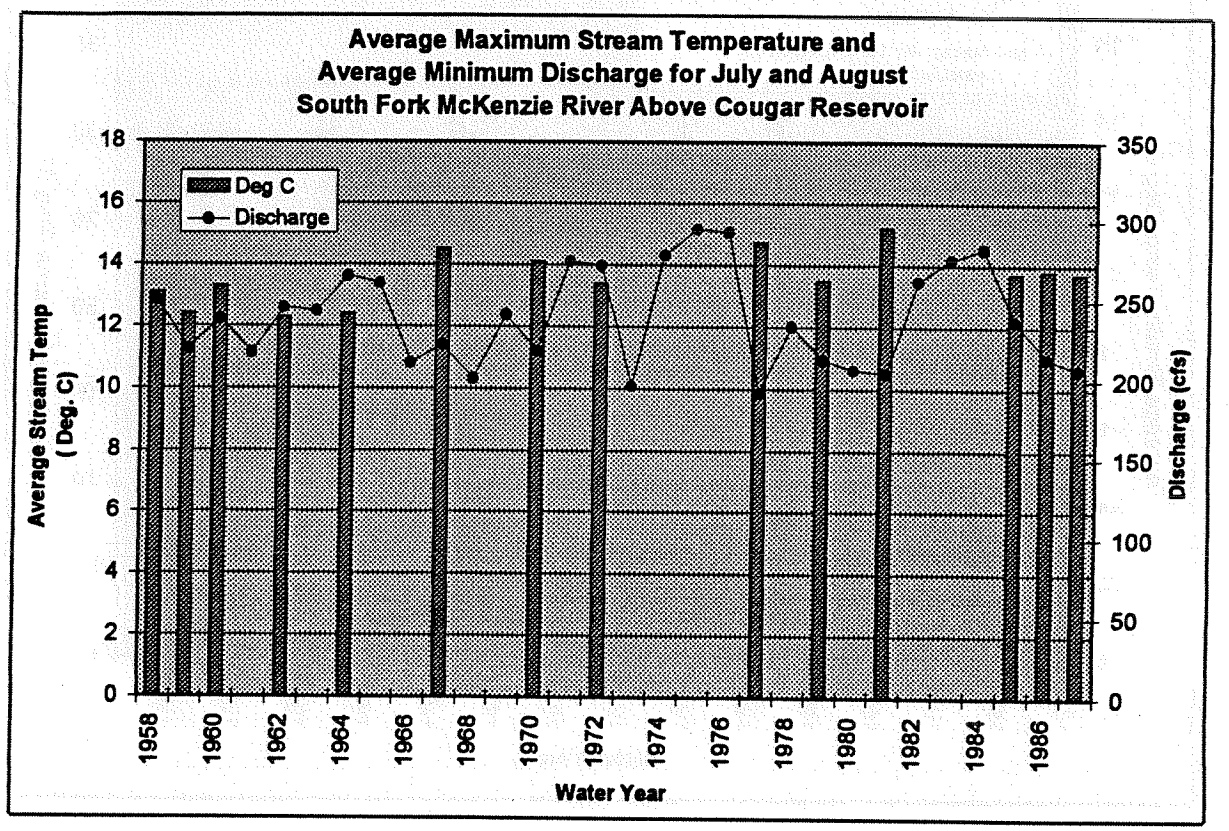


Figure 40

Figure 41 displays the average maximum stream temperature for July and August and average maximum air temperature for June, July and August. 1959 data was used as a control period with discharge and air temperature values in an average range, and average maximum stream temperatures approximately 56.3 °F. (13.5 ° Celsius). Discharge values for 1959, 1967 and 1970 are all approximately the same value. However, air temperature values are higher for both 1967 and 1970 as compared with the value for 1959. Thus, higher air temperatures in 1967 and 1971 may, at least in part, explain the higher stream temperatures. In 1977, air temperature was equivalent to values in 1959, however, discharge in 1977 is the lowest for the period of record. The driving factor for the high values of stream temperature in 1977 is probably the low flow values.

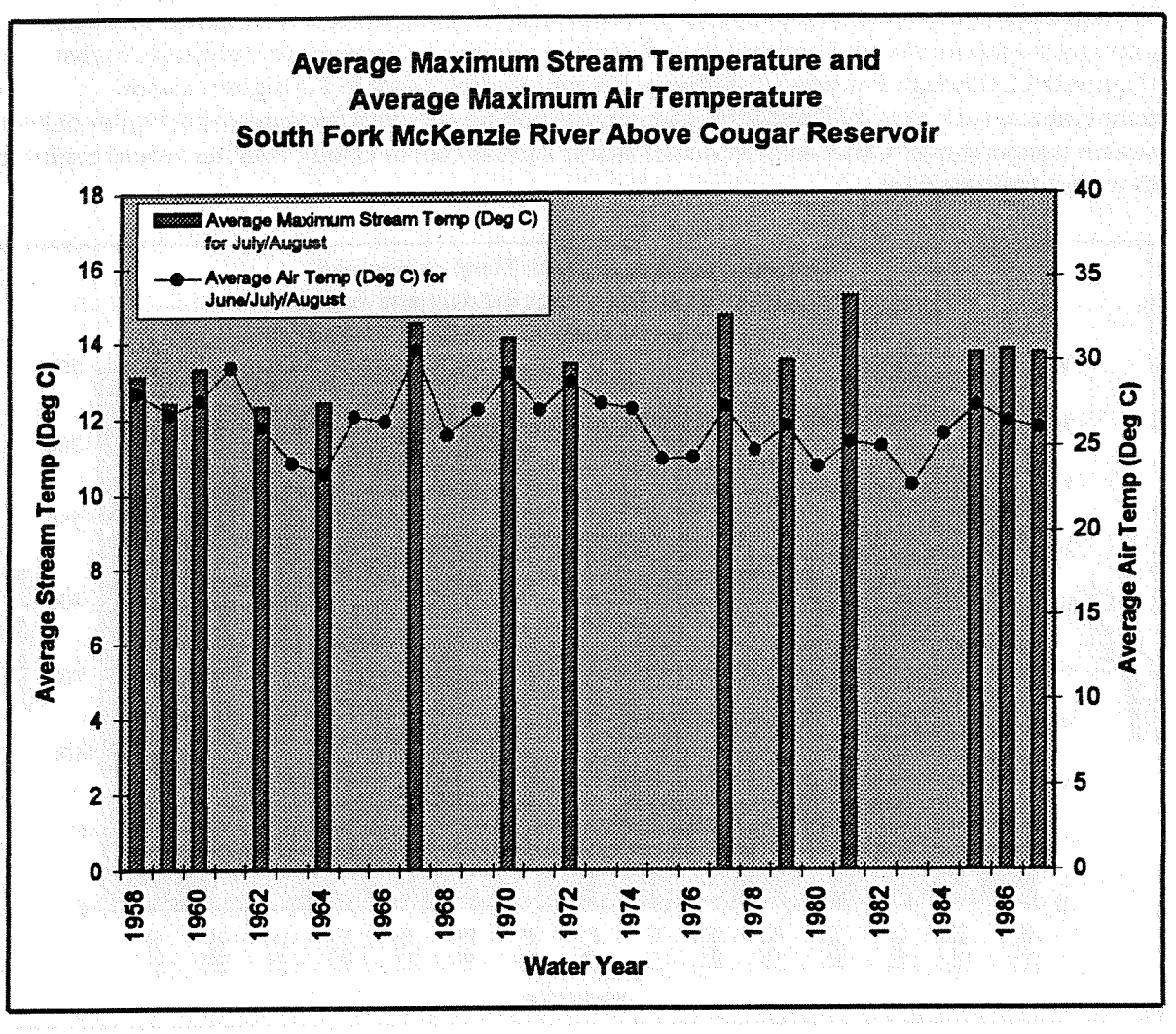


Figure 41

The values for stream temperature in 1981 can only be explained by variables other than environmental factors of stream discharge and air temperature. Comparison of 1959 values to 1981 values could not be made as discharge and air temperature in 1981 was lower than in 1959. However, comparison of the 1981 values to the more recent years, particularly 1987 values, indicate that stream temperatures in 1981 are high for the given flow and air temperature. Although discharge values are approximately the same in 1981 and 1987, and even though air temperatures are lower in 1981 than in 1987, stream temperatures are higher in 1981 than in 1987. Since harvest activities were at a peak in the 1970's, it is probable that harvest of riparian areas contributed to the high stream temperatures in the early 1980's. The good news is that the trend for increased stream temperatures was declining into the late 1980's. Additionally, stream buffers left on harvest units beginning in the mid-1980's should ensure a continued decline in high stream temperatures that result from timber harvest.

The number of days for which stream temperatures were in excess of 50 °F. (Figure 42) is displayed to determine how suitable the main South Fork immediately above the reservoir is to bulltrout migration. Required temperatures for migration (July-September) are 50-54 °F. and in some years there appear to be periods when temperatures exceed 50 °F for a significant number of days. Spawning and rearing require even colder temperatures. Spawning (September-October) 38-50 °F., and rearing (year round) 38-48 °F. (USFWS 1994).

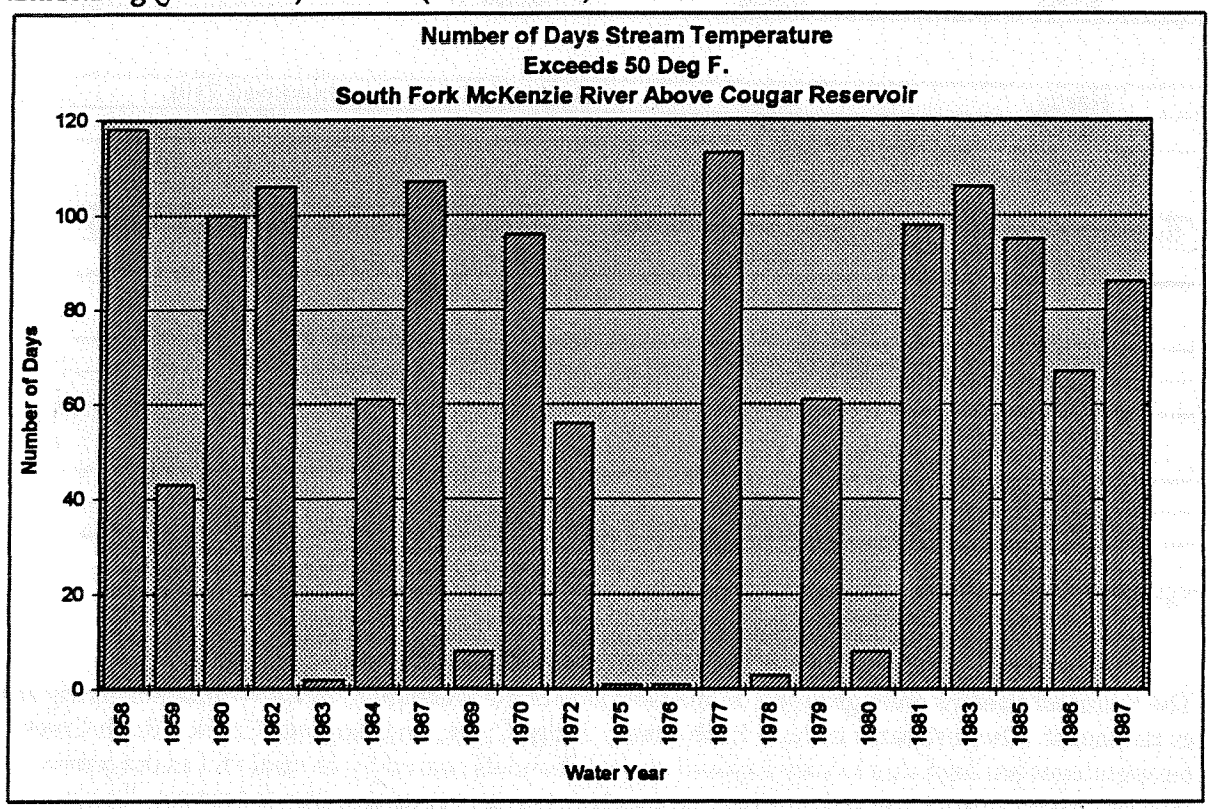


Figure 42

To locate sources of cold water from South Fork tributaries maximum-minimum thermometers were placed in twenty locations within the watershed. The thermometers were set into the streams on August 1, and read on a weekly basis for four weeks. Table 12 shows the range of values of the maximum and minimum values for the four week period ending August 31, 1994.

As suspected, the cold sources are grouped in the upper watershed and are fed by the snowmelt waters. Snowmelt is filtered through glacial terraces and outwash, and younger volcanic rock. These streams include Roaring River and its tributary McBee Creek, the upper mainstem of the South Fork above Elk Creek, and Elk Creek itself. The low temperatures of Elk Creek are surprising due to the extensive riparian harvest within the lower two miles of the stream and it's high exposure to solar radiation. It is probable that the stream temperatures of Elk Creek would be even cooler with regrowth of the stream canopy, and that the temperatures may be more akin to those found in Roaring River.

Range of Maximum & Minimum Stream Temperatures for South Fork Tributaries (Deg F.) Aug 1 - Aug 31, 1994

Rush	Basalt	Boone	Ridge
53-63	52-56	51-58	54-61

Hardy	Starr	Augusta Cr.	Unnamed Trib.
49-59	55-56	50-61	52-56

Roaring R.(mouth)	Roaring R. (below McBee)	McBee	Roaring R.(above McBee)
41-45	39-45	40-43	39-45

Elk	South Fork (abv Elk)	Cascade	Rebel
44-54	42-49	50-53	51-55

French Pete	Walker	East Fork	Cougar
51-59	52-55	55-56	50-56

Table 12

The warmest streams were grouped on the west side of the watershed, those watersheds facing east or northeast. Those streams include Rush Creek, Ridge Creek, and Augusta Creek. Rush Creek temperatures are high due to very exposed stream channels caused by natural and management induced debris torrents, as well as direct removal of riparian vegetation due to harvest. This is supported by temperatures observed within Basalt Creek, which is also located on the west side of the watershed, has intact riparian vegetation, and has relatively low stream temperatures. Ridge Creek (and likely Penny Creek) probably has high stream temperatures as a result of harvest of approximately 1/3 of the riparian vegetation along the channel, and narrow stream buffers where riparian vegetation was left. Augusta Creek is relatively warm due to aggradation of the channel and removal of riparian vegetation along the lower sections of the stream.

The remaining streams follow closely the warmer streams. Interestingly, Hardy Creek did not have as warm temperatures as expected considering the extent of channel aggradation and riparian harvest (58%). French Pete stream temperatures were in the same range as Hardy Creek and yet has no significant management history. Warm temperatures in French Pete are probably due to the aspect (west facing), as well as opening of the stream canopy due to debris torrents triggered by the 1964 flood. It was postulated that the smaller, north facing tributaries may provide cooler water than the south facing tributaries. However, an unnamed north facing tributary draining the north side of Chucksney Mountain proved warmer than Cascade Creek which is south facing. The unnamed tributary was one of the few north facing streams which flowed during the summer months.

Unfortunately, the creek flowed through approximately one third of a mile of harvest units immediately upstream of the thermometer location.

Water Quality - Sediment Contributions to the Mainstem

Relative rates of sediment introduced from tributaries into the South Fork McKenzie River were estimated for pre- and post- management time periods. Major tributaries were ranked as "high", "moderate", or "low" contributors of sediment relative to each other. This was based on fire history, hillslope processes, landtype, channel type, and current channel condition. Pre-management is from the 1800's to about 1950 and witnessed several fires and floods. Figure 43 shows the relative sediment yield rate for pre-management conditions. Several fires within the wilderness area and the Starr and Loon subwatersheds, coupled with the steep terrain probably pumped a lot of sediment into the East Fork, Walker, French Pete, Rebel, Starr, and Loon channels. Fires within the Roaring River area caused only moderate amounts of sediment input into the Roaring River channel due to its stable, flat terrain in the upper headwaters. However, Roaring River's tributary, Moss Creek, was a high contributor due to its relatively steep, unstable terrain. The Augusta Creek area was a moderate contributor, while its tributary, Loon Creek, and the Starr Creek area was high due to fires and relatively steep, unstable ground. The Hardy Creek subwatershed was a moderate contributor mainly due to its unstable south slopes, while the remaining streams in the stable earthflow area, Ridge, Penny, Rider, Annie, and Boone Creeks, were low contributors. Fires and unstable ground in Basalt Creek warranted a high rating of sediment contribution, while natural debris slides in Rush Creek caused some moderate input of sediment to the South Fork system. Cougar Creek was also low due to the stable nature of the subwatershed.

Within the past 40-50 years, the relative rates of sediment yield to the main channel changed for various reasons. Figure 44 displays the relative sediment yield rates from major tributaries for the post-management period of 1950 to present. Recovery from fire within many of the subwatersheds reduced the relative contribution of sediment delivered to the main channel as compared with pre-management rates. Some of the channels that reduced their relative input from high to moderate due to fire recovery include the East Fork, Walker, French Pete, Rebel, Moss Creek, and Basalt Creeks. Roaring River's relative contribution also reduced from moderate to low due to recovery from fire. The channels within the stable earthflow landform have remained the same as during the pre-management era, with a low relative contribution of sediment. The exception is Hardy Creek, whose relative sediment yield rate increased from moderate to high due to management. Although the relative sediment yield rates from Starr and Loon Creeks remained high due to natural instability, Augusta Creek and Grasshopper Creek rates increased from moderate to high rates. The increase in rates for the Augusta and Grasshopper subwatersheds is due to increased sediment input as a result of management activities. The Rush Creek subwatershed remained at moderate rates of sediment input due to natural instability, while that of Cougar Creek increased from low to moderate due to roading and harvest of the riparian area in the early 1950's.

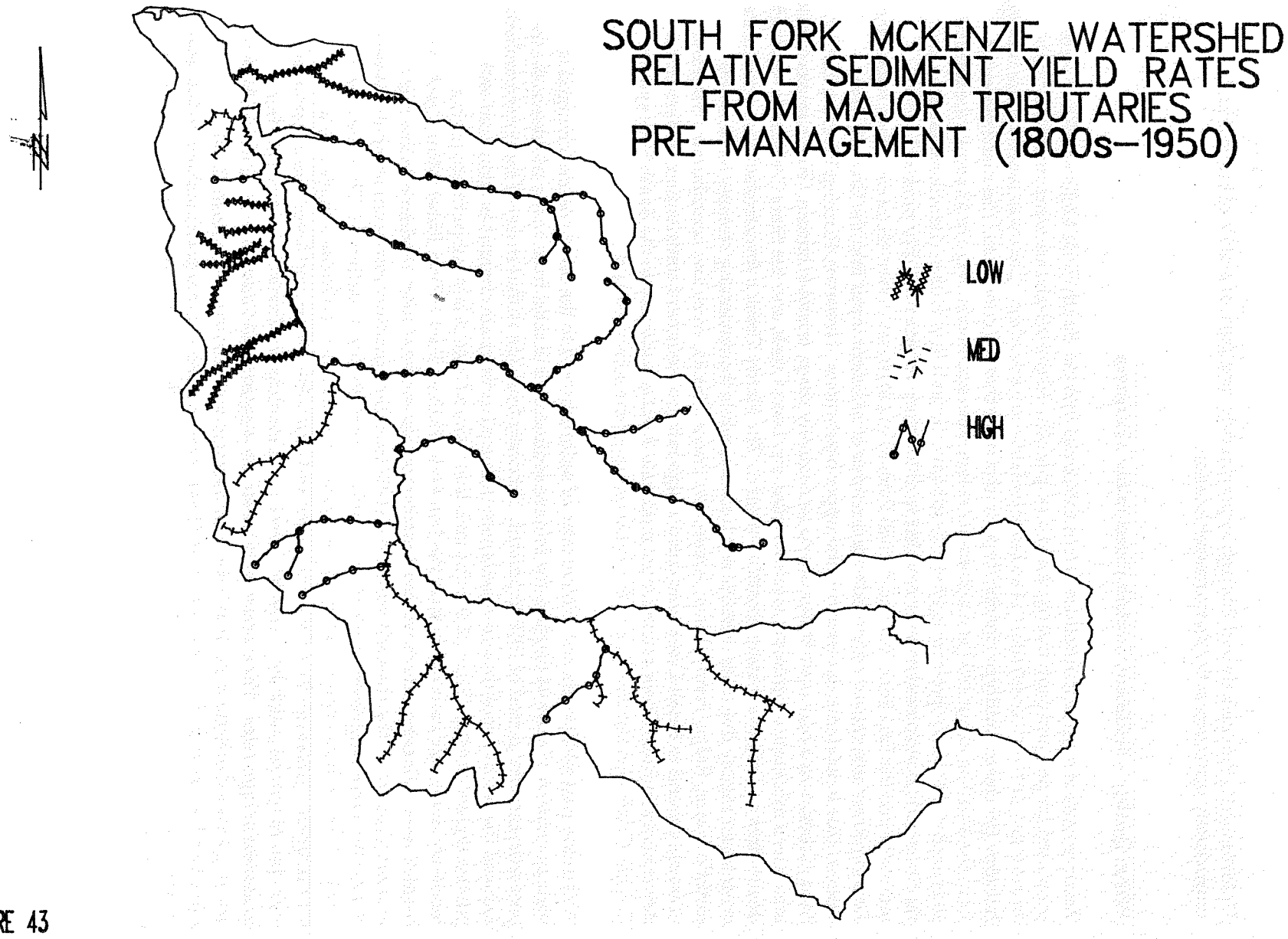

SOUTH FORK MCKENZIE WATERSHED
RELATIVE SEDIMENT YIELD RATES
FROM MAJOR TRIBUTARIES
PRE-MANAGEMENT (1800s-1950)
LOW
MED
HIGH

FIGURE 43

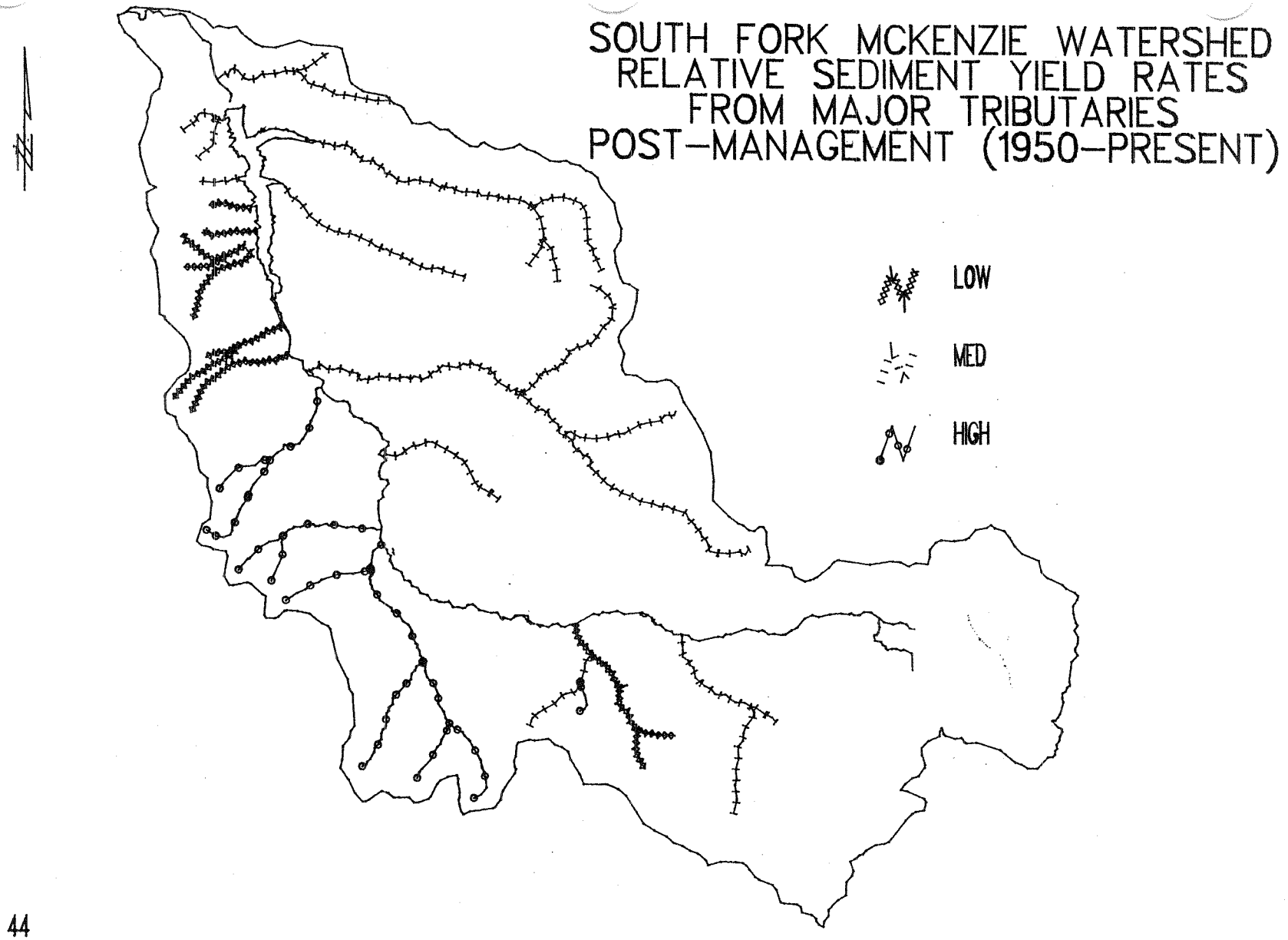

SOUTH FORK MCKENZIE WATERSHED
RELATIVE SEDIMENT YIELD RATES
FROM MAJOR TRIBUTARIES
POST-MANAGEMENT (1950-PRESENT)
LOW
MED
HIGH

FIGURE 44

SOILS SUMMARY OF PROCESSES

Relating environmental change to land use activities is one of the key goals of watershed analysis. The process for the uplands involves determining the type, aerial extent, frequency, and intensity of watershed processes, such as mass movements, fire and surface erosion, in order to compare natural disturbance regimes with disturbance regimes under managed conditions. The objective is to identify parts of the landscape that are sensitive to specific disturbance processes or critical to beneficial uses. Some sites are more sensitive to change than others. This sensitivity often results from the inherent properties and the ecologic history of a particular area. The Watershed Analysis Guide indicates that the direct effects of past land use activities on the uplands include altered soil characteristics, the removal or addition of nutrients and chemicals, and topographic change. In a like manner, the major short term impacts to soil productivity from harvest activity, as discussed in the Willamette National Forest Final Environmental Impact Statement (FEIS 1990), include displacement, compaction, nutrient loss, and instability.

The following sections, consider in a qualitative way, the effects of previous land management activities on the subwatershed(s) under discussion, and their relation to natural rates of disturbance in the study area. This section summarizes and explains the findings from the field evaluations. A full discussion of each area can be found in the Appendix Soil1.

Soil Displacement

Displacement occurs with three separate timber harvest activities: yarding, slash treatment, and road building and maintenance.

In summary, little or no evidence can be found to indicate that these two timber management activities have resulted in detrimental soil displacement or off site soil movement of any significant degree for any harvested unit in the analysis area. Willamette National Forest monitoring efforts over a number of years have consistently shown that off-site sediment movement from units where appropriate suspension and duff retention standards have been implemented, has been very low, especially in relation to natural disturbance events such as wildfire. Those conclusions were again reinforced with field observations for this investigation. To be sure, detrimental soil displacement from tractor piling likely resulted in many units on the Willamette Forest in years past, but that activity has not been considered an appropriate management option for about a decade. Whether inappropriate tractor piling occurred on the older units in this basin is now not pertinent; these areas have long since vegetated over and completely stabilized. Overland flow, indicative of compaction, but potentially resulting in erosion, was seldom noted in any of the field reconnaissance on the more gently sloping, older plantations.

Approximately, 337 miles of road currently exist in the basin. They range from a double lane, paved arterial (FS RD 19 or Aufderheide Drive) to grown over tracks that are difficult to walk along. Many miles of roads have been constructed on stable benches and flats, but numerous sidecast roads segments are also present. Road construction standards have varied over time and range from overbuilt sidecast extravaganzas to narrow lanes, laid lightly on the land. Displacement of soil from road construction and downslope creep from colluvial processes probably are of the same order of magnitude, when considered in approximately the same time frames and viewed over the

entire study area. When looking at only the managed landscapes, the same conclusion remains in effect, except for the subwatersheds of Grasshopper and Lower Augusta (subwatersheds 13U and 13V, respectively), where roads continue to provide sediment to the streams at rates above more natural mechanisms. The following discussion looks at roads as long term features that reside on the landscape. It does not evaluate the concern of short term turbidity increases that result directly from management induced activities. Natural rates of sediment movement are more pervasive than generally suspected. On average, each mile of stream naturally receives as much sediment each year as a corresponding mile of new road construction would dump into it. For this project area, there are approximately 258 miles of Class I, II, and III streams. This relates to about 337 miles of road. However, when the 335 miles of Class IV channels are included in the total, total stream miles increase to 1593, or almost a four fold increase over the perennial total. The wilderness and non harvest allocation stream miles are included in this discussion as all subwatersheds contain some miles of road.

This discussion would not be complete without calling attention to the consequences of "older" road construction (and some that is not so old). Some road segments constructed from the 1940's through the early 1980's were built without regard to sediment impacts to streams. Roads were located without consideration for steep sideslope slough situations; excess excavation was sidecast directly into stream channels; little heed was given to long term maintenance needs. Some of these situations have stabilized over time, and some still persist and produce higher than desirable levels of off site sediment movement. These are localized problems that require correction, but the adverse effects are usually associated with only the adjacent stream reaches.

Sediment from timber management activity is not a significant issue in this basin, except as noted previously. Factors that sideboard these conclusions include the current standards and guidelines (REFER TO THE DISCUSSION NEAR THE END OF THIS REPORT FOR MORE INFORMATION) approved in the 1990 Willamette National Forest Land and Resource Management Plan, as well as the Aquatic Conservation Strategy adopted in the Record of Decision for Management of Habitat for Late- Successional and Old- Growth Forest Related Species Within the Range of the Northern Spotted Owl. Also, stability issues are considered separately.

Subwatershed Cougar also contains Cougar Dam. The construction of this facility is rivaled in nature only by large scale slump/earth flow events and glaciations. Cougar Dam and the associated road construction around the lake as well as the effects of construction on such areas as Strube Flats and the cliff faces will not be evaluated in this report. At this point in time, it will be viewed simply as a feature that exists on the landscape and noted where appropriate.

Soil Compaction

The analysis indicated that existing compaction, which resulted from unrestricted tractor yarding and tractor piling, is not considered cumulatively significant within the basin. The more gently sloping, older plantations throughout the basin were likely tractor yarded with only minimal control on skid road density, and may have been tractor piled also. Considerable acreage, primarily in Subwatershed Green Ridge (PSUB 13Q), supports sideslopes that are sufficiently gentle to tractor log. Although overland flow (indicating increased density and poor infiltration) and extensive skid road scars were not noted in many of the existing plantations, it is likely that detrimental compaction exceeded the 20% Regional Standard level in many units in Green Ridge

subwatershed. These events may have been or may not be cumulatively significant. There is much less evidence of cumulative effects in Hardy and Boone Rider subwatersheds. The remaining subwatersheds generally have sideslopes that are too steep to tractor yard, except for Subwatershed Roaring (PSUB 13J).

Tractor harvest has been most extensive in the Skookum area of Subwatershed Roaring (PSUB 13J). Tractor roads are numerous, but fortunately this site is the least susceptible to adverse effects of compaction. Overland flow conditions (symptomatic of excessive compaction) are not common, and generally located on only the most heavily used road segments. Waterbars on these heavily used spurs are numerous and well spaced, and have effectively controlled most runoff.

Looking at the basin in total, mitigation of previous compaction concerns through subsoiling is not likely at this late date as most plantations have existing regeneration that is too large and closely spaced to effectively subsoil without excessive root pruning. In addition, more recent management activities have resorted to non ground based options, or severely curtailed tractor activities to existing skid road systems. Also, it is likely that compaction is beginning to ameliorate as root growth and frost action begin to operate to reduce soil density over the levels achieved in the late 1970's. Finally, subsoiling or obliteration has been planned for many of the reused skid roads incorporated into the more recent timber sale contracts.

Soil Nutrient Loss

Nutrient loss from harvest and slash treatment is not considered significant for subwatersheds in the South Fork, except possibly for Hardy, Green Ridge, and Boone Rider (PSUBs 13P, 13Q, and 13R). Much of the watershed was burnt, reburnt or underburnt in large scale fires that began approximately two hundred years ago. In many areas, these fires consumed most of the above ground organic matter, and extensive acreage now exists that displays almost no down woody debris or duff/litter layer (1 to 3 tons per acre) after 75 years. The older timber harvest plantations display a commensurate removal of above ground nutrient matter similar to the natural fires. More recent timber harvest has generally retained considerably more organic matter than was displayed by the stand replacement fires. Finally, as implemented, special forest product harvest has had little appreciable effect on nutrient cycling.

Hardy, Green Ridge, and Boone Rider have the highest concentrations and tonage (100-300 tons) of above ground decomposing organic matter. This may be due to limited reburns or underburns after stand replacement fires 300-400 years ago. This conserved fire kill and later down woody debris.

It needs to be pointed out that the previous discussion involves three subwatersheds with a total of about 14 thousand acres. A wide range of conditions exist, both manmade and natural, and general statements are necessary to capture critical highlights. From a long term soil productivity standpoint, high levels of carbon storage currently evident on some sites may be no more beneficial than situations where carbon storage is in shorter supply. However, productivity can be viewed from many vantage points. One that has achieved more prominence recently is habitat for a variety of ground dwelling amphibians and mollusks. It seems likely that these particular subwatersheds (PSUBs) have provided considerable high quality, productive, habitat for these creatures for the last several hundred years at a minimum.

Soil Instability

Several areas of critical highly dissected sideslopes with shallow, often unstable soils can be found in this study area. These areas display considerable natural, debris chute type, slope instability that appears to be related to the stand replacement fires, as well as flood events. Fortunately, for the most part, harvest units have not been located in the most sensitive areas. However, several road sidecast failures and in unit slope failures have occurred. Field inventories indicate that road sidecast failures, in unit slope failures, and natural failures have tended to occur at a relatively similar frequency, intensity and magnitude over the last four hundred years or so, except for Subwatersheds Hardy, Lower Augusta, and Grasshopper (PSUBS 13P, 13U, and 13V). Often failures have deposited material in similar areas lower in the drainages where several failure regimes are evident. Consequently, it appears that natural rates of slope instability are currently maintained when the entire basin is taken into account.

Several reports are available that suggest that roads and units significantly increase slope instability. In this area, that situation is simply not the case. Reasons for this apparent discrepancy are as follows: 1) Most published articles included inventories from photos, and they occurred within 10 to 15 years after a 100 year storm event. 2) Road construction standards have changed considerably in the last 10 to 15 years. 3) This investigation included extensive field reconnaissance within the timber. 4) Thirty years of events are now available since the last 100 year storm event. All these factors together have lead to an under representation of natural failures, and an over representation of management induced debris chute type failures at this time.

Subwatersheds Hardy, Grasshopper, and possibly Lower Augusta display more incidences of management induced slope failures than would seem appropriate under natural conditions (at this point in time). Interestingly, the problem is not so much one of increases in sediment, as in reduction of LWD. Extensive slope failures are present along the entire western bank of Hardy Creek below the 1980-225 road crossing. Most of the critical failure areas (though not all) occurred where harvest removed stabilizing old growth timber cover from adjacent stream sides. This situation coupled with considerable upland debris chute slope instability in harvest areas has resulted in extensive amounts of sediment to Hardy Creek without the accompanying structure. Where log jams are present, considerable flood plain development is now occurring. In this section, large rocks and boulders also provide substantive amounts of stream structure.

Fires and slope failures, debris chutes and debris dams are what makes and sustains streams like Hardy, Augusta, and Grasshopper Creeks. Indeed, with all the harvest activity and all the sediment, both Augusta and Hardy Creek support sustainable native trout populations and the middle reaches of both drainages also contain recently discovered populations of the State sensitive tailed frog. These species were located in the timbered sections of both creeks where log jams and LWD are common.

Timber management activities have increased slope instability in a few subwatersheds. This problem can be rectified in the future with good unit placement, appropriate harvest techniques, and suitable riparian reserve boundaries. The major concern, however, is not the fear of slope instability per se, but the problems that result with sediment input and no associated LWD.

RIPARIAN VEGETATION

This discussion of riparian vegetation covers:

- Riparian Disturbance
- Riparian Plant Communities
- Valley Segment Types
- Riparian Seral Conditions
- Riparian Large Woody Debris (LWD) Potential

Vegetation of riparian areas plays a wide range of roles for terrestrial and aquatic wildlife habitat as well as watershed processes controlling patterns of sediment, nutrient, and wood routing, temperature regulation, and bank stability. As part of the Aquatic Conservation Strategy, riparian areas are envisioned as ensuring spatial and temporal connectivity within and between watersheds for aquatic and riparian-dependent species as well acting as connectivity corridors among Late-Successional Reserves for terrestrial animals and plants. Species in the South Fork McKenzie which are intended to benefit from Riparian Reserve habitats include fish, mollusks, amphibians, lichens, fungi, bryophytes, vascular plants, American marten, red tree voles, bats, and northern spotted owls.

This discussion of riparian vegetation covers those plant communities found within the riparian area. This includes upland plant communities located on the valley bottom or lower slope positions which contribute shade, large wood, or nutrients to the channel or which may interact with the stream during high flows. Many riparian stands contain more old or large trees compared to adjacent upland stands due in part to favorable growing conditions and topographic protection from intense stand replacement fires. Riparian vegetation also includes communities whose habitats are most frequently found associated with streamsides, lakesides, or wetlands. These communities often contain species tolerant of flooding, high water tables, and/or frequent disturbance as well as early successional "invader" species which take advantage of freshly disturbed surfaces for establishment.

RIPARIAN DISTURBANCE

Condition of the riparian vegetation is the result of the interplay of three major types of disturbance: fluvial – flooding and channel reworking; hillslope failures – earthflows; landslides and debris flows; and fire. In small mountain streams, typical of the South Fork, hillslope processes largely control the morphology of the streams which in turn controls the behavior of flooding across riparian habitats (Grant and Swanson, 1994, in review). Fire responds to topography, fuels, and moisture. Because the disturbance regimes affecting riparian areas differ from those affecting stands upslope, the range of natural conditions characterizing adjacent upslope stands may not describe the range of conditions applicable to the riparian area. Stringers of large trees often observed in valley bottoms support the idea that moist microsites and landscape position lessen intensity of fires in riparian areas. Factors including stream order, aspect, slope, valley shape, precipitation, and lightning risk may determine whether seral stage/size classes in riparian areas will be distinct or similar to adjacent stands. While the hypothesis is that fire patterns should result in decreasing tree age with increasing distance from the stream, yet in some cases fluvial disturbance may cause near-stream stands to be smaller. Agee (1988) suggests that mid-sized streams may show largest tree sizes, being protected from some fluvial disturbances while also enjoying protection from many fires.

Research on streams in or near the McKenzie basin suggests that response of valley bottom vegetation to disturbance is related to size of stream and whether or not burning or cutting is compounded by churning of mineral soil, such as occurs with debris torrents (A.McKee, pers. comm.). According to this scenario, for first to third order streams, stand replacement events followed by debris flows or major soil exposure result in aggressive red alder invasion with deciduous canopy closure in less than a decade. In the understory, upland herbs are important for the first one to three years until being overtopped by red alder. After canopy closure, there is a sharp decrease in herb and shrub cover, yet the communities remain species rich. Conifer establishment is slow, with red alder declining at 100 to 150 years as the conifer finally overtops it.

Without debris flows or soil disturbance to prepare a seed bed, there are few invasives following stand replacement events. On-site shrub and herb cover increases in the early years. Conifer establishment is accelerated, with canopy closure at 20 to 30 years, associated with a decrease in herb and shrub cover, approximating the upland pattern.

Fourth order and larger streams show a more complex response to disturbance. Where channel disturbance has been prominent, red alder, willow, or cottonwood establish. Upland herbs and some upland shrubs also invade and persist longer on the streamside margins of the deciduous trees than smaller streams counterparts. Red alder canopy closure occurs at five to ten years. Conifer establishment is somewhat better on the larger streams due to improved light conditions, with scattered individuals taking 50 to 80 years to emerge from the red alder. On similar streams, but with an absence of flooding which changes the active channel shelf, a narrow band of invaders (red alder, cottonwoods, and/or willow) become established. Upland herbs are less prominent. Conifer presence becomes conspicuous 25 to 30 years after disturbance.

These patterns appear to be most common in the South Fork watershed in the western hemlock series. Transacts on higher elevation silver fir series did not contain occurrences of silver fir with

either red alder or bigleaf maple. To some degree this may be due to the location of the silver fir zone within the watershed; it is found mainly high in the drainage network along lower order streams which are less likely to show extensive flood effects. Silver fir series' riparian sampling elsewhere on the WNF shows red alder present on just less than half sites sampled. Disturbance patterns, seed availability, or elevation may limit red alder's distribution. If red alder is not present after disturbance, conifer re-establishment may proceed more quickly without competition from the aggressive deciduous species. Exceptions may be expected in cirque basins and other topographic microsites where soils, drainage, or frost may complicate response to disturbance.

In the mountain hemlock series sampling, no red alder was found, though sitka alder and willow appeared to replace it. Mountain alder was observed in the ecotone between the silver fir series and mountain hemlock series. Succession in the riparian zone after disturbance for this series may not follow the scenarios above. Community composition and dominant factors such as snow accumulation and persistence differ dramatically. Also, much of the mountain hemlock series in the South Fork lies on the high plateau. The creeks there are not typical steep mountain streams with the fluvial processes and geomorphic surfaces dominating the lower watershed. Effects of disturbance on riparian communities in this zone should be explored.

Past Condition of Riparian Vegetation

Fires, road construction and cutting on some land types, and flooding can accelerate debris flow occurrence. Conditions of riparian stands will depend on previous timing of fires and pulses of debris flows. It is reasonable to speculate that the extensive fires of the mid-1800's would have created open riparian stands in many drainage. Further, the fires combined with the great 1861 flood would have triggered debris flows in many first to third order streams during that period, with some affecting the larger streams. By 1900, many small riparian areas would have shown mixed conifer/red alder stands with the conifer about to go into a period of rapid height growth. For larger streams recovering from the impacts of 1800's fires and 1861 flood, some red alder, cottonwood or willow may have persisted near the active channel shelf, but conifers would have established and, by 1900, have overtopped the deciduous invaders to dominate floodplains. By the time of the twenty-five year flood in 1945, most of the stands would have lost remnants of the red alder and little evidence of these events would remain. With fire suppression, few large fires had occurred in the South Fork since the early 1900's, and logging had yet to have an appreciable impact on most of the riparian network. Riparian stands in valley bottoms would be directly affected only on active floodplains and alluvial fans. Disturbances under nearly closed canopies would discourage deciduous persistence. Conifers on surfaces above floodplains would be available to contribute shading, nutrients, and large wood to the stream. However, by the 1964 flood, road building and logging had opened more of the riparian areas in portions of the watershed. In those areas, impacts of the flood may have resembled the fire associated impacts of the 1861 event. Overall impacts of the 1964 may have been less than those experienced in the watershed after 1861. Nevertheless, it is possible that the stream network as a whole now, 30 years following the 100-year flood, would appear similar to the South Fork area viewed in 1900, 40 years after the 1861 event.

Effects of Management

Deviation from past patterns in the riparian due to management are likely to be found in the location, size, and structure of post-logging stands in riparian areas. Early cutting units often crossed streams, leaving logging debris in the riparian area as well as some standing live trees. Direct yarding impacts to the streams occurred before logging practices were changed to avoid the stream courses. Patterns often found in natural stands, where the near stream stand could be hardwood dominated while stands in or near the valley bottom often contained larger remnant conifers or old growth stringers, were changed to having blocks of conifer plantations which were relatively homogenous across geomorphic breaks. Continuity along riparian areas was disrupted. Where buffers were installed, the riparian/upland edge contrast was exaggerated and microclimate amelioration diminished. During the period when little large wood was left on the site, structure of the riparian stands was simplified on cutting units. Further, salvage in riparian areas along roads has removed current and near-term sources for standing dead and downed logs

RIPARIAN PLANT COMMUNITIES

Riparian zones display a wide variety of communities which result from highly variable patterns in substrate, soil development, moisture availability, light availability, and disturbance type, intensity, and frequency. Clearly, these factors interact. Distributions of broad categories of communities can be related to their geomorphic position. Generalizations can be made about communities associated with valley slopes above the major slope break, those from the slope break down to the valley bottom, higher surfaces within the valley bottom (often terraces or alluvial fans), floodplains, surfaces affected by frequent flooding or annual high water, and depositional surfaces (boulder, cobble, or gravel bars) within the active channel. The following discussion is drawn from unmanaged portions of streams, not adjacent to clearcuts, stream buffers, or valley bottom roads. It describes systems in fairly natural condition in the South Fork, yet strongly influenced in the active valley bottom by large floods (100 year return interval or greater) in 1964, and 1861.

Communities on lower slope positions adjacent to the stream zone belong to upland plant associations described in the Plant Association and Management Guide, Willamette National Forest (Hemstrom and others 1987), reflecting elevation, aspect, north-south latitudinal gradients, and topography. Species closely associated with wet conditions are generally found in these positions only where soil moisture is particularly high, e.g. silver fir/devils club or western hemlock/devils club associations, or where skunk cabbage indicates seeps, or poor drainage.

From the major slope break to the valley bottom, communities similar to upland plant associations are common, with western hemlock, pacific yew, western redcedar, and vine maple in the western hemlock series. Species' cover may be influenced by the large canopy gap created by the stream. Other surfaces which can show the same communities are terraces and "old boulder islands" which appear to have escaped major impact from the 100 year flood of 1964. These boulder islands are coarse depositional surfaces in the valley bottom adjacent to side channels, overflow channels, or abandoned channels showing that the surfaces act to confine flow. Alluvial fans may also support these communities, but were not broken out from other high surfaces during sampling.

Similar communities which include mature bigleaf maple and oxalis but not mature pacific yew also occur on surfaces below slopebreaks and surfaces in valley bottoms such as terraces and boulder islands, possibly including alluvial fans. Maple has been noted to preferentially occur on alluvial fans and coarse textured surfaces in the riparian zone within the McKenzie basin (A.McKee, pers. comm.).

Another community transitional to more "riparian" types occurs above the active channel and is dominated by mature western hemlock with some pacific yew, western redcedar, and oval-leaved mitella. Some species common in the "riparian" types begin to appear in this community, most notably lady fern but also including maidenhair fern, alpine circaea, and dewey sedge.

Red alder commonly invades riparian surfaces after disturbance in the South Fork McKenzie. It is a strong marker of major flood or debris flow events, and red alder ages are often used to date the events in a drainage. Post-1964 red alder communities are mostly found on frequently disturbed low floodplains and depositional bars.

Mature alder communities often include Cooley's betony, miner's lettuce, streambank springbeauty, coltsfoot, and maidenhair fern. These are found on stream banks, active floodplains and on boulder surfaces within the active channel. Regenerating tree species include red alder, bigleaf maple, western hemlock, western redcedar and minor amounts of pacific yew. Douglas fir is seldom present.

Young alder is commonly found on cobble and boulder bars, annual floodplains, rock cliffs, and lower banks. Species in this group include maidenhair fern, miner's lettuce, coltsfoot, western redcedar regeneration and western hemlock regeneration, but almost no conifer taller than 12 feet.

Shrub dominated communities are often associated with depositional bars within the active channel. These generally include some red alder regeneration, Cooley's betony, stink currant, salmonberry, fireweed, Menzie's tolmiea, miner's lettuce, and coltsfoot. Regenerating conifer species include western redcedar, western hemlock, and Douglas fir. Mature red alder can be found on some sites.

The lower reach of the mainstem South Fork below the dam supports several different communities not commonly found on the lower order tributaries. The lower reach provides willow and cottonwood types more common on wide valleys of large rivers. Conifer communities on the floodplains and terraces also include significant amounts of incense cedar and grand fir which are not major components of South Fork tributary riparian stands. These types are also described in Hawk and Zobel (1974).

More detailed community studies on nearby riparian areas can be found in Campbell and Franklin (1978) for low order streams. Hawk and Zobel examined stand and geomorphological succession on the mainstem of the McKenzie. Their study applies to the lower alluvial valley segment type in the South Fork McKenzie below Cougar Dam. However, control of high flows and sediment movement since construction of the dam will prevent further fluvial influence re-setting vegetation on surfaces above the current flow fluctuations. Communities below the dam may diverge in development from historic pattern or from similar communities in less dam-affected parts of the McKenzie mainstem.

While most of the communities briefly described above may be expected to have been present in the South Fork in the past, introduction of exotics has altered the composition of the riparian vegetation to some degree (Tabacchi and others, In prep). Wall lettuce is an example of species rapidly expanding in the watershed's riparian area. Some information drawn from riparian areas cut before 1960 suggests that red alder may have been less common after disturbance during some periods than currently, with proportionately more willow species (Art McKee, pers. comm.). Disturbance patterns within the McKenzie basin as a whole may determine red alder seed availability within the drainage over time.

Trends

With riparian reserve widths contained in the amended Forest Plan, the riparian areas within the watershed will increase dominance of conifer communities. Unlogged sites will continue recovery from the 1964 flood. Alder stands initiated during the 1945 or 1964 floods will persist until the middle of the next century when they will decline under the emerging dominant conifers. Older floodplains reset during the 1861 flood will be old growth by that time. Fire stands regenerated after the fires during the 1800s will become late seral or old growth, allowing favorable habitat conditions for late seral riparian dependent species in those areas. Where logging has removed both valley bottom and adjacent stands, recovery toward old growth riparian conditions will be delayed for an extra hundred years. A major flood would reset succession along floodplains, affecting the least confined valley segments the most. In the absence of large fires, however, the disturbance would be evident only for a century.

VALLEY SEGMENT TYPES

The stream network was stratified by valley segment type for description of riparian vegetation and habitat within the watershed. Valley segments define portions of the network with similar morphologies and governing geomorphic processes (Montgomery and Buffington 1993) and are identified by valley bottom and sideslope geomorphic characteristics which remain relatively persistent over a time scale relevant to land management planning (Cupp 1989a). The valley segment types used in the South Fork are based on the system developed by Cupp (Cupp 1989b) for the Gifford Pinchot National Forest and adopted as part of the standard stream survey for the Willamette National Forest (WNF 1992). Valley segment types were available for several streams within the South Fork. Topographic maps and aerial photos were used to verify, revise, or assign valley segments to the remainder of the perennial streams.

Criteria for assignment of valley segment types include stream order, valley sideslope gradient, channel gradient, ratio of valley bottom width to active channel width, geology, and channel pattern. There are 14 valley segment types associated with perennial streams in the watershed (Table 13 and Appendix Report FW 5 ,from WNF Stream Survey Guide). Some changes were made to the forest wide system to better fit types found in the area (Appendix Process 2). While stream surveys use minimum 1000 foot lengths to delineate valley segment types, some types such as alluvial fans had shorter lengths delineated.

Valley segment types were chosen for stratifying riparian vegetation because they may integrate effects of hillslope and fluvial processes which determine the substrate, moisture, light, and disturbance regimes controlling plant habitat. Our hypothesis is that the valley segment types will show patterns in the amount and type of riparian communities present, and allow assessment of broad distribution of riparian habitat across the watershed. A major objective is to allow some analysis of the biological function of different reaches and/or subwatershed groups to support riparian reserve delineation.

Our assumption in adopting the valley segment type classification is that the criteria for delineation and interpretation of processes are generally applicable to the South Fork since the geology, history, and environment are fairly similar to the area in which it was developed. Cupp (1989) demonstrated relationships between valley segment types, fish populations and fish habitat variables. Valley segment data taken across the Forest has not been formally evaluated. Until a channel matrix can be developed and tested locally, linking channel condition objectives to valley segment types would be inappropriate.

South Fork Valley Segment Types

Valley Segment Type	Miles	Percent of Perennial Network
Alluvial fan	5	2
Alluviated mountain valley	11	5
Cirque	8	3
High plateau/low gradient	1	1
Incised glacial till/colluvium	17	7
Lower alluvial valley	3	1
Meadow/wetland/lake outlet	4	2
Moderate slope bound valley	13	6
Steeply incised/moderate gradient	20	9
Steeply incised/steep gradient	19	8
U-shaped glacial trough	24	10
Valley wall tributary/moderate gradient	8	3
Valley wall tributary/steep gradient	86	37
Valley wall tributary/glacial U	10	4

Perennial stream network only. Does not include reservoir.

Table 13

The geologic history is reflected in the distribution of the valley segment types across the watershed (Table 14). Major glacial influence is apparent in the high proportion (13%) in U-shaped glacial troughs and cirques. The dissected topography is reflected in the steep gradient types (steeply incised/steep gradient and steep valley wall tributaries) which make up 45% of the total. Valley wall tributaries generally represent first and second order streams which account for 44% of the dendritic network.

Table 14 summarizes data from transects across valley segment types. Confinement is the ratio of bankfull width to valley floor widths; riparian width is the ratio of riparian vegetation to bankfull width; and buffer percent is the ratio of riparian vegetation to interim reserve width.

Valley Segment Type Descriptions

Valley Segment Type	Confinement	Riparian Width	Buffer %
U shaped glacial trough	L	H	H
Cirque	L	H	H
Alluviated mountain valley	L	H	H
Steeply incised, moderate grad.	L	H	Variable
Moderate slope bound valley	M	Variable	L
Incised glacial till/colluvium	M	M	L
Steeply incised, steep gradient	M	L	L
Class 4s high plateau	L	H	M
Class 4s non high plateau	H	Variable	L
Alluvial fan (1 sample)	L	M	H
Valley segment type averages	L => 3 M = 2 - 3 H =< 2	L = 0 - 50 M = 50 - 300 H => 300	L = 0 - 5 M = 5 - 20 H => 20

Table 14

The following types were variable, requiring more sampling and refinement for interpretation: high plateau low gradient, valley wall tributaries (all gradients), swampy reaches, and outlets to meadows, lakes, and wetlands.

Grant and Swanson (1994 , In review) have also shown that unconfined reaches in two McKenzie subbasin streams have wide channels, more side channels, and more old floodplains.

Habitat within the 100 year floodplain typically includes herb, shrub, and alder communities, while conifer/riparian understory communities are on older floodplains and toeslopes. Most floodplain habitat can be expected to occur in U-shaped glacial troughs, alluviated mountain valleys, alluvial sections of steeply incised/moderate gradient segments, and alluvial fans. Secondary channels are unlikely in moderately to highly confined segments. In cirques, riparian vegetation appears associated with snow and soil moisture patterns, not with fluvial or hillslope processes controlling patterns in the lower drainage network of steep mountain streams.

Valley Segment Types Summary

It seems likely that most riparian associated wildlife habitat will be associated with unconfined valley segment types (U-shaped glacial troughs, alluviated mountain valleys, steeply-incised/moderate gradient), swampy areas found in the gentle seepy areas of the landflows in the Boone-Hardy group, and some reaches of meadow/lake/wetland outlets. Valley wall tributaries may play locally important roles, but this needs more data. Valley segments with relatively little riparian habitat per mile include steeply incised/steep gradient, incised glacial till/colluvium, and possibly moderately slope bound valleys. Intermittent streams (Class 4s) especially need more data to develop valley segment types to describe their apparent variability.

Field experience shows wide variation in gradient, entrenchment, and amount of riparian vegetation, often responding to subwatershed groups. Steep lower elevation intermittents often have no vascular riparian species, though some areas in the silver fir zone have pockets of cool, moist devils club communities. The Mink and McFarland lake basins have few perennial streams, yet even intermittents have distinctive herb and shrub communities. These intermittents are close to palustrine patterns noted in the Tongass system (Paustian and others 1992) and may belong to the meadow/wetland/lake outlets or may need a new valley segment.

RIPARIAN SERAL CONDITIONS

General seral stage of the riparian reserve is an indicator of riparian wildlife habitat conditions, large woody debris input potential, and dispersal and connectivity of the reserve system. Current and historic seral condition of the interim riparian reserves is summarized in Table 15. Acres in early, young, mature, late seral, and non-forested conditions were calculated from the current and historic vegetation layers (definitions can be found in Table 16).

South Fork Riparian Seral Condition

Seral Condition	1900	Current
Early	< 1%	5
Young	39	11
Mature	17	37
Late	36	38
Non-forested	6	8

Percent of Interim Riparian Reserves
(all stream classes)

Table 15

The riparian condition echoes the results of the watershed-wide vegetation analysis. The stands regenerated after the fires in the 1800s account for the high proportion of the young class in 1900. Those stands appear as mature currently. Riparian areas now in early or young seral stages were largely created after logging of the 1900's late successional stands. Past and current seral stage distribution of the subwatershed groups are displayed in Figure 45.

The scale of information on large woody debris input potential available from this evaluation may not be appropriate, since actual input to streams is generally restricted to the area immediately adjacent to the channel. Therefore, a second analysis examined finer scale data. This is presented following Figure 45.

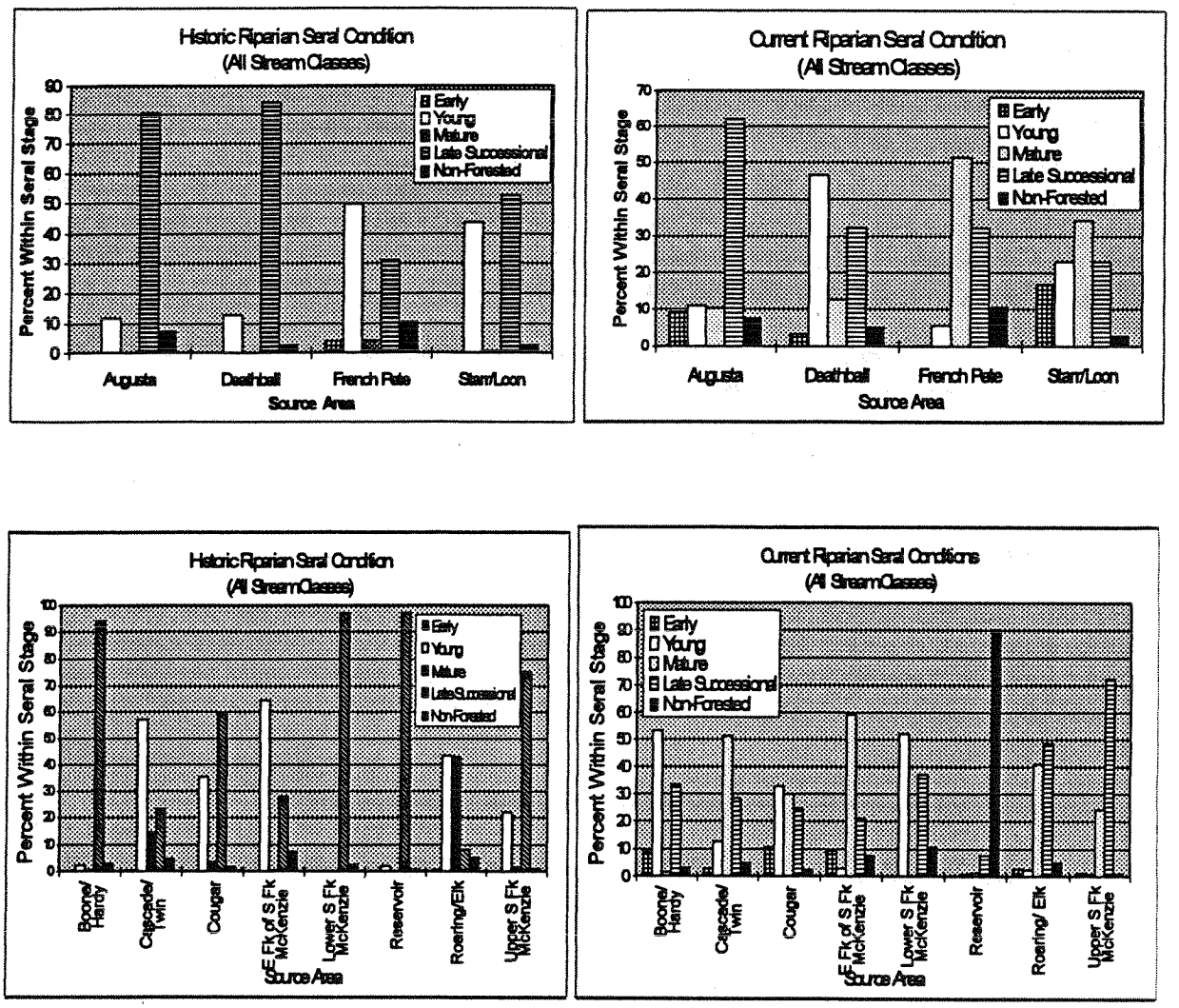


Figure 45: Comparison of historic and current riparian seral condition.

RIPARIAN LARGE WOODY DEBRIS (LWD) POTENTIAL

Valley segments were assigned high, moderate, or low potential for contributing large wood to the stream (Figure 46). The diameter class distribution of stands within one site tree distance of the creek was the criterion. Size classes for assignment of high potential were based on size thresholds in stream surveys for totaling the large class in woody debris. Remotely sensed data from Pacific Meridian Resources were regrouped into size classes (see Appendix Report, Process 2). Ratings were developed from calibration of eleven valley segments judged to be in high or low condition. All valley segments in the watershed were assigned a rating. Class 4 streams were included in the LWD source area analysis for four subwatershed groups: Augusta, Deathball, French Pete/Walker, and Starr/Loon (Figure 47). In these groups, intermittents are important source areas for wood. For the other groups, streamside stands provide a larger proportion of the LWD (Figure 48).

Note that valley segments differ in lengths, and that a branching segment will be assigned a single value. This may affect results for some Class 4s.

The Upper South Fork mainstem, East Fork, and French Pete/Walker show the highest potential of LWD, while the Lower South Fork, Deathball, and Boone/Hardy rank the lowest. This largely reflects the harvest history of the groups. The low rating for LWD in Lower South Fork may also be affected by young stands revegetating in the floodplains and in areas disturbed during dam construction.

The results are generally similar to the seral stage analysis of the interim riparian reserves. Differences may be seen most clearly in French Pete/Walker and the East Fork. Stands in the mature class regenerated after fires 80-200 years ago. Many such stands are predominantly small to medium diameter (9-31" DBH), too small to contribute logs sizable enough to be counted as large debris in stream surveys.

The discrepancy between the two analyses may be due to several factors:

- remnant old growth individuals may not have been included in the seral analysis, yet were picked up in the remote sensing data;
- stringers of old growth may have persisted in the valley bottom but not been distinguished from the adjacent stand; and
- remotely sensed data may have exaggerated amount of large diameter trees in riparian environments due to gappiness, mixed hardwood/conifer conditions, or presence of water.

Ground truthing is needed to verify interpretations separating high from moderate potential. The analysis should be given low to moderate confidence until such discrepancies are settled.

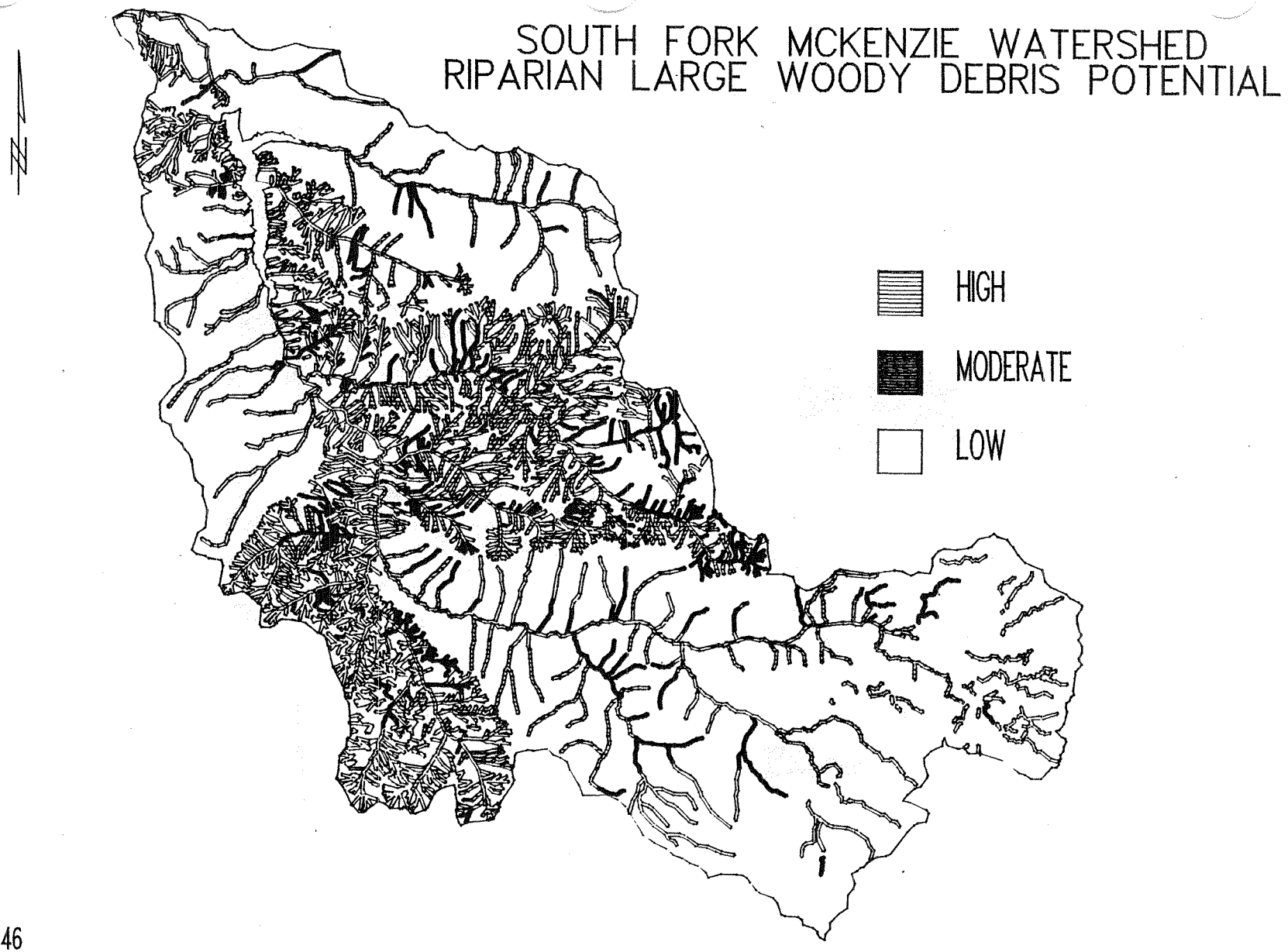

SOUTH FORK MCKENZIE WATERSHED
RIPARIAN LARGE WOODY DEBRIS POTENTIAL
N
HIGH
MODERATE
LOW

FIGURE 46

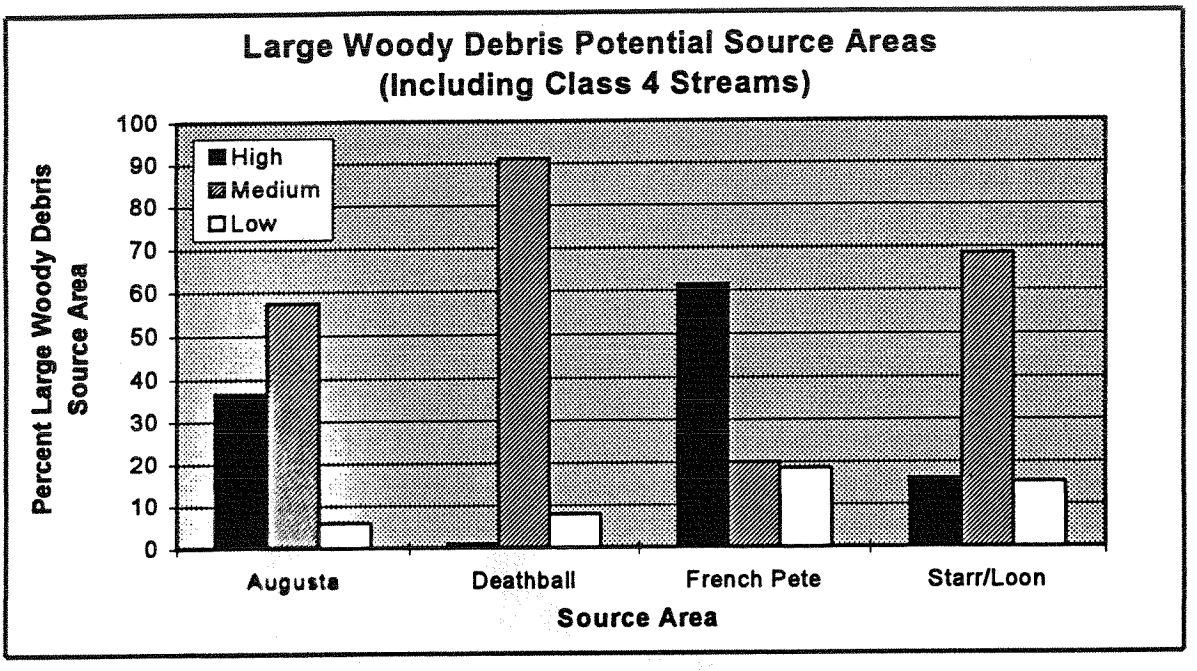


Figure 47

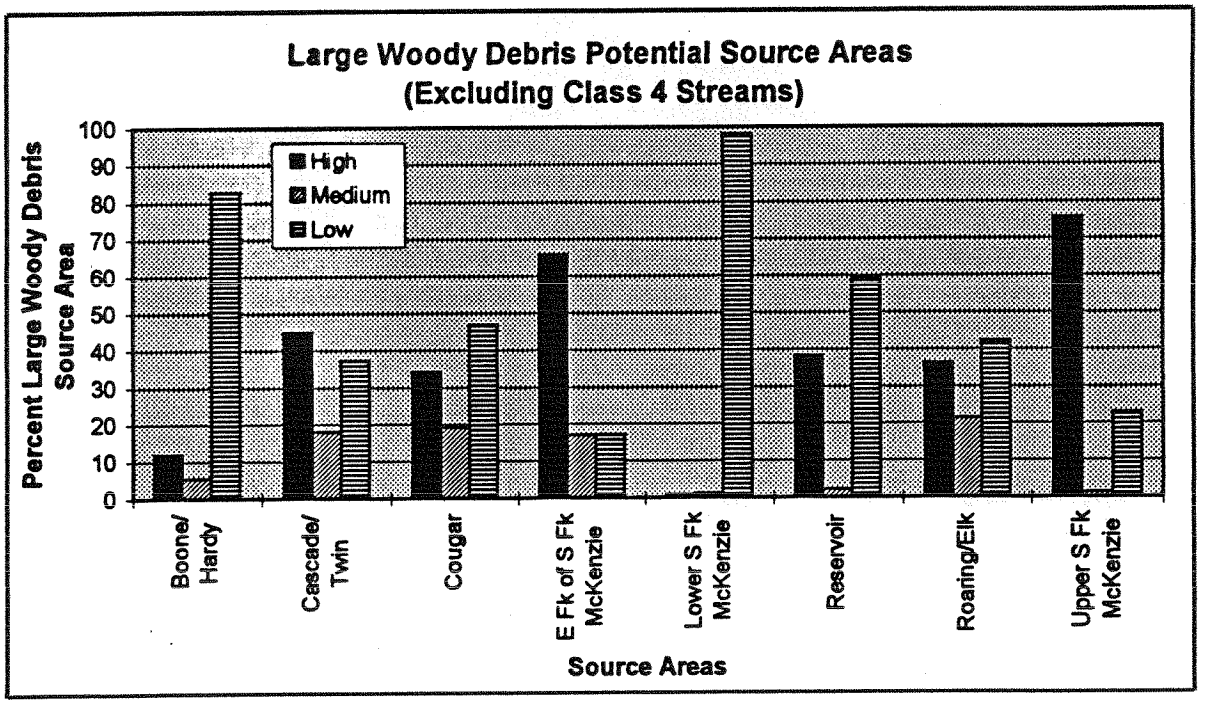


Figure 48

Low potential sites may contain significant amounts of large trees, but are dominated by size classes <21" (See LWD Potential: Methods, Report Process 2). These areas may need 150-200 years to develop high LWD potential unless they contain major components of mature stands which can cross the size threshold in the next century.

Valley segments classed as moderate may lack trees currently capable of becoming large debris. However, these stands are predominantly trees at least 21" DBH. Such trees do contribute significantly to in-channel habitat, particularly in smaller streams. Further, they should grow into the high potential class within a century. Rates of input may currently be limiting due to stand dynamics of those age classes. Many mature stands have low mortality and may drop logs into the creek only slowly. Most recruitment into the channel may be associated with floods, fire, or mass movements.

For those streams with stream surveys, further analysis of the size class distribution by reach would allow identification of smaller sections of streams currently low in large wood which also have low potential for recruitment of in-channel large logs in the near-term. Better resolution is also possible from developing categories of size classes which describe more structural conditions, particularly for the mature stands.

VEGETATION/WILDLIFE/WILDLIFE HABITAT

This section of the analysis will present two areas of discussion; Vegetation and Wildlife/Wildlife Habitat. The vegetation discussion will be presented first and will contain four broad areas of discussion:

- An overview of vegetation in the South Fork and a description of the stratifications used to analyse and display the conditions;
- A comparison of past and current conditions;
- A discussion of the main processes influencing the vegetation conditions;
- Landscape patterns/vegetation trends and;
- Unique vegetation

The wildlife discussion will be focused in four categories:

- General wildlife habitat and species use discussion displayed by plant series
- Habitat connectivity
- Species of concern including Threatened, Endangered and Sensitive species as well as late sucesssional associated species
- Big game

These categories were defined by the key questions outlined in Chapter 3. They represent the areas of greatest concern within the South Fork and where the greatest understanding of processes can be gained.

OVERVIEW OF VEGETATION

PLANT SERIES

Terrestrial ecosystems integrate the effects of climate, landform, geology and soils and reflect these in natural plant communities. Plant series classifications are a way of dividing forested ecosystems into smaller systems based on the climax tree species on the site.

The range of plant series typically found in the central Cascades are present in South Fork McKenzie watershed (Figure 49). They include:

1) Douglas-fir series – *Pseudotsuga menziesii,*
2) Grand fir series – *Abies grandis,*
3) western hemlock series – *Tsuga heterophylla,*
4) Pacific silver fir series – *Abies amabilis,* and
5) mountain hemlock series – *Tsuga mertensiana.*

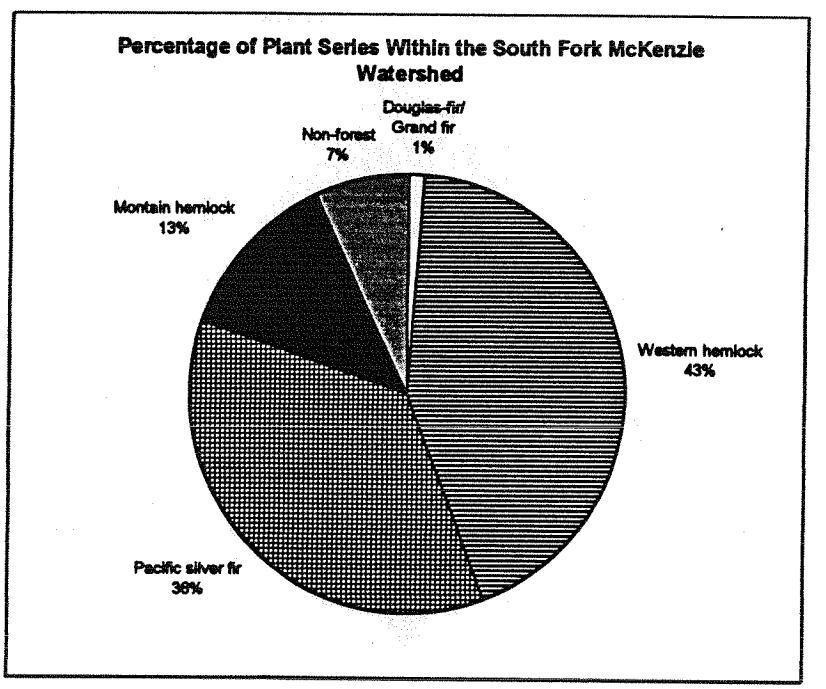
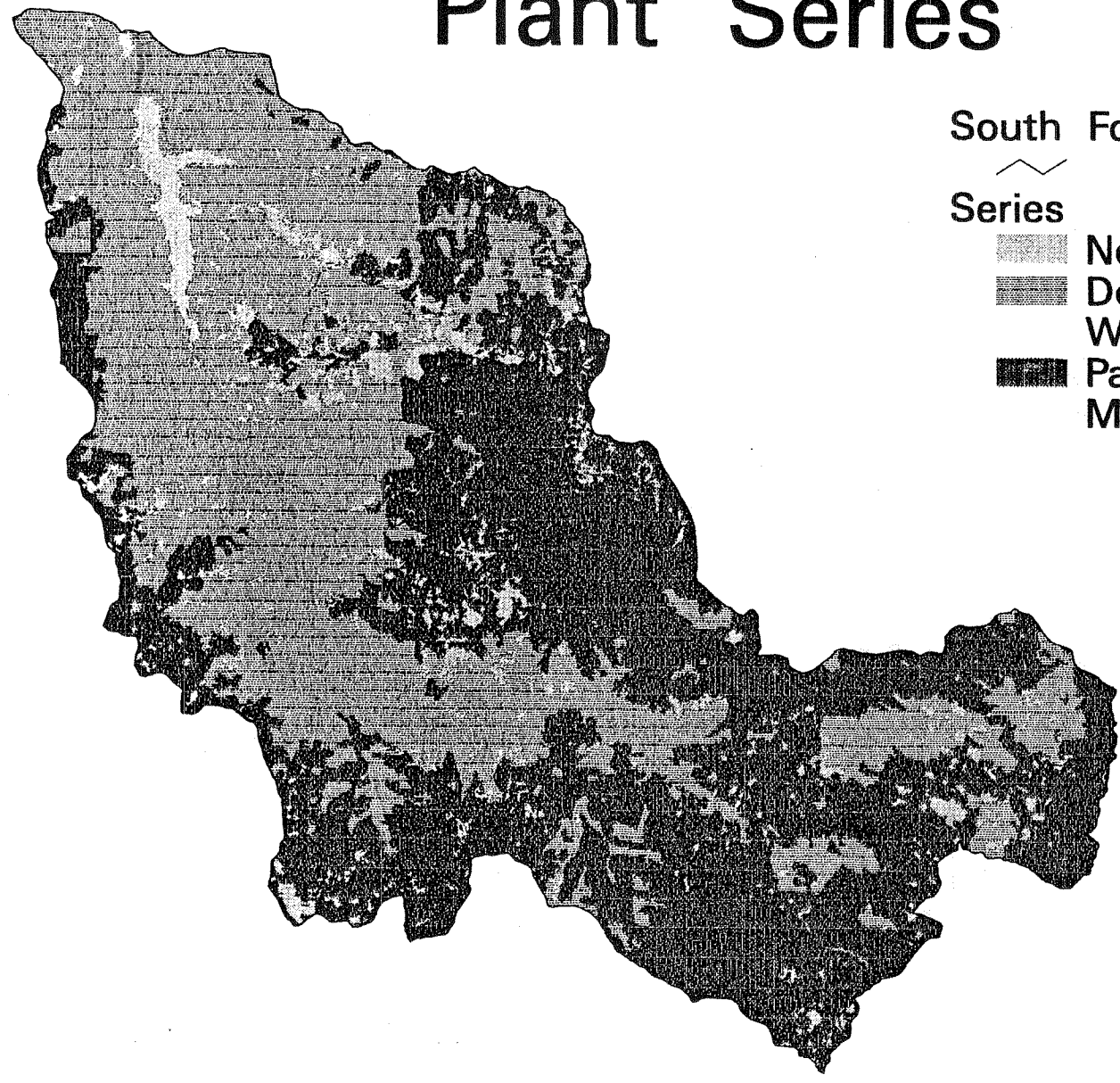


Figure 49

Plant Series



South Fork Boundary

Series

- Nonforest
- Douglas-fir & Western Hemlock
- Pacific silver fir & Mountain Hemlock

Figure 49a

For a more complete description of the environmental conditions, classification system, listings of plants species, and plant association groups for each series, refer to the Willamette National Forest Plant Association and Management Guide (Hemstrom and others 1987).

Douglas-fir

The Douglas-fir series occurs on warm relatively dry sites at lower elevation on southerly exposures. Major climax tree species include incense cedar and grand fir but Douglas-fir generally dominates both the canopy and regeneration layers. Common dry site indicator species associated with the Douglas-fir series are chinkapin, madrone, oceanspray, poison oak, dwarf Oregon grape, whipple vine, and other grasses.

The Douglas-fir series can be found along the river terraces of the South Fork McKenzie, the Delta flats area, and the southern aspects of McLennon Mountain., Sawtooth Ridge, Yankee Mountain. and Rebel Rock ridgelines.

Grand fir

The grand fir plant series may be found in the transition areas between Douglas-fir and western hemlock and in some case where the western hemlock transitions into the Pacific silver fir. This series is a minor component within this watershed. The grand fir series most frequently occurs on relatively dry, southerly facing slopes and excessively well-drained river terraces.

Important species include a mixture of those from the Douglas-fir series, the western hemlock series, and the Pacific silver fir series.

For the purposes of this analysis, the grand fir series will be grouped together with the Douglas-fir series.

Western hemlock

This plant series represents warm, moist conditions. The western hemlock series is the dominant plant series within the watershed.

Important species include: Douglas-fir, western hemlock, western redcedar, bigleaf maple, vine maple, dwarf Oregon grape, salal, rhododendron, swordfern, vanilla leaf, Oregon oxalis, and twinflower. Small, scattered pockets of western white pine and sugar pine also exist within this series.

The western hemlock series encompasses the majority of the area along the river drainage from the lower to the mid elevation slopes. This series covers the area from below Cougar Dam in the Delta and Cougar areas, the East Fork , up along the western portion of the watershed from Rush Creek

to Augusta Creek and around to lower Roaring River, Elk Creek and the upper South Fork McKenzie. In the wilderness area, the majority of Walker Creek, French Creek, and Rebel Creek are in the western hemlock series zone.

Pacific Silver fir

The Pacific silver fir series dominates the upper-slopes, between 3500 to 5000 feet elevation, and represents cool, moist conditions.

Important species include: Douglas-fir, noble fir, Pacific silver fir, mountain hemlock, western hemlock, lodgepole pine, vine maple, dwarf Oregon grape, huckleberries, rhododendron, coolwort foamflower, false solomonseal, queencup beadlily, dogwood bunchberry, and beargrass. Small clumps of Alaska yellow cedar can be found in these higher elevations.

The Pacific silver fir zone can be found along the north aspects of the upper slopes and major ridgelines which surround the watershed. The Pacific silver fir series covers the backside of the ridgeline along O'Leary Mountain, throughout the wilderness along Sawtooth and Rebel Rock ridges, and around Yankee, Lowder, Olallie, and Pyramid Mountains. Along the western and southern boundaries of the watershed, the Pacific silver fir zone covers Indian and Hiyu ridges, and the ridgeline from Grasshopper to Chucksney Mountains. This series transitions into the mountain hemlock series in the upper South Fork, Elk Creek, and Roaring River headwaters.

Mountain hemlock

The mountain hemlock series occupies the cold, moist condition generally above 4000 feet elevation.

Important species include: mountain hemlock, Pacific silver fir, noble fir, lodgepole and western white pine, Engelmann spruce, rhododendron, huckleberries, beargrass, prince's pine and luzula.

The mountain hemlock series cover most of the wilderness area on the High Cascade plateau which wraps around the headwaters of Roaring River and the South Fork from the Skookum area and McFarland Lakes, through the Mink Lakes Basin and on up to Olallie Mountain.

VEGETATION COMPOSITION

The composition of vegetation is defined by condition groups based on stand age and seral stages. Table 16 displays the assumptions used in defining vegetation conditions. These definitions and condition groups will be used througout the discussion on vegetation and wildlife.

Vegetation Condition Group Definitions

	Plant Series		
Vegetation Condition	Douglas fir & western hemlock	Pacific silver fir & mountain hemlock	Seral Stages
Early	0 - 10 yrs	0 - 20 yrs	Grass, Shrub, Seedling/Sapling
Young	11 - 80 yrs	21 - 100 yrs	Sapling, Pole, Small trees
Mature	81 - 200 yrs	101 - 200 yrs	Medium sized trees
Late	> 200 yrs	> 200 yrs	Large trees and old growth
Non-Forest			Water, Meadows, Rock outcrops

Table 16

STRATIFICATION AREAS

The watershed was stratified into five areas to summarize the composition of the vegetation. The stratification is based on a mixture of subwatershed, plant series, and management area boundaries (Table 17, Figures 50 and 51).

Vegetation Stratification Areas

	Stratification	
#	Area names	Watershed areas
1	Below Dam	Cougar & Delta flats area
2	Lower Watershed	Basalt, Boone, Penny, & Hardy Cks
3	Mid Wastershed	Starr, Loon, Augusta, & Moss Cks
4	High Cascades	Skookum area to Mink Lakes area
5	Wilderness	East Fork, Walker, French Pete, & Rebel Cks

Table 17

PAST AND CURRENT CONDITIONS

The historic vegetation for the South Fork McKenzie watershed analysis was reconstructed for the year 1900 (Figure 50). The year 1900 was chosen as the year of comparison because: 1) it can be reconstructed from ages of existing stands and, 2) it is prior to extensive landscape pattern alteration by logging. It is also recognized that prior to 1900, the native Americans and the Euro-Americans settlers possible disrupted the natural fire regimes, thus influencing the composition and patterns of the landscape in this area. Fires started by native Americans and early settlers are considered to be part of the given "natural" conditions for the year 1900.

The 1900 historic vegetation was reconstructed by reclassifying the current vegetation polygons based on their age. For example, a 150 year old forested polygon in mature condition today, would have been in a 56 year old young condition in 1900.

The current conditions were based on the vegetation as it exists in 1994 (Figure 51).

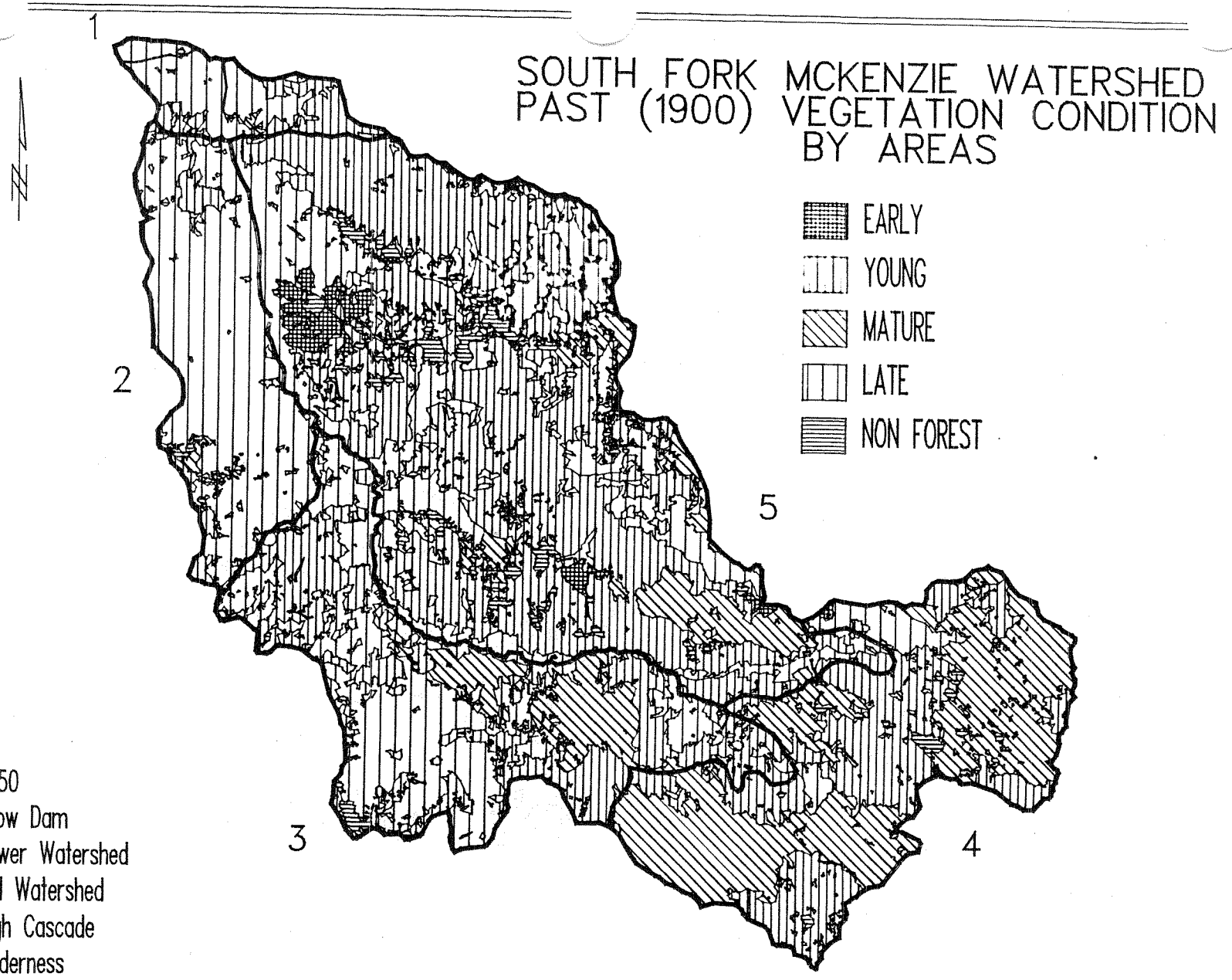


FIGURE 50
1 - Below Dam
2 - Lower Watershed
3 - Mid Watershed
4 - High Cascade
5 - Wilderness

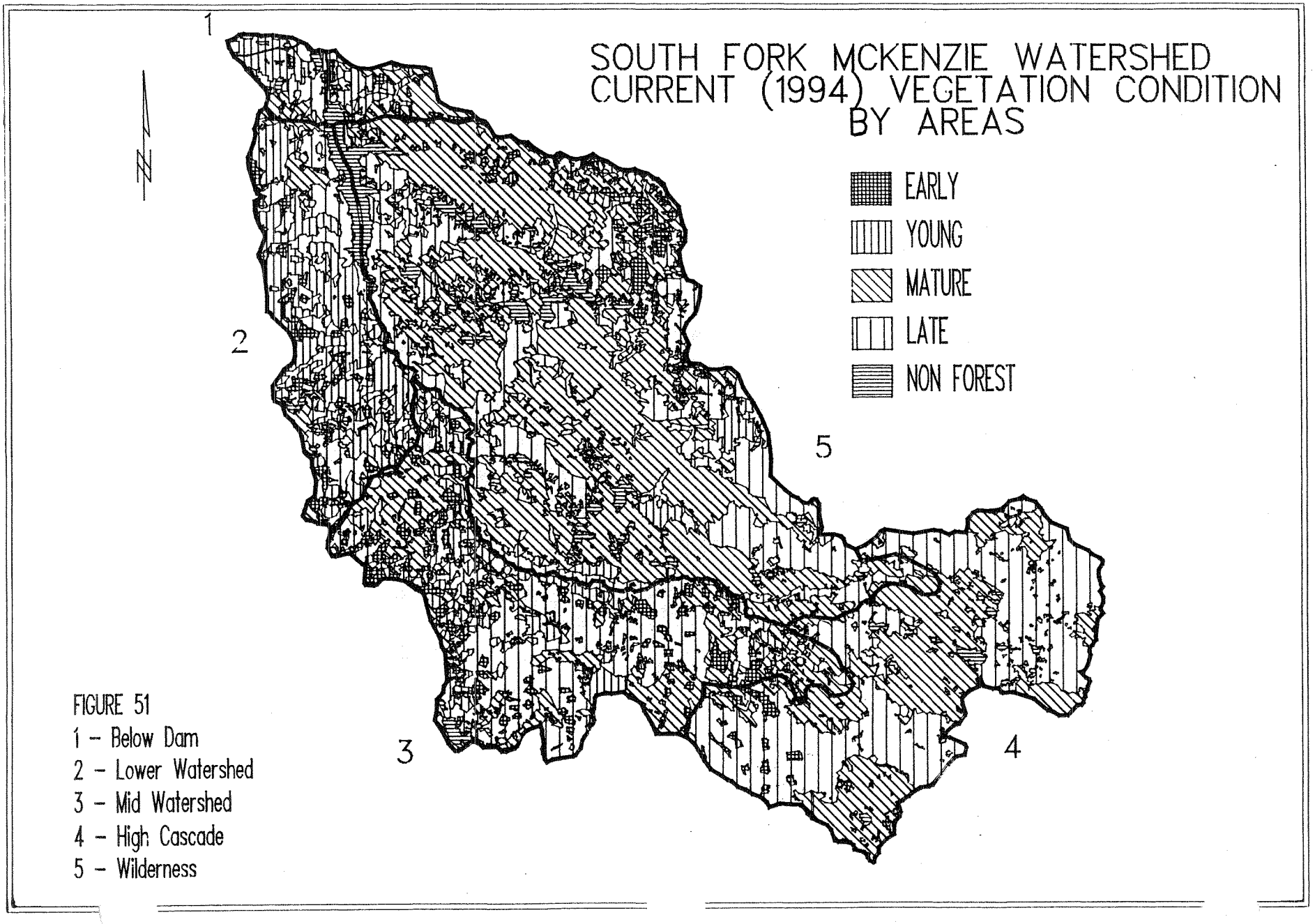


FIGURE 51
1 – Below Dam
2 – Lower Watershed
3 – Mid Watershed
4 – High Cascade
5 – Wilderness

COMPARISON OF PAST AND CURRENT VEGETATION CONDITIONS

Overall, the composition of current vegetation conditions is about the same as vegetation conditions in the period around 1900 (Table 18). The major shifts have occurred in the young and mature vegetation conditions. The changes reflect the growth of stands from the young to mature and the mature to the late seral conditions. A large proportion of the watershed, which is mostly in Wilderness, was comprised of young and mature stand conditions in 1900. These stands have now grown into the mature and late seral vegetation condition and make up a about 77% of the watershed.

Harvest activities have had a minor influence in the overall composition of the vegetation in the watershed. The early and young stand conditions which exist today, are predominantly the result harvest activities.

By looking at the stratifications of the watershed, the location of changes to the vegetation conditions becomes more apparent (Table 19). The area below the dam, in Cougar Creek and Delta flats, and the area of the lower watershed, ranging from Basalt to Hardy Creeks, show the largest changes from late seral condition to early and young stand conditions. This reflects the highest concentration of harvest activities. The mid watershed area, ranging from Starr to Moss Creek, shows a mixture of changes from harvest activity and growth of the stands. In 1900, about one third of the area was in young stand conditions as a result of wildfires. These stands have grown into mature stands today. In the lower area of Augusta Creek, harvest activities are the principle cause in the shifts from late seral to early and young stand conditions. The High Cascade and Wilderness areas show that past young and mature stand conditions have grown into today's mature and late seral conditions. The Skookum and East Fork areas were included in the stratifications of the High Cascade and Wilderness areas, respectively. A relative small percentage of these areas have been influenced by harvest activities.

Comparison of Watershed Past (1900) and Current Vegetation Conditions

Vegetation Conditions	Past Acres	Past %	Current Acres	Current %
Early	1,650	1%	7,300	5%
Young	58,115	42%	15,375	11%
Mature	23,732	17%	54,500	39%
Late	48,230	35%	52,848	38%
Non-forest	7,393	5%	9,093	7%

Table 18

Comparison of Past and Current Vegetation Condition by Areas

Area	Veg Condition	Past	Current
Below Dam	Non-forest	2%	7%
	Early	0%	8%
	Young	30%	35%
	Mature	1%	27%
	Late	66%	24%
Lower Watershed	Non-forest	3%	7%
	Early	0%	9%
	Young	9%	43%
	Mature	1%	8%
	Late	88%	34%
Mid Watershed	Non-forest	4%	4%
	Early	0%	12%
	Young	37%	13%
	Mature	14%	29%
	Late	45%	42%
High Cascade	Non-forest	4%	4%
	Early	0%	2%
	Young	37%	0%
	Mature	53%	37%
	Late	6%	57%
Wilderness	Non-forest	7%	9%
	Early	3%	3%
	Young	56%	5%
	Mature	7%	55%
	Late	27%	29%

Table 19

Spatial Analysis Comparing Past and Current Vegetation Conditions

Spatial statistics for the past and current vegetation conditions were calculated using FRAGSTATS software (McGarigal and Marks 1993) (Tables 20 and 21; Figures 52 and 53).

Table 20 and Table 21 display the spatial statistics, and Figures 52 and 53 show the patch size histograms for each landscape.

Comparison of Past and Present Landscape Statistics

Landscape Statistics	Past	Current
Mean Patch Size	138 ac	95 ac
Number of Patches	1021	1482
Patch Size Coefficient of Variation	1086	1282
Total Edge	6,121,021 ft	8,249,620 ft
Edge Density	44 ft/ac	59 ft/ac
Total Core Area	90,915 ac	75,148 ac
Number of Core Areas	571	1066
Total Core Area Index	65%	54%
Contagion Index	56%	51%
Interspersion/Juxtaposition Index	62%	73%

Table 20

Comparison of Past & Current Vegetation Condition Statistics by Area

Below Dam	Past				Current			
	Early	Young	Mature	Late	Early	Young	Mature	Late
Mean Patch Size(ac)	0	77	28	195	7	60	78	32
Number of Patches	0	8	1	7	24	12	7	15
Total Core Areas(ac)	0	353	4	963	12	327	264	151
Number of Core Areas	0	9	3	11	10	19	13	18

Lower Watershed	Past				Current			
	Early	Young	Mature	Late	Early	Young	Mature	Late
Mean Patch Size(ac)	0	22	55	1,134	11	108	18	50
Number of Patches	0	25	1	5	51	26	28	43
Total Core Areas(ac)	0	212	20	4,815	111	16	179	846
Number of Core Areas	0	21	2	7	37	33	20	73

Mid Watershed	Past				Current			
	Early	Young	Mature	Late	Early	Young	Mature	Late
Mean Patch Size(ac)	0	101	114	187	10	28	48	99
Number of Patches	0	41	14	27	137	52	67	48
Total Core Areas(ac)	0	2,287	1,090	3,278	275	569	1,383	2,510
Number of Core Areas	0	71	14	47	110	66	86	80

High Cascade	Past				Current			
	Early	Young	Mature	Late	Early	Young	Mature	Late
Mean Patch Size(ac)	22	187	616	218	6	0	194	739
Number of Patches	1	23	10	3	36	0	22	9
Total Core Areas(ac)	4	2,911	4,757	452	35	0	2,843	4,982
Number of Core Areas	1	35	19	2	12	0	42	17

Wilderness	Past				Current			
	Early	Young	Mature	Late	Early	Young	Mature	Late
Mean Patch Size(ac)	91	369	119	94	8	31	358	106
Number of Patches	7	37	14	70	77	38	37	67
Total Core Areas(ac)	299	9,283	1,003	3,477	134	482	8,502	3,509
Number of Core Areas	14	113	28	132	31	51	136	167

Table 21

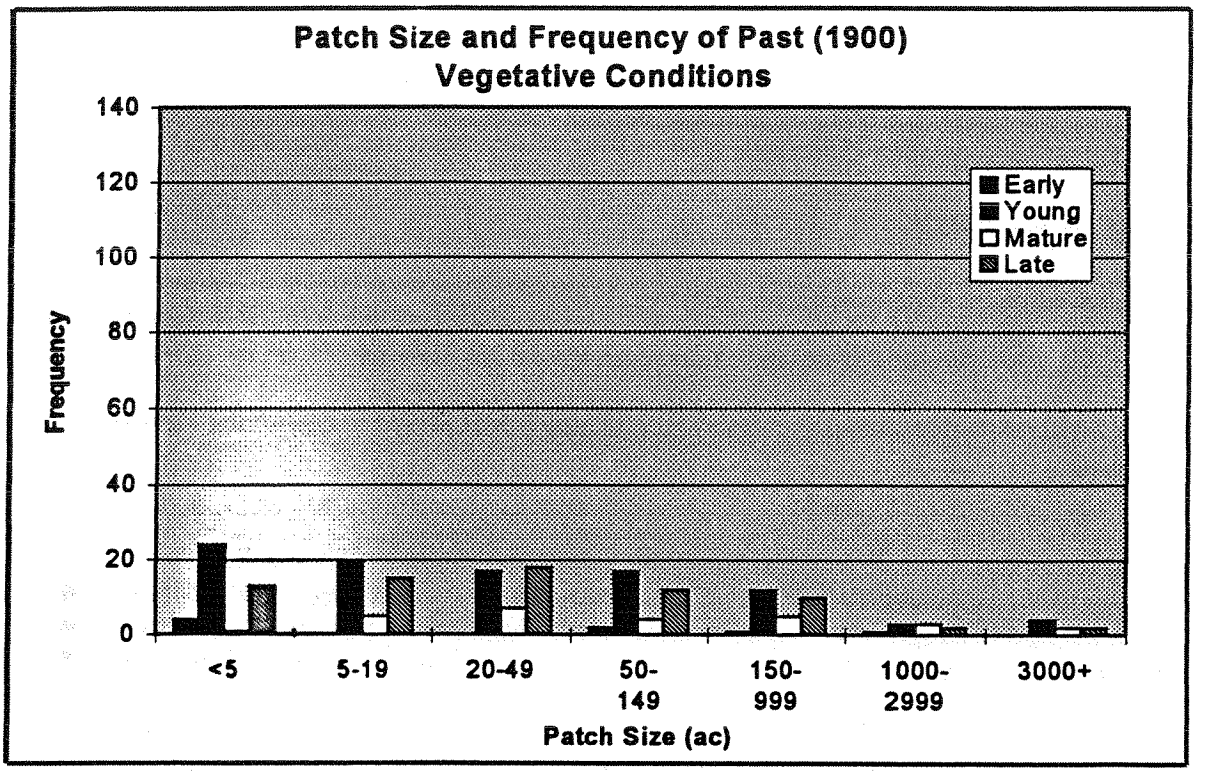


Figure 52

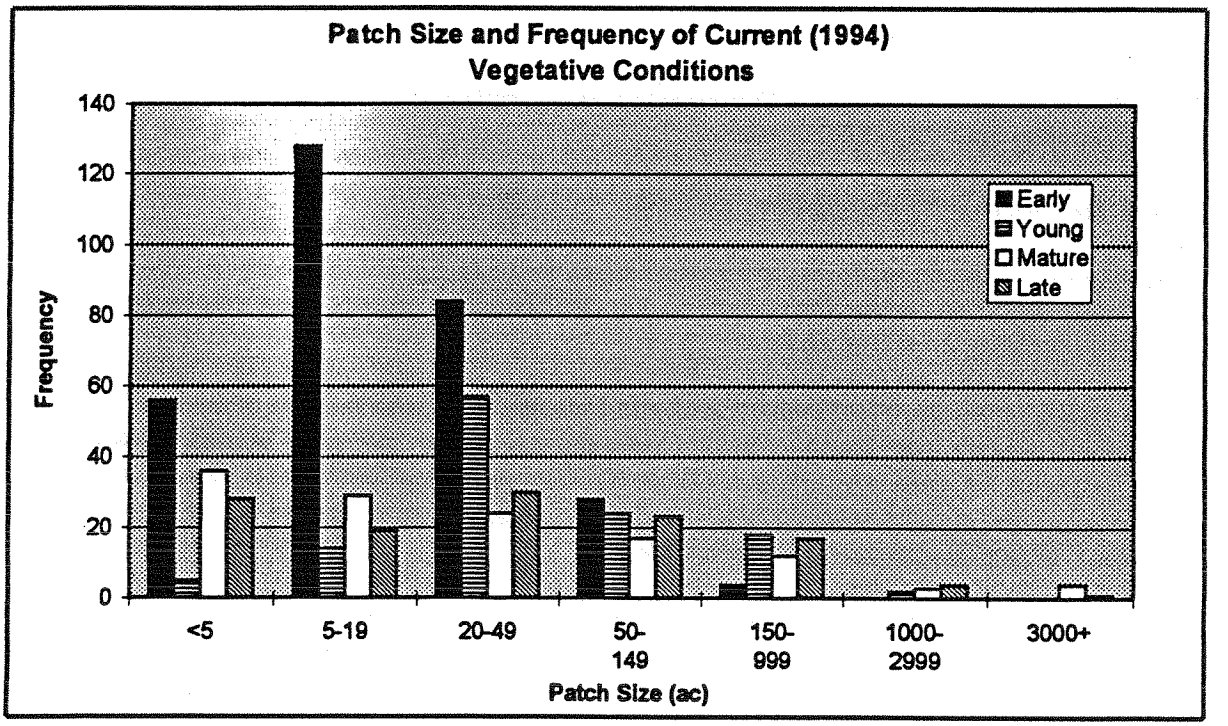


Figure 53

Discussion of spatial analysis

The spatial statistics for landscape features generally correspond to the same trends discussed in the composition of vegetation conditions.

At the watershed level:

The decrease in mean patch sizes and increase in number of patches begins to quantify some of the habitat fragmentation and heterogeneity of the current landscape (Table 20). Relative to mean patch size, patch size coefficient of variation shows patch sizes are more variable in the current landscape.

Increases in total edge and edge densities also illustrate spatial heterogeneity of the current landscape.

Reductions in total core area and increases in number of core areas correspond to a more patchy arrangement of vegetation conditions in the current landscape. According to total core area index, 65% of the past landscape was "interior' habitat (for all vegetation conditions - early, mid, mature and late) and the balance of 35% was in edge habitat. Current conditions trend towards less (54%) "interior" habitat and more (46%) "edge" habitat condition.

Contagion measures both patch type interspersion (i.e. the intermixing of units of different patch types) as well as patch dispersion (i.e., the spatial distribution of patch types). The higher value of contagion indicates a landscape with larger, contiguous patches, whereas a lower contagion value generally characterizes landscapes with smaller and dispersed patches.

The differences in the interspersion/juxtaposition index verifies that the current landscape has greater interspersion of available patches.

At the patch type level – vegetation condition :

There is a decrease in patch sizes and an increase in frequency of both the early and young vegetation conditions within the watershed (Figures 52 and 53). Again, these graphs quantify the changes occurring from fragmentation.

The area below the dam, the Cougar Creek and Delta flats area, and the area of the lower watershed, ranging from Basalt to Hardy Creek, show significant decreases in mean patch sizes and total core areas for late seral conditions (Table 21). The corresponding affect is shown in the increase number of patches of early stand conditions. Again, these areas are where the most of the harvest activities have occurred in the watershed.

The High Cascade and Wilderness areas shows the trending of young stands to mature stands and mature to late seral conditions. Young stand mean patch size and number of patches decrease. The mature and late seral conditions show increases in mean patch size, number of patches, and total core area.

NATURAL RANGE OF VARIABILITY

The Regional Ecosystem Assessment Project (REAP) used an approach developed by the Northern Region of the Forest Service entitled Sustaining Ecological Systems. This approach recognizes that ecosystems are made up of elements and processes, and that each functions within a range of natural variability. The main principle underlying this approach suggests that when an element or process is pushed outside this range, that element and those depending upon it may not be sustained naturally.

The assessment was designed to gain a "first approximation" or "coarse filter" analysis of ecological sustainabilty of northwest National Forests. Many assumptions and limitations are inherent in the assessment. However, the apparent patterns and trends are valuable to land managers.

The historic range of natural variability was reconstructed for a time period during 1600-1850. The information used to develop the historic range of natural variability for early and late seral conditions came from three fire history studies done on the Blue River District of the Willamette National Forest (Morrison and Swanson 1990, Teensma 1987, and Connelly and Kertis 1992) and on one fire study in the Mt. Jefferson Wilderness, Deschutes National Forest (Simon 1991). The Mt. Jefferson study was used for information in the mountain hemlock series.

The REAP process stratified the seral conditions into slightly different age classes for early and young conditions for each series (see Appendix Report, VEG 3 The mature condition was not analyzed during the REAP process.

The information below was derived from taking current vegetation back to 1900 (Table 22). The current conditions indicate the vegetation condition in 1994 from VEGIS data layers. The natural range of variability (NRV) indicate the percentages that existed between the years 1600 and 1850. The young and mature conditions are displayed without their natural range of variability. For the purposes of this analysis, young and mature conditions are displayed at least to show changes in conditions between past (1900) and current (1994).

Natural Range of Variability (NRV) by Plant Series

Vegetation Conditon	Series	Past	Current	NRV
Early	Douglas-fir/Grand fir	0%	11%	3-30%
	Western Hemlock	2%	5%	2-35%
	Pacific Silver fir	1%	7%	3-35%
	Mountain Hemlock	1%	2%	1-30%
Young	Douglas-fir/Grand fir	25%	58%	
	Western Hemlock	43%	18%	
	Pacific Silver fir	49%	6%	
	Mountain Hemlock	38%	8%	
Mature	Douglas-fir/Grand fir	6%	25%	
	Western Hemlock	8%	42%	
	Pacific Silver fir	19%	46%	
	Mountain Hemlock	49%	32%	
Late	Douglas-fir/Grand fir	69%	6%	50-90%
	Western Hemlock	47%	35%	35-85%
	Pacific Silver fir	31%	41%	40-70%
	Mountain Hemlock	11%	58%	2-25%

Table 22: Comparison of the Past (1900) and Current Vegetation Conditions to Natural Range of Variability for the South Fork Watershed.

Discussion of results of past and current comparison

Within all the series, there have been slight increases in early seral percentages from the past (1900) to the current (1994). All series are within the lower third of the range given for natural variability for early seral conditions. The increases in early seral percentages are certainly the result of harvest activities. Some of the differences in comparing amounts of current early seral conditions to natural ranges may be explained by suppression of wildfires within the last 94 years.

The young seral conditions show a decrease in percentages, except for the Douglas fir/grand fir series. The decrease in young seral conditions reflects the growth and development of young stands into mature stands within the last 94 years. In 1900, 42% of the watershed was in young seral conditions as a result of the high occurrence of wildfires in the late 1800's.

This trend is reflected in the increase of percentages in the mature seral condition. All series, except the mountain hemlock series, show an increase in percentage of mature condition from past (1900) to current (1994). The decrease in mountain hemlock mature conditions reflects the growth of these stands into the late seral conditions.

The late seral conditions show a mixture of results. The decrease in Douglas-fir/grand fir series again is more a result of the low percentage (<1%) of this series within the watershed. The western

hemlock series shows a decrease in late seral conditions, most likely due the concentration of harvest activities within the series zone. Late seral conditions are at the low end of the range of natural variability for the western hemlock series. Pacific silver fir and mountain hemlock series show increases in late seral conditions. These increases may reflect the transition of mature stands into the late seral condition and their locations predominantly concentrated in wilderness and no harvest management areas. Pacific silver fir series is at it's low end of the range for late seral conditions while the mountain hemlock is above the natural range of variability for late seral conditions.

PROCESSES

VEGETATION DISTURBANCE AND SUCESSION

Disturbance and succession are really two facets of a single phenomena: change. Disturbances are events that can result in radical change in vegetative characteristics within the landscape, often in a very short time. Disturbances can be described in terms of their type, intensity, frequency, duration and effect. Fire, wind, insects and pathogens, and landslides are the disturbance phenomena most useful for envisioning natural landscape patterns in the Western Cascades (Diaz and Apostol 1992). General stand development stages are as follows: stand initiation, stem exclusion, understory reinitiation, and late successional climax old growth. The stand initiation or early seral stage begins after a disturbance to the preexisting plant community. During this period seeds present in the seed bank and/or pioneer invader species, and regrowth from vegetative sprouts dominate the area. Conifer regeneration re-initiates the stand and shrubs and herbaceous species that were present in the preexisting plant community are usually reestablished in abundance. The next stage is stem exclusion. As saplings grow into a young pole stand, a dense canopy develops limiting the sunlight available to intolerant shade species and preventing further regeneration. During the understory reinitiation period, the stands mature and natural thinning of the conifers create openings in the canopy. Shade-tolerant trees, shrubs, herbaceous plants, and cryptograms are established in the understory. Eventually, large trees in the overstory die creating gaps, younger trees in the lower canopy layers are released, and the stand develops an uneven-aged, irregular canopy characteristic of the late successional old-growth stage (Oliver and Larson , 1990).

Plant succession does not typically proceed in chronological uniformity. It will vary depending on the type of disturbance and intensity, soil composition, macro and micro-environmental conditions and the preexisting plant communities. A seral stage can occupy or overlap in various sequences for an indefinite period of time until site conditions initiate change.

Vegetation disturbances will discuss:

- fire;
- wind;
- insects and disease; and
- human influences to vegetation condition.

FIRE

Fire has been an important disturbance process in the western Cascade Mountains landscape (Burke 1979, Teensma 1987, Morrison and Swanson, Agee 1993). In temperate forest ecosystems fire influences species composition and distribution, initiates succession, controls the patterns and scale of the vegetation mosaic and governs ecological processes by regulating fuel accumulations. Fire is also important in maintaining wildlife habitat, reducing forest insects and diseases, and influencing ecosystem stability and diversity.

Fires of varying intensities and diverse temporal and spatial extent have resulted in an extremely complex mosaic of forest composition and stand age structure. This complexity of forest composition and structure has created a diversity of habitats for biological organisms.

The maintenance of this rich biological diversity might be achieved by managing the forest landscape more closely along the patterns of natural disturbance. The patterns of historical fire occurrence and extent might be used as a "template" for forest management (Connelly and Kertis, 1991).

Periodic fire has been a normal and recurring component of the South Fork McKenzie watershed since the retreat of the last glacier. The forests periodically experience both large and small disturbances that destroy less than an acre to thousands of acres at a time. New forests regrow through a succession of plant communities and forest structures.

Many fires were probably ignited by lightning, particularly along prominent ridgelines. Fire spread depends on a host of climatic and fuel factors including fuel biomass and moisture content, ambient air temperature, humidity, wind direction and wind speed. Fires may be localized small events that follow topographic contours related to parameters of weather and fuels. Conversely, during droughty conditions and extreme fire weather, fires may be topographically independent.

The following summaries are general descriptions of the fire regimes in the watershed (Table 23 and Figure 54). The fire regimes are based upon the Augusta Fire History Study (Connelly and Kertis 1991, Kertis and Heyerdahl, unpublished) and the ongoing Cascade Crest Study (Kertis, Huff, and Martin, unpublished). Fire regimes were extrapolated throughout the watershed by applying regimes to landscape block based on similarities in age classes, stand structures, aspects, length of slopes, elevations and topographic features.

Fire Regimes

Regime	Frequency	Intensity	Size	Mean Fire Retur Interval (MFRI)
1	Infrequent	High	Large	460+ yrs
	Infrequent to Intermediate	Low-Mod	Small-Med	150-260 yrs
2	Intermediate	Mod-High	Med-Large	182 yrs
	Intermediate to Infrequent	Low	Small-Med	100-340 yrs
3	Frequent to Intermediate	Mod-High	Med-L:arge	180 yrs
	Frequent	Mod	Small-Med	65 yrs
4	Intermediate	High	Med-Large	107 yrs
	Frequent-Intermediate	Low-Mod	Small-Med	56-118 yrs
5	Frequent	High	Med-Large	80 yrs
	Frequent to Intermediate	Moderate	Small-Med	139 yrs

Frequency
Infrequent - > 300 year MFRI
Intermediate - 100-300 year MFRI
Frequent - < 100 year MFRI

Intensity
Low = 0-30% Mortality
Moderate = 30-70% Mortality
High = > 70% Mortality

Size
Small = < 350 acres
Medium = 350 - 700 acres
Large = > 700 acres

Table 23

SOUTH FORK MCKENZIE WATERSHED FIRE REGIMES

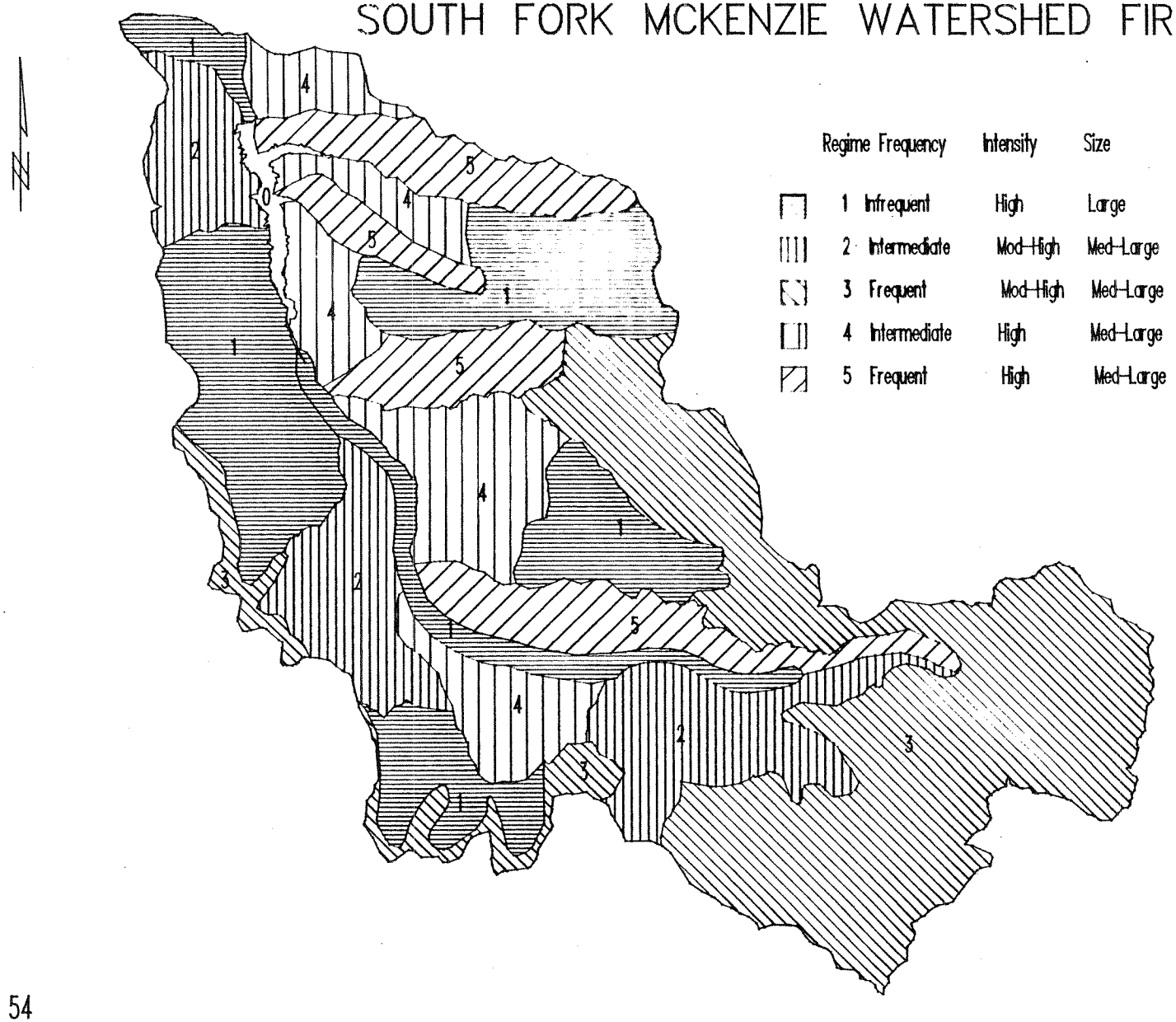


FIGURE 54

Discussion of Fire Regimes

Fire Regime #1

This fire regime characterizes areas which have maintained old growth stands in the watershed. The last high intensity burns occurred some 350-500 years ago as indicated by the dominant age structures of the stands. Generally the younger trees within this regime show a wide range in ages. This wide age range may indicate the occurrence of periodic low to moderate intensity underburns, inclusions of low to moderate intensity fire events that caused some small patch stand replacement in restricted pockets and/or natural gap processes. Low intensity disturbance may play an important role in maintaining an old age Douglas-fir composition by removing shade tolerant and fire sensitive western hemlock, Pacific silver fir, and western redcedar. This fire regime generally occurs in the western hemlock and Pacific silver fir series. The long fire return interval supports high levels of snags and LWD in the higher decay classes.

It occurs on north-facing high elevation headwaters and cirque basins, along the South Fork McKenzie river corridor, and across most of the gentle sloping earthflows along the western portion of the watershed.

Fire Regime #2

This fire regime characterizes areas with stands predominantly of only one or two age classes. The majority of the areas are composed of stands 100-200 years old with the remainder composed of the 400-500 year age class. The fire events appear to have been relatively large in size and mostly stand replacing. The fire events have created homogeneous stands of either all intermediate (100-200 years) ages, all old age, or a composite of intermediate and old. Most of the old age stands are located along side draws and creek bottoms. There also is evidence of scattered lower intensity underburns within this area with variable patch sizes. This regime appears to occur on steep, dissected east facing slopes or drainages which are exposed to east winds funneling through the watershed. The regime occurs mostly in the western hemlock series within the watershed. Stand structure (snags and LWD) would be low within the intermediate aged stand ranging up to moderate levels in the old age stands.

The Rush and Basalt Creek area across the reservoir from the East Fork drainage, lower reaches of Roaring River and Elk Creek, and Loon and Starr Creek areas which are exposed to the upper South Fork drainage are examples of areas influenced by this type of fire regime.

Fire Regime #3

This fire regime represents areas within the higher elevations ridgelines and High Cascade plateau of the wilderness. The predominant age classes range around 100, 150 and 200 years. Older age classes have remained in protected areas through successive fires. The regime is characterize by intermediate to frequent events of moderate to high intensity and medium to large patch sizes. Along the ridgelines, lightning ignitions play an important role in the ecological process, but fires have been relatively small in extent due to the nature of fuel packing, abundance and moisture at these sites. On the High Cascade plateau, large scale fire events have provided the disturbance resulting in the younger aged stands. Many of the 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 aboriginal prescribed burns to enhance berry productivity.

This area encompasses most of the mountain hemlock series and some of the Pacific silver fir series in the watershed. Stand structure (snags and LWD) is relatively low in these high elevations with this type of fire regime.

Indian and Hiyu Ridges, the area along the ridge from Grasshopper Mountain to Chucksney Mountain, Skookum flats, Mink Lakes basin, and the Olallie Mountain area are covered by this fire regime.

Fire Regime #4

This fire regime characterizes areas with a mosaic of small to medium sized stands of varying age classes. The stands are mostly intermediate and older age classes with a few dispersed younger age classes. This regime has created stands with the most complex age composition within the watershed. Most of the stand ages on the northern aspects are older than 150 years, with many greater than 200 years of age. The older age compositions are typically lower in elevation along the stream terraces. The mosaic of age classes may have been caused by numerous spot fires. It is possible that fires spotted across the drainage from the south aspect slopes which have higher fire intensities and frequencies. Fires could also have crept downhill from the ridgetop as backing fires with low intensity underburns flaring up to become high mortality patches in scattered locations.

The western slopes have been grouped in with this fire regime even though the fire events have been of higher intensities and somewhat larger sizes. This area contains a mosaic of stands of a younger age class interspersed with a couple of intermediate and older age classes. Much of the area is covered with a younger age class established after the 1920 fire compared to age classes over 150 years found on the north aspects. Again, older age classes are either grouped in dense stands along the riparian zones or scattered singly and in clumps up the draws and along the northwestern aspects of western lying ridges.

Western hemlock and Pacific silver fir series are common on the northern aspects and range from Douglas-fir, grand fir, to western hemlock on the western aspects. Stand structure (snags and LWD) would be low to moderate on the western aspects and range into high levels on the northern aspects.

This regime occurs on north and western facing aspects with highly dissected, long slope lengths. The northwestern ridgelines running from Chucksney Mountain, Rebel Rock, Tipso Butte, and Sawtooth Ridge and which line the eastern side of the South Fork McKenzie watershed exhibit these regime characteristics.

Fire Regime #5

This fire regime represents frequent, moderate intensity events which have created a mosaic of medium to larger patches of intermediate age classes. The most dominant age is younger than 200 years, with many trees less than 150 year old. Fires may have originated from ridgetops with fire

movement down and across slope. New tree regeneration following fire events was probably very slow on the predominant south aspects (warm and droughty) and thin, rocky soils along the upper slope near the ridgetop. This could explain the wide-span of years for a particular cohort following a specific event. It also appears that there may have been a recurrence of events as often as every 20 years between 1800-1900. This may explain why there is such a mixed distribution of tree ages across the watershed. A high percent of the watershed has been influenced by these events.

Douglas-fir and grand fir series are common within this regime. Stand structure (snags and LWD) is low within this regime due to the repeated nature and intensities of fire events.

This regime occurs on long, dissected south facing aspects. The south facing aspect along Rebel Rock ridge, and the south slopes above French Pete and Walker Creek, and the East Fork represents examples of this regime.

Discussion of Fire Disturbance

Most of the oldest trees within the watershed originated between 1450 and 1600, implying that a series of stand replacing fire events occurred during that time period. Based upon tree regeneration, it appears that a number of holicostic fires occurred particularly during the early 1500's and resulted in the removal of the existing forest and regeneration of new stands of trees across the watershed (Connelly and Kertis 1991).

Overall, there appears to be a higher frequency of fire events during 1800-1900 than in any of the last five centuries. Fires between 1800-1830 and between 1860-1880 resulted in the majority of tree regeneration in the watershed. This apparent elevated fire frequency may be partially accounted for as a common artifact of all fire history studies. More recent fires progressively remove information about less recent fire events as one moves backwards in time. Some of the elevated occurrence of fires in the 1800's may be attributed to aboriginal cultural changes and to the appearance of settler's in the area (see section on Human Influences to Vegetation Conditions).

The fire regimes exhibit great variability with some sites having been relatively fire-free for over 500 years to other sites which have experienced fire occurrences as often as every twenty years. Fire severity appears to have varied both in time and space.

WIND

Wind as a disturbance agent, plays a very small role in the South Fork McKenzie watershed. Windthrow risk is based, in part, on the probability of trees being uprooted by wind as a result of insufficient soil depth, inadequate soil strength to provide anchoring of tree roots, or a combination of both of these factors. Other disturbances which create high contrast edges between stands also increase the risk to windthow. The exposed "wall of trees" can be very susceptible to strong winds. Windthrow disturbance in the watershed is characterized as having a frequent interval of low intensity in small patch sizes.

Windthrow commonly occurs on Indian and Hiyu Ridges which border the watershed on the west. These ridges have shallow, rocky soils and are exposed to the predominate western flow of wind

into the watershed. Along the river terraces in the Frissel Crossing area, several occurrences of windthrow have resulted from saturated soils. Other areas prone to windthrow in the watershed are: French Mountain, Star, Tiny and Augusta Creeks. A majority of the windthrow has occurred along high contrast edges of clearcut harvest units.

INSECTS AND DISEAS

Insects and decease also play a small role as disturbance agents. The disturbance caused by these are generally within a stand and are at a small scale. The following insects and diseases are the predominant organisms influencing formation and structure of forest stand in the watershed.

Douglas-fir beetle (*Dendroctonus pseudotsugae*) is the primary insect attacking Douglas-fir trees in the watershed. Douglas-fir beetle population increases are strongly associated with areas of fresh blowdown or dead standing timber. Once Douglas-fir beetle populations have become elevated, they infest and are highly destructive to live green Douglas-fir trees, often tending to infest live trees that have been weakened by drought, disease or competition stress. Douglas-fir beetle often fly many miles over the landscape to find patches of weakened or stressed trees to attack.

Other key insects influencing stand structure and composition include mountain pine beetle (*Dendroctonus pondederosae*) and the fir engraver (*Scolytus ventralis*).

Mountain pine beetle infest stands which contain lodgepole pine and western white pine. As stand density increases these stands become susceptible to mountain pine beetle attack. In lodgepole stands, a significant proportion of the trees can be killed during an outbreak. Many of the western white pine are infected with white pine blister rust (*Cronartium ribicola*), but the cause of death for larger (dominant and codominant) trees is attack by mountain pine beetle when stand density reaches a level at which trees are stressed due to competition fore resources.

Like the Douglas-fir beetle, the fir engraver beetle is very opportunistic, attacking trees weakened by stresses such as root diseases, defoliating insects, high stocking levels, and drought. The fir engraver attacks and kills true firs of all sizes, and seems to have its greatest effect in stands with high densities. The fir engraver is commonly associated with root diseases. It is not currently a important factor within the watershed.

Root disease is a factor that affects the vegetative composition and health of the forests. Laminated root rot (*Phellinus weirii*) is the most prevalent root disease in the watershed. Laminated root rot affects stands comprised primarily of Douglas-fir and mountain hemlock. The fungus is passed from tree to tree through the root systems. Thus, if a root rot pocket is initiated, it will continue to grow as long as there are host trees available to infect. These root rot pockets probably were limited only by the occurrence of stand replacement fires, which would have greatly reduced the sources of inoculum by burning some of the root systems. In addition, if the fire was large, by the time host trees were established some of the root systems that had been infected may have become nonviable sources of inoculum.

Two other root diseases, annosus root rot (*Heterobasidion Annosum*) and Armillaria root rot (*Armillaria ostoyae*) are minor influences within the watershed. Annosus root disease mostly affects

the true firs (grand, Pacific silver, and subalpine) in the higher elevations. Armillaria root rot is a common conifer root rot in the Pacific Northwest. Infection results in growth loss, root and butt rot, uprooting, and tree killing. The fungus survives and grows in old stumps or dead trees; rhizomorphs are formed and grow through the soil to infect the roots of new hosts. Disease centers usually occur around infected stumps of the older trees. The effects of Armillaria infection are most severe with trees that are already stressed by insect attack and/or drought conditions.

Two decay fungi prevalent in the watershed are red ring rot (*Fomes pini*) and brown cubical butt rot (*Phaeolus schweinitzii*)

All of the disturbance agents generally show an interaction between each other. An example specific to this watershed helps to describe the complicated interactions and processes of the disturbance agents.

About 40% of the watershed consist of mature stands ranging from 80-200 years old. Many of these stands regenerated after the wildfires in the 1800's. The stands are considered to be in the development stage of understory re-initiation in the successional timeline. Natural thinning is beginning to create openings and gaps. Shade tolerant trees, shrubs, and herbaceous plants are establishing in the understory. Laminated root rot pockets are beginning to show up and assists in the natural thinning. The wildfires which re-set these stands may have controlled and reduced the root rots inoculum established in the root systems. It may have taken 100-200 years for the root systems to re-establish to a point where the root rots are beginning to re-establish. The root rots weaken the root systems making the trees susceptible to blowdown. Heavy rainfall with strong winds begin to knock trees down within the root rot pocket. Weakened trees, standing dead, and blowdown provide an environment for the spread of Douglas-fir beetle. The beetles assist in killing additional trees and expanding the gaps within the stands and thinning isolated weakened and stressed trees. The mortality from succession, insects and diseases contributes to a build up of down woody material and snags, and thus fuel loading on sites over time. And given the right circumstances, the cycle may return to the disturbance of fire.

HUMAN INFLUENCES TO VEGETATION CONDITIONS

Through time, the use of natural resources has changed as perceptions of them have changed. The forests, now a tremendously valuable resource, were once regarded as an impediment to travel and was intentionally burned by early settlers. Huckleberry fields, so important to native people of the area, were kept open by burning. Today, due to fire exclusion and suppression, the role of fire and it's influence on successional pathways has changed. These changes begin to describe an environment once dominated by nature to one dominated by humankind.

Native people historically applied fire to the landscape for a variety of reasons including the management of game populations and staple plant foods (Colville 1898, Boyd 1986). Game drives were suspected to occur along the main McKenzie River just north of the watershed (Teenmsa 1987). Ollalie Meadows and Indian Ridge was used for hunting and huckleberry picking by native people from the Warm Spring Indian Reservations until the 1920's (Teensma 1987).

Shifts in use by native people occurred during the mid-1800's. Many cultural changes resulted following the mass epidemics (disease contracted from initial contact with European explorers) among these native people (Burke 1979, Boyd 1986). Settler's probably began moving into the watershed around the 1850's. Viewing the forests as barriers to transportation, settlement, and progress, early settlers used fire as a tool to clear land, build roads, and improve grazing. Most forest fires likely resulted from unattended campfires and intentional ignitions by sheep herders to improve forage resources (Colville 1898). Sheep grazing has been documented in most of the high elevation montane meadows within the watershed from 1890-1930 (Appendix Report, VEG 1).)

The watershed includes portions of historical travel routes used by the early native people that were subsequently used by early explorers and settlers. The South Fork McKenzie River corridor was a major travel and trade route. Other routes within the watershed include the East Fork, French Pete Creek, Hiyu Ridge, Chucksney Mountain ridgeline, and the Rebel Rock ridgeline. It is likely that fire frequency was increased in areas adjacent to these routes through human activities (Burke 1979). The elevated occurrences of fires events dated between 100-200 years ago seem to correspond to these places and activities.

The late 1800's was dominated by the conflict of interests in the utilization, conservation and management of the forest resources. Lumbermen, and businessmen followed the early settlers, miners, and sheep grazers. Interest focused on the timber resource and extreme carelessness with fire was common. Although the conservation movement worked to halt some of these practices, by the time the Federal government passed the Forest Reserve Act of 1891, almost four-fifths of the nation's standing timber was privately owned. This period from 1850 to 1910 was characterized by exploration, expansion, and exploitation of the natural resources.

The establishment of the national forest in the early 1900's began an era of fire prevention and suppression. Cooperative forestry practices between federal, state and private timber owners authorized systems of fire prevention and suppression for timbered and cut-over lands. In the 1930's, the Civilian Conservation Corps played an important role in fire protection by constructing roads and trails, laying telephone lines, building fire lookout towers, and combating fires. With the need to protect forest from fires, the need to better understand fire effects was recognized. Initial research work focused on flammability of forest fuels, accurate fire weather forecast, fire behavior, and fire control planning. Fire studies took on added importance when protecting the nation's lumber supply became a matter of national defense, during World War II.

In the 1940's and 1950's the Forest Service adapted to the new age of technological change and economic growth. With increase of logging activity, interests focused on reforestation after fires, management of slash fuels, and improved timber harvest techniques to reduce other fire hazards. Utilization standards of slash material evolved with the management of slash fuels and demands from the market. Fuel management peaked in the mid 1970's with intensive slash burning programs and harvest techniques which yarded, piled and burned excessive slash material.

Harvests levels peaked in the 1970's and 1980's (Figure 14 and Figure 55). Harvest units have been distributed throughout the watershed in a dispersed or staggered setting pattern to enhance habitat for species which depended on high contrast edges for forage and cover, and to develop transportation systems.

Harvest by Decade

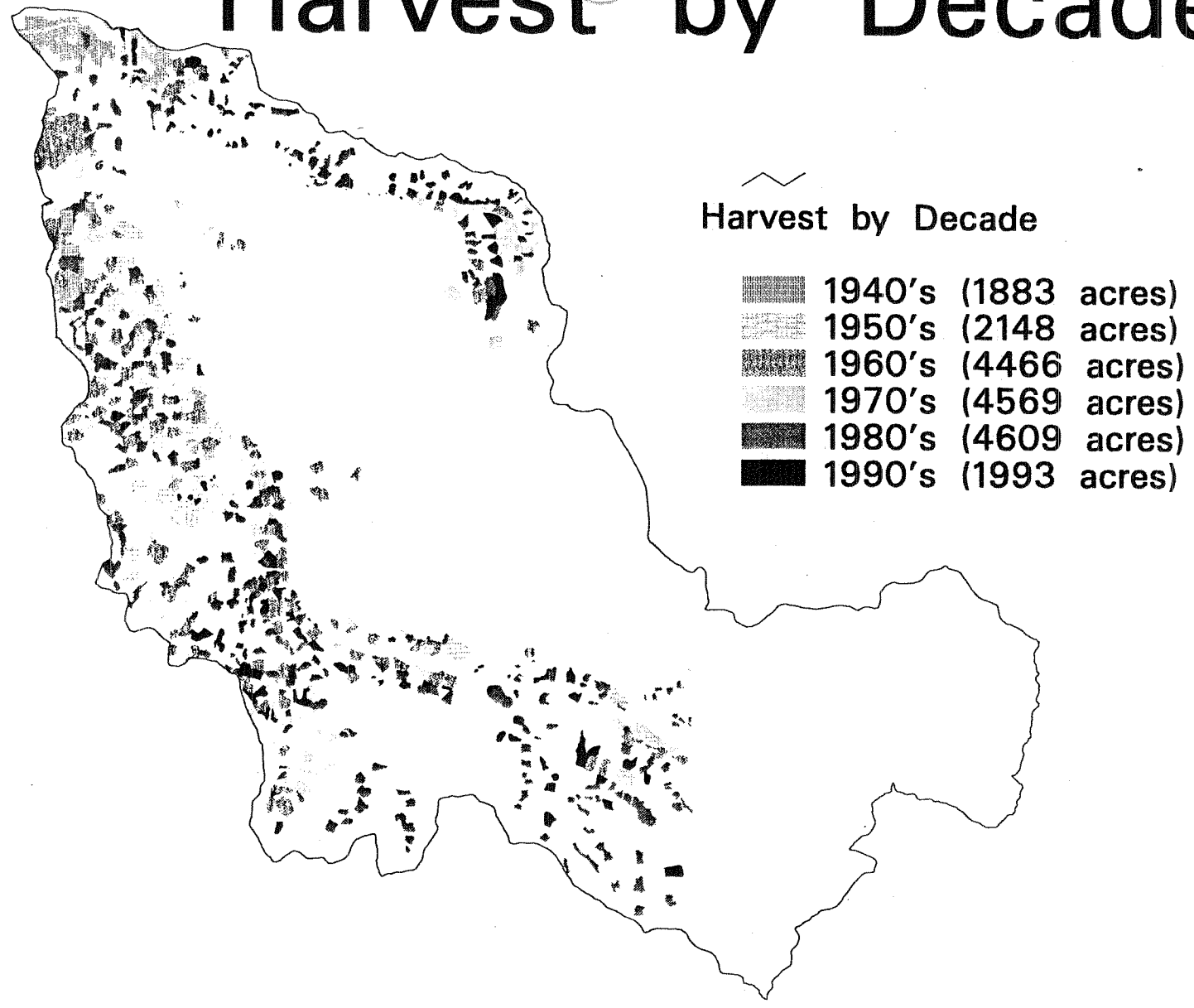


Figure 55

Plantations

Plantations are areas that have been harvested and replanted.

Site preparation, improved nursery seedling stocks, and quality planting techniques have contributed to the rapid reforestation of conifers. In natural conditions, grass/shrub early seral stages could persist for 30-50 years, whereas reforestation techniques shorten the time to 10-20 years.

Plantations are denser than most early seral natural stands. This practice was intended to ensure the survival and re-establishment of conifers to a given stocking level. The higher stocking levels were also planned as part of the management regime to contributed to intermediate thinning entries to increase total yields of timber.

The species composition of plantations favored the shade intolerant species (Douglas-fir) With clearcutting as the predominant silvicultural systems, shade intolerant conifer species were planted to take advantage of site conditions. Shade tolerant species (western hemlock, western red cedar) were generally expected to seed in naturally as site conditions became more favorable.

Precommercial thinning in the 1960's and 1970's favored the fast growing Douglas-fir as croptrees over the slower growing shade tolerant trees. In recent decades thinning prescriptions have changed to maintain more of a mixture of species such as would appear under natural conditions.

Fuels management and utilization practices govern the amount of LWD which has been retained in the plantations. Plantations harvested in the 1940's and 1950's generally have moderate to high levels of LWD. The plantations harvested in the 1960's through the 1980's exhibit lower levels of LWD from the intense slash burning and yarding of cull material. Only plantations harvested within the last 5-10 years reflect moderate levels of LWD which approach LWD standards established in Forest Plans.

Standing dead snags are all but non-existent in older plantations. Plantations harvested from the 1950's through 1980's either had snags felled during logging operations for safety, or destroyed during slash burnings. Cutting units harvested within the last 10 years have shown increasing numbers of standing snags and live trees retained for wildlife habitat.

LANDSCAPE PATTERNS/VEGETATION TRENDS

Based on the current percentage of mature stands in the watershed, there will be increasing amounts of late seral conditions in the future, mostly in the higher elevations and Wilderness areas.

With no harvest land use allocations and the system of riparian reserves, a network of mature and late seral conditions will develop throughout the watershed.

Early and young forest conditions will be interspersed and concentrated on upslope and ridgetop areas.

Plantations in the early and young forest condition will continue to move through the development stages of stem exclusion and understory re-initiation.

More structural components such as snags, green tree retention, and down woody debris will be evident in future plantations.

There will be reduced levels of regeneration harvest compared to past decades.

Fire suppression will continue to offset the occurrence of wildfire as a disturbance agent. Managed fires will be use to manipulate species composition, densities, and structural components of forest stands.

UNIQUE VEGETATION

Five categories of vegetation will be discussed within this section:

- Current rare plant populations;
- Non-forested habitat;
- Rare forested plant associations;
- Fungi, bryophytes, lichens and vascular plants; and
- Noxious weeds.

Current Rare Plant Populations

Rare plants have been tracked on the Blue River Ranger District since the early 1980s. The Willamette National Forest (WNF) rare plant species lists have changed over time as populations increase or decrease. Field surveys discovered new populations of eight rare plants located in the South Fork watershed.

Current rare plant populations are stable. Population stability may change if habitat hydrology or encroachment of vegetation occurs. The majority of the rare plants found within the watershed are located in the Three Sisters Wilderness Area or designated Special Interest Areas. These areas are rich in species diversity because of the variety of plant habitats found. These botanical places of interest add to the uniqueness of the South Fork watershed. Twelve rare plants have been found in the South Fork (Table 24) and there is potential habitat for approximately 80 additional species (Appendix BOT 1).

Current Rare Plants and Locations
South Fork Watershed

Species	Site Name	WNF Land Allocation
Lycopodiella inundata	Bear FLat Bog	Three Sisters Wilderness
Scheuchzeria palustris var. americana	Bear Flat Bog	Three Sisters Wilderness
Ophioglossum pusillum	Hardy Creek	Hidden Lake SIA
Oxypolis occidentalis	Hidden Lake	Hidden Lake SIA
Oxypolis occidentalis	Indian Ridge	
Oxypolis occidentalis	Olallie Meadows	Three Sisters Wilderness
Lycopodiella inundata	Olallie Meadows	Three Sisters Wilderness
Lycopodiella inundata	Quaking Aspen Swamp	Three Sisters Wilderness
Oxypolis occidentalis	Quaking Aspen Swamp	Three Sisters Wilderness
Utricularia minor	Quaking Aspen Swamp	Three Sisters Wilderness
Romanzoffia thompsonii	Rd. 19	Aufderheide Drive
Oxypolis occidentalis	Rider Swamp	Rider Swamp SIA

Table 24

Non-Forested Habitat

Past geological activity combined with climatic events have created the landforms in the watershed. The landforms over time have developed sites of differing soils, vegetation, and microclimates. Non-forested habitats are found within these environments. The botanical communities of these habitats are described in the following section.

Individual plant ranges can extend over a variety of related communities. Contiguous plant communities offer potential habitat for numerous species. For example, a species growing in a meadow habitat may range into a nearby forest edge. However, it is unlikely that a species can be found over a range of unrelated communities such as meadows and rock gardens.

Eighty-five percent of plant species diversity in the region can be found in non-forest plant communities such as meadows, rock outcrops, and wetlands, although these types account for only five percent of the land base (Hickman 1968). Biodiversity is the variety and complexity within all ecological systems that embodies ecosystem resiliency and stability. The majority of rare plants in the South Fork are found in these types of habitat (Appendix BOT1A).

For additional information on the plant associations, species, and environmental conditions refer to Plant Association and Management Guide, Willamette National Forest (Hemstrom, et al. 1987).

The following are descriptions of the non forested habitat in the South Fork.

Lakes/Ponds

These habitats consist of a body of standing water and its associated edge of water tolerant vegetation. Many of these ponds are seasonal and dry out each summer to become sedge (*Carex*) meadows.

The sedge/panicled bulrush association is commonly found adjacent to ponds in the Lake Mink Basin. Sitka sedge (*Carex sitchensis*), blister sedge (*C. vesicaria*), inflated sedge (*C. utriculata*), and panicled bulrush (*Scirpus microcarpus*) dominate this community. Grasses and herbs are abundant with few shrub species.

Riparian zones

This habitat includes the vegetation along streambanks, seeps, and headwaters with dense vegetation.

Bog

A bog is a permanently wet area dominated by sphagnum mosses, herbaceous plants and shrubs. There are numerous bogs within the South Fork watershed. Two of significant size are Bear Flat Bog and the bog adjacent to Hidden Lake. The Sphagnum bog adjacent to Hidden Lake is presently impacted by recreationists and it's close proximity to campsites. Bogs support a diversity of species including rare plant species.

Marsh

A marsh is a periodically wet or continually flooded nonpeat-forming ecosystem where the surface is not deeply submerged and supports sedges, rushes or other hydrophytic plants. Vegetation usually dominated by emergent herbaceous plants. Woody plants, lichens, and sphagnum are absent or rare. A marsh can be found at Quaking Aspen.

Swamp

A wetland site with a mineral soil dominated by tall shrubs and occasional trees. Standing or flowing water is usually present. Quaking Aspen swamp (240 acres), Rider swamp (21 acres), and Cow swamp are located in the watershed. Numerous small red cedar (*Thuja plicata*) swamps are found in the South Fork watershed. Skunk cabbage (*Lysichitum americana*) is often present in these wet areas.

Meadows

Meadows are dominated by herbaceous vegetation often grasses and sedges. The mesic and dry meadow communities in the South Fork watershed were heavily grazed by sheep and cattle from 1880 to 1947. Appendix Report, VEG 1 is the list of historical allotment records and report for the South Fork watershed. Fire suppression has allowed encroachment of trees and shrubs, and exotic species from past grazing to replace native grasses. The displacement of native plant species is particularly common in the Three Sisters Wilderness Area.

Approximately 3300 acres of conifer and hardwood meadows were mapped in the watershed. Approximately 2350 acres were mapped as Sitka alder (*Alnus sinuata*) thickets. Many of these thickets are found in draws on Grasshopper and Rebel Rock mountains.

Wet Meadows

Wet meadows are usually small or large depressions, most are glacial cirques or colluvial failures, found adjacent to water, or where water flows through. The ground is wet throughout the growing season but can dry out by late summer. The wet meadow community is composed of a mixture of annuals and perennials. Changes in the hydrology will influence the species composition of these habitats. There is approximately two hundred and forty acres of wet meadows in the South Fork watershed.

There are several wet meadow plant associations found within the South Fork watershed. The spirea/willow/sedge community occurs in cirque basins in the Mink Lake Basin. The water table is close to the soil surface. Spirea (*Spiraea spp.*), western bog blueberry (*Vaccinium occidentale*), willow (*Salix spp.*), and sedge (*Carex spp.*) dominate this community-type. Grasses, and forbes are also present. Douglas spirea/western bog blueberry/sedge (*Spiraea douglasii/Vaccinium occidentale/Carex spp.*) is a diverse community of shrubs and herbaceous species that is also in the Mink Lake Basin. The sedge/twinflower marshmarigold (*Carex/Caltha biflora*) association is dominated by sedges and grasses with a rich herbaceous layer. This community is usually found in forest openings.

Mesic meadows

Mesic meadows are found on mountain slopes and flat ground where the soils are deep and saturated for at least a portion of the year. Plant vegetation is dense which can reduce the soil moisture loss. Approximately two hundred and fifteen acres of mesic meadows are found in the watershed.

Thimbleberry (*Rubus parviflorus*) community is the most extensive of the montane mesic meadow types. This community-type is found midslope with southerly aspects on Lowder, Yankee, and Rebel Rock Mountains. Species commonly found are bracken fern (*Pteridium aquilinum*), Varileaf phacelia (*Phacellia heterophylla*), native thistle (*Cirsium callilepis*), and grasses. A common mesic meadow plant association on Olallie Mountain is the coneflower/bracken fern (*Rudbeckia occidentalis/Pteridium aquilinum*). Plant diversity is affected by mountain beaver disturbance and is typically low for this community. The false hellbore/common cowparsnip (*Veratum spp./Heracleum lanatum*) plant association is commonly found on moist, gentle, mountain slopes and draws with a dense herbaceous layer of sedges and grasses. Common shrubs for this association are salmonberry (*Rubus spectabilis*) and Sitka alder (*Alnus sinuata*).

Dry meadows

Dry meadows are typically dominated by grasses; fewer annuals and perennials are found. Dry meadows are common on the southern slopes and ridgetops of Lowder, Yankee, Pyramid and Chucksney Mountains. Approximately 840 acres of dry meadows are located in the watershed.

Several dry meadow plant associations occur in the South Fork watershed. The blue wildrye/brome (*Elymus glauca/Bromus spp.*) association; herbaceous plants found are aster (*Aster occidentalis*), red sorrel (*Rumex acetosella*), and goldenrod (*Solidago canadensis*). The common vetch/peregrine fleabane/blue wildrye (*Vicla sativa/Erigeron peregrinus/Elymus glauca*) association occurs between 3000 to 4800 feet. The thimbleberry/pokeweed fleeceflower (*Rubus parviflorus/Polygonum phytolaccefolium*) association forbs dominate; grass species are a minor component. These meadows are found at 4000 to 5000 feet. The beargrass/red fescue (*Xerophyllum tenax/Festuca rubra*) plant association is not particularly rich in plant species. This community is found in cold, dry areas, usually mountaintops. This plant association can be found on Chucksney Mountain, Yankee Mountain and the south slope of Lowder Mountain.

Rock

There is approximately one thousand seven hundred acres mapped as dry rock/rock in the watershed. Approximately 1470 acres are mapped as conifer/rock. Rebel Rock is an example of this type of habitat. Conifers and other vegetation is present where soil has accumulated to support growth in and around large areas of exposed rock.

Talus/Scree

The weathering of a cliff face may allow rock to accumulate at the base in the form of talus or scree. Scree is a sheet of coarse rock debris mantling a mountain. Whereas talus is an accumulation of rock material at the base of a cliff, scree includes loose material lying on slopes without cliffs. A critical ecological feature of talus habitat is its unstable surface over which stones and finer material continues to weather and fall to crush or bury the small plants. A scarcity of vegetation characterizes the large rock talus community. Trees, shrubs, or herbaceous plants are usually found in surrounding forests where soil and moisture is able to accumulate. There is approximately five hundred and seventy acres of talus/scree habitat in the South Fork watershed.

A common talus community found in the South Fork consists of shrubs, such as shinyleaf gooseberry (*Ribes cruentum*), trailing blackberry (*Rubus ursinus*), and vine maple (*Acer cicinatum*). Annual forbs or perennial grasses and rockbrake fern (*Crytogramma crispa*) are found in this harsh environment. The vine maple (*Acer circinatum*) plant association occurs over large andesite and basalt boulders where there is a high water table. Approximately 225 acres of vine maple/talus can be found in the watershed. Red elder (*Sambucus racemosa*), salmonberry (*Rubus spectabilis*), and herbaceous plants make up this community. Talus communities are most valuable for their contribution to the landscape diversity.

Rock Gardens

Rock garden communities are commonly found on exposed rocky ridges within the South Fork watershed: Rebel Rock, Olallie, Lowder, and Chucksney Mountains. Soil development is minimal. Plants splash the rocks with vibrant color in early summer. By mid to late summer, these communities have finished blooming and have begun to wither. Many of these species are unique to these harsh open sites and cannot compete on more mesic sites. Rock gardens are biological islands between which plant migration to sustain genetic diversity is difficult. These habitats can occur in dry or moist conditions. Approximately ten acres of rock garden are located in the watershed.

The upper slopes and ridgetops of Olallie and Rebel Rock mountains are dominated by small-flowered penstemon (*Penstemon procerus*), Sierra snake root (*Sanicula graveolens*), long-stolen sedge (*Carex pensylvanica*), and other herbaceous plants.

Rock outcrops

Rock outcrops are present on the steeper, higher slopes of Rebel Rock and Chucksney mountains. Where outcrops have been exposed to the erosional forces of glaciation, they may

be worn fairly smooth; otherwise, they are apt to be jagged. Rock outcrops tend to warm up quickly in the spring melting the snow. Plants initiate new growth and flower before summer. Approximately 270 acres of rock outcrops are found in the watershed.

Rocky slopes/soils

Herbaceous plants and grasses dominate this habitat. A minimal amount of shrubs are present.

Woolly eriophyllum/varleaf phacelia (*Eriophyllum lanatum/Phacelia heterophylla*) plant association occurs on southern exposure mid mountain slopes. Forbs, herbaceous plants, and shrubs such as serviceberry (*Amalanchier alnifolia*) and oceanspray (*Holodiscus discolor*) are common with the community.

Rare Forested Plant Associations

These are common groupings of plant species recurring across the landscape within particular environments (Daubenmire, 1968). The plant species present characterize the successional or climax vegetation of the site.

Rare forested plant associations were identified using the WNF ecoplot data. One hundred and eighty permanent ecoplots are distributed throughout the watershed, excluding the Three Sisters Wilderness Area. Additional information on rare and uncommon plant associations within the watershed was obtained from district personnel.

The ranking system is as follows:

A - Absent or unknown;
R - Rare, five or fewer sites found on the district;
U - Uncommon, six to 11 sites on the district;
C - Common, 12 or more sites located on the district.

Three Pacific silver fir plant associations -- the Pacific silver fir/dwarf Oregon grape, Pacific silver fir/rhododenron-Alaska huckleberry/dogwood bunchberry, and Pacific silver fir/rhododenron-dwarf Oregon grape are classified as common on the Blue River RD. These plant associations are uncommon in the watershed. The Pacific silver fir/dwarf Oregon grape and the Pacific silver fir/rhododenron-dwarf Oregon grape plant associations occur on warm, dry soils usually at the lower elevation zone (3000 to 5300 feet) of the Pacific silver fir zone. The Pacific silver fir/rhododenron-Alaska huckleberry plant association is commonly found on Sweet Home and Detroit Ranger Districts and is uncommon in this watershed. Two Plant associations for Pacific silver fir (Pacific silver fir/devils club and Pacific fir/Oregon oxalis)listed as uncommon on the district are also uncommon in the watershed.

The Douglas-fir plant associations (Douglas-fir,western hemlock/dwarf Oregon grape and Douglas-fir , western hemlock/salal) listed as uncommon are well represented in the watershed. These plant associations occur on dry, droughty, south aspect common on the east side of Cougar reservoir. Two rare Douglas-fir plant association (Douglas-fir/ocean spray-whipple vine and Douglas-fir/snowberry), and two uncommon Douglas-fir plant associations (Douglas-fir/ocean spray-dwarf Oregon grape-grass) are present, with low occurrence in the watershed.

The western hemlock/rhododendron-Alaska huckleberry/dogwood bunchberry plant association listed as common on the district, occur with less frequency in the watershed. This association occurs at moderate high elevations in the transition from Pacific silver fir to western hemlock zones.

Consistent with the district rating, the western hemlock/rhododendron/Oregon oxalis and the mountain hemlock/rhododendron plant associations are uncommon on the disctict and in the watershed.

The Pacific silver fir-grand fir/false solomonseal plant association is listed as uncommon on the district, however, it is well represented in the watershed. This is found on moderately steep slopes with southerly aspects above 4000 feet in elevation.

An undescribed plant association was found in the watershed. This association of Douglas-fir/Oregon white oak is found on dry, droughty sites with south aspects. It is recommended that this association be added to the WNF Rare and Uncommon Forested Plant Associations.

Appendix Table, BOT 3 lists plant associations and ecoplot locations in the watershed.

Fungi, Bryophytes, Lichens and Vascular Plants

Appendix Table, BOT 3 lists Table C-3 vascular and non vascular plant species, habitat information, documented or potential presence in the South Fork watershed, the Appendix J2 and the FEIS ROD survey and management standard and guideline strategies. Documented species are located in the Three Sisters Wilderness Area, designated Special Interest Areas, Research Natural Areas and Delta Old-Growth Grove.

A habitat guilding system was developed to analyze where Table C-3 species may potentially occur within the South Fork watershed. Species are grouped by their habitat requirements and may fall into more than one guild. Using this system 243 species are grouped in old-growth/late-successional habitat. Twenty-eight species are grouped in riparian habitats. The species/guilding habitat list can be found in Appendix List, BOT 4.

Fungi are important for their roles in forest succession and ecosystem processes; several are harvested for their food value. Most of the fungal species listed in Table C-3 are mycorrhizae fungi. Mycorrhiza fungi form a symbiotic association with live hosts such as conifers and hardwoods; host species depend on the fungi for uptake of nutrients and water. Many mycorrhizal associations are highly specific. Other listed groups are saprobic and parasitic species. Saprobic fungi are the forest decomposers; they live on organic materials from dead plants and animals. Parasitic fungi require living hosts for nourishment. Of the two hundred and forty fungal species listed, ten species are

documented in the South Fork watershed. Potential habitat exists for one hundred and seventy-two fungal species within the watershed.

Four species of fungi are located in the Lamb Butte Scenic Area and six fungal species are located in the Olallie Ridge Research Natural Area. These two areas run along a ridgeline east to west along the northwest boundary of the watershed. Douglas-fir dominates the lower elevations and mountain hemlock, and true fir species dominate the higher ridges. This ridgeline has been recognized as an area that supports a diversity of species and concentrations of rare and locally endemic fungi (FEIS, Appendix J2 1992).

The non-vascular plant group, bryophytes, listed in Table C-3 includes mosses and liverworts. Mosses and liverworts are commonly found in moist areas. Many are aquatic or are found on wave-splashed rocks. Similar to lichens, mosses and liverworts absorb most of their nutrients from the air, and are also very susceptible to air pollution. Twenty-four bryophytes are listed; two species are present, a liverwort and moss. Potential habitat in the watershed exists for fifteen species.

Lichens occur as either epiphytes growing on trees or growing on exposed rock and/or soil (Nash and Gries 1991). These species have important ecological roles (Slack and Seaward 1988) as interceptors of wet and dry deposition, as nitrogen fixers in cyanobacteria-containing species, as carbon fixers in ecosystems where they are abundant, in the weathering of rocks and the retention of soil in dry areas (Nash and Gries 1991). They can survive under adverse climatic conditions by their ability to withstand desiccation and remain dormant when dry. Lichens absorb all their nutrients from the air and therefore are very susceptible to air pollution, especially sulfur dioxide (Richardson 1988). Lichen distribution is closely related to forest continuity, stand age, and disturbance history. They provide important forage material for several species of mammals (Sharnoff 1992) and many bird species use lichens as nesting material (Richardson and Young 1977). Table C-3 lists eighty-one lichen species, four are present in the watershed; potential habitat exists for fifty-five species. Nitrogen-fixing lichens are common epiphytes on mature and old-growth forest stands 3,000 feet in elevation (FEIS Appendix J2 1994). Two of these species (*Lobaria oregana* and *L. pulmonaria*) are present in the watershed. All species in this group are potentially present in the watershed.

Table C-3 contains seventeen vascular plants. These plants are either, rare throughout their range or considered locally endemic. Three are federal candidate species. Unlike the non-vascular plants, considerable information exists regarding plant species range, distribution, and habitat. The species (*Botrychium montanum* and *B. minganense*) are currently listed on the Regional Forester's Sensitive Plant List for the Willamette National Forest. One species, *Cypripedium montanum*, is listed on the WNF Watch List. There are no known documented sightings of these vascular plants in the watershed; potential habitat exists for seven of the species listed.

As organisms that absorb water mosses, lichens, and liverworts play an important role in a healthy ecosystem. A forest with an abundant moss, lichen, and liverwort flora maintains more water availability after rainfall, increasing the time vascular plants can absorb the rain water (Dorris 1994). These species also maintain higher humidity levels. This humid environment decreases stress on the vegetation decreasing their susceptibility to disease, insects, and fire (Dorris 1994).

Vascular plants, lichens, bryophytes, and fungi are valued as indicators of biodiversity, stability, and the forest health. Data concerning the distribution of these species and how that affects the ecological processes is needed. Old-growth stands function as refugia where many of these species can persist until suitable habitat conditions become available in younger stands (FEIS Appendix Js 1994). Vegetation management includes the retention of clumped green trees of various sizes and structural diversity to provide dispersal of these species. Variation in tree size contributes to the diversity of microhabitats, both vertically and horizontally (Spies, Franklin 1988). Current Forest Plan Standards & Guidelines exceed the FEIS ROD recommendations for LWD needed by many of these species. The health and viability of the ecosystems within the South Fork watershed depend on maintaining riparian buffers, late successional reserves, and old-growth stands, well distributed throughout the landscape.

Noxious Weeds

Six noxious weeds are found in the South Fork (Table 25).

Classification of Noxious Weeds Found in the South Fork Watershed

Common Name	Species Name	Classification
Diffuse Knapweed	*Centaurea diffusa*	New invader
Spotted Knapweed	*Centaurea maculosa*	New invader
Candian Thistle	*Cirsium arvense*	Established
Scotch Broom	*Cytisus scoparius*	Established
St. John's wort	*Hypericum perforatum*	Established
Tansey Ragwort	*Senecio jacobaea*	Established

Table 25

Noxious weed species are distributed throughout most of the watershed due to activities associated with timber harvest and the extensive road system. The road system allows for easy establishment and the longevity of these species. Established populations of spotted knapweed (*Centaurea maculata*), scotch broom (*Cytisus scoparius*), and St. John's wort (*Hypericum perforatum*) are present. Most of the secondary roads throughout the watershed have populations of noxious weeds including the roads that access trails to the Three Sisters Wilderness Area. Many recreation trails throughout the watershed and in wilderness have scattered populations of noxious weeds. Campgrounds located around Cougar Reservoir have established populations of scotch broom that are displacing native vegetation. Other non-native invasive species, whch are not classified as noxious, are found in the same kinds of disturbed areas

These exotic plants are pioneer species usually occurring in the first stage of plant succession following a disturbance to the natural vegetation. Weed seeds are the principle means that these species spread and invade new areas. Seeds are dispersed by natural and artificial means such as birds, wind, and vehicle transportation. Soil substrate and the existing plant community will influence seed germination and plant growth. The South Fork watershed contains a rich diversity

of non-forested habitats. It is these areas, meadows, wetlands, and rock gardens that are the most affected by the introduction and establishment of non-native species. As time progresses the establishment of these non-natives plants may lead to the displacement of the natural vegetation of these areas. Populations of noxious weeds are established on road landings and present in many of the early seral conifer stands. The presence and abundance of these established populations are an active source of propagules to disperse to new areas. Many of these weed species are able to grow in conditions of full sun to partial shade.

The WNF Integrated Weed Management Environment Assessment (1993) for managing noxious weeds prioritizes weed species based on species present; the number of populations and their densities across the Forest. Three categories are used: potential, new invader and established populations. New invaders have the highest priority for control, all control methods available may be used for eradication of these species. The Oregon Department of Agriculture (ODA) supplies the beneficial insects that feeds on the seeds and roots of selected weed species. This control method has been the most successful in the South Fork watershed. Control methods currently used in the South Fork are biological, manual, roadside brushing and competitive planting along FS road 19.

During the period of the 1980's, tansy ragwort populations exploded at an alarming rate. The ODA released the cinnabar moth as a biological control. This insect successfully reduced the populations of tansy ragwort in the watershed. Populations of St. Johns's wort have also decreased as a result of biological control. A weevil was released in the summer of 1994 for the control of spotted knapweed present along Highway 19. If this insect is successful, spotted knapweed may be reduced from the main surface roads in the watershed. Populations of spotted knapweed, scotch broom, and Canada thistle have increased in the watershed. There are no known biological controls for scotch broom.

In addition to the noxious weeds present, several exotic plant species occur; wall lettuce (*Lactuca muralis*) is the most common species. This species appears to be tolerant of a wide range of environmental conditions and habitats (Parendes, 1994). Wall lettuce is of concern as it is commonly found in riparian zones (WNF riparian data 1994).

Oxeye-daisy (*Chrysanthemum leucanthemum*) is an established exotic species in the Willamette Valley. Recently it has been documented along roadsides in the H.J. Andrews Experimental Forest, WNF (Parendes, 1994). This aggressive species is not known to be present in the watershed.

The population graphs using 1988 and 1993 data show the decrease and increase in total populations of noxious weeds in the South Fork watershed (Appendix Figure, BOT 5).

WILDLIFE USE OF FORESTED PLANT ASSOCIATIONS SERIES

For purposes of explaining wildlife use in this watershed, the following discussion combines the four plant series described in Figures 49 and 49a into two zones:

Pacific Silver fir (includes Mountain hemlock)	High elevation "zone"
Western hemlock (includes Douglas-fir/Grand fir)	Low elevation "zone"

All forest zones in this watershed are used by wildlife species considered rare, unique, threatened, endangered, or sensitive. For each forest zone, the list of species of special concern is slightly different with a high degree of overlapping between the zones (Appendix Table s WL1 and WL2). The Blue River District has conducted surveys for most of these species and others (Appendix Table WL3) to varying degrees, but coverage of the watershed is limited. As a result of limited data on species or their populations, much of the information presented here is based on habitat modeling, known species occurrence, and existing vegetation patterns. These vegetation patterns include early, mid, and late successional stages of each major forest plant association within each plant series. Use of special habitats such as wetlands, caves, cliffs, and talus are discussed to illustrate their value and level of use by wildlife. In addition, snags and LWD in all forest zones is an indicator of overall biological health because it is considered to be key habitat for many species. However, amounts and types of snags and LWD vary depending on forest zone and fire history in each.

Wildlife habitats in this watershed around the turn of the century consisted of a mix of seral stages as they do today (Tables 18 and 19). It appears that similar quantities are evident between the two time periods, but the pattern of distribution and patch size has changed. The lower and mid portions of the watershed historically provided very good late seral habitats in the year 1900 whereas the wilderness area to the east consisted mostly of early seral habitats. Now, due to harvest activities and fire suppression efforts, the two have somewhat switched with the wilderness now providing ample mid and late seral habitats and the fragmented lower and mid portions containing a significant level of early seral habitat. This early seral fragmentation continues west into the adjacent watershed as well. There is a concern that the late seral habitats in the wilderness may never fully function as well as the lower and mid portions of the watershed in terms of late seral habitats due to the more frequent fire events suspected to occur here.

The plant communities then as well as today play an obvious role in wildlife habitats. They determine the kinds and quality of food and cover for all species occurring on the landscape. The seral communities vary from grasses and forbs to old growth forests (Hemstrom 1987). The resulting stand structure and plant species composition throughout each successional stage determines the different wildlife habitat features. In most cases, this stand structure is a function of the disturbance history and site productivity.

Upslope or terrestrial wildlife habitats do not usually function totally alone without influence from their associated riparian habitats, and vice-versa. While the habitat use between the two zones is usually linked, the use of and type of vegetation conditions is quite distinct. Upslope habitats provide different needs for different species. For example, upslope habitat use by tailed frogs may only be for dispersing to the next riparian area. However, the upslope may be primary breeding and feeding habitat for golden mantled ground squirrels and Townsends solitaires.

Wildlife species use riparian zones and wetlands disproportionately more than other areas (Brown, 1985). Though these zones occupy a relatively small portion of the overall territory, they are a critical source of diversity within the forest ecosystem. Species using riparian zones in this watershed are in Appendix Table, WL4.

Each of the "zones" contain a wide variety of structural components, habitats, and wildlife species (Table 26).

Number of Species Using Each Forest by Seral Stage

Forest Zone	Early	Mid/Late	Rare & Uncommon Species	Species Using Snags & Down Logs
Western hemlock	174	167	69	115
Pacific silver fir	144	150	58	103

Table 26

Wildlife Use of the Pacific Silver Fir "Zone"

General Discussion

This forest zone exists primarily above 4000 feet elevation, and includes a large portion of the wilderness area as well as the upper reaches of Chucksney and Grasshopper mountains through the Skookum area. This forest zone contains habitat for species such as the peregrine falcon, wolverine, and western spotted frog. Species distribution and occurrence in this forest type is dependent on the vegetative seral stages. Table 26 illustrates species richness by seral stage.

Fire histories and the resultant seral stages have provided a wide variety of structural components such as snags, large woody material, and multiple forest canopies over time. Thus, a wide and varied wildlife habitat community is present, such as summer range for black-tailed deer and Roosevelt elk. Mid and late seral conditions are abundant and provide multi-storied forests for species like the spotted owl, which prefers the large diameter Douglas-fir and Pacific silver fir overstory (Appendix Table, WL5).

Natural fires in this forest zone typically created both large and small habitat patches. These are unlike the average 40 acre clearcut harvest units scattered throughout portions of this zone, primarily in the upper reaches of Loon and Starr creeks as well as the Indian Ridge and Skookum areas. Fire suppression efforts will likely result in a trend of increased availability of mid and late seral habitat in this zone. Harvest activity will be the greatest landscape altering factor, unless a future natural fire event occurs. This habitat type, in all seral stages, is currently well distributed, and is high quality for existing wildlife species. The abundance of this habitat is within the normal range of habitat conditions, but may be outside the normal range of fragmentation in the area with harvest units, since the pattern developed by harvest is different from the patch size and configuration developed by natural fires (see Table 22).

Changes to this habitat have also occurred from insects, disease, and windthrow. These disturbances have contributed important structural components, improving the biological diversity in most stands, usually consisting of 0.2-5 acre gaps in the landscape. One of the more dramatic examples of this is where root rot has created a very diverse variety of stands in the Skookum area. On approximately 200-300 acres of managed stands, a combination of fire suppression and harvest of mature trees has resulted in a dense stand of young lodgepole pine in the disturbed skid trails with a variable mix of grasses, shrubs, and remnant trees. This provides some hiding cover and forage on big game summer range. In other unharvested areas with higher site potential, a more diverse habitat with larger trees and no root rot exists. Higher canopy closure, snags, and LWD is also present. However, these higher fuel loads make it susceptible to a stand replacement fire. These areas provide a good source of thermal and optimal cover, mostly for elk as well as some forage from big huckleberry and beargrass seedheads. In areas like Skookum, in the Pacific silver fir zone, which is subject to impact from insects such as the western spruce budworm and Douglas-fir beetle it is important to retain habitat for natural predators.

Eventually, a stand replacement fire will occur in this area again, shifting blocks of this habitat into an early seral stage. Small patch fires from lightning or spotting will also continue to alter the pattern of this landscape. This continuous cycle results in an ebb and flow of wildlife populations as they react to the periodic loss and availability of habitat. Reservoirs of early or late seral habitat have probably always existed at any point in time in this watershed, aiding in colonization following catastrophic events and succession. Fires have always existed in this area, and being variable in consumption have probably resulted in blocks of habitat that provided escapement cover. Scattered residual unburned patches also provided refugia for species. Research has shown that many species can escape fires by retreating underground or holding out in riparian areas and other patches that the fire misses. After the fire event, these individuals re-populate the area as suitable habitats develop through time. We assume that if the landscape is maintained within the known range of natural variability, that wildlife populations associated with the forested habitat will continue to exist on the landscape. Population levels will naturally fluctuate in response to catastrophic events, but the maintenance of species viability should be assured with the availability of habitat refugia for colonization.

Use of Special Habitats

The special habitats discussed previously exist throughout this zone. Appendix Table, WL2 displays number of species using these special and unique habitats. Riparian habitats of this upper elevation zone predominantly consist of lakes, wetlands, and narrow linear strips along class 4 streams. The lakes and wetlands mostly exist in the wilderness and the high cascade area.

The Mink Lake basin is a prominent source of lakes, wetlands, and meadow habitats. These provide important habitat for a wide variety of species including the spotted frog, sandhill crane, Cascade frog, Roosevelt elk, black tailed deer, osprey, and many species of waterfowl. This forest zone provides the source areas for many headwaters of streams like the South Fork of the McKenzie, Roaring River and Elk Creek . Most of these stream systems are important sources of cold water for mollusks and amphibians such as tailed frogs.

The wilderness area east of Cougar Reservoir contains many south facing dry meadows, most of which are quite steep with rocky outcrops. These provide habitat for the western fence lizard, racer,

horned lark, Swainsons hawk, and some winter use by big game. Talus slopes provide habitat for pika, rock wren, Townsends chipmunk, bobcat, bushy tailed woodrat, and western skink. Approximately 26 species are known to associate with talus habitats in this forest zone.

Snags And Large Woody Material

The Pacific silver fir zone contains stands capable of sustaining high snag levels except where the higher incidence of fires has occurred such as on south slopes of the East Fork and French Pete subdrainages of the wilderness area. Small snags in this forest zone averaging between 11-19 inch diameter at breast height (DBH) consist predominantly of lodgepole pine, grand fir, and subalpine fir. The large snags average 19-27" DBH and are mostly Douglas-fir, white pine, and western hemlock. Pacific silver fir stands normally contain an average of 8 snags/acre > 20" DBH (Hemsrom ,1987). Where fire frequencies are low, snag and LWD levels are normally high due to the incidence of insect and disease mortality across this zone (Figure 56). Most existing harvest units contribute no snags and low levels of LWD. The lack of LWD and snag retention requirements of past harvest practices in conjunction with PUM (Pile Unmerchantable Material) yarding and burning eliminated most organic matter on units harvested from about 1975 to 1986. Moderate levels have been retained since 1986 with new retention specifications in the forest plan standards and guidelines (Figure 56). Approximately 72 wildlife species are associated with snags in this forest zone.

The northern three-toed woodpecker, black-backed woodpecker, and Williamson's sapsucker are all on the state sensitive species list. This forest zone is considered habitat for these species (Marshal, D.B. 1992). However, no known sightings exist in this watershed, probably due to lack of specific surveys. Primary cavity excavator (PCE) species like these prefer sufficient large snag habitat (> 18" DBH) and trees developing heart rot over time to sustain population levels. The 100% population potential for the black-backed woodpecker is 0.12 conifer snags per acre > 17" DBH, or largest on the landscape over time. The minimum level required with the 1990 Forest Plan is 1.8 snags per acre on the landscape over time. On average, this level of snags currently exists in the late seral portion of this forest zone.

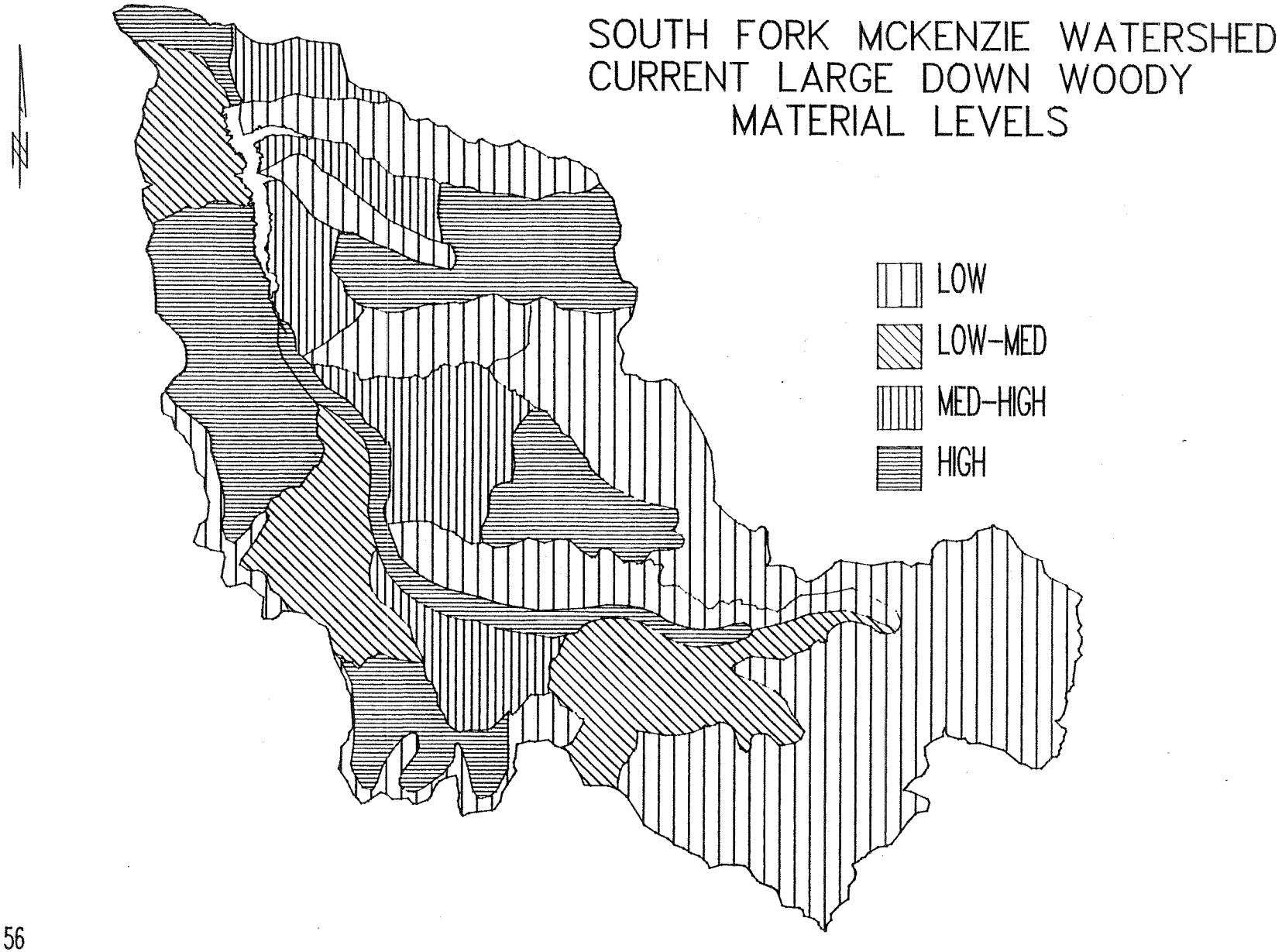

SOUTH FORK MCKENZIE WATERSHED
CURRENT LARGE DOWN WOODY
MATERIAL LEVELS
LOW
LOW-MED
MED-HIGH
HIGH
N

FIGURE 56

Specifics Concerning the Included Mountain Hemlock Series

The mountain hemlock series contains wildlife populations and habitat relationships similar to the Pacific silver fir zone. A few rare and uncommon species associated with mountain hemlock are common in the Pacific silver-fir zone. Such uncommon species in the mountain hemlock forest are: band-tailed pigeon, Calliope hummingbird, Oregon slender salamander, and the Pacific jumping mouse. This zone exists primarily along the crest of the Cascades creating an ecotone between eastern and western Cascades habitats. Species from both habitats often mix in this ecotone. With this habitat type primarily occurring in the wilderness portion of the watershed, seral changes in the forest zone occur mostly through natural fire, but also by insect and disease outbreaks. Most of this zone is in the mid and late seral condition where it exists in the watershed, and is beneficial to species such as the black-backed and three-toed woodpeckers which are highly associated to it. These stands are generally quite diverse, containing many non-forest habitats consisting of lakes, talus, wet meadows, and other special and unique habitats. Most snags in this area are <18" DBH and LWD levels are quite low due to high fire frequencies. The range of natural conditions for late seral habitats is only 2-25% of the landscape and currently 58% of it is in the late seral condition. This illustrates that it is outside the natural range of conditions, possibly due to fire suppression by humans. A significant amount of this habitat could be converted to an early seral condition in the next few decades by stand replacement fire.

Wildlife Use of the Western Hemlock "Zone"

General Discussion

This forest zone exists primarily below 4000' elevation. It contains habitat for TES species such as the northern spotted owl, peregrine falcon, and harlequin duck. Appendix Table, WL3 summarizes surveys completed for many species common to this zone. Table 26 illustrates species richness by seral stage.

The below dam and lower portions of the watershed consist only of this forest type except for small acreage's in the upper East Fork and Deathball Mountain areas. The mid and wilderness portions of the watershed are about half western hemlock and half Pacific silver-fir. The upper portion of the watershed contains only a small portion (<20%) of this western hemlock habitat type.

Early seral habitat of the western hemlock zone typically contain highly species associated with early seral habitat, for example the California quail, brush rabbit, and mountain bluebird. Mid and late seral habitats usually contain commonly observed species such as the belted kingfisher, common merganser, and red breasted nuthatch. Most early seral habitat created in this forest zone is the result of clearcut harvest activities in the past 30 years. These managed areas do not resemble the patch sizes of structural components that would occur through natural fire and disease disturbances. The existing patches are generally smaller and more numerous than in previous times (Table 20). This pattern exists primarily in the intensively managed areas of the watershed which are low and moderate elevations from Boone/Hardy south to the Augusta subwatershed area. This pattern also exists in the managed portion of the East Fork drainage.

Mid and late seral habitats within the western hemlock zone will likely be maintained over most of this watershed through fire suppression. This will continue to benefit species associated with these seral stages for example the pileated woodpecker, northern spotted owl, and tailed frog (Appendix Table, WL7). This forest zone contains the bulk of late seral habitat for the northern spotted owl. Forty one spotted owl sites exist in the watershed and approximately 90% are either within or no more than 1/2 mile outside the western hemlock forest zone.

Use of Special Habitats

Special habitats in the Western Hemlock Forest such as lakes, wet meadows, talus, hardwoods, and dry meadows differs from the Pacific silver-fir zone. The quantity of special habitats is much less frequent in the western hemlock forest zone. Hidden Lake and Lulu Lakes, located in the Hardy Creek area are examples of these uncommon habitat types and provide vital habitat for species such as the western grebe, Dunn's salamander, and several species of waterfowl. There is a high concentration of hardwood habitat located on point bars where flood deposits exist along the main South Fork. This occurs primarily in the Cascade/Twin springs area of the mid portion of the watershed and to a lesser extent in the Delta area below the dam.

Historic late seral riparian habitats not influenced by human activities, likely contained richer populations of most riparian associated species than currently exists.

Riparian habitat possess a high degree of connection and function with its adjacent aquatic and terrestrial habitat. It provides for effective transport of water, soil, plants, and nutrients to downstream areas as well as travel routes for many wildlife species.

Roads along riparian areas cause alterations in riparian areas as well as influences on animal populations that depend on them. The extent of these influences is unknown for the most part without specific monitoring data. Human disturbance is more significant in riparian zones than upland areas because of its vital association with wildlife.

Habitat unique to the area is also provided around Cougar reservoir. Including talus and cliff habitat around the dam for species such as pika, rock wren, and the prairie falcon. The reservoir pool and its shoreline habitat also provide habitat for migrating waterfowl, osprey, bald eagles, and the great blue heron.

The construction of Cougar Dam has altered the former natural water patterns. This has resulted in fewer side channels and less pool habitat which is valuable for waterfowl, turtles and beavers. This forest zone provides habitat for all wintering big game herds below the 3200'-3800' elevations. Big game is well distributed throughout this zone, especially in the mid watershed area. Herd sizes appear slightly less in the lower portion of the watershed in spite of the high concentration of suitable habitat.

Snags and Large Woody Material (LWD)

The western hemlock zone contains stands capable of sustaining higher levels of snags >20" DBH and LWD >20" dbh than other plant seies in the watershed. Hemstrom (1987) reported snag levels as highest in the unmanaged western hemlock/Alaska huckleberry/dogwood bunchberry plant association with 18.6/acre and lowest in the western hemlock/rhododendron/twin flower association with only 2.3/acre with an average of 9.2 snags/acre across all associations as indicated from intensive ecoplot data. Snags consist mostly of Douglas-fir and western hemlock and when in decay class 2, 3, and 4, are strongly related with wildlife use. Levels of LWD in western hemlock associations range from 104 tons/acre in the western hemlock/devils club down to 19 tons/acre in the western hemlock/salal association with an average of 38 tons/acre. Western hemlock associations with both high levels of snags and LWD are typically the most biologically diverse and productive in the watershed, especially on sites with higher moisture content, such as the Hidden Lake area.

Lowest snag and down wood levels are characteristic of Douglas-fir associations due to a combination of high fire frequency and low site productivity. This type is very rare in thie watershed.

As in the Pacific silver-fir zone, past harvest practices retained low levels of organic matter in harvest units from 1975 to 1986, and moderate levels since then. Snag creation has mitigated negative impacts to associated species in recent years. Approximately 115 wildlife species are associated with snags in this forest zone (see Appendix Table, WL2).

HABITAT CONNECTIVITY

Dispersal

Dispersal is most generally the random movement by an organism with no predictable direction, such as when subadults move away from their natal areas. Dispersal habitat varies for individual species. Tailed frogs disperse from one riparian area to another in the fall through forested habitat, while the Oregon slender salamander disperses in a vertical direction through suitable embedded soils to maintain needed moisture and temperature regimes. Northern spotted owls require forest conditions equivalent to 11" DBH trees with 40% canopy cover or better and room to fly through for successful dispersal.

Wildlife dispersal patterns often require movements across entire landscapes such as needed by the wolverine, or as little as a few feet in the case of the salamanders. Barriers to dispersal such as Cougar reservoir block wildlife movement to more species than does a river or a road. Isolated populations of species unable to cross barriers are doomed to localized extinction if their original habitat is lost. Human disturbances from recreation or highway use are other forms of barriers, such as along Road 19 and its associated dispersed recreation use areas.

Dispersal barriers can require an individual to stay in one habitat and not find a mate. Fragmentation is often considered a limitation of dispersal for species such as the red tree vole which is unable to disperse across openings common in recently harvested portions of the

watershed. Population division into isolated subpopulations with possible extirpation is possible for species if preferred habitats are not adequately connected. Patches of late seral habitat in the lower and mid portions of the watershed may likely suffer from effects of this sort of isolation for species. However, no surveys are available to verify this. Species usually most affected are those with small home ranges like tailed frog, Oregon slender salamander, red tree voles, and hairy woodpeckers. These species often require specific habitat components to persist such as snags for hairy woodpeckers and cold water for tailed frogs. A barrier to tailed frog dispersal could be a warm stream such as Rush Creek which ranges from 52-63 °F, however even though surveys did not confirm presence of tailed frogs when it was surveyed in 1992, the data is not conclusive. More surveys are needed to substantiate potential barriers such as this. As habitats are isolated or destroyed for some species, an increased rate of colonization through dispersal must occur to prevent local extirpation, maintain genetic integrity, and population viability.

Plant species also depend on wildlife to spread their seeds. Most dispersal of plant seeds by animals is positive except for examples like Canadian thistle, a noxious weed, spread by elk. Therefore, the lack of successfully dispersing wildlife species can also affect the persistence of some plant populations.

An analysis of spotted owl dispersal habitat and riparian areas was completed. Results show that dispersal habitat for spotted owls is very good with 80% of the landscape in a condition of 11" DBH and 40% canopy closure or better, and 64% of riparian areas, not reserved already, meeting this same standard. Further discussion of these results are described in the spotted owl dispersal discussion later in this document.

Migration

Neotropical bird species such as the olive-sided flycatcher, yellow warbler, and western tanager use the South Fork as breeding habitat during the spring and summer months. Elk migrate from their annual low elevation winter range to high elevation summer range mostly in the wilderness areas.

Migration is sometimes considered an animal's daily movement within its home range to and from food, water, and cover, or for feeding, breeding, and resting. Migratory species such as neotropical birds seasonally depend on two or more distinct habitats, and if either is significantly altered, or barriers exist to prevent migration, they may not be able to successfully reproduce and will ultimately cease to persist on the landscape (Primack, 1993).

This watershed is within the Pacific flyway and is used by many species of waterfowl that stop in the reservoir and high lakes to rest and feed on their way from northern breeding habitats to wintering areas in California and Mexico. Examples of species documented migrating through are the mallard, pintail, bufflehead, common loon, American widgeon, and green-winged teal.

It is suspected that the watershed provides additional habitat for other species such as butterflies and lepidopteran species. High levels of lepidopteran species were found in the Santiam Pass (40 miles NE) during a 1993 survey implying that this watershed is also important to additional species for migration purposes due to its location near the Santiam Pass area.

Habitat Corridors

Designation of habitat corridors by humans to provide successful species movements at the landscape scale is a difficult, if not impossible, task. Narrow corridors of habitat not only funnel target species through them, but also are preferred habitat for their predators. At the present time, empirical evidence to support the value of corridors for wildlife dispersal is very limited (Primack, 1993). However, in many areas, it is still the best option available for managers. Implementation of the interim riparian reserves across the watershed may suffer some of these same drawbacks in locations where the uplands provide inadequate dispersal habitat. In some cases, where special habitat and associated species are located, leaving small clumps of other less desirable habitat between large conservation areas, such as the 100 acre spotted owl core areas between the LSRs, movement of individuals and genetic material by this "stepping stone" process may be facilitated. The Biological Opinion on Alternative 9 (SEIS) identified concepts forming the foundation of the conservation strategy for the spotted owl.

The Biological Opinion identified that:

- large blocks of suitable habitat with multiple pairs are better than small blocks with few pairs,
- blocks of habitat close together are better than blocks far apart,
- less fragmented habitat (more contiguous) is better than more fragmented, and
- habitat between blocks is more effective as dispersal habitat if it resembles suitable habitat.

This same concept holds true for many species of the South Fork Watershed.

Development of corridors between winter and summer range could be effective for elk. An example of an effective corridor is if connected stands of mature forest cover at least 400 feet wide and are positioned downslope to a topographic saddle such as Boone Creek. At a different scale down wood, evenly distributed and in adequate quantities throughout a harvested unit, might provide for adequate movement of most amphibians and reptiles across the stand as it matures. One needs to remember that a seemingly adequate corridor of habitat that animals cannot use due to a barrier is not wise management. One suggestion is that "instead of establishing narrow passageways of vegetation with well-defined boundaries which may be at risk from windstorms and other catastrophic events, an alternative is to provide specific vegetation types and cover conditions across the planar landscape (Morrison, Marcot, and Mannan 1992)." This landscape design tends to provide more resilience and recovery from blowdown, fires, and other natural events.

Managing landscapes to provide adequate corridors of suitable habitat and minimizing human developments and obstacles is one necessary component of maintaining species viability. Habitat generalists such as the coyote and black bear can typically move more effectively between a variety of habitats whereas species with small home ranges like the white footed vole require specific habitats for dispersal. Fragmentation of habitat, may be precipitating population declines of affected species by dividing once widespread habitats into two or more subpopulations less likely to persist over time (Primack 1993).

Fragmentation

Natural fragmentation of habitats has been occurring across our landscapes for at least 6,000 years, only it was most likely more randomly distributed spatially and temporally. Timber harvest and fire suppression activities often resulted in ecotones/edges considered to be desirable by biologists in our recent past. This traditional prescription for creating edges and forest openings has been under scrutiny. The decline of numerous songbird species in North America has been linked to habitat fragmentation (Primack 1993). Habitat fragmentation often threatens the persistence of many species in subtle ways, limiting normal dispersal and colonization processes by creating unnatural barriers within the landscape. Interior forest associated species such as the northern spotted owl and red tree vole may not even cross very short distances of open areas due to the likelihood of encountering predators such as hawks, other owls, or bobcats at the habitat edge. In the past 40 years deer and elk have colonized early seral successional habitat created by timber harvest. These big game edge species have inhabited areas where late successional species were likely present. Our current landscape pattern of consistently scattered blocks of managed stands in the western portion, specifically the lower watershed, of the South Fork has resulted in a reduction of the original quantity of old growth (Table 19). This has occurred only in the last 40-50 years. Until recently, most biologists and land managers did not realize that within the range of the spotted owl, 1105 species of fish, wildlife, and plants are closely associated with these old growth forests (FSEIS 3&4-116). It is not the individual clearcut nor even all those in any single watershed that result in the overall impacts on so many species. However, it is the cumulative and consistent pattern of landscape fragmentation in a species range, created over a very short time period, that leads to many population declines. An analysis of 93 late successional Douglas-fir associated species were rated for risk of local extinction (Lehmkuhl and Ruggiero 1991). Over 80% of species rated had high to moderately high risk of local extinction. In this watershed the effect of fragmentation is not as dramatic because 51% is wilderness.

SPECIES OF CONCERN

The following discussion addresses species listed as threatened, endangered, sensitive, or of "concern" based upon their listing in the FSEIS ROD Table C-3 (survey and manage), FSEIS Appendix J2, the Regional Foresters Sensitive Species List, or as ecological indicator species listed in the Forest Plan (Appendix WL15). The species listed by Appendix J2 are rare or locally endemic species closely associated with old growth forests that warrant additional protection through mitigation measures to ensure their viability. This additional species analysis identifies the specific mitigation measures that are incorporated into the standards and guidelines of Alternative 9 prior to signing of the ROD on April 13, 1994. The following information summarizes the species occurrence in the South Fork, their habitat requirements, mitigations,and future trends.

Table 27 displays a summary of species designated by the R-6 Regional Forester's Sensitive Species List and

Threatened, Endangered and Sensitive Species

Preliminary guidelines for evaluating Threatened, Endangered and Sensitive Species (TES) through watershed analysis were provided in a memo from the US Dept. of Interior and US Department of Agriculture, June 13, 1994. The Endangered Species Act includes provisions of "a means whereby the ecosystem upon which endangered species and threatened species depend may be conserved (and) to provide a program for the conservation of such endangered species and threatened species..." (ESA 1988 amm.). Watershed analysis provides an avenue to assess habitat conditions for listed and candidate species. This information is then available for use in planning and subsequent Section 7 consultation and monitoring. Species such as the Northern spotted owl, bald eagle, amphibians, and peregrine falcon, which occur in the South Fork, are addressed below. Additional analysis may be required as guidance is provided by the Regional Ecosystem Office, and revisions to the Federal Guidebook (USDA/USDI 1994) are published.

Northern Spotted Owl
(Strix occidentalis)
Federal Threatened
State Threatened

Current habitat conditions for spotted owls are the focus of this analysis. Past conditions are illustrated based on seral stages in the year 1900 (Figure 60). No information is available on population levels prior to the mid-1970's when spotted owl surveys were initiated. Current population data is limited by incomplete survey coverage for any single year. Spotted owl habitat will be defined as nesting, roosting and foraging (NRF).

Past Conditions

A comparison of past and current vegetation conditions are displayed in the vegetation section of this document by Tables 18 and 19 as well as Figure 60. In 1900, the quantity of mature and late seral forest (NRF) was similar to today, but its distribution has changed. NRF habitat is more concentrated in the wilderness portion today rather than in the Below Dam, Lower, and Mid Areas of the watershed as compared to 1900. Also, late seral habitat was better connected in 1900 than today and occurred generally at lower elevations.
those listed in the ROD (C-3) and Appendix J2 that are suspected to occur on the South Fork.

Current Conditions

This watershed falls within the Western Cascades province, which is considered to be the core of the spotted owl range because it appears to be in the best condition relative to other provinces in the owl's range (Draft OR St. Review, USFWS). Populations remain moderately high. The north-south distribution is adequate, with the exception of the Santiam Pass area which has been identified as an area of concern for intra-provincial movement. With some exceptions, the overall quality and quantity of habitat is relatively high on federal lands. Connectivity between provinces through suitable and dispersal habitat is sufficient, excepting the Santiam area of concern.

Existing spotted owl habitat conditions are discussed in this document in terms of nesting, roosting, foraging (NRF) habitat and dispersal habitat. Nesting habitat refers to stands which exhibit moderate to high canopy closure (60-80 percent); a multi-layered, multi-species canopy dominated large overstory trees (>30 inches DBH); a high incidence of large trees with various deformities (e.g. large cavities, broken tops, dwarf mistletoe infections, and other evidence of decadence); numerous large snags; large accumulations of fallen trees and other woody debris on the ground; and sufficient open space below the canopy for owls to fly (USFWS Biological Opinion 1990, ISC 1990). Foraging and roosting habitat consists of mature stands that have at least two canopy layers; overstory trees greater than 21" DBH; snags and LWD present; and a 60-80% canopy closure (ISC 1990). Foraging and nesting habitat are considered "suitable habitat" within the Spotted Owl FEIS (1992). Dispersal habitat includes stands that have at least an 11" DBH average tree diameter and at least 40% canopy closure (ISC 1990, USFWS 1991).

Threatened, Endangered, Sensitive and ROD (J2 Appendix) Wildlife Species

Species	STATUS: Regional Foresters Sensitive Species List	STATUS: App. J2 Species of Concern (C)
Amphibians and Reptiles		
Red legged frog	S	
Northwestern pond turtle	S	
Oregon slender salamander		C
Cascade torrent salamander		C
Tailed frog		C
Clouded salamander		C
Birds		
Ferruginous hawk	S	
Northern bald eagle	T	
American peregrine falcon	E	
Northern spotted owl	T	
Greater sandhill crane	S	
Harlequin duck	S	
Common merganser		C
Black-backed woodpecker		C
Mammals		
Townsend big-eared bat	S	
White footed vole		C
Red tree vole		C
California wolverine	S	
Fringed myotis		C
Hoary bat	C	
Long eared myotis		C
Long legged myotis		C
Silver haired bat		C
American marten		C
Fisher		C
Molluses (Land slugs)		
Prophysaon coeruleum		C
Prophysaon dubium		C

Total = 27 species

S = Sensitive
T = Threatened
E = Endangered

Table 27

NRF habitat is somewhat fragmented, but well distributed throughout the watershed. Habitat conditions were determined through aerial photo interpretation, vegetative stand data, and field verification over the past 3 years by local biologists. The relative distribution of known spotted owl nesting, roosting and foraging habitat as well as dispersal habitat by ROD land allocation is displayed by Table 28 and Figure 57.

Spotted Owl NRF and Dispersal Habitat
By ROD Allocation

ROD Allocation	NFR Habitat Acres	NRF %	Non NRF Acres	Non NRF %	Dispersal Habitat Acres	Dispersal Habitat %	Non-dispersal Habitat	Non-dispersal Habitat %
AMA	2,828	.45	3,395	.55	4,174	.67	2,048	.33
LSR	4,846	.57	3,644	.43	5,986	.71	2,504	.29
Matrix	6,580	.42	8,932	.58	10,489	.68	5,022	.32
Spotted owl Core	1,490	.94	93	.06	1,526	.96	57	.04
Other Reserve	6,658	.50	6,597	.50	10,223	.77	3,032	.23
Private	1	.00	2,204	1.00	1,055	.48	1,149	.52
Riparian	8,247	.42	11,565	.58	12,665	.64	7,148	.36
Wilderness	40,781	.59	28,722	.41	61,521	.89	7,982	.11

Table 28

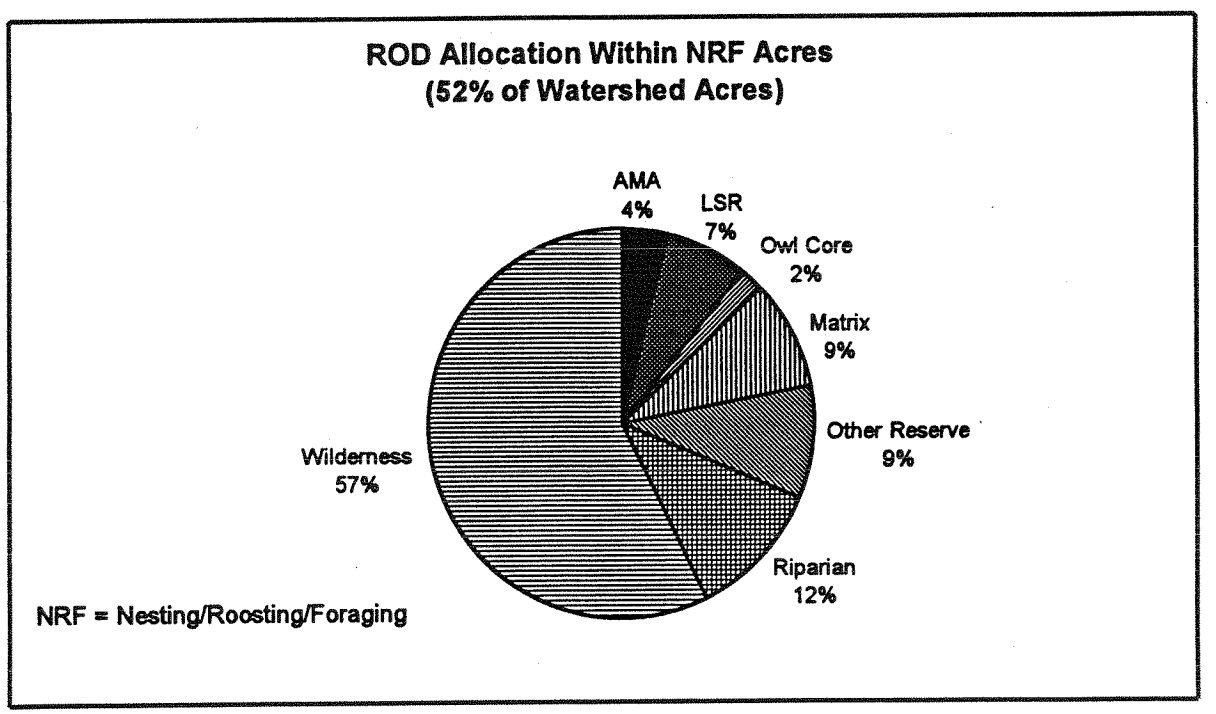


Figure 57

Late Successional Reserve (LSR) Analysis

The South Fork watershed contains part of one large LSR (RO218) (Figure 58) located within the East Fork drainage. There are 16 known historic owl activity centers within this LSR. Table G-11 (Vol. II, App. G, FSEIS) indicates that this LSR currently contains 70% suitable habitat, eight owl pairs, and three territorial singles at time of printing. The reproductive histories of these owls is displayed by Appendix Table WL8: Reproductive History on LSR RO218 and illustrates that overall, the current health of this LSR is fair to good. The King Creek drainage contains the best habitat and two very productive owl pairs (K.Swindle, Pers. Comm.). The remainder of habitat is fair to good, as it contains some marginally reproductive pairs. This LSR is very steep and difficult to survey, but between 1989 and 1992, 95% of it was surveyed to Region 6 Forest Service protocol. The future capacity of this LSR to become NRF habitat may be limited by the average fire frequency on the south facing slope of the East Fork. The north facing slope of this LSR has good potential to become higher quality NRF habitat.

The average distance between LSRs in the Western Cascades province is 6.4 air miles. Since owls normally disperse randomly from their natal areas, and barriers occasionally exist, successful dispersal often requires larger blocks of suitable habitat than single narrow strips of land. Appendix Table WL9 displays the distance by straight air miles and probable safest dispersal route for the nearest LSRs around LSR RO218. This safest dispersal route was delineated by assessing the most logical path a successfully dispersing juvenile spotted owl would likely cross to get to the nearest LSR.

Critical Habitat of the Northern Spotted Owl

Critical habitat units (CHU) were established by USDI, Fish and Wildlife Service (USFWS) in compliance with the Endangered Species Act (ESA). This watershed overlaps portions of two large CHUs (Table 29 and Figures 58 and 59). A total of 10% of the NRF habitat in the South Fork is within critical habitat boundaries.

Critical Habitat in the South Fork

Critical Habitat Unit	Total Acres	CHU/LSR Over-lapping Acres	% Overlap	Acres Outside LSR	Outside LSR %	NRF Acres Outside LSR	NRF Outside LSR %	Owl Site #	TAKE?
OR-17	5,712	8,382	0.53	7,330	0.47	4,538	0.54	1817	N
								2418	Y
								1413	N
								2425	N
OR-19	7,116	0.00	0.00	7,116	1.00	3,883	0.55	867	N
								869	N
								2416	N

Table 29

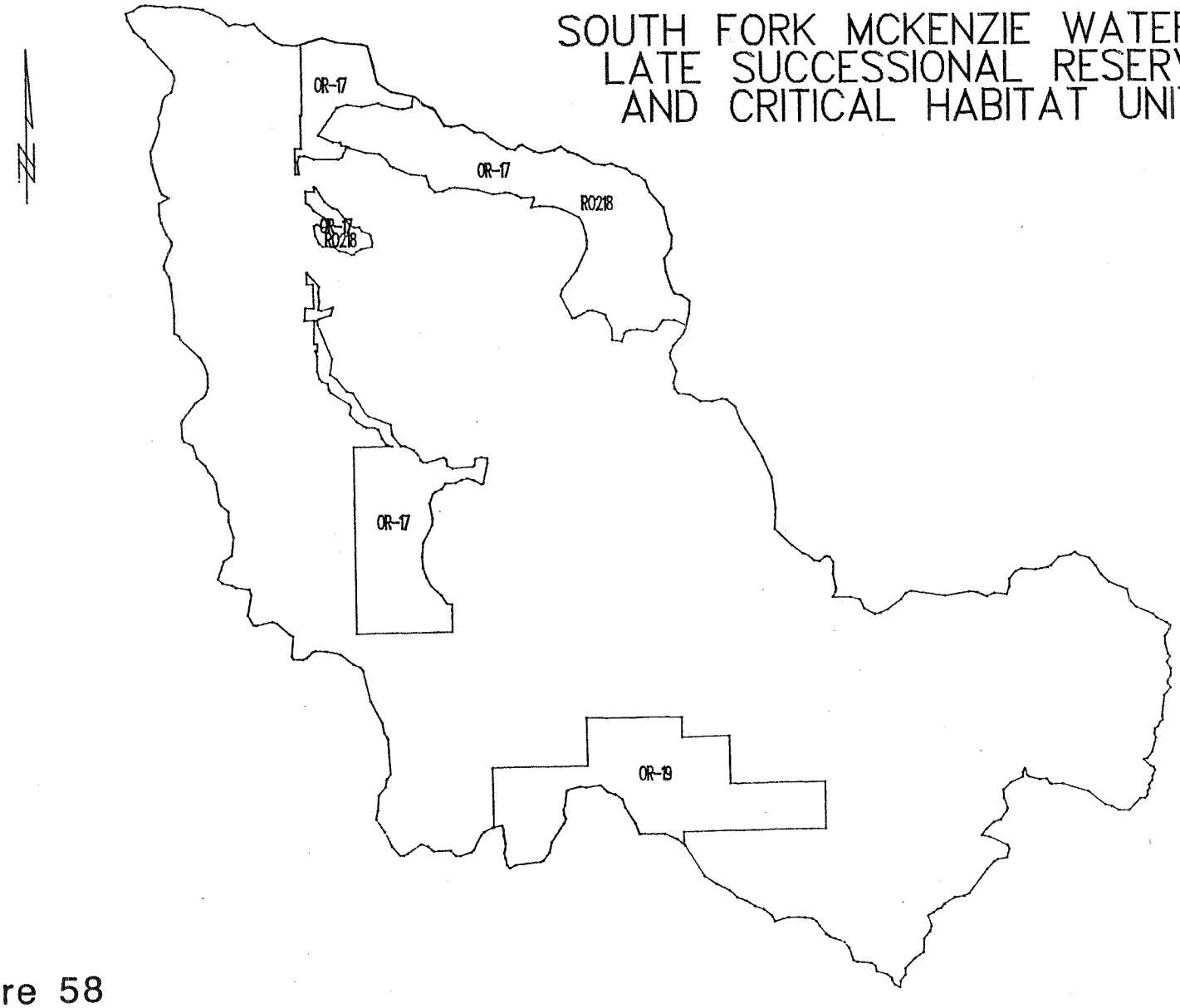

SOUTH FORK MCKENZIE WATERSHED
LATE SUCCESSIONAL RESERVES
AND CRITICAL HABITAT UNITS
N
OR-17
OR-17
RO218
OR-17
RO218
OR-17
OR-19

Figure 58

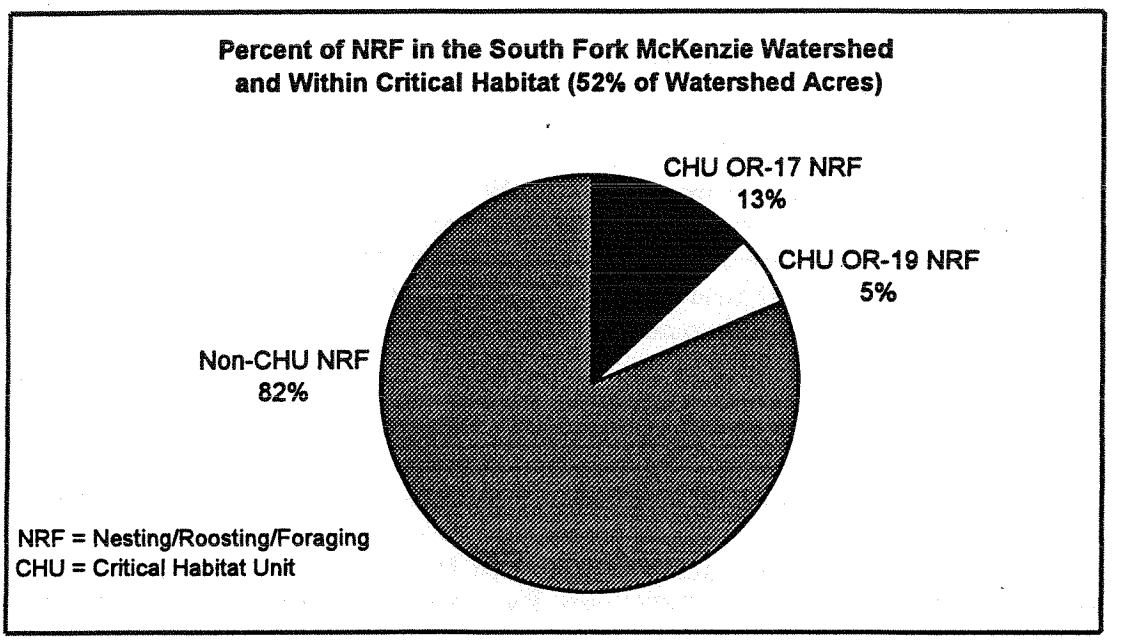


Figure 59

Thirty eight percent of CHU OR-17 lies within the South Fork watershed. This CHUwas designed with the purpose of maintaining and providing essential NRF habitat. It contains some of the areas' largest blocks of nesting habitat and provides an essential link to the Eastern Cascades province to the east. Table G-11 (Vol. II, App. G, FSEIS) displays that 65% of this CHU is suitable spotted owl habitat.

Only 5% of CHU unit OR-19 lies within the South Fork and it contains 3% of the total NRF in the South Fork (Figure 59). This CHU was designated also to provide NRF habitat in a fairly unfragmented block but also ensures connectivity between the western and eastern Cascades through the Waldo Lake, Three Sisters, and Diamond Peak wilderness areas. Table G-11 indicates that 52% of this CHU is suitable habitat.

The proximity of the South Fork to the Cascade-Coast Range connection near Cottage Grove was identified in the Draft Spotted Owl Recovery Plan as an area of special concern. The South Fork facilitates this dispersal connection.

Status of Known Owls in the South Fork

Appendix Table WL10 describes habitat conditions (NRF), reproductive history, and other indices for each known owl within the South Fork. These tables show that 35% (14 out of 40) activity centers have insufficient amounts of suitable habitat within their .7 or 1.2 mile radii.

The reproductive histories of all known spotted owls in the South Fork are displayed on Appendix Table WL11, as well as all spotted owls in LSR RO218 (Appendix Table WL8, and CHU OR-17 (Appendix Table WL12). Since these areas overlap, many owls are listed more than once. LSR R0218 and CHU OR-17 include certain spotted owl activity centers from outside the watershed but within the boundaries of the LSR or CHU. Not all owls listed in the LSR or CHU are found within the South Fork.

Spotted owl surveys were completed between 1989 and 1994 using Forest Service Region 6 protocol. The extent of completed surveys is presented in Appendix Figure WL13 illustrating that including the wilderness acres, 40% of the watershed has been surveyed and this includes 86-90% of the LSR and CHU areas. It should be noted that surveys were not completed in wilderness portions of the watershed except where 1.2 mile radii intrude into this wilderness.

The H. J. Andrews Experimental Forest (HJA), just five miles north of this watershed, is one of eleven spotted owl demographic study areas (Appendix J, Volume II, FSEIS). Findings for the HJA indicate a 9% annual population decline. An overall conclusion is that for all study areas, this same trend is consistent, and this rate of population decline is accelerating. However, the rate of decline is likely not this extreme because similar annual surveys over the last ten years indicate total population of banded owls would be noticeable if an annual 9% decline was occurring. It is more likely that the annual rate of habitat loss (1-2%) more closely resembles the population decline of the past three decades.

Dispersal Habitat of the Spotted Owls

The role of dispersal (11/40) habitat for spotted owls is to provide a functional and interconnected old growth ecosystem. The principle is that the LSRs would provide healthy clusters of owl pairs and resulting juveniles tcould successfully disperse to surrounding LSRs and suitable habitat blocks.

Dispersal habitat capability for spotted owls was measured across the watershed by calculating the amount of forest habitat currently at 11" DBH and ≥40% canopy cover on federal lands and for all quarter townships adjacent to the watershed. Only 7% (3 of 45) of the townships that touch the South Fork contain fewer than 75% federal lands (Appendix Table WL14). Results of this analysis indicate that dispersal habitat is above 50% for all but two quarter townships, and the lowest is predominantly outside the watershed. Dispersal habitat meeting this 11/40 standard averages 80% for all quarter townships adjacent to the watershed which are larger than 1000 acres in size. This information indicates that the uplands, with their included riparian areas, are providing adequate dispersal habitat for species like the spotted owl which use large stands for dispersal

A comparison of acres available for dispersal through riparian reserves was completed for the interim riparian reserve strategy outlined in the ROD. Results indicate that when averaged for all quarter townships adjacent to the South Fork, 64% of all riparian areas not already within another reserve, meet the 11/40 standard. Approximately 49% percent of the watershed lies within the interim riparian reserves.

One area of concern for dispersal is Indian Ridge in the lower portion of the watershed because the quarter township to the west is located mostly outside the watershed, and only contains 41.9%

dispersal habitat. This quarter township is mostly on private land. This area is the primary dispersal route between the two nearest LSRs.

Another area that appears not adequately connected is between LSR RO217 and LSR RO219. An aerial photo analysis indicated there are very narrow forested (11/40) routes going north-south between these LSRs, and since much of this is private land, there is a poor chance of successful dispersal through this area in the future.

Overall, dispersal habitat in the watershed is very good. However, when viewed subjectively using aerial photos and the forest connectivity map, successful dispersal beyond the watershed in a westerly direction appears limited by fragmentation and private lands. Dispersal in other directions is adequate.

Future Trends

Forest management as prescribed by the ROD in this watershed will enhance habitat for late successional and old growth related species such as the northern spotted owl.

Northern Bald Eagle
(Haliaeetus leucocephalus)
Federal Threatened
State Threatened

Bald eagles require habitat consisting of scattered old-growth conifer trees near available fish sources, such as lakes, reservoirs, and rivers. They are occasionally sighted over and adjacent to Cougar Reservoir, the largest body of water in the South Fork. No historical records exist for bald eagle nesting in the South Fork. Nesting habitat surrounding Cougar Reservoir is abundant, although the high level of recreational use and resulting possible disturbance may decrease ihabitat quality in those areas most adjacent to activity. Cougar Reservoir has been annually ground surveyed during winter by ODFW until 1993, and Blue River Ranger District conducted the survey in 1994. An aerial bald eagle nest survey was conducted in April 1994, and no bald eagles were seen. All potential bald eagle nesting habitat surrounding Cougar Reservoir and the McKenzie River has not been surveyed to bald eagle protocol standards, but it is generally thought that if eagles were nesting in the area, there would be many more sightings. Recreational use is heaviest in late spring through early fall in Cougar Reservoir and along the McKenzie River and bald eagle sightings are sporadic. Ground surveys along the McKenzie River would be extremely time-consuming due to the lack of good overview lookout points.

Future Trends

Bald eagle habitat quality in the South Fork is expected to remain fairly constant in the future. About half of Cougar Reservoir borders the Three Sisters Wilderness, where potential nest trees are scattered among fire-regenerated second growth. The west half of the reservoir, partially bordering the lower and mid portions of the watershed, also contains scattered old-growth potential nests Douglas-fir trees. A Bald Eagle Management Area consisting of 125 acres has been designated in

the Forest Plan surrounding Rider Creek, and overlaps the Terwilliger Hot Springs Special Interest Area. Due to the unusually high level of year-round recreational use this area receives, this may not be the most suitable location for future bald eagle nesting. However, due to the adjacency of the wilderness east of the reservoir, suitable nesting habitat will continue to be abundant in the future if other areas within one mile of the reservoir on the west side are logged. Any future logging activities within mile of the reservoir should allow continued provision of scattered and abundant eagle perch trees.

Due to continued fire suppression activities, including in wilderness within the last 40-50 years, many second growth fire regenerated stands such as those just east of Cougar Reservoir are somewhat suppressed. Some stands contain high amounts of undergrowth and LWD, making them susceptible to a stand replacement event (Figure 59). Allowing natural fire intervals to reestablish themselves in this area, initially with the aid of prescribed underburns, will help maintain future bald eagle nesting habitat, and prevent the probability of a catastrophic stand replacing event. Underburns would also accelerate the development of old-growth trees, which are used as nest and perch habitat by bald eagles.

At the present time, the U.S. Army Corps of Engineers is considering installation of a temperature control structure in Cougar Reservoir, which if implemented could result in the reservoir being drawn down over the two year construction period. Forage would be plentiful for eagles in the short term due to a concentration of fish but could then decline duringthe rest of each year.

The FSEIS ROD requires that riparian reserves be established around lakes and large streams which serve as bald eagle habitat. The protection and maintenance of this habitat on the landscape is critical to the maintenance of this species. There may be valid reasons for thinning within riparian reserves to promote the development of large diameter trees for eagle roost/nest sites. However, this activity would need to be balanced with potential impacts to other riparian-dependent species.

American Peregrine Falcon
(Falco peregrinus)
Federal Endangered
State Endangered

In the Pacific states, preferred peregrine falcon nesting sites are sheer cliffs 75 ft. or more in height within proximity to meadows, lakes, or riparian areas where there is an abundance of prey species. In 1991 and 1992 the ODFW, in conjunction with the WNF, completed an aerial reconnaissance of selected cliffs on the Blue River RD, including the South Fork area, to determine peregrine occupancy and identify those with nest site potential. Ground surveys to determine cliff occupancy have been extremely limited, with the exception of the one occupied aerie in the South Fork. Cliffs which appeared to contain suitable nesting habitat were examined on the ground, and a determination was made that they were not suitable due to lack of nest ledges, predator access, or lack of height. Since 1991, no major projects near high potential cliff sites have been planned during the peregrine nesting season, and the two-year protocol ground surveys have not been required or conducted. Other than the one existing aerie, no other historic (pre-1975) or traditional (post-1975) peregrine falcon aeries are known to exist in the South Fork. A site management plan for the existing aerie is in the final review stages and is scheduled for completion in 1995. Potential

peregrine nesting habitat does exist at many locations, both in the wilderness and especially in the Chucksney Mountain area, but it has not all been mapped and ranked in terms of quality. All of these areas are within foraging distance of the South Fork McKenzie River, and other smaller streams and wetlands that could provide an adequate food supply.

Future Trends

In the area of the occupied peregrine aerie in the South Fork, small-scale habitat enhancement projects will be recommended on the district to maintain and improve the area for peregrines and their prey. This might consist of snag creation activities beyond the usual percent levels for the secondary feeding zone, or shrub and berry plantings where they are not abundant. Seasonal restrictions on disturbance activities within the primary, secondary, and if necessary, tertiary zones will help maintain the integrity of the nest site and allow both peregrines and prey to inhabit an area which is relatively undisturbed. Conservation and enhancement of riparian areas within the zone of use will maintain foraging habitat for this species.

Greater Sandhill Crane
(Grus canadensis)
State Sensitive
R-6 Sensitive

The sandhill crane roosts, nests, and rears young in wet meadows and shallow marshes. The most successful nests are constructed near deeper water where hardstem bulrush are present, but typical nesting territories occur in meadows. Foods include tubers, seeds, grains, amphibians, small mammals, insects, crustaceans, and other invertebrates. A nesting pair may require 180 acres of habitat (Stern et al 1985).

Sandhill Cranes have been documented nesting in the wilderness portion of the South Fork analysis area in 1993, and a pair of cranes was seen in the same area in 1994. It is expected that other suitable habitat in the wilderness is occupied, although it has not been regularly inventoried.

These cranes are part of the Central Valley Population (CVP), which is one of four populations in North America. It is the western most and second most numerous (Schlorff et al. 1985). This population is fairly stable at this time (Littlefield, pers. comm., Marshall et al. 1992), and it has expanded its range into new areas, including the Cascade Range. Most pairs do not begin nesting until age 4 or 5, and most fail at fledgling young the first few seasons because of inexperience (Paullin 1989). Some birds are never successful (Ivey, pers. comm.). Factors such as predation, brood strife, disease, and starvation probably all contribute to poor reproductive success.

Future Trends

All potential sandhill crane habitat is located in the wilderness portion of the South Fork analysis area. At the present time, use of the wilderness near the crane sightings is very low for most of the year, and nesting cranes are probably not disturbed by human activities. Wilderness use is highest during fall hunting season, but even at that time is still judged to be low and would probably not impact cranes before their migration.

CALIFORNIA WOLVERINE
(Gulo luteus)
Federal Candidate Category 2
State Sensitive
R-6 Sensitive

No wolverine studies have been conducted in the Western Cascades. The most comprehensive wolverine study was in northwestern Montana (Hornocker and Hash 1980). They found that wilderness or remote country where human activity is limited appears essential to the maintenance of viable wolverine populations. High elevation wilderness areas appear to be preferred in summer, which may effectively separate wolverines and intensive human disturbance in most areas. In winter, wolverines move to lower elevation areas which are snowbound with very limited human activity. Wolverines do not significantly use young, dense stands of timber or clearcuts. The majority of wolverine activity occurs in large expanses of scattered mature timber, with some use of ecotonal areas such as small timber pockets, and rocky, broken areas of timbered benches. Heavy use was found in openings which support good winter populations of big game animals, the principal source of carrion which makes up much of the wolverine's diet (Marshall 1988). In addition to carrion, wolverines also feed on marmots, snowshoe hares, various rodents, insects, insect larvae, eggs, and berries (Marshall 1988).

Wolverines appear to be very wide-ranging, secretive, and unaffected by geographic barriers, such as mountain ranges, rivers, reservoirs, highways, or valleys. For this reason, Hornocker and Hash (1980) recommended that wolverine populations be treated as regional rather than local.

Habitat for wolverines does occur in the South Fork watershed analysis area, primarily in remote higher elevation areas of the Three Sisters wilderness near Mink Lake basin. The most recent wolverine sighting was documented at Frissell Crossing in late summer 1991, bordering the wilderness. The relatively low amount of human use in most of the French Pete addition to the Three Sisters Wilderness also helps provide the remoteness needed by wolverines.

Future Trends

Wolverines occasionally prey on big game, currently ranked at fairly high levels in the South Fork. ODFW trend predictions are that big game populations will continue to increase somewhat before leveling off. Planned future district habitat enhancement projects in the Special Wildlife Habitat Area below Rebel Rock area would benefit big game, and thereby wolverines. An evaluation of

Access and Travel Management in the South Fork may also result in additional road closures to meet required Forest Plan Standards and ODFW's concerns about road densities on Forest Service lands, benefiting both big game populations, and thereby wolverines.

FSEIS LWD requirements will benefit small mammals which are also preyed upon by wolverines.

If human use in the wilderness increases in the future, habitat quality will be reduced. The predicted population growth in Lane County will no doubt place increased user pressure on remote wilderness areas such as the Mink Lake Basin, although use might continue to be concentrated in the currently highest use areas. An increase in recreational activities such as hunting, fishing, and hiking in the South Fork area may all contribute to reduced habitat quality for wolverines over the long-term.

Townsend's Big-Eared Bat
(Plecotus townsendii townsendii)
Federal Candidate Category 2
State Sensitive
R-6 Sensitive

Although Townsend's big-eared bats are the most characteristic bat found in caves in the western U.S., the small amount of historical population data indicates a decline in numbers. Caves and cave-like structures are critical habitat for these bats as hibernacula in winter and as roosts for summer nursery colonies (Perkins 1987). They are known to roost primarily in caves in areas seldom disturbed by humans. Human disturbance may cause the bats to permanently abandon roost sites (Maser et al. 1981).

Isolated populations of this bat have been found on the Willamette National Forest. Potential habitat adjacent to management activities has been surveyed in the South Fork since 1989. Some additional bat surveys were conducted in 1992. No additional locations of this bat were found. One occupied hibernaculum exists in the South Fork, with only one Townsend's Big-Eared bat documented.

Foraging areas, which include special habitats such as riparian areas and meadows, are currently providing stable, high quality habitat for lepidoptera (moths), the Townsend's primary prey species.

Future Trends

It is expected that future habitat for the Townsend's Big-Eared bat will improve under management prescribed in the ROD. Snags at the loose bark stage may provide roosting habitat for individual bats, but caves are higher quality habitat and used as winter hibernacula and maternity colonies. With logging activities in the South Fork, some of the suitable roost snags will still continue to be lost. However, the continued snag creation program and 15% green tree retention requirements will mitigate this habitat over the long-term, as required by the Forest Plan and FSEIS ROD.

Protection of identified habitats, such as snags in clearcuts and edges like roads, caves, and riparian areas, as recommended in the Special Habitat Environmental Assessment and ROD, will help retain their microclimate and the integrity of bat habitat. Many rock outcrops which contain bat habitat can only be surveyed for bats with great difficulty.

Riparian areas protected by standards set for interim riparian reserves in the ROD will enhance habitat for this species. The maintenance of riparian habitats on the landscape is critical to the maintenance of the Townsend's Big-Eared bat.

Red-Legged Frog
(Rana aurora)
Federal Candidate Category 2
State Sensitive
R-6 Sensitive

Red legged frogs have been found in terrestrial and aquatic habitat up to approximately 5500 feet elevation. Breeding waters for the red-legged frog vary considerably, but they are generally found in ponds or low flow waters that last long enough for metamorphosis to occur, and contain sturdy underwater stems for egg attachment. Breeding seasons at higher elevations may occur in February or early March. They require water that will last into late May or early June. Water purity is very important for reproduction. A limited amount of silt is permissible, but foreign chemicals from herbicides or pesticides can be fatal to eggs and larvae. Hibernation sites occur under mud or silt in the bottom of water bodies or within rodent burrows and downed logs. Fairly dense vegetation along the shore will help to minimize predation of tadpoles. Outside of the breeding season, they may occur at considerable distances from water, and have been found 600-900 feet or more from any standing water. As aridity increases during summer, the frogs move towards stream and pond edges (Nussbaum et al. 1983).

Red-legged frogs have only been documented from three locations in the South Fork analysis area, but the area has not been extensively surveyed. Since 1990, wildlife biologists and technicians have conducted incidental amphibian surveys in project areas, but they were not based on a protocol. In 1992, several creeks in the South Fork were searched for amphibians, and since 1993, most creeks in project areas have had at least a cursory search. The basic guideline for creek searches within project areas has been 1/2 hour by one individual focusing on the best habitat. Although stream survey crews have always included amphibian sightings in their reports, awareness of amphibians has been increasing over the last few years, making sightings more likely. In 1994, stream survey crews included a specific amphibian search as part of their biological probes, and covered many stream miles in the wilderness portion of the South Fork. Based on all amphibian surveys within the South Fork, the absence of red-legged frog sightings in comparison with those of other amphibians makes it appear they are only patchily distributed, and not abundant.

Future Trends

The red-legged frog habitat in the South Fork is expected to remain stable in future years. All future projects will provide protection of all potential red-legged frog breeding habitat in compliance with the FEIS ROD (USDA USDI 1994). The provision of this habitat on the landscape is critical to the maintenance of this species. Water quality is not expected to be reduced in the lower elevation lakes or streams in the future, and thus no imminent risks to water quality are foreseen.

Species Listed in the ROD (C-3) and Appendix J2
(Appendix Table WL15)

Molluscs

An analysis of habitat requirements for the 97 species listed in Appendix J2, 43 species listed in Table C-3 of the ROD, along with expert opinion by Dr. Joseph Furnish determined that two species of land slugs have a reasonable chance of occurring on the Willamette National Forest and the South Fork.

Prophysaon coeruleum is a rare land slug occurring in relatively undisturbed, moist coniferous forests from low to middle elevations from South Puget Sound down into the Willamette Valley. No known locations exist as many historic sites are now within heavily urbanized areas, and on non-federal lands.

Prophysaon dubium is a very rare land slug, partially riparian associated but also found in rockslide areas, and range exists in Pierce County, Washington; Clackamas and Hood River Counties in Oregon; and Trinity County in California. Road building and road maintenance are potential disturbances to this species where it occurs in rockslide areas.

There is significant uncertainty about the specific distribution and potential occupancy of both these land slugs on the South Fork.

Arthropods

None of the four general groups of arthropods listed in Table C-3 of the ROD occur in the South Fork. The four groups listed include:

1. canopy herbivores;
2. coarse wood chewers;
3. litter and soil dwelling species; and
4. understory and forest gap herbivores.

Species within these groups occur in the Southern Oregon and Northern California area.

Amphibians

None of the species listed on Table C-3 in the ROD have range in this watershed, but 4 species listed in Appendix J2 do occur and have habitat on the South Fork (Appendix Table WL16). These include the riparian associated Cascade Torrent Salamander and Tailed Frog as well as the terrestrial associated Clouded Salamander and Oregon Slender Salamander.

Riparian Associated Amphibians

The Cascade Torrent Salamander *(Rhyacotriton cascadae)*, listed by ODFW as a sensitive species, has been found on the near by H.J. Andrews Experimental Forest, and is not known to occur in the South Fork. Habitat is present for this species on the South Fork. However, 20 locations are known to exist on BLM lands of the Eugene District. It normally occurs in or near cold, clear streams and seeps in association with talus, small rocks, and gravel, often in permanent streams with moss capped rock rubble in late seral forests or small openings. This species is sensitive to activities which impact headwater areas or seeps, such as logging and road building activities that increase sedimentation and/or temperatures of water in their coarse substrate habitat areas. Conservation of seep habitats is essential. It is usually not found in streams warmer than 55 °F. This species is a poor dispenser overland from one small stream to the next and may have a poor ability to recover from habitat disturbance.

There are over 1500 miles of streams in this watershed and their conditions are described within the groups of subwatersheds in the Soil/Water/Fish section. These riparian associated species are more likely to occur in the colder stream systems such as Roaring River, Elk Creek, and most of the perennial streams coming out of the wilderness.

The Tailed Frog (Ascaphus truei), an ODFW sensitive species, is also a riparian associated late seral species normally found in fast flowing, rocky, cold water streams and headwaters in coniferous forests. Surveys indicate that this species is well distributed across the watershed except possibly in the lower portions. Stream surveys from 1994 found tailed frogs in every major class II or III stream surveyed. Estimates of population densities have not been attempted. This species is reported to be quite sensitive to water temperature and quality changes. With its low reproductive ability, evidence suggests that localized populations can be extirpated in streams which drain extensively harvested watersheds. This species is known to disperse through forested habitats upslope during wet fall weather, occasionally to ridgetops and probably into adjacent drainages.

Terrestrial Associated Amphibians

The Clouded Salamander *(Aneides ferreus)*, an ODFW sensitive species, has been documented in the South Fork at only one location near Hidden Lake. This species normally inhabits large Douglas-fir logs and stumps of varying decay stage. They require permanent dampness, rotten logs necessary for specific invertebrates, and rocky or woody debris for cover such as large class III and IV Douglas-fir logs or snags with sloughing bark. Clouded salamanders are dependent on a continuous supply of suitable large rotting logs and snags. There is some question whether the LWD retention requirements of Alternative 9 are adequate in the matrix over the long run (FSEIS, App. J2, p.422). This species seems vulnerable to extirpation by high fire frequencies which destroy LWD.

The Oregon Slender Salamander *(Batrachoseps wrightorum)*, an ODFW sensitive species, is associated with large, well-decayed coarse wood debris in late seral forests with embedded soils. This species is endemic to Oregon. These are soils that contain adequate fissures and cracks that allow this salamander to move through them. They migrate vertically to maintain suitable moisture regimes. Oregon slender salamanders are often found in cracks within large logs or rock rubble areas of permanent dampness. This species has been documented at several locations throughout the watershed between 2000 and 4500 feet elevations. Surveys are needed to determine this species' level of sensitivity to activities and to further define its distribution. Surveys from the Hidden Lake area indicate that it may contain one of the best known populations of this species. Soil compaction and the loss of LWD, especially Douglas-fir logs, may negatively impact this species There is a concern that log retention standards of Alternative 9 may not be adequate over the long run for this species habitat needs (See FSEIS, App. J2, p. 425).

The presence of several other amphibians such as the Red Legged Frog, a R-6 USFS listed sensitive species, and other species are documented and illustrated on Appendix Table WL16 for the South Fork. Species documented include the western Redbacked Salamander, Cascade Frog, Dunn's Salamander, Northwest Salamander, and the Spotted Frog.

In addition to the late-seral associated amphibians discussed above and mentioned in the ROD, several other species of special concern, or their habitats are known to exist within the watershed of the South Fork. Included are the Northern Red-legged Frog (*Rana aurora*), an R6 USFS Sensitive Species, the Spotted Frog (*Rana pretiosa*), and the Cascade Frog (*Rana cascadae*), all three federal candidates for protection under the Endangered Species Act and documented as occurring on the South Fork. The Cascade Salamander (*Rhyacotriton cascadae*), listed in Oregon as Sensitive, has not been positively documented in the watershed.

Recent evidence documents declines throughout historic ranges for many species of amphibians. Local populations in specialized habitats exist within the South Fork watershed for some of these species known locations are identified on maps at the District. Permanently damp areas with good hiding cover such as talus slopes, large LWD, spring-fed ponds, seeps, and areas of good water quality are important critical habitats found in the South Fork, and utilized by specific amphibians. Although secretive, amphibians may constitute a large percentage of the vertebrate biomass in permanently wet or damp areas.

Amphibians in general are thought to be excellent indicators of environmental stress or change with skins more permeable than most vertebrates and a dependency for water. Recent evidence has suggested amphibian declines can be partially attributed to a lack of resistance to UV-B solar radiation, acidification, and habitat degradation

Reptiles

The Western Pond Turtle (*Clemmys marmorata*) is of particular concern and a federal candidate to be listed as Threatened under the Endangered Species Act. The pond turtle has been declining dramatically with exotic species competition and habitat degradation as important contributing factors. At this time there are no documented sightings of pond turtles in the South Fork watershed, however potential habitat does exist in the Delta area below the dam and on floating logs at the edge of the reservoir. This species has been documented on other parts of the Willamette National Forest. Overall, information is limited for amphibian and reptile distribution and habitat in the South Fork.

Birds

The black-backed woodpecker, (Picoides arcticus) may occur in the watershed but has not been documented. Habitat exists in mixed conifer and lodgepole pine stands at high elevation in the high cascades portion of the watershed. The South Fork is at the southern extension of its' range. Black-backed woodpecker habitat may be degraded by salvage and fuels management such as sanitation harvest operations that reduce beetle infested trees because the black-backed woodpecker forages on these beetles.

Common merganser *(Mergus merganser)*, sightings have been documented on the South Fork. This species is associated with larger moderate gradient streams, primarily at lower elevations. Habitat for this species occurs along the lower main stem of the South Fork, and outside the watershed along the main stem of the McKenzie River. Most of these habitats are on private lands and are in a degraded condition. This species is widely distributed common inhabitant of the McKenzie basin and is subject to limited hunting pressure.

Mammals

The fisher *(Martes pennanti)*, is suspected to occur but is not documented on the South Fork. Fishers are associated with forests in the low and mid elevations of the western hemlock forest zone. This species is not highly associated with late seral forests but is affected by fragmentation and possibly human disturbance. Fishers prefer a continuous canopy cover with a diverse structure on the forest floor that enhances their prey base habitat and populations. This species requires large cavities in snags for denning, usually greater than 18 feet above the ground. Large trees or snags with cavities are very valuable. These large trees can be somewhat uncommon in most mid seral to mature stands. Low elevation late seral habitats with large snags are preferred habitat for this species in the South Fork. Risk for maintenance of this species presence is dependent on well distributed large snags > 20" DBH for natal den sites and adequate LWD for foraging habitat.

The American marten *(Martes americana)*, has not been documented in the South Fork, but habitat is abundant. This species is generally more abundant and widely distributed than Fishers. Key habitat features are downed course woody debris of various decay stages, and large patches of late seral forest, generally at moderate to high elevations > 3500'. Marten are likely most prevalent in

areas with high snag and LWD levels within the pacific silver fir zone, such as the Pyramid mountain area of the wilderness and Grasshopper mountain in the mid portion of the watershed. Habitat condition and distribution for this species is well distributed and connected except possibly in the highly fragmented areas of the lower and mid portions of the watershed.

The Lynx *(Lynx canadensis)* has been reported to occur in the South Fork. Habitat exists at higher elevations of lodgepole pine habitat where snowshoe hares are suspected. This species is a federally listed category two species. Lynx have very large home ranges (50 sq. mi.). This rare species' viability will likely be assured in designated reserves.

The red tree vole (Phenacomys longicaudus), is expected to be abundant in late seral western hemlock forests of the South Fork, however, none are documented because surveys have not been conducted. Red tree voles have been documented on the H.J. Andrews Experiment Forest where they comprised 13% of the total diet of spotted owls (Forsman, et. al., 1984).

Bats

One of the five species of bats listed in Appendix J2 have been documented in the South Fork. All five species appear to use snags and decadent trees for roosting. Snags in clearcuts are generally used for roosts. Edges of clearcuts, roads and riparian areas are used for foraging. Bridges with crevices are often used as night roosts. Human created reservoirs and wetland areas have benefited bat populations in many areas. Habitat for bats is well distributed across the South Fork, primarily in mature and late seral forested areas.

The fringed myotis *(Myotis thysanodes)*, may occur in the South Fork. It is considered rare on this forest. One capture has been documented on the H.J. Andrews Experimental Forest to the north (Pers. Comm., P. Greenlee). The major portion of its range appears to occur in dryer habitats. This species forages at or within the forest canopy, and prefers riparian areas. The fringed myotis appears to roost and hibernate primarily in caves, under bridges, and buildings. It is not known how important snags are for this species. Surveys have not been completed specific to this species.

The hoary bat *(Lasiurus cinereus)*, is a migratory bat associated with mature forests and riparian areas for roosting and foraging. This species is likely to occur on the South Fork. Surveys have not been completed specific to this species. However, this species has been documented on the H.J. Andrews Experimental Forest (Pers. Comm., P. Greenlee).

The long-legged myotis *(Myotis volans)*, may occurs on the South Fork, foraging on moths and beetles near forest edges, along roads and riparian areas. It day roosts primarily in large snags, occasional rock crevices, and live trees.

The silver-haired bat *(Lasionycteris noctivagans)*, is suspected to occur on the South Fork but has not been documented. This migratory bat is strongly associated with late seral forests for both roosting and foraging. It roosts in crevices of large snags and decadent trees, rarely using caves. They typically forage over dense mature forests in riparian areas, and feed on a variety of arthropods.

Future Trends

With expected reduced rates of logging in the future, most early seral associated wildlife populations will decline in the next decade. However, if natural fire occurs, they could remain stable, or increase depending on the amount of acres burned. The transition from mid to late seral will occur over the next 50-80 years, resulting in a continued abundance of mid seral habitat associated species for several decades.

Future trends for bats and other wildlife populations under management as prescribed in the FSEIS ROD will reduce the risk of local extinction's, and likely improve habitats. Populations should be well distributed and maintained across the watershed. There is still some level of concern for some of these species due to the different prescribed levels of snags and green trees in the matrix, and buffer widths around riparian areas and wetlands. Specific knowledge of many of these species is still very limited. Alternate landscape designs such as that recently suggested by the research group working on Augusta Creek subwatershed merits consideration for meeting the needs of these species as well as the landscape design prescribed in the ROD.

Regardless of which of the landscapes prescribed, habitat trends for the two mollusc species, four amphibians, two birds, five bats, and three other mammals listed above are all expected to improve through the maintenance, enhancement, or protection of habitat components such as snags, LWD, decadent trees, patches of large trees, rock slides, talus, caves, and riparian zones.

Based on FSEIS ROD requirements, an increased rate of knowledge may evolve in the next decade through ongoing research and an increased level of surveys for species like molluscs and amphibians.

ECOLOGICAL INDICATOR SPECIES

The Forest Plan (1990) designated specific management areas (MA) for ecological indicator species. MAs with specific land boundaries are identified for marten and pileated woodpeckers across the forest. The purpose is to protect mature and old growth habitat for all dependent species by developing a network of suitable habitats large enough, and spaced close enough to maintain viability of the target species. Marten areas consist of 160 acres of contiguous denning habitat no more than three miles apart and contiguous nesting habitat of 300 core areas for pileated woodpeckers no more than five miles apart. Foraging habitat for each is also identified but not reserved in all cases.

The ROD and accompanying standards and guidelines states that "administratively withdrawn areas that are specified in current plans and draft plan preferred alternatives to benefit American martens, pileated woodpeckers, and other late-successional species are returned to the matrix unless local knowledge indicates that other allocations and these standards and guidelines will not meet management objectives for these species" (ROD p. C-3).

In the South Fork, comparison of reserved acres in designated Management areas and interim riparian reserves illustrates that there are many times more acres reserved by the interim riparian reserves than by administratively withdrawn areas within the 1990 Forest Plan. In most areas

however, the strips of riparian habitat only, without the current MA reserved areas, show an abundance of edge and a shortage of interior habitat provided by the blocks of habitat for marten areas which exceed 400 yards in width. This will remain the case until many of the riparian cluster areas transition into large enough blocks of mature or late seral habitats to function as interior habitat for these species. The spotted owl dispersal analysis identified that 64% of the interim riparian reserves, not already set aside by another reserve allocation, are in an 11/40 condition or older. Therefore, there are approximately 36% that are currently very young. If these blocks of interior habitat were harvested in the near future, the interim reserves would not be adequate in areas like the lower portion of the watershed. This could take up to 100 years since much of this habitat has been harvested in the last two decades, or they may remain too deficient of interior habitat indefinitely in areas where the class IV stream reserve areas are further apart. This watershed currently contains large enough blocks of mature and late seral habitats to provide for the needs of American marten and pileated woodpeckers.

If the existing blocks of late seral habitats are retained until adjacent suitable habitat is available by riparian reserves or other blocks, these species habitats will remain intact within the South Fork. An aerial photo examination illustrated that connecting habitats outside the watershed look adequate to the north and east. Connecting habitats to the south into LSR RO220 will improve over time and be adequate, but some fragmented early seral areas currently make it less than optimal. The main concern is connecting habitats to the west in the lower and mid portions of the watershed where lands to the west are highly fragmented. West of the mid portion, an expanse of private lands, heavily harvested in the past will continue to lack adequate connecting habitats.

This analysis demonstrates that the interim riparian reserves are not necessary to meet current objectives for the American marten and pileated woodpecker in this watershed alone. However, to meet the needs of additional late seral associated species, these blocks could be incorporated into an alternate riparian reserve strategy that would not only be sufficient for the marten and pileated woodpecker, but others as well. This strategy could be designed to meet the functional needs of the species by combining the riparian reserve strategy, Forest Plan, fire regime concepts, valley segment analysis results, and field verification site specifically.

BIG GAME

Past Conditions

Historical and census information published by Oregon Department of Fish and Wildlife (ODFW) for elk populations in the McKenzie herd management area is the basis for the following discussion. Additional specific reference data is available in the South Fork analysis file at the Blue River Ranger District.

The proposed management objectives for elk, published in 1994 by ODFW, speculates that big game populations were historically high and well distributed prior to European settlement in the early 1800's. Deer populations historically have remained at fairly high levels due to their ability to avoid exploitation. Through market hunting and overharvest, elk populations were reduced to extremely low levels by 1900. By closing all hunting for elk, populations recovered by 1938 sufficiently enough to initiate limited harvest. Timber harvest activities, elk harvest regulation, and elk transplanting in the last 56 years have resulted in a general increase in the populations. Over the last decade, deer populations have remained stable while elk populations have continued to increase in most of western Oregon as well as the South Fork, expanding their range of use into unoccupied habitat in many areas of the herd management area.

Prior to construction of Cougar Dam the area along the South Fork, now consisting of the reservoir, was a key wintering area for big game. The elk herd was mostly migratory using the Mink lake basin as summer range. As a result of Cougar Dam construction, this herd was forced into the Quartz creek drainage to the west to use as winter range. The east fork area was historically a very heavily concentrated area of elk use which has reduced since the construction of Cougar Dam, possibly due to loss of the winter range in the reservoir area.

During the mid 1970's several elk transplantation's were completed in the Blue River and McKenzie Bridge areas to enhance the population distribution and abundance. These introductions were considered quite successful and contributing to herd sizes today.

Current Conditions

The ODFW McKenzie herd management area extends generally from Springfield north to Lebanon, then east along Highway 20 to Big Lake at the crest of the Cascades, then south to Salt Creek Falls and west down highway 58 back to Springfield. The South Fork encompasses approximately 7.6% of the McKenzie herd management area and current census data estimates the current herd population at 2600 elk. The ODFW management objective is to increase herd size to 5200 elk. Based upon 1994 ODFW census results and overall population estimates, there are approximately 300 resident elk in the watershed. These estimates are very subjective considering variables such as weather conditions on the day of the census flight, time of day, and snow levels.

Potential population densities are based on calculations in winter range only. These are calculated using 0.2 elk/sq mi in low emphasis areas, 3.0 elk/sq mi in moderate emphasis areas, and 6.0 elk/sq mi in high emphasis areas. These calculations use emphasis areas rather than high density areas because the boundaries of the high density areas are not specifically delineated. If results of analysis were considered accurate, herd levels in the South Fork are already at maximum potential.

However, if all winter range acres, regardless of management emphasis (high, moderate, or low) were managed for high elk densities in their winter ranges, there would be a potential capacity for 400 elk in the South Fork.

Interviews of long term residents, elk hunters, and knowledgeable Forest Service employees indicate that the current projected population estimates of 300 elk in the South Fork is "realistic".

Field observations of elk use and previous planning documents verify higher elk use in the upper end of the East Fork to Olallie mountain, Grasshopper and Chucksney mountains through the Roaring River area and to upper French Pete Creek. Higher levels are often seen from the Skookum area through the Mink Lake basin. Low levels of elk use were observed in the lower portion of the watershed, except for some use by the Quartz Creek herd in the Penny and Balm Creeks area.

The Forest Plan requires big game habitat to be analyzed based on four factors:

- existing forage quality;
- cover quality;
- road density; and
- size and spacing of forage and cover areas.

This is completed through use of *A Model to Evaluate Elk Habitat in Western Oregon* (Wisdom, 1987) which estimates elk habitat effectiveness. This evaluation of overall forage, cover, and harassment relationship determines an overall rating of elk habitat effectiveness. Habitat conditions are rated based on a range from optimum use (1.0) to minimum use (0.05) for each of the variables described above as well as an overall combined effectiveness value for the area analyzed. This model does not consider differences such as slope, aspect, soil, and climate. As such, site specific interpretations of habitat effectiveness, population size and potential, and other habitat use variables must be completed by other methods of professional evaluation and field verification. The model is designated specifically to assess elk habitat, and should be used only on a relative basis for deer habitat needs.

Management objectives for deer and elk apply to specific mapped emphasis areas across the WNF with specific standards and guidelines of the Forest Plan for each variable in the model. These emphasis area designations were negotiated and determined by Forest Service managers in cooperation with ODFW. As a result, not all emphasis designations were established purely on the basis of the biological needs for big game.

The South Fork consists of 14 mapped emphasis areas within which winter range and summer range has also been delineated (Figure 60). For this analysis, values for each of the variables of habitat effectiveness are modeled within both winter range and the entire emphasis area. Within the South Fork, there is one emphasis area designated as low emphasis, six areas as moderate, and seven areas are designated for high elk emphasis management. These mapped emphasis areas range in size from 2345 acres (Smith) to 21,863 acres (South Fork-Mink). The management goal is to increase or maintain habitat effectiveness within a viable range for each emphasis area within the first ten years of the planning period for designated high, moderate, and low areas. Management standards for these are described in the Forest Plan and illustrated in Appendix Figures WL17 - WL24. The model assumes that high elk emphasis provides habitat capability for a potential

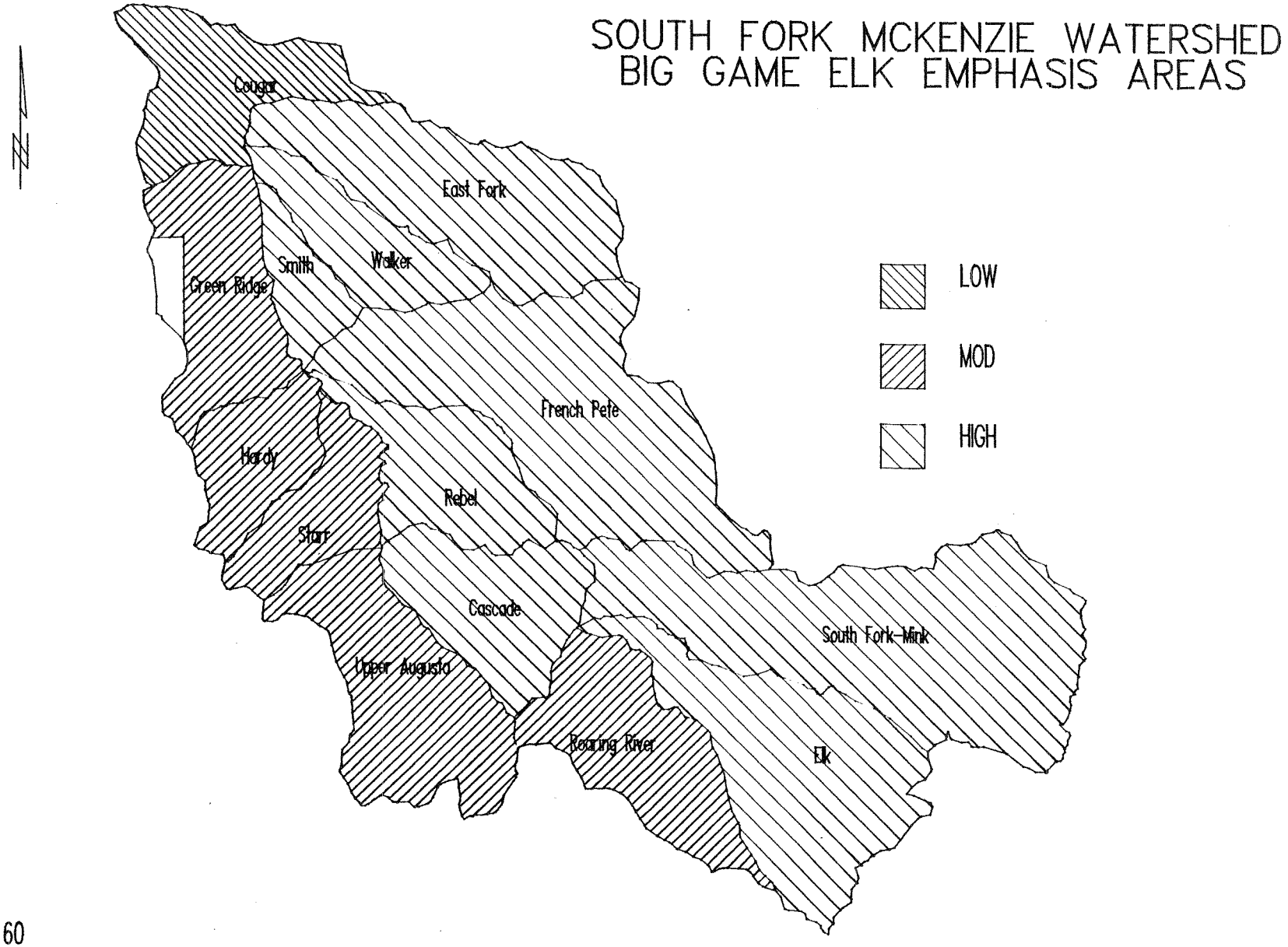

SOUTH FORK MCKENZIE WATERSHED
BIG GAME ELK EMPHASIS AREAS
N
Cougar
East Fork
Smith
Walker
Green Ridge
French Pete
Hardy
Rebel
Starr
Cascade
South Fork-Mink
Upper Augusta
Roaring River
Elk
LOW
MOD
HIGH

FIGURE 60

population of two elk and ten deer per 100 acres of winter range. In moderate emphasis areas, it provides for 0.8 elk and four deer, and in low emphasis areas, it provides habitat capability for 0.01 elk and 0.5 deer per 100 acres of winter range. Results of habitat effectiveness variables obtained from this model are displayed in Table 30. Findings are discussed below.

Elk Habitat Effectiveness Values (Wisdom Model)

Emphasis Area	Mgmt Designatio	HEs	HEr	HEc	HEf	HEI	Comments
Cougar WR	L	.69	.3	.56	.38	.46	
Cougar	L	.70	.26	.53	.39	.44	
Green Ridge WR	M	.72	.33	.55	.29	.44	
Green Ridge	M	.76	.26	.52	.35	.44	
Hardy WR	M	.83	.11	.5	.19	.3	5.4 mi rd/sq mi habitat 1519 ac area
Hardy	M	.76	.2	.53	.4	.42	4.7 mi rd/sq mi habitat
Starr WR	M	.77	.33	.55	.44	.5	
Starr	M	.82	.37	.53	.47	.53	
Upper Augusta WR	M	.82	.46	.69	.43	.58	
Upper Augusta	M	.82	.45	.65	.49	.59	
Cascade WR	M	.56	.61	.62	.49	.57	
Cascade	M	.57	.51	.64	.54	.56	
Roaring River WR	M	.88	.42	.87	.4	.6	1,500 acre area
Roaring River	M	.65	.36	.73	.32	.49	9,000 acre area
East Fork WR	H	.82	.66	.56	.48	.62	
East Fork	H	.82	.54	.56	.48	.59	13,000 acre area
Walker WR	H	.28	.52	.77	.75	.54	1,800 acre area
Walker	H	.66	.76	.69	.75	.71	
Smith WR	H	.30	.45	.69	.75	.52	
Smith	H	.33	.49	.66	.75	.53	
Rebel WR	H	.22	.52	.74	.75	.5	
Rebel	H	.51	.68	.69	.75	.65	
French Pete WR	H	.37	.98	.63	.75	.64	
French Pete	H	.56	.95	.65	.75	.71	
South Fork-Mink WR	H	.41	.73	.61	.75	.61	2,500 acre area
South Fork-Mink	H	.47	.97	.6	.73	.67	22,000 acre area
Elk Creek WR	H	.76	.33	.65	.36	.49	1,200 acre area
Elk Creek	H	.54	.81	.54	.42	.56	14,000 acre area

L = Low elk emphasis are
M = Moderate elk emphasis area
H = High elk emphasis area

Table 30

There is a total of 44,523 acres of winter range and 93,017 acres of summer range in the South Fork. Winter range was delineated by an elevation line below 3800' on south and west facing slopes, and 3200' on north and east facing slopes. Big game habitat was delineated and mapped across the watershed (Table 31, Figure 61). There is an abundance of thermal cover in the Below Dam, Wilderness, and High Cascades portions of the watersehed extending from below the dam to the southern portions of the watershed. (Figure 61 with overlay). An abundance of hiding cover is evident in the lower and mid portions.

Elk Habitat Definitions

Forage	=	Size classes <= 1.5
		Includes nonforest, stands without trees
		to seedlings and saplings mixed
Hiding Cover	=	Size clases 2.0 - 3.5
		Includes saplings, trees 1.0 to 4.9 inches dbh to
		poles and small trees mixed
Thermal Cover	=	Size classes 4.0 - 5.0
		Includes small trees, 9.0 to 20.9 inches dbh to
		medium trees, 21.0 to 31.09 inches dbh
Optional Cover	=	Size classes >= 5.5
		Includes medium trees and larg trees mixed to
		trees 21.0 inches dbh and larger

Table 31

The size and spacing variable of forage and cover (HEs) across all emphasis areas ranges from .28 in Walker winter range (Appendix Table WL17 and WL18) to .88 in the Roaring river winter range. This variable is generally a reflection of the level of fragmentation resulting from past timber harvest activities. In wilderness or other reserve areas it is generally below management goals. This variable, as well as others cannot be manipulated by projects such as timber harvest in wilderness areas or LSRs.

The cover quality habitat effectiveness variable (HEc) ranges from a low of .33 in the Elk creek winter range to a high of .97 in the overall rating of South Fork-Mink emphasis area. Cover values are generally very high in all emphasis areas dominated by wilderness forest (Appendix Table WL19 and WL20).

There is a shortage of forage in all emphasis areas, and an abundance of thermal cover in several emphasis areas within the wilderness such as Smith, French Pete, and South Fork-Mink (Table 32) Optimal cover is lowest in Elk creek, highest in Walker winter range area, and averages 34%. Thermal cover averages 44%, and hiding cover values average 14% across the whole watershed and 29% in the below dam, lower, and mid portions of the watershed which have been fragmented by timber harvest in the past.

Elk Habitat

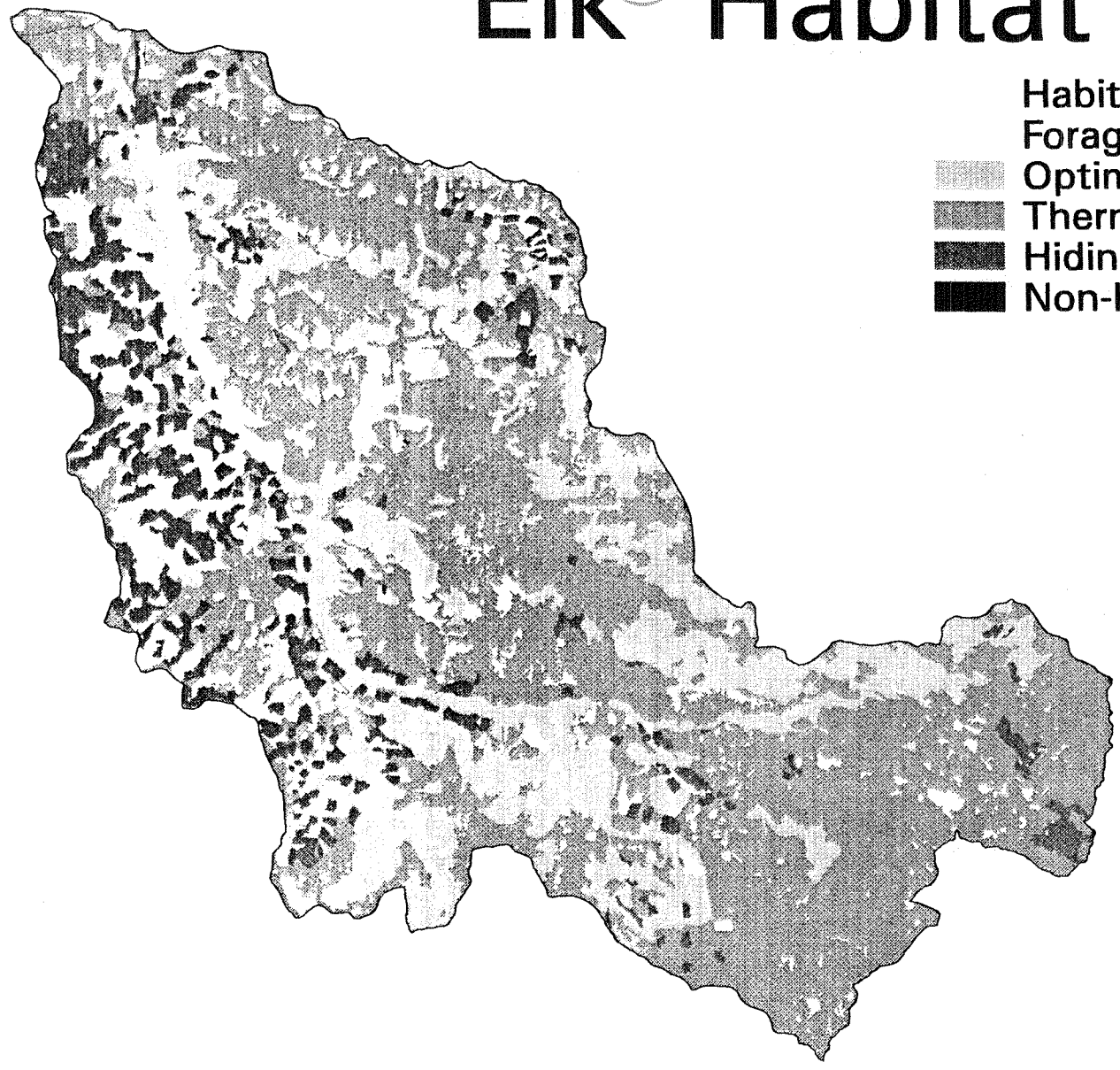


Figure 61

Elk Cover and Forage

Emphasis Area	Mgmt Goal	Miles Open Road	Optimal	Opt%	Thermal	Ther%	Hiding	Hid%	Forage	For%	Total
Cougar WR	Low	34.5	1,521	26%	2,909	49%	1,039	17%	464	8%	5,933
Cougar	Low	45.9	1,661	23%	3,351	47%	1,578	22%	597	8%	7,187
Green Ridge WR	Moderate	28.1	1,962	37%	775	15%	1,853	35%	655	13%	5,244
Green Ridge	Moderate	55.3	2,916	33%	1,320	15%	3,338	38%	1,154	14%	8,728
Hardy WR	Moderate	13.0	490	32%	51	3%	622	41%	356	23%	1,519
Hardy	Moderate	36.3	1,940	39%	344	7%	2,078	42%	613	12%	4,974
Starr WR	Moderate	14.7	738	27%	952	35%	621	23%	416	15%	2,726
Starr	Moderate	24.5	1,231	24%	2,045	40%	1,214	24%	618	12%	5,107
Upper Augusta WR	Moderate	9.8	1,317	48%	512	18%	531	19%	410	15%	2,770
Upper Augusta	Moderate	41.1	4,692	41%	3,109	27%	2,053	18%	1,476	13%	11,329
Cascade WR	Moderate	7.2	1,674	35%	2,184	46%	678	14%	244	5%	4,781
Cascade	Moderate	21.8	2,666	35%	3,902	51%	719	9%	363	5%	7,651
Roaring River WR	Moderate	6.3	959	64%	334	22%	0	0%	197	14%	1,489
Roaring River	Moderate	44.5	4,129	46%	3,721	41%	374	4%	797	9%	9,020
East Fork WR	High	17.1	148	3%	3,874	79%	172	3.5%	694	14%	4,887
East Fork	High	30.7	1,938	15%	7,985	62%	813	6.3%	2,096	16%	12,831
Walker WR	High	4.9	1,173	65%	359	20%	268	15%	10	0%	1,808
Walker	High	4.9	2,012	39%	2,462	48%	271	5%	406	8%	5,151
Smith WR	High	7.3	803	40%	1,140	57%	69	3%	0	0%	2,014
Smith	High	7.3	804	34%	1,437	61%	84	4%	21	1%	2,345
Rebel WR	High	8.6	1,684	52%	1,384	43%	153	5%	3	0%	3,224
Rebel	High	8.6	2,541	37%	3,495	51%	168	2%	710	10%	6,913
French Pete WR	High	.3	1,181	26%	3,287	71%	0	0%	138	3%	4,606
French Pete	High	3.6	5,718	28%	13,047	64%	204	1%	1,354	7%	20,321
South Fork-Mink WR	High	2.6	567	23%	1,840	74%	53	2%	46	1%	2,503
South Fork-Mink	High	2.6	5,213	24%	15,152	69%	1,057	5%	440	2%	21,863
Elk Creek WR	High	6.3	959	64%	334	22%	0	0%	197	14%	1,489
Elk Creek	High	10.2	1,395	10%	11,632	84%	352	3%	536	3%	13,921
Average		17.8	1,914	34%	3,320	44%	736	14%	632	9%	6,502

Table 32

The forage quality habitat effectiveness (Hef) indicates very high levels in several emphasis areas that are in the wilderness (Walker, Smith, Rebel, French Pete, and South Fork-Mink). There is less than 10% of these emphasis areas in a vegetative condition which provides forage. This model index of HEf is derived only from forage quality. In this case, many of the acreage's of dry meadow, which includes patches of tag alder and vine maple, common as special habitats in the wilderness, are given a rating of .75 in the model. This implies they are providing forage equivalent to a high quality forage meadow (Appendix Tables WL21 and WL22).

Forage values (Hef) in the lower and mid portions of the watershed average about .40 which meets the required minimum management goal for viability (>.40) in moderate emphasis areas. About 9% to 14% of the total vegetation for emphasis areas in these portions of the watershed is currently in a forage condition. All other emphasis areas within the watershed have <10% of their acres in a forage condition, which is below the desired level for big game management. Other than in optimal cover, this model does not take into consideration that most critical winter forage for most big game herds consists of lichen litterfall, especially at moderate to high elevations, and in high snowfall years (pers. comm. ODFW). The model also does not consider supplementary forage provided in the understory of cover areas such as precommercial and commercial thinnings.

Management of road densities is described by an interagency coordinated memorandum of understanding dated June 4, 1992. This agreement establishes the objectives and agency roles for travel management on Forest Service and BLM lands.

Elk Creek winter range, Green Ridge, Hardy, and Starr areas of the lower, and mid portions of the watershed have open road density ratings that do not meet the standards of the Forest Plan. In low emphasis areas like Cougar, the goal is an Her $\geq$ .2 which equates to $\leq$ 4.6 miles of open road per square mile of habitat. In moderate emphasis the management goal is Her $\geq$ .4 which equates to 2.7 miles of road, and in high emphasis areas, Her $\geq$ .5 which equates to $\leq$ 1.7 miles of open road per square mile of habitat. All other areas in the watershed do meet the Forest Plan standards for open road density.

The overall ratings for habitat effectiveness (HEI) indicate that with the exception of the entire Hardy area, all emphasis areas are above the minimum management goals for the South Fork (Figures 62 and 63). However, there are very low quantities of forage in most emphasis areas with only 8.4 % of the total winter range in a forage condition. A landscape consisting of 20% forage, 30% hiding cover, 30% thermal cover, and 20% optimal cover in winter range and a ratio of 30/30/20/20 in summer range is a more desirable mix, but this preferred landscape for big game cannot be achieved due to growth rate differences between the conditions.

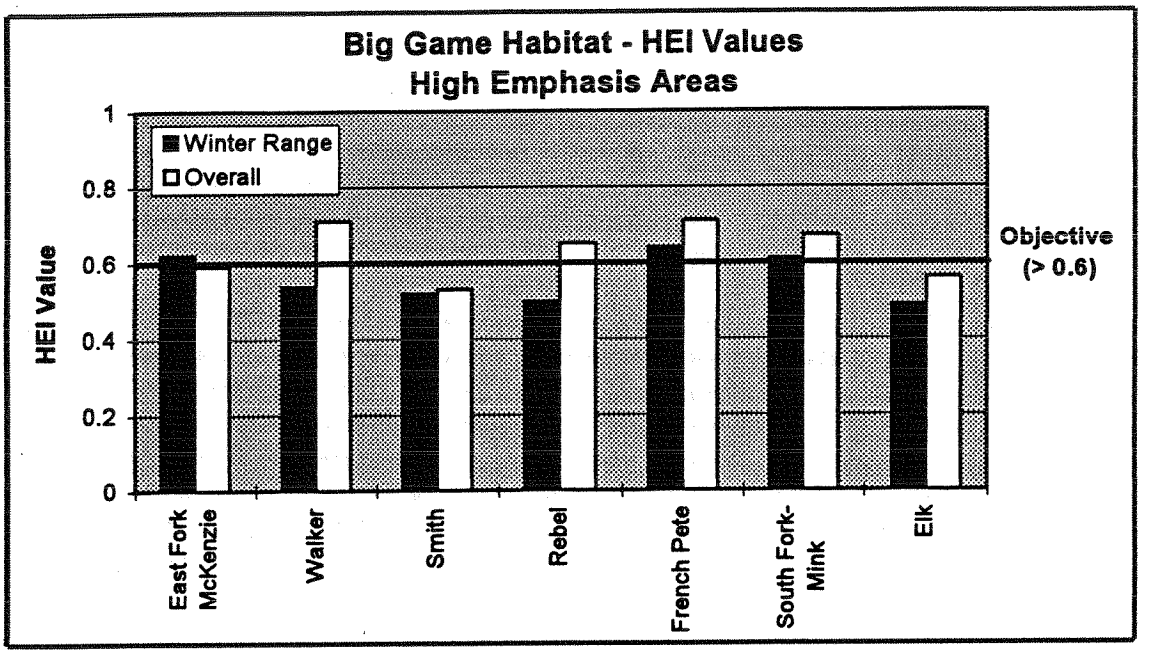


Figure 62

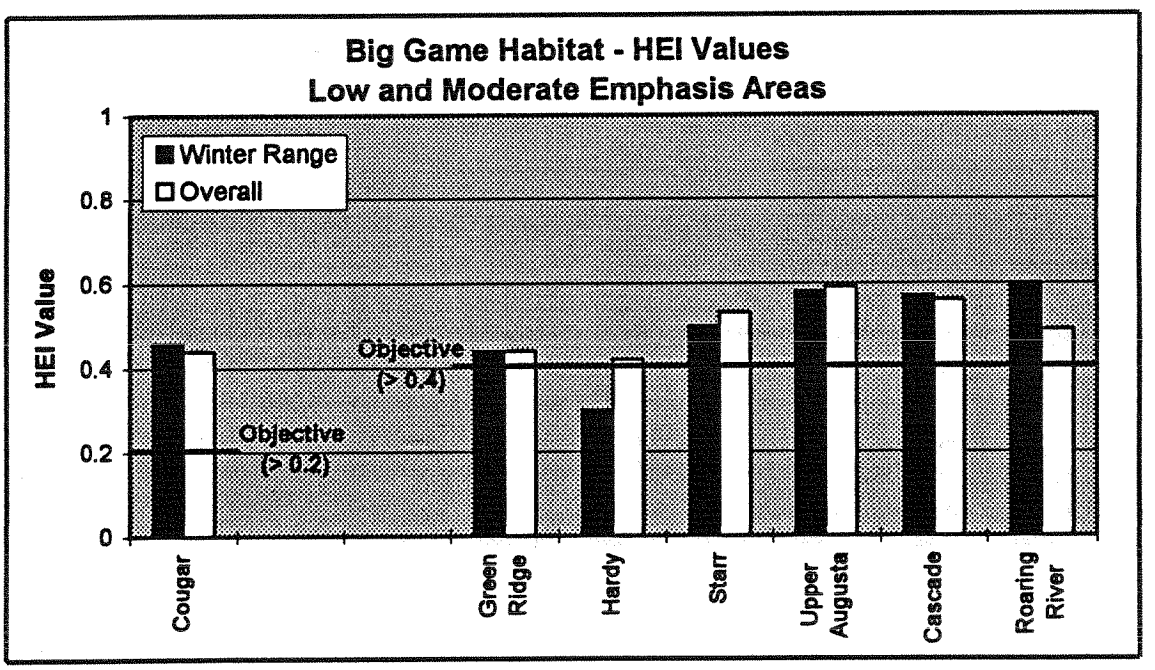


Table 63

Future Trends

In the wilderness and other no harvest reserve areas where fire suppression is continued, the absence of natural fire will result in a continued shortage of forage and contrasting edge habitats. Stand conditions will continue to slowly shift from thermal to optimal cover. Forage availability would be reduced over time if natural meadows in areas like Chucksney and Grasshopper mountains do not undergo natural or prescribed fires as trees encroach. Prescribed burns are planned for these meadows during the next five years, which will improve forage quality in these meadows.

In the lower and mid portions of the watershed, much of the young harvest units considered as forage will transition into hiding cover in the next decade. With management for late successional species a priority for management of these forests, it is unlikely current forage quantities will be retained through traditional means. Emphasis on higher quality forage areas that are secure from harassment by vehicle traffic and poachers can mitigate this effect. Development of permanent meadows in key winter ranges maintained over time with grass and shrub forage species which contain high nutrient qualities are needed in areas such as the Cascade Creek and below dam winter areas.