Tower Fire Ecosystem Analysis

North Fork John Day Ranger District
Umatilla National Forest

Final

1/31/97

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Introduction

The Task

This document presents the results of an ecosystem analysis of the Tower Fire. The fire occurred on the North Fork John Day Ranger District of the Umatilla National Forest in August - September of 1996 (Figure 1).

The analysis was conducted by a team of journey-level professionals, representing a range of resource specialties, and was guided in its work by a Board of Directors, consisting of three Forest Staff Officers and two District Rangers.

The objective was to conduct a focused ecosystem analysis of the fire area, on an accelerated timeline, concentrating on identification of restoration opportunities and salvage harvest.

The Federal Guide to Watershed Analysis served as the blueprint for the analysis. Because of the need to complete this analysis quickly, so that project level planning and NEPA analysis can begin, not all of the recommendations in the Federal Guide were carried out to their fullest extent. One of the most notable of those items was frequent involvement and participation by Tribes, other governmental agencies, and the public. Also, more time on integration, synthesis, and interpretation would have resulted in a more cohesive analysis and document.

Except for some references to its effects, grazing was not an issue that was addressed. Any adjustments needed as a result of the fire will have to be addressed at the project level. Impacts on visual resources were not addressed.

Fire Summary

As will be discussed in the analysis to follow, forested ecosystems have evolved with fire as a natural component. Fire plays a vital role in the balance of species composition, forest structure, nutrient cycling, and many other forest characteristics and ecosystem processes.

However, fuel levels in the Tower Fire area were observed to have been high as a result of factors such as fire suppression, drought, and insects and disease. The resulting fire thus was probably more severe than would have occurred under more "natural" conditions. Although the fire will have positive effects in the long-run, many short-term negative effects have been identified.

The Tower Fire, situated in the headwaters of the North Fork of the John Day River subbasin, burned about 51,000 acres, approximately 4.3 percent of the subbasin area, which has a drainage area of 1830 mi^2. The fire burned a 14 mile long, by 10 mile wide swath across the forest. Low elevation ponderosa pine forests, as well as high elevation spruce and subalpine fir forests burned. Large, contiguous blocks sustained 100 percent fire kill, yet isolated patches of trees somehow escaped the fire that killed everything around them.

Much of the Tower Fire is an example of a crown fire, a fire that spreads through the forest canopy. Crown fires are fast spreading and release tremendous amounts of heat energy in a relatively short period of time. Tower was an instance in which a strong convection column (plume) built vertically above the fire. The velocity of air rushing upward in a convection crown fire causes air near the ground to be sucked into the column, which promotes rapid fuel combustion. The resulting indrafts increase fire intensity, thus accelerating fire spread. It is also believed that the fire exhibited a dangerous condition called a downburst or microburst, where winds blow outward near the ground as the convection column collapses. These winds can be very strong and can greatly accelerate a fire.

About 6,000 acres were mapped by the Burn Area Emergency Rehabilitation (BAER) team as having burned at high intensity, meaning that virtually all surface organic material was consumed by fire. In terms of soil productivity, a majority of the nutrient capital, especially nitrogen, may have been lost for the next several decades. The effects on soil biota will be highly variable.

The loss of vegetation and ground cover will likely affect hydrologic and geomorphic characteristics and processes, such as increased soil moisture and overland flow leading to increased surface erosion and downstream sediment transport. Several subwatersheds are believed to be at "high risk", in terms of increased water yields, peak flows, channel response, and water quality effects.

Over half of the burned acres drain south, directly into the North Fork of the John Day River. The remainder of the burn drains north into the Camas Creek drainage, which also eventually feeds into the North Fork of the John Day River. In addition to the diminished quality of fish habitat resulting from the loss of shade, increased water temperatures, loss of hiding cover, and likely increase in sediment, the fire killed fish in several stream reaches.

The Forest Plan classifies about half of the Tower Fire area as Special Fish Management Area C7. This reflects the status of the John Day River Chinook salmon as the largest remaining wild stock of spring Chinook in the Columbia River system. Furthermore, Huntington et al (1996), in a recent evaluation of anadromous salmonid stocks in the Pacific Northwest and California, classified the John Day River summer steelhead as healthy stocks, identifying them as the only healthy steelhead stocks in the Columbia River system. These salmonids comprise a very special biological resource, a kind of last stronghold for these fish in the Columbia River system.

Prior to the fire, a wide variety of forest cover types and structure provided diverse habitats for terrestrial wildlife species. Approximately 33 species of amphibians, birds, and mammals are thought to have been extirpated from the fire area, due to loss of habitat. An additional 13 species have the potential for local extirpation if key habitats are not restored within the next 15-20 years.

In the Blue Mountains, western white pine exists only in limited areas. As much as 2/3 of the native western white pine stands for the North Fork John Day Ranger District, a high proportion of the Umatilla National Forest's stands, were killed by the fire

About 2000 acres of reforested stands were lost in the fire, representing over $1,000,000 of lost investment.

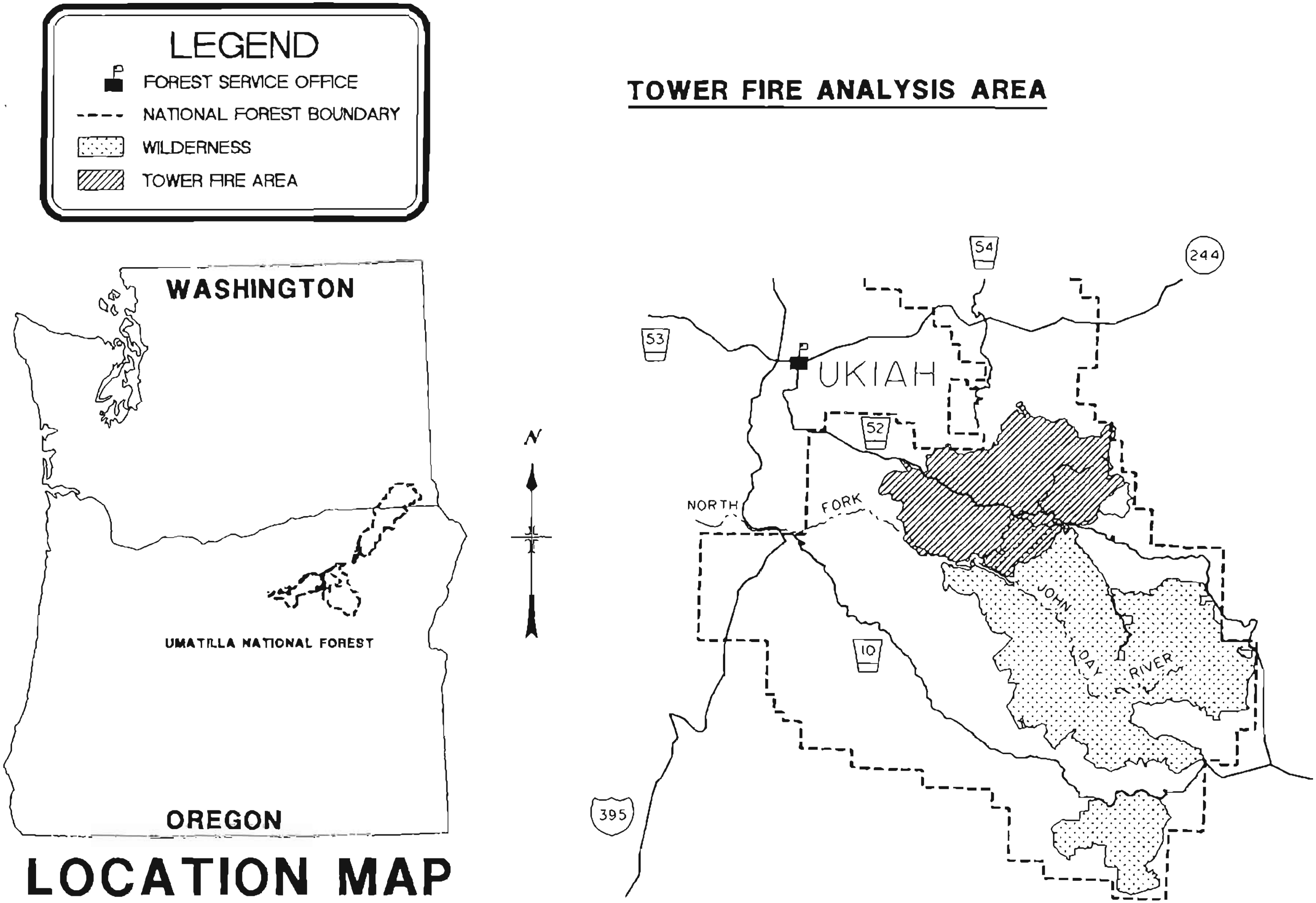
Approximately 22 species of plants are considered potentially "at risk", meaning they are of limited abundance within a given ecological setting across the entire Umatilla National Forest, and are unlikely to have sufficient refugia population to reinvade the burn area. The risk of invasion by noxious weeds has increased as a result of the fire , primarily through altered light regimes.

Recreation in the area represented a large portion of the Ranger District's use, particularly for hunting and off highway vehicles (OHVs). About 70 miles of wilderness and OHV trails were burned over, causing dangerous conditions from hazard trees along the trails, as well as at numerous trailheads and dispersed recreation sites. Ten OHV bridges, and one wilderness bridge were destroyed, as well as three recreational summer homes. Recreational use of the area is expected to decrease for several years.

Notes:

- Individual reports on each resource area are available upon request from each of the Analysis Team members, as shown in the "List of Preparers" at the end of this document.
- The maps in this document are not to scale, and are presented only to show general locations of features. If needed, larger maps to scale can be made.

FIGURE 1. VICINITY MAP



I. Characterization

General Information

The Tower Fire impacted nearly 51,000 acres in portions of five watersheds (Cable Creek, Bridge-Pine Creeks, North Fork John Day River, Big Creek, Hidaway Creek, and the Upper Grande Ronde River) of the Umatilla National Forest. The fire zone straddles a prominent physiographic feature called Pearson Ridge between Camas Creek on the north and the North Fork of the John Day River on the south.

Area and Intensity of Burn

Figure 2 displays the subwatershed (SWS) boundaries within the Tower Fire boundary. Figure 3 displays burn intensity as field mapped by the Tower Burn Area Emergency Rehabilitation (BAER) Team, and Table 1 shows burn intensity acres by subwatershed.

Subwatersheds 85D, 34A, 34B, and 96A were the least affected subwatersheds with less than 1 percent of their total acreage burned.

Subwatershed 95A was the most severely burned overall. 100 percent of it burned, and 27 percent of its total acres were high intensity burn.

Subwatersheds 33D and 33C were severely affected. 100 percent of 33D burned, with 23 percent of its acres in high intensity burn. 97 percent of 33C burned, with 19 percent of its acres in high intensity burn.

Subwatersheds with over 50 percent of their acreage burned were 33B, 35E, 95B, and 96B.

Table 1 - Subwatersheds by Burn Intensity (BAER)

Watershed	SWS	Total Acres in SWS	Low Burn Intensity Acres	Mod. Burn Intensity Acres	High Burn Intensity Acres	Total Burned Acres	% of SWS Burned
Upper Grande Ronde/Fly	85D	11,900	32	0	0	32	0.3%
Cable Creek	33A	5,946	649	166	0	815	14%
"	33B	5,638	2,254	868	1	3,123	55%
"	33C	6,051	1,935	2,771	1,158	5,863	97%
"	33D	6,640	3,404	1,699	1,537	6,640	100%
Bridge/Pine	34A	12,621	77	0	0	77	0.6%
"	34B	21,534	49	0	0	49	0.2%
North Fork	35B	6,297	2,153	2,053	701	4,907	78%
John Day	35C	5,425	1,427	593	0	2,020	37%
"	35D	8,722	1,760	2,143	73	3,976	46%
"	35E	7,018	1,900	2,373	492	4,765	68%
Big	95A	6,382	3,709	926	1,727	6,361	100%
"	95B	11,337	5,017	854	172	6,043	53%
Hidaway	96A	10,287	39	0	0	39	0.4%
"	96B	8,914	4,839	1,185	82	6,107	68%
	Totals	134,709	29,243	15,632	5,943	50,818	

Figure 2- Tower Subwatersheds

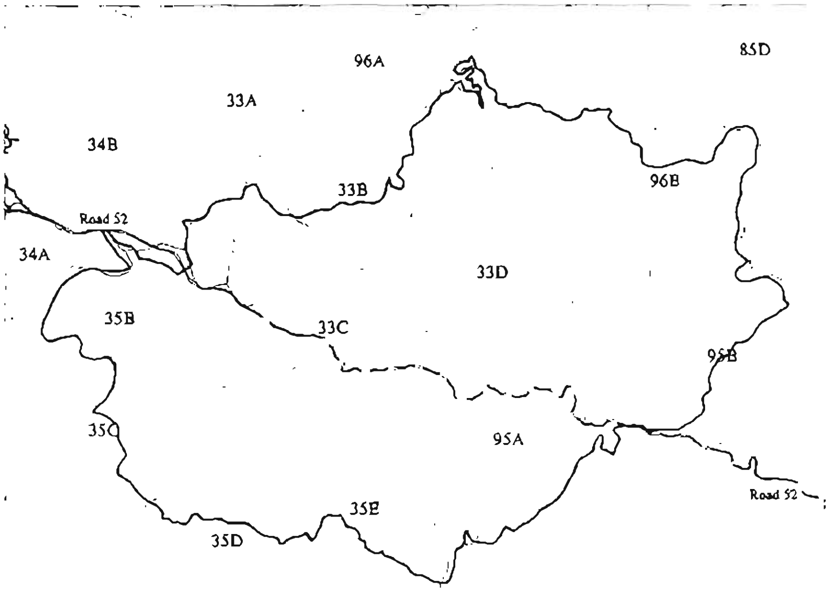
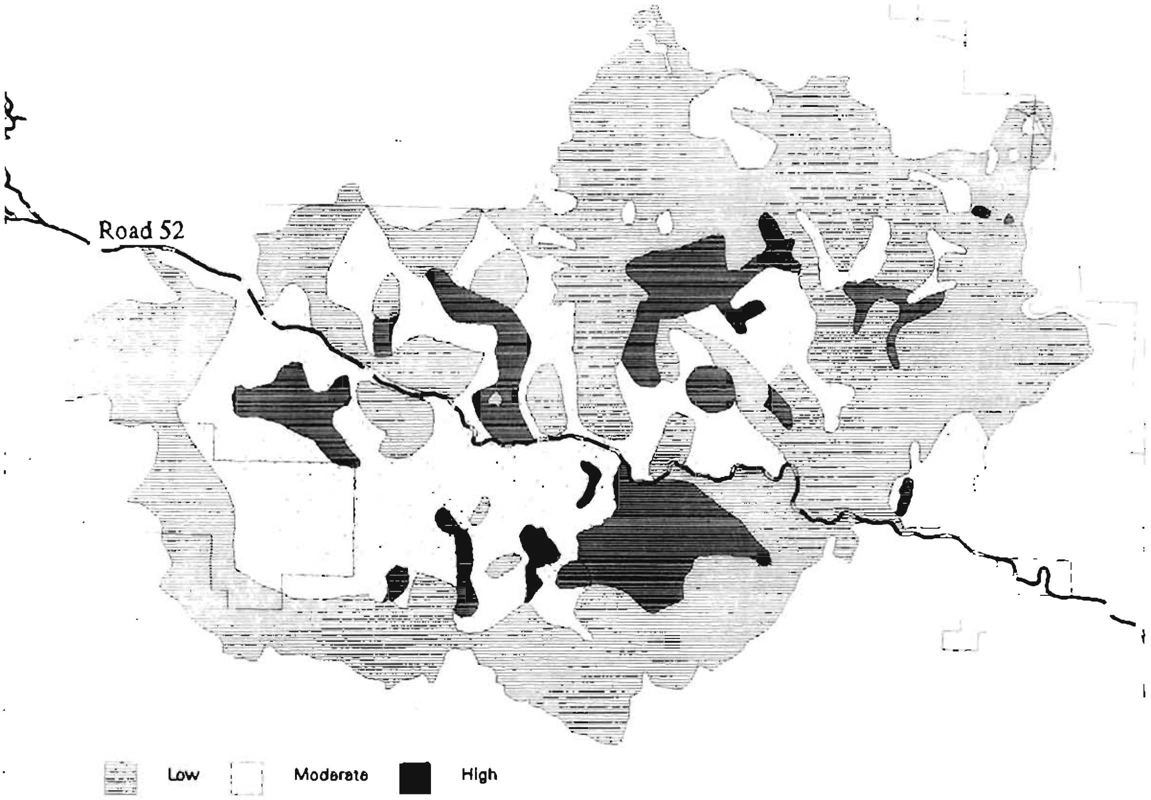


Figure 3- Tower Fire Burn Intensity



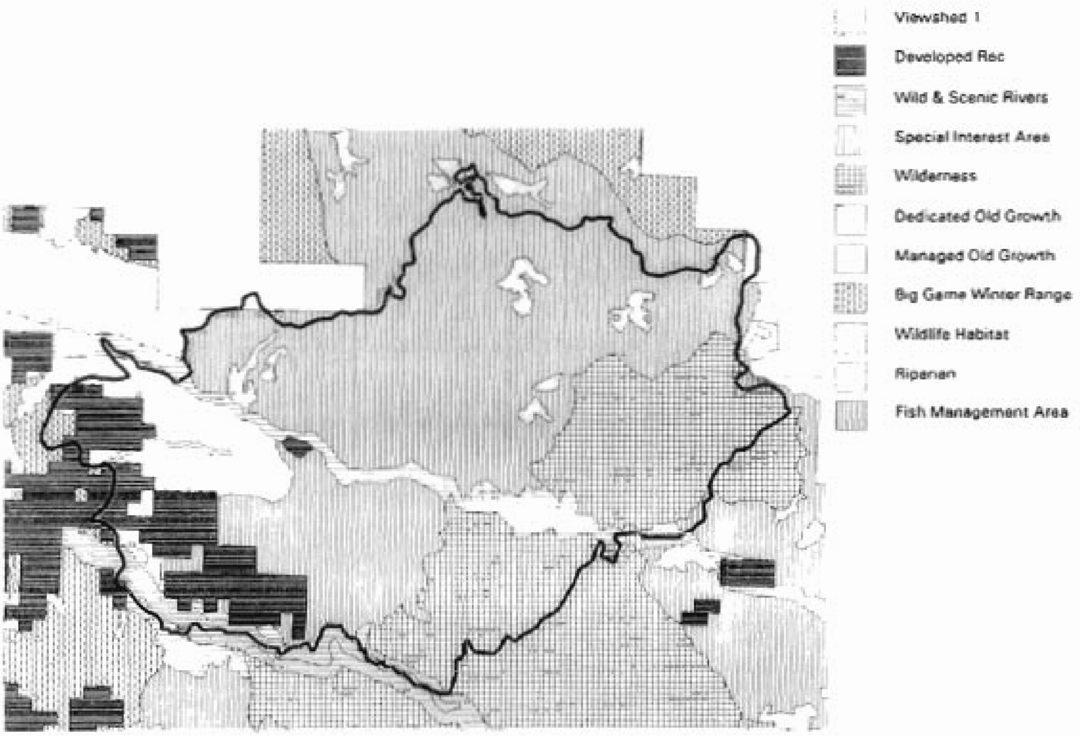
Forest Plan Management Areas

Table 2 displays the burned area by Forest Plan Management Area, in descending order based on the number of acres. Figure 4 displays management areas.

Table 2 - Forest Plan Management Areas

Management Area	Acres	% of Total
C7 - Special Fish	25,889.4	51%
B1 - Wilderness	11,615.0	23%
Private	4,465.6	9%
C4 - Wildlife	3,651.0	7%
A3 - Viewshed 1	2,538.3	5%
C1 - Dedicated Old Growth	1,005.3	2%
A7 - Wild & Scenic River	982.0	2%
C3 - Winter Range	223.3	0.4%
C2 - Managed Old Growth	194.4	0.3%
C5 - Riparian	117.4	0.1%
A6 - Developed Rec.	84.6	0.1%
A9 - Special Interest Area	39.3	0.1%
E2 - Timber/Big Game	12.1	0.0%
Totals	50,817.7	100%

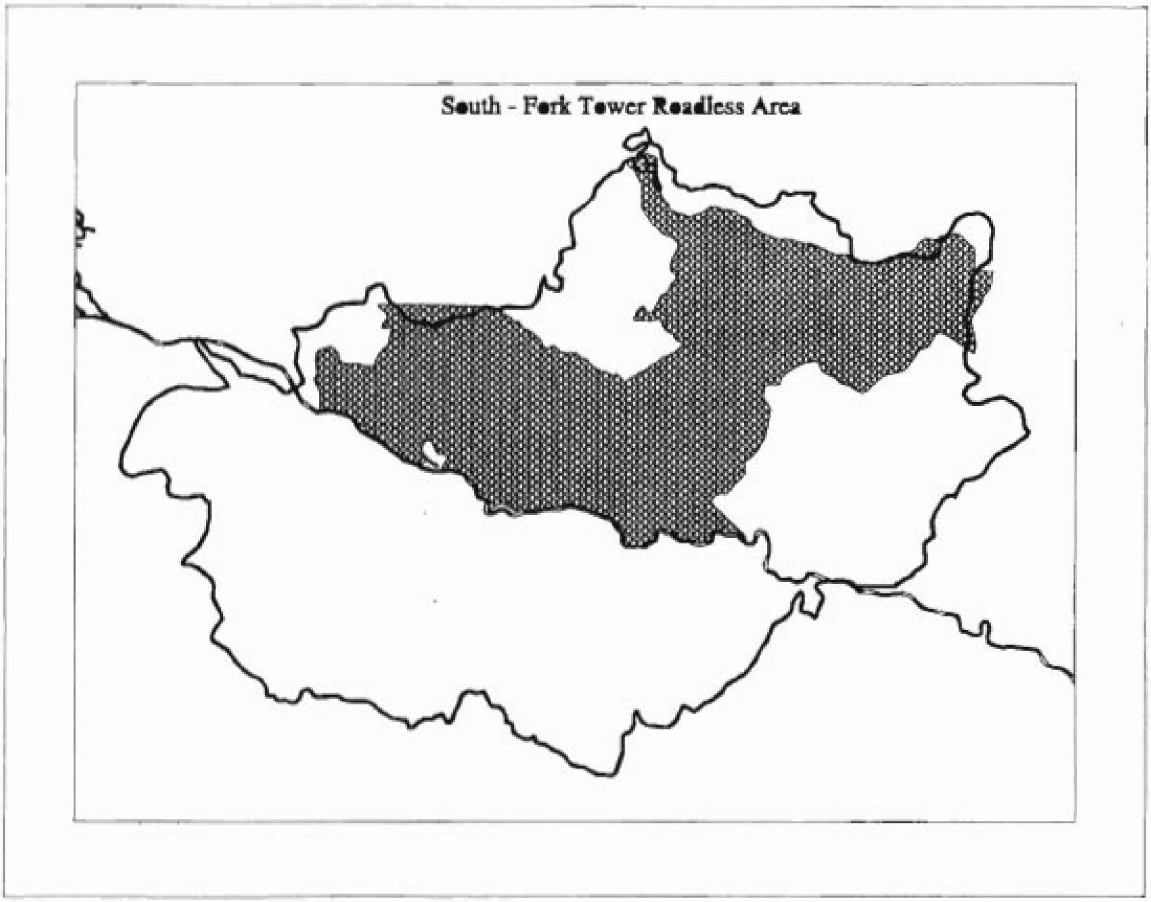
Figure 4 - Tower Fire Management Areas



Roadless

The fire burned most of the South Fork-Tower Roadless Area. The area contains17,000 acres, and about 16,305 acres burned in the fire (see Figure 5). Under the Forest Plan, it is scheduled to be developed consistent with the principal management areas: C7, C1, and A3.

Figure 5 - South Fork Tower Roadless Area



Federal Trust Responsibilities To Indian Tribes

In 1855, three treaties which affect the Umatilla National Forest were signed between the United States Government and several Indian tribes. The treaty with the Walla Walla, Cayuse, and Umatilla tribes, and bands of Indians in Washington and Oregon Territories (today referred to as the Confederated Tribes of the Umatilla Indian Reservation)was signed June 9, 1855. On June 26, 1855, a treaty was signed with the Tribes of Middle Oregon (these groups are now known as the Confederated Tribes of the Warm Springs Indian Reservation).

In each of these treaties, the tribes ceded certain traditional lands to the U.S. Government. The Umatilla National Forest includes portions of ceded lands. Reservation lands were retained by the tribes. The treaty also provided the Indians with the exclusive rights to taking fish in the streams running through and bordering the reservation, rights in common with citizens of the United States at all other usual and accustomed stations, and the right to erect suitable buildings for curing the fish. The privilege of hunting, gathering roots and berries, and pasturing their stock on unclaimed lands in common with citizens was also retained.

Treaties and executive orders after 1971 obligate the United States and its agencies to certain trust responsibility. This responsibility has been generally referred to as the federal trust responsibility. In addition to obligations in treaties and statutes, the Forest Service has an obligation to consult with Federally recognized Indian Tribes on a Government-to-Government basis throughout our planning process.

Indian Tribes having rights to fish, hunt, gather, graze livestock or trap on National Forest Lands also have the implied right to have associated resources (habitat) protected from degradation. The Forest views this ecosystem analysis as the beginning of the consultation process at the technical level with local tribal governments. The identification of treaty rights, treaty protected resources and other tribal concerns is the first step. This information will be used when developing specific Tower Fire Restoration projects. When consultation with tribes indicates a concern or conflict with the proposed action and that conflict is related to treaty rights or other rights or interests, those issues will be addressed in the site specific NEPA analysis. Depending on the character of the issues, they may be addressed in several different ways. An issue may be used to develop alternatives to the proposal, to develop mitigation measures or could be used by the decision maker in selecting among the alternatives. In all cases, tribal governments will be involved throughout the planning process.

Soils and Geology

Geology

The Tower Fire analysis area lies within the Blue Mountain section (M332G), and Ukiah subsection (M332Gj, Ukiah Mountain Slopes), located on uplands southeast of the town of Ukiah. Elevation within the fire area ranges from about 3,000 feet at the southwest corner along the North Fork John Day River, to about 6,800 feet at Tower Mountain on the eastern edge.

The Tower Fire affected a variety of soil types and different geologic formations. Figure 6 is a geologic map of the fire area.

Table 3. Geologic Types

GEOLOGIC TYPE	Acres	% of Area
John Day Volcanics (Tsfj)	33,077	65
Grande Ronde basalt, andesite (Tcg)	6,745	13
Granite, granodiorite (KJi)	6,100	12
Debris, landslide deposits (Qls)	2,623	5
Metavolcanics (TRPv)	2,273	5
	50,818	100

From: Walker & Macleod. Geologic Map of Oregon. 1991.

The largest geologic formation within the area is the (northeast Oregon) John Day formation, consisting of predominantly volcanic ashes, tuffs and lava flows with aeolian deposition in or near (ancient) lakes.. This formation dominates the Cable, Hidaway, Big, and upper Oriental, Winom and Texas Bar drainages.

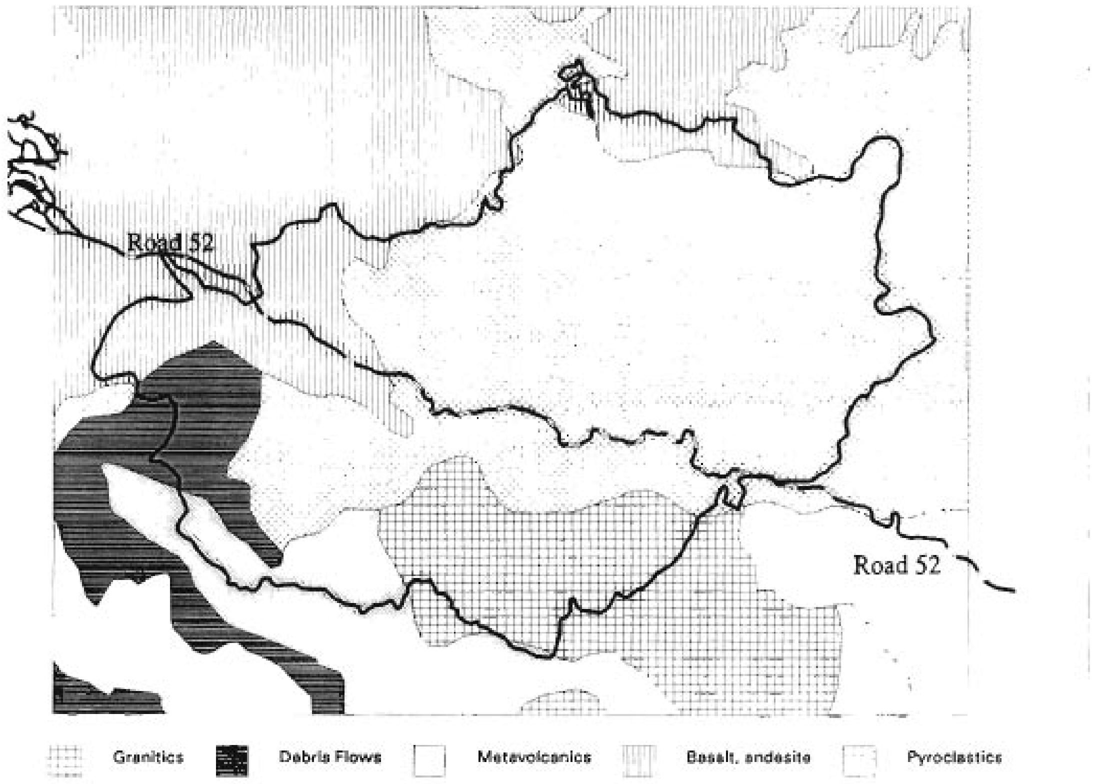
There is a considerable amount of unconsolidated material within this formation. Although relatively stable, it does exhibit behavior, in places, a propensity for local slumping.

Sorted fines tend to be medium to coarse textured as evidenced by the sandy substrate found in many of the streams within this unit. Stone size or larger coarse fragments are not common although metamorphosed tuffs of large gravel to cobble size are fairly common.

The geologic unit of 'Landslides and Debris Flow deposits' found in much of the Texas Bar drainage has shown itself to be quite stable within the fire area. There are no mapped slide areas although an observable slide is evident just above Texas Bar Creek and above the 55 Road. It does not appear to be recent and did not create any problem when the road was constructed there. Parts of this geologic unit do exhibit active instability south of the North Fork John Day in the Turner Basin area

Some of the southern fire area is within an area of granitic rock (granites and granodiorite). It includes a large section of the Oriental drainage system and eastward into lower Winom Creek. Portions of this formation have areas of weathered rock referred to as decomposed granite. This formation is significant as exposed granitics tend to dry ravel and are often difficult to stabilize active road cuts. Large amounts of medium to coarse textured fines can mobilize and travel to water courses should freshly exposed surfaces receive large precipitation events. This has occurred in the Oriental basin as is noted later.

Figure 6 - Tower Fire Geologic Types



All of these formations have a volcanic ash mantle of medium texture (silt loam to fine sandy loam) to varying depths depending on the amount of geologic erosion that has taken place. Much of the volcanic ash cap is completely eroded or redistributed off of narrow ridges, shoulders of steep slopes, and many of the south and southwest aspects, producing varying depths of ash-derived and residual soils.

Soils

Predominant soil types over the burn area include SRI map units 67, 678 (67 & 68 complex), 66, and 366 (66, 69 & alluvial complex). These are deep and moderately deep volcanic-ash derived soils with subsurface residual soils, or directly overlying, volcanic pyroclastic and metasediments typified by tuffs and tuffaceous sediments with some gabbro and rhyolite. These soils classify as Typic Udivitrands, deep, medial over clayey, and Typic Vitricryands, moderately deep, medial over loamy.

Table 4. Dominant Soil Units & Key Characteristics

SRI MAP UNIT #	TOTAL DEPTH(in.)	SURF. TEXTURE	MINERAL ASH (in)
67	50	SILT LOAM	26
68	26	SILT LOAM	10
66	60	SILT LOAM	26
69	36	SILT LOAM	11
81	26	SILT LOAM	22
48	30	SILT LOAM	18

Soils formed in the basalt formations common in the northwest part of the burn are stable and relatively less prone to erosion. These are commonly residual Inceptisols if without a volcanic ash cap, an Andic intergrade if they have a shallow mineral ash (volcanic) mantle, or Andisols if sufficient amounts of volcanic ash is present. The residual soils formed in basalt are most often shallow and of medium to medium-fine texture, and may have significant clay content in subhorizons.

Soils developed in granite and granodiorite, while not predominant on an acreage basis, are none-the-less significant. They are highly erodible nature when disturbed if water can concentrate and initiate rilling, and due to dry ravel. They are often difficult to revegetate on cut slopes or other areas where surface soils are displaced. In addition they are often hard to regenerate due to moisture holding limitations.

Erosion Processes

The dominant erosional process in the Tower Fire Analysis Area is surface erosion (sheetwash, rill, gully) with occasional mass wasting events. The west part of the fire area occurs in an area of relatively young, in geologic terms, material, mapped as Quaternary landslides and debris flows, this is an area of generally unconsolidated and unstable deposits in the vicinity of Texas Bar (middle section) Creek. The south portion of the fire area is in an area of granitic geology, more prone to surface and mass erosion, in the vicinity of Oriental and Winom Creeks.

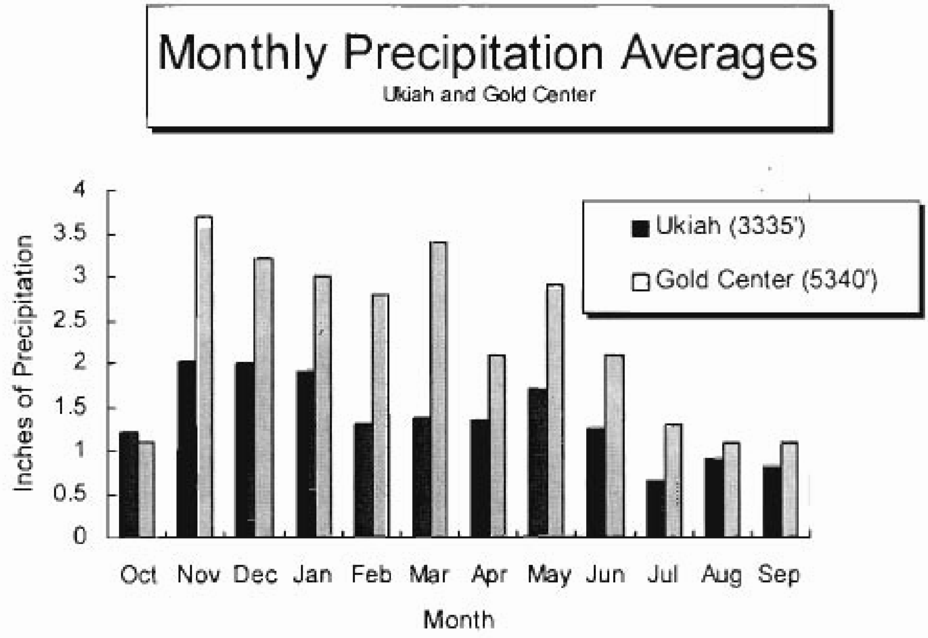
Watershed Hydrology

Geology and Climate

Five major geologic formations occur in the fire area and are described in the Geology and Soils Report. Groundwater characteristics, stability, and erosion potential vary among the formations, with two of the units posing relatively higher hazard of erosion; unconsolidated Quaternary landslide deposits on the west end of the fire area, and granitic rocks on the south end.

The climate of the fire, and surrounding areas, is continental with seasonal extremes of temperature; cold winters and hot summers. Annual precipitation ranges from 20 to 40 inches. Seasonal distribution of precipitation varies with elevation, aspect, and prevailing winds; more even distribution is apparent in the lowlands (less overall), while a slight winter-dominance is evident in the mountains (Figure 7). Summer convective storms are common in the Blue Mountains, and result in localized, often intense rain showers.

Figure 7 - Monthly precipitation averages for station in the vicinity of Tower Fire.

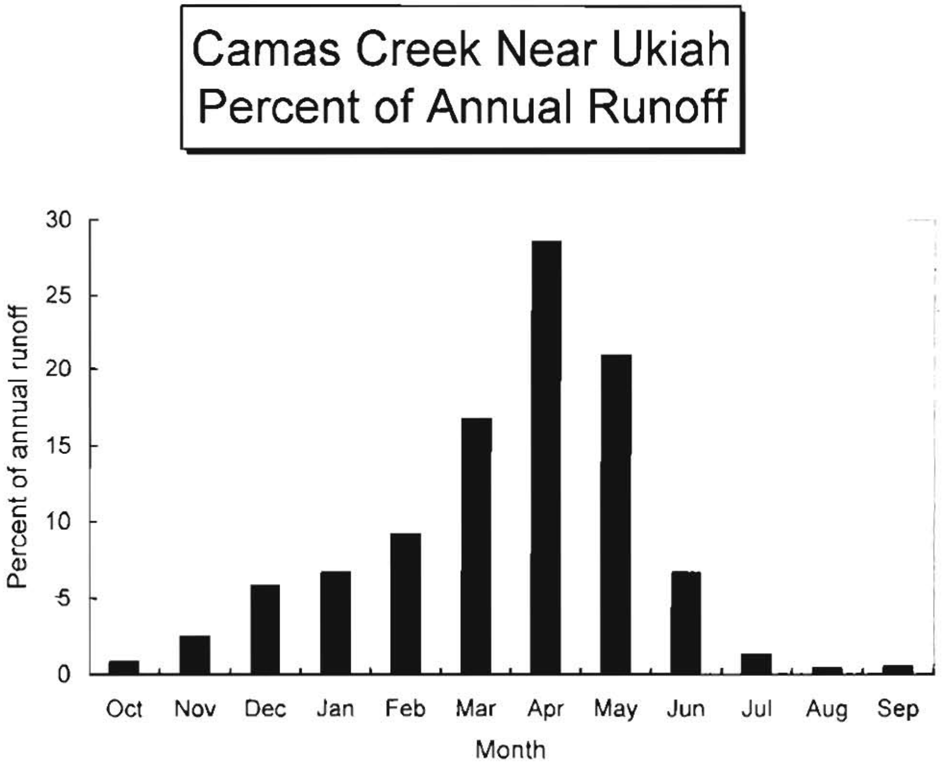


Hydrology

Annual runoff and seasonal distribution of flow in streams and rivers is dependent on many factors including the amount and seasonality of precipitation, temperature regimes, and groundwater characteristics of geologic units. Streams in the fire area are, for the most part, ungaged. Long term streamflow records are available for Camas Creek near Ukiah, Oregon.

Average annual discharge for Camas Creek near Ukiah is 96.7 cubic feet per second, cfs (or 0.8 cfs per square mile). April is the month with the greatest percentage of discharge, which occurs as snowmelt. Streams reach their lowest flows in August and September (Figure 8).

Figure 8 - Distribution of streamflow as a percentage of average annual runoff.



The 76 year record for the Camas gage shows 1965 as the year with the highest peak discharge (Figure 7). Distributing the peak flow (3840 cfs) over the watershed shows a unit runoff value of 31.7 cfsm. Several crest gages were operated on small streams in the vicinity of the Tower Fire, between 1965 and 1979. Table 5 includes data from these sites which can be useful in the proper sizing of culverts at road-stream crossings.

Figure 9 - Annual maximum flood series; Camas Creek, Oregon.

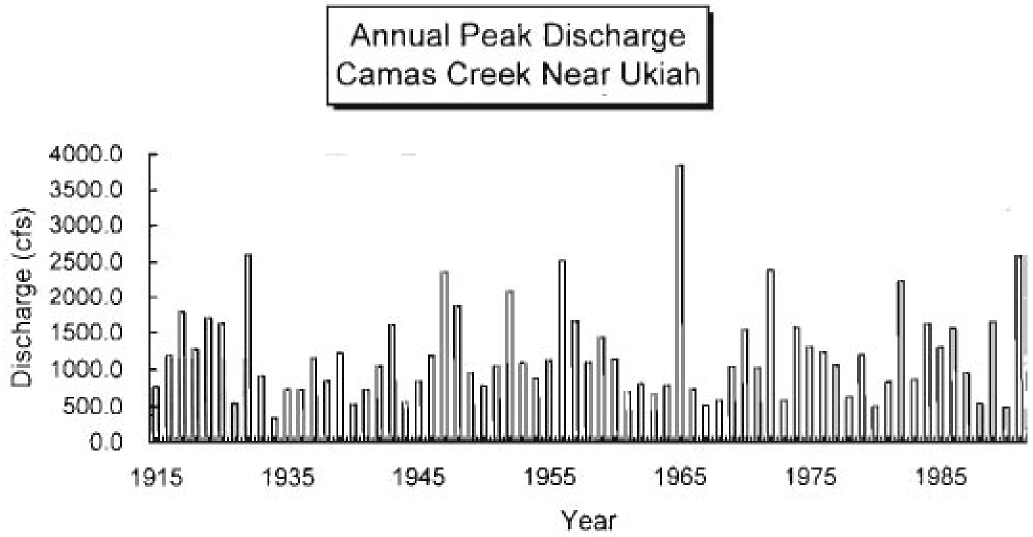


Table 5. Peak discharges recorded on small crest-gage stations in the vicinity of Tower Fire.

Gage Name	Drainage Area (mi^2)	Elevation (ft)	Period of Record	Peak of Record (cfs)	Basin Runoff (cfsm)
Granite near Dale	1.9	3740	1965-1979	66 (4/79)	34.7
Line Creek near Lehman	2.27	4065	1965-1979	90 (1/65)	39.6
Bruin Cr near Dale	4.63	4270	1969-1981	57 (4/76)	12.3

Stream Channel and Riparian Characteristics

Aquatic resources within the fire area include 321 miles of stream system classified as follows: 41 miles of Class I (anadromous fish-bearing); 11 miles of Class II (resident fish-bearing); 65 miles of Class III (perennial, non fish-bearing); and, 204 miles of Class IV (intermittent) streams. Figure 10 is a map of streams within and adjacent to the fire area.

A variety of stream types occur in the fire area from steep intermittent headwater tributaries, perennial streams draining midslope lands, to a section of the North Fork of the John Day River. Stream channels can also be described in terms of their process and function as the watershed's transportation and delivery system of erosion and organic products. In the Tower Fire there are *Source, Transport,* and *Response* stream types (Montgomery and Buffington, 1993). Distinguishing characteristics include aspect, elevation, valley confinement, gradient0, substrate, and riparian vegetation. Headwater channels, in higher precipitation zones, are source areas for water, sediment, and organic materials; steep tributaries transport erosion products to the main river. The North Fork John Day River within the fire area, a response reach, has a modest floodplain, approximately 300 feet wide, with valley fills that were dredged for gold in the early to mid part of this century.

Riparian vegetation which provides physical stability, organic inputs, and shade to stream channels, varies in the fire area with aspect, elevation, soil types and type of disturbance. Common disturbances include livestock grazing, mining, logging, floods, and fire, which chronically, in the case of livestock, or catastrophically, in the case of high intensity fire, influence species composition in streamside areas. One example of contrasting riparian-channel systems is between north-trending (Cable and Hidaway) and south-trending (Oriental and Texas Bar) streams. The ecological settings described in the Vegetation section incorporate factors such as moisture and temperature that influence plant distribution. The Cool/Moist setting, in general, occurs on the north-flowing streams where the Warm/Dry and Ponderosa Pine settings are more common on south-flowing streams. Riparian species lists contained in the Recommendations section describe native plants that would occur in each of these and other settings.

Water Quality

Beneficial Uses (as defined by the state of Oregon) of the John Day Basin include domestic and industrial water supply, irrigation, livestock watering, **anadromous fish passage, salmonid fish rearing, salmonid fish spawning, resident fish and aquatic life**, wildlife and hunting, fishing, boating, **water contact recreation**, and aesthetic quality. Highlighted uses are those most likely to be directly affected by the Tower Fire.

Water Quality Criteria and Standards most likely to be influenced by fire effects include: **habitat modification, sedimentation, and temperature**. Key indicators for evaluation of water quality effects are: streamflow, water temperature, sediment, and riparian-channel characteristics. Streamflow data are limited to major streams and rivers (Camas and NFJD). Water temperature data is available for many of the tributaries for the last 5 years. Sediment data are not readily available. Stream surveys have been conducted on some of the major tributaries so that some habitat information is available (see Aquatics report).

Water Quality Limited Water Bodies (303d streams) in the fire area were listed in the 1994/1996 Oregon update based on data supplied by the Forest from water temperature monitoring and watershed analysis (Camas Ecosystem Analysis, 1995).

Water Rights and Uses

The Forest Service holds fifty-five water rights under state permit within the Tower Fire area (39 developed ponds, 3 reservoirs, and 13 developed springs). The principle water use is livestock watering. Private water systems also occur within the fire zone. Parts of the NFJD River are designated a State Scenic Waterway, and Federal Wild and Scenic River.

Figure 10- Tower Fire - Streams

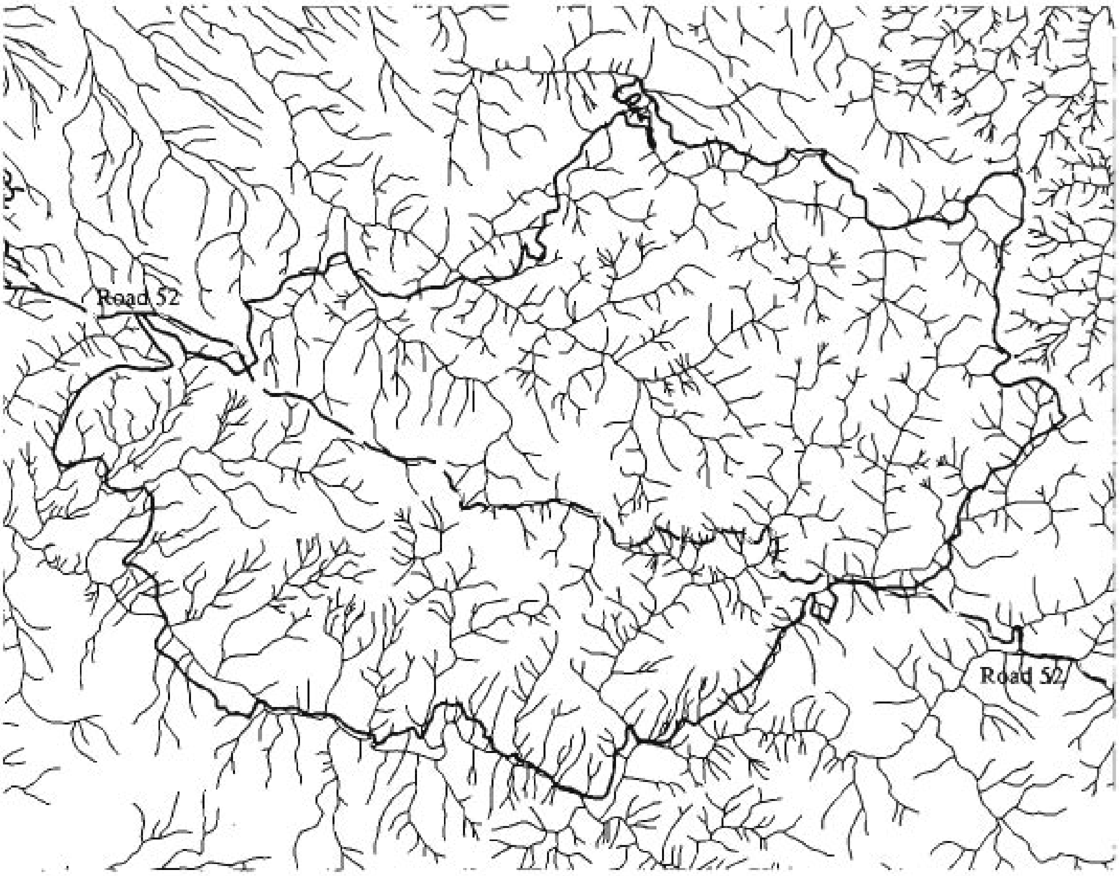


Table 6. Water Quality Limited Streams in the Tower Fire Area.

Name	Description	Parameter
Big Creek	Mouth to Headwaters	Temperature: Bull Trout - Summer
Bridge Creek	Mouth to Headwaters	Temperature - Summer
Cable Creek	Mouth to Headwaters	Habitat Modification Temperature - Summer
Hideway	Mouth to Headwaters	Habitat Modification Temperature - Summer
North Fork John Day River	Middle Fork to Granite Creek	Temperature - Summer

Vegetation

Pre-Fire Forest Cover Types

Pre-fire forest types were very diverse, largely in response to a relatively steep elevational gradient ranging from 3,000 feet near the North Fork of the John Day River at the southwestern corner of the fire perimeter to 6,850 feet at Tower Mountain lookout on the extreme eastern edge of the fire area.

Predominant forest cover types in the analysis area were combined into four major groups — dry forests, mesic forests, lodgepole pine forests, and cold forests. Selected characteristics of the forest cover type groups are provided in Table 7. The "coarse vegetation map" (Figure 11) shows the geographical distribution of the forest cover type groups.

Potential Natural Vegetation

The wide diversity of site conditions found in the Tower Fire is derived from changes in physiography (landform), topography, climate, soils, aspect, geology and other biophysical factors. Each combination of site factors results in slightly different temperature and moisture conditions. In the Tower analysis area and in other mountainous terrain, temperature and moisture tends to vary predictably with changes in elevation and slope exposure.

Since plant distributions are controlled largely by environmental factors, sites with equivalent temperature and moisture conditions will eventually support similar plant communities. Sites with the potential to support similar plant communities (associations) are called ecological settings. The plant associations in each setting are ecologically similar — they evolved in response to similar climatic and disturbance regimes, they have similar productivities, and they respond to management practices in a similar manner. Table 8 summarizes selected characteristics for the ecological settings: Figure 12 shows the geographic distribution of the ecological settings.

Potential Natural Vegetation (PNV) is valuable as an ecological template for developing management recommendations, since a particular management activity can have widely varying results when applied in different environments. For example, consider a prescribed burn with flame lengths of 2 feet and an intensity of 25 BTU/ft/sec — that practice would have nonlethal results when used in warm dry environments dominated by thick-barked ponderosa pines, Douglas-firs, and western larches, but would cause significant tree mortality on cold dry sites supporting subalpine fir and other thin-barked species.

Table 7: Characterization of pre-fire forest types for the Tower analysis area.

FOREST COVER TYPE GROUP	PREDOMINANT COVER TYPES	ECOLOGICAL SETTINGS	PERCENT OF FIRE AREA
Dry Forest	**PP, DF**	**PP, WD**	**23%**
Mesic Forest	**GF, Mixed, WL, WP**	**WD, CM**	**44%**
Lodgepole Pine	**LP**	**CM, LP, CD**	**27%**
Cold Forest	**AF, ES**	**CD**	**6%**

Source/Notes: Predominant cover type species codes are: PP: ponderosa pine; DF: Douglas-fir; GF: grand fir; Mixed: mixed species; WL: western larch; WP: western white pine; LP: lodgepole pine; AF: subalpine fir; and ES: Engelmann spruce. See Table 8 for a description of the ecological settings.

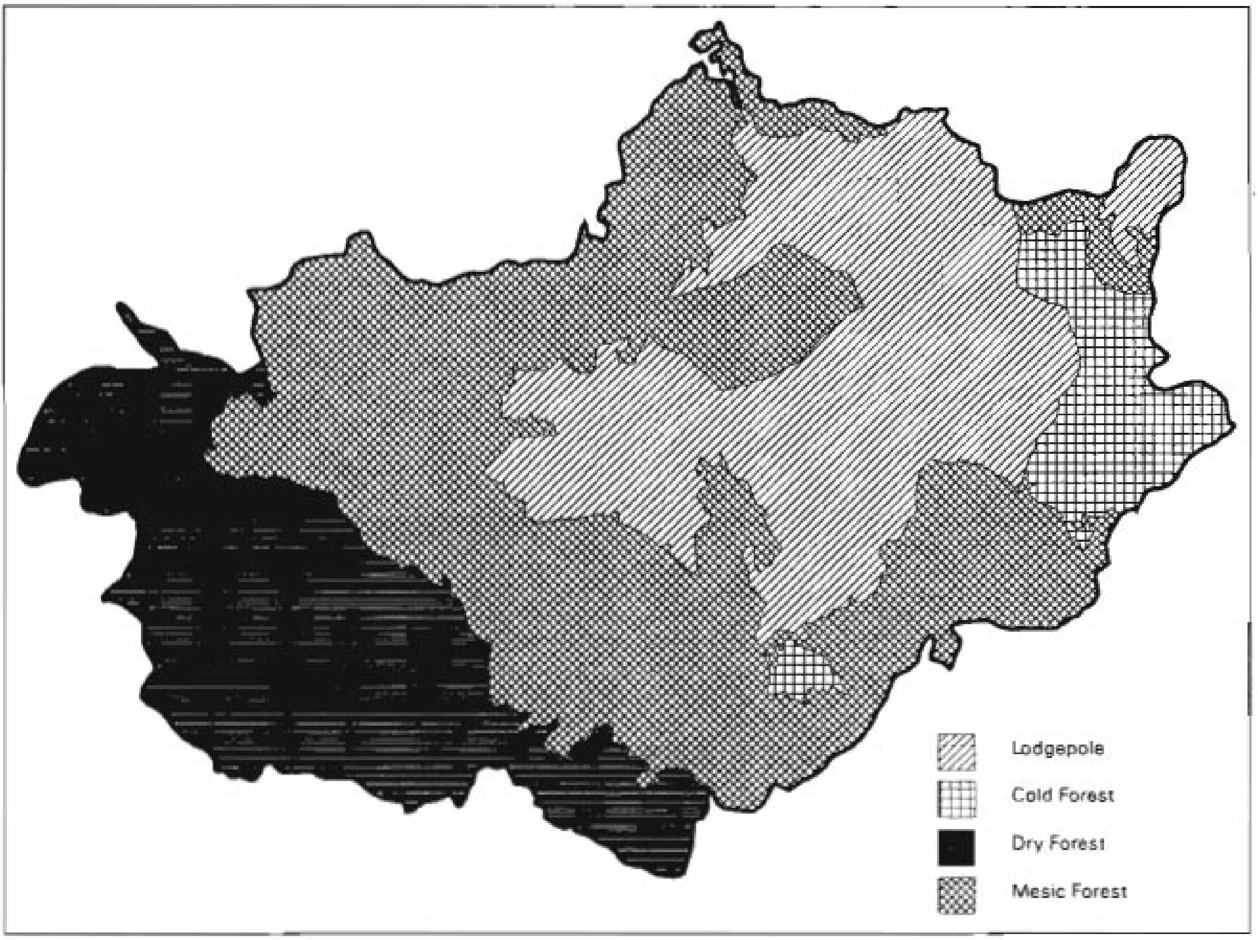


Figure 11 - Pre-existing forest vegetation types for the Tower Analysis Area. See Table 7 for information about the forest cover types that were combined to form the four groups shown above. This map portrays the geographical distribution of "generalized" groups of existing vegetation as they existed just before the fire in 1996. It is considered to be a "coarse" map because small inclusions of one group that occur within a larger one were ignored. It is not intended to depict the absolute acreage and location of the pre-fire forest cover types; rather, it was designed to show the relative abundance and distribution of the four groups using a "zonal" approach.

Table 9: Selected Characteristics For Forested Ecological Settings.

Ecological Setting	Disturbance Agents	Fire Interval	Fire Mortality	Patch Sizes	Primary Landform	Elevation Zone	Typical Aspects
Cold, Dry (CD)	Wind Insects Fire Diseases	> 100 years	> 70% of large trees	5–1,000 acres	Gentle Tablelands	High (> 5800')	North East Flat
Cool, Moist (CM)	Wind Fire Insects Diseases	26–100 years	20–70% of large trees	300–10,000 acres	Dissected Sideslopes	Moderate (4800–5800')	North East West
Warm, Dry (WD)	Fire Insects Diseases	1–25 years	0–20% of large trees	150–2,000 acres	Dissected Sideslopes	Low (< 4800')	South West
Ponderosa Pine (PP)	Fire Insects Diseases	1–25 years	0–20% of large trees	10–200 acres	Dissected Sideslopes	Low (< 4500')	South East
Lodgepole Pine (LP)	Insects Fire Diseases	> 100 years	> 70% of large trees	40–1,000 acres	Gentle Tablelands	Moderate (> 5000')	East North Flat

Sources/Notes: Fire interval and fire mortality ratings are from Agee (1993); disturbance agents, patch sizes, landforms, elevation zones, and aspects were adapted from Powell and Erickson (1996).

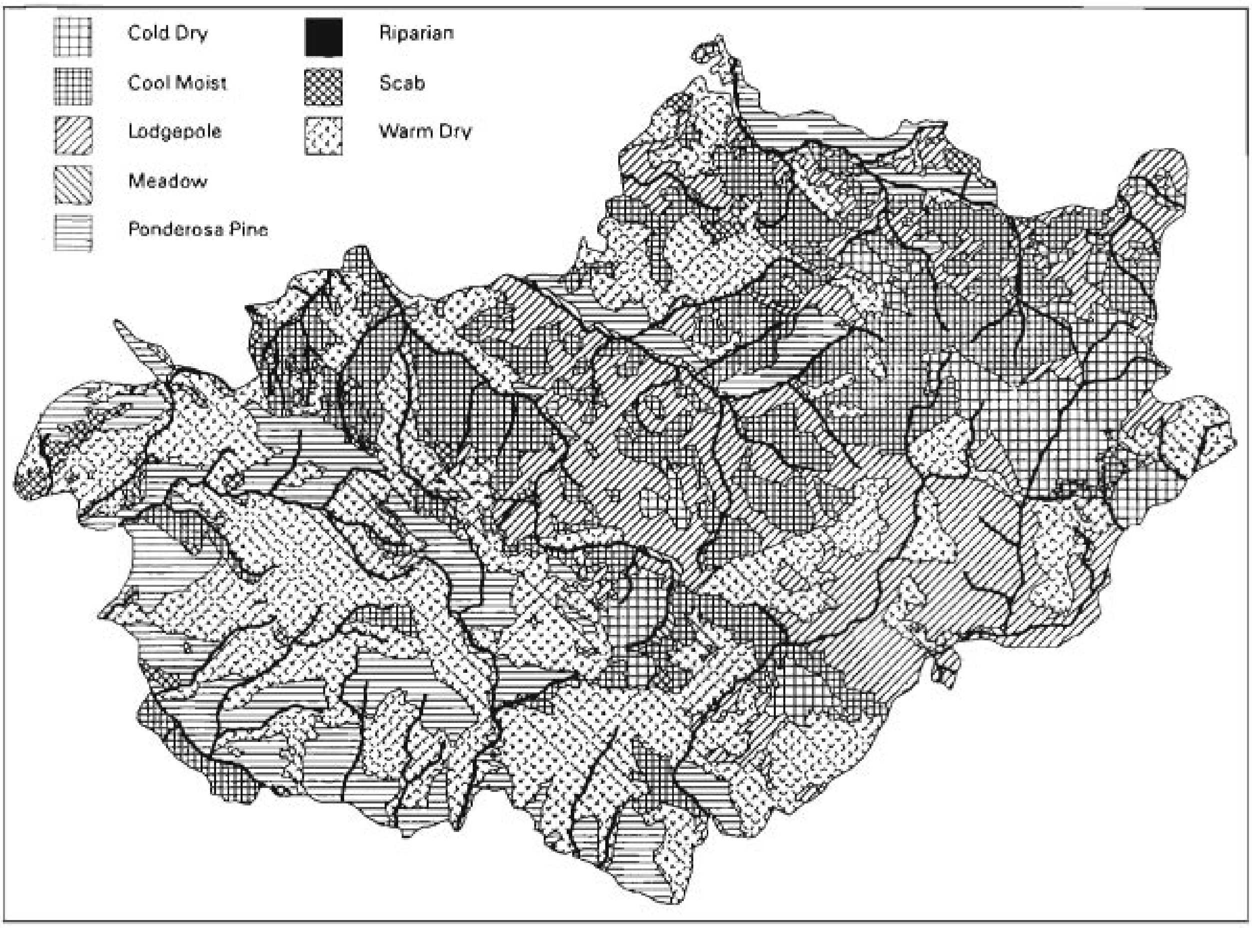


Figure 12- Potential natural vegetation (PNV) of the Tower analysis area This map shows the ecological settings present in the analysis area, including 5 forested settings and 3 nonforest settings (map prepared by Karl Urban, Forest Botanist for the Umatilla National Forest). PNV was used when developing recommendations

Effects of Fire Suppression

The effects of fire suppression in low-elevation forests were eventually dramatic. Multi-storied stands of shade-tolerant conifers became established, often at high densities. Thick layers of organic matter accumulated beneath the invading fir trees, tying up nitrogen and other nutrients that are cycled slowly without fire. Little natural mortality occurred, and the trees that died were usually the small pines and larches that succumb to suppression before the firs. Fuels accumulated at a rapid rate. Herbage production declined substantially, affecting both native and introduced ungulates

The policy of fire suppression failed to account for the ecological implications of a major shift in species composition. Grand fir and Douglas-fir may become established under ponderosa pine in the absence of underburning, but they may not have enough resiliency to persist over the long run, let alone survive the next drought. Perhaps the recent deterioration of forest health in the Blue Mountains is not surprising when considering the changes in vegetation composition and structure that occurred after fire was prevented from fulfilling its ecological role (Powell 1994).

Recent spruce budworm damage is just one legacy of fire suppression; perhaps more dramatic were the large wildfires that occurred in the Blue Mountains during the late 1980s and 1990s (Glacier, Snowshoe, Sheep Mountain, Buck Springs, Canal, Tepee Butte, Tower, Bull, Summit, etc.). Catastrophic fires occurred after fire suppression allowed fuel loads to reach unnatural levels, and because dense forests provide a stand structure that promotes destructive crown fires. Even though current technology allows low-intensity fires to be controlled, it is almost impossible to extinguish high-intensity wildfires in heavy fuels — they burn until the fuel is gone or until the weather changes.

Insects and Disease

Populations of bark beetles in ponderosa pine and Douglas-fir have maintained high endemic levels for several years due to a number of factors favorable to the beetles: defoliator-weakened trees, moisture stress from prolonged drought, overstocked stands, several mild winters, and a series of regularly-occurring stand-replacing fires that have provided abundant beetle habitat, among others.

Based on the 1995 aerial insect detection survey, Douglas-fir beetle (*Dendroctonus pseudotsugae*) populations were high throughout the area of the Tower Fire. No bark beetle populations in ponderosa pine were recorded from the aerial survey of this area in 1995. Fir engraver (*Scolytus ventralis*) populations also occurred in several scattered centers over the area where the fire occurred, prior to the fire, but these were relatively minor compared to the Douglas-fir beetles in 1995. The 1996 aerial survey occurred August 19-30, 1996, so the overlap with the dates of occurrence of the fire limited the extent to which insect populations could be mapped in the vicinity of the fire due to visibility problems and limited use of airspace during air operations on the fire.

A portion of the north Tower Fire Analysis Area was reviewed in 1994 for insect and disease problems Grand fir and Douglas-fir in this area were generally severely damaged by western spruce budworm (*Choristoneura occidentalis*), and subsequent infestation by bark beetles induced mortality. Heavy down lodgepole pine fuels had been in place as a result of the 1970's mountain pine beetle (*Dendroctonus ponderosae*) epidemic.

Armillaria root disease (*Armillaria ostoyae*) was noted in stands that constitute the northern Tower Fire Analysis Area. The presence of Armillaria will dictate how these stands regenerate to conifers. Since many of these stands had previously been partial cut and skidded using cats, soil compaction was noted as being often severe. Soil damage is a major contributing factor in Armillaria virulence.

Stands in the vicinity of Roads 5448 and 5448-010 experienced considerable western spruce budworm defoliation from the most recent outbreak (1980-1993). Budworm topkill in grand fir and Douglas-fir, and understory mortality in the suppressed true fir component were evident throughout the area. In addition, dead Douglas-fir and grand fir trees of all sizes occurred scattered over the area from a combination of budworm, bark beetles (Douglas-fir beetle and fir engraver beetle), Armillaria root disease, and drought stress. Douglas-fir beetles killed many of the root diseased Douglas-firs, and fir engraver killed similarly-infected grand firs in these stands prior to the fire.

Fire/Fuels

When the Tower Analysis Area is assessed for fire and fuels concerns in the immediate future it is commonly thought that the concerns associated with high fuels loads or dense multistoried forest structure are no longer at issue. This is partially correct: most available fuel has been consumed by the wildfire, and in areas of moderate to high intensity burning the multistoried forest structure is gone. The issue now is how to implement management and recovery projects needed to avoid a situation that promotes the development of crown fires over such an extensive area.

How a future forested setting may react to fire is largely dependent on the natural fire disturbance regimes involved. Fire regimes are generally defined by some combination of fire intensity and frequency. For natural fire regimes this is defined in a historical sense, generally pre-1900's (Agee, 1996). Agee (1996), identifies a generalized system for classifying fire regimes into high, moderate, and low categories of fire severity (although this system uses similar naming structure, it is not the same system as defined by the Burned Area Emergency Rehabilitation process). Low severity fire regimes typically had low intensity, frequent fires. High severity fire regimes had infrequent, but stand replacing fires, and the moderate severity fire regimes (also called mixed severity) had complex combinations of high, low, and moderate severity fires.

There is generally a strong correlation between Potential Vegetation Groups and natural (historic) fire regimes across the Tower Fire area Due to the relative constancy of climatic conditions and physical characteristics of the sites, as well as the plant species likely to occur within these plant association groups. The five groups of forested vegetation identified in this analysis display the three generalized fire regimes discussed above. Low severity fire regimes are likely to dominate the Warm/Dry and Ponderosa Pine Vegetation Groups, while high severity fire regimes will dominate the Cold/Dry and Lodgepole pine Vegetation Groups. The Cool/Moist association will reflect the more complex moderate severity fire regime.

The low severity fire regime for the Tower analysis area is expected to have naturally been present on approximately 24,056 acres or 47.1 percent of the area. A fire history study done in the Blue Mountains in 1994 specifically identifying sites in the warm/dry potential vegetation groups located a study plot near the Tower analysis area. This study indicated a mean fire return interval of 9.9 years, in a Douglas-fir/pine grass plant association, with a fire return interval range of 3-20 years (Maruoka, 1994). Because of the frequent fire return interval naturally inherent to the dry forests of the ponderosa and warm/dry potential vegetation groups these stands have been impacted most with the advent of fire suppression. With an average fire return interval of approximately 10 years it is likely that these stands have missed 5-8 fire return events that would have modified the vegetation composition of the forest as well as modifying the vertical continuity of the fuels.

The moderate severity fire regime is expected to have naturally occurred on approximately acres 10,828 or 21.3 percent of the area. The more complex moderate fire regime results in a wide range of years in the mean fire return interval. Arno (1980) indicated a range of 25-250 years in the grand fir stands in the northern Rocky Mountains. In a fire history study closer to the Tower Analysis Area, Bork (unpublished) found mean return intervals of 50-200 years in grand fir stands. The wide variation is generally considered to be the result of topographic settings and aspect that modify the fire regime within these more mesic sites. What would be likely in this fire regime is a mosaic of seral stages, stand compositions and stand densities. Although many stands within this group would be highly susceptible to crown fire, discontinuities in stand structure and composition would limit the extent of these events. Management practices such as total fire suppression without an offsetting prescribed fire program and harvest practices that favor shade tolerant species such as grand fir have created a landscape continuity of densely stocked stands highly susceptible to insects, disease, and stand-replacing fire. In many cases fire intensities and the potential extent of these fires are increased due to insects and/or disease mortality increasing the amounts of available fuel.

The high severity fire regimes for the Tower analysis area is expected to have naturally occurred on approximately 13,737 acres or 27.0 percent of the area. These areas are probably the least impacted due to past management practices as the fire return intervals were naturally long and when fire did occur in was often stand replacing even if the fire intensities were not that great because of the lack of resistance to fire in the tree species found in these areas, eg., subalpine fir, lodgepole pine, and Engelmann spruce. Mean fire return intervals of 75-300 years is likely and wide variety of age classes in discernible areas across the landscape are likely results. The impacts of management are limited here but continuing to suppress all fires without some other means to create new "large" scale patterns of varying age classes and seral stages will likely result in stand replacing fires becoming more extensive then in a historic fire regime.

Floristic Biodiversity

The Tower Fire of August and September 1996 impacted vegetation in all of the "ecological settings" (or plant association groups) used in watershed analysis on the Umatilla National Forest. Approximately 95 percent of the area encompassed by the fire had been subjected to botanical surveys between 1990 and August, 1996. The floristic biodiversity components of the Tower Fire Ecosystem Analysis include an analysis of floristic richness and composition, historically- and presently-listed sensitive plant species, culturally-significant (food) plant species, and noxious weeds in pre-fire and post-fire periods. Opportunities to utilize this information in restoration activities are discussed in the recommendations section. Lists of all (native and introduced) vascular plant species encountered in the analysis area and lists of native species found in each of the ecological settings are provided in appropriate appendices.

As noted previously, the fire zone straddles a prominent physiographic feature called Pearson Ridge between Camas Creek on the north and the North Fork of the John Day River on the south. Microhabitats for plant species of the fire zone show considerable contrast between the north-facing slopes and south-facing slopes of Pearson Ridge. The forested portions of the north slopes are decidedly more mesic than the south slopes. This aspect-driven moisture gradient creates differences not only in the dominant tree species of the north and south slopes but differences in the non-arborescent (non-tree) vegetation as well. A general ecological treatment of the vegetation of the Blue Mountains within the context of floristic composition, forest diseases, and fire ecology is found in Franklin and Dyrness (1988). The floristic biodiversity portion of this analysis focuses primarily on the non-arborescent vegetation in its pre-fire and post-fire condition.

Floristic Richness

Prior to the Tower Fire, 705 vascular plant species had been documented in botanical surveys within the fire zone. This represents 72 percent of the 975 vascular plant species that are known to occur on the North Fork John Day Ranger District and 53 percent of the 1,323 plant species with documented occurrences on the Umatilla National Forest through August, 1996. All of the vascular plant species of the Tower Fire zone occur elsewhere on the Umatilla National Forest. None of the 705 vascular plant species occur solely in the area that was impacted by the Tower Fire.

Within the Tower Fire Analysis Area, pre-fire vegetative composition was consistent with similar characteristics of watersheds of the Umatilla National Forest on which the same type of analysis has been conducted. Analysis of floristic biodiversity has been completed for Camas Creek (1994), Wall Creek (1995), Asotin Creek (1995), Umatilla River (1996), and Meacham Creek (1996). When categorized by life form, the 705 species are as follows: 15 trees (14 native), 70 shrubs (69 native), 495 forbs (440 native), 85 grasses (54 native), and 40 grass-likes (40 native). The overall ratio of native species to introduced species is 87.5 percent to 12.5 percent. Greatest departure from the Forest-wide ratio of native to introduced species occurs among the grasses of the Tower Fire Zone. Sixty-four percent of the grasses are native (to North America) and 36 percent of the grasses are introduced.

Plant species native to the eight ecological settings are listed in Appendix D.

Culturally-significant (Food) Plants

Based upon published accounts (Fowler, 1992, and Murphey, 1959) of plants used as foods by Native Americans, fifty-six culturally-significant food plant species occurred in the Tower Fire Analysis Area prior to the fire of 1996. This represents 82 percent of the culturally-significant plant species that have been documented on the North Fork John Day Ranger District and 71 percent of the culturally-significant plant species that have been documented in botanical surveys across the Umatilla National Forest.

Noxious Weeds

Thirteen species of noxious weeds were documented in botanical surveys of the Tower Fire Analysis Area prior to the fire. This compares with 25 noxious weed species at the District level and 36 noxious weed species at the Forest level.

Historically-listed and Presently-listed "Sensitive" Plant Species

Within the Tower Fire Analysis Area occur twenty-two plant species with status as historically-listed as "sensitive" on the Region 6 Regional Forester's Sensitive Plant Species List. A single plant species of the Fire Zone has status as "presently-listed as sensitive." This species is *Botrychium minganense*, Mingan Grapefern. Within the context of similar categories, on the North Fork John Day Ranger District, 38 plant species have status as "historically-listed" and 7 plant species have status as presently-listed as "sensitive" within the state of Oregon. From a Forest-wide perspective (which includes different status between the Oregon portion of the Forest and the Washington portion of the

Forest), thirty-six plant species have "historically-listed sensitive" status and twenty-eight plant species have "presently-listed sensitive" status. These pre-fire statistics provide a basis for answering questions about potential re-listing of the historically-listed sensitive species because of the impact of the Tower Fire and management activities associated with it.

Fish and Aquatic Habitat

The area encompassed by the Tower Fire boundary is in the John Day River basin and in fact is almost entirely within the North Fork of the John Day River subbasin. The John Day River Subbasin supports the largest remaining wild stock of spring Chinook salmon *(Oncorhynchus tshawytscha)* in the Columbia Basin. The North Fork John Day River and its tributaries account for about 70 percent of the salmon production in the subbasin. The John Day River basin once supported substantial runs of both spring and fall Chinook salmon and summer steelhead (*Oncorhynchus mykiss*). Fall Chinook now appear extinct and spring Chinook runs have declined to between 2000 and 5000 fish. Recent steelhead runs have averaged from 15,000 to 40,000 fish (Northwest Power Planning Council, 1989). Bull trout (*Salvelinus confluentis*) also utilize this river system.

The Umatilla National Forest Land and Resource Management Plan (1990) classifies slightly more than half of the area within the boundaries of the Tower Fire Analysis Areas as C-7, "Special Fish Management Area." The Forest Plan defines the management goal for this management area as:

> "Maintain and enhance water quality and produce high levels of anadromous fish habitat on an area-wide basis."

The Forest Plan designates much of the remaining land within the fire boundary as either or B-1 (Wilderness), C-1 (Dedicated Old Growth) areas. Most of the perennial streams within the fire boundary are within C-7 or B-1 management areas.

The fire boundary encloses parts of 6 watersheds and 13 subwatersheds. The area included within the boundaries of the Tower Fire Analysis Area contains 321.5 miles of streams, of which 117.4 are perennial, 52.5 fish bearing and 41.4 anadromous. The distribution of these between stream classes and fire intensity is given in Table 9. The 9.3 miles of Class I and II streams within areas that burned at high intensity are of particular interest from the fisheries perspective since these are the areas where fish were most likely directly and severely affected by the fire. Long-term damaging effects may extend to areas burned at moderate intensity and to Class III and to a lesser extent, Class IV streams. Appendix F contains a breakdown of burn intensity by stream class and subwatershed.

Table 9. Stream Miles by Burn Intensity and Stream Class

	Burn Intensity			
Stream Class	Low	Moderate	High	Totals
I	23.3	11	7.1	41.4
II	6.7	2.2	2.2	11.1
III	33.7	21.1	10.1	64.9
IV	116.2	61.5	26.4	204.1
Totals	179.9	95.8	45.8	321.5

Analysis of fish and aquatic resources focused primarily on the streams within the boundary of the fire and secondarily on reaches immediately downstream of the fire. It will not cover the entirety of any of the watersheds affected by the fire. This study should not, therefore, be referred to as a "watershed analysis," but rather as an ecosystem analysis at the landscape scale. It will utilize most of the methodology of watershed analysis, the exception being the geographic boundaries of the analysis area.

Terrestrial Wildlife

Habitat

Approximately, 3,650 acres of Management Area C4, Wildlife Habitat Emphasis occur within the Tower Fire. Management objectives are directed at maintaining habitat effectiveness and quality for big game and other wildlife species. In addition emphasis is placed on retention and protection of unique wildlife habitats and key use areas within the unit.

Two hundred twenty-three (223) acres of Big Game Winter Range (C3) occur in the Tower area. Land and Resource Management Plan, Umatilla National Forest (LRMPUNF p. 4-151) objectives for the management area emphasize management toward high levels of potential habitat effectiveness and quality forage for big game species. Emphasis is on low road densities and minimal disturbance from human activity.

The Riparian Wildlife (C5) management area in the Tower Fire contains about 117 acres. The goal in the LRMPUNF for this area (p. 4-163) is to maintain or enhance water quality and to provide a high level of potential habitat capability for all species within the riparian habitat area. In addition, the area should provide a high level of habitat effectiveness for big game.

Only 12 acres of management area E2, Timber and Big Game Winter Range, occur in the Tower burn. The LRMPUNF emphasis (p. 4-182) is to manage for the production of wood fiber, encourage forage production, and maintain a moderate level of big game and other wildlife habitats.

There are eight (8) ecological settings in the Tower analysis area. They include ponderosa pine, warm-dry forest, cool-moist forest, lodgepole pine, cold-dry forest, meadow/scabland, riparian/wetland, and rock/talus. The settings with limited availability include ponderosa pine

(14%), cold-dry forest (7%), meadow/scabland (2%), riparian/wetland (4%), and rock/talus (<1%).

Species

Management Indicator Species

All of the Forest Management Indicator Species (MIS) probably occurred in the area prior to the fire. The current list includes pileated woodpecker, Rocky Mountain Elk, mule deer, primary cavity excavators, American marten, northern three-toed woodpecker.

Threatened, Endangered, and Sensitive Species

Suitable nesting habitat for the threatened bald eagle occurs along the North Fork John Day River (along the southern boundary of the fire); however, no nesting bald eagles have been observed on the District. This species is known to winter along the North Fork John Day River (along the southern boundary of the fire). These eagles frequent the uplands, foraging on carrion or small mammals. Upland habitat within the fire was likely used infrequently for perching during foraging activity and for night roosting when food supplies were available (Kronner 1996).

Suitable nesting habitat for the threatened peregrine falcon is not present within the Tower Fire area. No active nests have been documented on the District, but nesting activity is suspected at a few select locations on the District. The Tower Fire and vicinity could be used as foraging habitat as individuals migrate through the area (Kronner 1996).

Townsend's big-eared bat, a Region 6 Sensitive Species ("Sensitive" species), may use large hollow trees, crevice trees, snags, cliffs, and rock outcropping within the fire zone as temporary day or night roosting habitat for individuals. This mammal is likely to be present elsewhere on the District, in habitats suitable for maternity colonies and winter hibernaculums. This habitat can be found near the town of Granite, where abandoned mines may provide habitat. One record of one individual was detected using an echolocation recording device approximately 13 miles southeast of the fire area (Kronner 1996).

The "Sensitive" species, Preble's shrew, has not been detected on the District. Results of survey efforts and habitat assessments within the fire zone indicated this species is not likely to occur within or adjacent to the Tower Fire (Kronner 1996).

The "Sensitive" species, California wolverine, is suspected to occur on the District and has a moderate to high potential for occurrence in the Tower Fire area. Surveys conducted on the District over the past few years have not detected their presence or signs of their activities. The fire area could serve as potential foraging habitat for the species. A thorough assessment of the burn for potential denning habitat has not been conducted (Kronner 1996).

All "listed" species that have the potential to occur in the Tower Fire area are identified in Table 10. The list includes U.S. Fish and Wildlife Service Threatened and Endangered species, Regional Forester's Sensitive Species (R-6), and Rare, Threatened, and Endangered Animals of Oregon (Oregon Natural Heritage Program, 1995).

Table 10. U.S. Fish and Wildlife Service "Listed" species (ONHP, 1995), Regional Forester's Sensitive species, and Rare, Threatened and Endangered Animals of Oregon (ONHP, 1995) that could potentially occur in the Tower Fire area.

Species	U.S. Fish and Wildlife Service	Regional Forester's Sensitive (R-6)	State Status (Oregon)
western toad			Sensitive-Vulnerable
tailed frog	Concern		Sensitive-Vulnerable
spotted frog	Candidate/Concern		Sensitive-Undetermined
bald eagle	Threatened	Sensitive	Threatened
peregrine falcon	Threatened	Sensitive	Endangered
white-headed woodpecker			Sensitive-Critical
three-toed woodpecker			Sensitive-Critical
black-backed woodpecker			Sensitive-Critical
long-eared myotis	Concern		Sensitive-Undetermined
fringed myotis	Concern		Sensitive-Vulnerable
long-legged myotis	Concern		Sensitive-Vulnerable
western small-footed myotis	Concern		Sensitive-Undetermined
silver-haired bat			Sensitive-Undetermined
Townsend's big-eared bat	Concern	Sensitive	Sensitive-Critical
marten			Sensitive-Vulnerable
wolverine	Concern	Sensitive	Threatened

Heritage Resources

All National Forest System lands within the Tower Fire Analysis Area, outside of wilderness and roadless areas, have been inventoried for heritage resources during four large planning area surveys. These inventories include: Oriental/Juniper, 1993; Turner Otter, 1992; South Half Bughunter, 1993; and South Half Bughunter Addendum, 1993. During these inventories, 14 heritage properties were located, one of which contained both an historic and aboriginal component. They include a telecommunication line, a stock driveway, 3 salt log troughs, an historic foundation, 4 log cabins, 2 historic trash scatters, an historic ditch, 2 aboriginal lithic scatters and the Pearson Guard Station.

In addition, the Forest has been informed, in a general way, of several other areas of aboriginal and present day use by members of the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). These areas include two trails utilized to go from the Pearson Creek area to the North Fork John Day, the Granite and Clear Creek areas, and on to Sumpter. Several other areas have been identified as areas utilized for hunting, food gathering, berry picking, and camp spots.

Recreation / Wilderness / Minerals

Located in the Tower Fire Analysis Area are the Tower Unit, and a portion of the North Fork John Day Unit, of the North Fork John Day Wilderness. The analysis area also encompasses the South Fork-Tower Roadless Area (RARE II), and a large portion of the Winom-Frazier Off-Highway Vehicle (OHV) Complex. Seventy-one miles of trail and 11 trail bridges are located in this area.

Private structures, administrative sites, and recreation facilities within the Tower Fire include the Pearson recreation residence tract, ten active mining claims, Pearson guard station, Tower Mountain lookout and cabin, Winom campground, Big Creek Meadows forest camp, seven trailheads, approximately 300 dispersed campsites, and 8 miles of the North Fork John Day Wild and Scenic River.

General recreational use within the Tower Fire Analysis Area is a major portion of the use which occurs on the North Fork John Day Ranger District; this is a very popular summer recreation area, and one of the most popular areas for fall hunting seasons. The Winom-Frazier OHV Complex is partially within the Tower Fire; this is a very popular and high-use motorized trail system from June through September, and has an estimated average use of 21,600 recreation visitor days (RVD's) on the trails within the fire area. Average recreational use for this entire area, excluding the motorized trail use reported above, is about 20,000 RVD's outside the Wilderness, and 11,000 RVD's in the Wilderness.

II. Issues and Key Questions

Key questions were used to focus the analysis. While answers to key questions were not always stated as such, and are not contained in a single section, all questions were addressed at some point in the analysis.

1. **Site productivity**

   Potential for erosion and mass wasting, with subsequent delivery of sediments to streams is significantly increased after fire. Severe burns can deplete site nutrient capital by transporting nutrients offsite during the fire, or during subsequent storm events that may erode soil from unvegetated slopes. Biological capacity and integrity need to be conserved or restored, while at the same time reducing hazards for future intense fires.

   Key Questions:

   a. What areas are at risk for mass movement, accelerated erosion, etc., as a result of fire, and what protection measures are needed?

   b. What changes in site productivity have occurred as a result of fire?

c. How can site/soil productivity be maintained/protected, or how can elevated risks be reduced?

2. Fisheries resource

Besides hosting bull trout and the largest remaining run of wild spring Chinook salmon in the Columbia Basin, the North Fork John Day River system is a popular salmon and steelhead fishery. This sport fishery plus the importance of these fish runs together with biological and environmental interest in the status of native, wild fish (Huntington et al 1996) assure the status of these fish populations as an important issue in the region.

Key Questions:

a. What short and long-term, direct and indirect effects will the fire have on fish habitat and populations?

b. What mitigation or enhancement measures would be most effective and appropriate to the fisheries resource?

3. Ecosystem Restoration, Terrestrial Wildlife and Habitats

Although fire is a normal component of the ecosystem, burn intensity in many areas may have been more severe than would normally occur because of unnaturally high fuel levels. Some resources and ecosystem processes may be at risk because of disturbance outside their natural range of variability. For example, late/old forest lost in the fire cannot be replaced within the fire area for a century or more. While some believe these areas may benefit from human intervention, others believe there is no ecologically-based need for human intervention after a fire.

Key Questions:

a. How has fire affected roads, trails, plantations?

b. What restoration opportunities exist?

c. How and where should C1 and C2 management areas, and the Camas old growth network be replaced?

d. How should partially burned areas be managed?

e. What resource or habitat values need to be retained/protected?

f. How should vegetation conditions and patterns be restored so as to be more ecologically sustainable?

g. What areas are at risk for insect, disease, and/or noxious weed infestations?

h. What terrestrial and/or aquatic species have been extirpated from the fire area (if any), or are at risk because of fire caused changes?

4. **Fuel loading**

Although a fire has just occurred, concern over a reburn in the not-too-distant future is high. Standing dead trees will soon begin falling. Over the next several years, falling dead trees, in combination with vegetation regrowth will gradually increase fuel levels.

Key Questions:

a. What are the natural ranges of fuel loadings by vegetation group?

b. Where are fuel loadings currently outside the natural ranges, or where in the near future are they expected to exceed their natural ranges?

c. What fuels treatments are needed to restore appropriate fire regimes across the landscape?

d. What areas require additional protection needs, e.g., private lands, facilities, plantations?

5. **Salvage**

Opportunities exist to harvest dead/dying trees, thereby capturing economic value, and supplying raw material to local mills. However, some believe the ecosystem has already been adversely impacted by past harvest activities, road construction, etc., and that salvage harvest is another negative impact.

Key Questions:

a. What areas are suitable for salvage harvest?

b. Where are riparian areas that meet the six criteria in Riparian Guidelines, thus being suitable for salvage harvest?

c. What areas are expected to produce economically viable salvage sales, and what logging systems would be most appropriate?

6. **Water Quantity and Quality**

Fire effects on watershed function (hillslope hydrology, erosion processes and rates, channel response) are dependent on fire intensity, burn pattern, and watershed characteristics. The following effects from large wildfires in forested landscapes have been documented in the Pacific Northwest and may be expected in the Tower Fire Analysis Area: increased soil moisture; increased water yields and peak flows; increased surface erosion rates and mass wasting events; increased sediment and nutrient loads in streams; increased bank erosion, localized deposition and channel scour, and elevated water temperatures. The magnitude and duration of these effects will vary with climatic conditions, watershed response (vegetation recovery), and management activities (restoration and salvage).

Key Questions

a. What areas are most at risk of increased peak flows, erosion, sedimentation, and channel response?

b. How will fire affect water quality especially those water bodies currently listed as Water Quality Limited (303d streams)?

c. What actions would be most effective in reducing adverse fire effects and effects of salvage logging that may occur?

III. Current Conditions

Soils and Geology

Erosion/Mass Wasting

Figure 3 shows the BAER Burn Intensity Map. This map was developed during the Burned Area Emergency Rehabilitation (BAER) process for the Tower Fire. Criteria used in determination of burn intensity followed BAER.

The moderate and high intensity burn areas will be closest to realizing the erosion potential risk given the high rates of consumption of vegetative materials including most of the tree canopy in the majority of the high and moderate areas. This is not to say that extensive erosion will necessarily occur. Fortunately, most of the areas with complete or nearly complete consumption of all live protective vegetation have significant amounts of down (and standing) trees/logs remaining to impede erosion if overland flow should occur.

Figure 13 is a map of the Tower Fire erosion potential. This assessment was developed using SRI interpretations for surface erosion potential in combination with the Burn Intensity map.

Post -fire assessment during the BAER process indicated little wide-spread increases in non-wettability or hydrophobicity resulting from the fire, despite high burn intensity in many places. Experience of the Forest Soil Scientist and others (Geist 1996) shows considerable natural water repellency of dry volcanic ash soils typical of the Umatilla National Forest. Increases or changes in wettability properties of the dry ash soils are therefore difficult to detect, though it does and has occurred (Geist 1996).

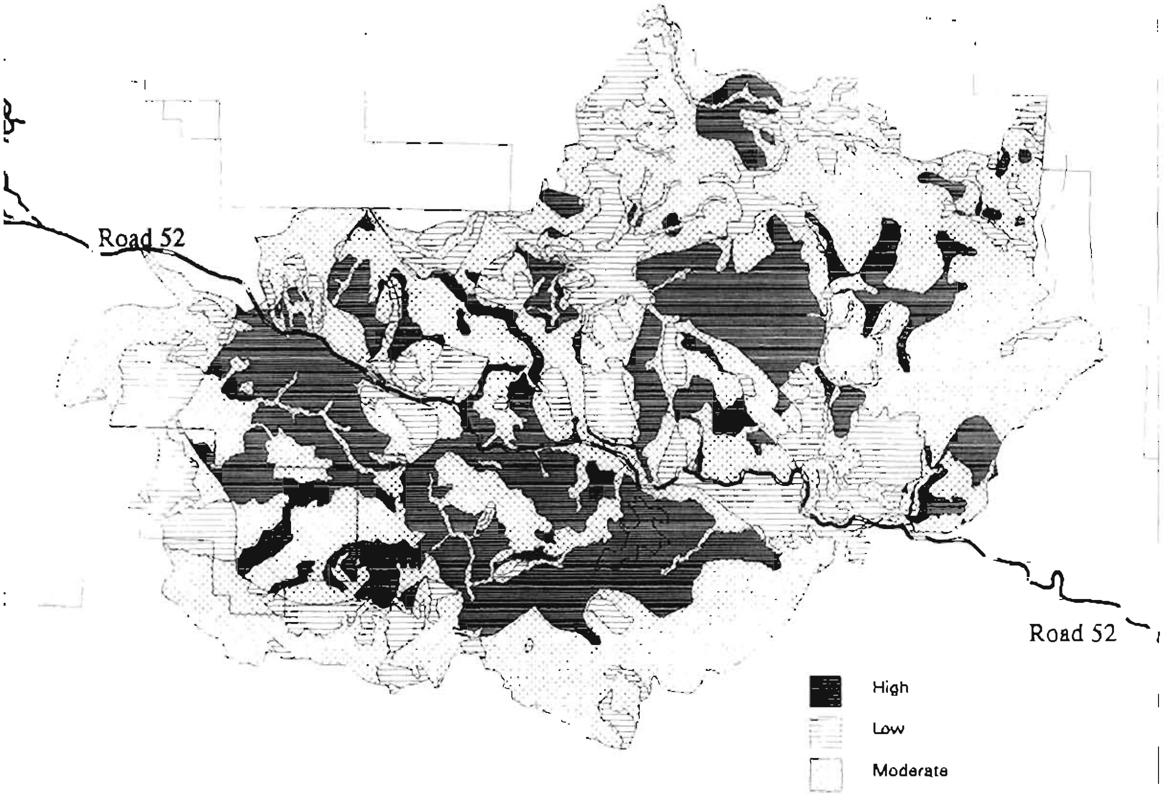
Experience with other fires in this area (the Boundary Fire of 1994 in particular) has shown that, in the absence of extreme climatic events, large-scale soil erosion should be limited (and the erosion *potential* unrealized). However, we cannot assume that we will not experience intense runoff events and should plan and conduct activities and protection measures as if we will. The *risk* of erosion is quite real.

Silt and fine sand size soil particles were windblown during and immediately after the fire in the more severe intensity areas and mixed with the surface fire ash. Some of this fire ash and soil mix on the surface can be expected to be carried into stream courses even under average precipitation conditions. There will likely be some localized rilling and possible small gully formation in specific locales where flow concentrates (natural channels, road culvert outflow points, etc.) and there is inadequate resistant substrate. A large thunderstorm or rapid snow melt, in the first year especially, would exacerbate this.

Given the fires occurrence and intensity, any landslide activity that might occur will likely do so now regardless of any additional activity we might undertake. The complete removal of the vegetative component, including death of trees and their root strength, will allow saturation conditions sufficient to release any readily unstable areas. Significant road building would be the one activity that could create some instability problems if it were to involve large cuts in colluvium, or in the toe of older slumps. This can be avoided with proper location and design.

Refer to Figure 14 for a flow chart illustration fire effects on vegetation, soil properties, hydrology, and geomorphic processes.

Figure 13 - Tower Fire Erosion Potential



Productivity

High burn intensity areas experienced a significant loss of nutrient capital due to the consumption of organics from the surface (and just below) and all vegetation (except for bole material containing few nutrients). Nitrogen loss in particular is expected to be very significant - as much as 97 percent of the nitrogen originally in the forest floor may have been lost in high severity areas (Grier 1975). Moderate severity burns experienced somewhat less of a nutrient capitol loss, but have lost the organics above the duff level essentially the same as the high severity areas. Low severity areas are highly variable but such areas generally do not experience significant loss of nutrients (Harvey et al 1989).

The impact on soil organisms is also quite variable, but it can be assumed that high intensity areas have had significant loss of soil biota.

Soil heating may affect microorganisms by either killing them directly or altering reproductive capabilities. Indirectly, soil heating alters organic matter and increases nutrient availability, thereby affecting subsequent microbial growth. The impact on soil organisms is also difficult to determine but it can be assumed that high severity areas have had large loss of soil biota.

Losses in moderate and low severity areas will vary considerably depending on duration of heating, maximum temperatures, and soil water content (DeBano 1991). Low burn severity areas should have relatively little negative effect on microbes. The increased availability of nutrients (from light burning) may have an enhancing effect where microbes were only lightly heated or unaffected.

Watershed Hydrology

Generalized Fire Effects

Fires are effective in altering vegetation and soil characteristics and can cause changes in the hydrology and geomorphic response of watersheds (Figure 14). Canopy loss and tree mortality reduces interception and evapotranspiration which leads to increased soil moisture. The blackened forest and increased openings may also change snow accumulation and melt rates (changed surface reflectance and snow drift. Effects of reduced evapotranspiration may be further complicated by increased overland flow caused by loss of litter and hydrophobic soils. These effects directly impact runoff and erosion rates. Increased water yields and peak flows after forest fire have been described in a number of studies (Swanson, 1978, Helvey, 1980).

Increased upland erosion following fire results from a variety of mechanisms including loss of organic layer, root strength, change in soil properties, increased depth of freeze-thaw (loss of insulating cover). These factors increase surface erosion (rilling and gullying) and mass failures such as debris flows and slides (Helvey, 1980). Increased delivery of sediment to stream channels may cause channel response such as aggradation or downcutting. Where fires burned streamside vegetation, loss of root strength may result in channel bank erosion. These effects may be offset over time by increased inputs of large wood into the active channel, which will act as storage sites for sediment.

The magnitude and type of geomorphic response depends on watershed characteristics, burn type and pattern, and post-fire climate conditions. Unusual climatic events following fire will result in more dramatic runoff and erosion. Overall, fire effects on hydrology and erosion rates diminish in subsequent years as vegetation is reestablished.

Role of Fire in Ecosystem (Hydrology Perspective)

Fire is the dominant disturbance process in the Blue Mountains which periodically alters vegetation patterns, soil properties, and hillslope hydrology, and may cause stream channel adjustments and changes in water quality. Landforms, weather patterns, and management activities (fire control, timber harvest, and grazing) in turn influence the frequency, extent, and magnitude of fire occurrence. Over the short term (seasons to years) wildfires are generally considered negative because of increased erosion (loss of productivity, stream sedimentation, effects to aquatic habitat and water quality. Over the long term, fires can be considered an important component of landscape evolution by altering soil properties, patterns of vegetation, and even valley form (Swanson, 1978).

Condition Assessment

The fire burned within portions of six Umatilla NFS watersheds. The percent of the watershed within the fire perimeter varies from less than a percent for two watersheds to 68 percent of the Cable Creek watershed (Table 11).

Table 11. Watersheds and Acres Burned.

NFS Watershed #	Watershed Name	Acres in WS	Acres in Fire Area	Percent WS in Fire Area
85	Upper Grande Ronde/Fly	36184	32	<1
33	Cable Creek	24272	16441	68
34	Bridge/Pine	34151	126	<1
35	NFJD	67063	15668	23
95	Big	38807	12404	32
96	Hidaway	19202	6146	32
Total	-	219679	50818	23

Loss of foliar vegetation, surface litter, and the soil humus layer varies across the burned area. In areas of high intensity burn, all foliar vegetation, litter, and humus is gone; in moderate burn areas, some canopy needles, litter, and humus remain; and, in low intensity burn areas most of the foliar vegetation, litter and humus are retained.

Physical stream channel conditions are also highly variable within the fire area. Results from a reconnaissance survey of key reaches of principal streams in the burned area are summarized in Table 12. Channel vulnerability is determined by channel types, using Rosgen's classification (Rosgen, 1995), and a stability evaluation. Channels vary in resistance to erosion; for example, high gradient channels formed in boulder substrate (Rosgen type A2) are more resistant to increased peak flows, compared to high gradient channels in finer substrate (Rosgen type A5).

Figure 14 Fire effects on vegetation, soil properties, hydrology, and geomorphic processes (Swanson, 1978).

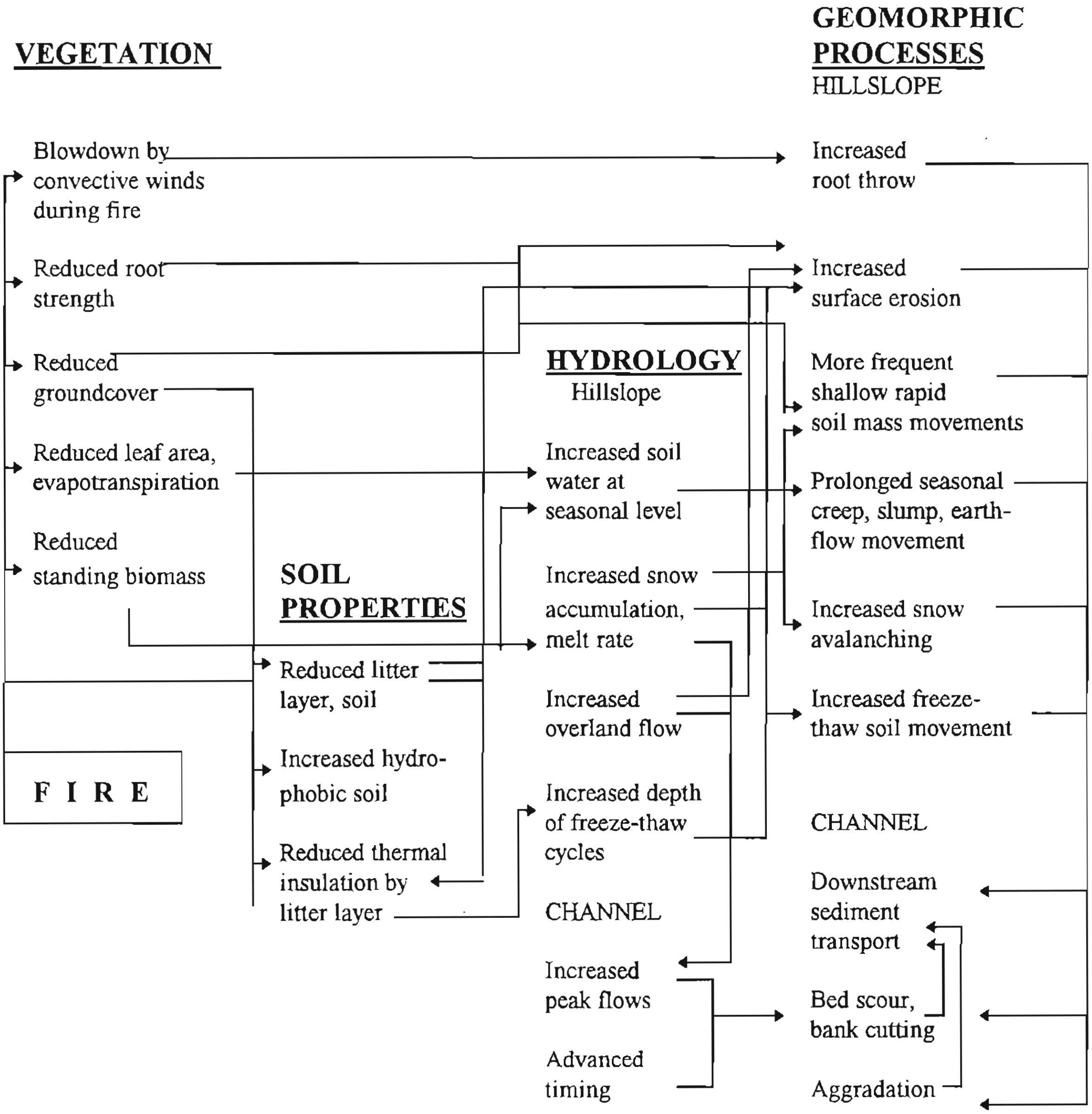


Table 12. Stream Channel Condition - Tower Fire

Stream Name	Surveyed Reach	Channel Types[1]	Stability Rating[2]	Vulnerability
SF Cable Creek	upper 1/3	B4a, A2/A3, E4/C4, B3	Fair	High
Oriental Creek	mid section	A5	Poor	High
Texas Bar	lower reach	A2	Good	Moderate

1 Rosgen Stream Classification
2 R-1 Channel Stability Evaluation procedure

The aftermath of forest fires often includes increased peak flows, erosion rates, sediment delivery to stream channels, and variable channel response. These effects are most likely during the immediate years following the fire (BAER vegetation recovery estimated at 5-10 years). There is also an inherent uncertainty of future climatic conditions, and some, however low, probability of an extreme event. **Hydrologic risk** is the probability of a hydrologic event of a given magnitude over a given time period, which can be defined. For example, there is a 5 percent chance of one or more events equal to or greater than a 100-year event occurring in the next 5 years, the time estimated for recovery of protective ground cover in the fire area (BAER report).

The size of the average flood event likely to occur every year or two, and the extreme event, or "100-year" flood which has a 1 percent chance of occurring in any given year, was estimated for several ungaged streams in the fire area using regional regression equations that are based on relationships found at gauged streams (Harris and Hubbard, 1983). Harris and Hubbard (1983) found drainage area, precipitation, and forest cover to be significant predictors of flood size. Table 13 shows estimated flood size (flow rates are in cubic feet per second, or cfs, and unit runoff is in cubic feet per second per square mile, or cfsm) using **pre-fire** forest cover. A reduction of the forest cover variable for Cable Creek, the most extreme example, results in a hypothetical 12 percent increase in the 2-year event and a 17 percent increase in the 100 year event.

Table 13. Pre-Fire Flood Estimates for Streams in the Tower Fire Area.

Stream	Watershed Size (mi^2)	Percent in Fire Area	Streamflow $Q_{0.50}$(cfs) (2 YR)	Unit Runoff (cfsm)	Streamflow $Q_{0.01}$(cfs) (100 YR)	Unit Runoff (cfsm)
Cable Creek	38	68	259	6.8	849	22.3
Big Creek	61	32	419	6.9	1267	20.8
Hidaway Creek	30	32	234	7.8	739	24.6

U.S. Geological Survey WRI Report 82-4078.

Flow increases are most likely in watersheds with significant area burned (> 30 percent), however, response will also depend on many factors which influence snow accumulation and melt rates, for example;

- future weather and climate
- physiography (aspect, elevation, soils, geology, landforms)
- fire extent and intensity
- vegetation distribution (living and burned)
- land uses (roads, skid trails, landings, livestock driveways)

Contrasting north-trending drainages (Cable and Hidaway) with south-trending drainages (Big, Oriental, Texax Bar), the following generalizations can be made; Cable and Hidaway will tend to accumulate and retain a snowpack later into the year, and have a slower melt-off; where Big, Oriental, and Texas Bar will tend to melt off earlier. Peak flows and snowmelt recession will also follow the pattern of later, slower falling streamflow for north-flowing tributaries. On north-trending watersheds, baseflows may be achieved later into the summer and be of shorter duration. Lastly, higher autumn soil moisture content throughout the fire area may be anticipated as a result of reduced evapotranspiration demand (Klock and Helvey, 1976).

In sum, the effect of wildfire on the hydrograph can include increased peak flows, earlier peaks, and increased total water yield. Complex interactions among numerous factors, future climate uncertainty, and lack of gaged streams in the fire area, make prediction of actual response difficult. However, scenarios can be developed using estimated discharge for various recurrence intervals and assumed percent increase in peak flow or water yield. For example, a 56 percent increase in peak flows on Cable Creek would shift the 2-year flood, which has a 50 percent chance of occurrence, to a 5-year event, which has a 20 percent chance of occurring in any given year. The implications to stream channels, and aquatic habitat would be increased channel instability (bank erosion, down cutting).

Water Quality

Water temperature has been monitored at numerous locations within and adjacent to the fire area, over the past 5 years (Table 14) and was recently summarized for the Camas watershed in the Camas Ecosystem Analysis. Cable and Hidaway creeks were identified as important cold water source areas to the Camas stream system, which has elevated water temperature problems. In comparing temperature regimes of these north-flowing tributaries to Camas Creek, however, peak summer water temperatures are not significantly cooler on either Cable or Hidaway Creek, than the main stem. Moving upstream on the tributaries, though, 10 degree cooler water has been recorded on upper Cable and Hidaway, which indicates the value of these tributaries as refuge areas during the hot summer period when the main stem is at a high stress or lethal level for fish.

Table 14. Water Temperatures of Streams in the Vicinity of Tower Fire (Annual 7 Day Moving Average of the Daily Maximum, °F)

Stream Name	Elevation	1991	1992	1993	1994	1995	1996
Big Creek @ mouth	3380			65	72	ND	72
Cable Creek @ mouth	3540	73	77	73	78	74	76
SF Cable @ mouth	4180			66	71	66	ND
Camas Cr @ mouth	2700			74		77	77
Hidaway @ mouth	3660	73	76	72	ND	78	75
Hidaway @ FS Bdy	4200				70	ND	69
Hidaway, upper	5400					59	61
Oriental @ mouth	3220		65	60	63	58	61
Winom Creek	5040			65	68		68

ND = not collected OR data recorded not valid

South-flowing tributaries are a mixed bag and do not show a strong pattern of warmer water which might be expected. Big Creek which is mostly a wilderness stream and has the highest elevations, exceeded 70°F in 1994 and 1996, where Oriental Creek, a smaller watershed in granitic geology, maintained peak summer temperatures below 65°F in the 5 years of monitoring. Groundwater or riparian canopy characteristics may account for these unexpected differences.

Other water quality data (physical and chemical) have been collected at various locations, however, these data have not been interpreted to date. All data have been entered into STORET, the Environmental Protection Agency's national water quality databank. Cursory review of summary data for several of the principal streams in the fire area show that automated pumping samplers were operated between 1983 and 1986 on Cable Creek, between 1993 and 1994 on Oriental Creek, and between 1982 and 1985 on Winom Creek. Sediment data for these and other sites include daily turbidity, conductivity, dissolved solids, and suspended sediment. Stream sediment is categorized by method of transport into suspended sediment and bedload. Sediment that is transported in suspension generally depends on availability and supply where sediment that is transported along the channel bed is more dependent on stream power (rate of doing work) which is related to streamflow and channel form (Williams et al, 1988). Both modes of transport are expected to be increased as a result of the fire.

Forest hydrology personnel also installed bedload boxes on Winom Creek and several smaller tributaries and found sediment production too great to maintain the boxes (Winom filled in a month's time and others were buried and lost, E. Calame, pers. comm.). More comprehensive analysis and interpretation are needed to understand sediment relationships in and downstream of the fire area.

Subwatershed Risk Assessment

Overall fire effects to water quality and beneficial uses were evaluated using a "Subwatershed Risk Assessment" based on the following factors which could be quantified for use in analysis:

- Percent Burn High Intensity
- Geology and Slope Group
- Road Density
- Water Quality Limited Status and Beneficial Uses

Table 15 displays risk factors and overall ratings by subwatershed (SWS). Risk designations are relative and not intended to denote absolute values; it is recognized that the entire fire area and downstream areas are at an elevated risk because of the fire, pre-existing conditions, and uncertain future weather and climate. The purpose of this assessment is to distinguish at a coarse level, where the greatest effects are likely. "High Hazard" threshold values were defined as follows:

- greater than 20 percent of the SWS was burned at high intensity
- greater than 50 percent of the SWS occurs in higher hazard geologic units
- greater than 20 percent of the SWS has steep slopes (greater than 40 percent)
- road density exceeds 1.5 miles per square mile.

Roads were included as a risk factor based on studies showing effects of roads on hillslope hydrology: roads extend the channel network; intercept subsurface flow; and increase overall hydrologic "efficiency" or routing of water and erosion products through stream systems. “Summary risk ratings” from Table 15 are mapped in Figure 15.

Beneficial use ratings combined water quality status (303d list) and presence of key fish species (bull trout and Chinook salmon) as determined by the team’s aquatic scientist (see Aquatic Habitat report). Summary risk ratings are one indication of where increased water yields, peak flows, channel response, and water quality effects are most likely to occur. “High” risk was assigned where two or more risk factors and 303d status or presence of key species occurred; “Moderate” risk was assigned where one risk factor and or 303d status or presence of key species occurred; and, “Low” risk was assigned where there were no risk factors, or beneficial use indicators. In essence, subwatersheds with less than 1 percent burn were rated “Low”, and all other subwatersheds were rated as “Moderate” or “High”. Results can be used as a first stage in planning and prioritizing management activities such as salvage, road erosion control, watershed restoration, and monitoring. Additional analysis at a more detailed scale is necessary to locate harvest units and conduct restoration planning such as streamside vegetation planting.

Lastly, livestock grazing uses were not included in the assessment (because of problems quantifying use by subwatershed in the timeframe of the analysis). Past grazing management would be expected to contribute to overall watershed response to the fire through a variety of mechanisms, for example, upland compaction and soil displacement and stream channel degradation through trampling and herbivory. A range assessment, was completed as part of the Tower BAER process, which provides a comprehensive evaluation of existing grazing systems within and adjacent to the fire. Key concerns from the fire include: damage to fences which are needed to control access, the recognition of need to suspend grazing in some units to allow for vegetation recovery, and the need to monitor recovery rates (ref. Range Assessment - Tower Fire, Sept. 11, 1997, report on file at District Office).

Tower Fire Ecosystem Analysis
Subwatershed Risk Assessment
01/24/97

			RISK FACTORS								RATINGS	
SWS Number	SWS Acres	SWS Mi2	HH Geolog Acres	%SWS	HH Slopes Acres	%SWS	HH Burn Acres	%SWS	ROAD Miles	ROAD DN	Beneficial Use Rating	Summary Risk Rating
85D	11900	18.6	32	0%	3.8	0%	0	0%	16.8	0.9	Snake tributary	Low
33A	5946	9.3	0	0%	40.5	1%	0	0%	10.6	1.1	303d	Moderate
33B	5638	8.8	3049	54%	67.4	1%	1	0%	26.5	3.0	303d	High
33C	6051	9.5	4437	73%	350	6%	1158	19%	16.2	1.7	303d, SACO present	High
33D	6640	10.4	6640	100%	1438.8	22%	1537	23%	14.2	1.4	303d, SACO/ONTS absent	High
34A	12621	19.7	0	0%	0	0%	0	0%	34.9	1.8	SACO/ONTS absent	Low
34B	21534	33.6	0	0%	0	0%	0	0%	59.5	1.8	SACO/ONTS absent	Low
35B	6297	9.8	0	0%	632	10%	701	11%	47.5	4.8	SACO/ONTS absent	Moderate
35C	5425	8.5	382	7%	283.7	5%	0	0%	25.3	3.0	SACO/ONTS present	Moderate
35D	8722	13.6	1982	23%	678.1	8%	73	1%	30.9	2.3	SACO/ONTS present	Moderate
35E	7018	11.0	4460	64%	1496.9	21%	492	7%	36.7	3.3	SACO/ONTS likely	High
95A	6382	10.0	6361	100%	1169.4	18%	1727	27%	4.6	0.5	SACO/ONTS likely	High
95B	11337	17.7	6036	53%	1353	12%	172	2%	16.9	1.0	303d, not surveyed	Moderate
96A	10287	16.1	39	0%	15.3	0%	0	0%	56.8	3.5	SACO/ONTS present	Moderate
96B	8914	13.9	4870	55%	1605.9	18%	82	1%	26.2	1.9	SACO/ONTS present	High

RISK FACTORS based on the following criteria:

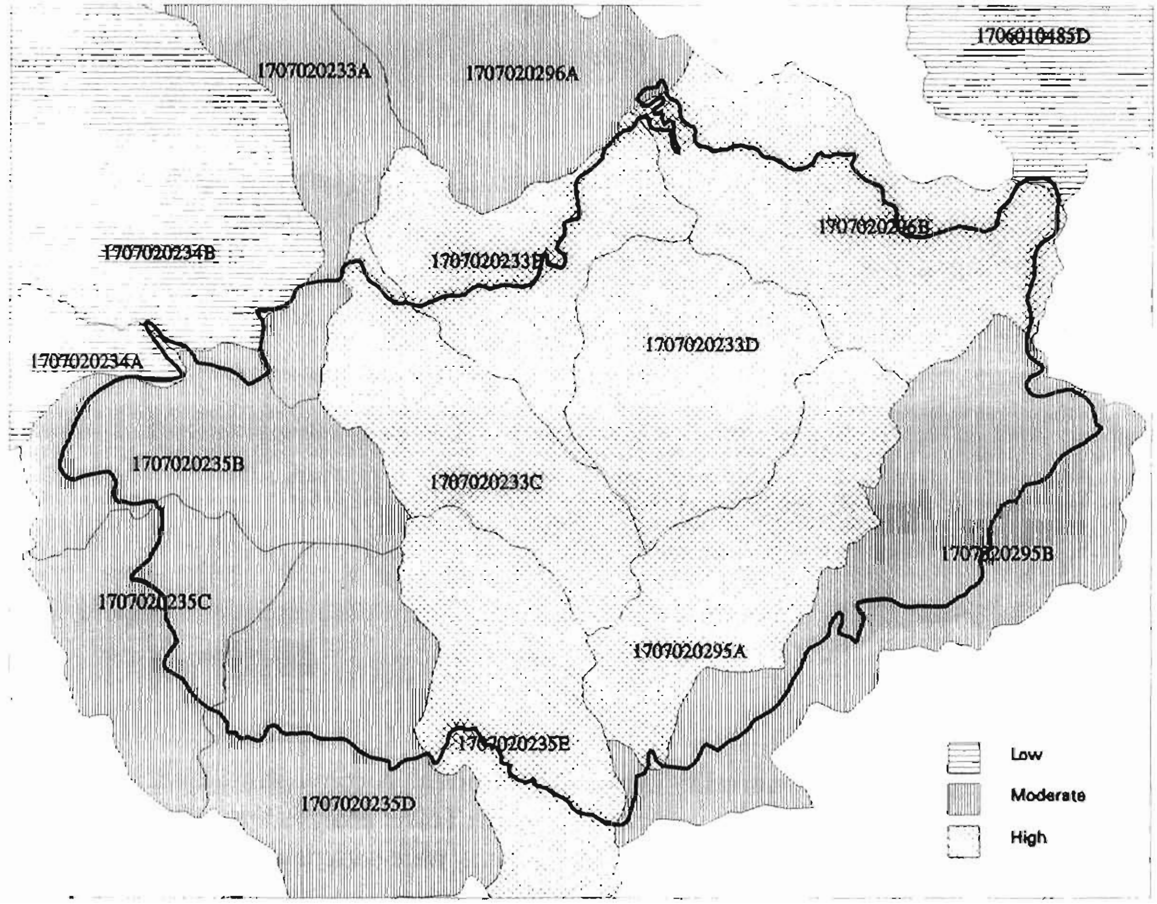
High Hazard Geology: acres of John Day formation and granitics
>50%=high risk
High Hazard Slopes: acres in >40 percent slope
>20% SWS in HH slopes=high risk
High Hazard Burn: acres in high intensity
>20% in HH intensity=high risk
Road DN: Road density (mi/mi2)
>1.5 mi/mi2=high risk

RATINGS based on the following criteria:
Beneficial Use rating: streams on 303d list, presence of
bull trout (SACO) and/or chinook salmon (ONTS)
Summary Risk rating: H >=2 high risk factors and 303d or
SACO or ONTS present or likely.
M >=1 high risk factor and/or 303d or SACO/ONTS
L = 0 risk factors, not 303d or SACO/ONTS

RISK is the relative likelihood of increased peak flows, erosion, channel effects, and impacts to beneficial uses.

TABLE 15-HYDROLOGIC RISK

Figure 15 - Tower Fire Watershed Risk



Vegetation

Forty-five percent of the forests in the analysis area experienced complete, or near-complete, mortality. The balance of the area (55%) sustained partial mortality — seldom were all of the trees killed in those stands. Partial-mortality areas with a high proportion of thin-barked trees may experience significant mortality because a small amount of bole scorch can be lethal for those species. Figure 16 shows the geographical distribution of two categories of stand mortality: partial (labeled "under") and complete (labeled "heavy").

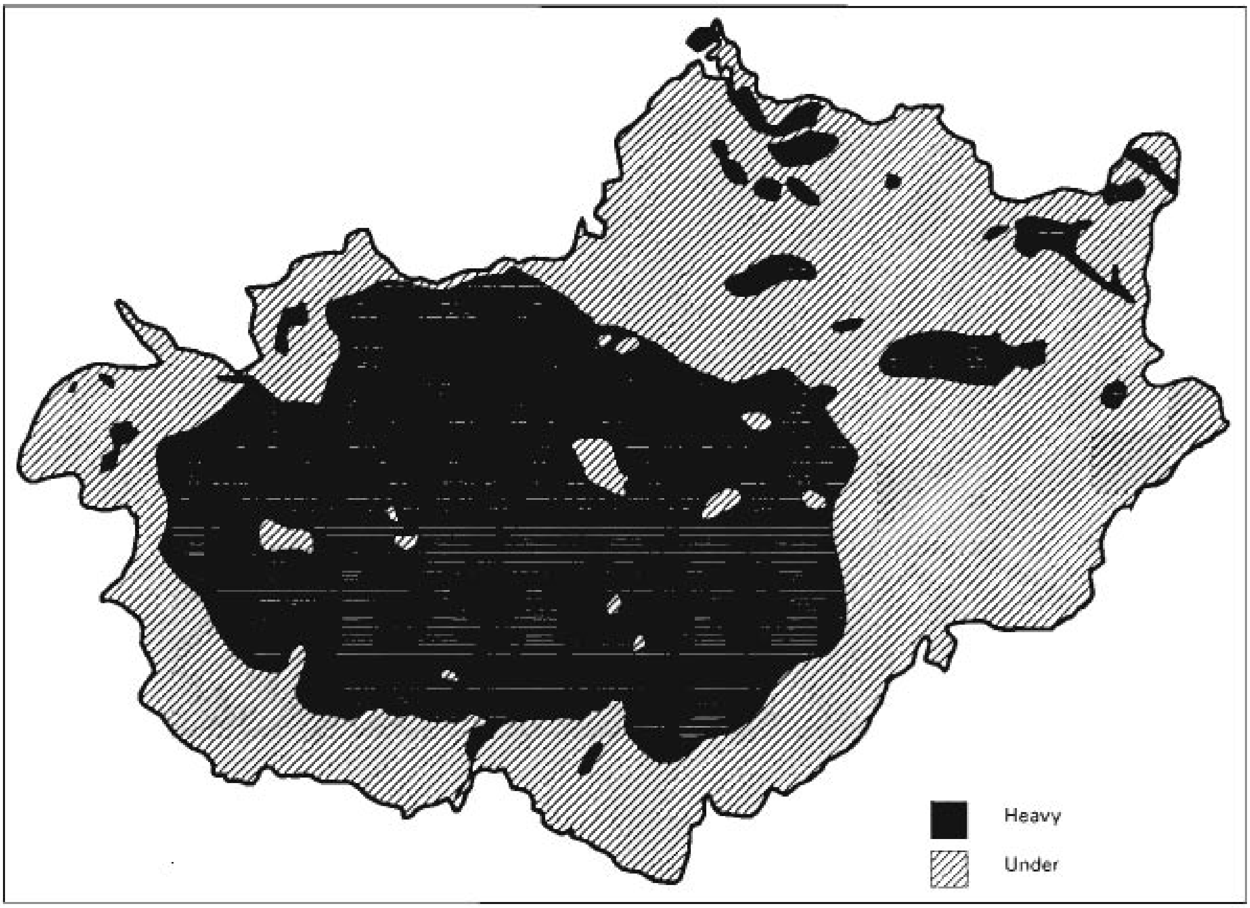


Figure 16 – Distribution of stand mortality in the analysis area. A convection crown fire resulted in stands with complete, or near-complete, tree mortality in the Tower analysis area. Those areas are shown as "heavy" fire damage in this figure. The "under" areas were underburned and sustained partial tree mortality; seldom were entire stands killed in those areas. The large area of complete mortality in the western half of the analysis area was the result of a "blow up" wildfire event that occurred from the afternoon of August 25th to about 5 PM on August 26th, 1996. Approximately 20,000 acres were consumed by the fire during that 24-hour period.

Table 16 summarizes the area burned by ecological setting and stand mortality category. It shows that stands on ponderosa pine and warm dry ecological settings had a higher percentage of complete mortality than would be expected from the historical fire regime. Conversely, stands on the cold dry and lodgepole pine settings had a lower percentage of complete mortality than would have been expected. The cool moist ecological setting had a balanced mix of partial and complete mortality, which is close to the expected values. Figure 16 shows the geographical distribution of stand mortality categories.

Table 16: Burn Summary by Ecological Setting and Mortality Category.

	ACRES (PERCENT) BY STAND MORTALITY CATEGORY				
Ecological Setting	**Partial Mortality**	**Expected**	**Complete Mortality**	**Expected**	**Total**
Cold Dry Forest	2,315 (69%)	20%	1,036 (31%)	80%	3,351
Lodgepole Pine	5,409 (58%)	20%	3,977 (42%)	80%	9,386
Cool Moist Forest	5,464 (50%)	40%	5,364 (50%)	60%	10,828
Warm Dry Forest	8,538 (50%)	90%	8,402 (50%)	10%	16,940
Ponderosa Pine	4,317 (61%)	90%	2,798 (39%)	10%	7,115
Meadows	99 (41%)		143 (59%)		242
Riparian	1,212 (57%)		921 (43%)		2,133
Scabland	608 (74%)		213 (26%)		821
Total	27,962 (55%)		22,854 (45%)		50,816

Sources/Notes: Based on the potential natural vegetation and stand mortality maps (Figures 12 and 16). Percentage values are percentages of the total by ecological setting. The "Expected" figures are the percentages that would have been expected based on the historical fire regimes (Agee no date).

Figure 17 – An example of a "partial mortality" burn area. Fifty-five percent of the Tower analysis area was affected by a fire intensity that did not kill all of the trees. This view, which was taken in the North Fork John Day Wilderness Area near Upper Winom Creek (north of the 52 road), shows a mosaic burn in which the fire crept around and caused intermittent consumption of the forest floor. The center of this photo is a small unburned area in which small lodgepole pine seedlings about one foot tall were not damaged by the fire. If not reburned in the near future, these small "escape" areas will form the basis of a future forest on these sites.

Figure 18 – Examples of "complete mortality" burn areas. Forty-five percent of the Tower analysis area was burned intensely enough to kill all, or nearly all, of the trees. These views show examples of dead stands (left, near lower Winom Creek south of the 52 road) and the forest floor (right) in areas that sustained complete mortality.

Previously-Established Plantations. According to field reconnaissance and a GIS analysis, it appears that 2,240 acres of well-established (certified) and recently-completed plantation were burned by the fire (Figure. 19). If that assessment is accurate, then an investment of well over $1,000,000 was lost in plantations alone, not counting additional losses for other cultural treatments.

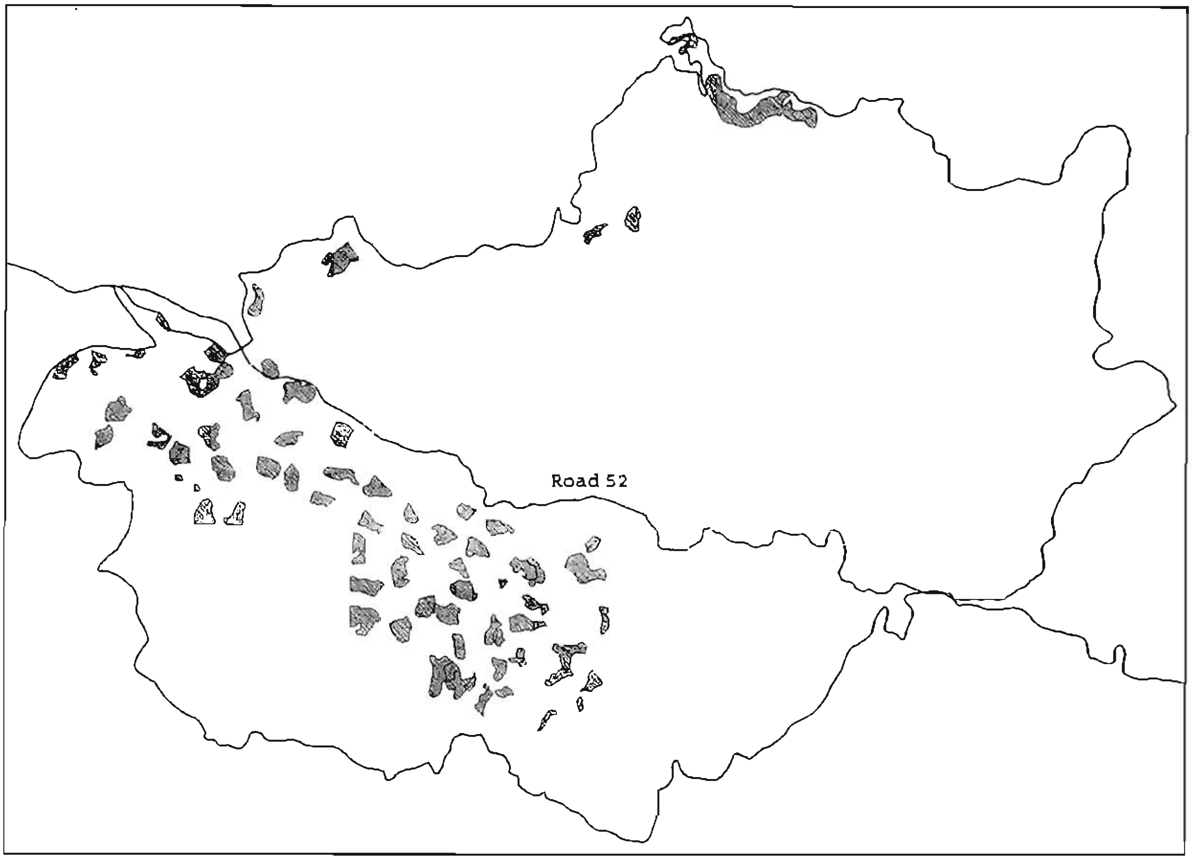


Figure 19 – Tower Fire's impact on established plantations. The Tower Fire burned about 2,240 acres of long-established and recently-completed plantation. When considering the investment to establish those plantations, the burned plantations represent a loss of more than $1,000,000.

Effects of the Fire on Western White Pine (Powell and Erickson 1996)

The Tower Fire adversely affected a number of natural stands of western white pine on the North Fork John Day District (NFJD), including those occurring in Hidaway Meadows, Winom Butte, Pearson Ridge, and the Texas Bar drainage Fire intensity was moderate to high in those areas and, as a consequence, an estimated 60–70 percent of the natural white pine populations on the District have been extirpated. This is of particular concern because the Blue Mountains have a restricted, outlier population of white pine.

In addition to their intrinsic biotic value, the burned stands would have served as a major source of reforestation seed for the District. Most of the remaining western white pine on NFJD is inaccessible or has high levels of blister rust. The loss of the 20-acre Texas Bar stand is especially significant since plans were underway to thin and culture it for use as a seed production area. In addition, a number of the burned white pines were select parent trees being screened for resistance to western white pine blister rust at the Dorena Genetic Resource Center.

Over the last 15 years, western white pine has increasingly been used in District reforestation plantings due to its high survival and juvenile growth rates when established on ecologically suitable sites. An estimated 25–50 percent of those plantings (approximately 300–400 acres) were destroyed by the Tower Fire. The majority of the plantations occurred in the Texas Bar and Oriental Creek areas.

The Role of Wildfire in Blue Mountain Forests

Dry forests evolved with fire as a frequent visitor. Historically, many low-elevation sites in the Tower analysis area supported open, park-like forests of ponderosa pine, often with a dense undergrowth of tall grasses. Those conditions had been created and maintained by low-intensity surface fires occurring every 8–20 years (Hall 1977). Although many fires were started by lightning in mid or late summer (Plummer 1912), a surprising number were ignited by American Indians (Cooper 1961, Johnston 1970, Robbins and Wolf 1994).

Fire has traditionally been viewed as an undesirable event, but in presettlement forests it was a critically important ecological process. In dry forests, natural decomposition of needles, twigs, and other forest litter occurs slowly. Low-intensity fire was important for periodically cycling the litter's rich supply of nutrients (Figure. 20).

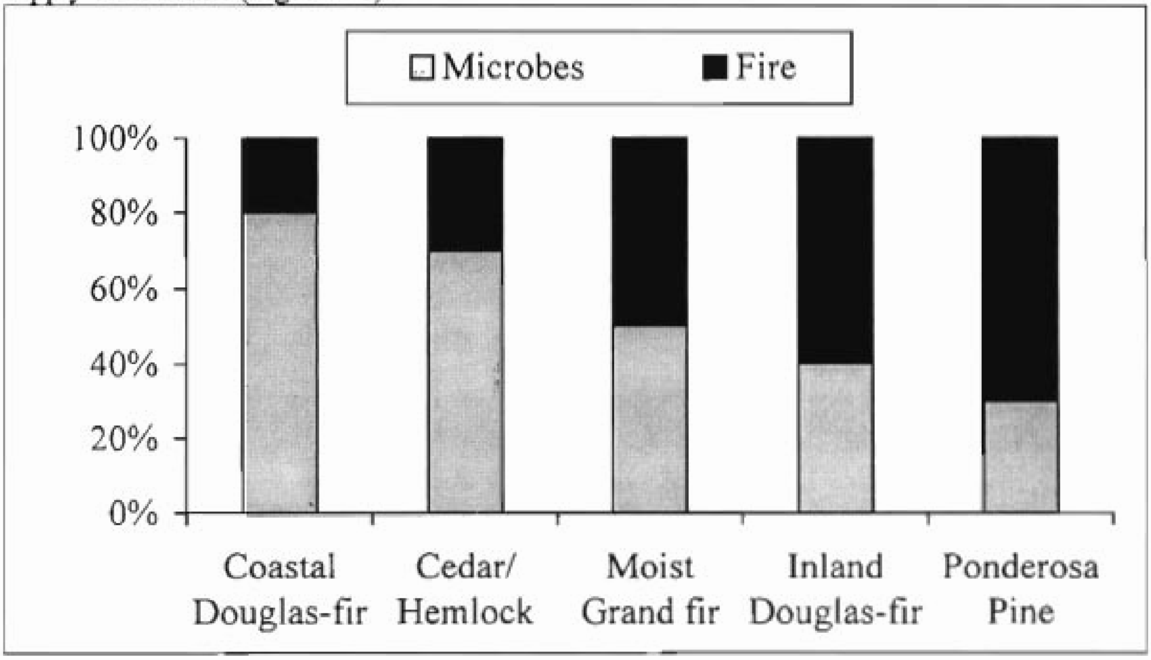


Figure 20 – Fire as a decomposer. In dry forests of the Inland Northwest, fire was an important ecological process for nutrient cycling. Coastal Douglas-fir forests and other areas with a humid, temperate climate can recycle nutrients using microbial decomposition, but microbes are relatively ineffective in dry ecosystems. After frequent, low-intensity fires were suppressed following Euro-American settlement of the Blue Mountains, microbial decomposition has been unable to recycle all of the organic debris (needles, twigs, branches, etc.) that accumulates beneath forests as they grow and develop. In such situations, a disturbance event eventually "resets" the system by converting the accumulated biomass back to its elemental constituents. A conflagration-type wildfire served as the "reset" event for the Tower analysis area. (Figure adapted from Harvey and others 1994.)

Low-intensity fire was also important for thinning (Weaver 1947, 1957), which was needed because ponderosa pine stagnates when growing in dense, crowded stands. If crowded pine stands were not thinned by fire, their density was eventually reduced by bark beetles or pathogens. Since fire's influence was so pervasive, underburned pine stands were stable, ecologically sustainable systems (fire-dependent plant communities).

Mixed-conifer (mesic) and lodgepole pine forests are similar in that a physical deterioration over time eventually induces high flammability. Most often, the physical deterioration is caused by defoliators (spruce budworm or tussock moth), bark beetles, root diseases, and other factors associated with dense, overstocked stand conditions. Once highly-flammable conditions exist, a stand-replacement fire is the ultimate result (Habeck and Mutch 1973).

In the cold-forest zone, plant succession and other ecological processes are slowed by a short growing season and low temperatures. Consequently, the effects of stand-replacement fire can be extremely persistent, often enduring for many decades. Unlike low elevations where frequent fires were important for maintaining biotic diversity (Hall 1991), the impacts from infrequent subalpine burns are long-lasting (Habeck and Mutch 1973).

Affects on Forest Health

The fire may contribute to future forest health problems by its impact on nutrients that were present in vegetation, litter, and the upper soil layers. Nutrients can be lost to the atmosphere during combustion (volatilized) or converted by heat to their mineralized or elemental form (oxidized). Oxidized nutrients are retained in the ash and remain on site unless ash is redistributed by wind or water. Mineralized nutrients are eventually returned to the ecosystem as water (snowmelt, rain) leaches them into the soil, where they are available for plant growth unless leaching moves them deeper than roots can reach.

From a forest health perspective, the primary concern is focused on volatilization losses of nitrogen, potassium, and sulfur. Nitrogen is a critical element needed for plant growth, and it is likely that a high proportion of the available nitrogen is now gone in areas that sustained complete stand mortality (i.e., the areas of moderate and high fire intensity). For example, measurements completed after the Entiat fire in 1970 showed that 97 percent of the nitrogen in the forest floor (litter and duff) was lost, and that 33 percent of nitrogen in the upper layer of mineral soil (A1 horizon) was also volatilized (Grier 1975). On the dry sites burned by the Entiat fire, those were significant losses — replacement of lost nitrogen from the atmosphere (via precipitation) would require 907 years. Obviously, nitrogen will need to accumulate from other sources — primarily weathering of soil parent material and symbiotic nitrogen fixation associated with the root systems of certain plant species (Grier 1975).

The loss of potassium and sulfur is also important since on-going studies indicate that those nutrients play an important role in forest health. Apparently, forests growing on soils derived from geological parent materials with low potassium concentrations are prone to poor health such as chronic outbreaks of insects and diseases. Fortunately, it appears that mineralized potassium is retained in the upper soil profile (0-8" depth) as ash is leached, thereby making it available for uptake by trees and other plants (Grier 1975).

Fertilization may provide other benefits that are related to insect and disease susceptibility. It provides opportunities to modify foliar chemistry and thereby improve a tree's resistance to budworm defoliation (Clancy and others 1993). It may help reduce stem decay for grand firs that have been wounded during logging or by other agents (Filip and others 1992). By changing root chemistry, fertilization with nitrogen and potassium apparently has beneficial effects on a tree's resistance to Armillaria root disease (Moore and others 1993).

Insects and Disease

The following excerpts were taken from a report by Don Scott and Craig Schmitt based on field reviews of the Tower Fire.

Generalized Fire Effects

Most of our focus on these fires was on those trees and stands that were fire-injured, but not killed by the fire. While fire-killed trees offer little or no risk of being attacked by bark beetle populations because the dead cambium in fire-killed trees is unsuitable for brood development, they are attacked by woodboring wasps and beetles (mostly of the families Siricidae, and Cerambycidae and Buprestidae, respectively) that develop in the sapwood or heartwood, and initiate the biodeterioration process in dead woody plants. Additionally, these insects provide food for various wildlife species. Their presence after the fire temporarily increases the abundance of food for various avian species and small mammals. These woodboring insects typically do not kill living trees, so buildup of their populations on the fire should not be a concern to the resource manager. Green, uninjured trees, and nearby stands are not at risk from these insects.

On the other hand, bark beetles of the family Scolytidae contain genera (e.g., *Dendroctonus* spp., *Scolytus* spp., and *Ips* spp.) that are well-known tree killers, and invariably attack fire-scorched conifers at some level following a fire. They sometimes build large populations that develop into outbreaks and move into healthy, green stands as a consequence.

Since the weakened condition of the fire-damaged host tree enables bark beetles to successfully colonize trees with little resistance, it is beneficial to review the effects of fire on conifers to understand the nature and degree of fire-injury that makes trees especially susceptible to insects following a fire. Much of this discussion is based on the report by Scott et al. (1996). The reader is referred to that document for additional details.

Fire injuries to conifers can be quite complex. The interactions of many factors operate together to make fire-injured trees susceptible to insects. Three principal injuries to trees are recognized: (1) root damage; (2) bole damage; and (3) crown damage. Most injured trees that become attractive to insects likely contain some combination of these three types of damage, but the specific degree of each type of damage is so variable that it is near impossible to define in precise terms how much of each type results in one tree being attacked over another.

Root damage is especially hard to quantify because the damage is largely hidden from view. Similarly, cambium damage is also obscured from view without removal of portions of outer bark from the bole. Scott et al. (1996) reviewed much of the fire effects literature, and based on published research as well as their own studies and observations, developed a simple set of visual fire effects indicators that can be used to determine different levels of mortality-risk for different conifers, based on the severity of fire injury to largely the bole and crown. Bole-charring is used in their tables as an approximate surrogate for cambium damage. In some cases, root collar-char approximates root injury in shallow-rooted, thin-bark species. This injury has been described for certain species whose root systems are especially sensitive to fire.

Decay and Deterioration

Trees killed directly by fire or subsequently by insects will soon start to deteriorate. A variety of factors determine the rate of deterioration and wood decay. Lowell et al. (1992) summarize the known information on this subject that pertains to western conifers. Some of the major points discussed:

1. Trees with thin bark deteriorate most rapidly, especially from weather checking.

2. Species with the highest proportion of sapwood have the highest rates of decay. Smaller diameter and faster growing trees will have a higher sapwood to heartwood ratio.

3. Less severely burned trees on moist sites deteriorate slower than severely burned, while on dry sites, severely burned trees take longer to deteriorate (decay) due to limited moisture.

4. Phloem feeding bark beetles and woodborers that attack and kill fire-weakened trees introduce fast-acting sapwood decay fungi and slower-acting heartwood decays. Trees that are not attacked by these insects because of severe fire damage will usually have slower decay rates, although weather checking is often severe.

The most important point regarding deterioration is that where salvage is planned, time is critical.

Effects Specific to the Tower Fire

To evaluate potential insect and disease concerns on the Tower Fire, we were most interested in the stands with large pole- and sawlog-size ponderosa pine and Douglas-fir, respectively, that survived the fire with fire injuries. These are the tree species that have greatest potential for attracting populations of bark beetles that could build to outbreaks and spread to nearby healthy, green stands.

Most other fire-injured conifer species have not normally contributed to outbreak populations of beetles in the past, though they may be attacked by bark beetles following a fire. In regard to the susceptibility to insects, we were less concerned with the condition of these other species than we were with fire-injured Douglas-fir and ponderosa pine.

Texas Bar Creek

The Texas Bar Creek portion of the fire consists of mixed-conifer stands within a mostly flat to gently-sloping creek bottom; joining steeper slopes at various distances from the creek. The stands contained a heavy component of grand fir, Engelmann spruce, and western larch in the creek bottom, with some ponderosa pine and minor amounts of large-diameter Douglas-fir scattered throughout. Most of the seral pine and the Douglas-fir experienced variable fire damage, but appeared to survive the burn reasonably well along certain stretches of the creek where fire was less intense.

Ponderosa pine should survive best in the seasons following the fire. The mature Douglas-fir, on the other hand, will likely be attacked and killed by Douglas-fir beetle in the next couple of seasons due to the presence of relatively high beetle populations on the fire area. Using the fire effects/burn severity visual indicators of Scott et al. (1996), we observed that most of the fire injury to the Douglas-fir component was in the "moderate" and "severe" categories. These trees have moderate to high risk of being attacked by Douglas-fir beetles.

Moderate populations of Douglas-fir beetle occurred along portions of the Texas Bar Creek, and Forest Road 55 in 1995. Areas where large Douglas-fir survived the fire will likely become centers of Douglas-fir beetle activity in 1997 and beyond for a period of up to at least 4 or 5 years, based on insect monitoring data from other fires (see Scott et al. 1996). Other high beetle population areas (based on the 1995 survey data) were probably largely wiped out by the high-intensity fire occurrence in those areas such as Oriental Creek and the Oriental Basin. We reiterate again that anywhere large-diameter Douglas-firs occurred and survived the fire, particularly those with moderate and severe fire injuries, those trees will likely be killed by Douglas-fir beetles in the next few seasons. If these beetles build populations in more than about 10 or 12 trees over a 20 or 30 acre area, an outbreak may ensue, and may spread to adjacent stands.

We noted that grand fir and Engelmann spruce in these stands were readily killed by even the lightest of ground fires owing to their shallow, fire-sensitive roots and thin bark.

Forest Road 5507

In the middle portion of section 36, T. 6 S., R. 32 E., we evaluated a stand containing a large component of Douglas-fir. Nearly all Douglas-firs at this location appeared to have initially survived the fire, but due to the weakened condition of trees with fire-injuries to bole and crown, we anticipate some of the largest diameter trees will be attacked by Douglas-fir beetle next spring. We estimate that roughly 10-20 percent of the trees contain major cambial damage from the fire. These trees would qualify as moderate or severe in the burn-severity guidelines of Scott et al. (1996), and fall into the moderate or high risk categories for insect attack.

We evaluated a third location along the 5507-200 road (section 31, T. 6 S., R. 33 E.). The stands along this road had received exposure to fairly high-intensity fire; and scorch damage to trees was mostly severe. Larch and ponderosa pine were represented in these stands, and most trees had severe crown scorch, where nearly the entire crown volume had been scorched by fire. We looked for cambial injury on these trees by removing portions of outer bark from around the bole with a hand axe, and found live cambium in nearly every location checked. The serious levels of fire-damage to crowns, however, makes the survival of many of these trees questionable. Delay in marking of these trees until after budburst next spring would give a better indication of survival, should salvage be considered for this area.

There is little risk of building bark beetle populations in any of the larch components on the burn, because we have no major bark beetle enemy of larch in the Blue Mountains. Fire-injured ponderosa pines, however, could become attacked next year since they are known to sometimes be attractive to a number of tree-killing bark beetles. Even if beetle infestations occurred in ponderosa pine, the infested trees could be removed within a reasonable window (within a year of infestation), so that buildup of beetle populations might still be avoided. Deterioration of sapwood or heartwood on these trees would not occur within this time period. However, there would be some degradation of wood quality due to blue-staining of the sapwood introduced by bark beetles.

In other locations along the 5507-200 road, some stands appeared to have been exposed to high-intensity, fast-moving fire, judging from the nature (i.e., foliage "frozen" in place in the direction of the fire movement; see Scott et al. 1996), and severity of crown and bole damage to trees. In spite of the severe damage to trees, larch probably have a better than 50 percent chance of surviving with fire injuries.

The deciduous nature of larch foliage provides an advantage for this tree in surviving fires. With photosynthesis and growth beginning to shut down at about the time of the fire's occurrence, these trees will have more carbon available to sustain the tree over the winter since they do not have to maintain a large crown biomass during the dormant period. Also, these trees contained healthy bole cambium, having been protected by their thick bark from the fire. Hence, they should have relatively high survival over the next several years. These trees will be important seed sources for naturally regenerating the burned-over areas around them in coming seasons.

North Tower Fire Area

During the Tower Fire visit, we noted severe Armillaria in stands adjacent to the 5448-010 road. Since only a portion of this area was visited, there are likely additional root diseased areas.

We accessed portions of the fire area via the 5448, 5448-010, and 5448-025 roads. The stands along these roads contained heavy components of grand fir, lodgepole pine, Engelmann spruce, Douglas-fir and larch. Some stands contained minor components of ponderosa pine in addition. Other areas, for example the riparian area near the junctions of 5448 and 5448-025, contained mostly spruce bordered by stands of predominantly young lodgepole pine. This riparian location was especially damaged by fire; virtually all spruce trees were severely charred for some distance up the drainage. It appeared that spruce beetle (*D. rufipennis*) had killed some of the spruce in this riparian area prior to the fire.

Spruce that survive the fire with fire injuries will likely be attacked and killed by spruce beetles next summer in this part of the burn, since spruce beetles are occasionally attracted to these trees (Scott et al. 1996). It is not known from our evaluations, how much of this spruce exists, and is susceptible to beetles on this location of the burn.

We observed a moderate amount of dwarf mistletoe (*A. douglasii*) in the Douglas-fir component of the stands that contained small to medium size trees along portions of the 5448 and 5448-010 roads. The trees that experienced moderate and severe fire injury in these areas, in addition to already being weakened by dwarf mistletoe, have the highest risk of being attacked by Douglas-fir beetle over the 1997 season or beyond.

This portion of the fire area also experienced considerable western spruce budworm defoliation from the most recent outbreak (1980-1993). Budworm topkill in grand fir and Douglas-fir, and understory mortality in the suppressed true fir component was evident throughout the area. In addition, dead Douglas-fir and grand fir trees of all sizes occurred scattered over the area from a combination of budworm, bark beetles (Douglas-fir beetle and fir engraver beetle), Armillaria root disease, and drought stress. This mortality occurred prior to the fire. Douglas-fir beetles killed many of the root diseased Douglas-firs, and fir engraver killed similarly-infected grand firs in these stands prior to the fire.

Stands in weakened condition from this multiplicity of factors will have difficult time recovering from even light exposures to the fire. Where these factors interact with tree wounding from fire, expect higher tree mortality than in other similar mixed-conifer stands on the fire that are not weakened by defoliation and root diseases. Douglas-fir and grand fir components are expected to show the greatest levels of post-fire mortality from insects since beetle populations have been maintained in these stands for many years by the chronic weakening of trees from root disease.

In summary, survival of trees will be variable depending on tree species, degree of fire injury, pre-fire condition of trees, and post-fire influence of insect populations in this northern portion of the burn. Most of the western larch we observed in this area had green crowns and received little injury from fire. They will survive well in the coming seasons. Douglas-fir are at moderate to high risk from insects, and will not fare as well as some other species because of the risk of insect attack. Grand fir and Engelmann spruce will not survive even light underburning in many cases because of roots and boles damaged by long-duration heating of these structures from smoldering duff and arrangements of burning fuels close to the bole. In addition, some surviving fire-injured spruce may be attacked and killed by spruce beetle. Lodgepole pine will probably experience moderate to high levels of mortality in some stands due to girdling of root crowns from the burning of concentrations of organic matter around the tree bases, even though little damage to crowns occurred. In other areas, where fewer bole and root injuries occurred, lodgepole pine may survive much better. Ponderosa pine and western larch in locations that experienced underburning will likely fare the best of all species components in these mixed-conifer stands.

We anticipate that Douglas-fir beetles will become very active in these stands next summer. The potential for building outbreak populations of beetles is high. Hence, we believe that much of this tree component over 8 or 10 inches (dbh) is imminently susceptible to being attacked and killed be insects in the next several seasons.

Fire/Fuels

The Tower Fire was the largest fire in recorded history on the Umatilla National Forest. The severity of the fire, particularly in the naturally low and moderate severity natural fire regimes, was probably well beyond what would be expected historically. The extent of stand replacement crown fire (particularly in the dry forest plant associations) with virtually complete consumption of surface down and dead woody fuels and the duff layer is likely the result of stands being over stocked, with extensive vertical fuel continuity and relatively high total fuel load.

Much of the Tower Fire area is a good example of the damage caused by a crown fire. A crown fire is one that spreads through the forest canopy. Crowning is one of the most spectacular fire behavior phenomena that wildland fires exhibit. Crown fires are fast spreading and release a tremendous amount of heat energy in a relatively short period of time. Spread rates exceeding 7 miles per hour and flame lengths over 150 feet have been recorded (Pyne and others 1996).

A running crown fire may spread for several hours, burning out entire drainages and crossing mountain ridges that would normally serve as topographic barriers. Fully-developed crown fires are of two types: wind driven or convection (also called plume-dominated fires). Tower was an instance in which a strong convection column (the plume) built vertically above the fire.

The velocity of air rushing upward in a convection crown fire causes air near the ground to be sucked into the column, which promotes rapid fuel combustion. The resulting indrafts increase fire intensity, thus accelerating fire spread. This process results in a towering smoke column and spread rates that are exceptionally fast for the prevailing winds — the fire expands at a speed much greater than would be expected from the ambient wind conditions (Pyne and others 1996).

It is also believed that the Tower Fire exhibited a dangerous condition called a downburst or microburst, where winds blow outward near the ground as the convection column collapses. These winds can be very strong and can greatly accelerate a fire. Downburst conditions are initiated by evaporative cooling that cools surrounding air, causing it to descend rapidly and spread horizontally at the ground surface (Pyne and others 1996).

A convection crown fire is one of the most intense disturbance events that wildland forests experience. They cause enduring changes to stand structure, species composition, and other ecosystem components. Occasionally, even the forest floor is consumed during a very intense fire, which can then affect nutrient cycling (Tiedemann and Klock 1973), soil wettability (Dyrness 1976), and other ecological processes with a direct influence on site productivity.

The high severity natural fire regime sites display characteristics that would seem to fit a historical pattern. Stand replacement occurs when weather conditions, topographical features, and fuel continuity all come together to favor crown fire. Areas where the stand composition was dominated by tree species with little fire resistance (e.g., lodgepole pine or subalpine fir), will undergo stand replacement due to bole scorch, even though the majority of the crowns were not consumed or scorched.

The intense burning conditions of this fire required the extensive use of heavy mechanized equipment (dozers), and aerially applied fire retardant. Although these tools can increase productivity and efficiency of the fire suppression effort, their use is not without risk: for example, dozer constructed fireline can produce erosion pathways that require extensive work to mitigate, exotic plant species (e.g., annual grasses, nitrogen fixing forbs) are often seeded to reduce the erosion potential. Aerial applied fire retardant is a chemical composition that can be deadly to fish if it accidentally reaches a stream or other fish bearing water source. To reduce the impact of suppression activities the management of the forested sites should consider practices that would reduce the potential of crown fires (e.g., increased stand density management, a program of prescribed fire entries in agreement with the natural fire regimes of the area).

Potential Future Changes in Fuels Conditions and Associated Fire Risk

The following is an assessment of general fuel condition changes expected over the next 20 years in the Tower Fire area. This assessment was prepared by Noel Livingston, District Fire Management Officer, North Fork John Day Ranger District and is based upon observations of how the fuel conditions have changed through time on past fires in the area. Table 17 is a general description of the fuel models used in N. Livingston's assessment to aid the reader.

Table 17 - Fuel Model Descriptions

Model	Description
Fuel Model 1	Grass Fuel Model. Fires are surface fires that move rapidly through cured grass and associated material. Very little shrub or timber present.
Fuel Model 2	Grass Fuel Model. Fires are surface fires where herbaceous material, in addition to litter and dead-down stemwood from the open shrub or timber overstory, contribute to fire intensity. Open shrublands or pine stands.
Fuel Model 8	Timber Fuel Model. Generally slow spreading with low fire intensity, although an occasional accumulation of heavy fuels any be encountered that can flare up. Closed canopy stands of short-needle conifers, with little undergrowth present.
Fuel Model 9	Timber Fuel Model. Fires run through the surface litter faster than model 8 and have greater intensity. Closed stands of long needle pines, e.g. ponderosa pine, concentrations of dead-down woody material will contribute to possible torching out of trees, spotting, and crowning.
Fuel Model 10	Timber Fuel Model. Fires burn in the surface and ground fuels with greater fire intensity than the other timber litter models. Dead-down fuels include greater quantities of 3-inch or larger limbwood or stemwood resulting from over maturity or natural events that create a large load of dead material on the forest floor. Crowning out, spotting, and torching of individual trees are more frequent in this fuel situation, leading to potential fire suppression difficulties. Any forest type may be considered if heavy down material is present.

The high tree mortality in a good deal of the Tower Fire area has led to the question; What will the fire risk be in the next 20 years or so as the standing dead material (vertical fuel profile) begins to decay, fall, and add to the surface material (horizontal fuel profile)? Unfortunately there are not quantitative models available that can give a definite answer to this question. The development of a surface fuel profile will be determined by a number of factors including; the decay rate of standing and down material, the size, number, and species composition of standing dead stems, and the rate of establishment and species composition of pioneer and introduced species (grasses, forbs, shrubs and tree seedlings).

Based on the current conditions and observations made on past fires on the North Fork John Day Ranger District some general assumptions can be made. For the purpose of this assessment can be broken into two categories, areas that burned with low intensities, and areas that burned with moderate to high intensities. In the areas of low fire intensity this can be further broken down into dry site ponderosa pine/mixed conifer stands and high elevation true fir/lodgepole pine stands.

Years 0-2

Mapped Low Intensity Burn in Ponderosa pine/mixed conifer stands: These stands essentially experienced an underburn. The majority of the fine fuels (<=3" diameter) in the surface fuels were consumed as were some of the larger fuels. Tree boles and crowns were scorched to varying degrees depending upon tree size and fire intensity at the site. Overall the majority of the larger trees (>9" DBH) survived the fire. The primary fire carrier in these stands for the next couple of years will be grasses and some needle cast, fuel model 2. As a result low to moderate rates of spread can be expected with relatively low fire intensities (flame lengths less than 4 feet).

Mapped Low Intensity Burn in True fir/lodgepole pine: These stands also experienced a low intensity, understory burn. However, because these trees are not fire resistant to fire it is expected that a large portion of the standing trees will die either due to bole damage or insect activity. The majority of the fine fuels (<=3" diameter) in the surface fuel layer were consumed although generally to a lesser degree than seen in a the ponderosa pine stands. During this time period it is expected the primary fire carrier will be needles and fine twigs from the dead overstory and to a lesser degree grasses, fuel model 8. As a result low rates of spread and fire intensities are expected until such time as the overstory further deteriorates and adds to the surface fuels.

Mapped Moderate/High Intensity Burned Areas: The majority of the trees in these stands are currently dead. The majority of the fine fuels (<=3" diameter) in the surface layer as well as much of the larger surface fuels were consumed. In addition much of the needle mass in the overstory was also consumed, effectively removing the vertical component of the fuel profile and eliminating the potential for future crown fires in these stands until they are regenerated. The amounts of fuels in this short term will depend upon the rate at which grasses and forbs become established, leading to a fuel model 1 to 2 where grasses are continuous. Rates of spread and fire intensities are expected to remain low until such time as vegetation becomes established.

Years 3-5

Mapped Low Intensity Burn in Ponderosa pine/mixed conifer stands: Expect continued needle cast and some small limbs to be added to the surface fuels. Surface fuel bed should consist of primarily < 1" diameter material, fuel models 2 and 9 depending upon the time of year. Rates of spread should remain moderate with some increase in fire intensity as depth of fuel bed increase - flame lengths should remain below four feet.

Mapped Low Intensity Burn in True fir/lodgepole pine stands: Needle loss from dead crowns should be complete and fire material < 1" diameter should also be decaying to the point that it falls to the surface layer. Grasses and forbs should be well established. Rates of spread and intensities should remain low - fuel model 8.

Mapped Moderate/High Intensity Burned Areas: Surface fuels will consist of the grasses and forbs that are established on the site, fuel model 1 to 2. Rates of spread expected would be moderate to high where fuels are continuous and exposed, intensities should remain relatively low.

Years 6-10

Mapped Low Intensity Burn in Ponderosa pine/mixed conifer stands: Expect little change in overall surface profile. Fuel bed depth should continue to increase with addition of annual needle cast and dead limbs. Seedlings and saplings killed by the fire should decompose to the point that they fall to the surface, fuel models 2 and 9 depending upon the time of the year. Little or no change in fire spread or intensity.

Mapped Low Intensity Burn in True fir/lodgepole pine stands: Expect an accumulation of 1-6" material as limbs and smaller trees begin to fall to the surface. Larger trees that were dead prior to the fire may also begin to add to the surface fuels. Fuel model will still be primarily an 8 but may start trending toward a 10 in areas of blowdown or previously diseased trees. Rates of spread should remain low but intensities will increase in pockets of heavier fuel.

Mapped Moderate/High Intensity Burned Areas: Expect an accumulation of 1-6" material as limbs and smaller trees begin to fall to the surface. Larger trees killed by beetle/budworm prior to the fire will also begin to fall. Grasses should be well established in many areas. Fuel models will still be primarily the grasses, 1 or 2 although jackpots of heavier fuels may develop. Rates of spread will remain moderate to high with an increase in intensities (4 - 8 feet flame lengths) expected in areas of heavy fuel accumulation.

Years 10-20

Mapped Low Intensity Burn in Ponderosa pine/mixed conifer stands: With the exclusion of fire expect an increase in fuel bed depth as well as the establishment of seedlings, including non-fire resistant species. In areas of seedlings, including establishment there should be an increase in the vertical fuel profile as young trees fill in the gap between surface and overstory fuels. Rates of spread will still be moderate although fire intensity may increase where individual and group torching is a potential.

Mapped Low Intensity Burn in True fir/lodgepole pine stands: Expect the continued accumulation of the 6 - 15" material. Lodgepole pine should be well established in much of the area, with anywhere from 300 - 3000 stems per acre. As the primary fuel component is large material, rates of spread should remain low while fire intensities may be moderate to high in areas where large fuels are concentrated. Suppression efforts will be hampered by heavy down fuels and potentially thick regeneration.

Mapped Moderate/High Intensity Burned Areas: Depending on snag longevity a good number of the less than 15" trees should be on the ground. Regeneration along the edges of the moderate to high intensity areas should be present. Grasses may continue to be the primary fire carrier in the majority of the stands. Rates of spread expected to remain moderate to high with higher intensities in heavy accumulations of larger fuels.

The fuels conditions summarized above are only an estimate based upon changes observed on other fires on the North Fork John Day Ranger District, primarily those that burned in the late 1970's and mid 1980's. It is expected that grasses will be the primary fire carrier in the burn area for the next 20 years and possibly beyond, until such time as the burn has been regenerated with tree species. While the rates of fire spread seen in grasses can be extreme (80 chains/hour or greater), they tend to be very weather sensitive, particularly to relative humidity and wind. As a result fires in these fuels generally make dramatic but short lived runs. Fire suppression methods are generally effective on grass fires and while these fires may get large in a short time they are generally contained within one burning period. The heavy fuels created by the large number of dead trees in the fire area will add to fire intensities as they accumulate at the surface, resulting in a heavy mopup workload following a fire but not severely affecting control capability primarily because the crown fire activity has been effectively removed for the nest 20+ years. Spotting associated with areas of high intensity will be a concern but again will be less than seen in timbered stands as many of the effective ember carrying elements that contribute to long range spotting such as cones will be missing from the fuel profile. Elements not include here that could significantly effect both fire spread and intensity are the potential for a heavy brush component to invade many of the sites (generally not seen in this area) and the possibility of an insect attack in low intensity ponderosa pine burn areas which would significantly increase the fuel loading and associated fire risk.

Floristic Biodiversity

General

This overview of the current vegetative condition of the Tower Fire Analysis Area provides a partial answer to the key question: "How should vegetation conditions and patterns be restored so as to be more ecologically sustainable?"

As mentioned in the characterization and reference portions of this document, an aspect-driven moisture gradient creates differences not only in the dominant tree species of the north and south slopes of Pearson Ridge, the physiographic feature of the Umatilla National Forest impacted by the Tower Fire, but in the understory vegetation as well. Superimposed upon and interacting with the physical factors that determine, to some extent, the existing and potential vegetation of the land, are numerous biological factors.

Several ecological imbalances resulting from historic resource management in the Blue Mountains of southeastern Washington and northeastern Oregon have been documented (Langston, 1995). In the aftermath of the Tower Fire, several symptoms of ecological imbalances became evident. As a result of long-term fire suppression fuel load levels in all of the ecological settings of the Tower Fire Analysis Area ,(with the notable exception of the steppe: grasslands, scablands), were excessive. In addition to excessive fuel loading, shade -tolerant trees replaced the fire-resistant, shade-intolerant species particularly in habitats where the natural aspect-driven moisture gradient favored the latter. As a result, suitable habitat for shade-intolerant understory species (certain shrubs, in particular) was diminished. The decline in the shade-intolerant understory species was further accelerated by grazing animals, both domestic and native.

The outcome of these events---displacement of shade-intolerant, fire-resistant species with shade-tolerant, disease-susceptible, fire-susceptible species---was strongly evident in the south- and west-trending riparian corridors of the Tower Fire Analysis Area (particularly in the riparian corridors of Texas Bar Creek and Oriental Creek). As a consequence, the riparian vegetation of these streams was more severely impacted than it would have been if the natural fire regime had not been disrupted over past decades.

Although some natural vegetative recovery is to be expected, the refugia (plants or seed) of quick recovery riparian species (shade-intolerant shrubs) was diminished in the south- and west-trending streams prior to the Tower Fire, and remaining refugia was lost in the fire. As a result, shade-intolerant shrub vegetation will probably not recover. In normal fire-driven plant succession, shade-intolerant shrub species play an important role in rapid re-colonization of burned areas. These species are eventually replaced as the light regime of the habitat is altered as the replacement tree canopy develops.

Lists of suitable species for restoration activities in the riparian-other ecological setting interfaces are given in the recommendation section. A broad spectrum of life forms is provided intentionally so that other vegetative layers than solely trees may be considered in the restoration projects. Lists of all native species encountered in each of the ecological settings are also provided in Appendix D.

Floristic Richness

This part of the analysis was designed to answer the question: "What terrestrial and/or aquatic species have been extirpated from the fire area (if any), or are at risk because of fire-caused changes?" Because of the commercial availability of seeds of introduced plant species, only native species of the Tower Fire Analysis Area were carried through the analysis.

Methods used to identify plant species potentially at risk of local extirpation were developed in the first watershed analysis completed by the Umatilla National Forest (Urban, 1994). In brief, the determination of species at risk of local extirpation is based upon successive database queries that focus on the relative abundance and distribution of each vascular plant species encountered in the analysis area. The results of this analysis process applied to pre-fire data from the Tower Fire Analysis Area enables changes in floristic biodiversity to be predicted.

A total of 22 vascular plant species that inhabited the Tower Fire Analysis Area prior to the fire were probably eliminated from the flora of the fire zone as a result of the fire. These species may reinvade the fire zone in the course of long-term succession. However, because of their limited abundance and distribution it is highly probable that they were locally extirpated as a result of the fire.

Of the 22 vascular plant species potentially extirpated from the Tower Fire Analysis Area, two inhabit the cool, moist forest ecological setting. These species are the Western Twayblade (*Listera caurina*) and Western White Pine (*Pinus monticola*). Western White Pine also occurs (infrequently) in the warm, dry forest ecological setting. The opportunities for Western Twayblade to re-colonize the severely burned cool, moist forest from riparian refugia may be limited because the light requirements (shade) requirements for this species were adversely altered by the fire. Western White Pine is of limited occurrence across the Umatilla National Forest. Natural regeneration of this species is unlikely in the burned area because the entire seed source was destroyed by the Tower Fire. The incorporation of this species into restoration projects offers a means of reintroducing this species into the fire zone.

Thirteen vascular plant species of the steppe ecological setting are at probable risk of "local extirpation" as a result of the Tower Fire. These species are: Stolonous Everlasting (*Antennaria flagellaris*), Sicklepod Rockcress (*Arabis sparsiflora*), Gray-green Thistle (*Cirsium canovirens*), Bush Rockspiraea (*Holodiscus dumosus*), Common or Mountain Juniper (*Juniperus communis*), Howell's Rush (*Juncus howellii*), Bitterroot (*Lewisia rediviva*), Clustered Broomrape (*Orobanche fasciculata*), Brewer's Cliffbrake (*Pellaea breweri*), Narrowleaved Skullcap (*Scutellaria angustifolia*), Sleepy Cat (*Silene anthrrhina*), Simcoe Mountain Starwort (*Stellaria simcoei*), and Fringepod (*Thysanocarpus curvipes*). Of these species, Bush Rockspiraea is the most limited in both abundance and distribution. Information from the Fire Effects Information System (FEIS) indicates that this species will probably become re-established in the fire zone.

Seven vascular plant species of the Riparian/Riverine Ecological Setting are at risk of local extirpation as a result of the Tower Fire. These species are: Leafy or Meadow Arnica (*Arnica chamissonis*), One-flowered Gentian (*Gentiana simplex*), Tapered Rush (*Juncus acuminatus*), Northern Rush (*Juncus alpinus*), Blue-eyed Grass (*Sisyrinchium angustifolium*), Springbank Clover (*Trifolium wormskjoldii*), and Skullcap Speedwell (*Veronica scutellata*).

Three of the species listed in the ecological settings above also occur with limited abundance in the meadow complex ecological setting.

The answer to the key question, then, is that the floristic richness of the Tower Fire Ecosystem was probably diminished by 22 vascular plant species as a result of the fire. The pre-fire total of 705 species can be compared with a predicted post-fire total of 683.

Culturally-Significant (Food) Plants

Two species from the final "at risk of local extirpation" category discussed above are also culturally-significant plants. Both of these species occur in very limited abundance within the steppe ecological setting of the Tower Fire Zone. These species are Bitterroot (*Lewisia rediviva*) and Clustered Broomrape (*Orobanche fasciculata*).

Of the fifty-six culturally-significant plant species documented in botanical surveys of the Tower Fire Analysis Area prior to the fire, two species may have been extirpated as a result of the fire. It is probable that the number of culturally-significant species has been reduced from 56 to 54 as a result of the fire.

Noxious Weeds

Prior to the Tower Fire, the thirteen species of noxious weeds with documented occurrences in the fire zone were evenly distributed across the ecological settings. This even distribution of 10 or 11 noxious weed species per ecological setting is attributable to the high correlation between noxious weed populations and transportation corridors which penetrate virtually all of the settings.

Because of the sparsity in vegetative cover, the drier ecological settings remain the most vulnerable to noxious weed invasions. Since the Tower Fire altered the light regime in forested ecological settings, the risk of noxious weed invasion has been elevated by the fire.

It is very probable that two noxious weed species which were recently (1997) added to the Forest's noxious weed list and which occur adjacent to the Tower Fire area will colonize the appropriate habitats of the burned area. Common Cocklebur (*Xanthium strumarium*) and Ventenata Grass (*Ventenata dubia*) have been increasing in abundance on the North Fork John Day District since they were first documented in the 1980's (Urban, 1990 and 1985). Common Cocklebur will probably colonize the gravel bars of Texas Bar and Oriental Creeks. Its present population center is the newly exposed gravel bars along the main stem North Fork John Day River between Oriental and Sheep Creeks. Ventenata grass is beginning to invade the scabland habitat throughout the Umatilla National Forest. This species becomes unpalatable to ungulates early in the season and has a greater capacity to disrupt the normal fire regime than does Cheat Grass (*Bromus tectorum*).

During suppression activities associated with the Tower Fire, an abundance of thistle down was constantly in the air. The sources of these thistle seeds were patches of Canada Thistle (*Cirsium arvense)* and Bull Thistle (*Cirsium vulgare*) that occurred within the fire boundary. Because of the universal occurrence of these species across the North Fork John Day District and the Umatilla National Forest and because of budgetary constraints which allow the treatment of only the most aggressive noxious weed species, these species are frequently not "tracked" by districts. The combination of freshly-exposed soils an abundance of windborne thistle seed indicates that both species will rapidly invade the burn. Because of its rhizomatous nature, Canada Thistle may diminish the success of restoration activities if it widely colonizes the burned area. Bull Thistle, conversely, appears to invade freshly disturbed soils as a pioneer species and then gradually decline after three to five years (Urban, 1985 and 1990).

The recommendations section encourages the North Fork John Day Ranger District to conduct frequent noxious weed inventories in the burned area in an effort to check noxious weed invasions that have been triggered by the fire.

Historically-listed and Presently-listed Sensitive Plant Species

Analysis of the historically-listed sensitive plant species that were documented in the Tower Fire ecosystem prior to the fire indicates that none of the 22 species were of such limited distribution and abundance that they will face local extirpation or enter a trend toward re-listing.

It is impossible to predict the effects of the Tower Fire on the single presently-listed sensitive plant species. When this single plant of *Botrychium* was found during the 1993 Neeves Creek botanical survey, it was too immature to key to species. Field notes (Yanskey, 1993) indicate that it was most probably *Botrychium minganense* and that it occurs just <u>outside</u> the burned area. Although the Oregon Natural Heritage Program considered de-listing *Botrychium minganense* at its Bend, Oregon, meeting of 1994, this change in status is not reflected on the Regional Forester's Sensitive Plant Species List which was last revised in June of 1991. The Heritage Program's actions were based on widespread distribution and sighting records exceeding 100 within just Oregon.

In answering the key question "What terrestrial and/or aquatic species have been extirpated from the fire area (if any), or are at risk because of fire-caused changes?" it appears that no historically-listed sensitive species will enter a trend toward re-listing as a result of the fire. Because of the many uncertainties associated with the single presently-listed sensitive plant sighting (identification problems, location problems—inside or outside the fire boundary, and exact list status questions) it is impossible to accurately answer the question for presently-listed sensitive plant species. Assuming a worst-case scenario, if the single plant found on Neeves Creek in 1993 is indeed *Botrychium minganense* and its occurrence is within rather than outside the fire boundary and if the species is retained on the Regional Forester's Sensitive Plant Species List when it is next revised, then there is a high probability that this sensitive species was locally extirpated from the fire zone as a result of the fire. Because adjacent populations of this species are about 6 miles south of the Neeves Creek site and because the fire-altered light regime of the habitat would be unsuitable for *Botrychium minganense*, this species is unlikely to re-colonize the burned area within the next decade or even longer.

Floristic Biodiversity: Conclusions for Current Conditions

The native plant life of the Tower Fire ecosystem has evolved under a moisture regime consistent with the natural fire cycle. Many plant species enter a state of drought-induced physiological dormancy by mid-summer and become less susceptible to destruction by fires that naturally occur in late summer and early autumn. Because fire suppression activities over much of the present century have caused changes in stand composition and elevated fuel loading, the burn intensity in portions of the Tower Fire was higher than it would have been under natural conditions.

Although it is impossible to assess completely the impact of the Tower Fire on all native plant species known to occur in the area, the floristic biodiversity analysis indicates that the fire altered the light regime of the understory and that, consequently, shade-dependent species will be slow to revegetate the severely burned areas. In instances in which plant species are of such limited abundance and distribution across the landscape, there may be no refugium or reservoir from which revegetation can be initiated. Twenty-two native plant species were identified in this analysis as being locally extirpated as a result of the fire.

This analysis indicates that changes (losses) in the floristic biodiversity of the Tower Fire Ecosystem will not be exacerbated by salvage operations. The biggest impact of the fire to native vegetation was the alteration of suitable habitat for shade-dependent species. The rate at which native species will reinvade the fire-altered habitats is species-specific, site-specific, and defies scientific prediction.

In conclusion, activities that will facilitate an ecologically-appropriate restoration of the Tower Fire will accelerate the re-establishment of native vegetation. In portions of the burn that supported forest-type vegetation prior to the fire, salvage operations and reforestation projects will enhance, rather than delay, the rate of re-establishment.

Fish and Aquatic Habitat

Fish Populations

Figure 21 shows streams by fire intensity. The fire burned at high intensity along substantial portions of Texas Bar, South Fork Cable, North Fork Cable, Winom, Oriental and Sheep Creek. This resulted in fish kills in at least some of these streams. North Fork John Day Ranger District fisheries personnel sampled South Fork Cable, Oriental and Texas bar Creek for fish survival in the weeks immediately following the fire. The sampling sites in the high intensity burn areas are also shown on Figure 21. District personnel also sampled Hidaway Creek, but the sampling there was directed more at evaluating the effects of the retardant drop in the creek. Table 18 summarizes the sampling results. The fire apparently extirpated fish from at least several stream segments in South Fork Cable, Oriental and Texas Bar Creeks. Fish numbers were much reduced in the affected portion of Hidaway Creek.

Table 18 - Fish Sampling by NFJD District Personnel in The Tower Fire Streams

	Status of Fish Population		
Stream	**Site 1**	**Site 2**	**Site 3**
S. Fk. Cable Creek	Rainbow & Sculpins (reduced numbers)	No Fish	No Fish
Oriental Creek	No Fish	No Fish	
Texas Bar Creek	No Fish	No Fish	
Hidaway	Rainbow & Sculpins (severely reduced numbers)	Rainbow & Sculpins (severely reduced numbers)	Rainbow & Sculpins (Severely reduced numbers)

Source: North Fork John Day Ranger District fisheries personnel.

District fisheries personnel also sampled aquatic invertebrates. The invertebrate data has not yet been tabulated or interpreted. Because of site remoteness and lack of time and personnel, the areas which burned at high intensity in North Fork Cable and Winom Creek were not systematically sampled after the fire. However, members of the Burned Area Emergency Rehabilitation (BAER) team observed dead fish in Winom Creek (Christine Hirsch, personal communication).

Aquatic Habitat

Those segments of streams over which the fire burned at high intensity will have more soil damage than other areas and will be especially susceptible to sedimentation from hill slope soil erosion (Beschta, 1990; McNabb and Swanson, 1990). Winom Creek and upper North Fork Cable Creek suffered the most high intensity fire (Table 19), although South Fork Cable, Texas Bar and Oriental creeks also experienced substantial lengths of high intensity burn. Where the fire burned at either high or moderate intensity, most vegetation is dead or will die within a year (David Powell, pers. Comm.). This exposes these reaches to increased insolation and makes them vulnerable to water temperature increases (Beschta, 1990). Streams with substantial lengths in this category include: South Fork Cable Creek, Upper North Fork Cable Creek, Texas Bar Creek, Oriental Creek and some of the minor tributaries of the North Fork of the John Day River (Table 19 and Figure 21).

Figure 21
Fire Intensity on Tower Streams and
Fish and Invertebrate Sampling Sites

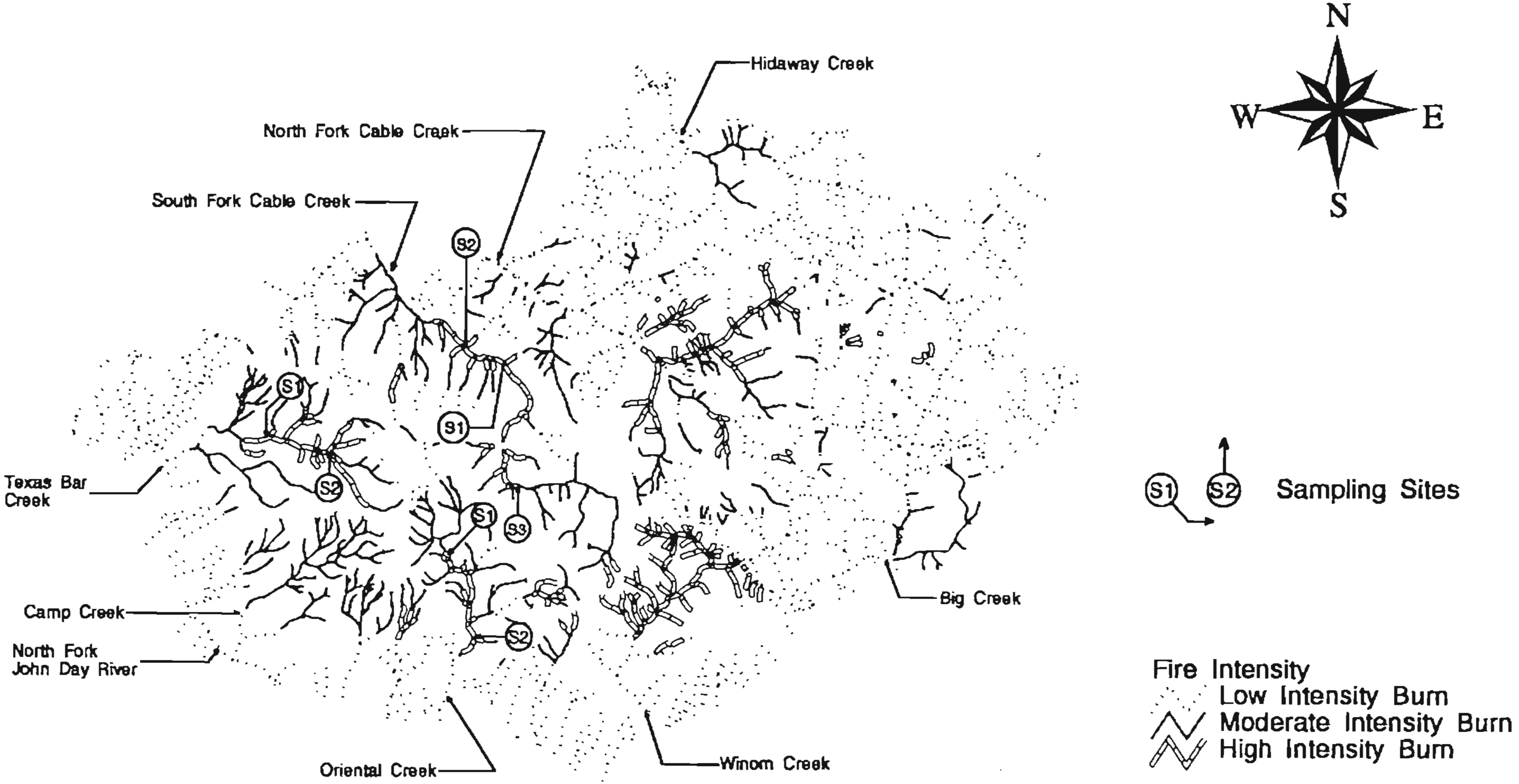


Table 19 - Lengths of streams subject to substantial habitat alteration from effects of the Tower Fire

Subwatershed (Major Stream)	Miles in Moderate Intensity Burn	Miles in High Intensity Burn	Total of High Plus Moderate Intensity
85d (Fly -- Upper Grande Ronde)	0.0	0.0	0.0
33a (Cable Creek Tributary)	0.9	0	0.9
33b (Lower North Fork Cable Creek)	6.6	0	6.6
33c (South Fork Cable Creek)	17.9	7.1	25.1
33d (Upper North Fork Cable Creek)	10.5	12.9	23.4
34a (Bridge Creek)	0.0	0.0	0.0
34b (Pine Creek)	0.0	0.0	0.0
35b (Texas Bar Creek)	12.1	5.5	17.6
35c (NFJD & minor tribs. Otter)	3.0	0.0	3.0
35d (NFJD & minor tribs. -- Camp, Sulphur)	16.7	1.0	17.7
35e (Oriental Creek)	13.0	4.2	17.2
95a (Winom Creek)	4.0	14.4	18.4
95b (Big Creek)	5.1	0.6	5.7
96a (Lower Hidaway)	0.0	0.0	0.0
96b (Upper Hidaway)	6.0	0.1	6.1

Aquatic habitat will have changed from immediate pre-fire conditions primarily in the amount of shade and vegetative hiding cover remaining over the stream. This will be mostly gone in areas that burned at high intensity (Figure 21), much reduced in areas that have burned at moderate intensity and may be still mostly present in areas that burned at low intensity. The Forest silviculturist (Dave Powell, personal communication, see silviculturist's report for Tower Fire) estimates that within one year, more than 95 percent of the trees will be dead in the areas that burned at moderate intensity. In that case, shade and hiding cover for fish will be mostly gone in those areas, too.

Cursory observation shows that considerable new wood has been added, and will continue to be added, to most of the streams as a direct result of the fire, particularly in areas that burned at high or moderate intensity. This will partially compensate for loss of live vegetative hiding cover.

Terrestrial Wildlife

Habitat

All or portions of the plant communities that provided wildlife habitat before the fire have burned. The composition and number of wildlife species in the area have changed and will continue to change in the burn area.

As a result of the fire, the area is predominately a homogenous landscape. Wildlife habitats remaining includes the following: early successional stage, dead standing trees, down woody material, rock outcrops, talus slopes, meadows, springs or seeps, and open water (streams and ponds). The area contains isolated and/or micro habitats of "green" tree patches or a scattering of individual "live" trees, primarily near the perimeter of the fire. The edge of the fire, contrasting the burned and unburned area, produces an ecotone high in habitat diversity and rich in wildlife species.

The Tower Fire burned several Management Areas at varying intensities Approximately six patches of Dedicated Old Growth (C1) and three patches of Managed Old Growth (C2) burned. The C1 and C2 units that were part of the Old Growth Network established in the Camas Watershed Assessment will be re-assessed. Eighty-three (83%) percent (3,013 acres) of Management Area C4, burned at high or moderate fire intensity. Forty-six (46%) percent (54 acres of Management Area C5 burned at moderate and high intensity and the remaining 54 percent (63 acres) burned at low intensity. All of Management Areas C3 (223 acres) and E2 (12 acres) burned at low intensity.

Old Growth Habitat

Approximately 1,000 acres of C1 and 159 acres of C2 management areas burned at high or moderate fire intensity. The remaining 36 acres of old growth habitat within the fire boundary burned at low intensity. Field reconnaissance of C1 and C2 management areas will be conducted to verify current habitat conditions.

A portion (44%) of the Camas Old Growth-Riparian Network occurred within the Tower Fire area. Mature and old/late blocks of network habitat burned at moderate or high intensity, killing most trees, with the possible exception of large diameter ponderosa pine

Dead Standing and Down Wood Habitat

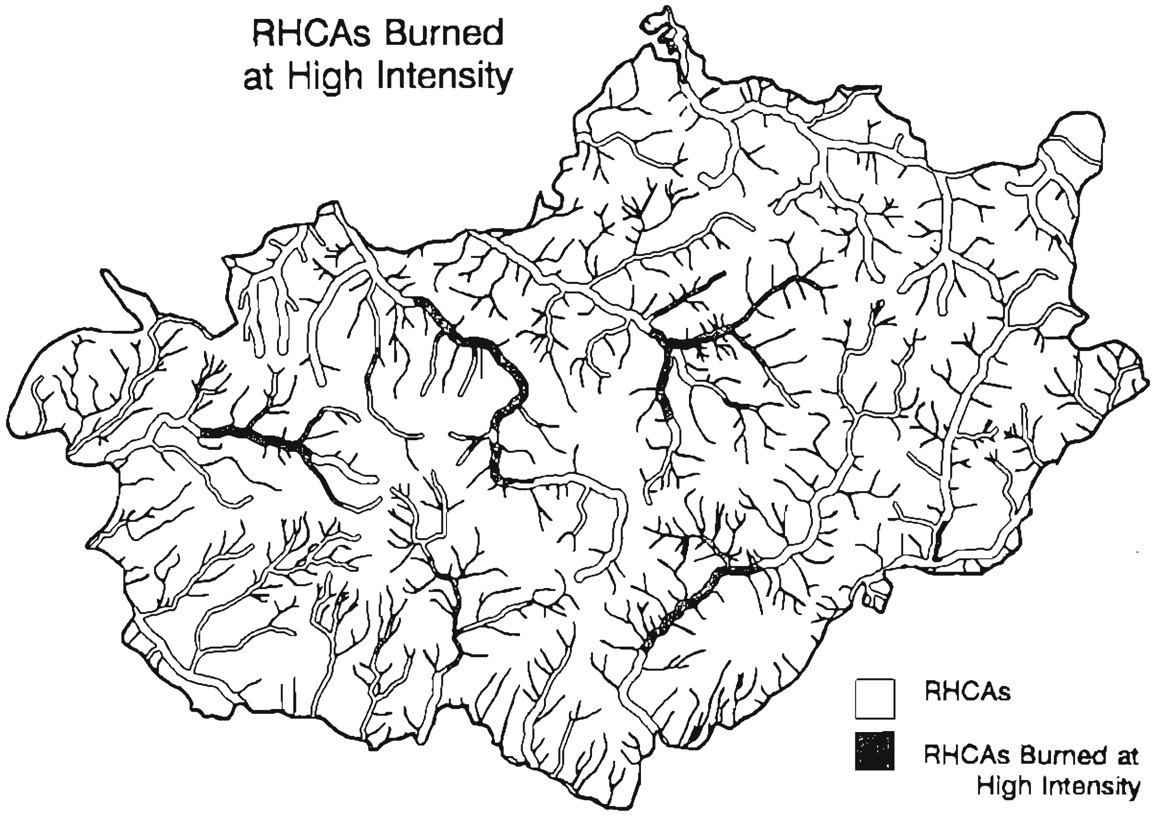
In the short term, overall snag densities will be high. All diameter classes will be represented and available for primary cavity excavators occurring in the area. However, dead standing trees will quickly begin to fall, especially in areas exposed to prevailing winds. Generally, the smaller diameter and less sound trees (at the base) will fall at a quicker rate than larger, more sound trees (base). Given the age, structure, and composition of the area before the fire, probably the majority of snags currently available are less than 16 inches d.b.h.. These small snags. are expected to fall within the next 3-5 years. Larger snags are expected to remain standing 10 or more years depending on their size.

Presently, down wood densities in the area are low, but will increase as snags begin to fall within the next three years. The majority of down wood expected to increase would be from small diameter trees (≤ 16" d.b.h.). Trees less than 14" in diameter would not meet the size class and length criteria (≥ 12" diameter (small end) and ≥ 6' in length) for wildlife habitat. Large (>14" diameter) dead standing trees would meet or exceed the need for wildlife habitat provided sufficient numbers occur on the site. However, larger trees are expected to stand longer, contributing little to down wood habitat for the next 10-15 years. In some areas, blowdown may contribute to a rapid increase in down logs, particularly in the smaller size classes, with a concurrent rate of snag loss.

Wetland, Riparian, and Aspen Habitat

Wetlands, riparian, and aspen communities were affected by the fire. Wetland and/or riparian habitat occurs, in all or portions of the stream channel in Texas Bar Creek, Oriental Creek, Winom Creek, Big Creek, Hideaway Creek, North Fork Cable Creek, and South Fork Cable Creek. The vegetation within wetland, riparian, and aspen communities was burned at different fire intensities, often severely affecting local plant community structure and composition. Vegetative communities which burned at low intensity should begin to recover within the next 3-5 years, but the wetland communities which burned at a high or moderate intensity may take longer to recover from the fire. Segments of Riparian Habitat Conservation Areas (RHCAs) burned at high intensity in the Tower Fire are identified in Figure 22.

Figure 22.



"Special" Habitats

Meadows, springs, and rock/talus were mostly unaffected by the fire. However, these habitats could be altered or lost through post-fire effects including erosion, mechanical disturbance, lack of shade, and significant changes to the adjacent burned landscape.

Species

In general, species richness for the area has been reduced following the fire. species diversity may be somewhat higher along the fire perimeter - the interface of two distinct habitats.

Two (2) threatened species have the potential to occur in the Tower area: the bald eagle and the peregrine falcon. The Tower area could potentially provide foraging habitat for both species. In addition, the North Fork John Day River provides potential nesting habitat for the bald eagle.

Three (3) Region 6, Regional Forester's Sensitive Species have the potential to occur in the Tower Fire area. They are the Townsend's big-eared bat, Preble's shrew, and California wolverine. Current habitat conditions provide suitable habitat for all of these species.

While all of the Forest Management Indicator Species (MIS) probably occurred in the area prior to the Tower Fire, post-fire habitat conditions should favor Rocky Mountain elk, northern three-toed woodpecker, and some primary cavity excavators. The pileated woodpecker and pine marten are expected to avoid the burn area. Suitable habitats may occur along the fire perimeter for all the MIS species.

Given the post-fire habitat condition , the anticipated vegetative composition and the expected rate of growth for the next 15-20 years, the burn area could potentially support 144 terrestrial wildlife species (Appendix E). This includes five amphibians, seven reptiles, 89 birds, and 43 mammals. Species richness was determined for the area by identifying the number of species with the potential to occur in each environmental setting (Table 20). Given the "normal" distribution of structural stages, the environmental settings with high species richness include ponderosa pine (64%), warm-dry forest (59%), riparian/wetland (59%), and cool-moist forest (44%). The environmental setting with the lowest species richness was rock/talus (15%).

Table 20. Potential habitat and species "richness" by ecological setting in the Tower Fire analysis area.

ECOLOGICAL SETTING	**"POTENTIAL" HABITAT (Availability)**		**CURRENT CONDITION**		**REFERENCE CONDITION**	
Group	Acres	Percent of Area	Number of Species	Percent Total Species by Setting	Number of Species	Percent Total Species by Setting
Ponderosa pine	7,115	14%	91	64%	113	64%
Warm-dry Forest	16,940	33%	84	59%	115	65%
Cool-moist Forest	10,828	21%	63	44%	89	50%
Lodgepole pine	9,386	18%	46	32%	67	38%
Cold-dry Forest	3,351	7%	52	36%	72	41%
Meadow / Scabland	1,062	2%	45	31%	46	26%
Riparian / Wetland	2,132	4%	84	59%	95	54%
Rock / Talus	4	<1%	26	18%	26	15%
Total	50,818	100%	142	-	177	-

The majority of species listed in Table 10 are directly associated with riparian habitat or dead standing tree habitat for part or all of their annual life cycle. In addition, species such as the bald eagle, peregrine falcon, wolverine, and many of the bats have large home ranges or are seasonal migrants, therefore limiting their use and dependency to the area. While many of the habitat features for these species are currently unsuitable, the area is expected to become increasingly suitable within the next 15-20 years as vegetative communities are partially restored.

Management Indicator Species

The Forest Management Indicator Species (MIS), Rocky Mountain elk, northern three-toed woodpecker, and some primary cavity excavators are expected to inhabit the Tower Fire area over the next 15-20 years. The pileated woodpecker is not expected to nest in the burn, although it may occasionally be observed foraging in the burn area. The pine marten is expected to avoid the burn because of the drastic reduction in closed canopy riparian forest. Suitable habitats may occur along the fire perimeter for all the MIS species.

Summer and winter foraging habitat for the Rocky Mountain elk should experience short term improvement as a result of the Tower Fire. The cover component for elk in the area has drastically been reduced, but suitable cover should re-develop 10-30 years after the fire.

The quality of elk calving habitat in the Tower area will be marginal through the first few years after the fire, with additional calving areas developing 3-5 years after the fire. However, many potential sites could be subjected to disturbances from post-fire activities; other sites may have been rendered unsuitable for decades as a result of high intensity fire.

Elk migration (spring and fall) is expected to continue through the burn area. Migration patterns may change as elk adjust to the burned conditions. Movement through the area will most likely be through areas with minimal exposure or disturbance. Migration through the area may also be at a quicker pace, as elk attempt to minimize their "vulnerability" to human disturbance.

Currently, open road densities in all the subwatersheds are below 1.3 miles per square mile. Open road densities will most likely increase from post-fire management activities (logging, planting, restoration, monitoring, recreation, etc.). This in turn will increase human activity over the area. With the combined loss of cover and increase in management activities, elk disturbance/displacement in the area is expected to be high.

Heritage Resources

All the known sites within the boundary of the Tower Fire were inspected after the fire. Several of the historic cabins had been damaged or destroyed. None of the sites had been damaged by fire suppression activities.

Recreation/Wilderness

Within the North Fork John Day Wilderness the Tower Fire burned 7900 acres (98%) of the Tower Unit, 3700 acres (4%) of the North Fork John Day Unit, and burned over 23 miles (17%) of wilderness trails and one trail bridge. These trails will remain closed until tread and drainage work can be completed.

The Tower Fire burned 16,300 acres (96%) of the South Fork-Tower roadless area and 60 percent of the Winom-Frazier OHV Complex including 48 miles (50%) of OHV trail and ten trail bridges. These trails will remain closed until tread, drainage, and bridge replacement work can be completed.

The Pearson Recreation Residence Tract had seven residences owned by private individuals. Three of these residences and numerous outbuildings were destroyed by the Tower Fire. Two outhouses and an outbuilding were burned at the Pearson Guard Station site. Rebuilding of these structures may or may not occur due to the costs of construction.

Winom Campground is closed, and will remain closed at least until summer 1997. A number of trailheads were burned over and will remain closed until hazard trees can be removed and signs replaced. Two mining claims lost appx. 1/2 mile of pipeline which must be replaced before operations can resume. The majority of the dispersed campsites were impacted by the fire and will not be usable and/or desirable for camping for several years. Overall, the recreational use within the Tower Fire Analysis Area is expected to decrease substantially during the next five to ten years until hazard trees come down and new vegetative growth occurs, making the area more visually appealing and providing improved big game habitat.

IV. Reference Conditions

Soils/Geology

Pre-fire erosion potential within the burn area is as follows:

High: 31,980	Moderate: 17,474	Low: 678

Erosion was not a significant problem pre-fire. While a few sections of road cut and fill are presenting problems revegetating, and a few sections of trail could use some improvement, general forest activity was creating little accelerated erosion.

At least one road failure (5510 in upper Oriental basin) has be observed where the road cuts through the lower portion of an older slump of volcanic colluvium. Exposed surfaces are prone to erosion. Road cuts, in particular, may erode when vegetation does not reestablish. Road cuts generally revegetate fairly easily in the area, although difficult sections exist (some of the major cuts along the 55 road, for example).

Geologic hazard mapping indicates small areas of existing slumps or escarpments on three of the quads within the fire area. There are three areas of 9, 10 and 11acres indicated in the upper Hidaway Creek headwaters (quad 64, 63). Another three areas of 5, 12, and 14 acres are mapped in the North Fork Cable Creek drainage within the roadless area. These slumps are mapped on the SRI maps and are indicative of some localized areas of geologic instability but are not necessarily of recent age. Quad 73 contains the 'Landslide' geologic unit (Qls) discussed elsewhere. Other known slide areas are mentioned elsewhere in this report. The individual units are quite small and not considered a significant risk for activity likely to be proposed other than road construction. A map was not developed separately for the fire area; the quad maps are available for viewing in the Supervisor's Office.

Table 21. -Geologic Hazard Acreage

QUAD	ACRE-TOTAL	LOCATION	TYPE
62	not mapped (in Qls)	middle Texas Bar	landslide debris
63	41	upper Hidaway; upper middle N. Frk Cable	slump
64	20	upper Hidaway	slump
73, 62	2,623 (Qls)	Qls geologic unit, middle Texas Bar	potential slumping or lndslide

Significant erosion and movement of materials to streams occurred in the 1970's in the Oriental Creek basin. This occurred when the bulk of the road system was constructed during a fairly extensive harvest operation. This also involved considerable skid road construction in the steep sidehills of decomposed granite in the middle and lower sections of the drainage.

Productivity

Some portions of the fire area have received prescribed fire treatments, generally confined to the lower elevations of ponderosa pine dominant forest. Individual harvest units from contemporary timber sales (notably Juniper-Cottonwood and Placer) have had unit by unit prescribed fire. Generally, fire has been suppressed in the area for many decades. Thus, the site productivity of much of the area has been increasing somewhat as biomass accumulates above ground in the absence of recurring fire (Landsberg 1992; Cochran 1996).

The dominant soils are relatively productive, especially those on the stable ridges with deep volcanic ash depths, and those on north-facing slopes or footslope positions. The shallow, more droughty soil types are capable of carrying less total biomass but can support large, widely spaced trees and populations of forbs and grass species adapted to those sites. Specifics of soil types, capabilities, and mapping is available via the SRI, GIS and soils database as needed.

Monitoring of harvest activity, primarily during and after the Juniper-Cottonwood and Placer timber sales, indicates some harvest units near or over Forest Plan guidelines for detrimental soil impacts. Soil compaction is the primary problem in these instances. It appears to be a cumulative effects situation - it is generally where several entries over the years has compounded to leave greater than desired levels of compaction in these units. These units may provide treatment opportunities. This is mentioned in the recommendations section following.

Watershed Hydrology

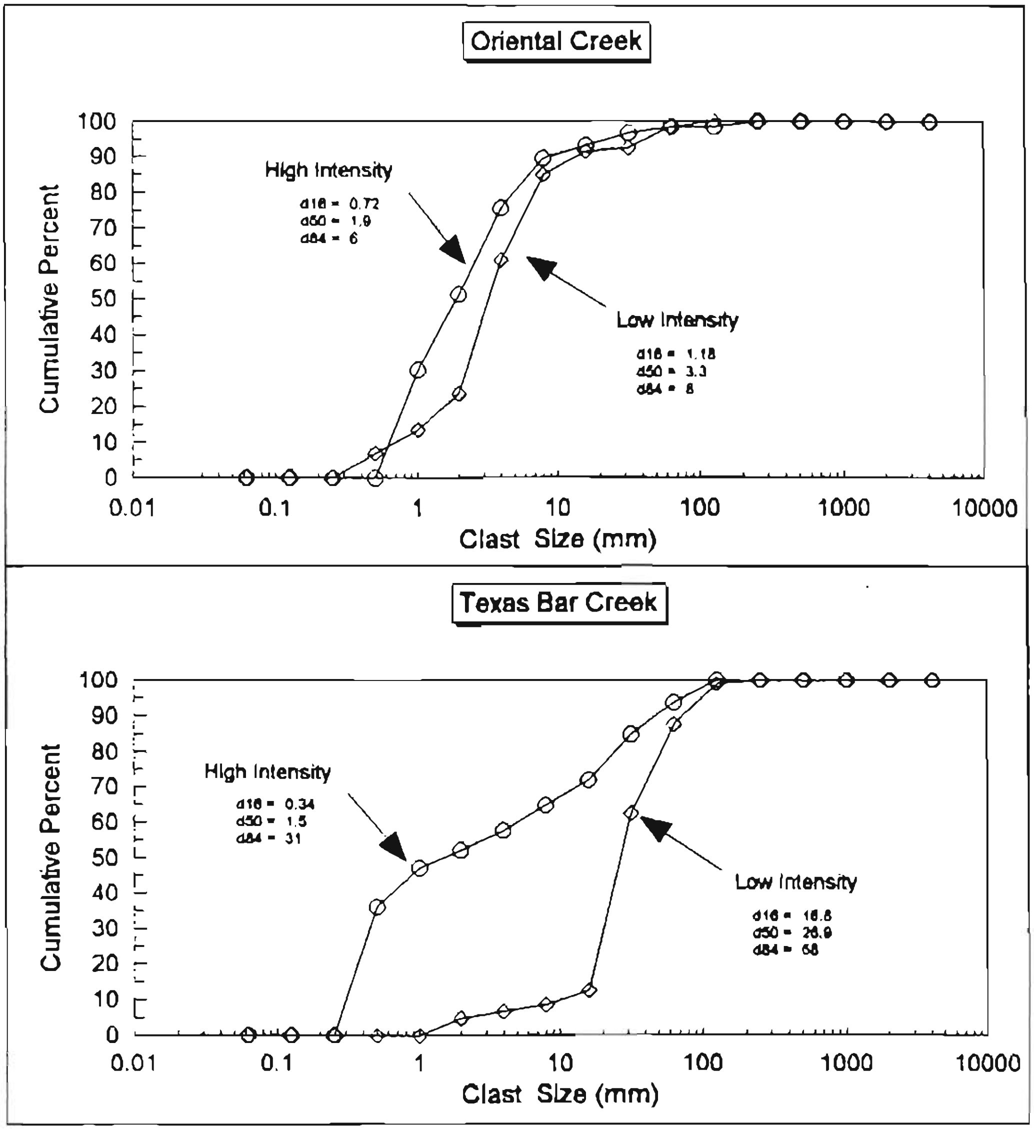
Pre-burn conditions for portions of the Tower Fire area are described in the Camas Ecosystem Analysis. Of note is the general issue of aquatic ecological health, reduced watershed function, and declining populations of Chinook salmon, steelhead trout, bull trout, and other aquatic species, themes that are repeated in the Tower Ecosystem Analysis. Also of note is the importance of Cable and Hidaway creeks to the Camas system in providing cold water refuge, one of the chief limiting factors to fish in the John Day Basin.

Nearby areas burned in the recent past such as the 1994 Boundary fire serve as reference of watershed response in the first few years after a major fire. For example, the majority of White Creek, a tributary to Big Creek, burned at high intensity, during this fire. In June 1995, a field review to evaluate watershed conditions noted vulnerable channel types and high sediment loads in headwater areas, although overall conditions were good given the severity of the fire, and riparian areas exhibited a recovering trend (ref 2523 memo to District Rangers, July 17, 1995). The 7-day moving average of the maximum daily water temperature in 1993 was 59.6°F. In 1995, the 7-day maximum temperature was 60.0°F (1994 data are not available). Both 1993 and 1995 were years with above-average precipitation, which may mask fire effects, if present. Longer records spanning pre and post-fire conditions are needed to capture effects of streamflow changes and canopy loss on water temperature.

Stream channel reference reaches were established on sections of Oriental and Texas Bar creeks, in the fall of 1996, to monitor channel response to the Tower Fire. Initial evaluation of the data shows differences in the composition of channel materials in low intensity reaches compared to high intensity reaches (Figure 23). Mean particle diameter in both high intensity reaches is in the coarse sand-size range compared to low intensity reaches where the average particle diameter is in the gravel-size range. The high intensity distributions are also in contrast; both surveyed high intensity reaches show a shift of particle sizes to the smaller, sand-size class, possibly indicating mobilization of upland and channel materials. Reaches were surveyed after several fall rain storms; field personnel had noted evidence of upland and instream erosion and sedimentation occurring in the fire zone, indicating what may be a rapid, measurable watershed response to the fire.

FIGURE 23

Umatilla National Forest: Fire Monitoring
Pebble-count data for Oriental and Texas Bar Creeks



Vegetation

Table 22 compares historical forest types (1937) with those that existed before the fire occurred in 1996. It shows that dry forests have declined 47 percent between 1937 and 1996, with a corresponding increase in mesic forest types. Although Table 22 also shows a high percentage increase in cold forest types, that change may not be real because the 1937 map did not distinguish cold-forest types to the same level of detail as current mapping. Figure 24 shows the geographical distribution of the 1937 forest type groups.

A substantial decline in dry forest types between 1937 and 1996 is a good example of an impact resulting from fire suppression over the last 75 years (see "Effects of Fire Suppression" in Current Conditions section). *Perhaps the most important management strategy that could be adopted for the Tower analysis area is one that would attempt to restore dry forests (those occurring on the ponderosa pine and warm dry ecological settings) to a level which approximates their historical abundance.*

Table 22: Comparison of historical and pre-fire forest cover type groups.

FOREST COVER TYPE GROUP	PERCENT OF AREA IN 1937	PERCENT OF AREA IN 1996	PERCENT CHANGE
Dry Forest	43%	23%	– 47%
Mesic Forest	30%	44%	+ 47%
Lodgepole Pine	27%	27%	0
Cold Forest	< 1%	6%	+ 500%

Source/Notes: The "percent of area in 1937" figures were derived from a 1937 forest type map prepared by the Pacific Northwest Forest and Range Experiment Station. Although the 1937 map varies somewhat from current standards, the 1937 types were grouped in a similar way as the 1996 types. The 1937 figures probably underestimate the true percentage of cold forest since some of that group was apparently included in a type that included higher elevation mixed-conifer forest (type code 19).

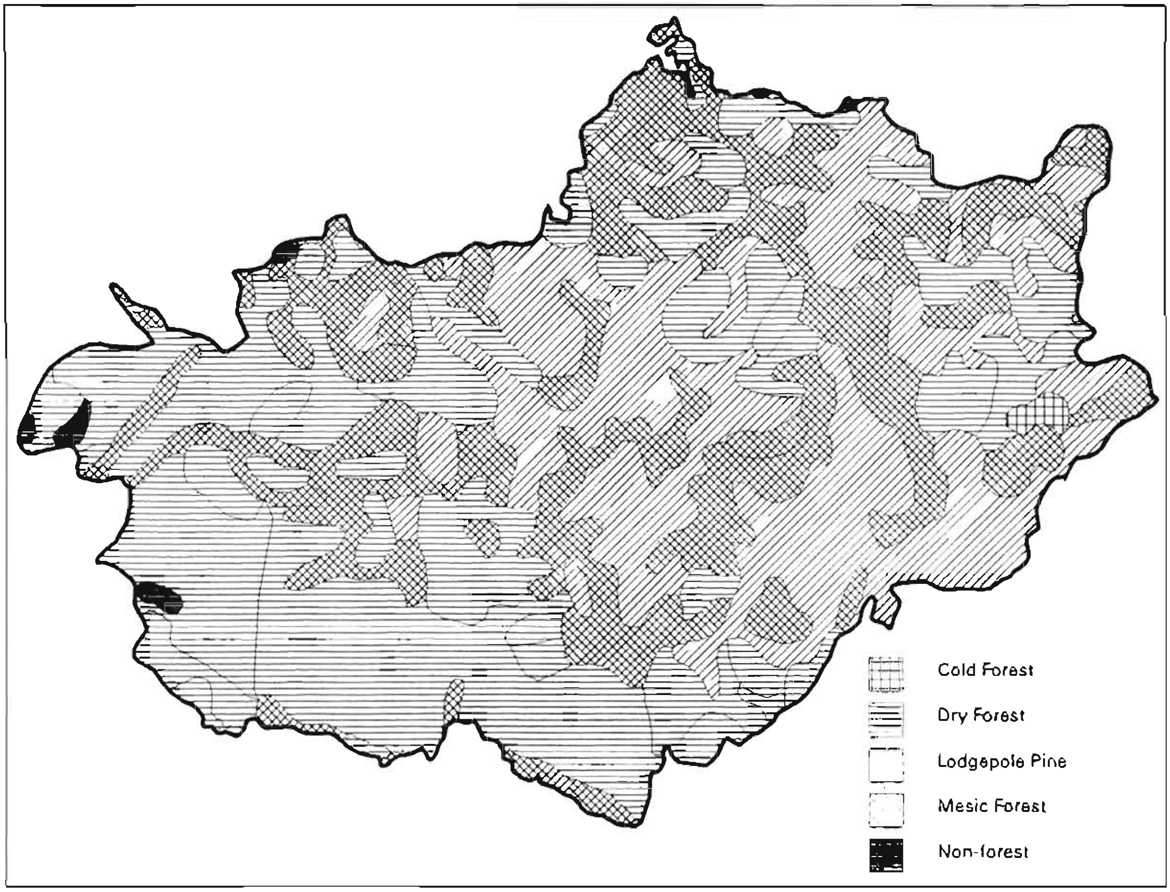


Figure 24 – Historical forest types. This map shows forest cover type groups as of 1937 (USDA Forest Service 1937). Cold forest was map symbol 03 on the 1937 map; dry forest was a combination of map symbols 06, 07, 08, 13, 14, 15, and 17 (ponderosa pine and Douglas-fir cover types); lodgepole pine was map symbol 04; mesic forest was map symbols 19 and 20 (true fir types); nonforest was map symbol 01.

Floristic Biodiversity

General

This portion of the Tower Fire Ecosystem Analysis focuses primarily on the pre-fire non-arborescent (non-tree) vegetation of the burned area.

The Tower Fire of August, 1996, impacted nearly 51,000 acres in portions of five watersheds (Cable Creek, Bridge-Pine Creeks, North Fork John Day River, Big Creek, Hidaway Creek, and the Upper Grande Ronde River) of the Umatilla National Forest. The fire zone centered on a prominent physiographic feature known as Pearson Ridge. Pearson Ridge is bordered by broad expanses of meadowlands along Camas Creek to the North and by the canyon-like channel of the main stem of the North Fork John Day River to the south. The microhabitats for the plant species of the fire zone show considerable contrast between the north-facing slopes and south-facing slopes of Pearson Ridge. The elevational relief of the fire area is another physical feature contributing to floristic biodiversity. Elevations in the fire area range from 3,050 feet near the confluence of Nye Creek and the main stem of the North Fork of the John Day River to 6,800 feet near the Tower Mountain Lookout.

All of the ecological settings or groups of plant associations used in the watershed analysis process on the Umatilla National Forest are represented in the burned area. The southern and western aspects of Pearson Ridge support Ponderosa Pine Forest and Warm, Dry Forest types. The northern and eastern aspects of Pearson Ridge support Cool, Moist Forest types and Lodgepole Pine Forest. Lodgepole pine appears to be the first seral tree species to reinvade islands in the other vegetative types that have been created by either natural or management-initiated disturbance. High elevation ridges support Cold, Dry Forest types dominated by Subalpine Fire (*Abies lasiocarpa*). The riparian or riverine corridors in the burn area are extensive and particularly prominent features of the south-facing slopes of Pearson Ridge. Steppe-type vegetation occurs on ridgetops and extremely steep slopes where soil depth is insufficient to support arborescent vegetation. Although only a small portion (< 1,000 acres) of the Tower Fire zone falls into the steppe ecological setting, this setting is extremely rich in terms of floristic biodiversity. Another poorly-represented (241 acres) ecological setting in the Tower Fire area is the meadow complex.

Prior to the Tower Fire several ecological imbalances were manifested in the dominant vegetation. Particularly in the Warm, Dry Forest there was evidence of excessive tree mortality and fuel loading in the forest understory. This imbalance was probably the product of historic fire suppression which allowed shade-tolerant, fire-susceptible species to replace shade-intolerant, fire-resistant species. In the absence of periodic, low-intensity fires and with domestic and native herbivory, the vegetation of the riparian corridors was also imbalanced and the understory thick with fuels. Most evident was the diminished suffrutescent (shrub) component of the south- and west-facing riparian zones. Particularly in the Oriental Creek and Texas Bar Creek riparian zones, the combination of fire suppression and grazing pressure resulted in diminished shrub communities.

Floristic Richness

Botanical surveys conducted in the Tower Fire area prior to the August 1996 fire covered approximately 95 percent of the area that ultimately was burned. Records from these pre-fire surveys were analyzed for this part of the Tower Fire Ecosystem analysis. Table 23 summarizes the pre-fire information on the 705 vascular plant species known to occur in the Tower Fire area.

Table 23 Ecological settings, acreages, and number of plant species documented in each setting in botanical surveys of the Tower Fire Analysis Area prior to the fire.

Ecological Setting	Number of Acres	% Acreage of Tower Fire area	Number of Vascular Plant Species	% Total Species of Tower Fire area
Ponderosa Pine	7,115	14%	332	47%
Warm, Dry Forest	16, 940	33%	339	48%
Cool, Moist Forest	10,828	21%	272	39%
Lodgepole Pine Forest	9,386	18%	226	32%
Cold, Dry Forest	4,626	6.5%	267	39%
Steppe	821	1.6%	423	60%
Riparian/ Riverine	2,132	4.1%	446	63%
Meadow	241	.004%	147	21%
Total	50,818 acres	100%	705 (not additive)	

One important outcome of the floristic biodiversity analysis provides supporting evidence for the ecological imbalance mentioned above. As with other watershed analyses conducted on the Umatilla National Forest, the coefficient of floristic similarity between the Warm, Dry Forest and Ponderosa Pine Forest was 90 percent. This indicates that a gradual conversion of Ponderosa Pine Forest to Warm, Dry Forest has occurred but similar changes have not been reflected in the understory vegetation.

Pre-fire qualities of the vegetation of the Tower Fire area include the ratio of native to non-native species. This ratio is 87.5 percent native species to 12.5 percent non-native species. This ratio is consistent with similar comparisons conducted in other watershed analyses on the Umatilla National Forest (Urban, 1994,1995, 1996).

Analysis of pre-fire data limited to native species indicates that 221 plant species were of limited distribution and/or limited abundance that they were considered in the first category of "plant species potentially at risk of local extirpation." Plant species with abundance but distribution limited to one ecological setting are eliminated from consideration for inclusion in the second category of "plant species potentially at risk of local extirpation." This analysis placed twenty-two of the 221 first category species in the second category (both limited abundance and limited distribution). It is probable that these twenty-two species (discussed under Current Conditions - Floristic Biodiversity) were locally extirpated from the Tower Fire area as a result of the fire. The total vascular floristic richness (native and introduced species) of the area was probably diminished from 705 to 683 species as a result of the fire.

Comparisons of native and introduced plant species encountered in the Tower Fire area are summarized by ecological setting in Table 24 below. The numbers are not additive since many of the same species occur in several ecological settings. These figures do not represent the acreages occupied by introduced species. Many (about 50%) of the 88 introduced species were deliberately seeded in the fire zone over past decades.

A list of all of the vascular plant species encountered in the Tower Fire area appears in Appendix D. Lists of native species by life form and ecological setting are provided in Appendix D.. These lists may prove useful in restoration activities involving native species.

Table 24. Ecological settings, acreages, number of plant species documented in each setting, and number of native plant species encountered in botanical surveys of the Tower Fire Analysis Area prior to the fire.

Ecological Setting	Number of Acres	Number of Species Encountered	Number of Native Species Encountered	% Native Species
Ponderosa Pine	7,115	332	273	82%
Warm, Dry Forest	16, 940	339	280	82%
Cool, Moist Forest	10,828	272	232	86%
Lodgepole Pine Forest	9,386	226	184	81%
Cold, Dry Forest	4,626	267	226	85%
Steppe	821	423	343	74%
Riparian/Riverine	2,132	446	391	88%
Meadow	241	147	139	96%
Total	50,818 acres	705 (not additive)	617 (not additive)	

Culturally-Significant Food Plants

Pre-fire botanical data indicates that a total of 56 culturally-significant (food) plant species were documented in the Tower Fire area. The distribution of these plant species across ecological settings of the burn area are given in Table 25 below. Since these species may occur in several ecological settings, the numbers are not additive.

Table 25. Ecological settings, acreages, number of plant species documented in each setting, number of native plant species, and number of culturally-significant (food) plant species encountered in botanical surveys of the Tower Fire Analysis Area prior to the fire.

Ecological Setting	Number of Acres	Number of Species Encountered	Number of Native Species Encountered	Number of Culturally-Significant Plant Species
Ponderosa Pine	7,115	332	273	31
Warm, Dry Forest	16, 940	339	280	30
Cool, Moist Forest	10,828	272	232	26
Lodgepole Pine Forest	9,386	226	184	22
Cold, Dry Forest	4,626	267	226	28
Steppe	821	423	343	34
Riparian/ Riverine	2,132	446	391	27
Meadow	241	147	139	21
Total	50,818 acres	705 (not additive)	617 (not additive)	56 (not additive)

Noxious Weeds

Prior to the Tower Fire, 13 plants listed on the Forest's list of noxious weeds were encountered in the burn area. Of these thirteen species, the North Fork John Day Ranger District has aggressively and effectively pursued the control of four of the most problematic species. Two noxious weed species that occur in areas proximal to the Tower Fire were added to the Forest's noxious weed list in 1997. Both Common Cocklebur (*Xanthium strumarium*) and Ventenata Grass (*Ventenata dubia*) can be expected to invade suitable habitats in the burn areas from their present "reservoir" populations. Common Cocklebur is presently abundant on the freshly-exposed gravel bars on the main stem of the North Fork John Day River between Overtime Spring and Oriental Creek. Ventenata Grass populations are now starting to explode principally in the grazed rangelands of the North Fork John Day Ranger District and also on the canyon benchlands of the Pomeroy Ranger District.

The occurrence of noxious weeds across the ecological settings of the Tower Fire area are given in Table 26 below. The numbers of species are not additive since each species occurs in multiple ecological settings.

Table 26. Ecological settings, acreages, number of plant species, and number of noxious weed species by ecological setting.

Ecological Setting	Number of Acres	Number of Species Encountered	Number of Noxious Weed Species Encountered
Ponderosa Pine	7,115	332	12
Warm, Dry Forest	16, 940	339	11
Cool, Moist Forest	10,828	272	10
Lodgepole Pine Forest	9,386	226	10
Cold, Dry Forest	4,626	267	10
Steppe	821	423	11
Riparian/Riverine	2,132	446	11
Meadow	241	147	4
Total	50,818 acres	705 (not additive)	13 (not additive)

Historically-listed and Presently-listed "Sensitive Plant Species"

Twenty-two plant species with historic status on the Regional Forester's List of Sensitive Plant Species were documented in botanical surveys of the Tower Fire area. There is a remote possibility that a single plant of a currently-listed sensitive species (*Botrychium minganense*, Mingan Grapefern) occurs within the fire area (see discussion under Current Conditions on p.68) The twenty-two historically listed sensitive species were de-listed because documented sightings (processed by the Oregon Natural Heritage Program) and population sizes exceeded the definition of "sensitive."

Distribution of historically-listed sensitive species is summarized in Table 27 below. The numbers are not additive since a single species may occur in multiple ecological settings. If the identification of the potential presently-listed sensitive species (*Botrychium minganense*) is confirmed and it does indeed occur within the fire boundary (it appears to be just outside the boundary at the present time) , then its ecological setting would be "meadow."

Table 27. Ecological settings, acreages, number of plant species, and number of historically-listed "sensitive" plant species by ecological setting.

Ecological Setting	Number of Acres	Number of Species Encountered	Number of Historically-listed "Sensitive " Plant Species
Ponderosa Pine	7,115	332	9
Warm, Dry Forest	16, 940	339	10
Cool, Moist Forest	10,828	272	7
Lodgepole Pine Forest	9,386	226	6
Cold, Dry Forest	4,626	267	10
Steppe	821	423	14
Riparian/Riverine	2,132	446	13
Meadow	241	147	3
Total	50,818 acres	705 (not additive)	22 (not additive)

Fish and Aquatic Habitat

Fish Distribution

At this point, no quantitative, historical (pre-management) data regarding fish distribution is available, but rainbow trout/steelhead probably inhabited most, if not all, of the named streams and many of their tributaries in the area.

Chinook salmon are known to utilize the North Fork John Day River and Hidaway Creek, downstream of the burned area, for spawning and migration, and many of the smaller streams for rearing. Historically, their distribution may have been more extensive. Fish distribution in the Tower Fire Analysis Area immediately prior to the burn is shown in Figure 25.

Bull trout were historically probably less plentiful than rainbow or steelhead but more numerous and distributed more extensively than they are today.

Brook trout are an exotic species, but now seem to be well established in some parts of the John Day River system.

Aquatic Habitat

Quantitative, historical (pre-management) information on fish habitat quality is not available. However, several other reference standards may be applicable. These include:

1. Pacfish standards (1995) for some parameters (pool frequency, woody debris frequency, water temperature, width/depth ratios -- Appendix G)
2. Compilations of values for aquatic habitat parameters from the database constructed by the

Eastside Ecosystem Management Project (pool frequency, large pool frequency, width/depth ratios, wood frequency – Appendix H).

3. Oregon State Department of Environmental Quality (DEQ) standards for water temperature (Appendix I).
4. Conditions immediately prior to the Tower Fire, while not appropriate as standards, may prove a useful reference for understanding some post-fire conditions and for developing management recommendations. USFS stream survey data and water temperature records since 1991 are available for some of these streams.

Of those streams which are at least partly within the fire boundary, most would have met the Pacfish "east of the Cascade crest" standards for large woody debris prior to the fire, Texas Bar Creek and two tributaries of Camp Creek being notable exceptions (Figure 26). All but reach two of Oriental Creek were well below the 50th percentile of the wood frequency data from the Eastside analysis (Figure 27). In any case, several reaches were very low in woody debris. Two major streams (Winom Creek and Big Creek) have not been surveyed with USFS/Hankin & Reeves protocol.

Pool quality before the fire in most of these streams compares favorably to Pacfish standards (Figure 28). It does not compare as well to the Eastside EIS data 50th percentile (Figure 29). Pool frequency was generally low in these streams before the Tower Fire and large pools were mostly absent (Figures 30 & 31).

Some of the streams in the Tower Fire Analysis Area, especially the lower reaches of Oriental Creek and Winom Creek, flow through substrates that are very susceptible to erosion and some of which tend to produce larger proportions of fine sediments in the stream. The hydrology and soils portions of this report will develop this subject in greater depth. Some streams already have high proportions of fine sediment as their substrates (sand reported as dominant or subdominant – compare Figure 32 and Table 30). These reaches should probably be considered as at high risk for sedimentation from any additional disturbance.

No streams met Pacfish or Oregon DEQ standards for water temperature in all years of record (Table 28). Oriental Creek was the coolest and would have met Pacfish standards in 1993 and 1995. Upper Hidaway would have met Pacfish standards for temperature in 1995.

Figure 25.
Perennial Streams and Salmonid Distribution in Tower Burned Area

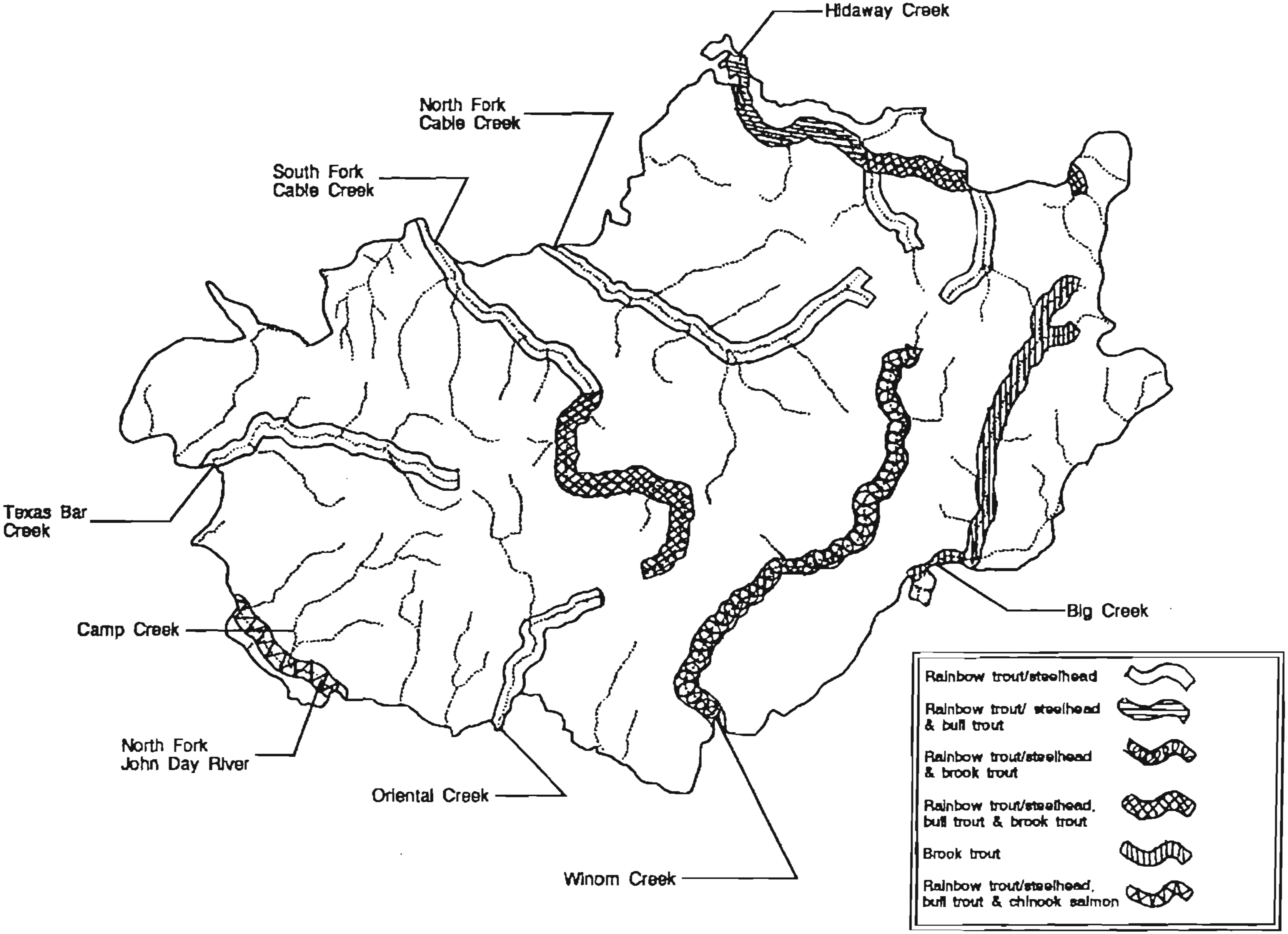


Figure 26

Wood Frequency in Pacfish Units

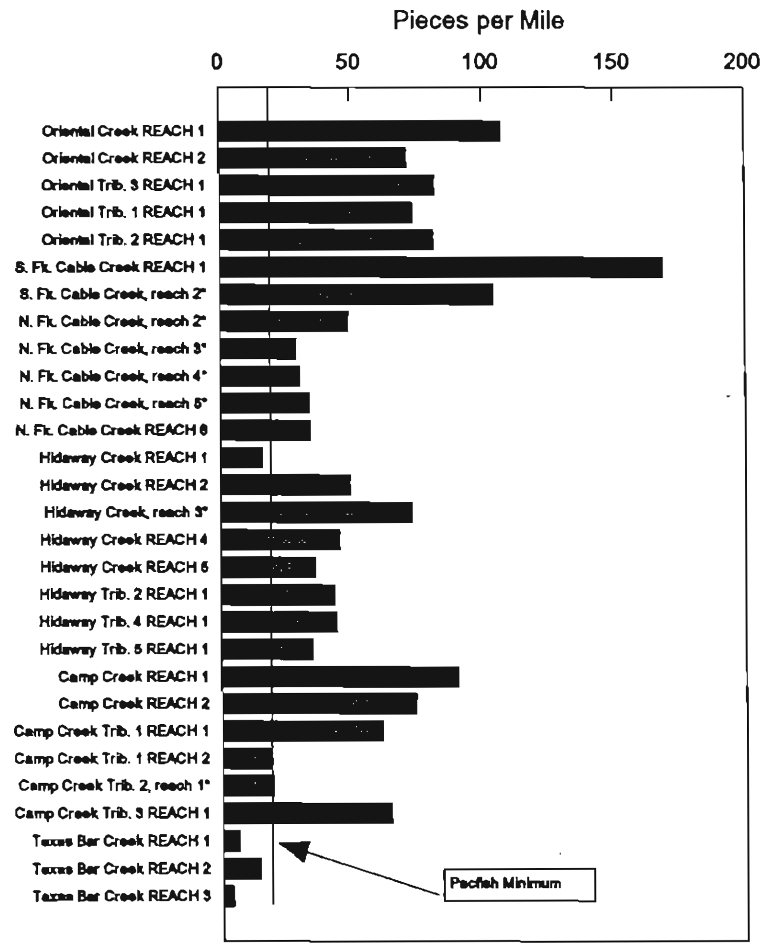
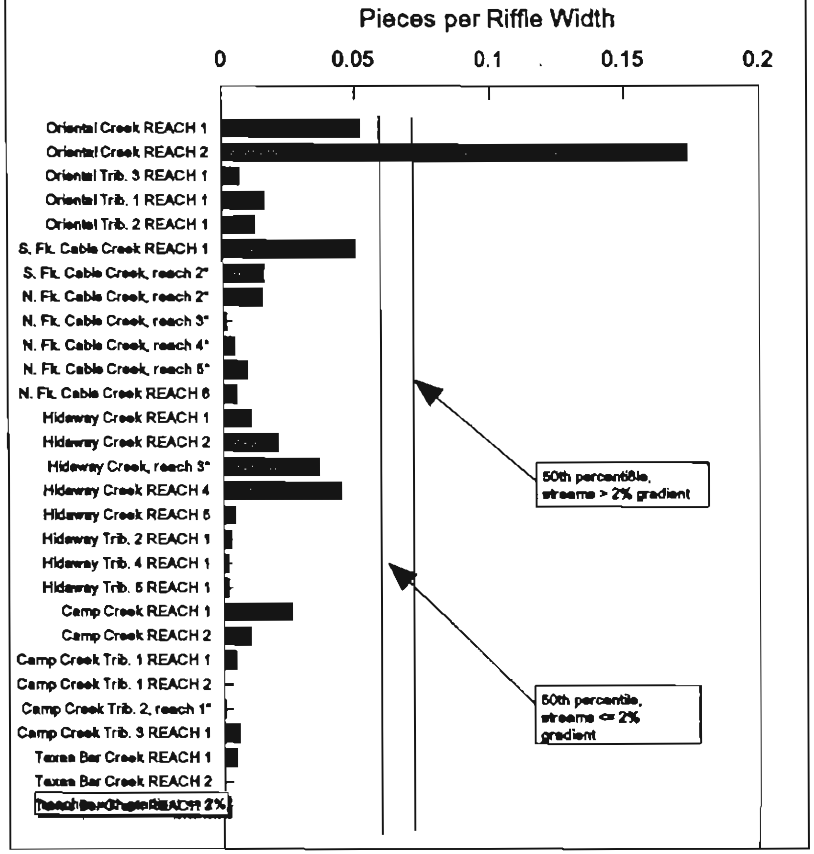


Figure 27

Tower Wood Frequency, in EEIS Units



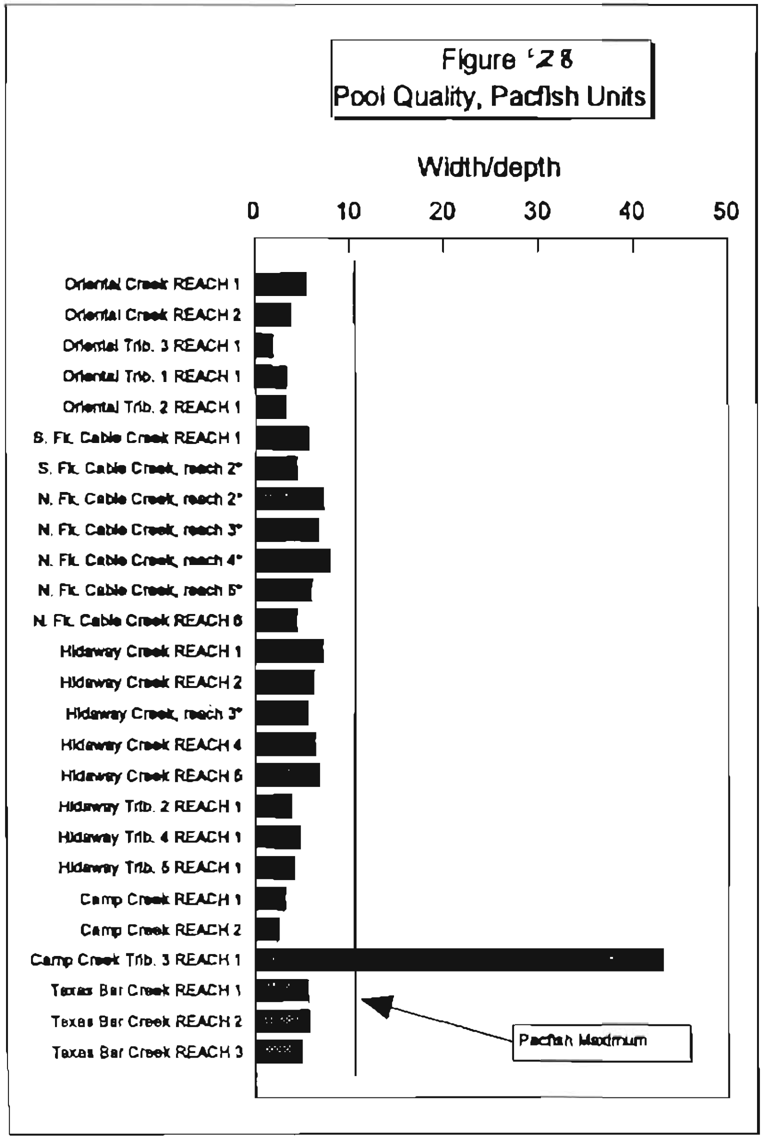


Figure 28
Pool Quality, Pacfish Units

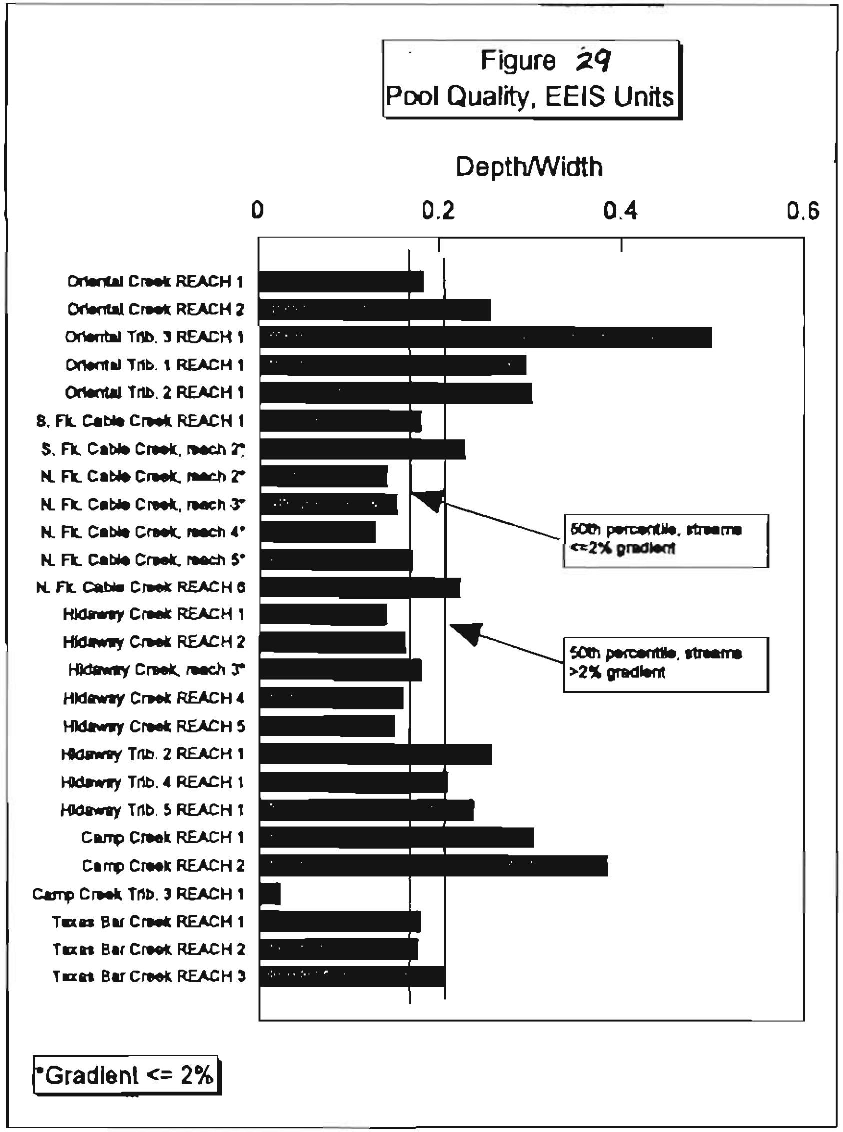
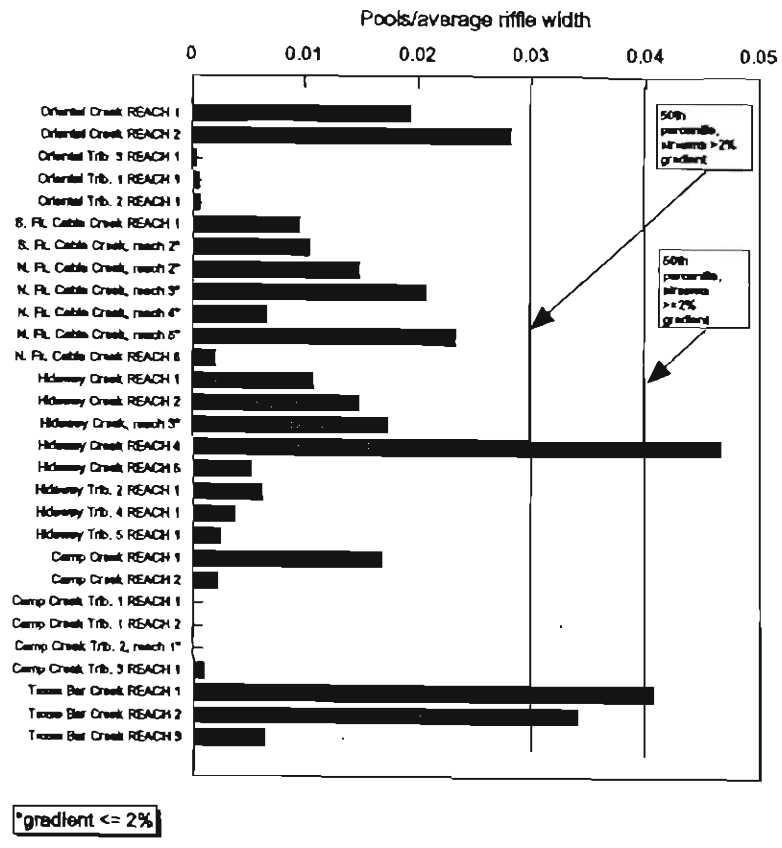


Figure 29
Pool Quality, EEIS Units

Figure 30
Pool Frequency, EEIS Units



*gradient <= 2%

Figure 31
Large Pool Frequency, EEIS Units

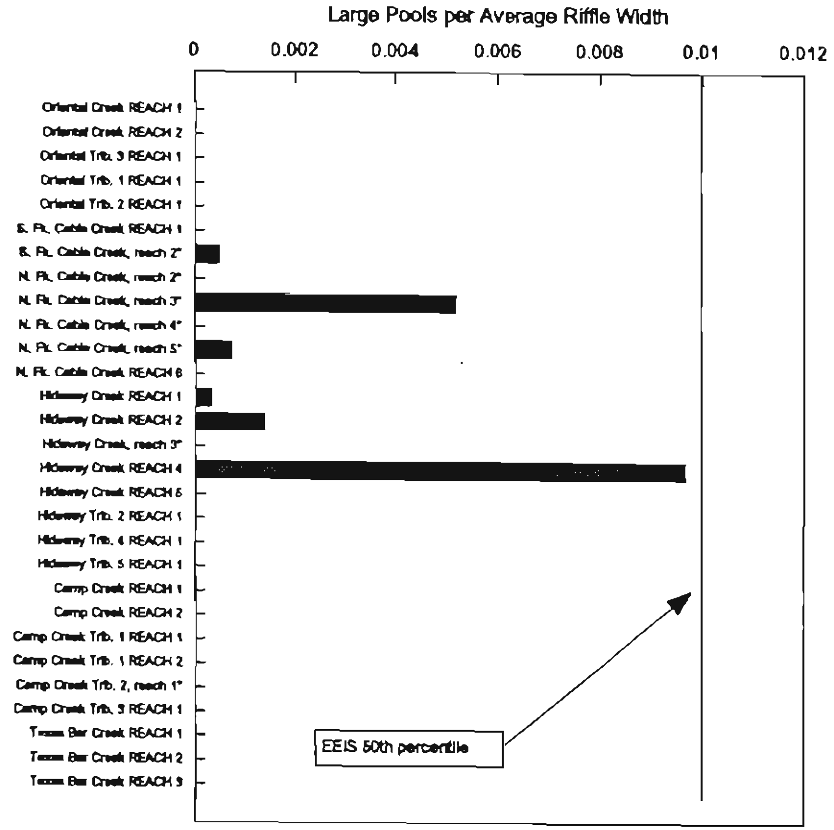


Figure 32
Stream Reaches within the Tower Fire
Surveyed by USFS (Hankin and Reeves) Protocol

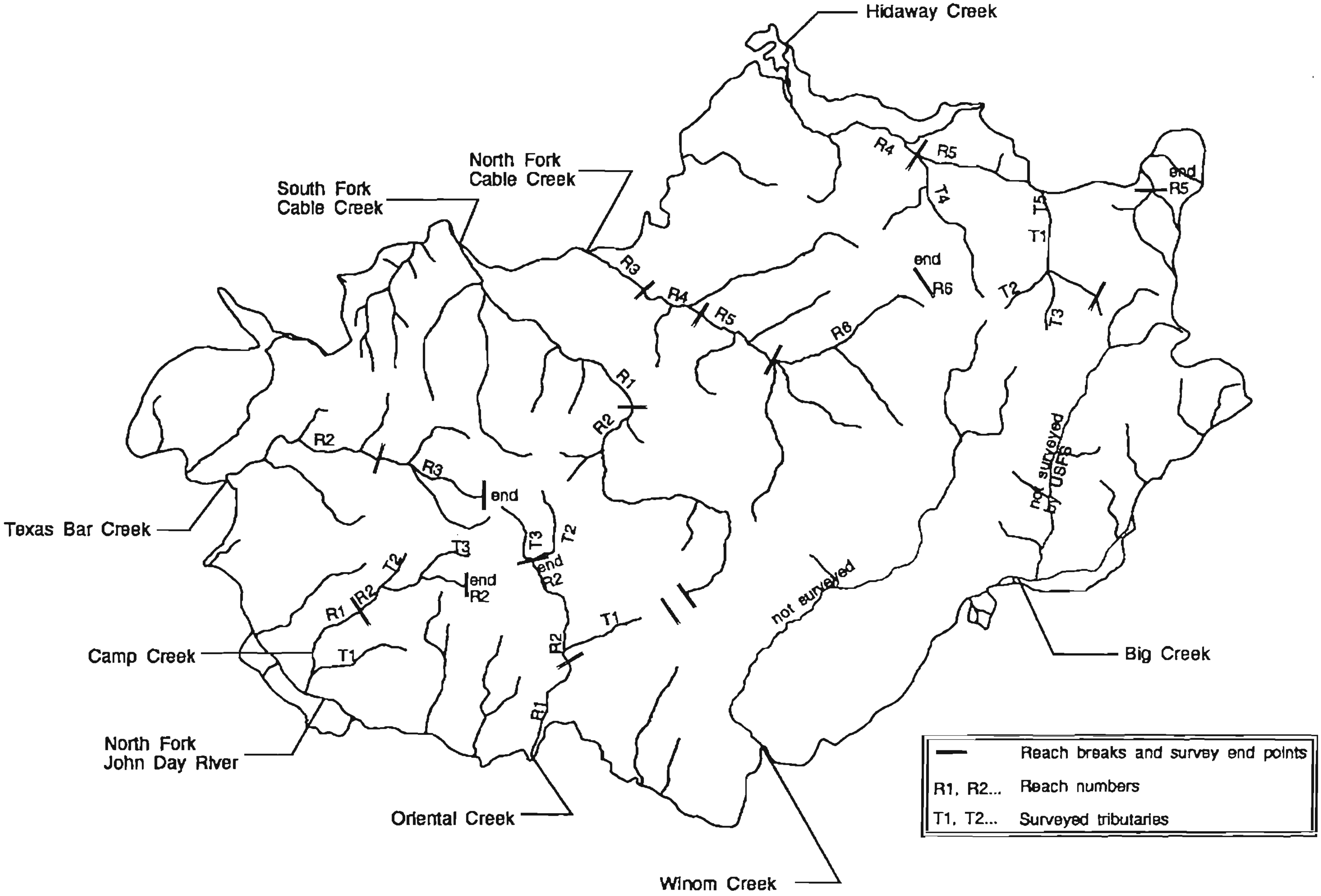


Table 28. Summary of Seven-day Max Water Temperature Data*
for Streams Within and Draining the Tower Fire Analysis Area

Stream Name & Site	Highest Recorded 7-day Max	Lowest Recorded 7-day Max
BIG CREEK @ mouth	72.29	65.43
BIG CREEK above 52 RD	67.29	67.29
CABLE CREEK @ mouth	77.57	73.14
NF CABLE CREEK @ mouth	68.86	66.43
SF CABLE CREEK @ mouth	87.86	66.14
CAMAS CREEK 200 yds above mouth	75.57	75.57
CAMAS CREEK @ mouth	76.71	74
CAMAS CREEK below CABLE CK	78	74.43
CAMAS CREEK below HIDAWAY	77.86	74
CAMAS CREEK below OWENS CK	77.71	75.14
HIDAWAY CREEK @ mouth	77.71	72.29
HIDAWAY CREEK @ forest bndry,	69.86	69.43
HIDAWAY CREEK upper half	60.57	58.86
NFJD above BIG CREEK	74.57	71.14
NFJD above CAMAS CREEK	75.57	75.57
NFJD @ TEXAS BAR	74.86	74.86
ORIENTAL CREEK @ mouth	64.57	58.43
TEXAS BAR CREEK @ mouth	65	60.86
WINOM CREEK above 52 Rd	67.86	65.14

*Seven-day moving average of daily maximum temperature measured as the average of the maximum daily temperature of the warmest consecutive 7-day period. Data from 1991 - 1996. Data for some years was not available for some stations.

Terrestrial Wildlife

Habitat

Old Growth Habitat

An assessment of historic old growth habitat for all of the Tower Fire area was not performed. However, an old growth assessment was conducted in the Camas Analysis Area that partially falls within the Tower Fire area. In the Camas Watershed Analysis (1994), approximately 75 percent of the forested area in 1937 and 33 percent of the area in 1994 supported mature or late/old forest conditions (Boula et al. 1995). Based on that analysis, it would be safe to assume that there has been a substantial decrease in old growth habitat from historical conditions in the Tower Fire area.

Prior to the fire, the area contained eight patches of Dedicated Old Growth (C1) and three patches of Managed Old Growth (C2). All but two of the patches occurred in the Camas watershed, with two remaining patches in the North Fork John Day watershed. Habitat conditions within dedicated and managed old growth areas did not fully meet the criteria in the LRMPUNF (1990, p 4-145 and 4-147-148) as results from documented surveys indicate. Criteria not met include, minimum requirements for stand size (acres), the number of trees per acre >21" d.b.h., and/or the number of vegetative layers in the stand.

Approximately 22,700 acres (31%) of the Camas Old Growth Network occurs within the Tower Fire boundary. C1 and C2 Management Areas, old forest blocks, inventoried old growth, and "connecting" habitat were used to develop the network for the Camas Watershed Analysis in 1994. This network was established to maintain and develop old growth habitat within the Camas drainage.

Dead Standing and Down Wood Habitat

Reference information for down wood and dead standing tree habitat for the area is mainly anecdotal. In general, snags and down logs were abundant in the lodgepole and true fir stands. That density can most likely be attributed to past insect infestations, the exclusion of fire, and the limited access to the area. These habitat conditions primarily occurred in the North Fork John Day Wilderness area and the South Fork-Tower Roadless area. Dead standing and down wood habitat was less common in stands of ponderosa pine and more common in mixed conifer stands. In general, dry site habitat is more accessible, was excluded from fire, and harvested for timber and fuelwood.

Wetland, Riparian, and Aspen Habitat

In more recent times, wetland, riparian, and aspen habitats have had limited distribution in the Blue Mountains and across the Tower Fire, these habitats were most likely larger in size and more common 50 to 100 years ago. Wetland and riparian habitat in the area is primarily limited to stream channels of the North Fork John Day River, Texas Bar Creek, Oriental Creek, Winom Creek, Big Creek, Hidaway Creek, and North and South Fork of Cable Creek. Riparian communities along these streams have been affected by management activities including recreation, mining (stream dredging), grazing (livestock), and timber harvest. As a result of management activities, riparian habitat quality and quantity has been degraded over the past 50-100 years in most of the locations identified. In general, the wetland, riparian, and aspen communities were considered to be in poor to fair condition prior to the fire.

"Special" Habitats

Reference information concerning unique habitats and habitat components in the area is extremely limited. Unique habitats occurring in the area include meadows, springs, and rock/talus.

Species

Prior to the fire an estimated 177 species of terrestrial wildlife had the "potential" to occur in the Tower Fire area (Appendix E), including five amphibians, seven reptiles, 118 birds, and 47 mammals.

From the list of species with the "potential" of occurrence prior to the Tower Fire (Appendix E), species richness was determined by identifying the number of species with the potential to occur in each environmental setting (Table 20). Given the "normal" distribution of structural stages, the environmental settings with high species richness include warm-dry forest (65%), ponderosa pine (64%), riparian/wetland (54%), and cool-moist forest (50%). The environmental setting with the lowest species richness was rock/talus (15%).

Threatened, Endangered, and Sensitive Species

Historically, resident and wintering bald eagles most likely occurred along the North Fork John Day River and main tributaries. Foraging primarily occurred along the river corridor. Prior to the fire wintering bald eagles were observed along the River.

Peregrine falcon eyries probably did not occur within the Tower area due to the lack of cliff habitat. However, suitable nesting habitat did occur in the vicinity of the area. Upland habitats were probably used extensively for foraging. In recent times, two observations of migrating falcons have been documented on the District.

Historically, all Regional Forester's Sensitive Species had the potential to occur in the Tower Fire area. Habitat for Townsend's big-eared bat and Preble's shrew probably occurred in the area but to a limited extent. Recent surveys detected the presence of Townsend's big-eared bat on the District but not within the Tower Fire. Past surveys conducted for Preble's shrew on the District, did not reveal the presence of this species.

Prior to the fire, extensive field surveys (meeting standard protocol) for wolverine were conducted within and adjacent to the burn area, none were detected. In addition, none have been detected on other survey route; on the District

Management Indicator Species

Population densities and distribution of pileated woodpecker, northern three-toed, pine marten, and primary cavity excavators prior to the fire is unknown. Based on the habitat that occurred in the Tower area prior to the fire, it can be assumed that these species occurred in the area in sufficient number to maintain populations.

The Tower Fire area is located in the south end of the Ukiah Unit of the Oregon Department of Fish and Wildlife. This unit consists of National Forest, Oregon State, BLM, and private lands. The population of elk in the unit has steadily increased over the past three years. ODFW estimated 5,500 individuals in 1996, about 9 percent above the Management Objective (5,000 elk), for the Ukiah Unit (personal communication, ODFW, Kevin Blakely). The Tower Fire area is only a small portion of the Ukiah unit and therefore contains a portion of the estimated population.

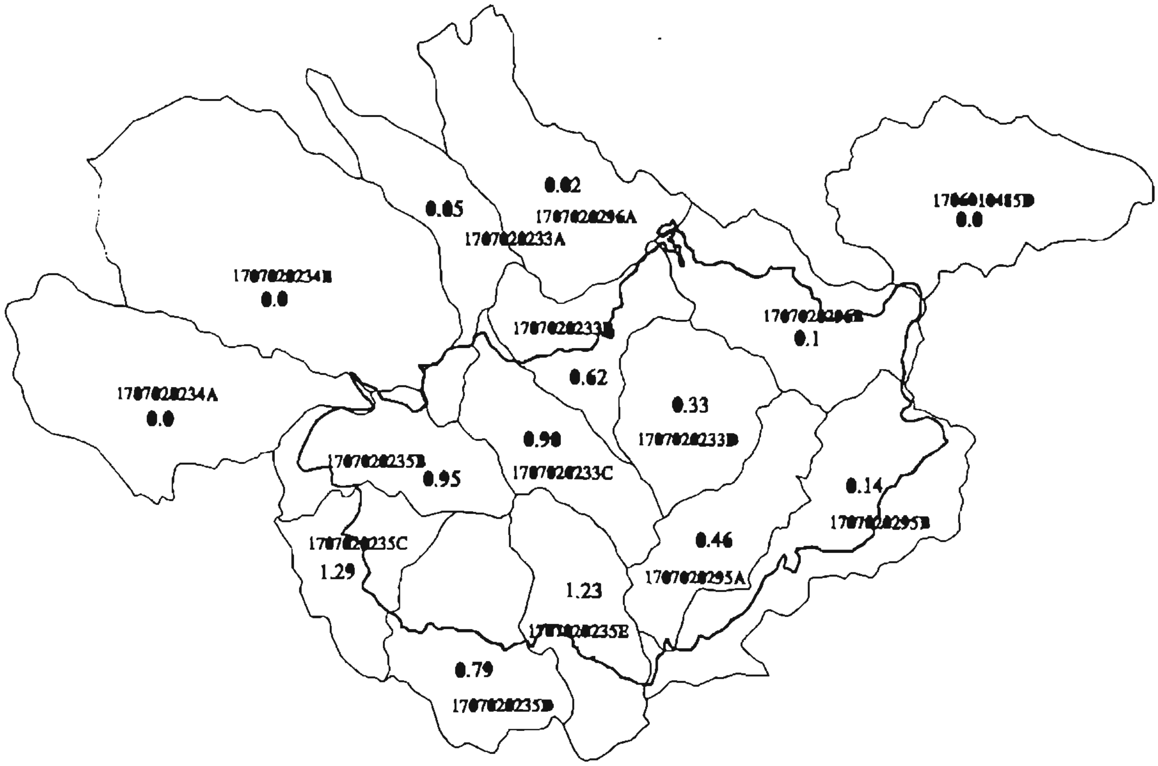
No information has been gathered to determine the quantity and quality of elk habitat prior to the fire. However, general observations by the author prior to and during the fire indicated that the cover component tended to be more satisfactory north of Forest Service Road 52 and more marginal south of the 52 road. Forage in the area appeared to be in fair to good condition.

Several calving areas occurred in the area prior to the fire. ODFW personnel have documented calving sites within the burn (personal comm., Kevin Blakely, ODFW). Prime locations include the roadless area north of the 52 road.

The Tower Fire area is near the Bridge Creek State Wildlife Area, an important winter range used extensively by elk. The movement of elk through and from the Tower area has been documented through telemetry studies (Wilt 1986 and Hattan 1987) conducted by the Oregon Department of Fish and Wildlife (ODFW). Data from this analysis indicates migration corridors occur near the east side of the Tower Fire area, in the west and northwest portion of upper Cable Creek watershed, and then southwest toward Bridge Creek Wildlife Area. Elk north and east of the Tower area tended to migrate south and west to the upper Cable Creek area, then southwest to Bridge Creek. These migration corridors generally incorporated portions of the North Fork John Day Wilderness Area and the South Fork-Tower Roadless Area. The telemetry data (Wilt 1986 and Hattan 1987) indicated little or no movement through the roaded area, on the south end and areas with high recreational use. However, observations by ODFW personnel indicate that elk do migrate through the Oriental Basin and Texas Bar Creek at a much faster rate than locations in the roadless section of the Tower area.

The overall road density for the area is high (see Fish discussion) but open road densities are generally low. The low open road density can be attributed to the large blocks of Wilderness, roadless, and numerous road closures. However, OHV trails chris-cross much of the South Fork-Tower Roadless Area. Thirteen (13) of the fifteen (15) subwatersheds in the area have an open road density of less than 0.95 miles per square mile. Subwatersheds 35C and 35E have open road densities of 1.29 and 1.23 miles per square mile, respectively. Open road densities for the Tower area are provided in Figure 33 for each subwatershed. Post-fire management activities (logging, planting, restoration, monitoring, recreation, etc.) are expected to increase the human activity and open road densities.

Figure 33 - Open Road Densities by Subwatershed (miles/square mile)



V. Synthesis and Interpretation

Watershed Hydrology

Patterns and trends of dominant watershed processes following wildfire have been characterized and described in earlier sections. Watershed response to wildfire is expected to peak in the next few years. Magnitude of response is dependent on future climatic conditions, the small likelihood of an extreme event, and post-fire management activities. A return to pre-fire conditions would not be expected for many years, because of the time to regrow a mature forest to the extent that occurred prior to the fire. As a result, there is lower threshold of vulnerability to climatic conditions and to management activities.

The Subwatershed Risk Assessment is a rapid tool to evaluate the most likely areas of increased peak flows, erosion, and effects to water quality. Additional, more detailed analyses, as well as monitoring watershed conditions, are needed to gage effects, plan activities, and measure response.

Some degradation of water quality is expected over the next few years, as a direct result of the fire and pre-existing watershed conditions. Loss of protective cover, streamside shade, and hydrologic response will result in channel changes in some locations, elevated water temperatures and an increase in fine sediment in streams. Improvement of Water Quality Limited streams will likely be delayed by fire effects.

Riparian areas in the Tower Fire pose complex and challenging management issues. Fire is believed to have been more severe on some south-aspect sites within riparian areas. One current debate centers on management needs for south-aspect streams and trade-offs between managing for abundant large instream wood for improved fish habitat in sites that may not have supported a major conifer component in the past. Vegetation mapping of ecological settings completed as part of the Tower Ecosystem Analysis identified native species in 6 "riparian interface zones". Streams that burned at high intensity include sections of South Cable, Hidaway, Winom, Oriental, and Texas Bar. Use of native species lists (provided by Karl Urban) will provide a foundation for restoration planning and activities for riparian areas, and will help guide future management towards more resilient riparian and aquatic ecosystems.

Data gaps and limitations include; the lack of data for private lands, and analysis by subwatershed which may mask or misrepresent processes or problems occurring at a finer scale. For example, road density is averaged over subwatershed and does not portray actual distribution of roads systems or effects on watershed function. Road densities in RHCAs (Table 29) provide more detailed information on roads that may be directly impacting streams. The role of livestock grazing, one of the major land uses in the fire zone, was not directly evaluated. Finally, lack of information on riparian vegetation in general, and channel conditions of intermittent streams is an ongoing concern.

Floristic Biodiversity

The native plant life of the Tower Fire Analysis Area has evolved under a moisture regime consistent with the natural fire cycle. Many plant species enter a state of drought-induced physiological dormancy by mid-summer and become less susceptible to destruction caused by fires that naturally occur in late summer and early autumn. Because fire suppression activities over the past century have caused changes in stand composition and elevated fuel loading, the burn intensity in portions of the Tower Wildfire was higher than it would have been under natural conditions.

Although it is impossible to completely assess the impact of the Tower Fire on all native plant species known to occur in the area, the analysis completed above indicates that the fire altered considerably the light regime of the understory and that shade-dependent species will be slow to revegetate the burned areas. In instances where species are of limited abundance and sparsely distributed across the landscape, there may be no reservoir or refugium from which revegetation can occur.

This analysis indicates that losses in the floristic biodiversity of the Tower Fire area will not be exacerbated by salvage operations. The biggest impact of the fire to native vegetation was the alteration of habitat attributable to loss of canopy and loss of shade. The rate at which the native species will reinvade appropriate habitats within the fire-altered ecosystem is species-specific and is difficult to predict.

In conclusion, activities that will facilitate the restoration of the forest canopy will accelerate the re-establishment of native vegetation. Salvage operations and reforestation projects will enhance, rather than delay, the rate of re-establishment.

Fish and Aquatic Habitat

Short Term Effects of Fire

The immediate increase in large wood frequency produced by the fire will tend to improve aquatic habitat by increasing fish cover and general habitat complexity. However, this beneficial effect will be largely negated by other effects of the fire mentioned below. Of course, in areas where there has been clear-cut (or equivalent) stream side harvest in the last 50 - 75 years, the fire will not have produced an increase in down wood. Stream survey data suggests that this may be the case for parts of Texas Bar and reach three of North Fork Cable Creek. Several persons familiar with the area question the wood frequency data for Texas Bar Creek (Karl Urban, Alan Guttridge, pers. comm.), so this must be verified with harvest records or site visits.

Complete removal of stream canopy cover has been shown to consistently result in increases in summer maximum water temperatures, decreases in winter minima and greater diurnal fluctuations (Beschta et. al., 1987; Beschta, 1990). The decrease in stream shade caused by the Tower Fire can be expected to degrade aquatic habitat in precisely these ways, and perhaps to also cause further habitat damage through ice scour of the channel (Hicks et al., 1991). Temperature increases caused by loss of stream canopy may sometimes be partially mitigated by increased late summer stream flows which may occur after removal of vegetation (Hicks, Beschta and Harr, 1991). However, such increases do not always occur and in fact, in a paired watershed study in another area of the Blue Mountains, Fowler, Helvey and Felix (1987) were unable to measure statistically significant responses in low or peak stream flows after clear cutting. Increases in flow cannot be counted on to compensate for increased exposure of streams to insolation in the Tower Fire area.

Bjornn and Reiser (1991) give 23.9°C (75°F) as the upper lethal limit for steelhead and 29.4° (89.4°F) or 25.0°C (77°F) -- depending on acclimation temperature -- as the upper lethal limit for rainbow trout. Although some salmonids can survive at relatively high, but sublethal, temperatures, most are placed in life threatening conditions when temperatures exceed 23°- 25°C (73°- 77°). Water temperatures in several of the streams draining the Tower Fire area have approached or surpassed these levels in the last 5 years (Table 28). Further increases can be expected as a result of canopy loss caused by the Tower Fire.

Water temperature increases that do not result in immediately lethal conditions may nevertheless reduce vigor and productivity. Bjornn and Reiser (1991) list preferred temperatures for steelhead as 10° - 13°C (50° - 55.4°F). Even smaller changes in water temperature may alter interspecific interactions. In a study by Reeves, Everest and Hall (1987) juvenile steelhead dominated in cool water (12° to 15°C) while redside shiners became dominant in warmer water (19° to 22°C).

The loss of closely overhanging and low growing vegetation constitutes degraded fish habitat through decreased escape and hiding cover. In some areas, especially in moist riparian areas, plant roots and crowns at the soil level were not destroyed and shrubs and grasses may sprout from these surviving crowns and roots. Regrowth of shrubs and other low growing vegetation over the first 3 to 10 years will provide some shade over the smaller streams. Although these plants should help restore some escape and hiding cover, they are not as effective as higher forest canopy in moderating water temperature (Hewlett and Fortson, 1983). Furthermore, at least one study (Hicks, Beschta and Harr, 1991) attributes a decrease in late summer stream flow to replacement of coniferous forest with hardwoods in the floodplain and riparian zone.

For the first few post-fire years, the loss of soil cover and cohesion on both the stream banks and in the uplands will result in more erosion (McNabb and Swanson, 1990) and delivery of sediment to the streams (Swanston, 1991). Higher runoff and increased peak flows due to reduced plant evapotranspiration and changes in snowmelt timing (Bosch and Hewlett, 1982; Klock and Helvey, 1976; Cheng, 1989) could further increase erosion. Management activities that expose or compact soil (e.g. road construction, logging skid trails), reduce sediment trapping surface roughness (e.g. removal of down woody material), or improve sediment transport efficiency (e.g. road ditching) could exacerbate this situation (Chamberlain et al, 1991; Furniss, Roelofs and Yee, 1991). Furthermore, increased traffic on currently closed roads could also increase sediment delivery to streams (Reid, 1991). Increased sediment delivery will degrade both spawning and rearing habitat quality by filling pools, capping spawning gravels, and filling interstitial spaces in the substrate. Concern should be high for burn areas that have experienced extensive management activities. Table 29 displays subwatershed burned acres, and three measures of road presence. Fish habitat in subwatersheds with high burn acres, and high road miles may be at increased risk to degradation from sediment, and should be managed cautiously. Subwatershed 35b, Texas Bar Creek, particularly stands out in this regard, although subwatersheds 35c, 35d and 35e also merit careful attention.

Filling of the interstices in the substrate also ultimately reduces the density of aquatic macroinvertebrates (Waters, 1995; Rinne, 1996), which are the primary food supply of salmonids (Willers, 1991). Deposition of ash in stream substrates following postfire flow events may be more toxic to invertebrates than to fish (Rinne, 1996).

The fire directly killed fish in some segments of the stream. In some cases (Oriental Creek, South Fork Cable, North Fork Cable, Texas bar, Winom, Big Creek), several miles of stream may now be devoid of fish. Depending on weather and streamflow conditions following the fire, additional fish could die from introduction of ash and fine sediment into the stream (Rinne, 1996). Fish present in adjoining reaches may eventually recolonize these areas. However, in South Fork Cable and Winom Creek, the already present, exotic, brook trout could recolonize the stream at the expense of the native species.

Table 29. Road Density in Tower Subwatersheds

Subwatershed (SWS) –Major Stream	**SWS Total Acres**	**SWS Acres Burned**	**SWS Road Density (mi/mi^2)**	**Road Miles Within PACFISH RHCAs for Entire SWS**	**Road Miles Within PACFISH RHCAs Within Burn**
85d (Fly -- Upper Grande Ronde)	11,900	32	0.9	13.4	0
33a (Cable Creek Creek Tributary)	5946	815	1.1	2.5	2.1
33b (Lower North Fork Cable Creek)	5638	3123	3.0	4.3	1.5
33c (South Fork Cable Creek)	6051	5863	1.7	4.5	4.5
33d (Upper North Fork Cable Creek)	6640	6640	1.4	1.6	1.6
34a (Bridge Creek)	12621	77	1.8	4.2	0
34b (Pine Creek)	21534	49	1.8	6.7	0.2
35b (Texas Bar Creek)	6297	4907	4.8	12.5	8.8
35c (NFJD & minor tribs. -- Otter)	5425	2020	3.0	4.7	1.7
35d (NFJD & minor tribs. -- Camp, Sulphur, Sheep)	8722	3976	2.3	6.9	4.2
35e (Oriental Creek)	7018	4765	3.3	6.7	3.4
95a (Winom Creek)	6382	6361	0.5	0.6	0.6
95b (Big Creek)	11337	6043	1.0	1.5	0.7
96a (Lower Hidaway)	10287	39	3.5	8.5	0
96b (Upper Hidaway)	8914	6107	1.9	6.0	2.4

Overall, the greatest short term problem in most of these streams will probably be temperature extremes, with increased sedimentation next in importance. In those areas that have granitics as baserock, sedimentation may be as important as temperature changes.

Both temperature and sedimentation problems could be partly mitigated by encouraging regrowth of streamside vegetation, particularly conifers that can supply most effective shade and also produce future large woody debris (McMahon and de Calesta, 1990). In areas distant from seed sources, planting of site appropriate coniferous vegetation could considerably speed vegetative recovery. Leaving all large wood on the floodplain and within one tree height of the floodplain or stream channel, both down and standing, will help provide fish cover and sediment trapping while the streamside vegetation recovers. Maintaining abundant large wood in the stream could help maintain a high pool frequency. Several studies have shown that water near the bottom of pools is sometimes 5° to 10°C cooler than water near the surface (see Beschta et al, 1987). Occurrence of such cool water sources seems to be rare, but fish seem capable of seeking them out. Adult salmon may hold over in such cool water refugia until spawning (Torgerson, Price, Li and MacIntosh, 1995). Such pools could serve as important thermal refugia during the first few years of high water temperatures following the Tower Fire.

Long term effects

Most escape and hiding cover in small streams in forested environments is provided by large woody debris (Everest et al., 1985). Although there will be a short term increase in frequency of large wood in the Tower area stream channels as a result of the fire, the post-fire absence of large trees in the riparian zones translates to a period of scarcity of large wood in the stream. Competition from smaller (hardwood) trees and shrubs will further delay recruitment of new large woody debris. Furthermore, hardwood and brush species such as alder and willow are not as desirable as conifers for creating complex fish habitat because they do not attain the size nor strength of conifers and are less resistant to decay (Sedell and Beschta, 1991). Depending on the establishment and growth rate of new trees, and the decay rate of down wood, this period of deficiency in recruitment of new large wood could be decades or a century or more. The resulting reduction in quantity of large in-stream wood, translates to reduction in quantity and quality of pool habitat, escape and hiding cover, and general habitat complexity.

Depending on the rates of establishment and regrowth of conifers, shrubs and other vegetation in the riparian areas, water temperature extremes could develop into a long-term problem for fish and other aquatic organisms. Continued growth of shrubs and hardwoods will help stabilize stream banks and provide some cover, but will not provide the degree of temperature moderation supplied by conifers.

High wetted width/depth ratios in summer subject the water to greater heating from insolation (Beschta et al, 1987). Cattle grazing in the riparian area can be a primary cause of widening of the stream (Platts, 1991). Until riparian plants have re-established substantial root systems, stream banks that burned at high intensity in the Tower Fire will be especially vulnerable to breakdown of banks by cattle. Allowing cattle free access to riparian areas would therefore increase risk of bank breakdown with attendant increased likelihood of steam sedimentation and widening (decreased width/depth) of the channel.

Fish kills in those sections of stream accessible to the exotic brook trout may have both short and long term effects, in that the aggressive brook trout may recolonize the disturbed habitat more quickly than the native rainbows or bull trout and then may persist in the streams, replacing the native species.

Summary

Late summer water temperatures within and downstream of the fire can be expected to increase. Since temperatures in most of these streams were already high with respect to salmonid requirements, this will impose additional physiological stress to a population that may already be existing near the limits of its tolerance. Any management activity that could further increase water temperatures within these streams should be considered a very high risk venture.

On those streams where previous management has removed streamside vegetation in the upstream reaches, managing for historically correct riparian shrub communities downstream could, in the short term, be antithetical to maintenance of high quality aquatic habitat conditions, since water temperatures there may already be unnaturally high. In such situations, it seems that restoration of riparian vegetation that will produce high quality shade in the naturally cool/moist settings should be of highest priority, and be followed at a later date by management designed to reduce conifer and increase hardwood and shrub cover in historically/ecologically hardwood/shrub locations.

Stream sedimentation can also be expected to increase as a result of the Tower Fire. This, plus loss of low growing vegetation will decrease escape and hiding cover for fish and could exacerbate water temperature increases by altering width/depth ratios and decreasing the amount of deep pool refuge areas available to fish.

Long term, quantities of large woody debris will decrease as a result of the fire. Without management regulations or prescriptions for maintaining and establishing conifers in riparian zones as a source of large woody debris, streams will lose, for an even longer period, much of their sediment and organic matter storage capacity and fish habitat provided by large downed conifers in the stream channel.

The Tower Fire has produced a high risk situation for native fish in all streams within its boundary and for some downstream reaches. Within that context, some streams and particularly certain stream segments, face a higher risk level than others.

Table 30 combines evaluation by several different standards for several habitat parameters for stream reaches within and downstream of the Tower Fire Analysis Area.

Combining the pre-fire habitat quality evaluations, road density, and burn severity factors, it appears that Texas Bar Creek, upper North Fork Cable Creek, and a couple tributaries of Hidaway Creek and perhaps Camp Creek are at extremely high risk of further habitat degradation.

Oriental Creek and parts of Winom and Sheep creeks drain an area that has a granitic type of baserock. Streams in granitic substrates tend to have much higher proportions of the more problematic (for fish) sand-sized fine sediments than do the basalt rocks of most of the rest of the area. This setting plus the high road density and high burn intensity over most of the drainage area would also place Oriental Creek and to a lesser extent, Sheep Creek and their tributaries in a high risk category.

TABLE 30

Comparison of Habitat Conditions to Various External Standards

		Exceeds 50th percentile of Eastside EIS data				Meets or exceeds Pacfish						
Stream	Reach	Large Pool Frequency	Total Pool Frequency	Width/Depth Ratios	Large Wood Frequency	Large Wood Frequency	Pool Quality	Pool Frequency	Wood Frequency >40/mile	Wood Meets Proposed UGRP stds.	Substrate Other than sand/silt	Count of Yes
Oriental Creek*	1	no	no	no	no	yes	yes	NA	yes	yes	yes	5
Oriental Creek	2	no	no	yes	yes	yes	yes	NA	yes	no	yes	6
Oriental Trib. 3	1	no	no	yes	no	yes	yes	NA	yes	yes	yes	6
Oriental Trib. 1	1	no	no	yes	no	yes	yes	NA	yes	no	yes	5
Oriental Trib. 2	1	no	no	yes	no	yes	yes	NA	yes	yes	yes	6
S. Fk. Cable Creek*	1	no	no	no	no	yes	yes	NA	yes	yes	yes	5
S. Fk. Cable Creek**	2	no	no	yes	no	yes	yes	NA	yes	yes	no	6
N. Fk. Cable Creek	2	no	no	no	no	yes	yes	no	yes	no	yes	4
N. Fk. Cable Creek	3	no	no	no	no	yes	yes	no	no	no	no	2
N. Fk. Cable Creek	4	no	no	no	no	yes	yes	no	no	no	yes	3
N. Fk. Cable Creek	5	no	no	yes	no	yes	yes	NA	no	no	no	3
N. Fk. Cable Creek	6	no	no	yes	no	yes	yes	NA	no	no	yes	4
Hidaway Creek**	1	no	no	no	no	no	yes	NA	no	no	yes	2
Hidaway Creek**	2	no	no	no	no	yes	yes	NA	yes	no	yes	4
Hidaway Creek**	3	no	no	yes	no	yes	yes	no	yes	no	yes	5
Hidaway Creek*	4	no	yes	no	no	yes	yes	NA	yes	no	yes	5
Hidaway Creek	5	no	no	no	no	yes	yes	NA	no	no	yes	3
Hidaway Trib. 2	1	no	no	yes	no	yes	yes	NA	yes	no	no	4
Hidaway Trib. 4	1	no	no	no	no	yes	yes	NA	yes	no	no	3
Hidaway Trib. 5	1	no	no	yes	no	yes	yes	NA	no	no	no	3
Camp Creek	1	no	no	yes	no	yes	yes	NA	yes	yes	yes	6
Camp Creek	2	no	no	yes	no	yes	yes	NA	yes	no	no	4
Camp Creek Trib. 1	1	no	no		no	yes	yes	NA	yes	no	yes	4
Camp Creek Trib. 1	2	no	no		no	no	yes	NA	no	no	no	1
Camp Creek Trib. 2	1	no	no		no	no	yes	no	no	no	no	1
Camp Creek Trib. 3	1	no	no	no	no	yes	no	NA	yes	no	no	2
Texas Bar Creek*	1	no	yes	no	no	no	yes	NA	no	no	yes	3
Texas Bar Creek	2	no	yes	no	no	no	yes	NA	no	no	yes	3
Texas Bar Creek	3	no	no	no	no	no	yes	NA	no	no	no	1

*Reach is partly outside of burned area
**Outside of burned area

Terrestrial Wildlife

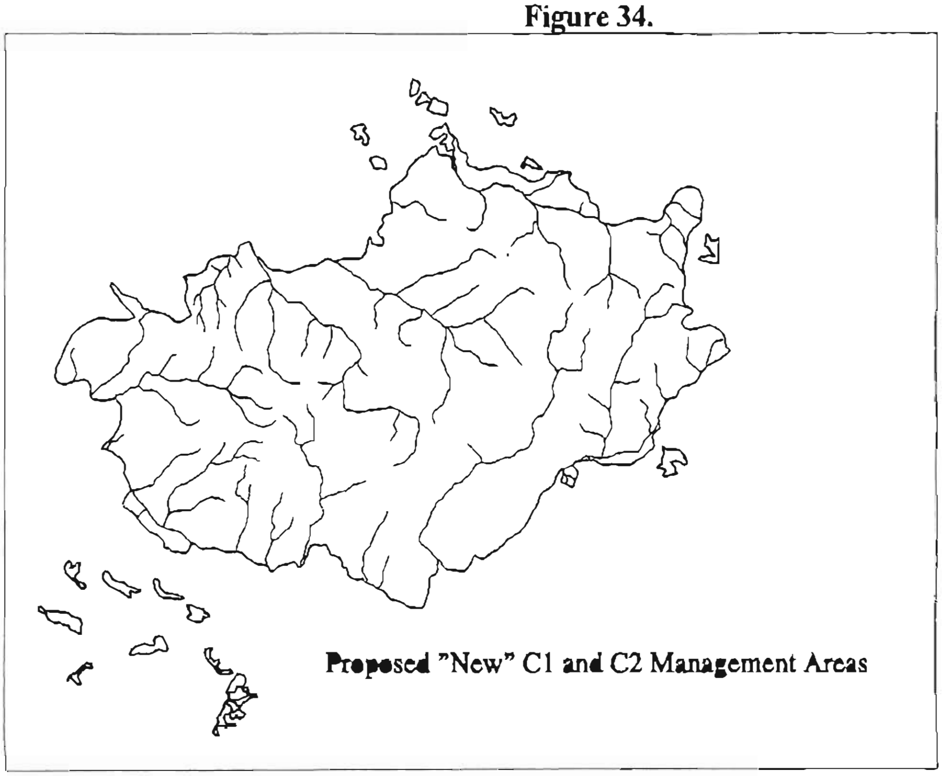
Habitat

Old Growth Habitat

Besides the loss of mature and late/old forest structure from the Tower Fire, the general area has experienced a drastic reduction in old growth forest habitat since the turn of the century. Old growth habitat was apparently reduced 42 percent from the historic reference point. With the combined loss of historic old growth and recently occurring old growth within the fire, options for managing viable old growth habitat and the populations associated with them, has been drastically reduced.

The Forest Plan directs management toward the replacement of C1 and C2 Management Areas in the event of catastrophic loss. As identified in the LRMPUNF, replacement units will be selected in close proximity to the original location. Potential replacement stands include "inventoried" old growth and stands with the potential to meet the old growth criteria as soon as possible. Stands selected for replacement were based on their potential to meet the criteria for C1 and C2 within the next 50 years and their close (3-5 miles) proximity to the Tower Fire boundary. All stands near the fire boundary were examined for their old growth habitat potential. Proposed "new" C1 and C2 Management Area are identified on Figure 34. A total of 1,700 acres has been identified for potential replacement of Dedicated and Managed Old Growth habitat.

Figure 34.



The portion of the Camas Old Growth Network that occurred in the Tower Fire area is no longer considered a viable management option. Mature and late/old habitat conditions are not expected to occur for the next 120-200 years and suitable connective habitat is not expected to develop for another 80-100 years. Movement across the 8-10 mile expanse will increase the vulnerability of wildlife species dependent on mature forest structure and closed canopies for dispersal. The development of an old growth network across the area could be re-visited, 60-80 years after the fire, once vegetative communities have developed. The riparian portion of the network would remain a management option since some riparian species would find regenerating riparian habitat increasingly suitable within the next 15-20 years.

Dead Standing and Down Wood Habitat

Snag standards were recently developed on the Umatilla National Forest because the current standards do not address wildlife needs in burned plant communities. The Standards for Post-fire Restoration (Appendix B) addressed snag densities, snag preference, and snag longevity in burned plant communities. The determination focused on primary cavity excavators that would effectively use (foraging and nesting) burned habitat. Selected species included the hairy woodpecker, black-backed woodpecker, three-toed woodpecker, Lewis woodpecker, common flicker, downy woodpecker, and white-headed woodpecker. Snag retention levels were based on the 100 percent potential population level (Thomas 1979) as directed by the by "Eastside Screens" (Regional Forester's Forest Plan Amendment #2, (USDA 1995)) and weighted for their estimated level of use within the ecological setting. Retention levels determined for each ecological setting are as follows: warm-dry forest - 5.13 snags/acre; cool-moist forest - 3.67 snags/acre; and cold-dry forest - 3.36 snags/acre (Appendix B). The preferred dead standing trees are Douglas-fir, ponderosa pine, and western larch that are generally straight and sound at the base. In order to maximize the time dead standing trees occur on the site and minimize blow down, trees selected for retention will be the largest trees on the site (Appendix B). Trees can be retained as individuals or in clumps of 8-10 individuals. Distribution of retention trees will follow their natural occurrence on the site.

Down wood standards were also revisited to address wildlife and soil concerns in burned plant communities. The Standards for Post-fire Restoration (Appendix B) addressed down wood densities in burned over plant communities and down wood preference. For the short and long term the dead down standards (Appendix B) fully meet the needs for wildlife.

Wetland, Riparian, and Aspen Habitat

Affects from the fire have brought riparian communities to their earliest successional level. However, not all riparian habitats were intensively burned by the fire. Areas in the worst condition (Figure 22) may take more than 10-15 years for riparian vegetation to re-establish. Areas burned with low intensity should show signs of re-establishment within the next 5 years. The majority of terrestrial wildlife species with the potential to occur in the area are associated with riparian and or wetland habitats. Given the limited availability of habitat and the number of species associated with riparian and wetland habitat, protection and restoration is essential to the recovery of terrestrial wildlife communities within the area. Potential threats to recovery include activities that would prevent the development and growth of riparian broadleaf species: the exposure of riparian communities to excessive ungulate browsing or mechanical disturbance leading to a delay in the development of a riparian community should be minimized.

"Special" Habitats

Meadows, springs, rock/talus are unique habitats or habitat components essential for many terrestrial species. These habitats are generally associated with the high species richness and or species with low versatility. Unique habitats can be relatively small in size and sensitive to the point where species could potentially be locally extirpated following disturbance or habitat alteration. These habitats should be protected to avoid potential disruption of habitat and species using the site. The integrity of the site should be maintained by buffering potential site disturbing activities.

Species

As a result of the Tower Fire, 35 terrestrial wildlife species are expected to be extirpated from the area which includes the potential reduction of 31 birds and 4 mammals. The occurrence of amphibians and reptiles species after the fire is expected to be the same as it was prior to the fire although populations may be reduced somewhat. A list of species not "expected" to inhabit the Tower Fire for 15-20 years are listed in Table 31.

Table 31. Terrestrial wildlife species not "expected" to inhabit the Tower Fire.

Sharp-shinned hawk	gray jay	Townsend's warbler
Cooper's hawk	mountain chickadee	Macgillivray's warbler
goshawk	chestnut-backed chickadee	Wilson's warbler
flammulated owl	brown creeper	western tanager
northern pygmy owl	winter wren	spotted towhee
great gray owl	Swainson's thrush	pine grosbeak
long-eared owl	hermit thrush	red crossbill
northern saw-whet owl	varied thrush	red squirrel
red-breasted sapsucker	solitary vireo	Douglas' squirrel
rednaped sapsucker	red-eyed vireo	northern flying squirrel
Williamson's sapsucker	orange-crowned warbler	southern red-backed vole
pileated woodpecker	Nashville warbler	

*inhabit - referring primarily to the reproductive season

In general, the bird species not expected to inhabit the burn include forest raptors, live-tree bark gleaners, leaf gleaners, understory feeders, and mature tree crown nesters. The mammal species primarily consisted of tree squirrels and understory foragers that require sizable areas with medium to large "green" trees and a developed understory. The lack of these habitat components in the area will result in the extirpation of some species for an extended period of time (60-80 years).

Table 32. Habitat and the potential occurrence of species in the Tower Fire analysis area.

ECOLOGICAL SETTING	**"POTENTIAL" HABITAT (AVAILABILITY)**		**"POTENTIAL" LOCAL "EXTIRPATION"**	
Group	Acres	% of Area	Limited Distribution	Limited Abundance
Ponderosa Pine	7,115	14%	10	3
Warm, Dry Forest	16,940	33%	6	2
Cool, Moist Forest	10,828	21%	1	0
Lodgepole Pine Forest	9,386	18%	1	1
Cold, Dry Forest	3,351	7%	2	1
Meadow / Scabland	1,062	2%	10	4
Riparian / Wetland	2,132	4%	30	15
Rock / Talus	4	<1%	3	3
Total	50,818	100%	44	20

Because of the amount of area (50,818 acres) the Tower Fire affected and the large amount of "severely " burned area [21,575 acres (42%)], a further analysis was conducted to determine the "potential" for "local" extirpation of post-fire species. The determination for "potential" local extirpation was based on available habitat, species distribution, and estimated species abundance in the Tower Fire area. From the 144 terrestrial wildlife species expected to occur with post-fire conditions, 141 species were associated with environmental settings that limited availability (ponderosa pine, cold-dry forest, meadow/scabland, riparian/wetland, and rock/talus) in the Tower Fire area. Forty-four (44) terrestrial wildlife species were associated with only two environmental settings (Table 32). The 44 species species were further screened to identify those considered to be uncommon or rare on the District (Table 32). The 20 species selected in this group were screened again to identify year-round residents and migrants-breeders. The 13 species identified also have home ranges less than 1,625 acres in size. The 13 species selected in Table 33, have the "potential" for local extirpation from the Tower Fire within the next 15-20 years.

Table 33. Species in the Tower Fire area with the potential for "local extirpation" within the next 15-20 years.

SPECIES	HABITATS
tailed frog	Forested habitat. Small perennial streams. Clear, cold, fast flowing water. (Corkran, Thomas. 1996)
spotted frog	Marsh, ponds, slow streams with aquatic vegetation. Breeds in flooded meadows adjacent to streams and ponds. (Corkran, Thomas. 1996)
wood duck	Inhabits riparian woodlands near water. River bottom, streams and ponds. Nest in trees with large cavities 20' above ground. (DeGraaf, et al 1991)
hooded merganser	Inhabits wooded areas next to water. Clear water ponds, streams, and rivers. Cavity nester within a few yard of water. (DeGraaf, et al 1991)
killdeer	Open dry uplands, meadows, and along watercourses. (DeGraaf, et al 1991)
white-headed woodpecker	Open ponderosa pine and white fir habitats. Nests in large dead trees. (DeGraaf, et al 1991)
three-toed woodpecker	Conifer forests, especially large stands of dead trees left by fire. Nests in cavities of large dead trees. (DeGraaf, et al 1991)
horned lark	Open habitats and grasslands. Nests on the ground with little or no vegetative cover. (DeGraaf, et al 1991)
tree swallow	River bottomlands, marshes, ponds, and wooded swamps where dead standing trees are near water. Nest in cavities of medium size trees. (DeGraaf, et al 1991)
northern rough-winged swallow	Inhabits open woodlands wherever a suitable nest site occurs near water. Often found around stream banks and other exposed banks of dirt or gravel. (DeGraaf, et al 1991)
cliff swallow	In habits open country near fresh water, in the vicinity of cliffs and banks. Nests on bluffs and cliffs and occasionally on the side of large pine trees. (DeGraaf, et al 1991)
rock wren	Inhabits open rocky areas such as canyons, outcrops, cliff faces, talus slopes, and dry earth banks. (DeGraaf, et al 1991)
northern oriole	Prefers riparian habitats. Nests in deciduous trees. (DeGraaf, et al 1991)

The majority of species (7) in Table 33. are associated with dead standing and down wood habitats and six are associated with the riparian and or wetland ecological settings. The remaining species are primarily associated with rock/talus or meadow/scabland habitat within the Tower Fire area. It is essential that the habitat needs for all 13 species be restored and protected to prevent them from being extirpated for the Tower area.

Management Indicator Species

Northern three-toed woodpecker

The northern three-toed woodpecker is expected to occur in the area since it prefers coniferous forests, particularly lodgepole pine, and subalpine fir stands. The woodpecker is especially drawn to areas where fire have left large stands of dead trees (DeGraaf 1991). Large dead standing trees should be retained in the area to maintain the 100 percent population potential for this species.

Primary Cavity Excavators

Not all Primary Cavity Excavators would benefit from post-fire conditions (see Table 31) because some are dependent on live "green" trees and uncharred logs for habitat. Primary excavators expected to do well are the hairy woodpecker, black-backed woodpecker, northern three-toed woodpecker, Lewis's woodpecker, common flicker, and the downy woodpecker. These species require large dead standing trees with cavities for nesting and roosting and tend to forage on dead standing and down trees or on the ground. Large dead standing trees should be retained in the area to maintain the 100 percent population potential for these species.

Pine Marten

The pine marten is expected to be restricted to the area near the fire boundary within the next 10-15 years. It will most likely return to the interior of the fire 15-20 years after the burn when riparian vegetation has been restored sufficiently enough to provide cover and the prey populations have developed to meet habitat requirements.

Rocky Mountain Elk

Summer and winter foraging habitat for the Rocky Mountain elk is expected to improve as a result of the Tower Fire, however, hiding cover and thermal cover for elk in the area has been drastically reduced and may take up to 15-20 years to recover. Some marginal cover occurs where the fire intensity was low and some green trees remain standing. In addition, dense thickets of burned trees could also provide some degree of cover for elk.

Areas identified as calving areas before the burn should remain suitable after the burn. However, timber harvest and restoration projects could jeopardize calving areas if they are implemented during the calving season or if they alter calving sites beyond their usefulness. Coordination on calving site locations with ODFW personnel is critical.

Elk migration (spring and fall) is expected to continue through the area but with increased exposure to disturbance and possible displacement. Established migration routes will generally remain the same for the next few years while elk adjust to the changed habitat conditions. Use will be linked to areas that provide some form of cover and security, including roadless areas, remaining stands of green trees, and dense stands of dead standing trees. "Cover" within projected/established migration routes will be protected to reduce elk exposure in the burn area.

Open road densities are expected to increase in some areas as a result of post-fire management activities (logging, planting, restoration, monitoring, recreation, etc.). The resulting management activity is expected to increase the human activity on open and closed roads for the next 5 years. Combined with the loss of hiding cover and potential management activities, elk disturbance and displacement in the area is expected to be high but will vary in intensity and duration throughout the year.

VI. Recommendations

The recommendations that follow were initially developed by individual specialists working in a "functional" mode dictated by the tight timelines established for this analysis. The team attempted to resolve conflicts; however, real or apparent incongruities in recommendations may still exist. These will need to be resolved at the project planning level.

A. Physical

Soils

Several of the high erosion hazard areas (Figure 13) have sufficient amounts of salvage timber available to consider for salvage operations. This does not mean that salvage cannot occur; only that care needs to be taken in choosing logging systems and transport plans. Salvage operations themselves would not be expected to create mass wasting events, but supporting activities such as road construction might in some situations. Given the burn intensity, slope and soil types creating the erosion potential, conservative approaches to additional disturbance activities should be followed.

Considerations include:

- using aerial, skyline yarding systems in high erosion potential areas
- using non-ground based on less sloping areas (<30%) normally considered tractor ground; expand use of aerial yarding
- while meeting Dead and Down Guidelines in Appendix B, additional down logs may be retained for erosion control purposes, soil productivity and soil organisms, within the constraints/concerns for fuel loading
- pulling in logs, any available slash, across yarding corridors in one-end suspension operations; waterbarring all potential erosion channels, e.g. yarding corridors
- strong control of operations including utilizing of BMPs/erosion control measures during operations, instead of waiting for completion of logging activities
- organic addendums in plantation situations (or other areas as desired), and fertilization in plantation situations (or other areas) as economics allow
- quick reestablishment of tree and shrub species...to benefit maintenance or reestablishment of

fungal and bacterial soil populations

- allow/encourage nitrogen-fixing shrubs (in particular) to establish and remain for several years in order to rebuild nitrogen levels

Other Potential Projects

- Round Meadows Rest & Restoration
- Trail (section) relocations; improvements
- Subsoiling major impact areas- prior harvest areas; some road beds
- Obliterating; decommissioning if unneeded roads (ATM based)
- Riparian plantings (as species guides, etc. are available)

Watershed Hydrology

Restoration Opportunities

The timeline and general nature of this assessment did not allow for specific identification of restoration opportunities. Instead, broad recommendations of appropriate types of management emphasis and/or activities are provided as follows:

- Upland treatments such as reforestation, native grass and forb seeding, and stabilization of slumps, and slides using bioengineering methods.

- **Roads** - Update the Access and Travel Management plan to evaluate road system in fire and adjacent area and identify **upgrading** and **decommissioning** needs and opportunities. Survey closed roads to identify problem road-stream crossings, and opportunities to remove roads from the system. Emphasis should be on subwatersheds with relatively high road density and erosion hazard - Lower NF Cable, Texas Bar, Turner, Oriental, and Hidaway. Refer to Tables 15 and 29 for subwatersheds where road concerns may be high.

- Use native plants by ecological setting in "riparian interface zones" to identify appropriate species for riparian enhancement. Target stream reaches in high intensity areas as high priority for evaluation of riparian restoration needs.

Protection Needs

Salvage of burned timber is likely in the next few years. Standards and guidelines were developed using an interdisciplinary approach to address wildlife, soils, silvicultural, aquatic and water resource concerns (Appendix B). Guidelines specific to water resources include Snag levels and Coarse Down Woody Debris requirements and Riparian Area requirements. Riparian area requirements include provisions that would allow for salvage within some RHCAs provided the listed criteria are met. Requirements were also amended to allow for an increase in RHCAs in high-hazard areas. Additional requirements are contained in R-6 General Water Quality Best Management Practices (1988).

Specific practices that would, in part, mitigate adverse effects to soil and water resources include use of skyline and helicopter logging systems; restricting equipment to existing trails and roads; and rehabilitation of skid trails and landings following use.

Roads - Immediate road management needs were identified in the BAER survey, (report on file, Supervisor's Office, Pendleton, Oregon). Long-term upgrading and road decommissioning projects should be pursued through project-level planning.

Range management needs were also identified in the BAER survey and include criteria for determining vegetation recovery and suitability for reintroducing livestock. A 2-year restriction (prohibition) of grazing was recommended to allow for recovery of vegetation. Lack of program funds to administer grazing permits, maintain range improvements, and monitor grazing activities is a serious concern.

Monitoring

- Maintain key stream temperature monitoring stations in the fire-affected area.

- Conduct upland and tributary surveys of erosion, sedimentation, and the role of large wood in storing hillslope and in-channel sediment. Resurvey 2 channel reference sites installed in fall of 1996.

- Conduct interdisciplinary team evaluation of representative riparian areas for purposes of resolving conflicting resource management issues encountered in the analysis.

- Conduct BMP implementation and effectiveness monitoring of BAER, fire salvage and restoration activities.

Fire/Fuels

Low severity natural fire regime:
Manage to maintain stand densities on at least 50 percent of the area to be 100 trees per acre or less by the time stands reach maturity (=>20" DBH). The remaining 50 percent of the area can in a diversity of stand densities, above and below the 100 trees per acre. Stand composition should be dominated (=>80%) by early seral tree species, e.g. ponderosa pine. Stand structure should be dominated by single canopy levels. Fuels management should identify a fuel profile (a combination of fuel load by size classes and physical arrangement) that would keep wildfires primarily as surface fires. Stand management practices should include establishing a natural fuels management program utilizing management ignited fire on an established rotation (15-25 years).

Moderate severity natural fire regime:
Manage to maintain stands so there is diversity in age classes and species composition across the landscape. The size of the patches in this mosaic pattern will be variable, but should be sufficient to modify crown fire runs to create openings (stand replacement) that are more likely to be within the historical range of disturbance patterns. To be meaningful to modify the characteristics of a wildfire

the patches of varying stocking, age class, and species composition should be several hundred acres in size.

High severity natural fire regime:
Maintain fuel break buffer around improvements (Lookout, electronic site) otherwise low priority for any treatments. The majority of these areas are in wilderness or roadless areas, a long term management plan of management ignited fire and/or mechanical treatments to reduce fuel loading near improvements and/or private boundaries should be developed.

Buffer areas along private boundaries:
Maintain single storied stands, w/ open spacing (20 ft x 20 ft or wider), species composition should be dominated by early seral species (e.g. ponderosa pine or western larch). Aggressively treat down and dead fuels either through harvest operations and follow-up treatments or through "natural fuels" program. Fuel treatments in these areas could either be underburning, YUM treatments, pile and burn, or some combination.

Riparian Areas:
Where ecologically appropriate, and compatible with PACFISH and/or Forest Plan standards, manage for long term (greater than 30 years) retention of "hardwood" domination along designated stream reaches. The intent of this recommendation is to provide riparian fuel breaks that are not replaced by dense, contiguous stands of conifers. Management of livestock use to reduce the impact upon hardwoods during sprouting initiation and to maintain the composition in the riparian areas would be necessary. Mechanical thinning and/or the use of prescribed fire within these stretches of the riparian area would be used to keep conifers only as scattered individuals rather than developing a continuous canopy capable of supporting a crown fire. Because of the inherently higher soil moisture availability in the riparian areas development of multiple layers of conifers could begin "early" in the riparian areas, if all "disturbances" such as fire or even thinning is excluded from the area.

System of Fire Breaks
In addition to any fire breaks that may be created along buffers with private lands or near developed sites, a larger landscape scale system of fuel breaks should be considered in planning for land management activities. This system should utilize ridges, roads, and natural openings (e.g., scablands) to make a large scale pattern of fuel breaks. An example of a proposed system of fuel breaks is displayed on Figure 35. The fuel breaks should be maintained as single storied stands, w/ open spacing (20 ft x 20 ft or wider), species composition should be dominated by early seral species (e.g. ponderosa pine or western larch). Aggressively treat down and dead fuels either through harvest operations and follow-up treatments or through "natural fuels" program. Fuel treatments could either be underburning, YUM treatments, pile and burn, or some combination. Relatively intense grazing within these fuel break areas could also be a means of reducing the annual growth of fine fuels (grasses). In the event of a large wildfire these fuel breaks could be utilized for indirect attack, e.g. fireline constructed and burned out in advance of the fire front.

B. Biological

Vegetation

This section provides management recommendations that could facilitate either short-term recovery or long-term restoration, of forest vegetation in the Tower analysis area. The recommendations did not explicitly consider project feasibility (logging operability, etc.), but basically represent management opportunities.

Tree Salvage (pertains to forested uplands only)
Salvage cutting is "the removal of dead trees or trees being damaged or dying due to injurious agents other than competition, to recover value that would otherwise be lost" (Society of American Foresters 1994). For the Tower area, salvage cutting could be considered for three categories of trees:

- dead trees that were killed by the fire;
- live trees that are likely to die in the near future as a result of fire-caused damage;
- live trees that are likely to be killed by insects which attack fire-stressed trees.

Salvage logging can have both positive and negative impacts. Some important benefits of salvage are to harvest and utilize wood fiber while it is still merchantable, to remove enough dead trees to promote regeneration of sun-loving seral species, and to reduce fuel loadings to the point where wildfire risk is acceptable and a prescribed burning program could be initiated (Powell 1994). Table 34 shows the management areas in which the Umatilla NF Forest Plan allows salvage cutting to occur.

Whether a tree was killed or damaged by the fire depends on a variety of factors, such as fire resistance characteristics that vary by species (Table 35), fire intensity, fire duration, when the fire occurred during the growing season, and the amount of tree damage caused by the burn. An important concern is the increased susceptibility of fire-damaged trees to insect attack. For ponderosa pine, the risk of western pine beetle attack varies in direct proportion to the amount of crown lost from fire scorch (Table 36).

The response of ponderosa pine and many other conifers to crown scorch varies depending on when the fire occurred during the growing season — early summer fires cause more damage than late summer burns. Less damage occurs in late summer because tree growth has slowed, terminal buds have formed, and root (food) reserves have been accumulated. Crown scorching in early spring, before or immediately after bud burst, often results in minimal damage to the tree (Crane and Fischer 1986).

Bark thickness has an important influence on tree survival; thin-barked species have a greater probability of dying within a year of being fire damaged than thick-barked species.

Insect Considerations. A recent study of fire-injured trees after the Yellowstone fires of 1988 (Ryan and Amman 1994) found that insects will attack a variety of conifers:

1. Douglas-firs with more than 50 percent crown scorch, or more than 75 percent basal girdling, suffered high mortality from Douglas-fir beetle and wood borers.

2. A large proportion of burned lodgepole pines were killed by beetles (mostly pine engravers) within 3 years of the fire, even though most trees had received less than 25 percent crown scorch. Although mountain pine beetle was not a major problem following the Yellowstone fires, it has infested large-diameter lodgepole pine in eastern Oregon following root injury or minor basal girdling caused by fire.
3. Engelmann spruce can experience very high levels of spruce beetle infestation following fire injury, either in standing trees or in windthrown stems whose shallow roots were damaged by surface fires that smoldered in accumulations of litter and duff at the tree bases.
4. For subalpine firs, virtually any fire vigorous enough to scorch the bark will cause cambial injury, followed by sloughing of the dead bark. Wood borers quickly and aggressively colonize the fire-damaged trees and thereby contribute to extremely high mortality rates.

Table 34: Management Direction Summary for Tower Analysis.

Management Area Allocation	**Salvage Permitted?**	**Suitable Lands?**	**Plant Using NFFV Funds?**	**Percent of Area**
A3: Viewshed 1	Yes	Yes	Yes	5
A6: Developed Recreation	Yes	No	No♦	< 1
A7: Wild and Scenic Rivers	Yes	Yes	Yes	2
A9: Special Interest Area	Yes	No	No♦	< 1
B1: Wilderness	No	No	No♦	25
B7: Wilderness (Wild/Scenic River)	No	No	No♦	< 1
C1: Dedicated Old Growth	Yes*	No	No♦	2
C2: Managed Old Growth	Yes	Yes	Yes	< 1
C3: Big Game Winter Range	Yes	Yes	Yes	< 1
C4: Wildlife Habitat	Yes	Yes	Yes	8
C5: Riparian (Fish and Wildlife)	Yes	Yes	Yes	< 1
C7: Special Fish Management Area	Yes	Yes	Yes	56
E2: Timber and Big Game	Yes	Yes	Yes	< 1
PACFISH (Riparian Mgmt. Areas)	Yes	No	No♦	N.A.

Sources/Notes: Management area allocations are from the Umatilla NF Forest Plan (USDA Forest Service 1990). The "salvage permitted?" item shows whether salvage timber harvests are allowed by the management direction (standards and guidelines) for each land allocation; the "suitable lands?" item shows whether capable forested lands in the management area are designated as suitable by the Forest Plan; the "plant using NFFV funds" shows whether denuded or understocked lands could be planted using appropriated timber management funds (NFFV); and the "percent of area" item shows the percentage of National Forest lands in the analysis area allocated to the management emphasis.

* Salvage harvest allowed ONLY if an old-growth tree stand is killed by a catastrophic disturbance.

♦ Although appropriated NFFV funds cannot be used for planting because these lands are unsuitable, planting could occur if appropriated funds were provided by the benefiting resource (wildlife, fish, etc.) OR if a salvage harvest occurred and K–V funds were collected to finance the planting.

Table 35: Fire Resistance Characteristics for Major Conifer Species.

Tree Species	Bark Thickness	Rooting Habit	Bark Resin (Old Bark)	Branching Habit	Stand Density	Foliage Flammability	Fire Resistance
Western Larch	Very thick	Deep	Very little	High and very open	Open	Low	Most resistant
Ponderosa Pine	Very thick	Deep	Abundant	Moderately high & open	Open	Medium	Very resistant
Douglas-fir	Very thick	Deep	Moderate	Moderately low & dense	Moderate to dense	High	Very resistant
Grand Fir	Thick	Shallow	Very little	Low and dense	Dense	High	Medium
Western White Pine	Medium	Medium	Abundant	High and dense	Dense	Medium	Medium
Lodgepole Pine	Very thin	Medium	Abundant	Moderately high & open	Dense	Medium	Low
Engelmann Spruce	Thin	Shallow	Moderate	Low and dense	Dense	Medium	Low
Subalpine Fir	Very thin	Shallow	Moderate	Very low and dense	Moderate to dense	High	Very low

Sources/Notes: Adapted from Flint (1925) and Starker (1934). Species rankings are based on the predominant situation for each trait. A species trait is not absolute — it can vary during the lifespan of an individual tree, and from one individual to another in a population. For example, grand fir's bark is thin when young, but relatively thick when mature.

Table 36: Relationship Between Crown Scorch and Mortality Caused by Western Pine Beetle for Ponderosa Pine.

Percent Scorch (Defoliation)	Percent of Trees Killed by Beetles
0–25	0–15
25–50	13–14
50–75	19–42
75–100	45–87

Sources/Notes: Adapted from Crane and Fischer (1986). [**Note**: although the original chart that this table was based on came from Crane and Fischer (1986), the data that they used to prepare it came from: Stevens, R. D.; Hall, R. C. 1960. Beetles and burned timber. Miscellaneous Paper 49. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 2 p.]

Some level of salvage cutting is appropriate in the Tower wildfire area. It should be done carefully. Enough dead trees should be left to provide adequate habitat for cavity-dependent birds, ants and other invertebrates that prey on the larvae of defoliating insects. Standing dead trees eventually fall to the ground, where they contribute to nutrient cycling, long-term site productivity, and mycorrhizal habitat.

A salvage program should be designed to address the following vegetation concerns:

1. Emphasize salvage in dry-forest areas (Figure 11) where fir encroachment and overstocking were present before the fire.
2. Emphasize salvage in mesic-forest areas (Figure 11) that have the capability to support a high proportion of ponderosa pine (Douglas-fir and warm grand fir plant associations). [Sites meeting this criterion would address the loss of dry forest from 1937 to 1996 (see Table 33).]
3. Consider salvage where timber volume, tree size, and species characteristics would generate sufficient revenue to fund tree planting and other restoration treatments. [This concern addresses the fact that tree planting is expensive, and that Congress may not fund all of it.]
4. Consider salvage for sites where the existing density of dead trees is great enough that a future reburn will probably destroy newly-established tree regeneration, especially if a reburn occurs shortly after the dead trees have fallen over and increased fuel continuity.
5. Consider salvage of live, damaged trees that are unlikely to survive more than a year or two:
   a. Ponderosa pines and western larches, in excess of wildlife and fisheries habitat needs, that have less than 20 percent green, healthy-appearing crown (by crown volume), regardless of bole scorch, scorch height, or duff consumption
   b. Douglas-firs having less than 40 percent green, healthy-appearing crown (by volume) AND scorch height greater than 16 feet AND more than 50 percent of the preburn duff around the base of the tree was consumed by the fire.
   c. Subalpine firs, lodgepole pines, and Engelmann spruces with less than 60 percent green, healthy-appearing crowns (by volume) AND bole scorch on greater than 50 percent of the tree's circumference AND scorch height greater than 4 feet AND more than 25 percent of the preburn duff around the base of the tree was consumed by the fire.

Natural Regeneration (pertains for forested uplands only)

The fire created conditions conducive to regeneration of early seral conifers. Unfortunately, it also killed most of the mature trees required for seed production. The probability of obtaining natural regeneration in the fire area will depend on several factors:

- the availability of surviving trees to serve as a seed source,
- the spatial distribution of seed trees, especially their proximity to severely-burned areas,
- whether the survivors are physiologically capable of producing seed in any abundance,
- whether cone (seed) crops are actually produced, and when.

We can expect forest recovery to be slow in many portions of the fire, especially areas that burned at a moderate or high intensity and whose pre-fire composition was dominated by species with low fire resistance (Table 35). Initially, severely burned areas will support herbaceous vegetation (forbs, grasses) and shrubs, with trees beginning to be dominant by the end of the third decade (Figure 36).

In the case of lodgepole pine, some natural regeneration may be produced by cones present in the canopy of dead stands, assuming of course that any canopy remained after the fire. In many areas that burned with a moderate intensity, all of the lodgepole pines were killed by the fire, although some of their crowns still persist and will serve as a seed source if cones were present before the burn. Although lodgepole pine has a low percentage of closed cones (serotiny) in the Blue Mountains, it is a prolific seed producer and good seed crops occur frequently (Trappe and Harris 1958). If 1996 was a good seed year for lodgepole pine stands in the Tower Fire area, we can expect adequate to overly-abundant lodgepole pine regeneration in the future.

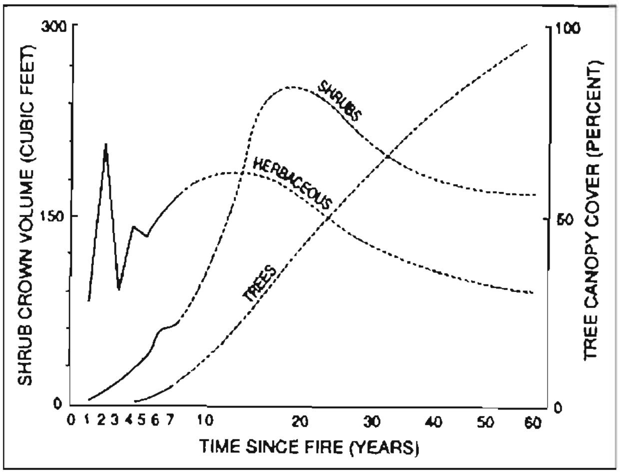


Figure 36 – Post-fire vegetation response. Initially the fire area will be dominated by herbaceous plants such as forbs and graminoids (grasses and sedges). As succession progresses, woody plants will eventually predominate, with shrubs peaking by the second decade and trees dominating about 30 years after the fire. Figure taken from Koch (1996a).

After considering information on seed production and seed dispersal distances, along with local experience gained by following recovery after other fires, it was possible to estimate lag times to obtain natural regeneration in the Tower Fire area. Those estimates are provided in Table 37 (see Forest Vegetation Report - Tower Fire for details). It is difficult to estimate lag times precisely due to variations in fire intensity, burn patterns, and stand mortality, all of which affect seed availability and establishment of natural regeneration. Figure 37 shows the areas where natural regeneration is expected to occur.

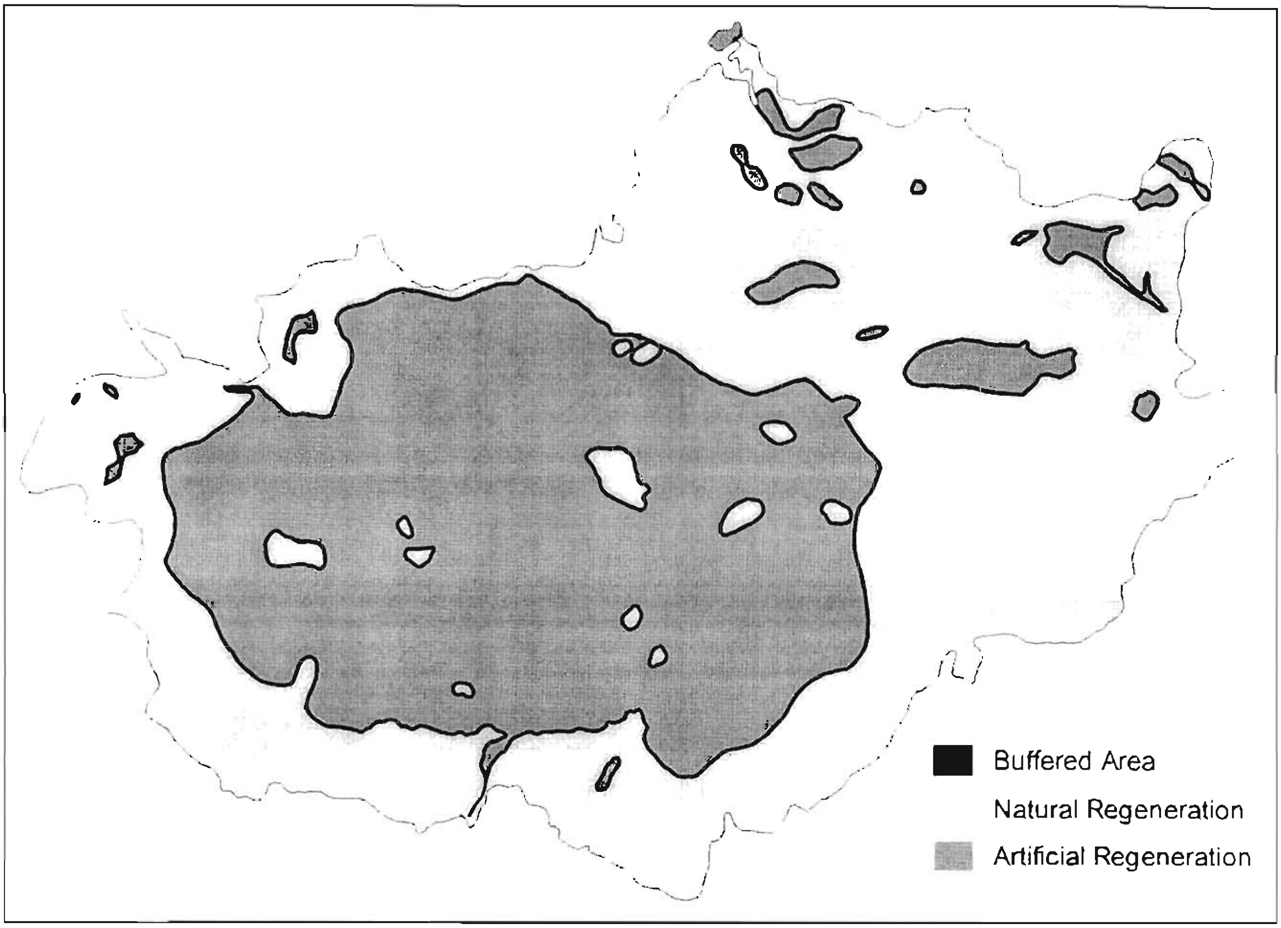


Figure 37 – Regeneration estimates for the Tower Fire area. It was assumed that a live seed source would be present in the "partial mortality" areas (see Figure.16 for a description of the stand mortality categories) and that it would allow natural regeneration to get established in those portions of the burn (shown as "natural regeneration" in this figure). It was also assumed that the seed source present near the edges of the partial-mortality areas would be sufficient to result in natural regeneration for at least 60 meters (197 feet) into the "complete mortality" portions of the burn. The 60-meter width (shown as "buffered area" above) was based on the seed dispersal information contained in Table 19, Appendix C. Refer to Table 38 for an acreage summary of the information portrayed in this figure; the "NR" columns in Table 38 are a combination of the "natural regeneration" and "buffered area" categories shown above. It is recommended that tree planting (shown as "artificial regeneration" above) occur on most of the severely-burned area; if that occurs, it is estimated that the cost could total $9,386,478.13 (see Table 39).

Table 37: Estimates of natural regeneration lag times for the Tower Fire area.

FOREST COVER TYPE	EARLY SERAL TREE SPECIES	NATURAL REGENERATION LAG PERIOD	
		Partial Mortality	Complete Mortality
Dry Forest	**PP**	**< 10 years**	**10–15 years**
Mesic Forest	**WL, PP, LP**	**< 5 years**	**5–10 years**
Lodgepole Pine	**LP, WL**	**< 5 years**	**5–10 years**
Cold Forest	**LP, WL**	**< 10 years**	**15–25 years**

Source/Notes: "Early Seral Tree Species" are ecologically adapted to site conditions created by a stand-replacing disturbance event such as wildfire. Estimates of natural regeneration lag times are based on the author's judgment, and assume that living trees of seed-bearing age are present within a reasonable distance of the site to be colonized. Table 7 describes the cover type and tree species codes; figure 16 describes the mortality classes.

Table 38: Estimated Regeneration Status by Ecological Setting and Management Area.

	Cold Dry		**Cool Moist**		**Lodgepole**		**Ponderosa**		**Warm Dry**		**Riparian**		**Grand Total**	
MA	**NR**	**PL**	**NR**	**PL**	**NR**	**PL**	**NR**	**PL**	**NR**	**PL**	**NR**	**PL**	**NR**	**PL**
A3	0	1	62	174	409	418	264	104	225	681	39	**72**	960	1378
A6	0	**0**	0	**50**	0	**0**	0	**1**	0	**9**	0	**10**	0	**60**
A7	0	0	239	0	0	0	427	0	67	0	59	**0**	733	0
A9	0	**0**	0	**0**	23	**0**	0	**0**	0	**0**	12	**0**	23	**0**
B1	1902	**334**	652	**637**	2729	**215**	468	**15**	3225	**944**	318	**58**	8976	**2145**
B7	0	**0**	0	**0**	0	**0**	101	**0**	39	**0**	7	**0**	140	**0**
C1	0	**7**	431	**301**	22	**43**	1	**9**	77	**32**	27	**38**	531	**392**
C2	25	0	57	5	84	14	0	0	0	0	8	**0**	166	19
C3	0	0	0	0	0	0	1	0	130	0	12	**0**	131	0
C4	0	0	49	161	23	6	428	668	646	1432	35	**109**	1146	2267
C5	0	0	10	1	0	0	4	11	2	42	13	**34**	16	54
C7	494	552	4332	3531	2388	2916	1676	1389	3315	3745	642	**444**	12205	12133
E2	0	0	0	0	12	0	0	0	0	0	0	**0**	12	0
P	0	0	54	24	0	0	1137	411	1248	1082	114	**72**	2439	1517
Total	2421	894	5886	4884	5690	3612	4507	2608	8974	7967	1286	**837**	27478	19965
NFFV		553		3896		3354		2583		6982		0		17368

Source/Notes: Derived from the potential natural vegetation (Figure. 12) and regeneration (Appendix C) maps, in combination with the management area allocations. Management area (MA) "P" refers to private land within the analysis area. The "NR" column shows the acres that are expected to naturally regenerate; "PL" summarizes the acres where planting is believed to be necessary to obtain prompt tree regeneration. *Shaded cells indicate the acres where forest vegetation funds (NFFV) can not be used to finance tree planting operations* (assuming they were appropriated by Congress). The NFFV total (bottom row) shows the acres that could qualify for planting using that funding source, if funds were available. Note that this table does not include all acres in the analysis area because nonforest ecological settings (meadows and scablands) were not included.

Artificial Reforestation (pertains to forested uplands only)

- *Reforest severely burned areas as soon as possible.*

According to field reconnaissance and a GIS analysis, approximately 19,965 forested acres were burned severely enough to warrant artificial reforestation. After removing severely-burned areas that are likely to regenerate naturally, and burned acreage which cannot be planted due to legal or administrative constraints (see Table 34), the remainder of the severely burned area (17,368 acres) be artificially reforested as soon as possible (see Table 38). Appendix C shows the geographical distribution of areas where artificial reforestation should be considered.

•*If forest health is an objective, planting should attempt to establish a future composition with at least 60 percent of the trees being early- and mid-seral species.* The successional (seral) status of 9 major conifer species is found in Appendix C.

•*Plantings should emphasize establishment of early-seral conifers, especially ponderosa pine and western larch, on upland sites, with additional, appropriate hardwood species in riparian zones* (see Floristic Biodiversity report for riparian species recommendations). Table 22 in Appendix C shows the early seral conifers that could be considered for each of the forested plant associations. Since lodgepole pine is expected to regenerate naturally on all but the highest intensity burns, upland plantings should emphasize other early-seral species (western larch and ponderosa pine) to a greater degree than lodgepole pine. Planting recommendations (species mixes and densities) are provided in Appendix ???.

It must be emphasized that the planting recommendations involve a mixture of species. Even if a mixture was not being planted, a mixed stand would eventually exist after natural regeneration. A common misconception is that plantations are monocultures — "corn-row" forests devoid of floristic biodiversity. This is generally not the case, although a monoculture is certainly possible for closely-spaced plantations comprised of a single species, especially if that species is susceptible to stagnation such as lodgepole pine or ponderosa pine.

Seedling density recommendations in Table 38A may seem low. Relatively low seedling densities were selected for the following reasons:

- silviculturists tend to be conservative and often plant more trees than are really necessary in order to "hedge their bets" for the future (Oliver and Larson 1996)
- stands with close spacings (high densities) often have poor tree-height differentiation, which can lead to stagnation and arrested or improper development from that point onward
- spinly trees that cannot support themselves, and fall over if adjacent support trees are removed or die
- open stands have low levels of inter-tree competition and are usually highly vigorous
- open stands yield high volumes of useable timber
- wide spacings allow ample opportunity for establishment of natural regeneration, while concurrently minimizing the need for precommercial thinning
- wide spacing may accelerate growth rates of individual trees, thus facilitating the ultimate re-establishment of mature and late/old forest habitats

Mixed-species, single-cohort (even-aged) stands in the Blue Mountains contain various combinations of western larches, ponderosa pines, Douglas-firs, grand firs, Engelmann spruces, and lodgepole pines. Although such stands contain trees of the same age, each species develops at a different rate so that a stratified or "layered" structure is the ultimate result (Figure 38). Those who observe these stands sometimes assume that their height variations reflect a range of ages (i.e., the stands are uneven-aged). Figure 38 shows those assumptions to be incorrect because a mixed-species stand in which every tree is the same age does not develop into a single-storied, biologically-simple structure, regardless of its origin (from planting or natural regeneration).

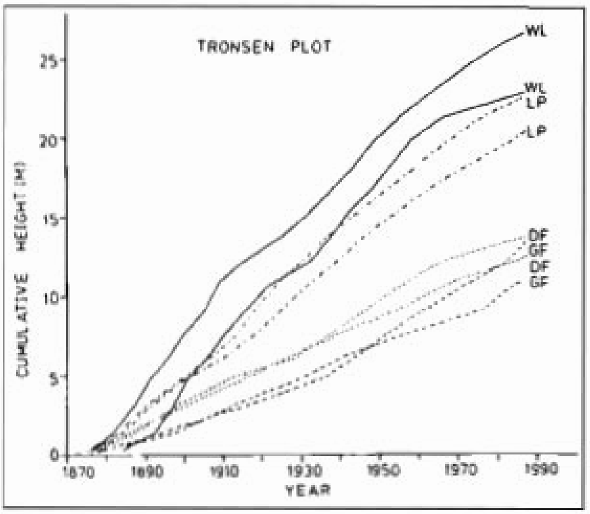


Figure 38 – Development of mixed-species, single-cohort stands (from Cobb and others 1993). Different tree species grow and develop at different rates. This figure shows how early-seral species (western larch and lodgepole pine) grow faster than their late-seral associates (grand fir and Douglas-fir) when both are present in an even-aged (single cohort) stand. The end result is a multi-storied structure sometimes mistaken for an uneven-aged condition.

Previously-Established Plantations

•*Replant burned plantations as quickly as possible.* These burned plantations represent a loss of timber productivity, and are areas where we have legal responsibilities to quickly reestablish tree cover (as required by the National Forest Management Act),. Table 39 shows the estimated costs associated with completing the plantings recommended in this section.

TABLE 38A: PLANTING RECOMMENDATIONS FOR TOWER ANALYSIS AREA.

	Seedling Density		**Species Composition of Planting Mix**							
Ecological Setting	**TPA**	**Spacing**	**PP**	**WL**	**LP**	**DF**	**WP**	**GF**	**ES**	**AF**
Cold Dry	222	14 feet		40%	NR	20%		NR	40%	NR
Lodgepole Pine – Cool♦	194	15 feet		30%	NR	30%		NR	40%	NR
Lodgepole Pine – Cold♦	194	15 feet			NR	40%		NR	60%	NR
Cool Moist – Moist♠	222	14 feet		30%	NR	20%	20%	NR	30%	NR
Cool Moist – Mesic•	222	14 feet	NR	40%	NR	40%		NR	20%	
Warm Dry – Mesic♣	151	17 feet	60%	20%		20%		NR		
Warm Dry – Dry♣	151	17 feet	80%			20%				
Ponderosa Pine	151	17 feet	100%							

Sources/Notes: Trees per acre (TPA) and spacing recommendations are based on the author's judgment and Powell (1992). The species composition recommendations are based on the author's judgment, Cole (1993), Kaiser (1992), and Wallowa-Whitman NF (1996). NR = Natural Regeneration.

♦ Cool types are PICO(ABGR)/ARNE, PICO(ABGR)/CARU, and PICO(ABGR)/VAME; cold types are PICO(ABLA2)/VASC and PICO/CARU/VASC.

♠ White pine is adapted to these plant associations on the North Fork District, not all of which occur in the Tower area: ABGR/TABR/LIBO2, ABGR/LIBO2, ABGR/CLUN, and ABGR/ACGL (Urban 1996).

• Includes all cool moist plant associations except ABGR/LIBO2 and ABGR/CLUN.

♣ Mesic plant associations are ABGR/CAGE, ABGR/CARU, PSME/SYAL, and PSME/VAME; all others in the warm dry forest setting are considered to be dry.

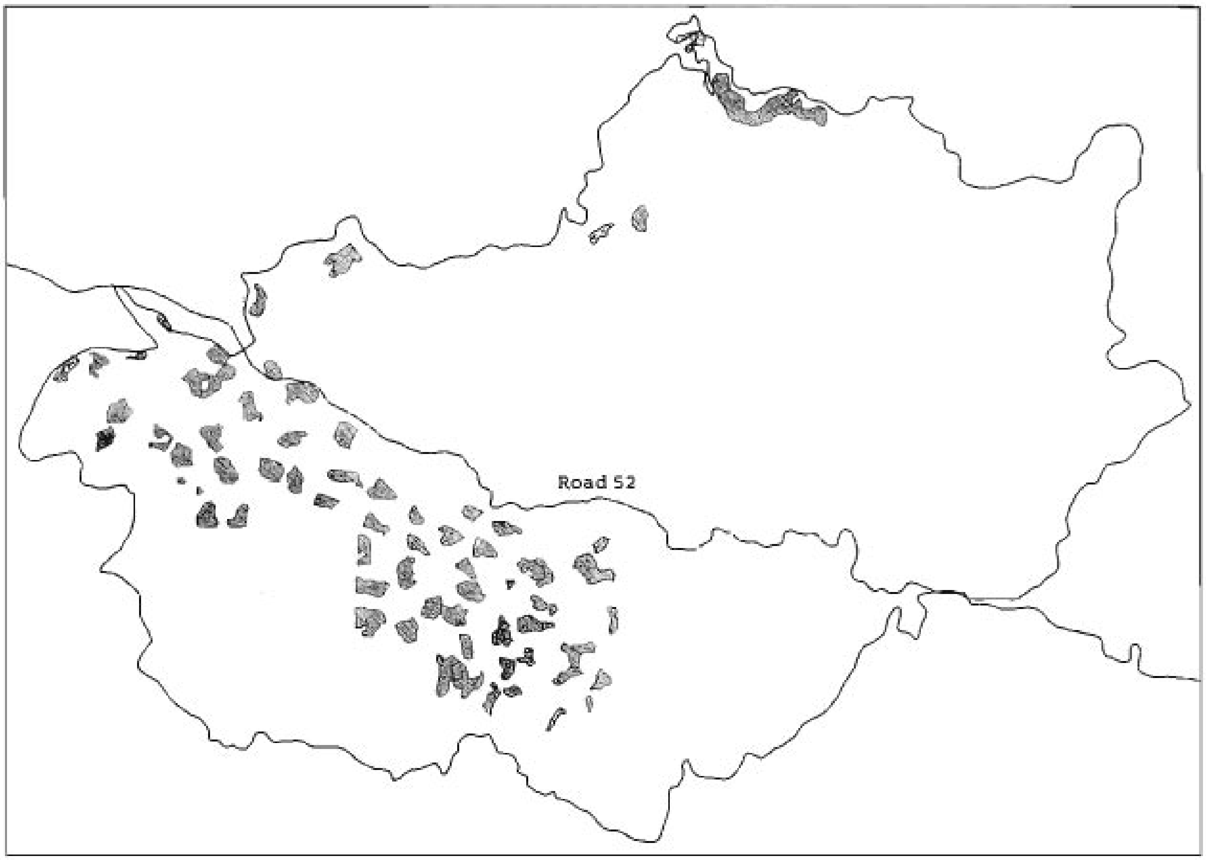


Figure 39 – Tower Fire's impact on established plantations. The Tower Fire burned about 2,240 acres of long-established and recently-completed plantations.

Table 39: Economic Consequences of the Planting Recommendations for the Tower Analysis Area.

ECOLOGICAL SETTING	PLANTING NEEDED (Acres)	PLANTING COST (Dollars/Acre)	TOTAL COST (Dollars)
Cold Dry	553	556.60	307,799.80
Lodgepole Pine	3,896	546.63	2,129,670.48
Cool Moist	3,354	556.60	1,866,836.40
Warm Dry	2,583	531.33	1,372,425.39
Ponderosa Pine	6,982	531.33	3,709,746.06
Total	17,368		$9,386,478.13

Sources/Notes: Spacing recommendations came from Table 38A; planting acres came from Table 38; planting cost was based on recent empirical costs for the North Fork John Day Ranger District; and the total cost is the product of column 3 (planting needed) multiplied by column 4 (planting cost). Planting cost includes the following activities: animal damage control (tubing for big-game damage), pre- and post-plant surveys, program management (traversing, contract administration, etc.), tree cooler maintenance, seed procurement, planting, and seedling procurement.

Western White Pine Situation (from Powell and Erickson 1996). At present, the District has less than 20 pounds of western white pine seed on inventory, enough to yield approximately 153,000 shippable seedlings. Another 9,000 seedlings are at Stone Nursery for 1997 delivery. Together these inventories are sufficient for planting approximately 1,860 acres (20% WWP in mix, 10'x10' spacing), roughly the acreage in the Tower Fire area suitable for planting white pine Once these sources have been depleted, the District will face a serious dilemma as to where to obtain additional western white pine seed for reforestation. Table 38A shows appropriate plant associations for western white pine planting.

Fortunately, western white pine exhibits little differentiation over geographic, ecologic, or elevational gradients, and nonlocal seed sources can thus be transferred widely with little risk of maladaptation (Rehfeldt and others 1984, Steinhoff 1979, Townsend and others 1972, Rehfeldt and Steinhoff 1970). In the future (approximately 20–25 years from now), reforestation seed may also be obtained from the Paddy Flat Seed Orchard (Pine Ranger District), which is being established to supply seed for the Umatilla, Wallowa–Whitman, and Malheur National Forests.

Several sources of non-local western white pine seed would be suitable for use in District planting mixes. ***•Seed origin should be documented in planting records, and survival and growth performance monitored closely over time so that transfer guidelines can be modified as needed.*** In order of preference, seed sources considered appropriate for District use include the following sources. Please see Forest Vegetation Report - Tower Fire for a complete discussion on these sources.

a) Other Blue Mountain sources:

b) Couer d'Alene Nursery Seed Orchard: *Surplus seedlings are currently available from this source for outplanting in 1997 (100M, 2-0 stock) and 1998 (100M, 3-0 stock?).* ***• If stock quality is acceptable, acquisition of these seedlings for District use is highly recommended.***

c) Moscow Arboretum:

d) Sandpoint Seed Orchard: Estimated resistance is 35 percent, so plant materials originating from this orchard are not recommended for use on high risk sites. *Coeur d'Alene Nursery currently has 28M surplus seedlings (3-0 stock) available for outplanting in 1997.*

e) Dorena Seed Orchard:. Plant materials from R–1 are preferable to those from this source.

Competing Vegetation.
•Planting should occur as soon as possible so that trees can be established before competition occurs. As described previously, one of the potential benefits of the Tower wildfire is that it provided a "site preparation" treatment in terms of tree regeneration. Rhizomatous grasses, shrubs, and other plant species that compete with trees for moisture, sunlight, and nutrients have been temporarily "knocked back" by the fire. If planting occurs quickly, trees could get established before allelopathic plants and other competitors have fully recovered.

produce an abundance of surficial roots that rapidly absorb moisture before it can percolate to the deeper roots of woody species. Their rooting habit gives grasses a competitive advantage over trees, particularly on droughty sites (Oliver and Larson 1996).

Thinning (pertains to forested uplands only)

•*Maintain future stands in the ponderosa pine plant associations at levels which minimize the potential for crown fire.* Recent concerns about forest health in the Blue Mountains (McLean 1992) have recognized the value of maintaining stand densities that promote high tree vigor and minimize damage from insects and pathogens. Thinning is effective at preventing or minimizing serious mortality from mountain pine beetle and, perhaps, western pine beetle. It can also prevent dwarf mistletoe from becoming a serious problem in even-aged stands of ponderosa pine (Cochran and others 1994). Density management can be used to shift a site's growth potential to fewer stems so that trees with "old-growth" size characteristics could be produced more quickly. Recommended stand densities are listed in Table 40.

Table 40: Maximum Stand Densities to Limit Crown Fire Susceptibility.

AVERAGE STAND DIAMETER (Inches)	MAXIMUM STAND DENSITY (Trees/Acre) Ponderosa Pine	Douglas-fir	Grand Fir
3.0	584	574	344
7.5	390	238	245
12.5	197	162	157
17.5	170	104	83

Source/Notes: From Agee (1996). These figures refer to single-sized, non-stratified stands that are predominately of a single species. They do not pertain to stands in which differentiation into crown strata has occurred such that ladder fuels from the understory to the overstory are present. To limit future crown fire risk, any stand density treatment (thinnings, weedings, release, etc.) should leave no more than the trees per acre given above. For example, if a pole-size Douglas-fir stand is thinned from below, and the average stand diameter after thinning is about 7.5", then the residual stocking should be no more than 238 trees per acre (13.5' spacing) to limit the risk of future crown fire. [Note: the ponderosa pine figures appear to be high and should be used with caution. These recommendations were developed from a fire management perspective. Stands managed for forest health or silvicultural objectives would typically have lower stand densities than those shown above.]

Understory Removals (pertains to forested uplands only)

•*Use understory removals for removing firs that have encroached on Warm/Dry sites.*
The objective of understory removals is to improve overstory vigor by reducing competition. When the overstory trees are overmature ponderosa pines and western larches, this treatment is particularly effective at ensuring the continued survival of these ecologically valuable stands.
Understory removals may also be effective on sites with a remnant pine/larch component, especially if thinnings reduce stand densities to more sustainable levels and improve the vigor and survivability of pine and larch. •*Also consider understory removals for partial-burn areas where multi-storied, mixed-species stands have survived the fire, especially if they occur on ponderosa pine or warm dry ecological settings.*

Prescribed Burning (pertains to forested uplands only)

•Development and implementation of a prescribed burning program is strongly recommended once salvage harvests, understory removals, thinnings and other treatments are completed. Once ponderosa pines and larches are 10 to 12 feet tall, a prescribed burn could be completed, although a low-intensity fire would leave most of the 6- to 8-foot trees undamaged as well (Wright 1978). From that point on, surface fires could be used regularly, usually at intervals of 15 to 25 years. Fall burns, which are desirable from an ecological standpoint because they replicate the natural fire regime, result in fewer losses of overmature ponderosa pines to fire damage or western pine beetle attack (Swezy and Agee 1991).

Periodic burning can also be used to increase the nutrient capital of a site by maintaining sparse stands of snowbrush ceanothus, lupines, peavines, vetch, buffaloberry, and other nitrogen-fixing plants. Numerous studies have documented the slow decomposition rates associated with large, woody material in the interior West (Gruell 1980, Gruell 1983, Gruell and others 1982). Forests of the interior West may have depended more on nitrogen-fixing plants to replenish soil nutrients than on the decomposition of woody debris. Providing adequate levels of site nutrition is important for maintaining tree resistance to insects and pathogens (Mandzak and Moore 1994).

Fire may not be beneficial on all mixed-conifer sites; on moist areas, burns could favor dominance by bracken fern, western coneflower, and other allelopathic plants that inhibit conifer regeneration (Ferguson 1991, Ferguson and Boyd 1988).

On poor to moderate forest sites (generally dry areas with coarse or shallow soils and thin forest floors), broadcast burning can be detrimental from a nutritional standpoint. The short-term benefits of prescribed burns, such as improved planter access, fuel reduction, site preparation, and increased soil temperature regimes, may be achieved at a cost of high soil pH, nitrogen and sulfur deficiencies, and other nutritional problems later in the stand's life (Brockley and others 1992).

•Prescribed burning should be used in existing dry-forest types (ponderosa pine and Douglas-fir) that have received an understory removal treatment, and should be considered as a future treatment for plantations established on ponderosa pine and warm dry ecological settings. Future prescribed burns will probably not occur until at least 30 years after plantations have been established, and could then be coordinated with pruning treatments to lower the risk of pole-sized trees being killed by a fire (torching).

Fertilization (pertains to forested uplands only)

•Consider fertilization as a future treatment for young stands growing on ponderosa pine or warm dry ecological settings. Fertilization would probably not be needed until 20 to 30 years after plantations have been established, and could then be coordinated with other cultural treatments such as precommercial thinning.

Pruning (pertains to forested uplands only)

- *Consider pruning as a future treatment for young stands on ponderosa pine and warm dry ecological settings where wildlife cover and/or stream shading are not limiting.. Pruning may not be needed until at least 30 years after plantations have been established, when it could then be coordinated with prescribed burning treatments as a way to lower the risk of pole-sized trees being killed by a fire (torching).*

Pruning is typically used to produce clear, knot-free wood, but it could also play a role in the future management of budworm-susceptible forests. In areas where budworm-host trees will continue to be a stand component, pruning could provide several benefits. The first and most obvious benefit is that by removing the lower crown portion of host trees, pruning results in less food for the survival and growth of budworm larvae.

After pruning trees that are large enough to have developed a fire-resistant bark, it would be possible to underburn mixed-species stands without "torching" the leave trees. Trees with short, pruned crowns would be less likely to serve as ladder fuels, thereby minimizing the risk of an underburn turning into a crown fire. Pruning must be carefully coordinated with the onset of an underburning program — if trees were pruned too soon, epicormic "water" sprouts could occur on the stem and increase a tree's risk of torching in an underburn (Oliver and Larson 1996).

Mechanical pruning would produce a stand that can be underburned much more quickly than waiting for natural pruning. For example, Table 41 shows that ponderosa pine can self-prune quickly, but that dead branches often persist and that mechanical pruning would be advisable if a perfectly clean, branch-free bole is desired to minimize the risk of crown scorch or torching.

Table 41: Natural Pruning in Ponderosa Pine.

Age	Height to Base of the Live Crown (Feet)	Bole Length Without Any Dead Branches (Feet)
20	3	1
30	18	2
40	28	3
50	36	4
60	45	7
70	50	11
80	56	19
90	61	27
100	65	29

Sources/Notes: From Kotok (1951). This data shows that ponderosa pine "lifts" its live crown very quickly (2nd column) when growing in a dense stand, but that dead branches are somewhat persistent and a "clean" branch-free bole requires a long time to develop (3rd column). Note that these figures were derived from dense, wild stands; open, thinned stands would lift their crowns much more slowly than is shown above.

Insects and Disease

1. Douglas-fir larger than 10 inches (dbh), with moderate and severe fire injuries are a poor survival risk due to recent high populations of Douglas-fir beetles in stands. Severely-injured, large-diameter trees (those over 18 or 20 inches dbh) are often the first to be attacked by beetles, with smaller diameters and less severely-injured trees subsequently attacked as the supply of large, severely-injured trees is depleted by beetles. Severely-injured and moderately-injured, large-diameter trees, and any trees with evidence of beetle attack (fresh red-brown boring dust in bark crevices and around the base, clear pitch streaming from upper portions of bole, and green foliage fading to yellow, then to red) are high priority for removal before beetles emerge next spring, from the aspect of forest pathogen control. However, these same trees meet other needs, such as wildlife habitat, down wood, etc., and this incongruity needs to be resolved during project planning.

2. Where salvage is being considered in the pine types following a fire, if possible it is best to delay marking until after budburst the following spring in order to get a better indication of tree survival.

3. Recognition of Armillaria root diseased areas is critical to successful reforestation of these sites. Since viable fungal pathogen-infected inoculum persists as buried roots following burning, infection can occur many years later when roots of susceptible trees make contact with this material.

Sites that are in or adjacent to confirmed Armillaria should be regenerated to tree species that will offer the most resistance to infection. Western larch and lodgepole pine are preferred species as they offer the most resistance to infection and damage. Ponderosa pine, Engelmann spruce and Douglas-fir offer somewhat less resistance, although these species should be included in the planting mix where site-adapted. True firs should be avoided in this areas. Use of natural regeneration should be emphasized since these trees offer more resistance than planted stock. Fire is suspected to improve soil conditions with respect to Armillaria, however, fire will not eradicate infection.

Maintenance of root disease-infected sites should include periodic removal of susceptible species. To assure that such work is carried out and continued well into the future, exact locations of treated areas of root disease should be kept in a GIS system.

4. Healthy stands of spruce adjacent to areas where spruce beetles infest fire-injured trees may be at risk, depending on the size and amount of healthy spruce in adjacent stands. Removal of fire-injured spruce prior to potential infestation next spring, or removal of beetle-infested spruce before brood develops to adult stage approximately one year after infestation (i.e., by May of 1998), will help prevent buildup of large beetle populations in stands. These areas could be monitored by the district over the next couple of seasons to detect potential spruce beetle population increases.

5. Where mistletoe-infected trees received only light fire injury, it is probable that those locations will be the sites of Douglas-fir beetle infestations in coming years as bark beetle populations build up in the more seriously injured trees on the burn and move to these locations. Those areas would merit monitoring by the district for increasing beetle activity over the next several years to detect beginning of potential outbreaks that could lead to more serious tree mortality, including movement of beetle populations into healthy green stands.

5. Where mistletoe-infected trees received only light fire injury, it is probable that those locations will be the sites of Douglas-fir beetle infestations in coming years as bark beetle populations build up in the more seriously injured trees on the burn and move to these locations. Those areas would merit monitoring by the district for increasing beetle activity over the next several years to detect beginning of potential outbreaks that could lead to more serious tree mortality, including movement of beetle populations into healthy green stands.

Floristic Biodiversity

Opportunities

The effects of the Tower Fire on riparian vegetation were particularly dramatic and the fire-altered riparian corridors present many challenges and opportunities for restoration and rehabilitation. Post-burn rehabilitation should include efforts to re-establish native riparian shrub communities where ecologically appropriate, particularly along the south-trending and southwest-trending stream channels. Care should be taken to ensure that restoration plans avoid overstocking riparian areas entirely with coniferous tree species. Restoration plans should incorporate the use of healthy riparian shrub patches which could serve as fire breaks in future arborescent vegetation. Widely spaced planted conifers and/or naturally regenerating trees may be compatible with the fire break concept and at the same time provide for long-term fish and wildlife needs. The re-establishment of the riparian shrub component would simultaneously protect the soil and water resource and enhance both the fish and wildlife resources of the area.

Guidelines for restoration activities involving native species are provided in the following tables Each table provides a list of native plant species that are suitable for planting in interfaces between the riparian corridor and the other ecological settings.

Principal Species for Consideration in Restoration of Riparian Interface Zones

Table 42 provides a list of 18 species in four (of five) life forms that could serve as "workhorse" species in the riparian-ponderosa pine ecological setting interface.

Table 42. Eighteen "workhorse" species recommended for restoration activities in the Ponderosa Pine Ecological Setting and Riparian Corridor Ecological Setting.

Genus	Species	Common Name	Life Form	Comments
Bromus	*carinatus*	Mountain Brome	G	Not recommended in coniferous interplantings
Elymus	*cinereus*	Great Basin Wildrye	G	Most successful on sites below 4,000' elevation
Elymus	*glaucus*	Blue Wildrye	G	Check native seed availability
Carex	*nudata*	Torrent Sedge	G-L	Must have root mass in stream channel; transplant via plugs
Amelanchier	*alnifolia*	Western Serviceberry	S	
Arctostaphylos	*nevadensis*	Pinemat	S	Not recommended in coniferous interplantings

Genus	Species	Common Name	Life Form	Comments
Crataegus	*douglasii*	Black Hawthorn	S	Does not transplant well; root penetration is problematic
Philadelphus	*lewisii*	Lewis Mockorange or Syringa	S	Fall propagation (vegetative) required
Prunus	*virginiana*	Common Chokecherry	S	
Rosa	*nutkana*	Nootka Rose	S	Sites below 4,000' elevation
Symphoricarpos	*albus*	Common Snowberry	S	Sites below 4,000' elevation
Symphoricarpos	*oreophilus*	Mountain Snowberry	S	Sites above 4,000' elevation
Acer	*glabrum*	Rocky Mountain Maple	T	
Larix	*occidentalis*	Western Larch	T	
Populus	*trichocarpa*	Black Cottonwood	T	Stream profiles are not appropriate for gallery plantings; use dispersed plantings
Pinus	*ponderosa*	Ponderosa Pine	T	

Twenty-five "workhorse" species are recommended for restoration activities in the interface between the Warm, Dry Forest Ecological Setting and the Riparian Corridor Ecological Setting. Species representative of four life forms are provided in this list. Potential forb species are too numerous to list.

Table 43. Twenty-five "workhorse" species récommended for restoration activities in the Warm, Dry Forest Ecological Setting and Riparian Corridor Ecological Setting.

Genus	Species	Common Name	Life Form	Comments
Bromus	*carinatus*	Mountain Brome	G	Not recommended in coniferous interplantings
Elymus	*glaucus*	Blue Wildrye	G	Check native seed availability
Poa	*canbyi*	Pine Bluegrass	G	
Trisetum	*canescens*	Tall Trisetum	G	
Carex	*hoodii*	Hood's Sedge	G-L	
Amelanchier	*alnifolia*	Western Serviceberry	S	
Arctostaphylos	*nevadensis*	Pinemat Manzanita	S	Not recommended in coniferous interplantings
Arctostaphylos	*uva-ursi*	Bearberry	S	Excellent on dry, cut bank sites; not recommended in coniferous interplantings
Ceanothus	*sanguineus*	Redstem Ceanothus	S	
Cornus	*stolonifera*	Red Osier Dogwood	S	

Genus	Species	Common Name	Life Form	Comments
Crataegus	*douglasii*	Black Hawthorn	S	Does not transplant well; root penetration problems
Holodiscus	*discolor*	Creambush Oceanspray	S	
Philadelphus	*lewisii*	Lewis Mockorange or Syringa	S	Vegetative propagation must be started in fall
Prunus	*virginiana*	Western Chokecherry	S	
Rosa	*nutkana*	Nootka or Spalding's Rose	S	Sites below 4,000' only
Rosa	*woodsii*	Wood's Rose	S	Sites above 4,000' only
Sambucus	*cerulea*	Blue Elderberry	S	
Symphoricarpos	*albus*	Common Snowberry	S	Sites below 4,000' only
Symphoricarpos	*oreophilus*	Mountain Snowberry	S	Sites above 4,000' only
Acer	*glabrum*	Rocky Mountain Maple	T	
Larix	*occidentalis*	Western Larch	T	
Pinus	*monticola*	Western White Pine	T	
Pinus	*ponderosa*	Ponderosa Pine	T	
Populus	*trichocarpa*	Black Cottonwood	T	Gallery plantings of this species are inappropriate in the Tower Fire area. Dispersed plantings are appropriate.
Pseudotsuga	*menziesii*	Douglas Fir	T	

Table 44 below provides a list of 25 "workhorse" species recommended for restoration activities in the interface between the Cool, Moist Forest Ecological Setting and the Riparian Corridor Ecological Setting. This list contains representatives of four of the five life forms (trees, shrubs, grass-like species, and grasses). Forbs appropriate for this interface are too numerous to list.

Table 44. Twenty-five "workhorse" species recommended for restoration activities in the interface between the Cool, Moist Ecological Setting and the Riparian Corridor Ecological Setting.

Genus	Species	Common Name	Life Form	Comments
Bromus	*vulgaris*	Columbia Brome	G	Not recommended in coniferous interplantings
Bromus	*carinatus*	Mountain Brome	G	Not recommended in coniferous interplantings
Elymus	*glaucus*	Blue Wildrye	G	Check native seed availability
Melica	*subulata*	Alaska Oniongrass	G	
Carex	*lenticularis*	Densely-Tufted Sedge	G-L	
Carex	*deweyana*	Dewey's Sedge	G-L	

Genus	Species	Common Name	Life Form	Comments
Alnus	*incana*	Mountain Alder	S	
Alnus	*sinuata*	Sitka Alder	S	
Berberis	*nervosa*	Cascade or Dull Oregongrape	S	
Ceanothus	*sanguineus*	Redstem Ceanothus	S	
Cornus	*stolonifera*	Red Osier Dogwood	S	
Crataegus	*douglasii*	Black Hawthorn	S	
Holodiscus	*discolor*	Creambush Oceanspray	S	
Lonicera	*involucrata*	Bearberry Honeysuckle or Black Twinberry	S	
Pachistima	*myrsinites*	Oregon Boxwood	S	
Rosa	*woodsii*	Wood's Rose	S	
Salix	*sitchensis*	Sitka Willow	S	Placement dependent upon stream channel morphology at microsite
Salix	*rigida*	Rigid Willow	S	Placement dependent upon stream channel morphology at microsite
Vaccinium	*membranaceum*	Big Huckleberry	S	
Abies	*grandis*	Grand Fir	T	
Larix	*occidentalis*	Western Larch	T	
Picea	*engelmannii*	Engelmann Spruce	T	
Pinus	*monticola*	Western White Pine	T	
Populus	*trichocarpa*	Black Cottonwood	T	Gallery plantings not appropriate for the Tower Fire area; dispersed plantings are appropriate.
Taxus	*brevifolia*	Pacific Yew	T	

Table 45 below lists 18 plant species recommended for restoration activities in the interface between the Lodgepole Pine and Riparian Corridor Ecological Settings. Refer to the potential vegetation map on p.26 for locations of this interface. This list includes representatives of four of the five life forms (trees, shrubs, grass-likes, and grasses). Native forbs were excluded from this list because they are too numerous.

Table 45. Eighteen "workhorse" species recommended for restoration activities in the interface between the Lodgepole Pine Ecological Setting and the Riparian Corridor Ecological Setting.

Genus	Species	Common Name	Life Form	Comments
Bromus	*vulgaris*	Columbia Brome	G	Not recommended for coniferous interplantings

Genus	Species	Common Name	Life Form	Comments
Elymus	*glaucus*	Blue Wildrye	G	Check native seed availability
Carex	*deweyana*	Dewey's Sedge	G-L	
Carex	*lenticularis*	Densely-Tufted Sedge	G-L	
Carex	*vesicaria*	Inflated Sedge	G-L	
Alnus	*incana*	Mountain Alder	S	
Alnus	*sinuata*	Sitka Alder	S	
Arctostaphylos	*nevadensis*	Pinemat Manzanita	S	Excellent on cut banks; not recommended for coniferous interplantings
Cornus	*stolonifera*	Red Osier Dogwood	S	
Lonicera	*involucrata*	Bearberry Honeysuckle or Black Twinberry	S	
Salix	*sitchensis*	Sitka Willow	S	Placement dependent upon stream channel morphology at microsite
Shepherdia	*canadensis*	Russet or Canada Buffaloberry	S	
Sorbus	*scopulina*	Mountain Ash	S	
Vaccinium	*membranaceum*	Big Huckleberry	S	
Betula	*occidentalis*	Red Birch or Water Birch	T	
Picea	*engelmannii*	Engelmann Spruce	T	
Pinus	*contorta*	Lodgepole Pine	T	

Table 46 below lists 19 "workhorse" plant species recommended for use in restoration activities in the interface between the Cold, Dry Forest Ecological Setting and the Riparian Corridor Ecological Setting. The potential vegetation map of the Tower Fire (p.26) shows the locations of this interface. A broad-spectrum of representatives of life forms is provided in this list.

Table 46. Nineteen "workhorse" species suitable for restoration activities in the interface between the the Cold, Dry Forest Ecological Setting and the Riparian Corridor Ecological Setting

Genus	Species	Common Name	Life Form	Comments
Bromus	*carinatus*	Mountain Brome	G	Not recommended for coniferous interplantings
Bromus	*vulgaris*	Columbia Brome	G	Not recommended for coniferous interplantings
Phleum	*alpinum*	Alpine Timothy	G	
Carex	*pachystachya*	Thick-headed Sedge	G-L	
Carex	*raynoldsii*	Raynold's Sedge	G-L	

Genus	Species	Common Name	Life Form	Comments
Carex	*vesicaria*	Inflated Sedge	G-L	
Alnus	*incana*	Thin-leaved Alder	S	
Alnus	*sinuata*	Sitka Alder	S	
Juniperus	*communis*	Common or Mountain Juniper	S	
Rosa	*woodsii*	Wood's Rose	S	
Sambucus	*racemosa*	Black Elderberry	S	
Salix	*sitchensis*	Sitka Willow	S	Placement dependent upon st ream channel morphology at microsite
Sorbus	*scopulina*	Cascades Mountain Ash	S	
Vaccinium	*membranaceum*	Big Huckleberry	S	Deep soil site
Vaccinium	*scoparium*	Grouse Huckleberry or Whortleberry	S	Shallow soil site
Abies	*lasiocarpa*	Subalpine Fir	T	
Betula	*occidentalis*	Water Birch	T	
Picea	*engelmannii*	Engelmann Spruce	T	
Pinus	*contorta*	Lodgepole Pine	T	

Table 47 below provides a list of 14 "workhorse" plant species recommended for restoration activities occurring in the interface between the Steppe Ecological Setting and the Riparian Corridor Ecological Setting. The potential vegetation map of the Tower Fire (p.26) shows the locations of this interface throughout the fire area. Species representing four of five life forms are provided in this list. Forbs are too numerous to list.

Table 47. Fourteen "workhorse" species suitable for restoration activities in the interface between the Steppe Ecological Setting and the Riparian Corridor Ecological Setting.

Genus	Species	Common Name	Life Form	Comments
Bromus	*carinatus*	Mountain Brome	G	Not recommended for coniferous interplantings
Elymus	*cinereus*	Great Basin Wildrye	G	Sites below 4,000' elevation only
Trisetum	*spicatum*	Downy Oatgrass	G	
Carex	*aquatilis*	Water Sedge	G-L	
Carex	*deweyana*	Dewey's Sedge	G-L	
Carex	*lanuginosa*	Woolly Sedge	G-L	
Carex	*nebrascensis*	Nebraska Sedge	G-L	

Genus	Species	Common Name	Life Form	Comments
Berberis	*repens*	Low Oregongrape	S	
Cercocarpus	*ledifolius*	Curlleaf Mountain Mahogany	S	
Cornus	*stolonifera*	Red Osier Dogwood	S	
Salix	*exigua*	Coyote Willow	S	Placement dependent upon stream channel morphology at microsite
Salix	*lasiandra*	Pacific or Red Willow	S	Placement dependent upon stream channel morphology at microsite
Symphoricarpos	*albus*	Common Snowberry	S	Sites below 4,000' only
Symphoricarpos	*oreophilus*	Mountain Snowberry	S	Sites above 4,000' only

Fish and Aquatic Habitat

Within that portion of the burned area classified in the Forest Plan as a "Special Fish Management Area," all management activities should be directed towards maintaining or enhancing water quality and producing high quality of anadromous fish habitat.

PACFISH establishes some standards (RMOs) to guide management that may affect habitat conditions in streams. However, PACFISH RMOs are not meant to "establish a ceiling for what constitutes good habitat conditions. Actions that reduce habitat quality, whether existing conditions are better or worse than objective values, are inconsistent with the purpose of this interim direction."

The following recommendations are intended to further Forest Plan and PACFISH objectives and respond to parts of the Key questions identified earlier in this document.

1. Within Riparian Habitat Conservation Areas, manage for plant species ecologically appropriate to the site, which will produce high quality shade and large woody debris. In RHCAs that experienced high burn intensity (Figure 22, p.75) where natural regeneration may be delayed because of a lack of seed (probably parts of all streams except Big Creek and Hidaway), planting of the appropriate tree species may be necessary. Conifers produce more effective shade than shrubs and supply larger and longer lasting woody debris than hardwoods and so wherever feasible and ecologically appropriate to the site, they would be the preferred species.

2. Favor types of management activities that would minimize delivery of sediment to any stream channel. In most cases this means avoidance of soil compaction or exposure of bare soil surfaces near stream channels. The specific distance from the stream channel for operations would vary with the site. Generally PACFISH standards would be adequate, although in some cases it would be appropriate to increase or reduce the width of the RHCA. The soils and hydrology reports develop this topic in more detail.

3. A set of standards and guidelines developed for short term management of the burned area establishes criteria for management of large woody debris in and adjacent to the stream (Appendix B). The intent of these guidelines is to ensure that woody material important to stream function and aquatic habitat remains in place during immediate post-fire management of the area (primarily fire related salvage logging). For long term management, PACFISH, or whatever standard supersedes PACFISH, will apply. In addition to their functions for aquatic habitat, complexes of large down wood near the stream will also aid soil development and help restrict access of cattle and big game to the stream channel and help promote rapid recovery of riparian vegetation.

4. In cases where there is a shortage of wood in the stream as a result of past management activities and no recruitment by the fire (e.g. previous logging adjacent to the stream channel), it may be useful to move offsite wood to the stream channel. This may be the case with Texas Bar, Camp Creek, and N. Fk. Cable reach 3, but would require site visits to verify appropriateness of such management.

5. In addition to consumption of shade producing and bank stabilizing vegetation, cattle, especially when allowed to congregate or linger in riparian areas, break down stream banks. This increases the width depth ratio and the amount of stream surface exposed to insolation. The Tower Fire has eliminated nearly all shade over much of the streams within its boundary. Therefore in the near future, maintenance of a low surface area exposed to direct sunlight (low width/depth ratio) will be critical for short term water temperature management (See Beschta et. al, 1987). Deferring grazing of these areas or limitation of livestock access to minimum necessary water gaps would aid development and maintenance of low width/depth ratios.

6. Because of uncertainties regarding the quality of stream survey data for Texas Bar Creek, it would be appropriate to review that data, correct errors in the SMART database, and consider resurveying the creek.

7. Current knowledge of fish distribution in streams of the Tower Fire area does not everywhere agree with GIS stream class mapping (e.g. Oriental Creek). Updating GIS to reflect current knowledge would make management of the resource more effective.

Terrestrial Wildlife

Habitat

Establish and recover vegetative communities and conditions that are ecologically appropriate for sites in the Tower Fire Analysis Area. Reference historical data bases and potential vegetation maps to determine the appropriate vegetative community and species composition for the site.

Old Growth Habitat

Conduct further analysis with ground verification to determine the extent of fire damage to C1 and C2 Management Areas. Determine habitat suitability and replace those stands which no longer have the potential to meet or maintain habitat suitability. Proposed replacement C1 and

C2 Management Areas are identified in Figure 34). Incorporate the "new" C1 and C2 Management Areas in the Camas Old Growth-Riparian network.

Dead Standing and Down Wood Habitat

Follow recommendations outlined in the Standards for Post-fire Restoration Projects (Appendix B) for determining dead standing tree and down wood requirements for retention in each environmental setting. Consider topping retention trees to increase the longevity of dead standing trees on the site.

Wetland, Riparian, and Aspen Habitat

Emphasize the restoration of riparian and wetland communities in the Tower Fire area. Promote the restoration and recovery of ecologically appropriate wetland and riparian vegetative types in the area. Favor and or propagate willows, alder, and black cottonwood species for riparian development.

Restore and protect aspen communities by constructing barriers or fences when appropriate to maintain site productivity and integrity.

"Special" Habitats

Protect and maintain meadow, springs, rock outcrops, and talus slopes as sensitive wildlife habitats. Buffer these habitats to protect their integrity, to aid in fire recovery, and to avoid disruption to species associated with them. Buffers should be applied when ground disturbing activities occur adjacent to these habitats, and buffers should be 1 ½ tree lengths wide (100-150 feet) between the edge of the habitat and the activity. This distance will insure site integrity by maintaining characteristics (down logs, dead standing, and or live tree) that contribute to unique habitat types. No mechanical disturbance should occur in these habitats or their buffers.

Species

Restore and protect habitats and components identified in Table 33 for species with the "potential" to become locally extirpated within the next 15-20 years..

Threatened, Endangered, and Sensitive Species

Maintain the dead standing tree component adjacent to the North Fork John Day River with large snags (>30" d.b.h.) to provide perching and roosting habitat for wintering bald eagles.

Maintain buffers (see above) around rock talus and rock outcrops as "potential " denning habitat for the California wolverine.

Maintain large snags (see above) around and adjacent to water sources and rock outcrops as "potential" roosting habitat for Townsend's big-eared bat. Buffer (see above) rock outcrops and water sources to protect and maintain "potential" roosting habitat.

Management Indicator Species

Primary Cavity Excavators

Maintain snag densities at the 100 percent potential population level (Thomas 1979) for primary cavity excavators as directed by "Eastside Screens" (Regional Forests Forest Plan Amendment #2, 6/15/95) and recommendations in the Standards for Post-fire Restoration on the Umatilla National Forest.

Rocky Mountain Elk

Retain remaining "marginal" cover on the landscape to reduce the disturbance and exposure of elk. When available, maintain "green" patches of trees and/or dense patches of dead standing trees as cover.

Protect elk calving areas within the Tower Fire area. Minimize management activities in the vicinity of calving areas and maintain site characteristics. Schedule treatments to avoid disturbance during the calving season.

Delineate travel ways in order to reduce elk vulnerability and facilitate spring and fall migration through the area. Reference historical migration routes and incorporate "green" stands of trees and dense stands of dead standing trees to establish travel way corridors. Travel ways will be identified in cooperation with ODFW personnel.

To reduce potential elk disturbance and/or displacement in the area, maintain the open road density at 1 mile per square mile or less in all the subwatersheds wherever possible. When available, maintain "green" patches of trees and dead stems along roadways for screening elk and other wildlife species in the burn area.

C. Social

Heritage Resources

Any management activities within the Tower Fire perimeter will comply with the National Historic Preservation Act as amended. Those areas that have been previously inventoried will have to be reinventoried based on changed conditions, and those areas not previously inventoried will be inventoried for heritage properties. Particular attention will be expended in those areas that have been identified as aboriginal or present day activity areas. Section 106 consultation with the CTUIR and other interested tribes will take place when specific management activities have been identified.

Recreation/Wilderness

Restoration Opportunities: Trails will need to be re-waterbarred and tread work done on major portions due to erosion and fire suppression impacts. Trail bridges will need to be replaced to provide safe creek crossings and protect the streambanks from down cutting. Hazard trees will need to be removed from trails and trailheads. These measures are necessary to protect water and fisheries resources and provide for user safety. Winom Campground will require hazard tree removal, picnic table replacement, and cleanup. Traditional use dispersed campsites will require hazard tree removal and cleanup; large numbers of "camp dumps" have been exposed by the fire.

Logging Analysis

Three key questions were posed with respect to the salvage issue. Following are the team's findings:

What areas are suitable for salvage harvest?

On-the-ground, interdisciplinary, site specific analyses should identify those areas suitable for salvage harvest The following areas are not suitable for salvage harvest:

- Wilderness.
- Riparian Habitat Conservation Areas (RHCAs), except under very limited conditions as outlined in the Guidelines for Post-fire Restoration Projects.
- Buffers around "special areas" such as meadows, springs, etc. See Terrestrial Wildlife recommendations.
- Additional areas as identified in Recommendations.

Where are riparian areas that meet the six criteria in Riparian Guidelines, thus being suitable for salvage harvest?

At least three of the six criteria, items b, c, and e, will require a site visit to make this determination.

What areas are expected to produce economically viable salvage sales, and what logging systems would be most appropriate?

To determine economic viability, accurate information is needed on costs and values. Although logging systems costs can be fairly well estimated, timber stand information was lacking for this analysis. Spatial information on timber volumes by species and size classes would be needed to identify areas of economically viable sales. We attempted to utilize our Existing Vegetation (EVG) layer from our Geographic Information System, which theoretically would contain the needed timber information; however, it was found that insufficient data were available.

Following are the results of an initial harvest accessibility analysis, focused primarily on the South-Fork Tower Roadless Area, as it was the area that we knew the least about in terms of logging feasibility.

Tower Burn - Initial Harvest Accessibility Analysis

Rick Toupin - 10/25/96

1. What is this analysis?

The analysis documented here is not a logging feasibility analysis. It is also not an economic analysis in the sense that a thorough and accurate set of volume, acreage, value, cost, and limitation data is available. It is an initial examination of the burn area for the purpose of estimating what MAY be feasible.

My focus was the roadless area, although I did calculate some costs that should apply to the roaded portion as well.

For costs I used the HELIPACE program to determine helicopter logging costs and TEASKY and SKYAPRSL to calculate skyline logging costs. For values I contacted Ed Tarneski at Blue Mtn. Lumber Products, and Bruce Schvarch at Boise Cascade.

2. Process.

My focus was the roadless area. To determine what portions of it could be logged, I needed to determine the status of any roads around it or into it. I also examined on the ground as many possible helicopter landings and skyline opportunities as I could. As a part of this I identified some limited road construction opportunities that would allow helicopter landings to be located at stratigic locations. The landings and roads are shown on the map and discussed in the landing notes section of this document. For some of the area I identified where I thought the timber volume looked good for harvest by looking at the stand on the ground. Since it was not possible to look at much of the area, I made some interpretations of the photo map. The interpretations are probably poor however. I have no idea of volumes or species or the amount of cull.

I used the costing software to determine logging and haul costs.

To obtain values I contacted Boise Cascade and Blue Mtn Lumber Products.

3. Results.

The ability to successfully access timber within the roadless area is totally dependent on it being worth more than it costs to get it to a mill. Pine value is going to change rapidly due to blueing and the presence of char. The following table show what the values are today. The diameters mentioned are the scaling diameters. A 12 inch scaling diameter is 12 inches inside bark on the small end of the log. It has nothing to due with DBH.

Blue Mtn Lumber Products

Pine

Scaling Diam	Non-Blued/Non-Charred	Non-Blued/Charred
<12 inches	$270/MBF	$220/MBF
>12 inches	$550/MBF	$500/MBF

	Blued/Non-Charred	Blued/Charred
<12 inches	$135/MBF	$ 85/MBF
>12 inches	$275/MBF	$225/MBF

DF, larch ==> $425/MBF Sound.
WF ==> $350/MBF Sound.
Spruce ==> $280/MBF Sound.

Boise Cascade

Pine

Scaling Diam	Non-Blued/Non-Charred	Non-Blued/Charred
6-12 inches	$300/MBF	$270/MBF
12-17 inches	$450/MBF	$420/MBF
17+ inches	$500/MBF	$470/MBF

	Blued/Non-Charred	Blued/Charred
6-12 inches	$100/MBF	$ 70/MBF
12-17 inches	$250/MBF	$220/MBF
17+ inches	$300/MBF	$270/MBF

DF, larch ==> $440/MBF Sound.
WF ==> $410/MBF Sound.

Haul costs could be as high as $75/MBF due to the haul distance (70 miles), and the cost to operate a log truck as well as the effective hour of the log truck ($60/hour, and 50 minutes).

For blued charred pine, the logging costs can't be any higher than $150 to $175/MBF since logging costs plus haul must be lower than $225 to $270/MBF. There is probably considerable error in the assumptions behind the calculations since much of the necessary information is not known yet.

To helicopter log blued/charred pine, either uphill or downhill, flight distances need to be less than 1/3 mile, the volume per acre to cut needs to exceed 10 MBF per acre, and the 10 MBF per acre to yard needs to have small end scaling diameter inside bark greater than 12 inches. There is not likely to be any room for BD or KV deposit collections. This is a difficult number to come up with, but I believe that most of the timber to be cut will need to be greater than 18 inches in diameter. The important point though is the scaling diameter. The 10 MBF per acre should consist of logs that are above the scaling diameter.

To helicopter log charred pine that has not yet blued, flight distances can be up to a mile up or down hill. the need to fly over ridges will reduce this distance. Need to yard at least 10 MBF per acre with minimum scaling diameters of 10 inches if at least 2/3 of the logs have a scaling diameter of 12 inches. There may be some room for moderate deposits of up to $50/MBF.

I have drawn on the map the land I think can be reached if the requirements are met. Landings are shown and numbered. Also it will be necessary to allow roads to be used for landings (not the 52 road).

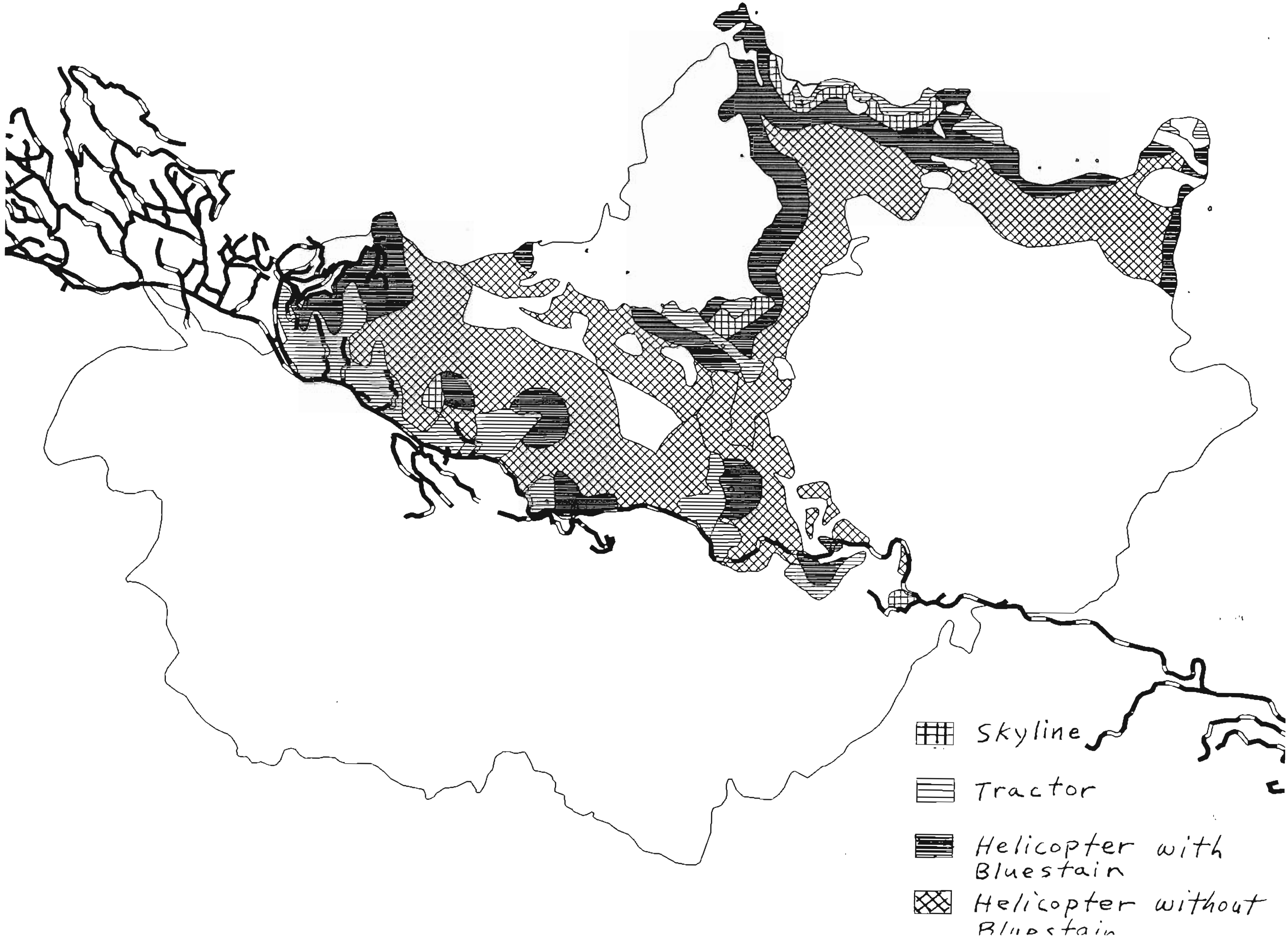
I encourage the Forest to allow feller bunchers or harvesters to fall and bunch timber for the helicopter wherever the slope will allow. This may make the yarding operation more efficient and enhance the viability of the sales. The impacts of the feller buncher and harvester is far different when used with a helicopter than when used with skidding or fowarding equipment.

An estimated skyline logging and haul cost for a cut of 10 MBF per acre with a minimum scaling diameter of 12 inches and a average yarding distance of about 800 feet is $200 to $220/MBF. A guide for locating skyline units is to locate them where the volume per acre to be cut is at least 10 MBF/acre and the timber size is larger than 16 to 18 inches. I did look at some of the skyline ground and it appears that it will not be possible to access all of the skyline ground with a yarder due to topography. If this is the case consider using helicopter logging on the inaccessible ground.

4. Safety.

You will need to consider OSHA when you design the sales. A logging crew can't operate in dangerous situations. I strongly urge you to follow what OSHA says about danger trees. The publication called Oregon Guidelines for Selecting Reserve Trees 1995. 21 pages. should be used as a guide. It talks about the definition of danger trees and the zones around them. This has affected sale feasibility in the region in both burns and bug killed

Tower Fire - Logging Feasibility



timber.

5. Landing notes (refer to map).

Landing H1 - Need to reconstruct the road to the helic landing. Dangerous trees in some of the area to be accessed. The area along the road between H1 and H2 can be cat logged.

Landing H2 - Section 13. Near creek. Should try to locate the landing away from the creek. Looks like it is possible.

Landing H4 - S of road 52 in SE 1/4 of section 29. Put landing at end of point. There is a closed road (440) sorth of road 52 that will access some cat ground.

Landing L1 - Tractor and helicopter landing. I don't think it will be visible from road 52 if it is constructed above the road.

Landing H6 - This landing will require about 4000 feet of new low standard road that can be obliterated. It is a very important landing because it accesses helicopter and cat volume.

Landing H7 - This landing requires some temporary road. The road to the landing will provide some skyline access, and the landing is a tractor and helic landing.

Landing H8 - this landing is beyond the big natural pile of rock on the ridge. Don't know where the end of the road is. Some skyline but not much. If the road could be extended another 2000 feet down the ridge to H9 there would be more ground accessed.

Landing H10 - This landing requires a new temporary road down the ridge in sec 8 & 17 from the end of road 262 (about 2500 feet). There is an old road at the end of road 262 that does not have suitable alignment for log trucks. Will require careful location within 1000 feet of the end of 262 since the road is on about a 20% slope. The road will access cat ground on the ridge and portions of the slopes. Good important helic landing location.

Road 265 in section 17 needed to skid to. Skid trails parallel to contours on slopes will be major skid trails. Try to minimize these. Skid down to the main ones then skid along them.

Landing H11 - End of road 296 off 292. Didn't look at this. Looking down into the area of H11 from H10 it looks like there are some gentle slopes for a helic landing. On the map it looks like there is a knob just east of the road. If so, try to get the helic landing on it. This will be a very important landing.

The mess of roads in the vicinity of 292 in sec 7 and 8 should provide for skyline. Didn't look at these roads.

Landing H12 - At end of road 5450 at the section line between sections 3 and 12. Landing on turnaround. May be within buffer but this landing is almost completely constructed. Not sure of the ownership.

Landing H16 - In the saddle near the intersection of 573 and 560. Skyline vol south of road 573 and 560 beyond intersection.

Landing H21, H22, H23 - Helic landings on road 90 off road 5226. Area below road skyline although not all burned. Probably will need to span creek with skyline.

Landing H24 - Near end of 095 road in section 36 off the 5226 road. Some skyline but road isn't on break so skyline limited.

Landing H25 - At end of 075 or the road adjacent to it. Didn't look at it.

Landing H26, H27, H28 - On roads 105, 107, and 157. Didn't look at them. May not need all of them.

Landing H13 & H14 - On road 085 in the N1/2 of sec 11.

Landing H15 - On knob east of intersection of 5448 and 560. Will require about 400 feet of road. Away from creek. Important landing.

```
nit 1           Page  1              |      1        |                               |
                                     |  * Selected * |                               |
                                Sale | TOWER         |                               |
                               Acres |         300.0 |                               |
             Unit Centroid: Easting  |          7280 |                               |
                            Northing |          2000 |                               |
                           Elevation |          5000 |                               |
                   Log Landing (LL)  | 2             |                               |
                Log Landing: Easting |          2000 |                               |
                            Northing |          2000 |                               |
                           Elevation |          5600 |                               |
                  Unit/LL Elev Change|           600 |                               |
         Include Service Flight Time?| N             |                               |
                Service Landing (SL) |               |                               |
            Service Landing: Easting |             0 |                               |
                            Northing |             0 |                               |
                           Elevation |             0 |                               |
                                     |               |                               |
AIRCRAFT                             | BV 107 - 61A  |                               |
                         Design Load |          6782 |                               |
             Mean Flight Path Length |          5314 |                               |
             LL to SL Flight Path Length |          0 |                               |
           SL to Unit Flight Path Length |          0 |                               |
                                     |               |                               |
STAND                                | Summary       |                               |
                     Stand Data File |               |                               |
           % Crown Closure Over Logs |            10 |                               |
               Gross Scale MBF/acre  |         10.00 |                               |
                    Scaling Defect%  |            15 |                               |
                 Net Scale MBF/acre  |          8.50 |                               |
         Yard Additional Fiber (AF)? | N             |                               |
  Additional Fiber to Yard Tons/acre |        0.0000 |                               |
          Add Wt% for Unintended AF  |             2 |                               |
                     Pounds/Gross BF |         10.00 |                               |
                                     |               |                               |
        Total Weight to yard lbs/acre|        102041 |                               |
         Includes AF Weight lbs/acre |          2041 |                               |
          % of Butt Logs to be Ripped|             0 |                               |
                                     |               |                               |
WOOD AVAILABILITY                    |               |                               |
                     Cut Trees/acre  |         16.00 |                               |
                      Cut Logs/acre  |         50.00 |                               |
               Tree Avg Gross Scale BF|          625 |                               |
                Log Avg Gross Scale BF|          200 |                               |
                     Ave Tree Weight |          6250 |                               |
                      Ave Log Weight |          2000 |                               |
          Ave Number of AF Pieces/acre|            0 |                               |
                Ave AF Piece Weight  |             0 |                               |
                         Design Load |          6782 |                               |
                    Mean Target Load |          6765 |                               |
              Average Available Load |  6088 -     0 |                               |
                         Load Factor |  0.90 -  0.00 |                               |
      Plausibility Test:   Logs/Turn |  3.04 -  0.00 |                               |
                      AF Pieces/Turn |  0.00 -  0.00 |                               |
                                     |               |                               |
PRODUCTION RATE                      |               |                               |
     Restricting Residual Tree Height|        100.00 |                               |
               Additional Turn Time  |          0.10 |                               |
                      Mean Min/Turn  |          3.20 |                               |
           Mean Turns/Effective Hour |         18.76 |                               |
         Effective Yarding Hours/Day |          7.40 |                               |
                    Yarding Workdays | 36.22 -  0.00 |                               |
                                     |               |                               |
       Production Rate Gross MBF/Day |  82.8 -   0.0 |                               |
         Production Rate Net MBF/Day |  70.4 -   0.0 |                               |
          Production Rate Tons/Day   | 422.6 -   0.0 |                               |
                                     |               |                               |
```

Non-Blued
Charred

1 mile uphill ord flight

10 MBF/acre
of valuable
material with
small end diam.
> 10" inside bark. Over
two thirds of
logs need to
have small end
diam > 12".

Some room for
moderate deposits
maybe 50 $.

```
Unit 1                   Page 12             |          1
                                             |   * Selected**
PRODUCTION COST                              |
       Total Payunits: NetMerch MBF |            2550.00
               Aircraft Fixed $/Day |               4865
            Aircraft Variable $/Day |               5365
               Yarding System $/Day |              10230
         Aux Support Aircraft $/Day |       0 -        0
                            Sawyers |       5 -        0
              Woods and Landing Crew |     10 -        0
              Loaders with Operators |      2 -        0
            Additional Ripping $/Day |      0 -        0
               Support System $/Day |   5632 -        0
         Ground Support Fixed $/Day |               1215
        Production Cost Range $/Ton |      40 -        0
          Production Cost $/Net Ton |              40.41
    Production Cost Range $/Net MBF |     243 -        0
          Production Cost $/Net MBF |             242.54
```

```
Summary for Sale: TOWER  (Part 2)

|Unit         |Alt|Acres|Landing          | AYD  | Work Days | Mean Load |  Aircraft  |
|             |   |     |                 |      |           |           |            |
|1            |  1|  300|2                | 5314 |     36.2  |      6088 |BV 107 - 61A|
|             |   |     |                 |      |           |           |            |
| COUNT       |   |TOTAL|                 | MEAN |   TOTAL   |   MEAN    |            |
|           1 |   |  300|                 | 5314 |     36.2  |      6088 |            |
```

```
Summary for Sale: TOWER

|Unit        |Alt|Acres|NetMBF/Day|NetMBF |  $/NetMBF  Tons/Day|  Tons  | $/Ton |
|            |   |     |          |       |                    |        |       |
|1           |  1|  300|        70  2550.0|   242.54      422.6| 15306.1| 40.41 |
|            |   |     |          |       |                    |        |       |
| COUNT      |   |TOTAL|   MEAN     TOTAL |    MEAN       MEAN | TOTAL  | MEAN  |
|           1|   |  300|        70  2550.0|   242.54      422.6| 15306.1| 40.41 |

Cost Recapitulation
                         ---- Extended Cost ----      --- Cost/Net MBF ---     ---- Cost/Ton ----
Yarding                         507949.84                    199.20                   33.19
Falling                          63390.55                     24.86                    4.14
Loading                          47155.13                     18.49                    3.08
Landings                          2000.00                      0.78                    0.13
Aircraft MoveIn/Out               6325.00                      2.48                    0.41
Ground MoveIn/Out                 5098.50                      2.00                    0.33
Special Costs                        0.00                      0.00                    0.00

TOTAL                           631899.01                    247.80                   41.28


Landings Construction Cost Detail

1                            2000.00

TOTAL                        2000.00
```

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nit 1                 Page  1 |        1              |                       |                       |
                              |  - Selected -         |                       |                       |
                         Sale | TOWER                 |                       |                       |
                        Acres |                 300.0 |                       |                       |
       Unit Centroid: Easting |                  3760 |                       |                       |
                     Northing |                  2000 |                       |                       |
                    Elevation |                  5400 |                       |                       |
             Log Landing (LL) | 2                     |                       |                       |
         Log Landing: Easting |                  2000 |                       |                       |
                     Northing |                  2000 |                       |                       |
                    Elevation |                  5600 |                       |                       |
        Unit/LL Elev Change   |                   200 |                       |                       |
Include Service Flight Time?  | N                     |                       |                       |
         Service Landing (SL) |                       |                       |                       |
     Service Landing: Easting |                     0 |                       |                       |
                     Northing |                     0 |                       |                       |
                    Elevation |                     0 |                       |                       |
                              |                       |                       |                       |
AIRCRAFT                      | BV 107 - 61A          |                       |                       |
                  Design Load |                  6782 |                       |                       |
      Mean Flight Path Length |                  1771 |                       |                       |
    LL to SL Flight Path Length |                   0 |                       |                       |
  SL to Unit Flight Path Length |                   0 |                       |                       |
                              |                       |                       |                       |
STAND                         | Summary               |                       |                       |
              Stand Data File |                       |                       |                       |
      % Crown Closure Over Logs |                  10 |                       |                       |
       Gross Scale MBF/acre   |                 10.00 |                       |                       |
              Scaling Defect% |                    15 |                       |                       |
          Net Scale MBF/acre  |                  8.50 |                       |                       |
   Yard Additional Fiber (AF)? | N                    |                       |                       |
Additional Fiber to Yard Tons/acre |            0.0000 |                       |                       |
      Add Wt% for Unintended AF |                   2 |                       |                       |
             Pounds/Gross BF  |                 10.00 |                       |                       |
                              |                       |                       |                       |
  Total Weight to yard lbs/acre |              102041 |                       |                       |
    Includes AF Weight lbs/acre |                2041 |                       |                       |
    % of Butt Logs to be Ripped |                   0 |                       |                       |
                              |                       |                       |                       |
WOOD AVAILABILITY             |                       |                       |                       |
               Cut Trees/acre |                 16.00 |                       |                       |
                Cut Logs/acre |                 50.00 |                       |                       |
       Tree Avg Gross Scale BF |                  625 |                       |                       |
        Log Avg Gross Scale BF |                  200 |                       |                       |
              Ave Tree Weight |                  6250 |                       |                       |
               Ave Log Weight |                  2000 |                       |                       |
  Ave Number of AF Pieces/acre |                     0 |                       |                       |
          Ave AF Piece Weight |                     0 |                       |                       |
                  Design Load |                  6782 |                       |                       |
             Mean Target Load |                  6765 |                       |                       |
       Average Available Load |    6088 -           0 |                       |                       |
                  Load Factor |    0.90 -        0.00 |                       |                       |
  Plausibility Test:  Logs/Turn |    3.04 -      0.00 |                       |                       |
               AF Pieces/Turn |    0.00 -        0.00 |                       |                       |
                              |                       |                       |                       |
PRODUCTION RATE               |                       |                       |                       |
 Restricting Residual Tree Height |              100.00 |                       |                       |
         Additional Turn Time |                  0.10 |                       |                       |
               Mean Min/Turn  |                  2.30 |                       |                       |
      Mean Turns/Effective Hour |               26.05 |                       |                       |
    Effective Yarding Hours/Day |                7.40 |                       |                       |
             Yarding Workdays |   26.09 -        0.00 |                       |                       |
                              |                       |                       |                       |
  Production Rate Gross MBF/Day |   115.0 -        0.0 |                       |                       |
    Production Rate Net MBF/Day |    97.8 -        0.0 |                       |                       |
      Production Rate Tons/Day |   586.7 -        0.0 |                       |                       |
                              |                       |                       |                       |
```

Blued
Charred
uphill or downhill
1/3 mile distance

10 MBF/acre
of vol with
small end inside
bark scaling diam.
> 12".

No BD or
other deposits.

Timber size approx.
- 13" dbh.

```
Unit 1                Page  2       |        1         :                        |
                                    |  * Selected *    .                        |
PRODUCTION COST                     |
      Total Payunits: NetMerch MBF  |          2550.00 .                        |
              Aircraft Fixed $/Day  |             4865 .                        |
           Aircraft Variable $/Day  |             5365                          |
              Yarding System $/Day  |            10230 .                        :
         Aux Support Aircraft $/Day |     0 -  [illegible]                      |
                           Sawyers  |     4 -  [illegible]                      |
              Woods and Landing Crew|     8 -  [illegible]                      :
             Loaders with Operators |     2 -  [illegible]                      |
           Additional Ripping $/Day |     0 -  [illegible]                      |
              Support System $/Day  |  4766 -  [illegible]                      |
         Ground Support Fixed $/Day |             1015                          |
        Production Cost Range $/Ton |    28 -  [illegible] |                    |
          Production Cost $/Net Ton |            27.63 .                        .
    Production Cost Range $/Net MBF |   166 -  [illegible]                      |
          Production Cost $/Net MBF |           165.54                          |
```

```
C:\HPWIN27\TOWER.HPC                          Thu Oct 24 1996  04:43:40 PM
Version: 2.70(Aug 1996)                         Cost Revision: Aug 1996
```

```
Summary for Sale: TOWER  (Part 2)

|Unit        |Alt|Acres|Landing       | AYD  | Work Days | Mean Load |  Aircraft   |
|            |   |     |              |      |           |           |             |
|1           |  1|  300|2             | 1771 |    26.1   |     6088  |BV 107 - 61A|
|            |   |     |              |      |           |           |             |
| COUNT      |   |TOTAL|              | MEAN |   TOTAL   |   MEAN    |             |
|           1|   |  300|              | 1771 |    26.1   |     6088  |             |
```

```
Summary for Sale: TOWER

|Unit       |Alt|Acres|NetMBF/Day|NetMBF  | $/NetMBF  |Tons/Day|  Tons    | $/Ton  |
|           |   |     |          |        |           |        |          |        |
|1          |  1|  300|        98 | 2550.0|   165.84  |   586.7| 15306.1| 27.63  |
|           |   |     |          |        |           |        |          |        |
| COUNT     |   |TOTAL|   MEAN   | TOTAL  |   MEAN    |  MEAN  | TOTAL    | MEAN   |
|          1|   |  300|        98 | 2550.0|   165.84  |   586.7| 15306.1| 27.63  |

Cost Recapitulation
                           ---- Extended Cost ----     --- Cost/Net MBF ---     ---- Cost/Ton ----
Yarding                           352401.75                   138.20                   23.02
Falling                            36521.02                    14.32                    2.39
Loading                            33964.55                    13.32                    2.22
Landings                            2000.00                     0.78                    0.13
Aircraft MoveIn/Out                 6315.00                     2.48                    0.41
Ground MoveIn/Out                   5098.50                     2.00                    0.33
Special Costs                          0.00                     0.00                    0.00

TOTAL                             436300.81                   171.10                   28.50


Landings Construction Cost Detail

2                         2000.00

TOTAL                     2000.00
```

```
### T E A - SKYLINE ###

10-24-1996    16:26:50

Timber Sale       ===>  TOWER BURN

System Size       ===>  L

Volume per acre   ===>   10

Acreage           ===>   300

Yarding distance  ===>   800

Log volume        ===>   600

Total cost on the truck.   ===>  $ 143.74  <===
```

Haul Costs

Haul costs 70 mile haul with truck cost 60 $/hr, 50 mi effective hour, 4MBF/load equals about 75 $/MBF

Skyline

Pine when blued and changed in worth, about $225/MBF for scaling diameter greater than 12". Timber < 12" scaling diam is worth $85/MBF. Worth far less than the handling costs. The minimum tree size and volume per acre to cut of pine is 10 MBF/acre and no logs with a small end diameter inside bark less than 12 inches. Timber size will probably need to be 16 to 18 inch dbh, and there should be the majority of the timber bigger than this.

The cost to log and haul is 144 + 75 = 219.

Blue Mtn Lumber Products - Ed Tameski
276-4304

Pine

	Non-Blued	IF charred
<12" scaling diam	$270/MBF	$220/MBF
>12" scaling diam	$550/MBF	$500/MBF

	Blued	IF charred
<12" scaling diam	$135/MBF	$85/MBF
>12" scaling diam	$275/MBF	$225/MBF

DF, Larch	$425/MBF sound
WF	$350/MBF
Spruce, fir	$280/MBF

10/24

Boise Cascade - LaGrande
Bruce Schwarch

Another contact is Vince Naughton
962-2000
cell 962-9047

Pine

Non-Blued

If charred
6-11" scaling diam $300/MBF ⇒ $270/MBF
12-17" scaling diam $450/MBF ⇒ $420/MBF
17"+ scaling diam $500/MBF ⇒ $470/MBF

Blued

If charred
6-11" scaling diam $100/MBF ⇒ $70/MBF
12-17" scaling diam $250/MBF ⇒ $220/MBF
17"+ scaling diam $300/MBF ⇒ $270/MBF

DF sound $440/MBF
Larch sound $440/MBF
WF sound $410/MBF

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