Willamette National Forest Pilot Road Analysis

Appendix C

Fisheries Process Paper

October 1998

Background Statement

Aquatic species of interest on the Willamette NF include those currently considered as PETS (proposed, endangered, threatened, or sensitive): bull trout (threatened); spring chinook (proposed threatened); winter steelhead (proposed threatened); and Oregon chub (endangered). Also of interest are native rainbow trout (including the McKenzie "redside" rainbow); native coastal cutthroat trout (including Hacklemann cutthroat); introduced summer steelhead; and introduced brook trout. Several other fish species occur on the forest, but they will not be discussed in this pilot project, including five sculpins, two dace, two lamprey, mountain whitefish; suckers; squawfish; and warmwater fishes that have been introduced into the reservoirs behind Army Corps of Engineer dams.

Roads influence the health and distribution of aquatic species on National Forest System lands by several mechanisms:

a) impacts to riparian areas can lead to: loss of streamside shade; loss of nearstream vegetation which would otherwise provide a pathway for nutrient inputs (e.g. insects, leaves) and large woody material: reduction or loss of a filter which prevents sediment from entering the stream course; compaction or loss of floodplains; destabilization of steep slopes adjacent to streams; channelization of the stream course; allowing access to people that may result in behaviours such as poaching, vandalism, or litter, and localized erosion from vegetation removal/trampling.

b) impacts to stream channels due to inherent/natural characteristics of watersheds where road building on soils with moderate and/or high potentials for fine sediment; unstable soils; or severe erosion, especially on steep slopes, may lead to excessive fines entering stream channels. The fines are likely to settle in relatively low gradient, depositional sections of stream channels that are often favored as spawning sites by salmonid species. Fines interfere with reproductive success by interrupting the ability of eggs to metabolize and/or smothering young fish that have not emerged from the interstitial spaces of spawning gravel areas.

c) increase in risk of impact by roads to stream channels and aquatic species due to events related to management: the age of a road, the surface material, the number of stream crossings and drainage features, the density of roads, together with the percent of a watershed that has been harvested (e.g. hydrologically unrecovered) are all factors which can interact with the inherent characteristics to increase the risk that roads in a given watershed may be impacting beneficial uses such as fish reproduction, distribution, and survival. Such events are most likely to occur through chronic impacts (e.g. sedimentation from road and roadside run-off, fish distribution restrictions and alterations in stream channel morphology due to improperly sized or placed culverts), or to more significant episodic events such as floods or catastrophic fires which may lead to increased runoff and impacts to water quantity and quality.

Process description and documentation

Issues and Key Questions

The two main issues identified which are directly related to fisheries are:

1. ***How and where do roads affect fish populations?***
2. ***How and where do roads affect fish habitat?***

The issue begins with identifying which watersheds and subwatersheds are important for fish or other aquatic organisms of interest. In the Pacific Northwest the focus is salmonid spawning and rearing, and whether or not the population status of a species is known. The methodology for determining sample units and status was similar to that used for the Interior Columbia Basin Ecosystem Management Project (Volume III PNW GTR-405 USDA/USDI 1997). Sixth Field subwatersheds were the sample unit and the status of naturally producing populations was rated with the following criteria:

- **Present – strong:** (no populations are known to meet this criteria which includes: stable or increasing numbers; all major life history forms are present that were historically present; and the population includes 500 adults within the Sixth Field. It is probable that some of our native cutthroat and rainbow trout populations meet this criteria, but we do not have valid information to document this).
- **Present – depressed:** (populations that meet this criteria must have one of the following characteristics: a major life-history component has been eliminated; numbers are declining or less than half of the historical habitat is occupied; or total abundance is less than 500 adults).
- **Absent:** this was modified from the ICBEMP to be defined as Sixth Fields where the species is extinct (primarily due to passage blocking large flood storage dams on the Willamette National Forest) and does not include subwatersheds that were never occupied by the species.
- **Present**: migration corridor (does not support spawning or rearing, but functions as a route or wintering area for migrating fish).

During analysis with other resource areas the criteria listed above were lumped into the categories of :

- "**T&E occupied**" which means that either bull trout, winter steelhead, spring chinook, Oregon chub or a combination of those species occur in the subwatershed and the subwatershed is used primarily for spawning/rearing, or migration.
- "**Historic T&E**" which means that the subwatershed once supported bull trout, winter steelhead, spring chinook, or a combination of those species and was used for spawning/rearing and migration.

Subwatersheds currently occupied by bull trout, winter steelhead, spring chinook or Oregon chub were identified, as were watersheds of historic occupation, which will be important for consideration during species recovery planning under the Endangered Species Act. These

watersheds were compared to other resource "hot spots" to provide a Forest level idea of priority areas for road and transportation system management.

Table 1. Sixth Field subwatersheds important for fish production or migration

Fifth Field/ Sixth Field	Bull Trout	Spring Chinook	Winter Steelhead	Oregon Chub	Native Resident
Little North Santiam					
01-1	absent	present - d			present
01-2		present - d			present
Breitenbush					
02-1	absent	absent	absent		present - d
02-2	absent	absent	absent		present - d
Middle North Santiam					
78-2		absent	absent		present - d
78-4		absent	absent		present - d
78-6	absent	absent	absent		present - d
78-7	absent	absent	absent		present - d
Upper North Santiam					
79-1	absent	absent	absent		present - d
79-2	absent	absent	absent		present - d
79-3	absent	absent	absent		present - d
South Santiam					
06-1	absent	absent	present - d		present - d
06-3		present - d	present - d		present - d
06-9			present - d		present - d
McKenzie					
07-1	present - d	present - d			present - d
07-3	present - d	present - d			present - d
07-4	present - d	absent			present - d
07-5					present - d
07-6	absent	absent			present - d
07-7	present - d	present - d			present - d

Fifth Field/ Sixth Field	Bull Trout	Spring Chinook	Winter Steelhead	Oregon Chub	Native Resident
Calapooia					
09-1		present - d	present - d		present - d
Blue River					
10-1		absent			present - d
10-2					present - d
10-4					present - d
Lower McKenzie					
11-1	absent	present - d			present - d
11-3	present - d	present - d	Summer steelhead		present - d
Quartz Creek					
12-1		present - d	summers		present
South Fork McKenzie					
13-1	migrate	migrate			present - d
13-2	migrate	present - d			present - d
13-3	migrate	present - d			present - d
13-4	present - d	present - d			present - d
13-5	present - d				present - d
13-6	present - d	present - d			present - d
Horse Creek					
14-1	present - d	present - d	summers		present - d
14-2	present - d	present - d	summers		present - d
Fall Creek					
15-1		present - d	present - d		present - d
15-2		present - d	present - d		present - d
15-3		present - d	present - d		present - d
Winberry					
16-1		present - d	present - d		present - d

Fifth Field/ Sixth Field	Bull Trout	Spring Chinook	Winter Steelhead	Oregon Chub	Native Resident
North Fork Middle Fork Willamette					
17-1	absent	absent			present
17-2	absent	absent			present
17-5	absent	absent			present
Salmon Creek					
18-1	absent	absent			present - d
Lookout Reservoir 19		absent		present	present - d
Salt Creek					
20-1	absent	absent		present - d	present - d
20-2	absent	absent			present - d
Middle Fork Willamette					
21-3	migrate	present - d			present - d
21-4	migrate	present - d			present - d
Hills Creek					
22-1	absent	present - d			present - d
Upper Middle Fork Willamette					
23-1	present ?	absent ?			present - d
23-3	present ?	present - d			present
23-4	present - d	present - d			present - d
23-5	present ?	present - d			present - d
23-6	migrate	present - d			present - d
Upper North Fork Willamette					
24-1	absent	absent			present

Documentation will be provided by having a Forest-wide map that illustrates: administrative boundaries, lakes, Class I and II streams, 5th Fields ("watersheds"), 6th Fields ("subwatersheds"), with certain 6th Fields highlighted for importance, especially of spawning, of the various salmonids and the Oregon chub. This map will be produced on a transparent mylar layer so that it can be posed on top of the transportation layer, hydrological and geological information/areas of concern. Recreation, other social, wildlife and other spatially located information can also be compared to aquatic values for further analysis. Spatial

knowledge can be obtained of the areas of high risk to aquatic beneficial uses based on either inherent or managed characteristics. Another result will be a table highlighting 6th Field subwatersheds within 5th Field watersheds that may be a priority for taking further steps and designing a site-specific action or project through later ATM and/or NEPA process.

Findings and Results

Key Questions from the 8/16/98 Appendices - Fisheries/Aquatics response:

AQ(1) ***How does the road system affect fine sediment that enters streams, lakes, or wetlands?***

At the Forest scale a map was produced of quaternary landslide geology, which was presumed to be a high risk source for fine sediments to aquatic systems. We do not take direct measurements of fine sediment in our streams, but have made estimates for embeddedness or substrate size distribution of individual channel habitat units during low flow summer stream inventories. At the scale of analysis done for Pilot Roads there is no definitive answer for this question as it relates to site specific aquatic species habitat or survival. During watershed analysis some riparian roads were noted as affecting fine sediment in aquatic habitat due to chronic maintenance problems.

AQ(2) ***How does the road system affect mass soil movements that affect aquatic or riparian ecosystems?***

A count of ERFO (flood events from major weather systems in 1964, 1986, and 1996) sites was summed for each Sixth Field subwatershed and compared to overall road density in that Sixth Field. There was a slight increase in the trend of ERFO sites as road densities increased, but without further evaluation of the watershed characteristics and the ERFO data this information does not provide any great insight.

AQ(3) ***How does the road system affect sedimentation downstream (aggradation of channels, reservoirs)?***

In the Western Cascades major channel changes, including noticeable aggradation often occur during high flow flood events. The road system, as well as harvest units, were documented as contributing to stream aggradation at specific sites on the Forest after the floods of 1996. The result of the Pilot Road Analysis at the Forest scale points to watersheds with high numbers of stream/road crossings. Further analysis, which would look site specifically at channel reaches that are impacted needs to be done at a smaller scale than the Pilot effort.

There is evidence of aggradation in areas of the large flood control reservoirs, but the contribution of non-road causes (e.g. wind and wave erosion, amounts of previous riparian harvest, and natural sedimentation) cannot be easily separated from the influence of roads.

AQ(4) ***How does the road system modify drainage density which affects water quality and quantity?***

Not addressed by fisheries. Ditto for AQ (5) How does the road system affect movement of groundwater?

AQ(6) ***How does the road system affect invasions of non-native aquatic species?***

As of 1998, the Willamette National Forest has not had a significant problem of accidental or intentional releases of non-native aquatic plants or animals (with the exception of bull frogs and warmwater fishes which were introduced many years ago for the most part). Non-native aquatic plants are beginning to be of concern. Many of these introductions are tied more to the presence of large amounts of reservoir habitat, and less tied to the road system. The road system does allow the State of Oregon to accomplish fish stocking for recreational fishing. They use a combination of native and non-native salmonids, and have used less non-native species/stocks as ecological concerns have increased over native aquatic species.

AQ (7) ***How does the road system affect at-risk aquatic species through changes in public access resulting in increased fishing-related mortality or habitat loss?***

The fact that most of the main rivers and many of the larger fish-bearing tributaries outside of Wilderness have riparian roads has allowed people access for legal and illegal angling. Where we have an at-risk species, such as bull trout, which has been impacted by many factors (State of Oregon eradification efforts in the 1950's and 1960's; habitat impacts due to pre-1990 National Forest management practices; and liberal angling regulations up to the mid-1990's) there is concern about poaching and it does occur. Part of this issue relates to dispersed camping site access to rivers, part to the lack of both state and Forest Service law enforcement capabilities, and part due just to the location of roads next to streams where bull trout migrate, spawn and/or rear. The U.S. Fish and Wildlife Service would like the Forest Service to take a hard look at these roads in the long term, as they relate to bull trout recovery. In some cases the road is an established paved travel route (e.g. scenic byway) and there is limited possibilities to relocating the road. Dispersed access is an issue that can be (and is being) addressed to a certain extent, but not significantly analyzed in this pilot effort.

Habitat loss due to roads located in riparian areas does contribute to loss of shade, loss of floodplain, constriction of channel reaches, and has allowed for easy access to remove large instream or near-stream wood until policies changed for a wider range of ecosystem values in the 1990's. These types of impacts are fairly common on the Willamette National Forest outside of Wilderness and many of these situations were identified in Watershed Analysis. As follow-up to Watershed Analysis some of these site specific impacts will be addressed or are currently being addressed. There are some key stream reaches occupied by at-risk bull trout, winter steelhead, and spring chinook that do not have riparian roads and these areas provide refugia that are likely to remain protected into the future.

Due to time and a limited data set, we did not take a statistical look at fish population status as correlated with road density. In the Columbia Basin assessment the result was documented that there was an increasing absence and decreasing proportion of strong non-anadromous salmonids with increasing road densities at the Sixth Field subwatershed scale. The strongest aquatic populations were associated with the lowest mean road densities.

AQ (8) ***How does the road system affect key interactions between aquatic and terrestrial systems?***

Density of roads within Riparian Reserves was analyzed during this Pilot effort. That analysis helped the team to identify the subwatersheds with the greatest amount of riparian road densities. The legacy of forest management prior to 1990, as discussed above, has left the landscape with many riparian roads and significant riparian areas that were clearcut to the

streambank. Many of the impacts were analyzed during watershed analysis and included looking at stream temperature increases that could only be explained by timber harvest, which involved riparian harvest and sometimes roads and even landings in riparian areas. This in turn has impacted the ability of streams to support native salmonids due to loss of habitat complexity, and in some cases where warmer temperatures occur we have observed the movement upstream of fish species associated with warmer stream temperatures (e.g. redside shiners, squawfish, suckers).

AQ (9) ***How does the road system alter the storage capacity of stream channels for coarse woody debris, sediment, and organic matter?***

Due to the significant road infrastructure on the Willamette, some of it built before fish passage in smaller tributaries was of concern to managers, we know that the road system has altered the capacity of stream channels for large woody material. This is primarily due to culverts which are undersized, easily plugged by woody material, or failing because of their age. It is less clear if sediment and organic matter are prevented from moving downstream due to culverts. Because the road system has allowed for removal of instream and nearstream large woody material prior to 1990, that type of activity has allowed for **increase** in the movement of sediment and organic matter downstream due to the decrease in hydraulic complexity of stream channel reaches (in contradiction to the question which talks about **prevention** from moving downstream). This lack of hydraulic complexity has been studied on the Willamette National Forest at Quartz Creek by Oregon State University, however the role of roads is not explicity examined in the study which covers several years of stream channel and fish data from 1988 to the present (1998).

AQ (10) ***How does the road system affect risks to water quality from chemical spills or roadway-applied chemicals, such as oils, de-icing salts, herbicides, and fertilizers?***

A main railroad follows along areas where the endangered Oregon chub reside. A main highway on the Forest crosses the two primary bull trout spawning streams left in the Western Cascades of Oregon. At this time the biggest impact from winter road treatments on the highway is the tons of cinder rock used to provide traction. These cinders end up in the spawning streams and are of concern to spawning and rearing habitat conditions. Salts are not the primary winter highway treatment, so have been less of a concern. Newer chemicals are being used, but based on the MSDS information they appear to be relatively safe. The biggest risk is most likely from transport of chemicals which could have a major affect on aquatic life if (when) a truck or railroad accident occurs.

AQ (11) ***How does the road system affect channel structure and geometry, and isolation of floodplains from their channels?***

This was not answerable at the Forest scale. We currently have smaller scale efforts ongoing on portions of the Forest which does get at this question: 1) Fall Creek ATM, and 2) Blue River Watershed Road Risk Assessment Study. The Fall Creek ATM effort uses an interdisciplinary risk/value analysis by road segment. The Forest took examples of ATM efforts on the Umpqua NF and carried them into site specific ATM for the Willamette NF's Fall Creek watershed with some modifications. The Blue River effort also works at the road segment scale. Examples of the site specific forms for data collection on Blue River will be

attached to the final report. Watershed analysis also provides some examples of identified important stream reaches that are impacted by the road system due to constriction of the channel.

AQ (12) ***How does the road system affect wetlands?***

From an aquatic biological perspective, the road system has impacted small wetlands through both interception of existing small wetlands and creation of small wet areas by ground water interception. As awareness of the value of wetlands has increased over the last decade the road system has had less impact on existing wetlands of all sizes during road location and construction.

AQ (13) ***What indicators are most useful to define interactions between water, aquatic ecosystems, and roads?***

The following information is being collected in Blue River Watershed (see examples of field forms):

- Adequate information at a road segment scale for type, condition, and number of stream crossings.
- Road segment interaction with a stream's floodplain, where the road is parallel to the stream.
- Road surface type.
- Culvert fill failure risk.
- Sustained steep (>15%) road grades in excess of 500 feet.
- Percent of road with sideslopes >51%.
- Other items of interest for looking at impacts to the aquatic ecosystem:
- Road maintenance records, at a minimum a record of maintenance accomplished (date, type) including knowledge of site specific chronic or severe maintenance sites.
- Documentation of known spawning reaches with review by state and other agency biologists.
- Tracking of temporary road locations, construction, and decommissioning or obliteration, which is vital to endangered species act consultation, but not currently tracked in the Forest road database.

Key questions (in addition to the questions **AQ (1-13)** are:

- ***Where do the inherent and/or the managed characteristics of a watershed, with respect to aquatic values, display a high risk to aquatic beneficial uses?***

We did look at this in a cursory manner and the results are provided in the Pilot report.

- ***Where do streams/rivers have a road (or multiple roads) in the riparian reserve on both sides of the channel?***

There are places on the Forest where a multiplicity of roads appear, and site specific analysis is needed to define the need and proper amount of road. We did not get to this for scale and time reasons.

- ***Where are chronic maintenance problems or trouble spots and can they explain any stream channel or fish population conditions?***

Some of the Watershed Analyses provided very useful information on location of road maintenance problem sites, which is allowing the districts to follow-up at a project scale. This question also relates to the importance of knowing something about fish population status, which takes coordinated interagency and stakeholder cooperation to be most efficient and cost-effective for identifying populations to monitor.

References

US Department of Agriculture and US Department of Interior. 1997. *An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basin, Volume III.* PNW-GTR-405. Pacific Northwest Research Station. Portland, Oregon.

Willamette National Forest Pilot Road Analysis

Appendix D

Terrestrial Wildlife Process Paper

October 1998

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Introduction

The road network on the Willamette National Forest is extensive, totaling over 7300 miles of paved and unpaved roads. This road network can significantly alter wildlife habitats and negatively impact wildlife populations. The negative effects of roads on wildlife can be classified into three general categories: (a) edge effects; (b) barriers to movement; and (c) avenues for resource extraction.

Edge effects

Roads and intensive timber harvesting are the major causes of forest fragmentation on the Willamette National Forest. Forest fragmentation can threaten native wildlife populations by eliminating blocks of continuous habitat or by degrading the quality of remaining habitat for those species sensitive to an increase in the amount of forest edge. Forest fragmentation exposes the organisms that remain in the fragment to the conditions of a different surrounding habitat, and consequently, to what have been termed 'edge effects'. Edge effects are the result of the interaction between two adjacent habitats, when the two habitats are separated by an abrupt transition (edge) (Murcia 1995).

The ecology of forest edges is characterized by changes in biotic elements (parasites, predators, and herbivores) and abiotic elements (microclimate, disturbance regime), both of which have been documented in bird and plant communities (Paton 1994; Yahner et al. 1989). If exposure to the edge modifies the features of the forest beyond their range of natural intrinsic variation, then the fragment's area will be effectively reduced for conservation purposes (Murcia 1995). Although the juxtaposition of two contrasting habitats can produce effects on both, our concern is the effect of edges on the remnant forest patches.

During the daytime, forest edges typically have lower humidity, higher air temperatures, higher soil temperatures, increased solar radiation, lower soil moisture, and higher windspeeds, than interior forest. Physical edge effects from roads are expected to be similar, although smaller in magnitude, than edge effects from clearcuts into forests. On the Willamette National Forest, microclimatic variables in clearcuts can extend up to 240 m into adjacent late-successional forest (Chen et al. 1993, 1995, 1996; Brosofske et al. 1997).

The direct and indirect effects of altered microclimate along the forest edge manifest themselves in several ways. For example, several studies have shown that depredation and parasitism rates of birds' nests increase as forests are fragmented into smaller and smaller patches (Hartley et al. 1998; Paton et al. 1994; Keyser et al. 1998). Amphibian distributions and abundance (Demaynadier et al. 1998), as well as plant distribution and abundance (Fraver 1994), are also known to be influenced by proximity to edges. In addition to these effects, noise from dense vehicular traffic degrades habitat, especially for avian communities (Klein 1993; Reijnen et al. 1995; Reijnen et al. 1996), and big game such as deer and elk (Thomas et al. 1979; Lyon 1983; Lyon et al. 1985; Wisdom et al. 1986).

Barriers to movement

A second major impact of roads on wildlife is as a barrier to species movement. The barrier effect is sensitive to both road width and traffic density (Forman and Hersperger 1996). As road width and traffic density increase, roads become more effective barriers to movement (Reudiger 1996). Roadkilled animals are conspicuous examples of the barrier effect. Many species also avoid roads. In this case, most animals remain at some distance from roads, and rarely or never attempt to cross. Hence, a once continuous large population is fragmented into smaller subpopulations. When populations become subdivided, there is increased risk of demographic fluctuation, local extinction of subpopulations, less recolonization after local extinction, and a progressive loss of local biodiversity (Soule 1987).

Avenues for resource extraction.

The extensive network of Forest Service roads also creates opportunities for humans to extract natural resources. Indeed, the construction of the vast majority of the Willamette's road system was to extract timber. In addition to timber harvesting, many animals (e.g., deer, elk, and bear) are hunted, and most hunters camp and hunt close to roads. "Special products" such as fungi, lichens, berries, and mosses are increasingly being collected on the Forest, and firewood collecting has traditionally been a common activity on the Willamette. To reduce hazards for public and Forest Service activities, snags (standing dead trees) are routinely removed from near roadsides. Generally speaking, human influences on the forest are greatest near roads, and decrease steadily with distance from roads.

Road density as an index to measure ecological effects of roads

Road density is a useful measure of the ecological effects of roads in a landscape (Forman and Hersperger 1996). Road density is defined as the total length of miles per unit area (e.g., miles/sq. mile). As road density increases, edge effects, barriers to faunal movement, population fragmentation, and human access usually increase, leading to significant changes in the biological community.

With the availability of GIS (Geographic Information Systems), it is very easy to calculate road densities across the landscape and display the results on a map. In this report, we calculated road densities in habitats of concern (using a "moving window" analysis originally developed for grizzly bear habitat analysis) and displayed the results on maps. This allowed us to locate priority areas, or "hot spots", for potential, future road closures and decommissioning.

A caveat on road data used in these analyses

For this pilot analysis, we used the best road data available for the Willamette National Forest, the transportation layer in GIS. Although there are known inconsistencies in the quality of the data across the Forest (see *Section 4: Current Situation* of the Willamette National Forest Roads Analysis), we feel the accuracy of the layer is acceptable for setting priorities for most wildlife and TES (threatened, endangered, and sensitive species) issues. Nevertheless, an updated transportation layer that is consistent across the Forest is desired so that priorities can be established with a higher degree of accuracy and reliability.

Process Description

List of issues and key questions

In the beginning of this analysis, we considered answering fourteen different questions pertaining to the impact of roads on wildlife and their habitats (**Table 1**). Of this original list of issues and key questions, we carried out analyses for the eight questions for which we had sufficient data to do so (questions 1-8 in Table 1). Because the results from two of the eight analyses (questions 7 and 8, Table 1) provided little additional insight, the results from these two questions are not reported here.

The six questions addressed in this document provide two general types of information:

a. *Quantitative* information on the overall, negative impact that roads have on habitats of concern (Questions 1-3).

b. *Geographically* explicit information on where priority areas, or “hotspots”, are located (Questions 4-6). The maps produced to address Questions 4-6 will probably be the most useful for identifying areas of concern for wildlife.

How each key question was addressed

In this section, we briefly discuss the methodology used to address each of the six questions we analyzed for this report (Table 1).

Question 1: ***Roadsheds created by state highways***

This was a very simple analysis, conducted at the Forest scale. To determine how the state highway system divides the Forest into major habitat blocks (i.e., roadsheds), we utilized the GIS layers with the road system (tran), and the boundary of the WNF (wil_bnd). From these two layers, we generated a new polygon coverage that shows the roadsheds of the WNF (**Map W1a**).

Questions that were analyzed in this report
1. How does the state highway system divide the Forest into major habitat blocks, or “roadsheds” (W1)?
2. Of the total amount of spotted owl habitat on the Forest, how much is impacted by the "edge effects" of roads (TW1, TW4, TW5)?
3. Of the total amount of interior, late-successional, habitat on the Forest, how much is influenced by the "edge effects" of roads (TW1, TW4, TW5)?
4. What are the current road densities in riparian reserves (W2)?
5. What are the current road densities in connected, late-successional, habitat in no-harvest status (TW1, TW4, TW5)?
6. Where does the current density of open roads exceed Willamette Land Management Plan objectives for big game (i.e., deer and elk) (W3)?
Questions that were considered and analyzed, but not included in this report*
7. What are the current road densities in spotted owl habitat (TW1, TW4, TW5)?
8. What are the current road densities in interior, late-successional, habitat (TW1, TW4, TW5)?
Questions that were considered, but not analyzed, in this report:**
9. How and where do roads affect special and unique habitats (e.g., caves, cliffs, meadows) (TW7)?
10. How and where does the road system affect the removal of habitat structural components (e.g., hazard trees/tree removal along roads, woody debris for firewood) (TW10)?
11. Which late-successional related species are affected by roads and how are they affected (W4
12. How and where does the road system affect direct mortality (e.g., road kill, legal and illegal hunting) (TW8, TW9)?
13. How do road maintenance chemicals (e.g., de-icers, road oils) used on all roads affect wildlife? Which chemicals have adverse effects? (W5)
14. How, when, and where does the road system affect habitat of threatened, endangered, sensitive (e.g., wolverine), and proposed (e.g., Canada lynx) species habitat due to the proximity of roads to key habitat such as nesting, roosting, denning, and foraging areas (W6

Table 1. Issues and key questions pertaining to the effects of roads on wildlife and their habitats. The number-letter combinations beginning with TW refer to specific questions developed by the National Roads Team. The number-letter combinations beginning with W refer to specific questions developed by the Willamette National Forest Wildlife Department.

*These two analyses were similar in scope and approach to Question 5. Due to their similarities, these two analyses identified the same resource "hot spots" as Question 5. Therefore, we only included the results for Question 5.

**Questions 9-13 were not analyzed because the data to address them were non-existent or inadequate. Question 14 could have been analyzed for spotted owls, but concerns for this species were already addressed with Questions 2-5, and 7-8. Question 14 is more appropriately addressed with project-level analyses. Question 9 was partially analyzed by the Botany Department.

Question 2: ***Edge effects on spotted owl habitat***

We conducted this analysis at the Forest scale, including all land allocations except wilderness and roadless areas. Results were then summarized by roadshed. The main GIS layers used for this analysis were: transportation (tran), roadshed (roadshed), and spotted owl habitat (ohab). The key logical steps in this analysis were:

1. *To generate a coverage showing the "edge effects" from roads.* Published results from the WNF (Chen et al. 1993, 1995, 1996; Brosofske et al. 1997) show that microclimatic variables (e.g., temperature, wind speed, and relative humidity) in clearcuts can extend up to 240 m (787 feet) into adjacent late-successional forest, while biological variables (e.g., sun scald, windthrow, response of understory plants) can be measured up to 120 m (394 feet). Although roads *per se* are expected to generate less edge effects than clearcuts, the vehicular and human uses of roads generate effects (e.g., noise, poaching, removal of snags and trees that pose hazards, etc.) that clearcuts do not. Based on these considerations, we considered edge effects from state highways to extend 240 m (787 feet), and from all other road types to extend 120 m (394 feet). Therefore, we generated an "edge effects" coverage by buffering state highways by 240 m (787 feet) and all other roads by 120 m (394 feet) (railroads and trails were not included in this analysis). A map was created that shows the roadsheds (not including Wilderness and Roadless Areas) with the edge effects erased from it (**Map W1b**).
2. *To create a coverage showing spotted owl habitat in each roadshed.* This is a simple GIS procedure to assign a roadshed value to each polygon of spotted owl habitat. From the spotted owl habitat layer, we selected only the "typical nesting" and "typical roosting" habitats.
3. *To erase the "edge effects" coverage from the roadshed coverage.* This step generates a new coverage that shows only the spotted owl habitat that is not impacted by edge effects from roads.

Question 3: ***Edge effects on interior habitat***

We conducted this analysis at the Forest scale. This analysis was identical to the analysis for Question 2, except that interior, late-successional habitat was substituted for spotted owl habitat. An interior habitat layer was created from the seral stage data in the GIS layer, called LSR VEG, created during the Mid-Willamette LSR Assessment (USDA/USDI 1998). Because the Mid Willamette LSR Assessment did not cover watersheds north of the Little North Santiam River, the resulting interior forest habitat also does not include these areas. However, because the excluded area is currently proceeding through a process to become the Opal Creek Wilderness area, its exclusion from this analysis is not a problem (since we excluded Wilderness and Roadless areas from analyses for Questions 2-3).

Seral stages present in the LSRVEG layer are the following: (a) early; (b) early-mid; (c) mid; (d) late-mature; and (e) large-old growth. Actual assignment of each stand to a seral stage was dependent on dbh, plant association, and age. For more information on how seral stages were assigned, see the Mid-Willamette LSR Assessment (1998). To create the interior habitat layer, "late-mature" and "late-old growth" seral stages were "buffered" inward 400 feet.

Question 4: ***Road densities in riparian reserves***

We conducted this analysis at the Forest scale. We used the transportation (tran) and riparian reserve (strbuf) GIS layers for this analysis. With these two layers as starting blocks, we then ran a sequence of GIS steps to calculate the density of roads within and adjacent to riparian reserves. This sequence of steps, called a "moving window analysis" was written as an aml (Arc Macro Language). The product of this analysis is a map (**Map W2**), which highlights the stretches of riparian reserves with the highest road densities.

Question 5: ***Road densities in connected, late-successional habitat***

We conducted this analysis at the Forest scale. The Northwest Forest Plan established a system of reserves to provide connected late-successional habitat across the landscape for late-successional species. There are two basic kinds of reserves: large reserves and riparian reserves. The large reserves (e.g., Late-Successional Reserves, Administratively Withdrawn Lands, and Congressionally Reserved Lands) are often connected through the linearly shaped riparian reserves. It is not always necessary for patches of late-successional habitat to be adjacent for late-successional species to successfully disperse among patches. Many species can cross short distances of other habitat types before arriving at late-successional habitat. For this analysis, we assumed that low-mobility, small-bodied species can travel no more than about 350 m (1148 feet) through non-late-successional habitat. ***Connected late-successional habitat****, then, consists of late-successional habitat in a no harvest status (this includes all reserved lands and land with unsuitable soils for harvest) buffered by 191 m (627 feet).* With the pixel size we used in GIS (one pixel = one acre), 191 m (627 feet) is as close to half of the maximum gap distance of 350 m (1148 feet) as we could get. This is the same layer of connected, late-successional habitat that was used for the Mid-Willamette Late-Successional Reserve Assessment (USDA/USDI 1998).

With this connectivity layer, we then ran the same "moving window" analysis as we did for Question 4. The product of this analysis is a map (**Map TW4**) which highlights the areas of connected, late-successional habitat where road densities are relatively high.

Question 6: ***Road densities in BGEAs***

We conducted this simple analysis at the Forest scale. Two GIS layers were used: transportation (tran) and Big Game Emphasis Area (bgea). From the transportation layer (tran), we selected only those roads that are open. We then calculated the miles of open road per Big Game Emphasis Area. The results from this analysis are displayed on the map, **Map W3**.

Results and Interpretation

Question 1: ***Roadsheds created by state highway***

The state highway system divides the Forest into six distinct roadsheds (**Map W1a**), that vary greatly in size (**Table 2**). Because many species will not cross major highways, or suffer high mortality rates when attempting to cross them (due to collisions with vehicles), roadsheds may represent regions into which some populations are subdivided.

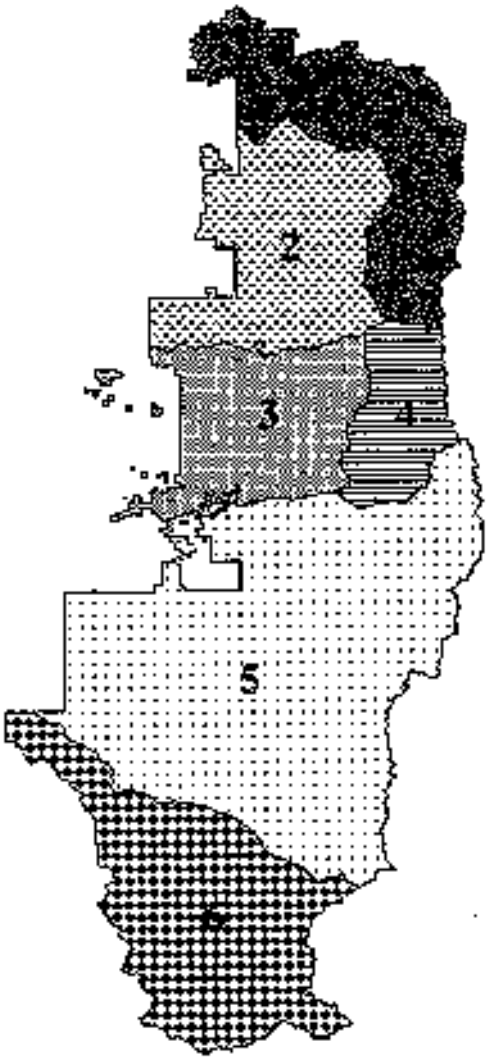
Roadshed	Area (sq. miles)
1	171
2	301
3	272
4	67
5	609
6	460

Table 2. Area of each roadshed. Wilderness and Roadless Areas not included in calculations.

Generally speaking, the smaller the roadshed, the higher the probability that highly mobile, terrestrial organisms (e.g., carnivores) will encounter a major highway. Of the six roadsheds on the Willamette, Roadshed 4 is tremendously smaller than the other five. Therefore, an individual whose home range overlaps or borders the highways will have a higher probability of encountering high density, high velocity traffic if it attempts to disperse than individuals whose home ranges do not overlap or border highways.

Map W1b offers a striking representation of how much land is impacted from the edge effects of roads. In each roadshed, over 40 % of all the land is impacted by edge effects (**Figure 1**). We consider this to be a very high percentage of land to be negatively impacted by roads. Roadshed 4 has the most land that is affected by edge effects from all road types, followed by Roadshed 2 (**Map W1b**, **Figure 1**).

Map W1a. The Six Roadsheds on the Willamette NF.



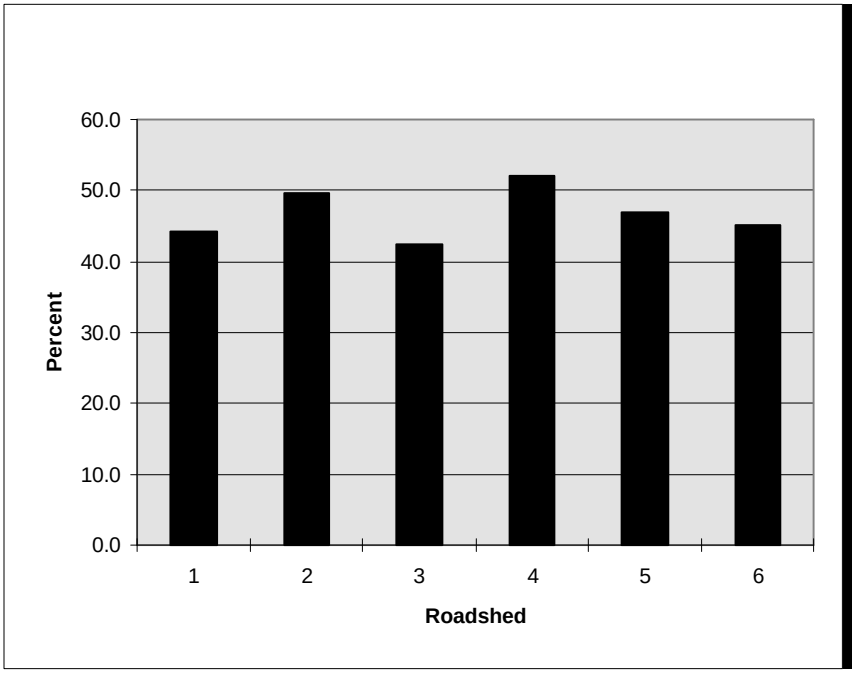


Figure 1: The percentage of each roadshed that is affected by edge effects from roads. Roadshed 4 has the highest percentage of its total area impacted by edge effects, while Roadshed 3 is least affected. Wilderness and Roadless Areas not included in calculations.

Question 2: *Edge effects on spotted owl habitat*

The amount of spotted owl habitat varies greatly among roadsheds, from a low of 26.9 square miles in Roadshed 4 to a high of 270 square miles in Roadshed 5 (**Figure 2**). Edge effects impact 31 - 49 percent of the spotted owl habitat per roadshed (**Figure 3**). Twelve percent more spotted owl habitat in Roadshed 4 is impacted by edge effects than in any other roadshed (**Figure 3**).

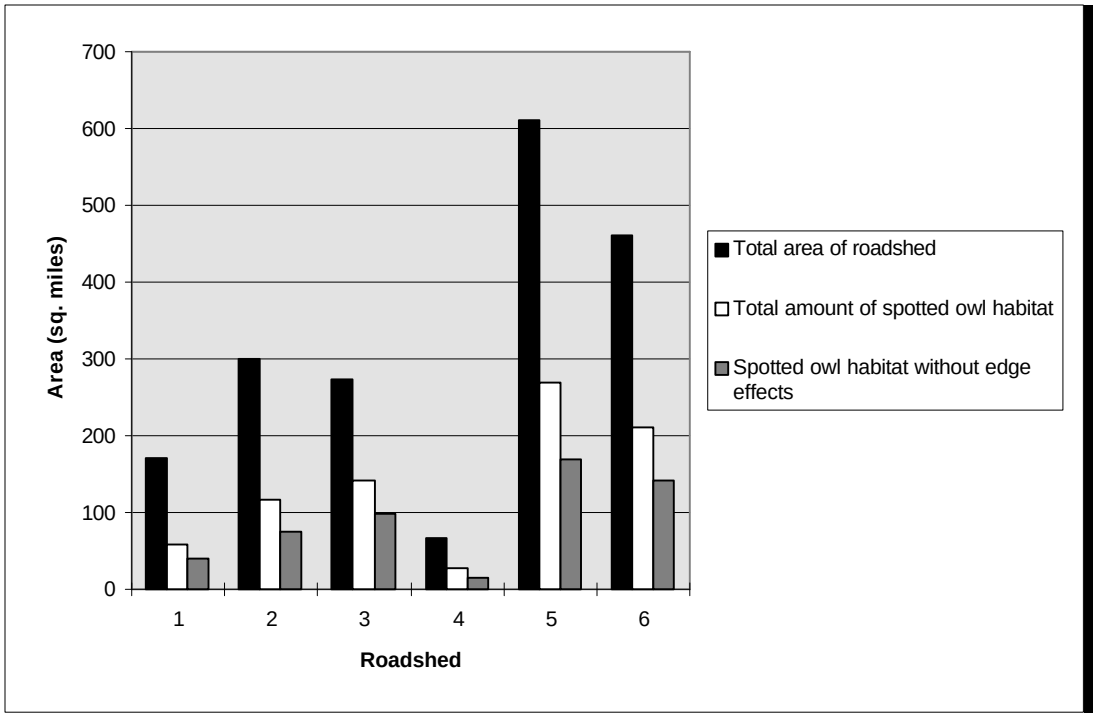


Figure 2. Comparison of roadsheds based on total area, area of spotted owl habitat, and area of spotted owl habitat that is not affected by edge effects from roads. Wilderness areas and roadless areas are not included in these calculations.

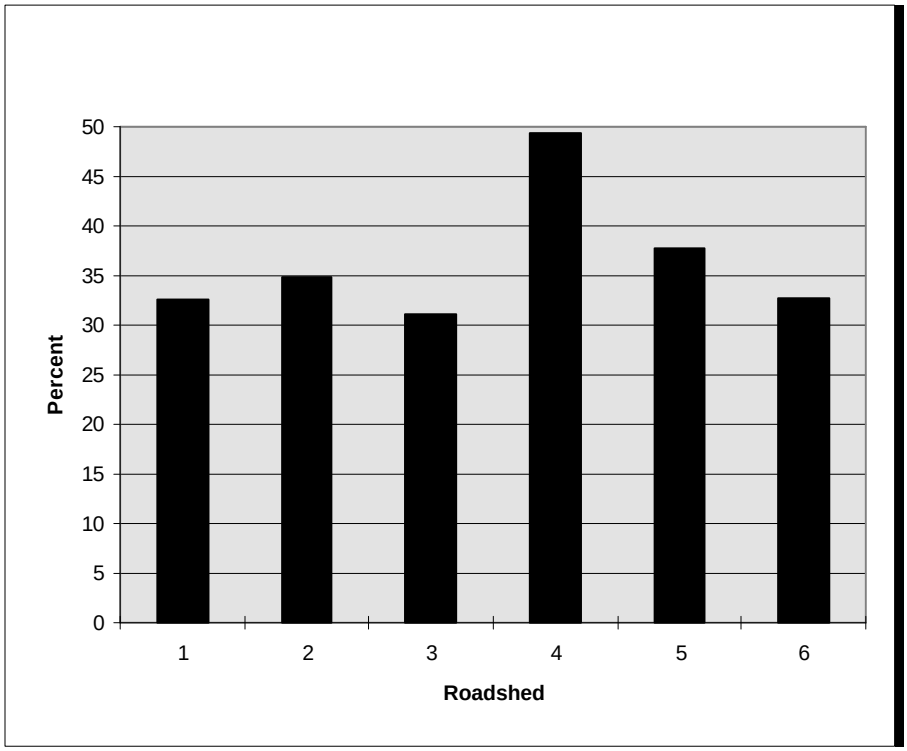


Figure 3. The percentage of spotted owl habitat that is impacted by edge effects from roads. Spotted owl habitat in Roadshed 4 is most impacted by roads, while owl habitat in Roadshed 3 is least affected by roads. Wilderness areas and roadless areas are not included in these calculations.

Question 3: *Edge effects on interior habitat*

The amount of interior habitat varies greatly among roadsheds, from a low of 7.7 square miles in Roadshed 1 (6 percent of the roadshed) to a high of 60.1 square miles in Roadshed 6 (16 percent of the roadshed) (**Figure 4**). Of the current amount of interior habitat in each roadshed, 22 - 41 % is impacted by edge effects (**Figure 5**). Interior habitat in Roadshed 4 is impacted to a much greater extent by edge effects than the other roadsheds (**Figure 5**).

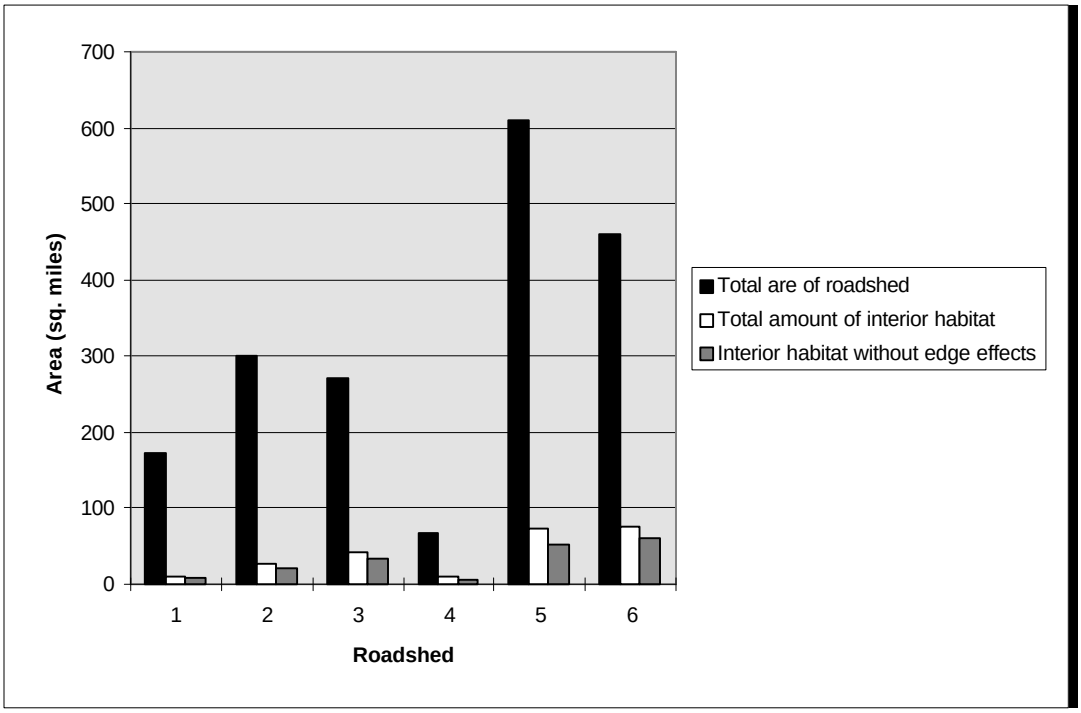


Figure 4. Comparison of roadsheds based on total area, area of interior habitat, and area of interior habitat that is not affected by edge effects from roads. Wilderness areas and roadless areas are not included in these calculations.

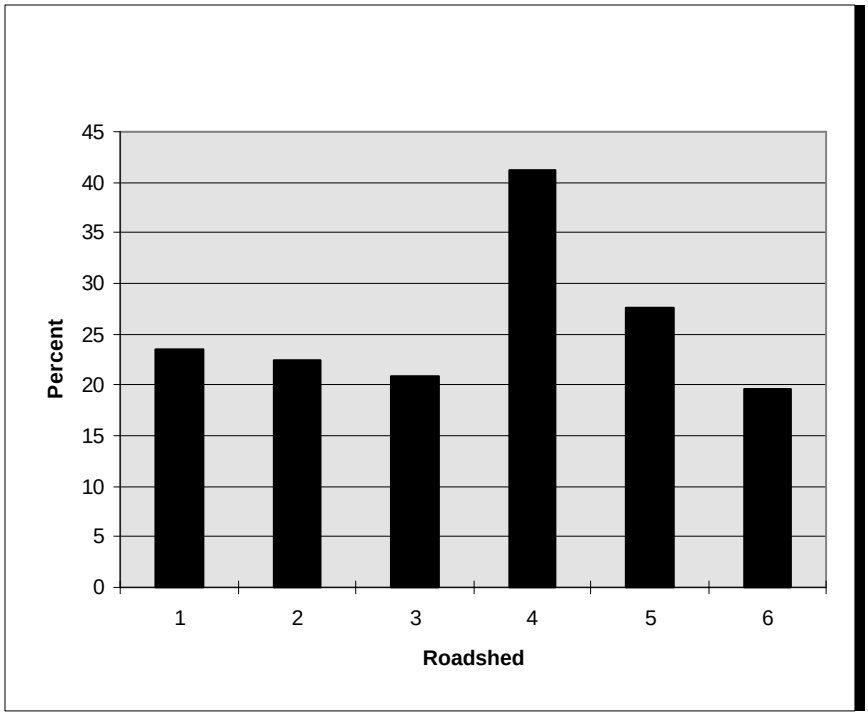


Figure 5. The percentage of interior habitat that is impacted by edge effects from roads. Interior habitat in Roadshed 4 is most impacted by roads, while interior habitat in Roadshed 6 is least affected by roads. Wilderness areas and roadless areas are not included in these calculations.

Question 4: *Road densities in riparian reserves*

Map W2 highlights the areas of concern based on road densities in riparian reserves. The highest priority areas are those that have road densities of 4-5 miles/sq. mile. In several areas on this map, the riparian reserve width appears to be much larger than in the other areas. These areas represent places where the riparian reserve intersects a primary management zone for a threatened or endangered raptor. On the south end of the Forest, there is a priority area (4-5 mi/mi2) close to Road 23 that is an important raptor management zone. This area should be considered a particularly high priority, given the conservation importance of threatened and endangered species.

Question 5: *Road densities in connected, late-successional habitat*

Map TW4 highlights areas of concern based on road densities in connected, late-successional habitat. The highest priority areas are those that have road densities of 6-8 miles/sq. mile. Note that several of the areas in the highest road density categories are in Late-successsional Reserves (LSRs). Because these areas are supposed to be managed for late-successional dependent species, it is of concern that some of the highest road densities for connected, late-successional habitat occurs in the LSRs. The Mid-Willamette Late-Successional Reserve Assessment (USDA/USDI 1998) also discusses the problem of roads within LSRs. This LSR Assessment should be consulted for a more detailed discussion of the role that roads may play in the management of the LSRs.

Question 6: ***Road densities in BGEAs***

Of the 53 High Emphasis Areas for big game on the WNF, 26 (49%) have road densities that exceed WNF Land Management Plan objectives. Of the 110 Moderate Emphasis Areas for big game, 36 (33%) have road densities that exceed the objectives. On an acreage basis, 218,493 acres (43%) of the land in the High Emphasis Level exceeds the objectives, whereas 270,163 acres (29%) of the land in Moderate Emphasis Level exceeds the objectives (**Table 3**). **Map W3** displays the Big Game Emphasis Areas where WNF Land Management Plan objectives for big game are not being met.

Big Game Emphasis Level	Total # acres in Emphasis Level	# acres that exceed objectives for Big Game (% of total acreage)
High	508,533	218,493 (43%)
Moderate	930,321	270,163 (29%)
Low	352,025	0 (0 %)

Table 3. Number of acres that exceed objectives for big game, by emphasis level.

Summary of results

High road densities can pose problems for wildlife populations because of the biological and abiotic edge effects associated with roads. On the six roadsheds of Willamette National Forest, 31 - 49 percent of the current spotted owl habitat, and 22-41 percent of the interior habitat, is impacted by edge effects. These statistics indicate that a large percentage of late-successional habitat, upon which many plant and animal species depend (USDA/USDI 1994), incurs negative impacts from roads.

Non-late successional dependent species, such as elk, can also be negatively impacted from high road densities. Our analysis of road densities in Big Game Emphasis Areas shows that current road densities exceed management objectives for big game in 33% of Moderate Emphasis Areas and 49% of High Emphasis Areas.

Given the high road densities on the Forest, where should efforts be taken to close or decommission roads to benefit wildlife? We produced **three maps (Maps W2, TW4, and W3)** to help prioritize areas of the Forest where roads should be closed or decommissioned. Each map shows priority areas, or hot-spots, based on the impacts of roads to one particular species or habitat type. These maps should be used in conjunction with the maps produced by other natural resource departments (e.g., botany, fisheries, and hydrology). The highest priority sites for management action should be those where there is congruence, or overlap, among two or more maps. For example, if there is a riparian reserve with very high road densities (from Map W2), that also overlaps a stream with endangered fish species, or an area with high potential for landslides, then that would be a priority area. Areas identified as a priority by one map, but not on any others, may still be a Forest-wide priority, but the trade-offs of focusing on one site to the expense of other sites must be weighed carefully.

Process Critique

Overall, I felt the process used for the pilot roads analysis was effective and efficient. I felt the leadership team did a solid job of keeping all the participants informed of timelines and expectations. I felt the composition of the analysis team was sufficiently experienced, and encompassed a wide spectrum of expertise. From my perspective, the lack of public involvement made the analysis much easier to complete in a timely fashion. However, public involvement may have generated ideas or issues that we did not think of ourselves.

The greatest drawback to the process was the lack of updated GIS data. Most importantly, the transportation (roads) layer does not contain consistently good data across the forest. Certain Districts have been very conscientious about digitizing each road that exists on their District, while other Districts have not. Therefore, attempting to prioritize areas of concern based on road densities may be biased towards Districts that have updated their GIS layer. Districts that have not digitized all their roads may, in reality, have more roads (and therefore, more need to close or decommission roads) than the other Districts, but because they are not in GIS, our analyses would not include them.

In addition to the roads layer, several of the forest-wide layers for wildlife have not been updated recently. While each District may have updated layers for species of concern, it was not possible with the time frame of this project to gather all the data and convert it into forest-wide layers. We are currently rectifying this situation so that all of our GIS wildlife layers will be standardized across all Districts and annually updated.

Once this updating process is complete, we would be able to address the following questions:

1. *Are any peregrine falcon management areas negatively affected by roads?*
2. *Are any bald eagle management areas negatively affected by roads?*
3. *What portions of Canada lynx and wolverine habitat are most impacted by roads?*

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Willamette National Forest Pilot Road Analysis

Appendix E

Botanical Species Process Paper

October 1998

Background

Botanical species diversity is dependent on the variety of habitats found throughout the National Forest matrix. Ross and Chambers (1988) estimate that 95% of the biodiversity in forests from the western Cascades are found in special and non-forested habitats. Special habitats are defined as those habitats that are not part of the dominant (coniferous) forest matrix. Examples include areas such as forested wetlands (hardwoods and swamps), springs, meadows and rock outcrops. Most of the Regional Forester's sensitive species for Region 6, Willamette National Forest, and other rare species whose distributions are tracked to ensure their viability (NFMA direction) grow in meadows, rock gardens, rock outcrops and riparian areas.

Roads have historically been built along riparian lowlands and ridgelines for both economics and feasibility. All of the major highway and many scenic byway corridors are built adjacent to major waterways: North Santiam (Highway 22), South Santiam (Highway 20), McKenzie (Highway 126), South Fork Middle Fork Willamette (21), North Fork Middle Fork Willamette and South Fork McKenzie (15) and Salt Creek (highway 58). Midslope roads intersect riparian areas as they travel upslope. Roads often intersect with special habitats along ridgelines. These areas are often rocky, with little soil development; factors which favor development of dry meadows or rock gardens rather than a forest. Not only are these habitats situated where roads are most easily built, but it is also presumably cheaper to build through a rock garden than a forest. Many of these habitats have had fill placed on top of existing habitat as roads are built through them. The resulting changes in drainage patterns, changes in soil composition, and introduction of noxious weeds from roadside shoulders may cumulatively result in significant alteration of the existing plant communities.

Other botanical species unique to the Pacific Northwest are species on the "survey and manage" list. These species were elevated in importance by their inclusion in Table C3 of the ROD (USDA and USDI, 1994a). These species are largely non-vascular plants (mosses and liverworts), lichens and fungi. The importance of these species to the health of ecosystems is just being recognized. The majority of these species are found in mature to late-successional forests. Intact forests have substrates and microclimate (temperature and humidity) preferred by these species. Several species are dependent on pristine riparian or aquatic conditions. Roads create openings to interior forest habitats, reducing the quality of the habitat. Fragmentation of habitat creates conditions which many species may not survive.

The final botanical feature affected by roads is noxious and invasive nonnative weeds. The Oregon Department of Agriculture's Weed Control program began mapping weed infestations across the Forest in the late 1980's. In 1993, the Forest wrote an Environmental Assessment for an Integrated Vegetation Management Program (LRMP standard and guideline) that directs the Forest to use all available control methods found in the EA, based on site-specific analysis. The EA is tiered to the Regional EIS for Managing Competing and Unwanted Vegetation. The preferred alternative is prevention of noxious weed movement and infestation. The second priority is control of new invaders. On this Forest, knapweeds,

toadflax, giant knotweed, false brome and new infestations of evergreen and Himalayan blackberry are new invaders and are targeted for treatment.

Roads are the vectors disseminating most of our weeds throughout the Forest. Most roads are maintained, creating early seral habitat, devoid of competing vegetation, for weed establishment. Without immediate revegetation of road cutbank and shoulders following construction, weeds establish. Vehicles, animals, and machinery move noxious weeds from place to place. Weed populations are found in dispersed campsites, hunting camps, trailheads and timber harvest landings.

Maintenance of roads also contributes to movement of weed seed and propagules, especially along the crest of the Cascades. Knapweed is our largest problem and it is largely referred to as a "road runner". It has very light seed similar to that of a dandelion, which may easily be transported on the undercarriage of vehicles in soil or debris. This species seems to be moving from population centers on the east side of the Cascades via State highways through the Forest down into the Willamette Valley. The largest concentrations of this weed are along the major highway corridors, 22, 20, 126 and 58. Populations on the 126 corridor seem to be spreading at an alarming rate off the major highway along Forest Service arterial roads. One factor we have been able to document is movement of weed seed from cinder pits (waste disposal areas) used for icy highways in the winter. This species is highly drought-tolerant and can survive in areas of minimal soil such as cinder or on road shoulders.

Process description and Documentation

1. ***How do roads change special, mostly nonforested, plant habitats?***

- ***How and where do roads affect special and unique habitats (e.g. meadows and rock gardens)?*** Forest and project scale

This question would ideally be answered using a GIS layer for special habitats and intersecting it with the roads layer. Unfortunately, a forestwide special habitat layer has yet to be consolidated from Ranger District layers (which are in various stages of completion). In the absence of this forestwide tool (which should be available summer 1999), we may look at the nonforested habitats in the forestwide vegetation layer (Vegis). Conclusions from this query will be very general as the only habitats featured in Vegis are greater than 1 acre and we know that a large percentage of habitats across the forest are smaller than this. Also, very general habitat identification (for example shrubland, wetland) is used.

To get a more detailed description of the effects previously constructed roads have had on special habitats, one may use data from the three Watershed Analyses completed on Lowell Ranger District of the Willamette National Forest: Fall Creek, Winberry and Lookout Point Reservoir (note: most Watershed Analyses on this Forest have used this process). The special habitat layer manuscripted from orthographic photos, hand digitized into GIS, and attributed as to non-forested plant association/special habitat type (see Dimling and McCain, 1996) was used to overlay roads.

- ***How do roads impact reserved lands (Late Successional Reserves and Riparian Reserves) which are habitat for rare and unique species?***

- ***What late-successional-related species are found adjacent to roads and how is their habitat affected?*** **Forest scale**

This question can be answered using the two forestwide layers for survey and manage species (survmanage and allotropa) and intersecting them with roads that are buffered by 120 m (387 ft) on each side. The reason for buffering the roads by this amount is that research has shown opening of the forest can cause changes in microclimate up to 500 feet from the opening (Chen et al, 1995). This research was conducted to determine changes induced by opening up the canopy by regeneration harvest, but effects are assumed to be similar.

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2. ***How do roads affect sensitive plant species and other plant species of concern?***

- ***What species are located in habitats with high probability of impact from road building and quarries?***

This question may be partially answered using the analysis completed for Botany question #1 as most of the sensitive plants on the Regional Forester's Sensitive Plant List for Region 6, Willamette National Forest, are highly correlated with special habitats. The sensitive plant GIS layer was overlain with roads buffered by 50 feet to determine whether any intersections occur. And finally, we may use the results of our Willamette National Forest LRMP Monitoring question # 16.4 that asks whether any sensitive plant species have been adversely affected by management actions.

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3. ***How does road maintenance and construction contribute to movement of noxious and undesired non-native plant species?***

- ***How and where do roads contribute to the spread of exotic species (i.e. noxious weeds)?*** Forest scale

To analyze the distribution of weeds and the contributory nature of roads to weed movement, overlay the weed infestation GIS layer with roads. There is almost a 1 to 1 correlation between movement of the new invaders and the road network.

Results and Interpretation

Special Habitats

The first part of the analysis was determining the intersection of roads with a 120 meter buffer on the forestwide special habitat layer (map ef1a). Table 1 illustrates the percentages of habitats that are affected by roads on a rough scale using polygons of one acre or larger.

A significant number of special habitats have been affected by roads. The number of affected habitats presented is deceptively low as special habitats counted include those in roadless and Wilderness areas where there are no roads to impact special habitats. Thus this analysis at the forestwide level does not accurately portray the issue.

An analysis was conducted on a forestwide scale to determine where on the landscape special habitats are most affected by roads built through them ("hot spots"). The hypothesis was that the habitats most greatly affected are often found along the ridgelines (shrub =vine maple and

alder in Table 1) and in the valleys (wet meadows and ponds in Table 1). These areas are where many of the Forest roads and major highways are built. The results of this analysis showed that only 2% of affected habitats were within the top 10% of the slope and 16% of affected habitats are within the bottom 10% of the slope. This analysis disproves the hypothesis about ridgeline habitats but supports the hypothesis about riparian habitats. One would expect a random distribution to show 10% of habitats affected per 10% slope.

Table 1. Analysis of Intersection of Roads with Forestwide Special Habitat Polygons

Habitat Type	**Acres Affected By Roads**	**Total Acres Forestwide**	**Percentage of Habitats Affected by Roads**
Rock garden	25.7	1013.3	2.5
Mesic Meadow	554.3	15703.4	3.5
Dry Meadow	204.7	4344.8	4.7
Shrub	520.6	8067.8	6.4
Rock Outcrop	98	2267.5	4.3
Wet Meadow	124.6	2420.2	5.1
Talus	1151.5	43364	2.6
Pond	15.6	242.2	6.4

Hot spots were more numerous in the riparian than the ridgeline watersheds. Hot spots for ridgeline habitats affected are only in Fall Creek (27%). Hot spots for special habitats affected in riparian areas include North Santiam Downstream (53%), Willamette Middle Fork Downstream (44%), Hills Creek (33%), North Santiam Blowout-Woodpecker (29%), Willamette, Upper north Fork (23%) and McKenzie South Fork (22%), McKenzie, Minor Tributaries (14%). A forestwide analysis is the only way to portray where on the landscape these features are most affected.

Table 2 portrays the acres of special habitat impacted by roads in each sixth field watershed as a percentage of total special habitat acres. The “hot spots” are Lookout Point (85%), Hills Creek (75%), Upper North Fork, Middle Fork Willamette (58%), Quartz Creek (57%), Fall Creek (56%) , Middle Santiam (53%) , McKenzie Downstream Tribs (53%). In all these watersheds, over half of the special habitats are affected by roads.

Table 2. Special Habitats affected by Roads

Sixth Field Watershed	% Special Habitats Affected By Roads
Little North Santiam	7
Breitenbush	14
Upper Quartzville	21
Middle Santiam	54
South Santiam	32
McKenzie	27
Blue River	47
McKenzie, Downstream	53
Quartz	57
McKenzie, South Fork	27
Horse Creek	5
Fall Creek	40
Winberry	40
North Fk Mid Fk Willamette	40
Salmon Creek	20
Lookout Point	85
Salt Creek	20
Hills Creek	76
Staley	46
Upper N. Fk. Mid Fk. Willamette	58
Blowout	39
Upper N. Santiam	9

An analysis of the effects of roads on special habitats may be extrapolated from watershed analyses conducted on Lowell Ranger District. Table 3 depicts the percentage of special habitats affected by roads by habitat type. Road densities in Winberry and in Lookout Point watersheds are much higher than in Fall Creek because Fall Creek has some large unroaded areas (soils that are unsuited for timber harvest).

Table 3. Percentage of Special Habitats Intersecting Roads in Three Watersheds on Lowell Ranger District

Habitat Type	Fall Creek	Winberry	Lookout Point	Average
Rock garden	3	83	37	41
Mesic Meadow	3	20	84	36
Dry Meadow	6	26	53	28
Shrub Talus	1	0	53	18
Rock Outcrop	5	0	32	12
Hardwood	2	0	14	5
Wet Meadow	8	0	0	3
Pond	8	0	0	3

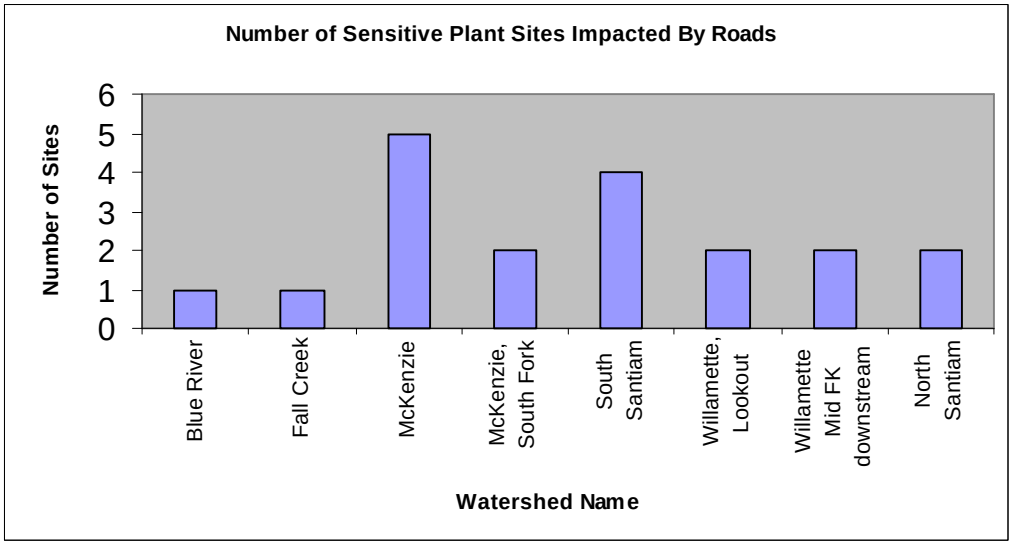
This scale of analysis shows the effect of road construction on diverse plant habitats. Habitats particularly affected by roads and associated quarries and disposal areas tend to be rock gardens and mesic to dry meadows and shrub talus found along ridgelines. This type of analysis may be used by resource specialists to determine restoration needs and priorities for special habitats at the watershed scale, to be implemented at the project scale.

Sensitive Plants

The only known population of a sensitive plant that has been directly affected by road construction in the 1980's is *Aster gormanii*, Gorman's aster (see Figure 1, North Santiam). This species grows along ridgeline scree slopes on Detroit and Sweet Home Ranger Districts. A spur road was placed through a section of one population. Results of this action are difficult to determine as the population was not monitored prior to road construction.

The most commonly affected sensitive plant is *Romanzoffia thompsonii*, Thompson's mistmaiden, in rock gardens adjacent to roads on Detroit, McKenzie, Middle Fork and Blue River Ranger Districts (see Figure 1). This species is an ephemeral annual that blooms during the spring when runoff moistens its habitat. Adverse effects to the populations probably occurred during the period of road construction. However, that construction led to the discovery of most of these populations. In all cases, roads are below the population and do not obstruct drainage; the chance of the road adversely affecting this species is minimal. In some cases (McKenzie South Fork in particular), road maintenance should take into consideration the close proximity of the population.

Figure 1. Number of TES Plant Sites Impacted By Roads/Watershed



The only other issue where road use could affect mistmaiden would be increased access to the site by having the road situated so close to the populations.

Four populations of tall bugbane,*Cimicifuga elata*, are found near roads. All of these subpopulations occur in the central core of the population, in the South Santiam watershed (Figure 1). This species occurs in mixed coniferous/deciduous forests at low to moderate elevations in the Cascades. It is tolerant of shade, but benefits from opening of the canopy (Kaye and Kirkland, 1994). One population has a skid road running through its center, providing a road for travelling deer and elk who find this rare plant a favorite food. Recommendations for these roads would be to allow them to revegetate themselves with no further disturbance.

Umpqua swertia,*Frasera umpquaensis* is found adjacent to a road at the headwaters of the Fall Creek drainage (Figure 1). A ridgeline road (1824/142) was built through the meadow community that provides habitat for this plant. It is unknown if the road decreased the population size; a subpopulation is less than 15 feet from the road (1824/142). Maintenance of this road should take into consideration affects to this species. Because this system is frequently used, restoration of the meadow is probably not realistic.

The final sensitive plant affected by roads is an odd ephemeral vernal pool species called *Montia howellii*, Howell's montia. This species grows in mud puddles in the parking lot of a very heavily used trail(Figure 1, Lookout Point). Plants are only discernable in February-April. After the rainy season ends, pools dry up and plants die. Recommendations for managing this site would include no grading activities that would fill up those pothole habitats. Other options would include not using the parking lot where the plants are located until April.

Late Successional Species

A number of survey and manage species have the potential to be affected by roads. The species are classified into four types: vascular plants, bryophytes, lichens and fungi. Life

histories differ dramatically for these species, management recommendations for each species group will differ.

Table 4 shows the only vascular survey and manage species adjacent to roads is *Allotropa virgata*, candystick. This species is mycotrophic; it has no chlorophyll so it attaches itself to a host tree roots for food via a mycorrhizal fungus. Experiments in the Umpqua National Forest (Dan Luoma, pers. comm.) have shown that similar mycorrhizal species can tolerate commercial thining; a closed old growth canopy is not necessary for maintenance of the species. Changes to the microclimate created by roads should not affect this species. Only direct impacts to the mycorrhzal symbiont or host trees would adversely affect candystick.

The bryophytes featured in Table 4 are very different from one another. *Buxbaumia viridis* grows on decomposing class 3 or 4 logs. It is sensitive to changes in light level and microclimate caused by removal or thinning of the canopy and is dependent on adequate levels of coarse woody debris (Bryophyte Management Recommendations, *Buxbaumia*, p. 2) *Racomitrium aquaticum* is a bryophyte which grows on rocks on or near streams. *Racomitrium* would be vulnerable if road culverts were removed and extra sediment washed downstream. This species is also vulnerable to erosion and scouring floods that could remove the species from its substrate (Bryophyte Management Recommendations, *Racomitrium*, p. 2). If populations of this species are located in areas of potential road failures, this would represent a “hot spot” for survey and restoration (see map ef1c- aquatic bryophytes).

Table 4. Survey and Manage Species Affected By Roads

Species Group	Species	Survey Strategy	**Populations Affected by Roads**
Vascular	*Allotropa virgata*	1,2	20
Bryophyte	*Buxbaumia viridis*	Protection Buffer	1
	Racomitrium aquaticum	1,3	1
Lichen	*Bryoria subcana*	1,3	1
	Fuscopannaria leucostictoides	4	1
	Fuscopannaria saubinettii	4	2
	Hydrothyria venosa	1,3	2
	Hypogymnia oceanica	1,3	8
	Lobaria hallii	1,3	4
	Lobaria oregana	4	9
	Lobaria pulmonaria	4	11
	Lobaria scrobiculata	4	3
	Nephroma bellum	4	3
	N. helveticum	4	4
	N. occultum	1,3	3
	N. parile	4	3
	Peltigera collina	4	6
	Pseudocyphellaria anomala	4	12
	P. anthraspis	4	10
	P. crocata	4	3
	P. rainierensis	1,2,3	3
	Sticta fuliginosa	4	2
	S. limbata	4	1
	Usnea hesperina	1,3	1
	U. longissima	4	1
Fungi	*Boletus pulcherrimus*	1,3	1
	Choiromyces alveolatus	1,3	1
	Destuntzia fusca	1,3	1
	Geelatinodiscus flavidus	1,3	1
	Gymnopilus puntifolius	1,3	1
	Mycenia monticola	1,3	1
	M. quinaultensis	1,3	1
	Neournula pouchettii	1,3	3
	Pithya vulgaris	1,3	2
	Rhizopogon inquinatus	1,3	2

Most of the species in Table 4 are lichens. Most are old-growth associates which depend on maintenance of interior habitat with associated temperature and humidity regulation (USDA and USDI, 1994b, p. 231) because of their epiphytic habit. Epiphytes are species that grow in the canopy of trees without rooting in soil. They depend on the air for moisture and nutrients. When specific species have been transplanted experimentally to the edge of clearcut stands, these species reproduced poorly and viability was low (USDA and USSDI, 1994b, p. 231). A prioritization of closing and revegetating roads within late-successional reserves should benefit these species viability (see wildlife discussion on maintenance of interior habitat for late-successional species).

Other lichens are associated with riparian areas. *Hydrothyria venosa* is an aquatic lichen. As mentioned above in the *Racomitrium* discussion, care should be taken with restoration projects around populations of this species due to affects from increased sediment loads (see map ef1c- aquatic lichens). "This lichen appears to be more sensitive to stream sediment than are salmon" (USDA and USDI, 1994b Appendix J2, p.243). Populations of *Hydrothyria* located in areas with potential road failures or in areas scheduled for road reconstruction should be considered "hot spots".

Usnea longissima is an epiphyte on hardwoods. The increased humidity within riparian zones is critical to maintenance of this species (USDA and USDI, p. 239). Restoration and closing of roads within riparian areas in late-successional reserves should aid in maintaining species viability (see wildlife section on interior habitat).

The final group of survey and manage species are the fungi (Table 4). Most are mycorrhizal species, connected underground to host tree roots that supply some nutrients while the fungus provides macronutrients from the surrounding soil (and maybe some other benefits such as disease resistance). Some are truffles (*Rhizopogon*) which fruit underground but are also mycorrhizal. Others are cup fungi (*Gelatinodiscus*, *Pithya*) which grow out of twigs or needles. Green hazard tree removal could affect some fungi in removing their hosts. Road maintenance activities outside of the road prism could compact soil and kill fungi.

Table 5 depicts the number of survey and manage species affected by roads within 6th field watersheds. The McKenzie and Willamette, Lower North Fork Middle Fork have Survey and Manage Species Impacted By Roads By Watershed the highest number of affected species and would be considered "hot spots". However, these watersheds are both large in size and do not have a greater density of survey and manage species/area than other watersheds presented.

Table 5. Number of Sites Affected by Roads

Watershed Name	Number of Sites
Breitenbush	9
Upper North Santiam	1
Quartzville	2
Middle Santiam	4
South Santiam	10

Watershed Name	Number of Sites
McKenzie	37
Blue River	5
Horse Creek	1
South Fork McKenzie	6
Winberry	3
Willamette, Lower N Fk	34
Willamette, Upper N Fk.	1
Salmon Creek	6
Salt Creek	2
Willamette, Mid Fk Downstream	13
Willamette, Upper Mid Fk	10

Noxious Weeds

The analysis of noxious weeds using GIS layers focused on new invader weed populations. Established weed infestations would be found along most road corridors making analysis of hot spot areas impossible.

Table 6 shows the number of new invaders affected by road corridors. The majority of new invaders documented on the Forest is associated with a road. Roads are vectors for dispersal of weeds. Additional standards and guidelines for the Willamette Land and Resource Management Plan are proposed in a new Environmental Analysis for Integrated Weed Management for prevention of weed movement along road corridors:

- Immediately seed (with native species where possible) roads following construction, removal or maintenance, using a competitive cover to discourage weed movement.
- Require that vehicles used under contract (such as logging, road construction and stream restoration equipment) be steam cleaned prior to movement from one project area to another (used as a contract clause for ground-disturbing activities).
- Use only certified weed-free seed for revegetation purposes. Try to use native, non-invasive seed.
- Use only weed-free rock sources for road construction/restoration projects
- Close roads to reduce the number of weed travel corridors on the Forest.

In a Master's theses conducted on HJ Andrews Experimental Forest (Blue River watershed, Parendes (1998) found that closed roads have less or no weeds as compared to roads that remain open. A serious effort should be undertaken, via ATM, to document necessary roads and close those which do not contribute to necessary activities. Even gates provide the decrease in disturbance necessary for native species to reinvade and outcompete weedy species (Ford, pers. comm.).

Table 6 Number of New Invader Weed Sites Located Adjacent to Roads

Weed Species	Number of Sites
Spotted knapweed	76
Himalayan and Evergreen Blackberry	55
Meadow knapweed	15
Yellow toadflax	7
False brome	6
Diffuse knapweed	5
Giant knotweed	3
Dalmatian toadflax	1
Houndstongue	1

The number of new invading weeds located in watersheds throughout the Forest varies, depending on the density of roads and number of highway travel corridors found within the watershed. Blackberry sites are not included in **Table 7** because surveys are not consistent forestwide. The McKenzie, Willamette Middle Fork Dowstream Tribs and South Santiam watersheds have the highest density of weed infestations. The McKenzie corridor is highway 126. In the past 5 years we have noted significant movement of spotted knapweed from this highway corridor on to secondary Forest Service roads. As spotted knapweed continues to be spread by vehicles coming from the east side of the Cascades and as road maintenance activities continue to move weed seed around with cinder for icy roads, this trend will continue. The South Santiam watershed, through which highway 20 runs, is in a similar situation. The Willamette Middle Fork Downstream tributaries is an area accessed by highway 58, another highway corridor which crosses the Cascade crest. Expansion of populations here, along roads 21 and 23, are probably due to recreation, such as dispersed camping and hunting, as well as equipment used in timber harvest activities. These areas should be considered “hot spots” for weed infestation. Road projects should include costs associated with weed prevention in their budgets (see measures outlined above). An option to address recreational user spread of weeds would be to close dispersed campsites and hunting camps with documented weed infestations until they are “cleaned” of existing weed infestations.

Table 7. Number of New Invader Weed Populations By Watershed

Watershed Name	Number of Weed Sites
McKenzie	24
McKenzie, South Fork	12
Willamette, Mid Fk Downstream	12
South Santiam	10

Watershed Name	Number of Weed Sites
Willamette, Upper Mid Fk	8
Salt Creek	5
Willamette, Lower N Fk Mid Fk	5
McKenzie, Minor Tribs	4
N. Santiam, Upstream Tribs	4
Salmon Creek	4
Blue River	3
Fall Creek	3
N. Santiam, Blowout-Woodpecker	3
Quartzville	2
N. Santiam, Downstream	2
Willamette, Lookout	2
Hills Creek	1
Horse Creek	1

Process Critique

The timeline for this analysis was too short. Tell the story part was a very valuable step in getting ideas on analysis from other members of the Team. We had only one person doing all the GIS requests and it was too much for one person given time constraints. I received my final data requests after the integration step had taken place. Botanical issues were largely left out of this step as a result of this lack of data.

Data consistency and availability as well as questions of scale always confounds analysis. Using forest-level, generalized data to analyze special habitats did not work. Data on special habitats at the District scale is much more telling of the effects of roads on these species. Data on sensitive species is very good and an analysis of effects can be done at the forest scale. Inventory for survey and manage species is in its infancy. Data collected tends to be in areas of project activity so Late-Successional Reserves and other reserve areas may be underrepresented in distribution. Analysis is appropriate at the forest scale. Data on weeds is good for all new invaders except blackberry. Analysis at the Forest or province level might be most appropriate for weeds which move along major highway corridors although prevention measures to stop movement of the weeds needs to be local. This means Forest Service road maintenance contractors and contractors for ground-disturbing activities need to be educated as to the effect they are having on movement of weeds across the Forest and measures they can take to stop the spread.

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Willamette National Forest Pilot Road Analysis

Appendix F

Fire and Fuels Process Paper

October 1998

Background

The Willamette National Forest observes a moderate to high fire activity load during each fire season. Normally, fire seasons on the Forest occur from June 20 to October 15, each year (1). Fire occurrence for the Forest from 1970 through 1994 (25 years) indicates the Forest average fire loaded is 0.453 lightning fires per ten thousand acres and 0.42 human caused fires per ten thousand acres, annually (2). Current Federal Wildland Fire Policy states: *fires are to be suppressed at minimum cost, considering firefighter and public safety, benefits, and values to be protected, consistent with resource objectives* (3).

Roads are an important factor, both positively and negatively, in the nature of wildland fire and fuel management on the Willamette National Forest. Roads networks provide a positive benefit by allowing travel access to and from forested areas for fire suppression and fuel management activities . They provide access to and from water sources, lookouts, helispots and other fire resources. Within the Forest roaded areas, suppression response time is reduced increasing efficiency and effectiveness of firefighter suppressing both human and natural fires. Roads also provide barriers or fire breaks for fire suppression and fuels activities. From a safety standpoint, roads provide anchor points for line construction, escape routes, and in some cases safety zone for both wildland fire and prescribed fire personnel. In some cases wildland fire strategies have been developed around road networks (4).

Contrary to the positive benefits forest roads and other forms of transportation systems provide for firefighters, they also they also have negative aspects. These effects are increases in risk of ignitions of human caused fires. Human caused fires along roadways throughout most the Forest have a random distribution. However, there are geographical, public high uses, areas which have higher frequencies of fires. In some cases, data analyzed indicates, these areas have significantly higher human caused fire frequencies. The majority of these areas were identified along major State of Oregon highway corridors and a railroad transportation systems within the Willamette National Forest boundary.

Disturbances of forested areas by fire can change ecosystems and interacts with geomorphic processes. The geomorphic processes from the fire and road construction to harvest fire-killed timber can have an important effect on the overall rate of erosion (5).

Process Description and Documentation

1. ***How do roads provide for or affect protection in terms of efficiency, effectiveness and safety?***

Fire Suppression (Efficiency, effectiveness, and safety)

Historically, road systems have provided for an efficient transportation route for an appropriate fire suppression response on the Forest. Roads have normally been associated with strategies and tactics that were the most cost-effective commensurate with objectives for management areas in which the fires occur (6).

The level of fire suppression efficiency was measured for the Forest by an analytical process known as the National Fire Management Analysis System (NFMAS) in 1994. NFMAS

objectively measured the net value change between the fire protection program, fire related cost, and resource losses on the Forest. This process identified the most efficient organizational needs for fire protection and proposed the most efficient funding level for the Forest fire protection organization.

Efficiency of transportation by emergency and other vehicles on Forest road systems played a key role in the NFMAS process. Vehicles were utilized, as the primary mode of transportation, in 87% to 90% of representative fires analyzed. The primary reason for the high utilization of vehicles was due to the high road density on the Forest.

Within NFMAS, fire management analysis zones were identified based on access and travel management within ranger districts boundaries and whether or not the area is designated as wilderness. Within the Forest, three nonwilderness zones were identified for each ranger district based on the primary type of initial suppression actions historically taken on wildland fires (1). The percentages of the initial suppression responses are shown below in *Table 1.* The "roaded-engine/hand" are initial attack forces going to the fire being transported in a vehicle or engine. The "remote hand" initial attack forces require walk in time, in addition to the vehicle travel time on existing Forest road systems.

Table 8. Forest Suppression Response Method

Forest Area-NonWilderness	Primary Suppression Response Method	Percent of Fires
Detroit / Sweet Home RD's	Roaded - Engine/Road - Hand Remote - Hand	89% 11%
Blue River / McKenzie RD's	Roaded - Engine/Road – Hand Remote - Hand	90% 10%
Middle Fork RD	Roaded - Engine/Road - Hand Remote - Hand	87% 13%

Based on the scope of the Forest Road Analysis, data, and time frames available to identified site specific changes in the road systems, quantifiable to changes to fire protection efficiency and effectiveness will not be analyzed in this process paper. The Forest Fire Managers are planning to calibrate NFMAS by March of 1999. The scope of this analysis should address travel management as a key issue or theme. If travel management is identified as an issue, base on current and future road closures, primary suppression response methods will be adjusted in the analysis. These adjustments, if made, will adjust the frequency of the distribution of the representative fires in the analysis. The change in frequency of the distribution will change the acres represented in the "roaded-engine/road-hand" and apply those acres to the "remote-hand". To apply this process road closures, future road closures and acres those road closures represent will need to be identified within the Forest's 3 non wilderness Fire Management Analysis Zones (FMAZ). This process will allow for frequency distribution changes to be utilized and will provide a detailed look at the net-value change for fires in areas where road closures occur.

The example in *Table 2* illustrates the estimated adjustment to the acreage on the Forest given a 2% frequency change in the NFMAS calibrations for suppression methods for firefighters traveling to fires. Again, this is just an example to reflect a change on Forest if road system being closed were to change suppression from "roaded-engine/road-hand to "remote-hand" in approximately 38,000 acres.

Table 9. *(Example)* Effect of Acreage Change with a 2% Change in NFMAS Frequency for Initial Attack Transportation Method

Suppression Method	**Current Acres (Forest wide)**	**Acres Change @ 2% Freq. Change in NFMAS (approx. 38,000 acres**
Roaded - Engine/Road - Hand	1,180,000	1,142,000
Remote - Hand	118,600	156,600

The example in *Table 3* illustrates the change of expected burned acres and cost plus the net-value change if a 2% frequency change (38,000 acres) was made in the NFMAS analysis on Forest.

Table 10. *(Example)* NFMAS Cost Plus Net-value Change and Burned Acres @ 2% Frequency Change

(Acres and dollar amounts are set at -30% Most Efficient Level and expressed in 1993 dollar values)

	Acreage change	**Expected Burned Acres**	**Cost + NVC (1000 Dollars)**
Current NFMAS Theme	0	1014	$8,902
NFMAS Theme @ -2%	38,000	1274	$9,645
Difference	38,000	+260	+$743

Safety in relation to road systems and travel management on Forest, along with all other safety considerations, will be the highest priority for firefighters and publics. When considering fire responses to wildland fires, fire managers along with firefighters need to identify tactics and strategies that do not compromise safety of firefighters. Issues such as road surface type and condition, road clearances, visibility of roadways on corners, maintenance levels, and traffic levels are just a few of the safety or possible safety issues emergency vehicle drivers deal with when responding to wildland fires. The scope to this analysis at a Forest level was too broad to deal with site specific and random information that requires on site data needs. In addition, the data sets are not currently available, and the time frame for this analysis was too restrictive to identify all the fire suppression safety issues as they relate to roads systems on a Forest scale. We would suggest that future analysis occur at the watershed level through water shed planning, NFMAS, and wildland fire situation analysis to answer questions relating to firefighter safety and access management travel.

When road maintenance issues are identified during fire suppression, corrective actions are taken. Many of these issues are as simple as brushing out narrow roads, grading roads, or doing other maintenance work to make road systems safe for travel by firefighter. When safety issues dealing with access and travel management on Forest cannot be mitigated, other forms of suppression transportation or methods of suppression actions will be utilized, by fire managers.

Access for Fuels Treatment and Management

It is anticipated, future fuel management and prescribed burning on the Forest will decline at the activity fuel project level and may increase on a ecological landscape scale. Activity fuel treatment projects funded by trust fund accounts on the Forest have been decreasing since the early 1990's (7). In 1996-97 a forest-wide Fire Management Plan was developed to identify the role of prescribed burning, within LSR's, at an ecological landscape level. In addition, a wilderness prescribed natural fire plan was developed for three of the wilderness areas on the Forest. It's anticipated that roads and road networks leading to and from activity fuel areas will not change significantly in the near future. This is based on the activities and access needs normally associated within watershed planning areas. In the future, if management ignited fires (MIF) are used to meet wildland fire objectives at an ecological scale, road systems maybe be utilized to provide for effective barriers during the ignition and holding stages of the prescribed burn. At this time, however, this program is still in the planning stage with no site specific prescribed burns planned that can be analyzed in regards to road access. Again, these are issues that are best analyzed and managed at the watershed level and not at a forest level. In regards to safety, fuel management would be address the same as in subsection "A. Fire suppression" portion of this process paper. Safety is recognized as the number one priority for local fire managers dealing with access travel management to and from activities, and needs addressed at a site specific or within each watershed level.

Access to Fire Resources

Fire resources are defined as lookouts, helibases, developed water sources, developed incident base camp locations, radio hill top sites, preattack fire breaks, helispots, and other related areas on the Forest. These resources were developed to support fire activities and safe factors relating to fire detection, fire prevention, Forest communications, and suppression of wildland fires.

An analysis of these resources was not done in relation to access and travel management, due to the nature and of the scope of this analysis.

Helispot, preattack fire breaks, and developed water sources need to be review at the watershed level scale and not at a Forest scale analysis. Road access to permanent lookouts and radio hill top sites or trail heads leading to those facilities need to be retained and maintained due to investments in the facilities, personnel safety factors, and communications network they provide for the Forest. At this time the only developed incident base camp within the Forest is the Hills Creek Dam site, located five miles southeast of Oakridge, Oregon. This site is located on Corp of Engineer lands under special use agreement with the Forest (see *Table 4*, below).

Table 11. Fire resources located on Forest

Type of Resource	Number of Resources on Forest
Lookouts (permanent)	4
Lookouts (other)	3
Radio Base Hill Tops	11
Heliports (not on FS lands)	2
Developed Water Sources	281
Helispots	79

2. How do roads increase the risk of fire occurrence?

Public Access in Relation to Fire Occurrence

Public access to National Forests is an important issue. Undoubtedly, the high density of roads on the Forest have contributed to a higher frequency of human ignitions in some areas (4). Also it can be assumed that public high uses areas have higher then average human ignitions. The randomness of each fire occurrence makes it very difficult to analyze.

Historical fire occurrence data on the Forest was assessed to determine if there was any correlation in human fire occurrence on the Forest to road density and high public uses areas. The historical fire occurrence data set was utilized to assess the fires that occurred on the Willamette National Forest between the years of 1970 and 1994. Also reviewed at the Forest scale were the spacial relationships between high intensity fuels models, dry southern aspects, areas where slope was greater then 50%, and human fire occurrences across the Forest.

Table 5 shows the number of human caused fires for standard road densities identified on the Forest. The statistical information is from fires occurring between 1970 though 1994.

Table 12. Human Caused Fire by Road Density

Road Density Mile/Mile²	#'s of Human Caused Fire/ Road Density
0	270
0-2	244
2-4	618
4-6	485
6-8	69
>8	12

The road density assessment does not indicate a correlation in road mile density and human caused fires on the Forest. The frequency and distribution of human caused fires may be related to factors other then road densities. At this point more analysis is needed.

Greater access to such areas as dispersed campsites, backcountry camping and hunting may contribute to the higher incidence of human-caused fires – up to a point. Areas with the highest road densities are generally highly industrialized and therefore are less appealing to recreationists and hunters as camping sites.

The assessment at this time doesn't verify the need to alter, close, or change road systems based on just human caused fire occurrence.

Human caused fires were also reviewed from a non statistical process by identifying areas on a GIS created map with human fire occurrences. Occurrence data was overlayed and reviewed with transportation systems on the Forest, high intensity fuel within the Forest, slopes greater then 50% slopes and southern aspects. Identified were the high-risk areas based on fuel model, slope, and aspect in relation to fire occurrences. Nine areas were identified with high human caused fire occurrences for the 25 year period. None of the high occurrence sites identified had significant amounts of high-risk areas associated in them. Three of the nine areas were identified to have very high occurrences of human caused fires. The first was the Lookout Point area northeast of Oakridge, Oregon. High human fire occurrence in this area was due to a high frequency of railroad fires in the early 1970's through the early 1980's. The Forest area surrounding the Oakridge area also had a high occurrence rate due to the high amount of recreational activities outside the Oakridge City limits and occurrences along the Oregon State Highway 58 corridor. The third area was in the Upper McKenzie river area. The Upper McKenzie area is a very high recreational area during the summer.

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3. How do roads affect the fire protection in the urban interface?

An assessment for road affects on Urban interface within the boundaries of the Willamette National Forest was not accomplished. This was due to short time frames of the process and quality of information available on a Forest scale. Assessment for affects on Urban interface will be recommend to be accomplish at local levels where public comments and information can be utilized to make site specific evaluations for each area of concern.

Interpretation

This assessment presents limited results due to time frames and process time. The nature of fire protection and assessment of fire protection of this scale is limited by well define information that can be utilized to identify cause and effect. Besides GIS data, studies and information sources on Forest and nationally are very limited when discussing fire management and road issues, however this is a good starting point. In this assessment there was not a determination on the values of roads in relation to fire protection and impacts to fire protection if road were closed. To assess values of roads in relation to fire protection and cost, quantifiable information, such as miles of road to close, site specific locations, and types of closures will need to be determined in advance of the analysis.

Future fire management issues dealing with road access will be a key issues on the Willamette National Forest this winter. The Washington National fire management group has request all National Forests in all Regions to calibrate NFMAS. The fire managers on the Forest have already identified that changes in road systems are forthcoming. Areas that were once accessible by roads four to five years ago are blocked or no longer in existence. Changes in current road access, availability of road access, or future access will need to be analyzed. This ultimately will influence strategies, tactics, burned acre area, and budgets on the Forest in the future.

Process Critique

Time of the year and process knowledge were key factors during the assessment. My lack of technical capabilities in GIS and not having good processing time was lacking thought the first month of the project. Lack of quality technical information relating to the effects of roads on fire management or fire on roads could not be secured. There seems to be very few reports addressing this issue. For a Forest scale assessment, background information would have been helpful. What little information I did find was helpful.

Competition for data through GIS seemed to be the one major problem. Time frames were short and not having maps and other data available in a timely manner was a key factors. Also, much of the fire data, on file, was not related to the issues of the analysis and did not really answer questions about access and travel management. The data that was relevant in some cases created more questions then answers, causing a need for more data.

Limited public involvement did not affect fire management input to the process, however, public involvement is an important factor in any Federal assessment and time will tell how critical not having public involvement in this process was.

Literature Cited, Key References, and Data Source

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Appendix

GIS Data

Data Table:

1. Number of Human and Lightning Caused Fires By Road Density

Bar Chart:

2. Number of Human and Lightning Caused Fires for Each Road Density Category

Data Table:

3. Forestwide Road Density - Acres

Forest Map:

4. Human Caused Fire Cluster Count

Data Table:

5. Human Caused Fires per Fifth Field Watershed

Bar Chart:

6. Number of Human Caused Fires in Each Watershed

Data Table:

7. Results of Evaluating Overlap of Significant Hazard and Resource Concerns

Data Table:

8. Description and Count of Various Structures that Occur on Willamette National Forest Land

NFMA and F.BEHAVE Data

Data Tables:

9. Summary of Option - Theme 4
10. Summary of Option - Group 2%
11. Summary of Option - Group 4%
12. Summary of Option - Group 6%
13. Summary of Option - Group 8%
14. Summary of Option - Group 10%
15. Burn Subsystem, Fire1, Behave Run (3 pages)