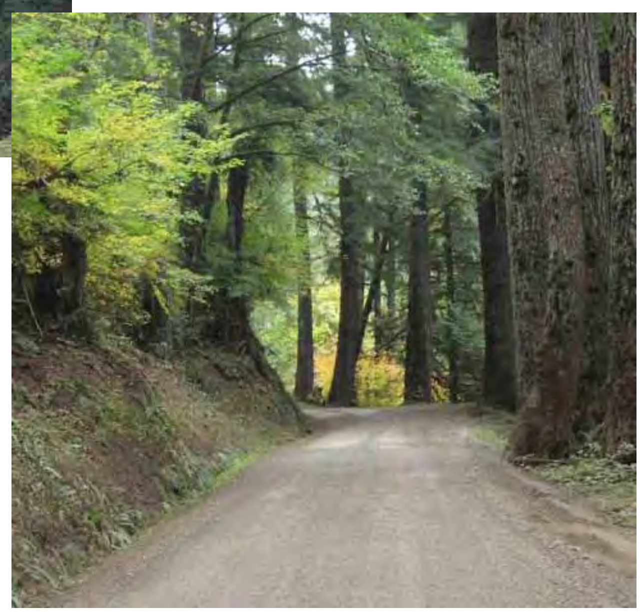
Siuslaw National Forest

2014 Travel Analysis Report
Analysis: Forest-Scale



March 2014

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Executive Summary

This 2014 update to the Roads Analysis Report for the Siuslaw National Forest is the latest in a series of travel management analyses dating back two decades. The Siuslaw National Forest has undergone enormous change since 1990. With implementation of the Northwest Forest Plan in 1994, the Forest went from a program of intensive timber management providing an annual timber harvest of over 300 million board feet, to a program composed of riparian and late-successional reserves with a harvest of 40 million board feet. This change reversed decades of road system expansion and led the Siuslaw to evaluate the strengths and liabilities of its entire road network.

In 1994, following extensive public involvement efforts, the Forest issued an Access and Travel Management (ATM) guide that identified the basic primary and secondary (Key) road system deemed essential for public access and travel throughout the Forest. The primary and secondary road system comprised about one third of the road network, leaving the other two thirds of the system open to question. Due to reduced timber harvest, road maintenance funds became scarce, forcing the Forest to make choices about which non-primary and non-secondary (Non-Key) roads to maintain or close.

In 1996, an intense rainstorm hit Oregon causing numerous landslides, floods, and debris flows. The Forest seized the opportunity to learn from this natural phenomenon and teamed up with researchers from the Pacific Northwest Research Station (PNW) to study environmental effects. Studies revealed a complex interaction between floods and roads culminating in the Assessment of the Effects of the 1996 Flood on the Siuslaw National Forest (USDA 1997). This report confirmed much of what was suspected about the effect of severe storms on roads, *i.e.*, failures primarily occurred due to inadequate culverts and a smaller number of failures occurred on roads that had been waterbarred or decommissioned previous to the storm event.

At the same time, the production of a video called “Torrents of Change” (FSEE 1996) indicated a high level of public interest in the status of forest roads. Since then, the Forest has embarked on an aggressive program of stream and forest restoration with road management at the forefront.

Watershed analyses have now been completed for nearly the entire Siuslaw (Watershed Analysis References). All of these assessments have recognized the significance of roads and their impact on the environment. Most have made recommendations regarding specific roads and their future management. Many roads have been decommissioned or otherwise hydrologically stabilized and closed as a result of these analyses.

On March 29, 2012, the Forest Service Chief reaffirmed the agency’s commitment to completing a travel analysis report for Subpart A of the travel management rule by 2015. For units that have previously conducted their Roads Analysis Process (RAP), the appropriate line officer should review the prior report to assess the adequacy and the relevance of their analysis as it complies with Subpart A. This analysis will help determine the appropriate scope and scale for any new analysis and can build on previous work. A RAP completed in accordance with publication FS-643, “Roads Analysis: Informing Decisions about Managing the National Forest Transportation System,” will also satisfy the roads analysis requirement of Subpart A.

The Siuslaw National Forest completed a RAP in 2003 in response to the January 12, 2001, National Forest System Road Management Rule. All roads (Maintenance Level 1 through 5) were analyzed. This travel analysis is not a decision, but rather a compilation of information useful for making informed decisions about road management. It had two primary focuses. First, the analysis reviewed the Key Forest Routes concept and validated its continued use as a tool for making decisions about road management. Second, the analysis captured the cumulative knowledge gained from years of studying

Siuslaw National Forest roads and road management in order to better inform land managers about the benefits and liabilities of roads, ways to mitigate risks, and sources of additional information.

In 2003 an interdisciplinary team used the Forest Service publication *Roads Analysis: Informing Decisions About Managing the National Forest Transportation System* (USDA 1999). The team followed the six-step process outlined in this document and used its list of 71 Ecologic, Economic and Social considerations in order to identify issues specific to the Siuslaw. The team found that many of the suggested road issues are best addressed at the watershed or project scale rather than the Forest scale. Other issues were not found to be important in making road decisions pertinent to the Siuslaw. The Team's responses to those considerations are listed in Appendix A. In all, eight issues were found to be important for informing road decisions on the Siuslaw:

Economics – Low maintenance funding affects our ability to maintain key access routes.

Community Impact – People depend on Forest roads for safe travel and Forest access.

Aquatics and Water Quality – Roads influence hydrologic function and stream dynamics.

Fisheries – Roads affect fish habitat and fish passage.

Terrestrial Wildlife – Roads affect wildlife through habitat fragmentation and disturbance.

Vegetation Management – In the short-term road access is critical for restoring desired forest characteristics.

Noxious Weeds – Roads and people can increase the spread of noxious weeds.

Wildfires and Fire Suppression – Roads influence both wildfire occurrence and suppression strategies.

When the strategy for the Travel Analysis Report was being considered, the Forest Service staff concluded that these issues remain relevant. Each of these issues is discussed in detail in Chapter 4. Each issue has a discussion of the current situation, risks and benefits, desired future conditions, and recommendations. Recommendations concerning all issues are summarized in Chapter 5, 5. Key Recommendations. In addition, the analysis includes a map of the current Key Road system and lists roads and maintenance objectives for the rest of the system in Appendix C.

Figure 1 US Highway 101 viewed from Cape Perpetua viewpoint

In 2011, the Siuslaw National Forest was designated as a pilot forest to implement those sections of Subpart A of the Forest Service (FS) Travel Management Rule, which requires each unit of the NFS to identify the minimum road system needed for safe and efficient travel and for the protection, management, and use of NFS lands (36 CFR 212.5(b)(1)); and identify roads that are no longer needed to meet forest resource management objectives and that, therefore, should be decommissioned or considered for other uses (36 CFR 212.5(b)(2)). The Travel Analysis Process (TAP) is described in Forest Service Manual 7712 and Forest Service Handbook (FSH) 7709.55, Chapter 20. This process includes the following 6-steps: 1) setting up the analysis; 2) describing the situation; 3) identifying issues; 4) assessing benefits, problems, and risks; 5) describing opportunities and setting priorities; and 6) reporting. Travel Analysis considers access needs, environmental risks, and financial considerations.

On March 29, 2012, the Forest Service Chief reaffirmed the agency commitment to completing a travel analysis report for Subpart A of the travel management rule by 2015. For units that have previously conducted their travel or roads analysis process (RAP), the appropriate line officer should review the prior report to assess the adequacy and the relevance of their analysis as it complies with Subpart A. This analysis will help determine the appropriate scope and scale for any new analysis and can build on previous work. A RAP completed in accordance with publication FS-643, "Roads Analysis: Informing Decisions about Managing the National Forest Transportation System," will also satisfy the roads analysis requirement of Subpart A.

The Siuslaw National Forest had analyzed the entire forest's road system (Maintenance Level 1 through 5) with the 1994 ATM and the 2003 Roads Analysis Process. The Key Roads identified in those efforts constitute the Forest's minimum road system. What was missing from the 2003 Roads Analysis was more thorough discussion of economics and the ability to model risk and project road use over time.

The 2003 Roads Analysis indicated that only about 22 percent of the Key Roads could be maintained with the expected maintenance funds (CMRD). Inspecting the Key Road system essentially 10 years later, we found the Key Road system in better shape. How was that possible? The 2013 evaluation reveals the other sources of road maintenance dollars that made this possible. These include timber sales, legacy funding (CMLG), stewardship, Emergency Relief for Federally Owned Roads, road use permits, Secure Rural Schools, and road maintenance funds (CMRD). Following the recommendations in the 2003 Roads Analysis, road maintenance and repairs were prioritized to the key road system leading to the current improved conditions of those roads. It is impossible to predict with certainty the availability of funds from all sources that may contribute to maintenance of key roads over the next decade. But, perhaps periodic assessment of trends in funding and in road condition offers a better window on our progress towards sustainability.

We are still learning about roads and the complex interaction of people and environment that they afford. This roads analysis captures what we know to be important today. As we learn more about roads through monitoring and site-specific analysis, these recommendations, including the primary and secondary road system itself, will undoubtedly change. If changes are needed, adjustments or modifications to the Key Road system can be addressed at the appropriate scale.

When taken as a whole, the recommendations of this report inform readers concerning the critical issues related to road management on the Siuslaw. It is our hope that these recommendations will lead to wise choices in road management in the future.

1. Introduction

Background

On November 9, 2005, the Forest Service regulations at 36 CFR part 212 governing administration of the forest transportation system and regulations at 36 CFR part 295 governing use of motor vehicles off National Forest System (NFS) roads were combined and clarified in the final rule as part 212, Travel Management, covering the use of motor vehicles on NFS lands. Subpart A, remained essentially unchanged from the January 12, 2001 rule. The rule revised regulations concerning the management, use, and maintenance of the National Forest Transportation System. The goal of the rule was to ensure that additions to the national forest system road network were essential for resource management and use; that construction, reconstruction, and maintenance of roads minimized adverse environmental impacts; and that unneeded roads were decommissioned and restoration of ecological processes initiated.

From 1994 to 2003, road management decisions on the Siuslaw were guided by the Siuslaw Access and Travel Management Guide (Appendix B), which established a system of prioritized Key Roads. This system has provided the basis for making site-specific decisions concerning road management on the Siuslaw. Road management decisions have also been informed by watershed analyses that focused largely on roads and their impacts on terrestrial and aquatic restoration efforts. The Forest is currently focused on restoration of aquatic and terrestrial ecosystems and has been a leader in addressing problems and issues presented by roads.

Since 2003 the Siuslaw Roads Analysis Process has guided road management decisions. It was designed to provide decision-makers with important information to develop road systems that are safe and responsive to public needs and desires, are affordable and efficiently managed, have minimal negative ecological effects on the land, and are in balance with available funding for needed management actions. This 2014 Siuslaw Travel Analysis Report updates the 2003 Siuslaw Roads Analysis Process information and analysis procedures.

A Word About Scale

There are multiple scales at which travel analysis may be conducted to inform road management decisions. Generally, road management decisions should be informed by travel analysis at a broad scale such as the Forest or Province level. The Siuslaw Forest Supervisor determined that this travel analysis would be at the Forest-level. Guidance on selecting the appropriate scale and those proposed actions which may trigger a need for a roads analysis is set forth in Forest Service Manual 7712 (USDA 2009a) and Forest Service Handbook 7709.20 (USDA 2009b).

Objectives of the Analysis

- To update and validate the 2003 Roads Analysis Report, extending the analysis to the current date.
- To evaluate the current Forest road network and system of prioritizing road maintenance based on criteria for Key and Non-Key designations, and validate the criteria for continued use as a tool for making decisions about road management.
- To display the extent of Watershed Analysis coverage for the Siuslaw by reference and map (Figures 6 and 7).
- To display the extent of NEPA analysis coverage for the Siuslaw by reference and map (Figures 8 and 9).

- To collate and display the Forest's Key road system (Appendix C)

- To collate and display the Forest's Non-Key roads that had been covered by a NEPA analysis for closure (Maintenance Level 1) or decommissioning. (Appendix D). These roads have not yet been closed or decommissioned due to timing considerations, but will be closed or decommissioned in the next few years.

- To collate and display the Forest's Non-Key roads that had been covered by a NEPA analysis that are and will remain open and have not been planned to close or decommission. (Appendix E)

- To collate and display the Forest's Non-Key roads that have not been covered by a NEPA analysis. (Appendix F)

- To evaluate the various sources and levels of past road maintenance funding.

- To capture the cumulative knowledge and wisdom gained from years of studying roads and road management in order to better inform land managers making site-specific decisions about roads.

- To ensure that the Forest transportation system provides sustainable access to national forest resources over the short and long term.

- To identify the minimum road system necessary for the safe and efficient travel and for administration, utilization, and protection of National Forest System lands.

- This analysis incorporates and updates previous Roads/Transportation analyses for the Siuslaw National forest, rather than starting over from scratch. Whenever still relevant, we have simply updated the language of the 2003 Roads Analysis Report.

What this Analysis Does ***NOT*** Do

- This analysis will not make site-specific decisions about which roads will be retained or closed. Those decisions are made at the project scale with public input on site-specific situations.

- This analysis is not a decision document. Recommendations and findings will only be used to inform decisions at higher or lower scales. They are not standards or guidelines under the Siuslaw Forest Plan. Recommendations and findings are subject to change as new or better information becomes available.

- This analysis does not address off-highway vehicle (OHV) use on the Oregon Dunes National Recreation Area (ODNRA). That decision, which amended the Siuslaw Forest Plan (1990), was made in the Record of Decision for the Dunes Management Plan (1994). Route designation within Management Area 10C on the ODNRA analysis and decision is expected to be completed in 2014. OHV use at Sand Lake is addressed in the Sand Lake Management Plan (1980) which was incorporated in the Siuslaw Forest Plan (1990).

- This analysis does not affect the 2009 Siuslaw Travel Management Project decision, which amended the Siuslaw Forest Plan (1990), designated roads, trails and areas for motorized travel on the Siuslaw National Forest. The Motor Vehicle Use Map (MVUM) implemented the 2009 Siuslaw Travel Management Project.

The Analysis Process

An interdisciplinary team composed of resource and technical specialists conducted the 2003 Siuslaw Road Analysis. The team relied on the Forest Service publication FS-643, *Roads Analysis: Informing Decisions About Managing the National Forest Transportation System* (USDA 1999) for conducting the analysis. FS-643 outlines a six-step procedure. These steps are designed to be sequential with the understanding that the process may require feedback and iteration among steps over time as an analysis matures.

Setting up the analysis – includes setting objectives and planning the analysis.

Describing the situation – includes describing the current road management system and current road network.

Identifying issues – uses a list of 71 considerations described in FS-643 to help identify a subset of key issues specific to road management on the Forest.

Assessing Benefits, Problems and Risks – where each issue is viewed within the context of the road system with problems and benefits of the system assessed.

Describing opportunities and setting priorities – management opportunities and technical recommendations are developed to address the benefits, problems and risks identified.

Reporting – documentation of the process, key findings, and recommendations. For the sake of clarity, in this report, steps 3, 4 and 5 have been blended into Chapter 4, Issue Analysis. The 71 considerations listed in FS-643 are addressed in Appendix A. Key Recommendations are found in Chapter 5, Key Recommendations.

In July 1993, the Forest began to develop an Access and Travel Management (ATM) Guide that would identify a Key Road system composed of primary and secondary roads. The Key Road system included access routes for administrative and public travel on Forest Service lands, including connections to the county, state and federal highways. Primary (Key) roads would get highest priority for funding followed by secondary (Key) roads and then “other” (Non-Key) roads.

The Siuslaw Access and Travel Management Guide, September 1994 identified a network of 630 miles of Key Roads and provided a framework for reviewing the road network during watershed and project planning. Existing Forest roads not selected as primary or secondary (Key) were to be evaluated at the watershed or project scale to determine whether they should remain intermittent-use roads (Non-Key with long-term access not maintained for public travel) or be decommissioned and removed from the system.

In 2003 an interdisciplinary team used the Forest Service publication Roads Analysis: Informing Decisions About Managing the National Forest Transportation System (USDA 1999). The team followed the six-step process outlined in this document and used its list of 71 Ecologic, Economic and Social considerations in order to identify issues specific to the Siuslaw. The team found that many of the suggested road issues are best addressed at the watershed or project scale rather than the Forest scale. Other issues were not found to be important in making road decisions pertinent to the Siuslaw. The Team’s responses to those considerations are listed in Appendix A. In all, eight issues were found to be important for informing road decisions on the Siuslaw:

Economics – Low maintenance funding affects our ability to maintain key access routes.

Community Impact – People depend on Forest roads for safe travel and Forest access.

Aquatics and Water Quality – Roads influence hydrologic function and stream dynamics.

Fisheries – Roads affect fish habitat and fish passage.

Terrestrial Wildlife – Roads affect wildlife through habitat fragmentation and disturbance.

Vegetation Management – In the short-term road access is critical for restoring desired forest characteristics.

Noxious Weeds – Roads and people can increase the spread of noxious weeds.

Wildfires and Fire Suppression – Roads influence both wildfire occurrence and suppression strategies.

Each of these issues is discussed in detail in Chapter 4. Each issue has a discussion of the current situation, risks and benefits, desired future conditions, and recommendations. Recommendations concerning all issues are summarized in Chapter 5, Key Recommendations. In addition, the analysis includes a map of the current Key Road system and lists roads and maintenance objectives for the rest of the system in Appendix C.

In 2011, the Siuslaw National Forest was designated as a pilot forest to implement those sections of Subpart A of the Forest Service (FS) Travel Management Rule, which requires each unit of the NFS to identify the minimum road system needed for safe and efficient travel and for the protection, management, and use of NFS lands (36 CFR 212.5(b)(1)); and identify roads that are no longer needed to meet forest resource management objectives and that, therefore, should be decommissioned or considered for other uses (36 CFR 212.5(b)(2)).

The 1994 Siuslaw Access and Travel Management Guide (Appendix B) identified a primary and secondary (Key) road system deemed essential for public access and travel throughout the Forest. The 2003 Siuslaw Roads Analysis Process (RAP) reviewed the Key Forest Routes concept from the 1994 Siuslaw Access and Travel Management Guide. It identified the Key Road system as the minimum road system and validated its continued use as a tool for making decisions about road management. The 2014 Travel Analysis Process reviewed the 2003 Siuslaw RAP and validated the Key road system as the Forest's minimum road system. The 2003 Roads Analysis has been updated to strengthen economic analysis, validate financial sustainability, model environmental risk and projected road use, and account for changes in the forest transportation over the past decade.

The 2003 Roads Analysis indicated that only about 22 percent of the Key Roads could be maintained with the expected maintenance funds. Inspecting the Key Road system essentially 10 years later, we find the condition of the Key Road system has actually improved significantly. How is that possible? The 2014 evaluation reveals the other sources of road maintenance dollars that made this possible. These include timber sales, legacy funding (CMLG), stewardship, Emergency Relief for Federally Owned Roads, road use permits, Secure Rural Schools, and road maintenance funds (CMRD). Following the recommendations in the 2003 Roads Analysis, road maintenance and repairs were prioritized to the key road system leading to the current improved conditions of those roads.

The 2003 Road Analysis found that the ATM process of Key and Non-Key Roads was functioning well. The 2014 updated travel analysis found that the Key Roads are roughly equivalent to the Minimum Road System that can be maintained over the long term. Non-Key Roads will be opened and closed over time as needed to facilitate restoration treatments under the Northwest Forest Plan and will be stored or decommissioned as those treatments are completed.

Figure 2 Road with stream crossing

Interdisciplinary Team Members and Contributors

2003 IDT	Position	2014 IDT	Position
Craig Snider	Team Leader	Frank Davis	Team Leader
Barbara Ellis-Sugai	Forest Hydrologist	Stuart Johnston	Forest Silviculturist
Binky Hendrix	GIS Analyst/Assistant Road Manager	Ken McCall	Transportation Planner
Carl West	Forest Fire Management Officer	Kami Ellingson	Forest Hydrologist
Ken McCall	Transportation Planner	Barbara Ellis-Sugai	Assistant Forest Hydrologist
Dan Segotta	Forest Botanist	Michael Harvey	Recreation Specialist
Michael Clady	Fisheries Biologist	Dan Eddy	Forest Fire Management Officer
Michael Harvey	Recreation Specialist	Paul Thomas	Wildlife Biologist
Palmer Utterback	Forest Transportation Engineer	Wayne Patterson	Operations Staff
Paul Thomas	Wildlife Biologist	Viva Worthington	Deputy District Ranger
Phyllis Steeves	Forest Archaeologist		
Sonja Weber	Writer/Editor		
Stuart Johnston	Forest Silviculturist		
Wayne Patterson	Resource Assistant		
William Eaton	Road Systems Engineer		

2. Describing the Situation

Existing Road and Access System Description

A 2013 snapshot of the Siuslaw System Roads reveals 609 miles of Key Roads and 1,534 miles of Non-Key Roads totaling 2,143 miles of System Roads. All Key Roads are open. Focusing on the Non-Key roads reveals that there are 1,072 miles of open Non-Key Roads and 462 miles of closed Non-Key Roads. The forest road network also includes approximately 700 miles of state and county public roads within the Siuslaw boundaries. Private landowners also maintain extensive road networks on adjacent lands, though many of these are closed to public access. Cars, trucks, motorcycles, bicycles, and other modes of transportation traverse these many roads for recreation, resource management projects, and private property use. This variety of uses and demands makes management of the Forest transportation system a complex task. The Forest must provide many different recreational experiences and management opportunities, and at the same time protect resources, minimize safety hazards, and reduce user conflicts.

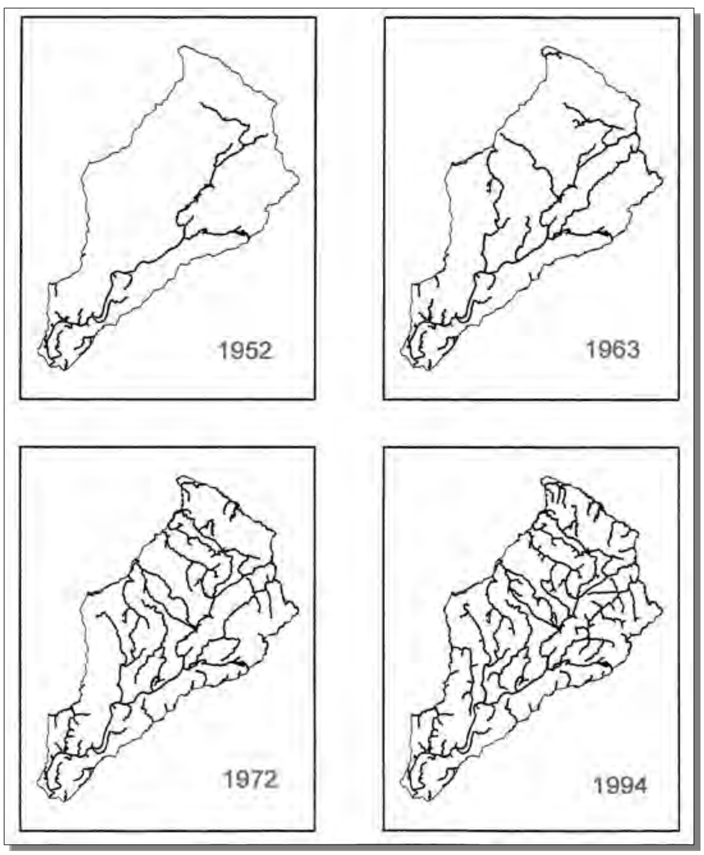


Figure 3 Growth of the Forest Service Road System in the North Fork Siuslaw Watershed.

From 1950 to 1990, the Siuslaw National Forest carried out an intensive program of timber management. This emphasis required the development of a road system to access timber and other forest resources. The growth of the road system in the North Fork Siuslaw watershed from 1952 through 1994 is shown Figure 1. Similar trends were seen throughout the Forest during the same time period.

Beginning in the early1990s, timber harvest declined dramatically with listing of the northern spotted owl (*Strix occidentalis*) and the marbled murrelet (*Brachyramphus marmoratus*). Both species were listed as “threatened” under the Endangered Species Act.

The Northwest Forest Plan (USDA, USDI 1994) radically changed management direction on the Forest. Instead of the system of intensively managed tree plantations, the Forest was to become a system of large late-successional and riparian reserves, where timber harvest was largely a by-product of efforts to restore late-successional or “old growth” conditions. This change reduced the annual timber harvest from up to 400 million to 30-40 million board feet per year.

An indirect effect of this harvest reduction was a drastic reduction in the Forest’s ability to maintain the 2,500 miles of system roads existing in 1990. A portion of timber sale receipts is used for road maintenance and, in some cases, timber purchasers perform road maintenance with their own equipment. The reduction in timber harvest meant there were insufficient funds to maintain all the roads in service. Without maintenance, roads are more prone to erosion, washouts and landslides. Culverts can become plugged creating small dams of water that can burst, sending sediment downstream, ruining salmon spawning grounds.

The Forest was faced with a dilemma and realized that most of the road system could not be maintained and that risks of road failures were increasing. What could the Forest do to stabilize roads and still provide access essential for commerce, safety and recreation access? Clearly, only a limited number of roads could be maintained to standard and many other roads would need to be closed or stabilized to minimize maintenance requirements.

To meet this challenge, the Forest began storm proofing some roads by waterbarring in 1991. Two years later, in July 1993, the Forest began to develop an Access and Travel Management (ATM) Guide that would identify a Key Road system composed of primary and secondary roads. The Key Road system would include access routes for administrative and public travel on Forest Service lands, including connections to the county, state and federal highways. Primary roads would get highest priority for funding followed by secondary roads and then “other” (Non-Key) roads. Interested and affected publics were informed that the Siuslaw would need to reduce its open road network to less than 1,000 miles from the then-current 2,500 miles. In August 1993, public workshops were held in Florence, Corvallis and Lincoln City to define criteria for identifying primary and secondary roads. By March 1994, public involvement was completed and a map showing the Key Road system of primary and secondary roads was completed. Use of the selection criteria in the ATM Guide resulted in a Key Road network very similar to the road network of the 1960s, prior to development of the extensive logging road system.

Appendix B contains a copy of The Siuslaw Access and Travel Management Guide; September 1994.This guide identified a network of 630 miles of Key Roads and provided a framework for reviewing the road network during watershed and project planning. Existing Forest roads not selected as Key Roads (primary or secondary) were to be evaluated at the watershed or project scale to determine whether they should remain intermittent-use roads (with long-term access not maintained for public travel) or be decommissioned and removed from the system.

Following adoption of the ATM road strategy the Forest began an aggressive program of waterbarring Non-Key Roads to prevent runoff from running down wheel tracks and causing erosion. These water bars were much deeper than waterbars typically used to divert water off road surfaces and rendered the treated road non-drivable by passenger cars. Without regular maintenance to clear brush, such roads were expected to grow over with vegetation after a few years. This strategy developed as a result of the Forest’s experience with failed culverts and road damage during heavy winter rains in the Coast Range. Following severe storms and flooding in 1996, the Forest conducted an assessment of flood effects

(USDA 1997). The assessment confirmed the effectiveness of the waterbar strategy. The vast majority of road damage from severe storms was on roads (including the Key Road network) that had not been treated with deep waterbars.

The expectation was that the Key (primary and secondary) Road system developed under ATM guidelines would remain dynamic, based on new or changing information. Since adoption of the ATM guidelines for selecting Key (primary and secondary) Roads, project and watershed level planning efforts (in addition to changed conditions on some selected roads) have resulted in changes to the original primary and secondary road selections. Two examples of such changes are summarized below.

Road 1900. The 1900 road system accesses the Drift Creek Organizational Camp on the Hebo Ranger District and was designated a Key Forest Route. Heavy rainfall and runoff during the 1996 and 1997 winter storms caused slides and washouts along the 1900 road, which made it impassable. Rather than attempt extensive repairs, the road was decommissioned and traffic rerouted to the 1924 road. The 1924 road was subsequently upgraded from a non-Key Road under ATM guidelines to a primary low clearance road. By using the 1924 road and stabilizing the 1900 road, access to the Drift Creek Organizational Camp was retained at a net savings in repair cost and reduced environmental risk.

Road 63. Road 63 was a designated Key Forest Route adjacent to Deadwood Creek on the Mapleton Ranger District. In order to improve fisheries habitat and reduce aquatic impacts along the main stem of Deadwood Creek, Road 63 was proposed for partial decommissioning. However, it was important to maintain access to the upper Deadwood Creek area.

The Upper Deadwood Creek Restoration Project Environmental Analysis (USDA 2001c) considered alternate routes through the area. Roads 3500 and 3515 roughly paralleled Road 63; both met the access needs and general criteria for selection as a primary low clearance Key Forest Road. However, Road 3515 was considerably less costly to upgrade and maintain for use by passenger vehicles. Analysis of the environmental, economic and access issues resulted in selecting Road 3515 as the replacement Key Forest Road, since it was the least costly, most stable road in the area.

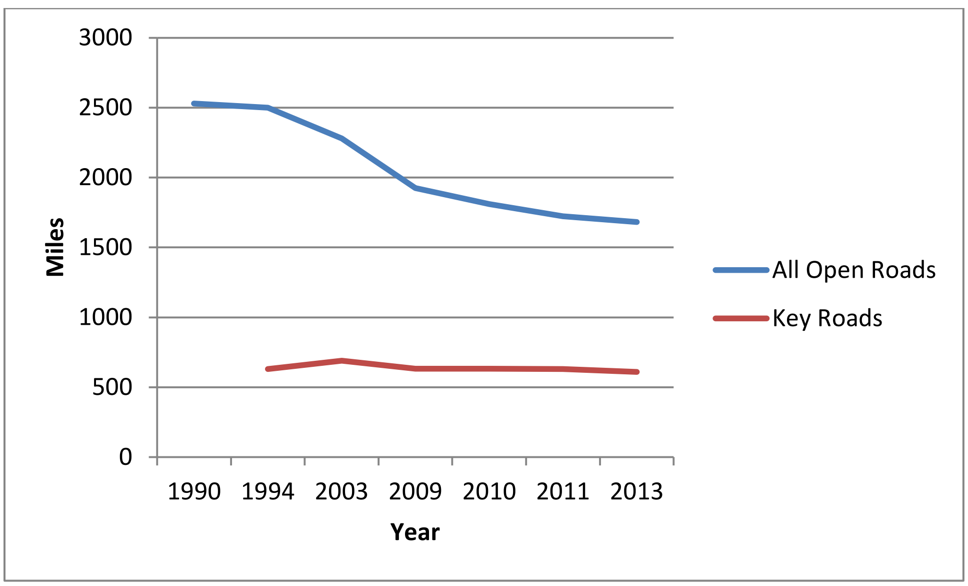
Figure 4 Reduction of the Forest Service Road System in the North Fork Siuslaw watershed.

Total system road mileage has declined due to decommissioning roads not needed for long-term access to national forest lands and resources. These roads receive a variety of treatments to stabilize them, restore hydrologic function, and remove the road from the drivable Forest network. The majority of these decommissioned roads were short logging spurs not needed for current management or access. Other decommissioned roads were those presenting a high risk of resource damage, primarily along mid-slope and valley bottom sections that adversely impact aquatic resources. Table 1 illustrates how the system has changed since 1990. INFRA is used for the basis of calculating road mileage.

Table 1 - Comparison of Forest transportation system. Mileages are approximate;

Year	System Road Miles	Miles Open	Miles Open Key Roads	Miles Open Non-Key Roads	Miles Stored Non-Key (Closed)	Miles of Road Decommissioned
1990	2530	Not available	Not available	Not available	Not available	Not available
1994	2500	Not available	630	Not available	Not available	30
2003	2280	2280	690	1590	Not available	Not available
2009	2200	1924	633	1291	276	288
2010	2166	1811	633	1178	355	318
2011	2149	1722	630	1092	427	333
2013	2143	1681	609	1072	462	339

Figure 5 Siuslaw National Forest Open roads over time.



Since the Northwest Forest Plan (NWFP), in 1994 amended the Siuslaw Forest Plan the Forest has been implementing restoration activities which include precommercial and commercial thinning to accelerate the development of late-successional habitat. When Non-Key roads are identified for future activities, but not needed at the present, those roads are closed(Maintenance Level 1). Maintenance Level 1 road closure can take many forms depending upon the location on the landscape. Ridgetop roads may only require a berm at the beginning point to stop traffic. Mid-slope or valley bottom roads may require water-barring and stream culvert removal to protect the investment until the next entry. A road is decommissioned if the road is no longer needed for access or poses an ecological hazard to a resource.

The Siuslaw began developing watershed analyses to assess watershed condition, prioritize restoration, and to meet the requirement in the NWFP (See Figure 6). Watershed analyses follow a six steps process: Characterization, Identification of issues and key questions, Description of current conditions, Description of reference conditions, Synthesis and interpretation, and Recommendations. The seven core analysis topics are: Erosion processes, Hydrology, Vegetation, Stream channel, Water quality, Species habitat, Human uses.

The Siuslaw began large watershed NEPA planning analyses at about that same time. In 2001, the Forest produced a Business Plan brochure entitled, “Decades of Change…A Challenge for the Future.” This brochure outlined high priority restoration areas and program of work. In 2006, the Forest updated the Business Plan and produced a new Business Plan brochure entitled, “Meeting the Challenge. Providing Ecosystem Services for our Communities.” This brochure outlined the status of watershed restoration work. Both these Business Plans provided guidance for prioritizing NEPA analysis areas. Figure 7 displays the NEPA analysis the Forest has completed to date. Since 1998 these NEPA analyses were whole watershed efforts implementing first the 1998 Siuslaw Access and Travel Management Guide and since 2003 the Siuslaw Roads Analysis Report.

Figure 6 Hebo Watershed Analyses

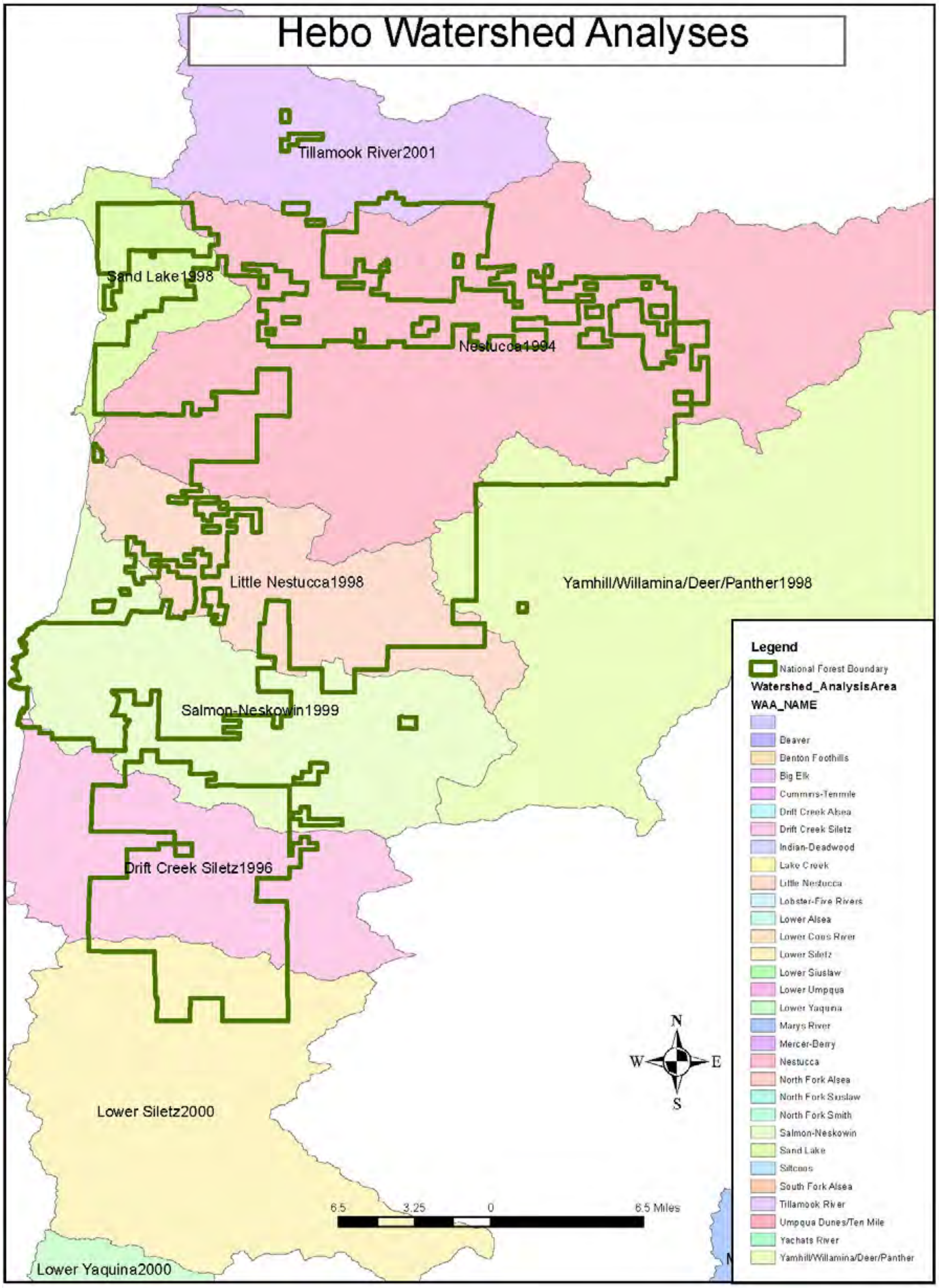


Figure 7 Central Coast Watershed Analyses

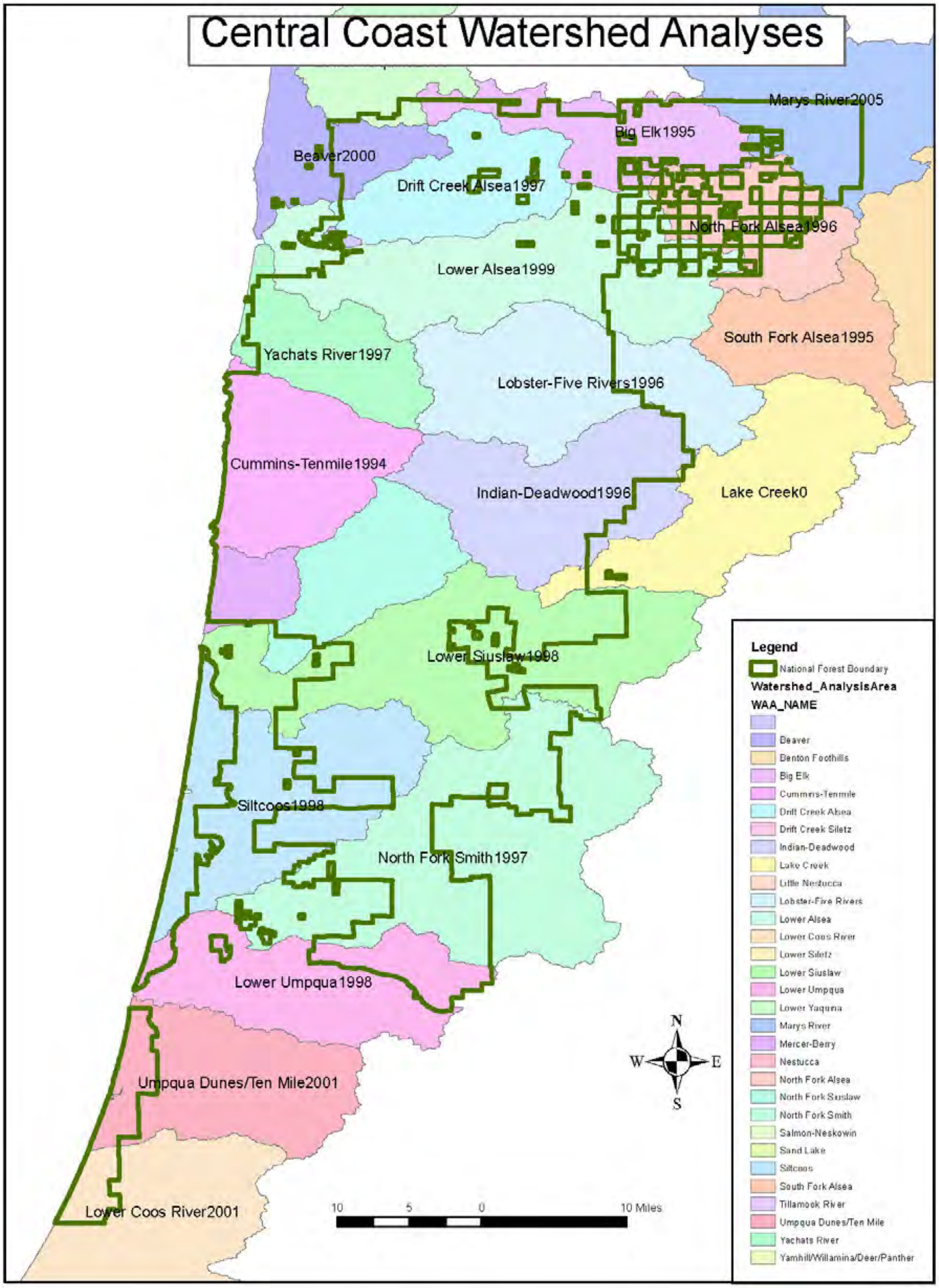


Figure 8 Hebo NEPA Analyses

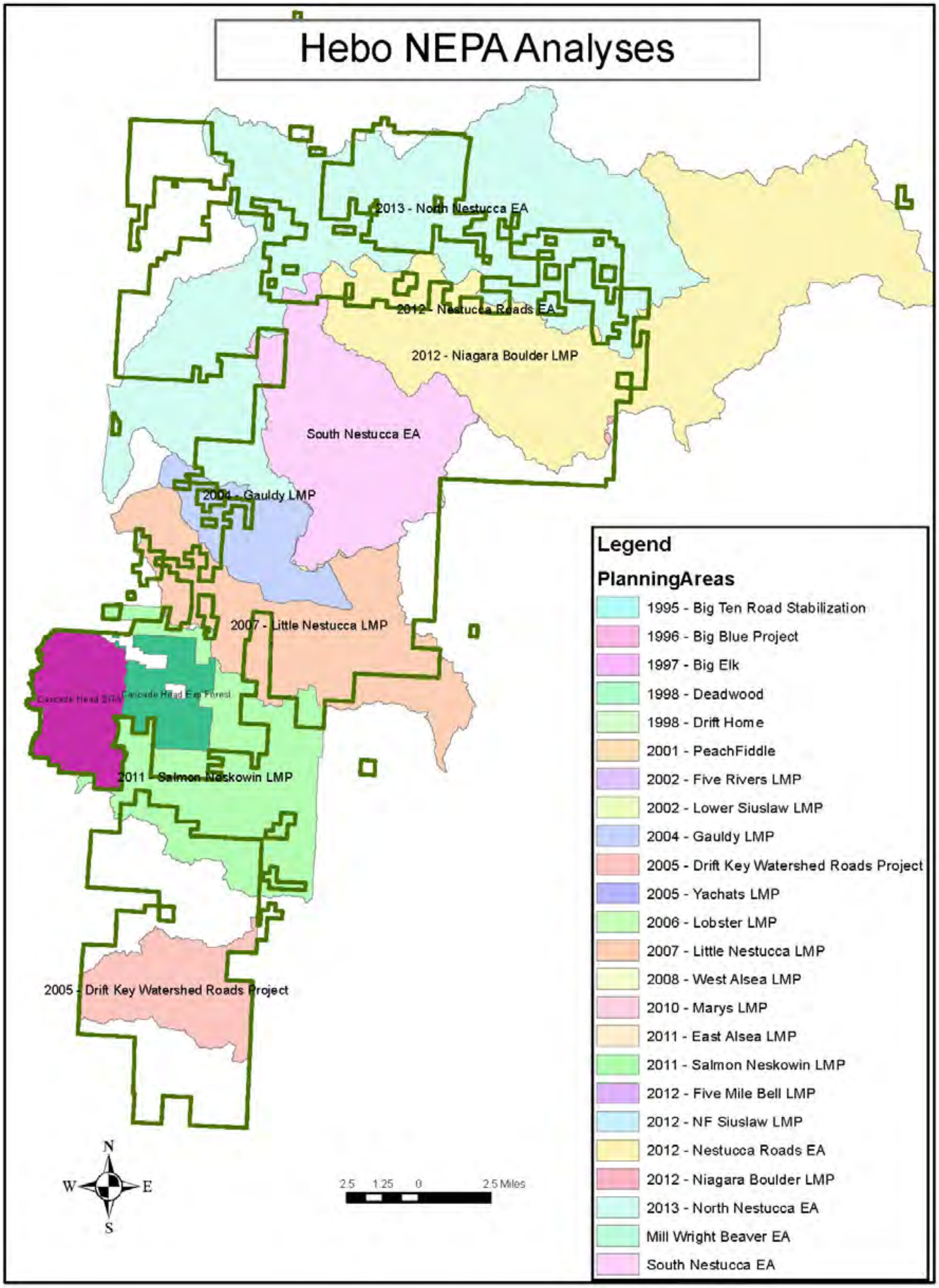
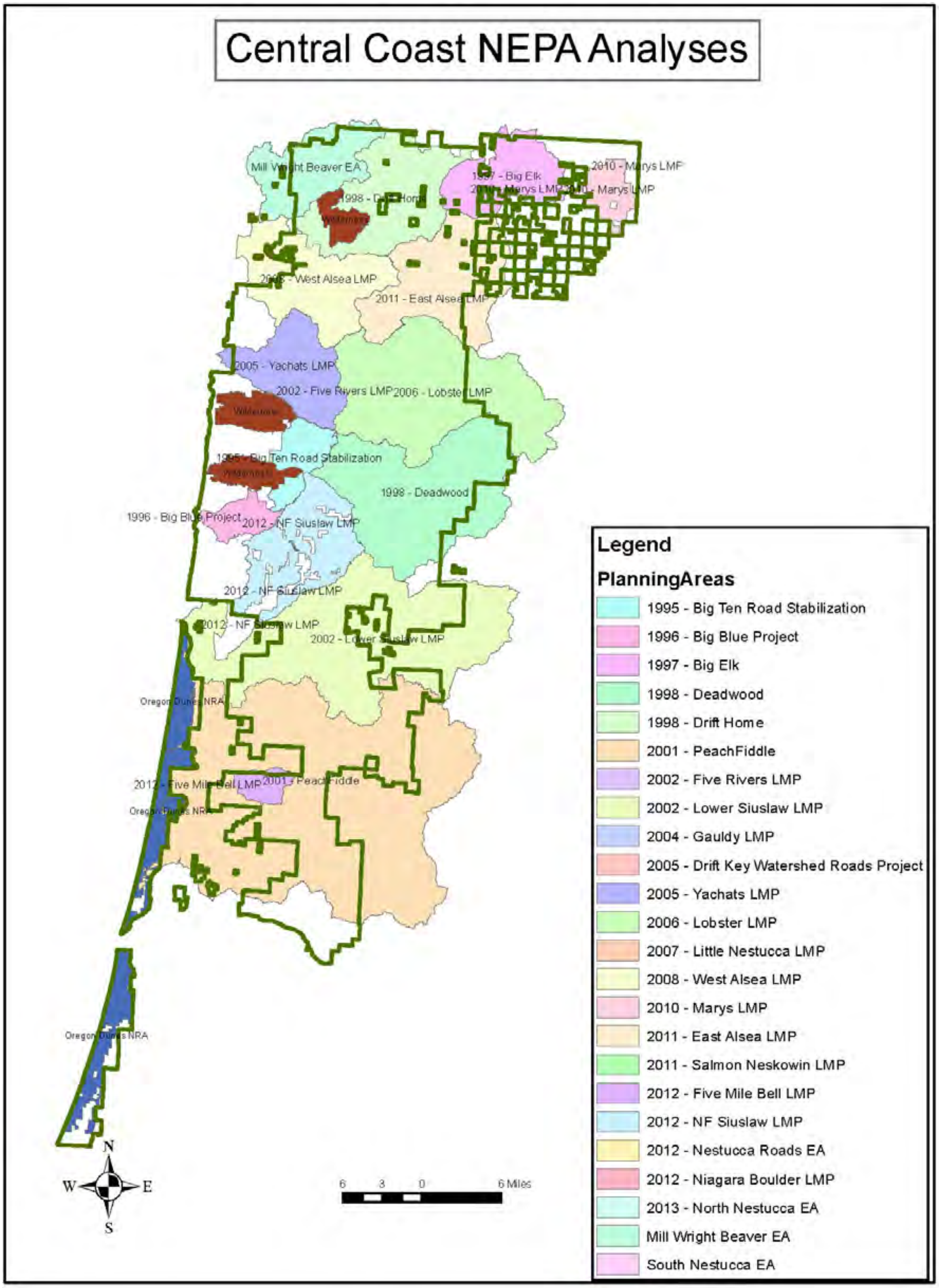


Figure 9 Central Coast NEPA Analyses



INFRA is the basis for calculating road mileage, both objective and operational. The objective is how the road is to be eventually maintained. It can be changed through a NEPA Decision. Operational is how the road is classified currently.

A 2013 snapshot of the Siuslaw System Roads reveals 609 miles of Key Roads and 1,534 miles of Non-Key Roads totaling 2,143 miles of System Roads. All Key Roads are open. Focusing on the Non-Key roads reveals that there are 1,072 miles of open Non-Key Roads and 462 miles of closed Non-Key Roads. The 1,072 miles of open Non-Key Roads have been further defined. See Figures 7 and 8.

There are 464 miles of Non-Key Roads that have been analyzed in a NEPA analysis to be closed (Maintenance Level 1) or decommissioned. About 365 miles of the 464 miles are to be closed (Maintenance Level 1). About 99 miles are to be decommissioned. Of these 99 miles to be decommissioned, currently 37 miles are closed (Maintenance Level 1). This leaves 427 miles of the 464 miles currently open. Most of the 365 miles planned for closure that are still open due to operating timber sales and will be closed when that work is completed. The 99 miles planned for decommissioning are generally waiting for funding for decommissioning. This funding has come from Legacy Road funds, Stewardship, or other funding sources.

There are 482 miles of open Non-Key roads that have been analyzed in a NEPA analysis and remain open for various reasons (Appendix E).

There are 232 miles of Non-Key Roads that have no NEPA analysis, but 70 miles of these roads are closed (Maintenance Level 1), leaving 162 miles open (Appendix F).

Table 2 displays the projected closure and decommission miles in the various stages of the process. First, some roads been entered into the objective side of INFRA and have had a NEPA Decisions to close or decommission, however pending or active timber sales need to be completed prior to the action taking place and moved into the operational side of INFRA. Also, funding may not be available at this time to complete the action. Second, a NEPA Decision is about to occur, but until it does, the projected work is not entered in INFRA. And third, project planning indicates that some future opportunities and again this projected work is not entered in INFRA.

Figure 10 Central Coast Ranger District Forest Roads

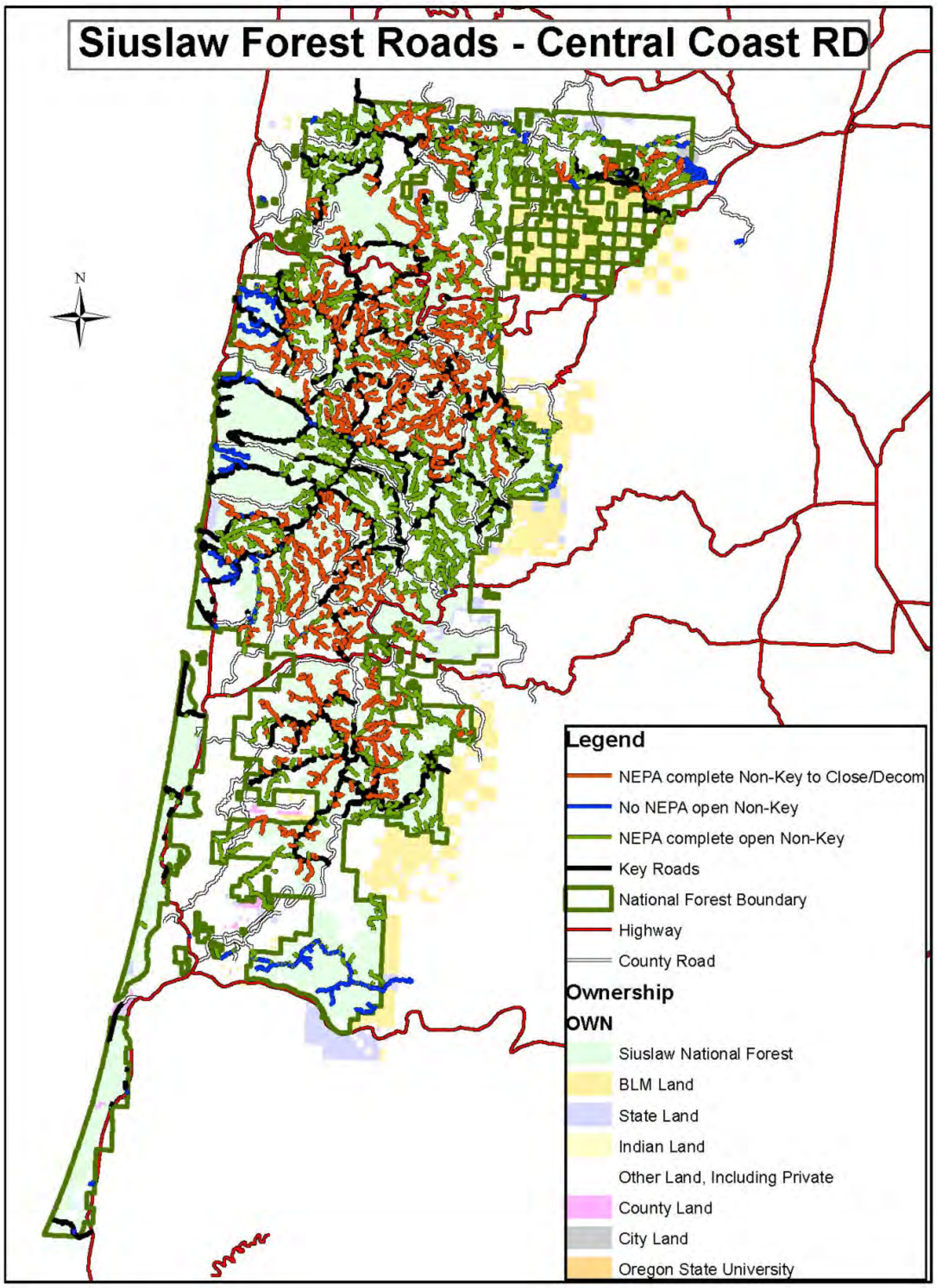


Figure 11 Hebo Ranger District Forest Roads

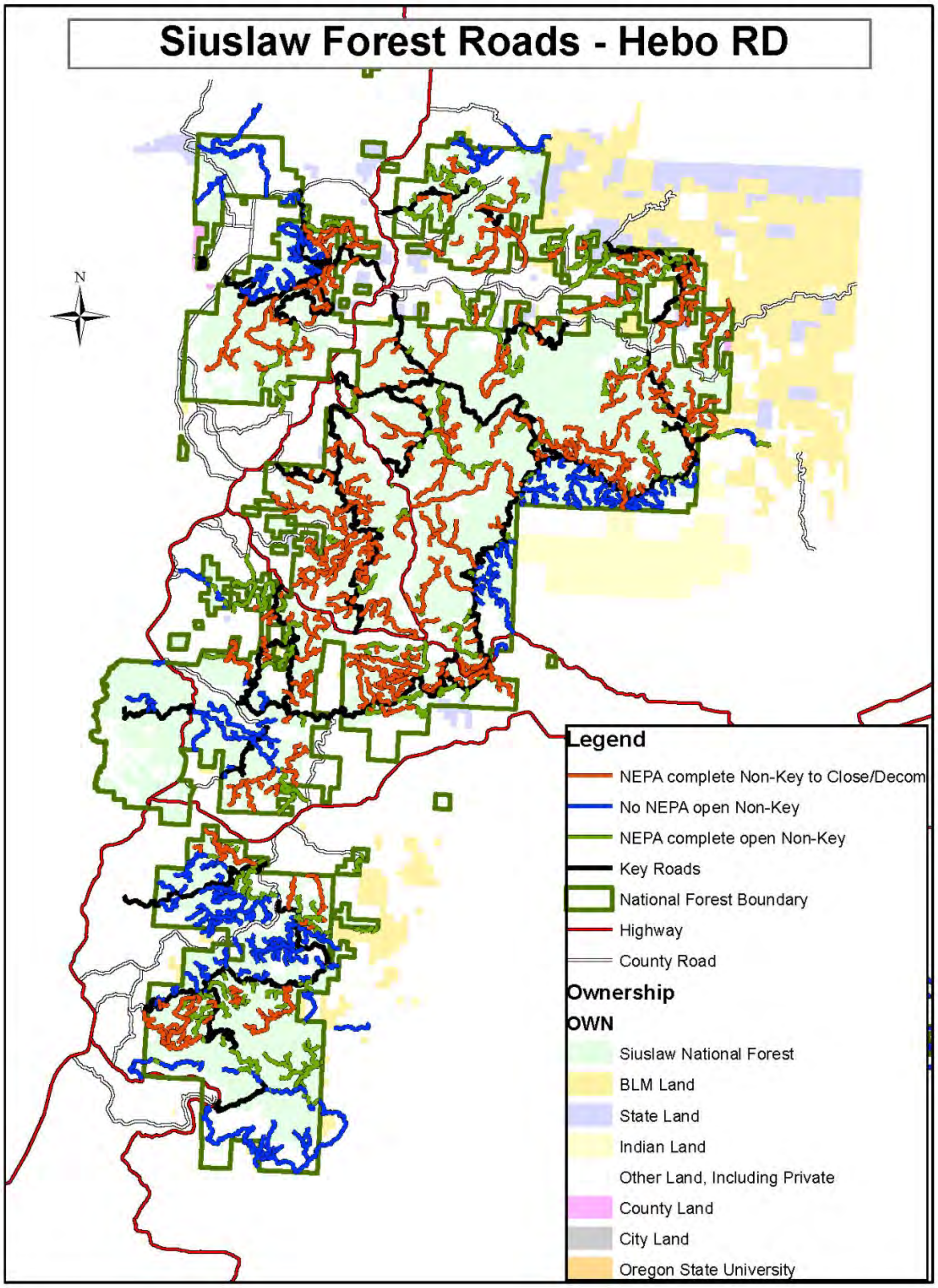


Table 2 - Projected closure and decommission miles, Various Stages of NEPA Process as of June 2013

Projection	ML1 Stored	Decommission
Decommissioning in NEPA decisions recorded in INFRA but not yet implemented (Pending Timber Sales and/or Funding)		99 miles. (37 miles currently in ML 1 Stored)
Maintenance Level 1 Storage in NEPA decisions recorded in INFRA but not yet implemented (Pending Timber Sales and/or Funding)	365 miles	
Maintenance Level 1 Storage with no NEPA decision recorded in INFRA but implemented.	70 miles	
Total Projected Decommission miles		99 miles
Total Projected ML1 Close/Store miles	365 miles	

Today, the Siuslaw National Forest is committed to terrestrial and aquatic restoration while considering the role, importance, and interdependency of all resources, including people. Following 2005 Travel Management rule, the Siuslaw National Forest designated roads, trails and areas that are open to motorized travel. The Forest's operating budget continues to decline impacting its ability to maintain an extensive road system. Therefore, Non-Key roads will continue to be closed until future access is needed (Maintenance Level 1) or if determined to be excess to the system or causing environmental damage may be removed from the system (decommissioned).

Ability of the Road System to meet Objectives

The Siuslaw National Forest envisions a less extensive road system. This system will allow travel across the Forest and provide reasonable access to major points of interest and resource management areas. To achieve such a system and meet management objectives, the Forest identified Key Forest Roads.

The process of selecting and managing the network of Key Forest Roads is designed to be fluid and adaptable over time. To achieve this, the selection criteria for Key Forest Roads should be reviewed, modified, and adapted on an “as needed” basis in response to changing budgets and Forest management goals and objectives. If this is done then it is anticipated that the network of Key Forest Roads will evolve and approach the minimum Forest transportation system that best serves current and anticipated management.

Figure 12 Typical “High clearance” Key Forest road

3. The Travel Analysis Model

The Siuslaw National Forest developed a draft travel analysis model in 2011 to evaluate road access needs, risk factors, and maintenance costs.

From the past 10 years of restoration activity planning and implementation, the Forest is in a position to project future road use needs and maintenance level costs. We have constructed an interactive model (using GIS; spreadsheet tools) to assess road use scenarios with road costs and risk to aquatic habitat thru the next 20 years. Once a watershed planning area entry schedule for thinning sales has been established and linked to the Road layer, the maintenance levels and costs can be projected through time and assessed with expected future funding. The southern portion of the Hebo ranger district was chosen to pilot the model.

Commercial thinning is a major terrestrial habitat activity which drives road access needs and provides revenue. Roads are a major source of aquatic impact. The objective of this analysis process is to display the tradeoffs of key aquatic risk factors with access needs and costs. Trade-offs can be assessed at the road segment, stand, watershed and Forest level.

Analysis Components

- Risk Factors (Figure 3)
- Roadbed slope position. Digital terrain model which classified the Forest terrain into three categories; valley bottom, mid-slope and ridge-top. (Figures 13 and 14)
- Live stream culvert data was used from the 2001 culvert inventory.
- Fill volume
- Culvert size
- Torrent Routing Risk model was used from the Coastal Landscape Analysis and Modeling Study (CLAMS)
- Cost Factors (Tables 5 and 6)

Risk Analysis

Several factors have been selected as contributing to the probability that any given road segment will fail. The factors considered in this analysis are listed below. Intrinsic factors in the landscape (those that can't be changed through management activities) are slope position and debris torrent potential in stream channels. The other factors regarding culverts and maintenance level are subject to change.

Slope position of the road:

- Roads located at the top of the ridge: In general, roads located on the ridge are the least likely to fail. Usually the road doesn't cross streams, and there is no cut slope above the road.

- Mid-slope roads: These road segments have the higher risk because there are usually multiple stream crossings with steeper stream gradients.
- Valley bottom roads: These road segments are considered to have moderate risk due to possible proximity to the mainstem stream. They are more prone to flooding, and may cross tributaries.

Debris torrent potential mapping:

Mapping done for the CLAMS project by Lee Benda and Dan Miller identified the relative potential risk of debris torrents for stream segments in the Coast Range. This mapping was incorporated into the road risk analysis.

Stream crossing culvert factors in the risk analysis:

- For stream-crossing culverts, the culvert width relative to the bankful width of the stream: The ratio of the culvert width to the stream width is an indicator of the risk that the culvert will plug up with debris. If a culvert is plugged during a storm event, the fill material could saturate and fail; or the streamflow may be diverted down the ditchline until the water encounters a low spot in the road and flows over the fillslope, possibly creating a landslide and a new stream channel location.
- The amount of fill material over the culvert at the stream crossing. The more fill material, the larger the debris torrent is likely to be.

Road maintenance level: It is assumed that roads that receive a minimum of maintenance are more likely to fail due to plugged culverts, etc. Roads that receive high maintenance are less likely to fail.

Table 3 - The following values were assigned for relative risk for each factor:

Ratio of Culvert diameter to stream width	Fill volume over culvert at road/stream crossing	Slope position of road	Debris torrent potential value	Road maintenance level	RISK LEVEL
less than .5	greater than 6000 cubic yards	midslope roads	0.07 to .876834	low maintenance (level 2 maintenance)	High (3 points)
.5 to .75	1000 to 6000 cubic yards	valley bottom roads	0.024 to 0.070	Moderate levels of maintenance (Levels 3 through 5 maintenance)	Moderate (2 points)
greater than .75	less than 1000 cubic yards	ridgetop roads	0 to 0.024	Closed or decommissioned or stored roads (level 1 maintenance)	Low (1 point)

For each road segment, if there was one stream crossing with a high risk value, the entire segment was rated as “high” for that factor. For example, if there was one culvert with a fill volume over 6000 cubic yards, the entire road segment was rated as “high” for fill volume risk.

The highest risk score a road segment could get is 15. The road was given a risk rating of:

- High risk - Score of 11 to 15:
- Moderate risk - Score of 6 to 10:
- Low risk - Score of 0 to 5:

Table 4 - An example of the risk table produced for the road layer in GIS

Road segment	**Ratio of Culvert diameter to stream width**	**Fill volume over culvert at road/stream crossing**	**Slope position of road**	**Debris torrent potential value**	**Road maintenance level**	Risk Score
Identified segment	3	2	3	1	3	12 (high)
Identified segment	2	1	2	2	1	8 (moderate)

Based on this table, a color-coded map of the road layer and relative risk of failure can be produced.

Cost Factors

Several Cost Factors were used in the model and are described below.

Physical road characteristics

Surface type (Aggregate, Paved).

Slope position (ridge top, mid slope, valley bottom). Road segment slope position was determined by overlaying the Forest Road coverage over the digital terrain model which classified the Forest terrain into the three categories; valley bottom, mid-slope and ridge-top.

Minimum road network status – Key roads (roads remaining open for a variety of reasons other than a specific project). Non Key roads – open and maintained only for specific projects (In most cases commercial thinning haul) or specific administrative sites.

Prescribed maintenance levels – Key roads will be maintained continuously at the prescribed (INFRA) maintenance level (levels 2 to 5 – see definition). Non-key roads have prescribed open maintenance levels usually level 2 and a prescribed inactive maintenance objective, either stored (level 1) or decommissioned.

Annualized road maintenance costs are calculated using recent Indefinite Delivery Indefinite Quantity (IDIQ) contract bid costs by maintenance item annualized by intervals of the maintenance item. For example, road brushing would be done more often on a maintenance level 3 to 5 mid slope road than on a maintenance level 2 ridge top road due to differences in both brush growth and maintenance level standards.

Costs for decommissioning or placing a road in maintenance level 1 storage are based on the most recent multi-forest IDIQ task order bids. Costs for reopening a maintenance level 1 stored road are based on recent examples of maintenance items in timber sales.

It should be noted the routine maintenance costs and storage/decommission costs are at lower levels than similar work done 3 to 5 years in the past and may not reflect future costs. The costs are the best estimate for current price expectations.

Key road costs are generally higher due to differences in maintenance levels. For example, a level 3 to 5 gravel road would be bladed more often than a level 2 since the level 3 to 5 roads are maintained for passenger cars (low clearance) while level two roads are maintained for pick up (high clearance) vehicles.

Replacement costs for ditch relief and live stream culverts vary for a number of reasons, the depth and volume of fill material over culverts is the primary cost.

Estimated per mile costs for ditch relief culvert replacements on key road is often lower than similar costs on non key roads due to the policy of prioritizing maintenance and reconstruction to the key road system. Over the past decade, a higher portion of ditch relief culverts have been replaced on key roads than non key roads. Maintenance and reconstruction funds are prioritized to roads getting the higher levels of traffic and roads with higher maintenance level standards. The primary criterion for road decommissioning is based on the need for a road for access. If a road is not needed for continued or predicted future use the road is either decommissioned or converted to another use. The other factor considered is whether the road is causing resource damage. For roads determined to have actual or potential resource impacts, either a process to mitigate the impacts is initiated or an alternative access route is found and the road is proposed for decommissioning. Roads that are determined as needed for future access but not needed for access for more than one year can be stored as maintenance level 1 roads.

Figure 13 Risk Analysis Map (zoomed in)

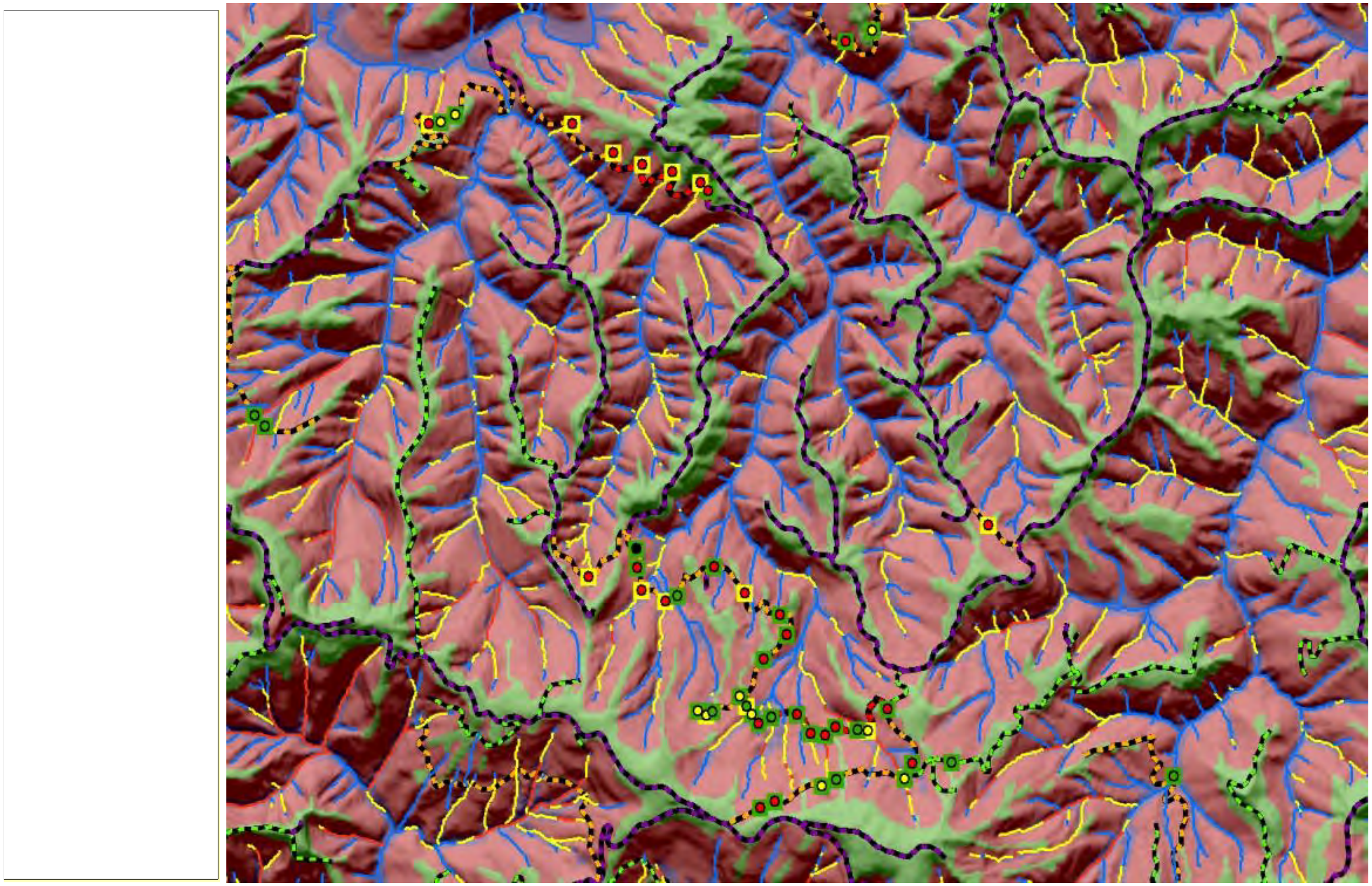
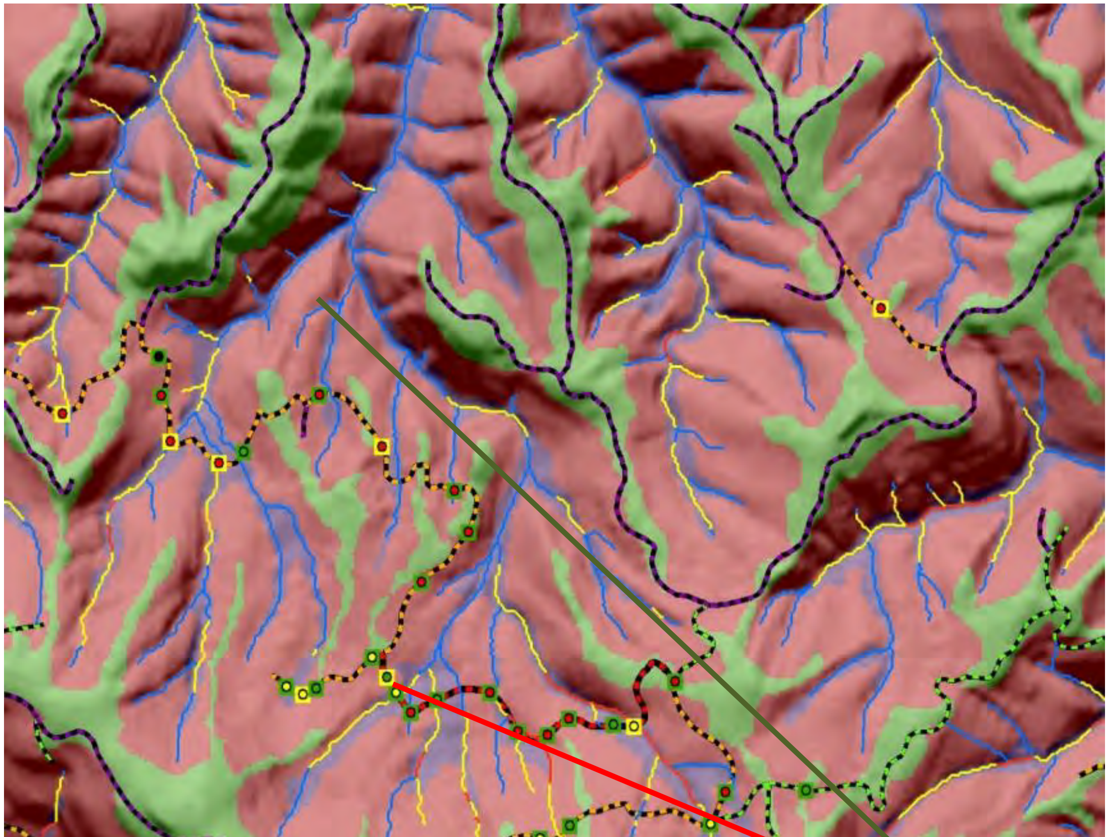


Figure 14 Risk Analysis example



Culvert Size Risk	Fill Volume Risk	Slope Risk	Debris Torrent Risk	Mtc Level Risk	Total Risk Score	Total Road Risk
3	2	3	3	3	14	High
0	0	1	0	3	4	Low

Table 5 and 6 below summarize the costs for routine maintenance (Table 5) and the costs for road activities – storage and decommissioning (Table 6). Table 5 breaks out the costs by location on the slope (ridgetop, mid-slope, valley bottom), road type and maintenance level. The table shows that Maintenance Level (ML) 1 roads – regardless of where they are located, have the lowest maintenance cost per mile. ML 3-5 roads that have an aggregate surface that are located mid-slope have the highest annual maintenance cost ($6,352 per mile per year) This is because steeper side slopes result in more sloughs, slides and fill failures.

Table 6 summarizes the costs for storage and decommissioning work for various options. The table indicates that decommissioning costs located along valley bottoms have the greatest cost per mile. This is because there are more streams intersecting valley bottom roads and the streams that intersect the valley bottom roads are larger resulting in larger culvert s and possibly larger fill volume. One time storage costs (from ML2 to ML1) are the lowest when no culverts need to be removed, but there is an additional annual maintenance cost for storage and an opening cost (from ML1 to ML2).

- Costs are annualized per mile costs for routine maintenance and ditch relief culvert replacement only, no costs included for major repairs or resurfacing.
- Routine maintenance includes brushing, blading, ditch and culvert cleaning, spot rock or pavement cleaning on varying cycles depending on maintenance item.
- Closed road costs assume inspection on foot to monitor for resource damage and road stability, replacement or refresh on barricades at a 5 year interval.
- Costs are based on recent Indefinite Delivery Indefinite Quantity (IDIQ) road maintenance contract prices for Siuslaw National Forest road maintenance.
- Costs current as of December 13, 2011.
- Ditch relief culverts calculated on 20 year replacement schedule using estimated pipes per mile and estimated recent replaced in prior 10 to 20 years.

Table 5 - Annualized routine maintenance costs

Road Type	**Routine Maintenance** **(Brushing, surfacing, blading)**	**Ditch Relief Culvert replacements**	**Total annual costs**
Ridgetop			
ML0 (decom) [0]	$0	$0	$0
ML1	$95	$0	$95
ML2 Project Asph	$323	$750	$1,073
ML2 Project Agg	$773	$450	$1,223

Road Type	Routine Maintenance (Brushing, surfacing, blading)	Ditch Relief Culvert replacements	Total annual costs
ML2 Key Asph	$765	$600	$1,365
ML2 Key Agg	$1,800	$360	$2,160
ML 3 to 5 Key Asph	$2,371	$375	$2,746
ML 3 to 5 Key Agg	$5,421	$225	$5,646
Mid Slope			
ML0 (decom) [0]	$0	$0	$0
ML1	$95	$0	$95
ML2 Project Asph	$393	$1,688	$2,081
ML2 Project Agg	$843	$1,012	$1,855
ML2 Key Asph	$859	$1,350	$2,209
ML2 Key Agg	$1,684	$810	$2,494
ML 3 to 5 Key Asph	$2,592	$844	$3,436
ML 3 to 5 Key Agg	$5,846	$506	$6,352
Valley Bottom			
ML0 (decom) [0]	$0	$0	$0
ML1	$95	$0	$95
ML2 Project Asph	$393	$1,031	$1,424
ML2 Project Agg	$773	$619	$1,392
ML2 Key Asph	$859	$825	$1,684
ML2 Key Agg	$1,684	$495	$2,179
ML 3 to 5 Key Asph	$2,592	$515	$3,107

Road Type	Routine Maintenance (Brushing, surfacing, blading)	Ditch Relief Culvert replacements	Total annual costs
ML 3 to 5 Key Agg	$5,846	$309	$6,155

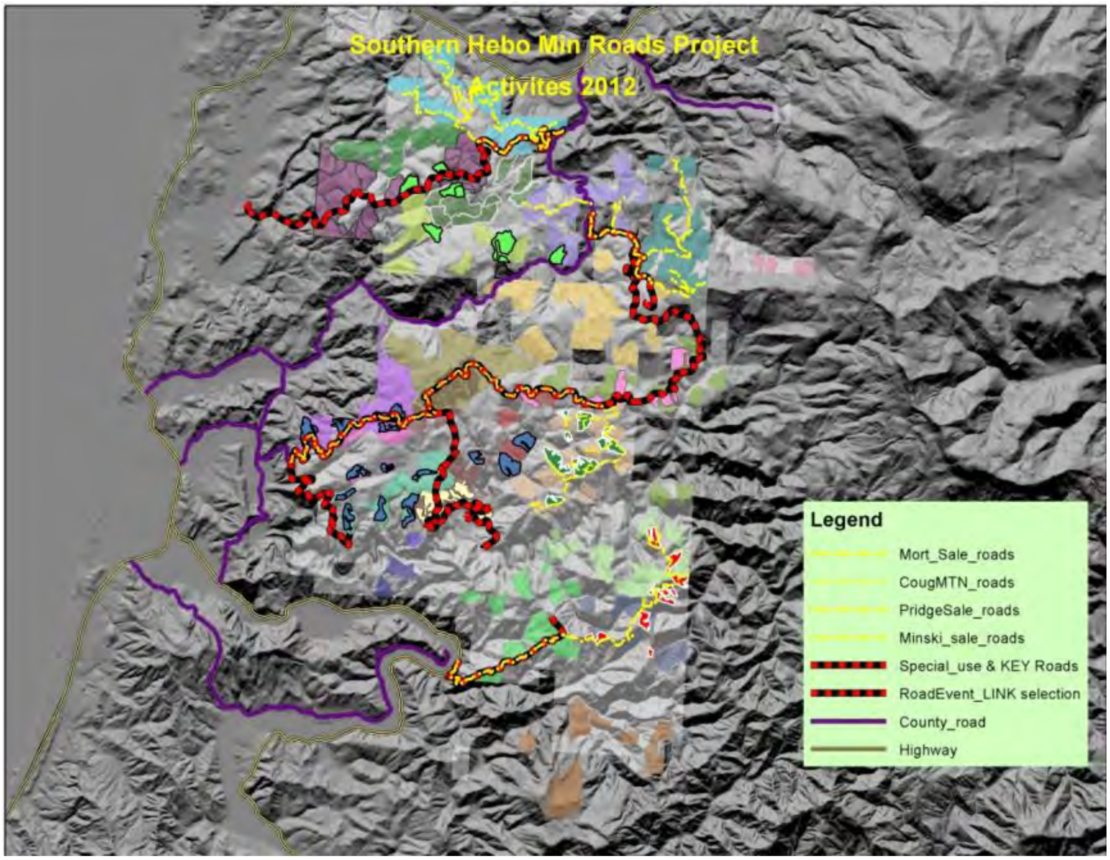
Table 6 - Storage and decommission Cost Summary

Road Activity	Valley Bottom	Mid Slope	Ridge Top
ML 2 to ML1 (to store costs), Assumes no culvert removals	$950/mile	$950/mile	$950/mile
ML 2 to ML 1 (to store costs) with ditch relief and live stream pipes removed	$950/mi Plus $1950 per Live Stream Pipe	$950/mi Plus $1950 per Live Stream Pipe	$950/mi Plus $1950 per Live Stream Pipe
ML1 to ML2 (From Store Cost)	$4390/mile	$5085/mile	$3445/mile
Decommission Costs	$22,700/mile	$16,530/Mile	$4650/mile
ML 1 Storage costs	$95/mile/year	$95/mile/year	$95/mile/year

Model results

The model was run for the southern portion of the Hebo Ranger District. The south Hebo area was selected for the analysis because it contained an isolated section of forest roads which would not be affected by adjacent forest access needs. This area was also considered representative of road access needs throughout time for the Forest.

Figure 15 Travel Analysis model for southern portion of Hebo Ranger District.



The Roads cost analysis program uses a proposed thinning entry schedule to identify road use needs over time. A road use schedule is associated with each road segment.

The program has 2 interactive maintenance options for non-key roads.

A minimum year value between road use needs to determine if the road segment will be put in storage or maintained/maintained deferred between needs.

Years of deferred maintenance before next activity. This allows the user to simulate deferring maintenance a selected number of years before an activity, anticipating the activity will provide revenue for maintenance. For example the user may select to defer maintenance 4 years on less risky ridge top roads and 0 to 2 years on midslope roads.

The program is presently set to calculate a 20 year time table for a maintenance schedule and associated costs. Road segment activity status and associated costs for each road segment and values are calculated for all Forest Service roads in the designated analysis area. The data can then be linked to GIS roads coverage to be used for a variety of spatially explicit analysis, or used in a tabular format for analysis in a spreadsheet or database program. Figure 7 shows a typical road segment moving from Maintenance Level 2, to deferred maintenance, to Maintenance Level 2 during a timber sale, to maintenance Level 1 at the completion of the timber sale activities.

Figure 16 Sample road use and maintenance schedule and costs

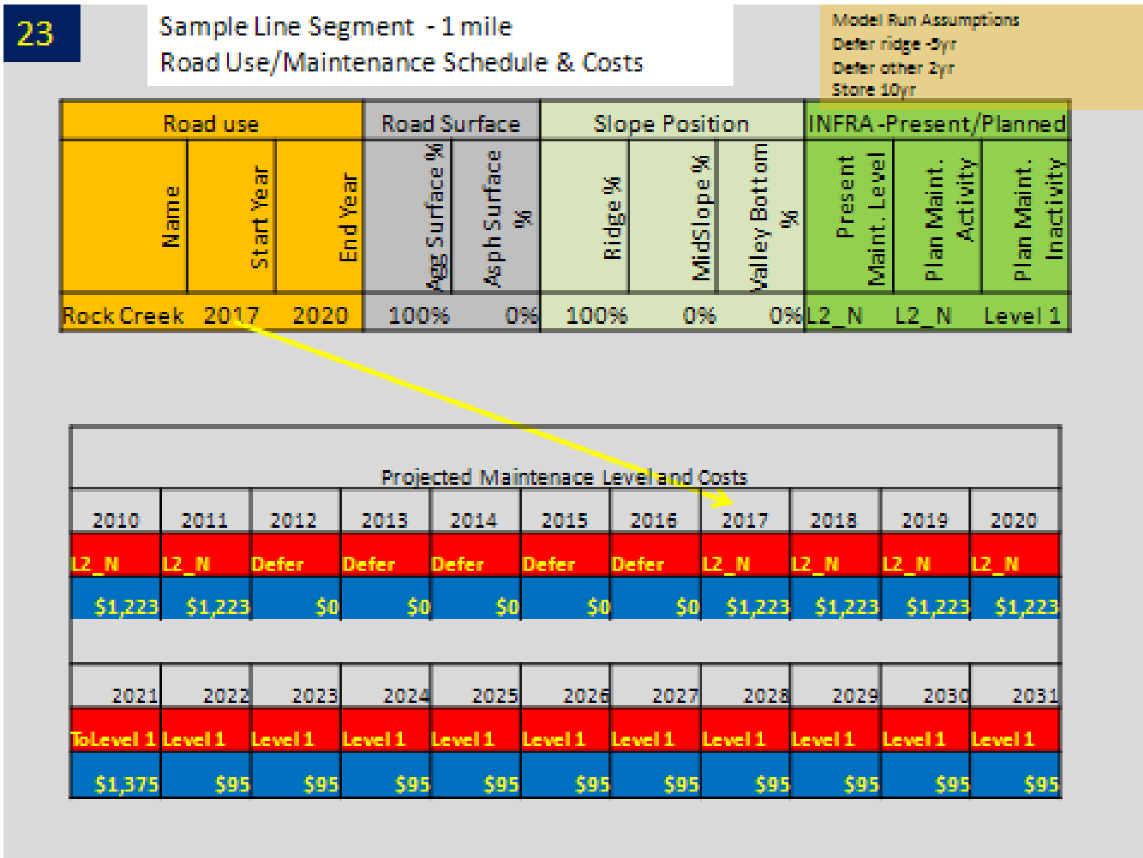


Figure 8 displays the annual maintenance costs for the southern portion of the Hebo District example. The Key Roads (indicated by L2_Y and Level 3-5) show a constant predictable maintenance cost. The maintenance Level 2 (indicated by L2_N) road maintenance costs fluctuate over time as timber sales utilize the roads and close them following the timber sale and enhancement activities.

There are several reasons why roads were moved from open Maintenance Level 2 to closed Maintenance level 1 instead of decommissioning following the initial timber sale. First, some stands on the roads may be too young for commercial thinning at the time of the initial entry. Therefore, the road would be used again for treating those stands. Second, it was not determined at this stage whether a second entry to thin the stands would be necessary to meet resource needs.

If the road is excess to the needs of the Forest or causing resource damage the Interdisciplinary Team can use this information to inform the Line Officer when making road management decisions.

Figure 17 Model generated annual maintenance costs for southern portion of Hebo Ranger District

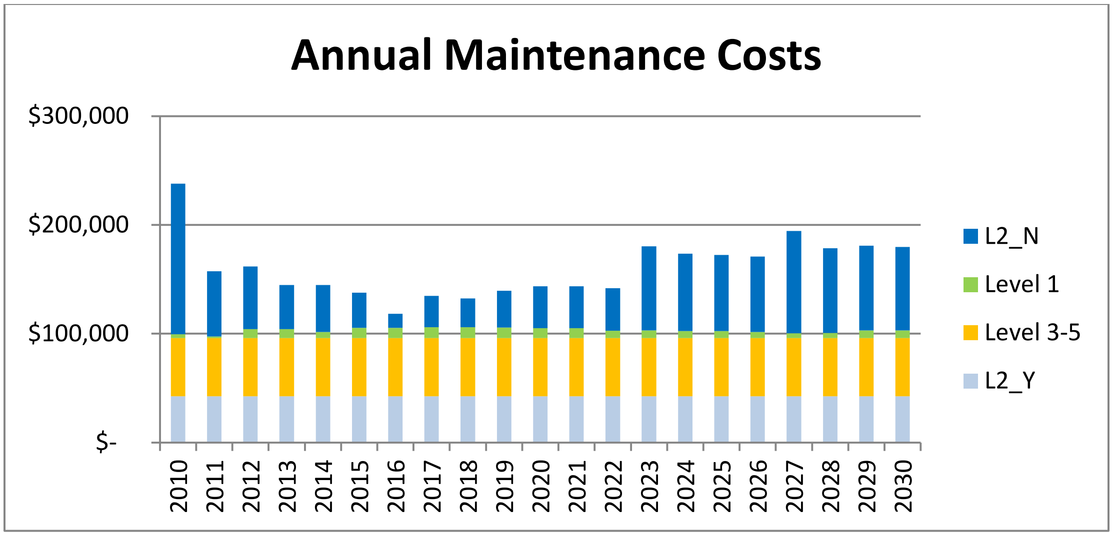
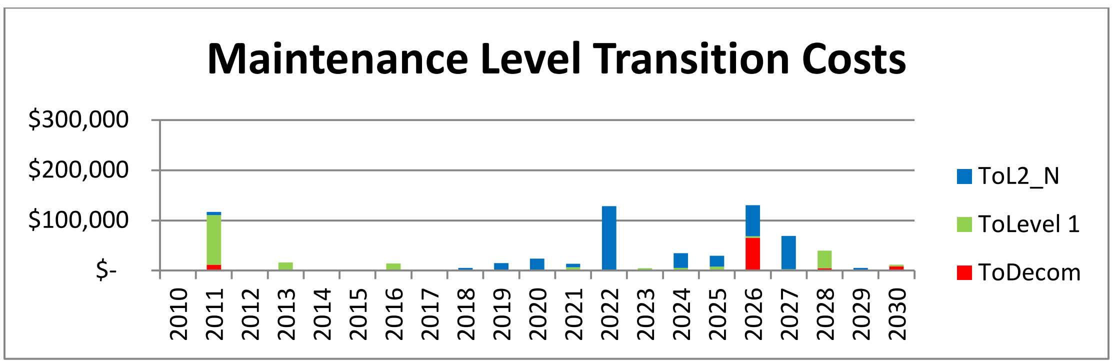


Figure 9 displays the maintenance level transition costs when roads move from open Maintenance Level 2 roads to closed Maintenance Level 1 roads when timber sales are completed and vice versa when timber sales are initiated. In some cases roads that may be determined to be excess to the needs of the Forest could be decommissioned. For example, Figure 9 shows that in the year 2026, there could be approximately $50,000 in cost to transition some roads to decommissioned status. This is because planned vegetation management would be completed.

Figure 18 Maintenance level transition costs for southern portion of Hebo Ranger District



4. Issues

In 2003 an interdisciplinary team used the Forest Service publication *Roads Analysis: Informing Decisions About Managing the National Forest Transportation System* (USDA 1999). The team followed the six-step process outlined in this document and used its list of 71 Ecologic, Economic and Social considerations in order to identify issues specific to the Siuslaw. The team found that many of the suggested road issues are best addressed at the watershed or project scale rather than the Forest scale. Other issues were not found to be important in making road decisions pertinent to the Siuslaw. The Team's responses to those considerations are listed in Appendix A. In all, eight issues were found to be important for informing road decisions on the Siuslaw:

Economics – Low maintenance funding affects our ability to maintain key access routes.

Community Impact – People depend on Forest roads for safe travel and Forest access.

Aquatics and Water Quality – Roads influence hydrologic function and stream dynamics.

Fisheries – Roads affect fish habitat and fish passage.

Terrestrial Wildlife – Roads affect wildlife through habitat fragmentation and disturbance.

Vegetation Management – In the short-term road access is critical for restoring desired forest characteristics.

Noxious Weeds – Roads and people can increase the spread of noxious weeds.

Wildfires and Fire Suppression – Roads influence both wildfire occurrence and suppression strategies.

Each issue has a discussion of the current situation, risks and benefits, desired future conditions, and recommendations. Recommendations concerning all issues are summarized in Chapter 5, 5. Key Recommendations. In addition, the analysis includes a map of the current Key Road system and lists roads and maintenance objectives for the rest of the system in Appendix C.

Economic Issues

- **Road Maintenance funding is not adequate to maintain the current Forest Service road system to standard (i.e., all Forest roads).**

- **Future funding trends indicate that Road Maintenance funding may not be adequate to maintain the *Key Forest Routes* to standard. The Key Forest Routes/Roads (identified as *primary* and *secondary* in the Siuslaw Access and Travel Management [ATM] Guide) are believed to represent the minimum road system needed for public and administrative access.**

Current Situation

During the early 1990s, reductions in timber harvest and corresponding reductions in maintenance and repair budgets associated with timber sales highlighted the need to reduce overall miles of maintained roads. It was apparent from an economic standpoint that projected budgets for maintenance and needed repairs of the Forest road network would not meet the needs of the extensive road system. In addition, as management direction changed from an emphasis on timber commodity production to protection and restoration of wildlife and fish habitat, the Forest recognized that the existing road system would quickly become a liability to resources if not properly maintained.

Much of the Forest road budget in the 1980's came from Congressionally allocated budgets which were often associated with the timber program but a large portion also came from cooperative deposits associated with timber sales. By the early 1990s the allocated and cooperative funds were reduced by about 75% of previous budget totals for road maintenance. The reduction in timber sales also caused an almost immediate halt in new road construction and reduced the ability to use timber-generated funds for reconstruction and repair of the existing system. This trend of reduced timber funding opportunities and redirection of management priorities led to the initial strategy of Key Road selection implemented by the ATM guide in 1994. The appropriated budgets in subsequent years have continued to decline leading to reduced maintenance and a need to prioritize the distribution of available maintenance funds to the Key Road system.

In recognition of the potential resource damage inherent in a poorly maintained road system given the high precipitation in Oregon's coastal mountains, roads not selected as part of the Key Road system were stabilized by constructing fairly deep diagonal water bars across the road surface, thus allowing water to drain off the roads when culverts eventually plugged due to lack of maintenance. In most cases those roads that were not regularly driven by high clearance vehicles became overgrown with brush and down trees in less than five years due to the rapid growth of vegetation and regular windstorms common in the Coast Range. It was expected the stabilized roads would be resistant to washouts and fill failures since the waterbars were designed to remove water from the road surface regardless of rainfall intensity.

This strategy was tested by the winter storms of 1996 and 1997 that caused extensive damage to the Key Road system with almost no effect on the waterbarred, stabilized roads. About half the damage to Key Roads resulted from overflowing culverts and flooded streams washing out road segments and damaging road surfaces; the other half from slumps and fill failures.

This is partly due to the difference between most Key Roads and those that sustained little damage. The majority of waterbarred and stabilized roads are fairly short dead-end spurs accessing timber harvest units and project sites while the Key Road system is mostly comprised of older roads that were in place prior to 1970. Many of the Key Roads are valley bottom and mid-slope roads with high numbers of stream crossings and culverts. Key Roads are also more costly to maintain since they are more difficult to stabilize, more prone to winter storm damage, and more traveled by both public and forest management traffic. The existing road system is a combination of Key Roads that receive prioritized maintenance and stabilized roads that are not regularly maintained.

The 2003 Roads Analysis indicated that only about 22 percent of the Key Roads could be maintained with the expected maintenance funds (CMRD). Inspecting the Key Road system essentially 10 years later, we found the Key Road system in better shape. How was that possible? The 2014 evaluation reveals the other sources of road maintenance dollars that made this possible. These include timber sales, legacy funding (CMLG), stewardship, Emergency Relief for Federally Owned Roads, road use permits, Secure Rural Schools, and road maintenance funds (CMRD). As portrayed in Figure 10, these funding sources fluctuate over the years and in the future some may be eliminated and others may appear. Following the recommendations in the 2003 Roads Analysis, road maintenance and repairs were prioritized to the key road system leading to the current improved conditions of those roads.

An internal paper written for the Siuslaw National Forest (Ellis-Sugai, 2012) to compare and evaluate the 1996 and 2012 large winter storms to determine whether the road treatments, e.g.. waterbarring, decommissioning, culvert replacement, and ditch cleanout were effective was prepared. Following the 1996 event, 140 slides were classified as associated with roads. Following the 2012 flood event only 12 slides were found. The precipitation amounts during the 90-day period to the peak of the flood events were greater in the Coast Range in 1996 than in 2012. Soil saturation amounts were probably higher when the February 1996 storm occurred, which could have been a factor in the greater number of slides that were documented during the 1996 flood event, as compared to 2012. For both events, roads that had been ‘storm-proofed’, e.g. drainage improved by installing waterbars, replacing culverts, grading the roads, and/or cleaning ditches and culvert inlets, had fewer landslides than roads that had not received attention.

Figure 19 Road maintenance funding comparison.

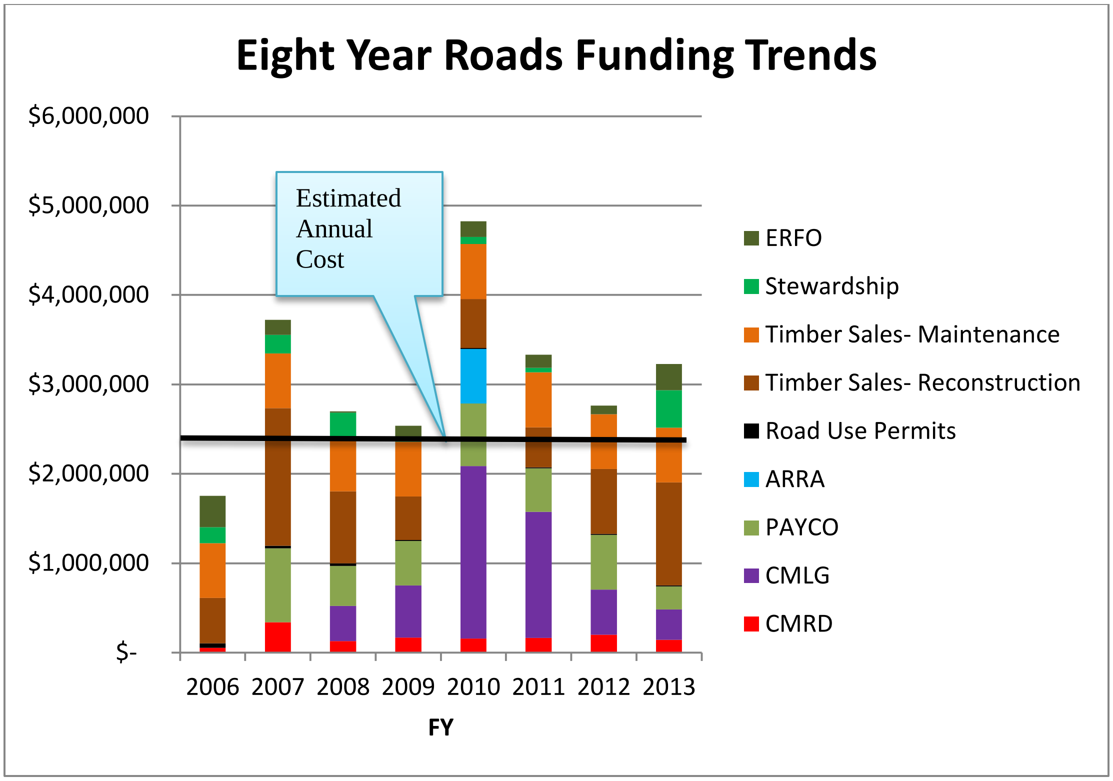


Figure 10 displays several years of the different sources of funds used to maintain roads on the Forest. Table 5, below, utilizes the estimated maintenance costs from the southern portion of the Hebo Ranger District and extrapolating that to the Forest. It is estimated that about $2.3 million are needed for road maintenance each year for the current road system (shown by the solid line in Figure 10). The costs are described in greater detail in Section 3.

Table 5. Estimating Forest Roads from South Hebo Analysis Area

Area	Total Road Miles	Percent of Total	Estimated Annual Cost
South Hebo	180	8.4%	$191,821
Forest	2143	100%	$2,283,736

Figure 20 "Low clearance" Key Forest Road

Risks and Benefits

Potential risks associated with reduced or limited road maintenance are decreased user safety and increased resource damage. Smaller routine maintenance budgets result in less road brushing, surface maintenance and signing, which decrease visibility, driving comfort and directional information. Less ditch line and culvert cleaning increases the likelihood of water damage to road surfaces and increased sedimentation into aquatic systems. Deferred maintenance on road segments that have deteriorated over time contributes to unsafe use of the roads and potential for catastrophic damage resulting from storm events.

The benefit of prioritizing limited maintenance funding is that available funds can be used on the areas of highest public road use and locations that have a higher risk of road system and environmental damage. Documenting maintenance shortfalls and inventorying long-term needs helps prioritize projects where needs exceed funding sources.

Desired Future Condition

A minimum Forest transportation system that safely and efficiently serves current and anticipated management objectives and public uses.

A balance of routine and deferred maintenance funding maintains this system, which meets public uses and resource protection objectives.

Available funding is primarily allocated to the Key Road system. Roads not a part of the Key Road system are maintained by project-associated funds commensurate with project use.

Recommendations

Use the Key Road system as basis for making site-specific road management decisions. If needed, adjust the system to meet changing needs and conditions over time.

Annually inventory annual and deferred maintenance needs of the Key Forest Road system. Prioritize road maintenance work to ensure resource protection and user safety within current and anticipated Forest budgets.

Consider alternative funding sources for road maintenance and repair. Examples include:

Internal funding programs to supplement maintenance budgets in order to meet minimum maintenance standards.

Cooperative agency funding and grants for improvements to the Key Road system resulting in improvements to fish and aquatic habitat.

Partnerships with other road management agencies, local communities and user groups.

Special Use and Road Use Permits for the maintenance of project roads during periods of use by non-Forest Service users. Permits identify maintenance to be performed by permittees commensurate with use.

Access and Community Impact Issues

- **The current Forest road system provides access to public lands but funding has not kept pace with maintenance needs.**

- **Local communities and businesses may depend on Forest roads as alternate access routes between rural communities and emergency evacuation routes.**

- **People and communities who depend on Forest roads will be affected as access to many areas of the Forest becomes limited. Creative ways to reduce costs and maintain roads should be developed.**

Current Situation

Community impacts in relation to declining maintenance funding and reduced open road access were addressed in the Siuslaw National Forest Access and Travel Management analysis in 1994 (see Appendix B). The analysis developed a process for identifying a network of **Key Forest Roads** as a means of reducing costs and applying limited funds to roads most vital to communities and long-term management of the Forest.

The question to be answered in relation to the issue of community impact is:

Can the process for identifying, maintaining, and managing the network of Key Forest Roads in the 1994 Access and Travel Management Guide and the 2003 Roads Analysis be brought forward as a key result of the 2014 Travel Analysis?

Figure 21 High clearance" Key Forest Road

The 1994 Access and Travel Management analysis included extensive public involvement that resulted in contacts with the general public and local communities, as well as state, county, and local road agencies. The information, concerns, and access needs collected from this effort were analyzed and are incorporated into the process of selecting and managing the network of Key Forest Roads. This process is based on categorizing each national forest system road into one of three categories:

Key Primary Roads

Primary roads are to be kept open and are first priority for maintenance funding. These roads are typically maintained to safely accommodate passenger cars.

Key Secondary Roads

Secondary roads make a direct single connection to management areas outside the reach of primary routes. These roads are typically managed at a lower maintenance standard than a primary road.

Non-Key Roads

These roads will be considered for lower maintenance standards, restricted access, closure, or decommissioning during watershed or project level analysis.

The Access and Travel Management analysis recognized that people and local communities depend on some Forest roads more than others. The primary and secondary selection criteria were developed as a means to identify and prioritize maintenance for roads vital to local communities. These are the priority roads that connect public roads, provide access to communities, connect land in other ownerships, and are first to receive funding to address the safety of road users.

The 1994 Access and Travel Management analysis resulted in the following criteria for the selection of the network of Key Forest Roads:

Primary Route Selection Criteria:

Roads that link state and county roads, which connect high-use entry points or population centers and provide major access into and through the Forest.

Among primary road alternatives, select the one that favors the greatest use of state and county road systems (these are usually double-lane roads and highways).

Roads that help provide the most extensive linkage to secondary networks.

Roads that are designated scenic routes or auto tours.

Roads that provide access to recreation areas, which contain a number of developed sites and facilities

Secondary Selection Criteria:

Roads that give the best access to management areas outside the proximity of the primary network, considering that these areas or project sites cannot be accessed by short-term, temporary roads, or by means other than highway vehicles.

Routes that extend primary Forest roads as well as state and county roads, and give needed long-term access.

Long-term roads with only periodic or seasonal restrictions.

Roads that access developed sites, wilderness trailheads, multiple resource management areas, and special sites and facilities that require permanent vehicle access.

A single road selection from alternative routes to the same area, site or destination that will generate the least amount of negative resource impacts (*e.g.*, selecting a ridge-top road over one within a riparian zone that meets the same destination access needs).

Long-term roads that are supported by cooperative share-cost agreements or other partnerships and open to public travel.

The process outlined in the 1994 ATM Guide was evaluated based on Road Analysis Questions GT(1-4) and SI(6) to determine whether it is still valid based on these questions.

Conclusion:

It was found that the 1994 ATM process and 2003 Road Analysis, as described and updated in this document, is functioning well.

Risks and Benefits

If maintenance budgets continue to decrease, there is a risk that road safety deficiencies will increase over time. If these roads deteriorate over time, local communities and businesses that depend on these roads for access or as emergency evacuation routes may suffer.

Medical response time is also greatly increased in areas with limited access. Should a medical emergency occur, treatment and evacuation of people using the Forest (*e.g.*, by hiking, hunting, fishing, gathering of forest products) would decrease in efficiency with a decrease in road density.

The benefit of identifying and managing the network of Key Forest Roads is that it prioritizes funding to those roads most important to the local communities. The maps of Key Forest Roads (Appendix C) display the priority road network in a way that is easily understood by the public as well as forest management specialists.

Desired Future Condition

The Forest transportation system provides key access routes through the Siuslaw National Forest within current budget allocations.

Responsible officials coordinate with other public agencies and private stakeholders to identify and integrate current access needs and balance these with transportation system costs.

Recommendations

Use the Key Road system as the basis for making site-specific road management decisions. If needed, adjust the system to meet changing needs and conditions over time.

Maintain access to private lands. Roads to private lands that are not part of the Key Road system will be maintained only to prevent environmental damage, not necessarily drivability. If the landowner needs access to their property, the Forest Service will issue a special use permit or a haul permit specifying road maintenance requirements.

Maintain linkages between State Highway 101 and the county road system, as well as the east-west flow of local community and emergency traffic over the Oregon Coast Range.

If budget shortfalls limit maintenance of the Key Forest Road system to standard, consider site-specific maintenance as problems arise. For example, risks to public safety can be mitigated by clearing brush along hazardous routes, spot rocking damaged road surfaces, or by signing critical junctions until full maintenance can be accomplished.

At the district or appropriate scale, consider whether the Key Forest Roads meet current public access needs.

If such needs are not addressed by the current Key Road system, adjustments or modifications to the Key Road system can be addressed at the watershed/project scale analysis.

Environmental Issues

The Forest Road system affects the basic resources of soil, water, fish, wildlife, and vegetation. Access to prime habitat areas can increase the vulnerability of animals and cause a re-distribution into less desirable areas. These same travel ways also provide access for recreation and resource management projects. Human access into remote areas can disturb wildlife and sensitive plants. While these effects are addressed in general terms in this analysis, they are considered in more detail at the watershed/project level.

Aquatics and Water Quality

Roads can affect streams in a variety of ways. The potential for landslides can be increased, both fine and coarse sediment input may be increased, subsurface flow can be intercepted and rerouted through ditches and culverts, low-gradient streams may be constricted in valley bottoms by the presence of roads, the movement of large woody debris from upper hillslopes to valley bottoms can be interrupted by mid-slope roads, and riparian vegetation can be affected.

Figure 22 Typical directional signing on Key Forest Roads

◈ Roads can increase the potential for landslides.

Current Situation

In the Oregon Coast Range, road-related landslides are usually debris flows, which flow down high gradient stream channels. Depending on the volume of the material, the valley configuration, and the angle of stream confluences, these debris flows can travel long distances, and may reach perennial, low gradient streams. Debris flows occur naturally but the presence of roads can increase the potential for occurrence in moderate size storms.

On the Siuslaw National Forest, risk factors for road related landslides include mid-slope roads, roads built using side-cast techniques where unstable fill can become saturated and fail, and undersized culverts that can become plugged and cause water to be diverted out of a stream channel.

Until the early 1970s, Forest roads were commonly built using side-cast techniques, where excavated material was simply pushed over the side of the road to create the shoulder. As a result, the roads with the higher risk of landslides tend to be the older roads, which are often in the Key Forest Road system. These older roads also tend to have undersized culverts that are more likely to plug with debris.

Beginning in the early 1990s, all roads on the Siuslaw National Forest were inventoried and surveyed for problem areas, and culvert locations. In addition, all culverts were inventoried, and problems and diversion potential were documented in 1995. This information is available on the GIS system. More information and recommendations were provided by watershed analyses.

Risks and Benefits

Mid-slope roads crossing streams on steep ground that receive little or no maintenance are at the highest risk of debris flows. Debris flows originating at roads tend to have very little large woody debris input into streams. While they can add gravels to low-gradient streams, which could be considered a benefit in gravel-deficient streams, the debris flow input can have short-term detrimental effects, such as aggrading the stream bed, filling in pools and covering existing spawning gravels with fine sediment.

Figure 23 Stabilized mid-slope road

Many of the roads at high risk for landslides have already been closed or decommissioned on the Siuslaw National Forest; however, some roads, especially those that will remain open, continue to be at risk.

Desired Future Condition

Mid-slope roads located on steep slopes with multiple stream crossings are either:

Closed, with the stream crossing culverts and fills removed and the road bed and fills stabilized; or

Stabilized with upgraded culverts.

Recommendations

Follow recommendations of watershed analyses and the Meeting the Challenge…Providing Ecosystem Services for our Communities (USDA 2006).

Identify the roads that are still at a high risk of landslides. If they are part of the Key Road system stabilize them; if they are not, consider them for closure or decommissioning.

Tools useful in this analysis are:

Watershed analyses.

Slope stability maps that identify steep, concave slopes. These maps were generated for specific watershed analyses.

The debris flow models created by the CLAMS project. These maps show areas where debris flows are likely to originate, and how far the debris flow will travel.

The Forest culvert inventory that shows the location and diameter of culverts.

During project planning, identify roads that will not be needed and close or decommission them.

- **There is a potential for increased input of fine and coarse sediment into streams from roads.**

Current Situation

In the Oregon Coast Range, the dense vegetation cover and high infiltration rate of soils results in low to non-existent surface erosion in natural areas. Surface erosion from roads can occur where steep, unvegetated cut slopes are present, in ditch lines (especially those with a moderate to steep gradient), and from roads with no gravel or asphalt.

Depending on the type of bedrock, some areas of the Coast Range have a higher potential for erosion and generation of fine sediment. Generally, areas underlain by basalt generate less fine sediment while areas underlain by fine siltstones (such as areas around Hebo) generate more.

Sediment generated from roads may or may not reach stream channels. Sediment diverted off the road and out of ditches by water bars is usually deposited on the slope below the road and does not reach stream channels. Sediment that travels down ditches may reach live stream crossings where it enters the stream system or is carried through a cross-draining culvert and deposited on the hill slope below the road.

Risks and Benefits

Increased fine sedimentation can cover spawning beds. Although many of the roads on the Siuslaw National Forest have been waterbarred, and most have a rocked surface (which reduces the fine sediment production), some roads still have the potential to produce fine sediments.

Desired Future Condition
Roads with a high potential to produce fine sediment have been treated to reduce fine sediment deposition into streams.

Figure 24 Stabilized, non-Key Forest Road

Recommendations
Follow recommendations of watershed analyses and the Meeting the Challenge…Providing Ecosystem Services for our Communities (USDA 2006).

Leave ditches vegetated as often as possible. Vegetation acts as a filter and reduces the amount of fine sediment that reaches stream crossings.

Provide an adequate covering of rock on roads that will remain open.

Restrict timber haul to the dry season on roads prone to sedimentation. If timber haul must take place during the wet season, monitor rainfall, and reduce or eliminate timber haul during rain events. (See Siuslaw Road Rules, USDA 1998b.)

Install and maintain surface crossdrains (*e.g.*, waterbars, grade dips, outslope drains, *etc*.) on roads not designated for passenger cars.

- **Roads can intercept and re-route subsurface flow resulting in increases in peak flows, and in changes in the timing of storm runoff to streams.**

Current Situation
Mid-slope and valley bottom roads can intercept subsurface flow. On the Siuslaw National Forest, most valley bottom roads are either county roads or private roads. Many of the mid-slope roads have been decommissioned. Those that remain can still intercept the subsurface flow from cut banks and re-route it through ditches into cross-drains and stream crossings. During storms, ditch lines act as an artificial extension of the stream network, thereby increasing peak flows.

Risks and Benefits
Increased peak flows can alter stream morphology. Stream channels are formed by the "bankfull" flow, which is defined as the flow that fills the channel to the top of the banks, and is thought to have an average recurrence interval of 1.5-2 years. Increasing the flow may cause the channel dimensions to change, *i.e.*, get deeper and/or wider to accommodate the higher flows. In the Coast Range, this change will be hard to document because stream flows tend to be "flashy," *i.e.*, they

rise and fall quickly with rainfall events, and flows tend to be highly variable. For instance, North Creek, a tributary to Drift Creek of the Siletz River has low summer flows of 6.5 cubic feet per second (cfs), and a two-year flow of 390 cfs.

Desired Future Condition

Mid-slope roads are closed, stabilized or decommissioned.

The fills and culverts of closed roads have been removed to prevent landslides, stream diversions and to hydrologically disconnect the road. The road surface is waterbarred to allow water intercepted by cut banks to flow across the road and into the slope below the road.

Recommendations

Follow recommendations of watershed analyses and the Meeting the Challenge…Providing Ecosystem Services for our Communities (USDA 2006).

Close and decommission unneeded mid-slope roads.

Install and maintain surface crossdrains (*e.g.*, waterbars, grade dips, outslope drains, *etc*.) on secondary high clearance roads to allow water from the ditch line to travel across the road surface to the slope below. This would dissipate water intercepted by cutbanks and prevent it from being delivered directly to stream channels.

Disconnect road system from stream channels by waterbarring roads wherever possible. This would deliver water as naturally as possible to the slope below the road rather than concentrating runoff along ditch lines to the nearest stream, thereby extending the stream network artificially.

◈ Roads can alter the geomorphology of streams and floodplains.

Current Situation

Roadbeds located in valley bottoms can reduce the width of the floodplain and constrict the area across which the stream can meander. This situation can lead to placing riprap on the side of the road or on the stream bank to prevent the stream from undercutting the road. Stream velocities tend to be higher near banks with riprap than those with vegetation, since riprap is a hard surface that doesn't absorb the stream's energy in the same way as vegetation. As a result, bank erosion downstream from riprap can increase. Riprap also doesn't provide habitat for fish and riparian species.

On the Siuslaw National Forest, most valley bottom roads are either private or county roads because of the history of homesteading in the valley bottoms. Therefore, decommissioning or re-routing these roads will take cooperation between the Forest Service, other agencies and governments, such as counties, and other landowners.

Risks and Benefits

Roads that impinge on low gradient stream channels impede channel migration and the processes of erosion and deposition, and habitat creation associated with migrating channels. Also, the roadbed is at risk of erosion, which usually requires bank stabilization measures, such as riprap.

Desired Future Condition

Roads do not impede stream channel movement.

Recommendations

Follow recommendations of watershed analyses and the Meeting the Challenge…Providing Ecosystem Services for our Communities (USDA 2006).

Forest roads adjacent to low-gradient streams and floodplains should be relocated or decommissioned. Work with the county governments and willing landowners to relocate easements or rights-of-way.

◈ Mid-slope roads can interrupt the movement of large woody debris from upper hillslopes to valley bottoms.

Current Situation

In the Oregon Coast Range, much of the large woody debris in low gradient streams is deposited by debris flows from high-gradient tributaries. Over time, these woody debris deposits create complex aquatic habitat. Mid-slope roads that cross high-gradient tributaries can act as barriers between the source areas of debris flows and woody debris and the low gradient streams. Wood and sediment can become trapped behind stream crossings, reducing downstream delivery and increasing the risk of road failures.

Risks and Benefits

With existing mid-slope roads located on steep ground that have not had stream crossing fills and culverts removed, the possibility of debris flows occurring upslope and depositing wood and sediment at the road crossing still exists. Potential detrimental effects include: reducing the amount of wood that would otherwise reach the stream channel down slope, plugging the culvert at the road-stream crossing and diverting the stream channel's flow down the ditch, and/or road failure, resulting in a larger debris flow continuing down the channel.

Figure 25 Stabilized mid-slope road

Desired Future Condition

Few, if any, unstabilized mid-slope roads remain open.

The fills and culverts of closed roads have been removed at stream crossings such that if debris flows did originate upslope of a road location, the debris flow could continue downstream without incorporating the road fill.

Recommendations

Follow recommendations of watershed analyses and the Meeting the Challenge…Providing Ecosystem Services for our Communities (USDA 2006).

Identify mid-slope roads located on high-risk land for debris flows. If they are part of the Key Road system stabilize them; if they are not, consider them for closure or decommissioning. Seek alternative routes for Key Roads that cross unstable areas.

During project planning, identify roads that will not be needed and close or decommission them.

Fisheries

Roads influence the health and distribution of stream-dwelling species in several ways. When roads encroach directly on stream channels and adjacent riparian areas, natural stream processes are modified. Wood and sediment can be trapped behind stream crossings, reducing downstream transport and increasing risk of crossing failure. Road alignment and road fills can isolate floodplains, constrict the channel, constrain channel migration, and simplify riparian and aquatic habitat. Also, in some places, road encroachment can divert stream flows to the opposite bank, thereby destabilizing the hill-slope and resulting in increased landslides. Construction and use of roads can lead to unwanted sediment and human activities, while culverts may often limit passage of aquatic organisms under roads.

On the Siuslaw National Forest, Oregon Coast coho salmon, eulachon, and green sturgeon are currently listed as threatened under the Endangered Species Act. (Habitat for eulachon and green sturgeon is not widely distributed on the Forest and not significantly affected by road interactions.) Since the 1950's, Oregon Coastal coho salmon population numbers have fluctuated widely, but overall showed a dramatic decline into the late 1990's. The amount and quality of habitat available for coho was significantly impacted by road construction, operations and maintenance both on and off the Forest during that time.

Since 1997, there has been a generally improving trend in returning coho spawners. This population recovery is likely due to several major management changes including modification of hatchery programs and reductions in harvest, but is also certainly linked to aggressive whole-watershed restoration efforts initiated by the Forest and partners at that time. Special focus has been placed on road system improvements including road decommissioning/closure, drainage improvements, and culvert fish passage. These, coupled with riparian planting, large wood placements in-channel, and estuary reclamation have reopened much of the historic habitat and reduced elevated levels of sedimentation and water temperature in many areas.

Several other fish species are of special interest and listed as "sensitive" by the Forest Service, including winter steelhead, spring Chinook, and chum salmon. Other fish species include sculpins, dace, lamprey, coastal cutthroat trout, suckers, northern pikeminnow, estuarine species like surfperch and starry flounder, and warm water fishes introduced primarily into lakes at the Oregon Dunes NRA. The Forest has about 1,200 miles of anadromous fish streams (all free-flowing, more than any other Forest in the contiguous U.S.) as well as a number of estuaries.

- **Impacts of roads on riparian areas and fish habitat and populations include loss of streamside vegetation and shade; compaction or loss of floodplains; destabilization of steep slopes adjacent to streams; fishing; poaching; vandalism; and litter.**

Current Situation

As a legacy of timber management prior to 1990, the Forest landscape was left with many riparian roads and significant riparian areas that had been clear-cut to the stream bank. Many of the impacts were analyzed during watershed analysis. One impact, increased stream temperature, could only be explained by timber harvest, which involved riparian harvest and sometimes building of roads and even landings in riparian areas. This in turn reduced the ability of streams to support native salmonids due to loss of habitat complexity. In some cases, where warmer temperatures occurred, upstream movement of fish species associated with warmer stream temperatures was observed (*e.g.*, redside shiners, pikeminnows, suckers).

Roads in riparian areas resulted in widespread reduction of shade and floodplain habitat, constriction of channel reaches, and provided easy access for removal of large instream or near-stream wood until policies changed to emphasize a broader range of ecosystem values in the NW Forest Plan. These types of impacts were fairly common on the Siuslaw NF outside of congressionally designated wilderness areas. Many of these situations were subsequently identified in watershed analyses. As follow-up to watershed analyses, many of these site-specific impacts have been or are currently being addressed. Roads have been eliminated along many key stream reaches occupied by steelhead trout, Chinook salmon, and threatened coho salmon, improving conditions in these important refugia areas.

Since most of the main rivers and many of the larger fish-bearing tributaries outside of congressionally designated wilderness areas have riparian roads, access for legal and illegal angling has increased. Poaching is a concern for at-risk species due to lack of state and Forest Service law enforcement capabilities, and increased access to streams where fish migrate, spawn and/or rear young.

As of 2014, the Siuslaw NF has not had a significant issue of accidental or intentional releases of non-native aquatic organisms (with the exception of warm water fishes which, for the most part, were introduced many years ago in lakes at the Oregon Dunes NRA). However, in those same lakes, non-native aquatic plants are of concern. Many of these introductions are tied to the road system and associated boat ramps. The extensive road system allows easy access for the State of Oregon to stock fish supporting recreational fishing. They use a combination of native and non-native salmonids, but in recent years have used fewer non-native stocks to address concerns about effects to native aquatic species.

Risks and Benefits

When roads were constructed adjacent to streams, riparian vegetation was often removed to accommodate the road right-of-way, improve visibility, and reduce any hazard of trees falling on the roadway. This action reduced shading of the stream, however, contributing to increased stream temperatures, reduced potential for recruiting large woody debris in the stream, reduced leaf fall and riparian invertebrates, and loss of habitat for aquatic and riparian species. Another risk is from transport of chemicals or contaminants that could seriously damage aquatic life in the event of an accident.

Not all areas have the same biological values. The first step of any recovery plan is to secure the best habitats and populations to the degree possible. It is recommended that restoration efforts begin in refugia that have particularly good fish habitat and/or populations in order to protect these special resources (*e.g.*, through storm proofing of roads). The degree of acceptable risk of activities in such areas is lower and restoration priority is higher because these refugia are so critical for the recovery of fish runs. Determining the spatial coincidence of roads with such areas is a first step in determining if roads are affecting them. Roads in such areas may be a high priority for detailed examination and analysis to determine the extent of actual effects.

The road system facilitates access to streams, lakes and wetlands where at-risk species may live. Recreational use of aquatic resources, if improperly managed, can contribute significantly to declines in rare or unique native invertebrate populations or damage to important aquatic habitats.

Figure 26 Stabilized, Non-Key Forest Road

Due to the significant road infrastructure on the Siuslaw National Forest, we know that the road system has altered the capacity of stream channels for large woody material. This is primarily due to undersized culverts easily plugged by woody material, or culverts failing due to age. It is less clear how much smaller sediment and organic matter is prevented from moving downstream due to culverts. The road system allowed removal of in-stream and near-stream large woody material prior to 1990, which has apparently **increased** stream energy and the resultant movement of sediment and organic matter downstream (as opposed to the issue about **prevention** of downstream movement)

Desired Future Condition

The Meeting the Challenge…Providing Ecosystem Services for our Communities (USDA 2006) calls for "well designed stream crossings, minimal sediment, adequately sized road system for forest use, appropriate road drainage and a stable road system." Stream channels would be dynamic. They would migrate within historic flood plains, eroding the bed and banks in one place while aggregating the bed and building new banks in other places.

Streams would also transport and deposit large pieces of woody debris and fine organic matter, providing physical structure and diverse aquatic habitat to the channel.

Vegetation near streams would deposit nutrient inputs (*e.g.*, insects, leaves) and large woody material in the channels, while resultant shade would keep water temperatures relatively cool. A filter of plant material would prevent most sediment from entering stream courses; floodplains would be pervious and freely connected to channels; steep slopes adjacent to streams would be relatively stable; and evidence of behaviors such as poaching, vandalism, littering, and removal/trampling of riparian vegetation would be rare.

Recommendations

Follow recommendations of watershed analyses and the Meeting the Challenge…Providing Ecosystem Services for our Communities (USDA 2006).

During project planning, explore all reasonable options for reducing or eliminating impacts to coho salmon.

This is in line with the National Marine Fisheries Service's request to eliminate or mitigate roads that pose risks to coho salmon recovery. It is recognized that this may not be feasible in cases where the road is an established travel route, and there are limited possibilities for relocating the road.

Reduce disturbance of coho salmon resulting from access to and use of dispersed areas.

Minimize the effects of simplification of channel conditions at road crossings (*e.g.*, removal of roughness elements like large woody debris) on streamflows and fish habitat.

◈ Road construction, maintenance, and use may lead to excessive fine sediment entering stream channels.

Current Situation

Surface erosion occurs on most wildland roads because their surfaces, cutslopes, fillslopes and associated drainage structures are usually composed of erodible material and are exposed to rainfall and concentrated surface runoff. Surface erosion and associated sedimentation are highly sensitive to road maintenance practices, and small changes in road drainage configuration can markedly increase erosion and routing of eroded sediments.

In the Coast Range major channel changes, including noticeable aggradation, often occur during high flow events. The road system, as well as past timber units, was documented as contributing to stream aggradation at specific sites on the Forest after the floods of 1996, particularly in watersheds with high numbers of stream/road crossings.

Figure 27 Stabilized, Non-Key Forest Road with Vegetation encroachment

Risks and Benefits

Heavy use of roads during wet weather conditions, particularly from trucks hauling logs or gravel, can damage road surfaces and increase runoff of sediment into nearby streams. This occurs through rutting and resultant transfer of fine sediments from within the gravel to the surface of the road.

Culverts at road-stream crossings can cause large inputs of sediment to streams when hydraulic capacity is exceeded, or the culvert inlet is plugged and streamflow overtops the road fill. The result is often erosion of the crossing fill, diversion of streamflow onto the road surface or inboard ditch, or both.

On soils with moderate or high potentials for fine sediment, unstable soils, or steep slopes, roads may lead to excessive fine sediment entering stream channels. These “fines” are likely to settle in relatively low gradient, depositional sections of stream channels often favored as spawning sites by salmonid species. Fine sediments 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.

Desired Future Condition

The Meeting the Challenge…Providing Ecosystem Services for our Communities (USDA 2006) envisions "well-designed stream crossings, minimal sediment, adequately sized road system for forest use, appropriate road drainage and a stable road system." In particular, any amounts of sediment from roads and road-related activities are small, and a filter of plant material prevents most of it from entering stream courses.

Recommendations

Follow recommendations of watershed analyses and the Meeting the Challenge…Providing Ecosystem Services for our Communities (USDA 2006).

Identify roads chronically increasing fine sediment in aquatic habitat and take corrective action (*e.g.,* closure, decommissioning, upgrading).

Identify roads that pose a high risk of landslides (a source of fine sediments) and take corrective action (*e.g.,* closure, decommissioning, upgrading).

Create an inventory of all road-stream crossings (i.e., culverts) on the Forest. Prioritize repair and upgrade of culverts based on severity of risk of failure and cost.

Identify areas with a high risk of fine sediment deposition (i.e., landslides), which would impact fish-bearing streams and prioritize for corrective action.

Explore opportunities to learn more about the impact of fine sediment on aquatic species habitat and survival. Use floods as an opportunity to learn more about stream dynamics.

◈ Risk of impacts from roads on stream channels and aquatic species depends on location, road age, type of surface material, and number of stream crossings.

Current Situation

The degree of surface erosion from any particular road segment on the Siuslaw National Forest differs greatly depending primarily on the erodibility of the exposed surface; the slope of the exposed surface; and the area of the exposed surface that generates and concentrates runoff.

Risks and Benefits

The age of a road, surface material, number of stream crossings and drainage features, density of roads, and the percentage of a watershed that has been harvested (*e.g.,* hydrologically unrecovered) are all factors that can increase the risk of roads impacting beneficial uses such as fish reproduction, distribution, and survival. Impacts can occur chronically (*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 as a result of significant episodic events, such as floods or catastrophic fires, that may lead to increased runoff and therefore impact water quantity and quality.

Desired Future Condition

The Meeting the Challenge…Providing Ecosystem Services for our Communities (USDA 2006) envisions "well-designed stream crossings, minimal sediment, adequately sized road system for forest use, appropriate road drainage and a stable road system." In particular, roads that pose high risks of damage to aquatic habitats would be in a treated or decommissioned state that minimizes those risks.

Recommendations

Follow recommendations of watershed analyses and the Meeting the Challenge…Providing Ecosystem Services for our Communities (USDA 2006)

Consider the following factors in determination of impacts on fish and other aquatic resources:

Type, condition, and number of stream crossings at a road-segment scale.

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%.

Road maintenance records. At a minimum, a record of maintenance accomplished (date, type), including knowledge of site-specific chronic or severe maintenance sites should be documented.

Documentation of known spawning reaches with review by state and other agency biologists.

Ensure temporary road locations, construction, and decommissioning is documented in environmental documents and executed as planned. This information is required in ESA consultation.

Explore opportunities to learn about specific fish runs in areas with high road densities. Consider partnerships with other agencies and stakeholders for more efficient and cost-effective analysis.

◈ Culverts of inadequate size or performance restrict passage of fish and other aquatic organisms.

Current Situation

Using a consistent Regional protocol for aquatic organism passage culvert inventory, the Siuslaw National Forest found that 310 culverts blocked or impeded migration of some life phases of various species of fish and other organisms. Since 2003, 74 culverts in this inventory have been removed or replaced with culverts enabling aquatic organism passage. Culvert removal or replacement is prioritized so that those located lower in the watersheds are completed first. In 1995 a culvert inventory identified approximately 3000 total culverts on the forest. Between 2003 and 2010, 230 of these culverts were removed from fish bearing streams. Since many resident aquatic species travel significant distances along streams throughout their life, both diurnally and seasonally, this situation probably had the most serious (though largely undocumented) consequences on anadromous salmonids (salmon, steelhead, and searun cutthroat trout) and lampreys and therefore has been a Forest priority.

Risks and Benefits

Most culvert blockages prevent or restrict upstream migration, though sometimes downstream migration through a culvert can also pose hazards to the fish from poor outlet conditions (e.g., high perch with no outlet pool). Blockages at the crossing may be partial or total, and they can affect adult spawners, migrating juvenile fish, and other aquatic organisms.

Removal or replacement of such artificial barriers with stream simulation crossings (USDA, 2008) will provide each species with the greatest opportunity to capitalize on available productive habitat, and recovery of species like the coho salmon is dependent upon the ability of all life stages to move to suitable habitat.

In rare cases, maintaining barriers at road crossings is desirable where such barriers prevent invasions by unwanted aquatic species.

Desired Future Condition

The Meeting the Challenge…Providing Ecosystem Services for our Communities (USDA 2006) envisions "well-designed stream crossings, minimal sediment, adequately sized road system for forest use, appropriate road drainage and a stable road system.." In particular, nearly natural stream conditions (gradients, flows, substrate) extend through road crossings.

Recommendations

Follow recommendations of watershed analyses and the Meeting the Challenge…Providing Ecosystem Services for our Communities (USDA 2006).

Utilize the stream crossing inventory to identify all road-stream crossings (*i.e.*, culverts) on the Forest. Prioritize repair and upgrade of culverts based on risk of failure and impact to fish passage and other aquatic resources.

Where fish passage is affected, use an interdisciplinary process in the design of culverts (*e.g.*, fisheries biology, engineering, geomorphology, hydraulics, hydrology).

Figure 28 Two views of the same culvert. Notice the culvert is large enough to accommodate high water flows. The rocks on the bottom recreate natural stream flows, which allow passage of aquatic organisms through the pipe.

Terrestrial Wildlife.

The Forest road network can significantly alter wildlife habitats and negatively impact wildlife populations. The negative effects of roads on wildlife (including listed and sensitive species) can be classified into three general categories:

- **Edge effects and fragmentation;**
- **Barriers to species movement; and**
- **Disruption of activities such as breeding, feeding, resting or dispersal activities as a result of the use and maintenance of the road system.**

Current Situation

Edge effects are the result of the interaction between two adjacent habitats, when the two habitats are separated by an abrupt edge (Murcia 1995). The ecology of forest edges is characterized by changes in biotic (parasites, predators and herbivores) and abiotic (microclimate, disturbance regime) elements. If exposure to the edge modifies the features of the forest beyond their range of natural intrinsic variation, then that area will be effectively reduced for conservation purposes (Murcia 1995).

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. Currently, roads and the history of intensive timber harvesting are the major causes of forest fragmentation on the Siuslaw National Forest. The Assessment Report of Federal Lands in and Adjacent to the Oregon Coast Province (USDA 1995a) documents changes in the size and composition of patterns as a result of road construction and harvest activities. The report concluded that the large (1001-10,000 acres) and jumbo (>10,000 acres) scale disturbance regimes, which previously dominated the landscape, have been replaced by small (<100 acres) and medium (100-1000 acres) scale disturbance regimes. It also documents the associated loss of large blocks of isolated forest habitat favored by species such as fisher and wolverines. During the 1980s and into the early 1990s the continued decline in mature forest habitat led to listing of Northern spotted owls and marbled murrelets as threatened under the Endangered Species Act (ESA).

A second major impact of roads on wildlife is 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). Roads create additional barriers to movement where the road shoulders and cutbanks create an over-steepened slope, and where undersized culverts bisect channels. When populations become subdivided, there is increased risk of demographic fluctuation, local extinction of subpopulations, less re-colonization after local extinction, and a progressive loss of local biodiversity (Soule 1987).

Finally, the extensive network of Forest Service roads also creates opportunities for **human activities** to impact terrestrial wildlife. In past decades, the Siuslaw road network was used to support timber harvest activities. As timber harvests declined, the road network continues to provide access for recreationists and hunters, impacting animals directly (*e.g*., deer, elk, and bear) or indirectly (disturbance from roadside camping).

Generally speaking, human influences on the Forest are greatest near roads and decrease steadily with distance from roads. Noise associated with road maintenance and use can disturb the breeding, feeding and rearing behavior of sensitive species such as marbled murrelets, and Northern spotted owls. Through agreements with ODF&W (Oregon Department of Fish & Wildlife), some roads have been closed to reduce the impact of vehicles on elk feeding and calving areas.

Risks and Benefits

The effects of fragmentation will continue until plantations (either through treatment or natural process) begin to reflect the composition and structure of adjacent natural stands. As fewer miles of open road are maintained, the barriers associated with an active road system are limited to the Key Road system, or project roads during periods of active management. The remaining roads have become less of a barrier as vegetation has started to grow in them, fallen trees have remained in place, and culverts are removed during periods of closure. Chronic levels of disturbance from use and maintenance of the entire road system have been reduced as the total miles maintained annually have been significantly reduced. Disturbances will continue to occur as All Terrain Vehicles (ATVs) pass closure devices in an attempt to access closed areas.

Desired Future Condition

The Key Forest Road system is limited to those roads required to connect major areas of the Forest and adjacent communities.

Roads closed or decommissioned are free of barriers during periods they are not used for major forest management activities.

Roads closed or decommissioned are not a source of disturbance during critical breeding, or rearing periods.

Recommendations

Close or restrict access to roads used intermittently for forest management activities.

Decommission unneeded roads.

Limit roadside salvage sales to the Key Forest Roads. Non-Key roadside salvage associated with project planning may be appropriate.

Minimize the effect of noise from road maintenance, reconstruction or decommissioning by managing the seasonal and hourly operating periods of projects.

Eliminate the operation of ATVs (All Terrain Vehicles) and other vehicles on closed or decommissioned roads through appropriate barriers and utilizing the Motor Vehicle Use Map regulations.

Vegetation Management

◈ Maintain access to current or planned vegetation management projects.

Current Situation

The Siuslaw National Forest is virtually all in a Late Successional Reserve (LSR) or Riparian Reserve (RR) Land Use Allocation under the Northwest Forest Plan. Matrix lands receive the same treatment as LSRs and RRs due to their small size (under 10 acres) and scattered distribution on the landscape.

Natural stands on the Forest are primarily composed of 100 to 150 year old Douglas-fir stands and scattered, relatively small patches of remnant old growth. These stands originated following the last large fire in the coast range, the Yaquina Fire in 1850. Thus, most of the current natural stands are in a mid seral stage. It’s estimated that less than 10,000 acres of late successional forest survived this fire and subsequent harvesting.

Harvesting during the past 50-60 years has resulted in a highly dissected landscape. About 40% of the Forest is comprised of dense, uniform Douglas-fir plantations (10 to 100ac), resulting from intensive reforestation after harvest.

Figure 29 Stabilized, closed road.

The Northwest Forest Plan indicates that active management of these plantations is important to restoring late successional forest conditions throughout the LSRs. Silvicultural activities promote diverse stand structure by manipulating stand density and establishing shade-tolerant species in the understory.

Most remaining natural stands exceed 80 years of age, beyond which stands are not treated under the Northwest Forest Plan. Therefore, access to these older stands is not an issue.

The type of road access and maintenance level is a major factor in determining the type and intensity of stand treatment. For example, where roads are absent or decommissioned the cost to harvest and treat stands is increased. Additionally, these stands require longer duration and higher intensity silvicultural treatment. Stands adjacent to Key Forest Roads, however, are managed assuming access to the stand will be available in the future, allowing frequent, low intensity silvicultural treatment.

The Meeting the Challenge…Providing Ecosystem Services for our Communities (USDA 2006) prioritizes watershed restoration activities, including silvicultural treatments, to concentrate management activities over a short timeframe followed by a period of minimal management. During the latter, roads can be closed for a period of time (one year or longer) and later re-opened for silvicultural treatment.

Risks and Benefits

The current road system provides access to most of the stands requiring silvicultural management on the Forest. However, as more roads are closed or decommissioned, silvicultural activities may be limited or precluded due to higher treatment costs.

Desired Future Condition

A limited Forest road system maintains access to stands less than 80 years old in order to allow silvicultural treatments to develop late successional conditions. Once this condition has been achieved, access to stands is no longer needed and non-Key Forest Roads are decommissioned.

Recommendations

Identify and maintain key access points to accommodate equipment needed for thinning stands.

Focus treatment on stands accessible from the Key Road system and other hydrologically stable roads (*e.g.*, ridgetop roads). Roads that will be decommissioned may be used for silvicultural treatment prior to decommissioning.

When closed roads are reopened, use minimal impact techniques. For example:

Keep clearing width to a minimum.

Avoid sidecasting clearing debris and rootwads.

Provide temporary drainage such as waterbars for wet areas (*e.g.*, seeps, springs). Reestablish natural drainage prior to road closure.

Match road design with season of operation (*i.e.*, rock to support winter haul; rock north slopes when hauling during rainy season).

Eliminate the operation of vehicles on closed roads through appropriate barriers and utilizing the Motor Vehicle Use Map regulations.

◈ Roads and associated human activities increase the spread of noxious weeds.

Current Situation

Roadside areas throughout the nation frequently support an abundance of non-native invasive plants (weeds). Weed abundance in these areas is often attributed to three factors:

Level of initial disturbance from road construction resulting in extensive areas of mineral soil and exposed parent material that provide ideal sites for weed colonization;

Frequent disturbance regimes as a result of regular road maintenance and use that provide opportunity for additional weed colonization and expansion of established populations; and

Vehicles traveling the roads and other human activities along road corridors often transport weed seed or propagules into the area (Baker 1986).

Roadside areas of the Siuslaw National system roads currently support substantial populations of non-native invasive plants. The 2010 the Forest Supervisor signed a Decision Notice for the Siuslaw Invasive Plant Treatment Project Environmental Assessment which identified 1,966 acres (74 sites) of invasive plants and sites that are a high priority for treatment using herbicides, and manual and mechanical methods.

Several recent Environmental Assessment Decisions (East Alsea, North Fork Siuslaw) have included invasive plant treatments and an early detection rapid response strategy.

Risks and Benefits

The risk of weed introduction and spread posed by roads is a function of road use and maintenance level, and the proximity and biology of individual weed species. Weed species found along forest roadsides generally fall within three risk categories.

Category I (Low Risk) – Common weed species with short-term occupancy (or frequent disturbance)

These species are found along most roadsides on the Forest and are generally dependent on frequent disturbance, such as road maintenance, for long-term site occupancy. Dispersal mechanisms and vectors for seed transport of many of these species is wind. However, road traffic, maintenance machinery and other human uses contribute to seed transport and spread. Some species in this category are listed on the Oregon Department of Agriculture's Noxious Weed List. Examples of plants in this category include tansy ragwort, bull thistle and Australian fireweed.

Risks associated with weed species in this category are generally low. Benefits of initiating new management actions to contain or control spread along roads would be minimal.

Category II (High Risk) – Common weed species with potential for long-term site occupancy

These species are found along many roadsides on the Forest (estimate is 35-40% based on 2002 inventory work). Once established, they are not dependent on frequent disturbance for long-term site occupancy. Vehicles, heavy equipment, and other human activities (yard waste disposal, animal feed, contaminated seed) have been documented or are suspected as long-range vectors for spread of many species in this category. Once established, these species have potential to disrupt natural successional pathways of forest vegetation. Most species in this category are listed on the Oregon Department of Agriculture's Noxious Weed List. Examples of plants in this category include Scotch broom, Himalayan berry and Evergreen blackberry.

Scotch broom

Risks associated with weed species in this category are high. Initiating management actions to contain established populations and prevent weed spread along roads would be beneficial. Implementation of management actions along primary and secondary roads traversing areas of the Forest where these species are not present, such as the Mary's Peak Scenic Botanical Area, would provide the greatest benefits.

Category III (Very High Risk) – Uncommon weed species with potential for long-term site occupancy

These species are found or suspected in only a few locations on or adjacent to the Forest. Once established, they are not dependent on frequent disturbance for long-term site occupancy. Vehicles, heavy equipment, and other human activities (yard waste disposal, animal feed, contaminated seed) have been documented or are suspected as long-range vectors for spread of many species in this category. Once established, these species have potential to disrupt natural successional pathways of forest vegetation. These species pose the greatest threat of spread along forest roads with potential adverse effects to ecosystem function and natural processes (Miller, personal communication). All species in this category are listed on the Oregon Department of Agriculture's Noxious Weed List. Examples of plants in this category include purple loosestrife, Portuguese broom and gorse.

Risks associated with weed species in this category are very high. Initiating management actions to contain and control established populations and prevent the spread of weeds in this category along roads is critical to maintaining ecosystem function and resource values. Measures to contain known infestation sites and prevent the spread of weeds in this category have been implemented in some areas where primary and secondary roads traverse known infestation sites. New infestations and new species that fit this category and further increase risk are anticipated in the future (Steinmaus 2002).

Most risk of weed infestation is associated with primary and secondary roads that are regularly maintained for public use and new construction of "temporary" roads associated with timber harvest activities. Closed roads and roads that are not regularly maintained (storm-proofed and allowed to "grow-in") pose a relatively low risk of weed infestation to category II and III weeds (Parendes 1997).

Desired Future Condition

New detections of category II and III weeds show a decreasing trend annually with no increases in percent cover of weeds along roadsides. Weed prevention measures are incorporated into all project planning and implementation including timber sales, service contracts, construction contracts, special use permits and force account work. Site-specific management plans are in place to contain, control and prevent the spread of category III weeds as new sites and/or species are detected.

Recommendations

The following weed prevention measures for road corridors should be considered and, where applicable, included when planning and implementing work (USDA 2001a).

Equipment cleaning – Require equipment cleaning for:

- All equipment brought onto the Forest;
- All equipment moved from infested areas (category II and III weeds) to uninfested areas; and
- Equipment moved from anywhere into an uninfested sensitive area (such as Mary's Peak).
- Equipment cleaning should apply to all contract, force account, cooperator and special use equipment and would apply to tractors, mowers, graders and other equipment including vehicles and ATVs that have been used off the road surface.

Competitive seeding – Seed disturbed sites lacking canopy cover using native species seed mix. Consult with Forest botanist for current seed mix, seeding window and fertilizer prescription.

Maintain Canopy Cover – Maintain existing canopy cover to the extent possible when designing new roads or marking clearing limits for temporary roads.

Certified Weed free Seed – Use only certified weed-free seed for roadside revegetation. Seed purchased should be tested using the All States Noxious Weed List.

Weed-Free Rock Sources – Consider development of a quarry certification program and use only weed-free rock sources for road construction and maintenance.

Close roads – Close Forest roads not needed for the foreseeable future. Gated roads and roads that are storm-proofed and allowed to grow-in are at a much lower risk for weed invasion and transport than maintained roads.

Quarantines – Consider the use of Oregon Department of Agriculture quarantines (ORS 561.510 & 561.540, 2001) if needed for new weed species or plant pathogens.

Inventory – Conduct annual weed inventory of the Forest road system and maintain a current GIS weed inventory layer available for use by project planners and implementation personnel.

Treatment – The 2010 Siuslaw Invasive Plant Treatment Environmental Assessment Decision Notice identified 1,966 acres (74 sites) of invasive plants and sites that are a high priority for treatment using herbicides, and manual and mechanical methods. Additionally, Several recent Environmental Assessment Decisions (East Alsea, North Fork Siuslaw) have included invasive plant treatments and an early detection rapid response strategy.

Internal and External Weed Education – Address weed issues during school presentations and interpretive walks. Provide increased awareness of weed issues and prevention methods within the Forest Service workforce through training sessions and presentations during workforce meeting.

Social Issue

Wildfire Occurrence and Suppression

- **Roads influence wildfire occurrence and suppression by increasing human access to the Forest.**

Current Situation

Road systems within the national forest system, serve a very important purpose in the suppression of wildfires. Fire Regimes are based on frequency and intensity of wildfires across the land base. Areas with a long fire return interval of hundreds of years are usually high intensity stand replacement events over a large-scale area and occur during the most severe dry weather patterns for those areas. Road systems can affect the response time to “initial attack” fires and can make the difference whether or not these fires become extended attack project type fires. In addition, the road system increases access to humans, thereby increasing the incidence of human caused fire ignitions.

On the Westside of the Siuslaw National Forest, the fire suppression effort is a cooperative effort between Oregon Department of Forestry (ODF) and the US Forest Service (USFS) working under a cooperative agreement. When the USFS decommissions roads, that action can affect the ability of cooperators to access lands for which they have fire protection responsibility. These roads need to have ODF oversight and agreement.

In general, roads have to be evaluated on a case-by-case basis while maintaining the big picture, sub-basin approach. On the Westside, if we can limit public access, we normally can limit the risk of human caused wildfires. However, in the event that we do incur fires with poor accessibility, the risk of a catastrophic event occurring is greatly increased.

Figure 30 Roads provide access to fire engines

Risks and Benefits

The majority of fire ignitions are human caused, as lightning is a rare event or is accompanied by rainfall amounts that keep fires small. The level of public access to the Forest is commensurate with the risk of a fire ignition during severe fire weather conditions. Access that allows the public to drive over waterbars, but hampers access by fire equipment is the worst-case scenario. Roads that are gated or block public access during fire season, but still maintain access for administrative use in order to fight wildfires are the best-case scenarios. However, funds for the best-case scenario transportation systems are not available and wildlife and hydrologic systems do not benefit from maintaining a high road intensity level.

Another risk is that the amount of commercial thinning on the Siuslaw is creating an increase in fuel loading above historic levels without generating a level of funding to properly treat hazardous fuels on the ground. Therefore, any fires that do occur in unroaded areas, or areas where we have decommissioned the road system, have the potential to become high intensity fires and delay stands from reaching the desired late seral stages of development.

Risk to the public in areas with poor accessibility could result in higher property damage and a greater risk of the fire spreading off of national Forest lands. Dead-end roads are a high risk to firefighter safety as the escape routes are very limited. These areas also need to have agreement with our cooperators concerning any road decommissioning that could affect their ability to provide adequate fire protection.

The amount of road system left intact and accessible is a real key to the fire suppression effort, especially where adjacent private landowners are in the process of harvesting their lands or have the potential to harvest their lands in the future. The majority of these lands are located in the valley bottoms with national Forest lands above them on the ridge tops. Thus, the road system positioned on ridge tops soon become the best alternative for firebreaks and control lines.

Desired Future Condition

The Key Road system is maintained to a high standard that provides safe access for fire suppression crews and equipment.

Strategic ridgetop roads are maintained and regularly cleared of brush for potential use as fuel breaks.

Access to water in the stream bottoms is maintained. Road systems that lead to these areas are identified in pre suppression plans and maintained as a key component of the fire suppression effort. Suppression actions are undertaken quickly and initial attack objectives minimize the amount of acres burned.

Figure 31 Road access assists wildland firefighters

Recommendations

Roads determined to be Key Forest Routes should be maintained at a high level for quick response of emergency vehicles of all sizes and visibility for safe travel.

Identify key water sources at the district level and maintain road access to these key water sources.

Consult with suppression cooperators when determining which roads to close or decommission.

For Firefighter Safety: Roads accessible by fire equipment should be accurately mapped and signed, and this information provided to firefighters to support effective suppression/pre-suppression strategies and avoid potential entrapment.

This information should also reside in the Forest Geographic Information System (GIS) for use at the appropriate scale based on fire size and location.

Identify ridgetop roads that should be maintained to serve as firebreaks and control lines.

5. Key Recommendations

This section summarizes the key recmmendations outlined in prior sections. The recommendations are organized by activity, such as, planning, road maintenance, etc. Page references are provided for easy referral to more detailed information related to the recommendation.

Project Design

Strategic Planning

Use the Key Road system as the basis for making site-specific road management decisions. If needed, adjust the Key Road system to meet changing needs and conditions over time (pp. 42, 46).

Follow recommendations of watershed analyses and the Meeting the Challenge…Providing Ecosystem Services for our Communities (USDA 2006) (pp. 48, 49, 50, 51, 54, 56, 57, 58).

Maintain access to private lands (page 46).

Maintain linkages between State Highway 101 and the county road system, as well as the east-west flow of local community and emergency traffic over the Oregon Coast Range. If budget shortfalls limit maintenance of the Key Forest Road system to standard, consider site-specific maintenance as problems arise (page 46).

At the district or appropriate scale, consider whether the Key Forest Roads meet current public access needs. If such needs are not addressed by the current Key Road system, adjustments or modifications to the Key Road system can be addressed at the watershed/project scale analysis (page 46).

Consult with fire suppression cooperators when determining which roads to close or decommission (page 67).

Ridgetop roads should be maintained to serve as firebreaks and control lines (page 67).

Limit roadside salvage sales to the Key Forest Roads. Non-Key roadside salvage associated with project planning may be appropriate. (page 60).

Site-Specific Planning

Identify roads at risk for resource damage. Close, decommission or stabilize them. Seek alternative routes where possible.

- Mid-slope roads (page 51).
- Roads with a high risk of landslides (pp. 48, 51)
- Roads adjacent to low-gradient streams and floodplains (page 51).
- Reduce or eliminate impacts to coho salmon (page 54).
- Reduce disturbance of coho salmon (use of dispersed areas) (page 54).

Consider the following factors in determination of impacts on fish and other aquatic resources (page 57):

- Type, condition, and number of stream crossings at a road-segment scale.

- 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%.
- Road maintenance records. At a minimum, a record of maintenance accomplished (date, type), including knowledge of site-specific chronic or severe maintenance sites should be documented.
- Documentation of known spawning reaches with review by state and other agency biologists.
- Track temporary road locations, construction, and decommissioning or obliteration. This information is required in ESA consultation, but is not currently tracked in the Forest road database.

Minimize disturbance to wildlife and fish resources by:

- Closing or restricting access to roads used intermittently for forest management activities (pp. 54, 60).
- Decommissioning unneeded roads (page 60).
- Minimizing the effect of noise from road maintenance, reconstruction or decommissioning by managing the seasonal and hourly operating periods of projects (page 60).
- Prohibiting the operation of ATV (All Terrain Vehicles) and other vehicles on closed or decommissioned roads by using road closure devices and administrative regulations (page 60).

Where fish passage is affected, use an interdisciplinary process in the design of culverts (*e.g.*, fisheries biology, engineering, geomorphology, hydraulics, hydrology) (page 58).

Focus silvicultural treatment on stands accessible from the Key Road system and other hydrologically stable roads (*e.g.*, ridgetop roads). Roads that will be decommissioned may be used for silvicultural treatment prior to decommissioning (page 62).

Road Maintenance

Roads determined to be Key Forest Routes should be maintained at a high level for quick response of emergency vehicles of all sizes and visibility for safe travel (page 67).

Annually inventory annual and deferred maintenance needs of the Key Forest Road system. Prioritize road maintenance work to ensure resource protection and user safety within current Forest budgets.

Consider alternative funding sources for road maintenance and repair (page 42).

- Identify roads at risk for resource damage. Close, decommission or stabilize them. Seek alternative routes if possible.
- Roads chronically increasing fine sediment in aquatic habitat (page 56).
- Roads with a high risk of landslides (pp. 48, 51).
- Close Forest roads not needed for the foreseeable future. Gated roads and roads that are storm-proofed and allowed to grow-in are at a much lower risk for weed invasion and transport than maintained roads (page 65).
- Prioritize repair and upgrade of culverts based on risk of failure and impact to fish passage and other aquatic resources (page 58).

Use available references for road closure and obliteration. The following is a partial list:

- A Guide for Road Closure and Obliteration in the Forest Service (Moll 1996).
- Forest Road Obliteration and Upgrade Guide (USDA 1995b).
- Waterbar Placement and Construction Guide for Siuslaw Forest Roads (USDA 1998a).

Identify and maintain road access to:

- Key water sources (page 67).
- Key access points to accommodate equipment needed for thinning stands (page 62).

Road Treatments

When closed roads are reopened, use minimal impact techniques (page 62). For example:

- Keep clearing width to a minimum.
- Avoid sidecasting clearing debris and rootwads.

Match road design with season of operation (*i.e.*, rock to support winter haul; rock north slopes when hauling during rainy season) (page 62).

Ensure road is properly closed, when work is completed.

Waterbars:

- Install and maintain surface crossdrains (*e.g.*, waterbars, grade dips, outslope drains, *etc*.) on roads not designated for passenger cars (page 49).
- Install and maintain surface crossdrains (*e.g.*, waterbars, grade dips, outslope drains, *etc*.) on secondary high clearance roads to allow water from the ditch line to travel across the road surface to the slope below. This would dissipate water intercepted by cutbanks and prevent it from being delivered directly to stream channels (page 50).

- Disconnect road system from stream channels by waterbarring roads wherever possible. This would deliver water as naturally as possible to the slope below the road rather than concentrating runoff along ditch lines to the nearest stream, thereby extending the stream network artificially (page 50).

- Provide temporary drainage such as waterbars for wet areas (*e.g.*, seeps, springs). Reestablish natural drainage prior to road closure (page 62).

Rock:

- Provide an adequate covering of rock on roads that will remain open (page 49).

- Use Weed-Free Rock Sources – Consider development of a quarry certification program and use only weed-free rock sources for road construction and maintenance (page 65).

Vegetation:

- Leave ditches vegetated as often as possible. Vegetation acts as a filter and reduces the amount of fine sediment that reaches stream crossings (page 49).

- Maintain existing canopy cover to the extent possible when designing new roads or marking clearing limits for temporary roads in order to reduce invasive noxious weed species (page 64).

Seeding:

- Competitive seeding – Seed disturbed sites lacking canopy cover using native species seed mix. Consult with Forest botanist for current seed mix, seeding window and fertilizer prescription (page 64).

- Certified Weed free Seed – Use only certified weed-free seed for roadside revegetation. Seed purchased should be tested using the All States Noxious Weed List (page 64).

To control spread of noxious weeds, require equipment cleaning for:

- All equipment brought onto the Forest;

- All equipment moved from infested areas (category II and III weeds) to uninfested areas; and

- Equipment moved from anywhere into an uninfested sensitive area (such as Mary's Peak).

- Equipment cleaning should apply to all contract, force account, cooperator and special use equipment and would apply to tractors, mowers, graders and other equipment including vehicles and ATVs that have been used off the road surface (page 64).

Consider the use of Oregon Department of Agriculture quarantines (ORS 561.510 & 561.540, 2001) if needed for new weed species or plant pathogens (page 64).

Where fish passage is affected, use an interdisciplinary process in the design of culverts (*e.g.*, fisheries biology, engineering, geomorphology, hydraulics, hydrology) (page 58).

Restrict timber haul on sensitive roads to the dry season. If timber haul must take place during the wet season, monitor rainfall, and reduce or eliminate timber haul during rain events (page 49).

Inventory & Monitoring

Inventory:

- Utilize the stream crossing inventory to identify all road-stream crossings (*i.e.*, culverts) on the Forest. Prioritize repair and upgrade of culverts based on risk of failure and impact to fish passage and other aquatic resources (page 58). Update as necessary.
- Annual weed inventory of the Forest road system; maintain a current GIS weed inventory layer available for use by project planners and implementation personnel (page 64).

Monitoring:

Report Forest-wide system road miles, open road miles, closed (stored) road miles and road miles decommissioned in the Annual Monitoring and Evaluation Report

Additional Analysis

Explore options for learning about the effects of simplification of channel conditions at road crossings (*e.g.*, removal of roughness elements like large woody debris) on streamflows and fish habitat (page 54).

Explore opportunities to learn more about the impact of fine sediment on aquatic species habitat and survival. Use floods as an opportunity to learn more about stream dynamics (page 56).

Explore opportunities to learn about specific fish runs in areas with high road densities. Consider partnerships with other agencies and stakeholders for more efficient and cost-effective analysis (page 57).

Other

For Firefighter Safety: Roads accessible by fire equipment should be accurately mapped and signed, and this information provided to firefighters to support effective suppression/pre-suppression strategies and avoid potential entrapment (page 67).

This information should also reside in the Forest Geographic Information System (GIS) for use at the appropriate scale based on fire size and location.

Internal and External Weed Education – Address weed issues during school presentations and interpretive walks. Provide increased awareness of weed issues and prevention methods within the Forest Service workforce through training sessions and presentations during workforce meeting (page 64).

Glossary

Road terms are defined in FSM 7705 (USDA 2001b). Some terminology has been updated, and is therefore different than that described in the 1994 ATM Guide in Appendix B.

Bridge A road or trail structure, including supports, erected over a depression or an obstruction, such as water, a road, a trail, or railway, and having a deck for carrying traffic or other loads.

Closed Roads A road on which traffic has been excluded by natural blockage, barricade, regulation, or by obscuring the entrance. A closed road is still an operating facility on which traffic has been removed (year-long or seasonal) and remains a national forest system road.

Debris Flow A debris flow is a highly mobile slurry of soil, rock, vegetation, and water that can travel thousands of yards from its point of initiation and usually occurs in steep (greater than approximately 6 degrees) and confined mountain channels. Debris flows are initiated by liquefaction of landslide debris concurrently with failure or immediately thereafter as the soil mass and reinforcing roots break up. Erosion of additional sediment and organic debris in small and steep channels can increase the volume of the original landslide by 1000% or more, enabling debris flows to become more destructive as their volumes increase with distance traveled." (Benda Unknown)

Designated road, trail or area A National Forest System road, a National Forest System trail, or an area on National Forest System lands that is designated for motor vehicle use pursuant to Section 212.51 on a motor vehicle use map (36 CFR 212.1).

Forest road or trail A road or trail wholly or partially within or adjacent to and serving the National Forest System that the Forest Service determines is necessary for the protection, administration, and utilization of the National Forest System and the use and development of its resources (36 CFR 212.1).

High Clearance Road **–** Suitable for standard pick-up truck travel.

Low Clearance Road **–** Suitable for passenger car travel.

Forest transportation facility A Forest road or trail or an airfield that is displayed in a forest transportation atlas, including bridges, culverts, parking lots, marine access facilities, safety devices, and other improvements appurtenant to the forest transportation system (36 CFR 212.1).

Forest transportation system The system of National Forest System roads, National Forest System trails, and airfields on National Forest System lands.

Forest transportation system management The planning, inventory, analysis, classification, recordkeeping, scheduling, construction, reconstruction, maintenance, decommissioning, and other operations undertaken to achieve environmentally sound, safe, cost-effective, access for use, protection, administration, and management of national forest system lands.

Grade dip A shallow, long, rolling dip in the road surface that intercepts surface water running on the road and in the road ditch and then deposits it over the outside edge of the road.

Interstitial In this document, small, narrow spaces between gravel particles.

Maintenance Level 1. These are roads that have been placed in storage between intermittent uses. The period of storage must exceed 1 year. Basic custodial maintenance is performed to prevent damage to adjacent resources and to perpetuate the road for future resource management needs. Emphasis is normally given to maintaining drainage facilities and runoff patterns. Planned road deterioration may occur at this level. Appropriate traffic management strategies are "prohibit" and "eliminate" all traffic. These roads are not shown on motor vehicle use maps.

Roads receiving level 1 maintenance may be of any type, class, or construction standard, and may be managed at any other maintenance level during the time they are open for traffic. However, while being maintained at level 1, they are closed to vehicular traffic but may be available and suitable for nonmotorized uses.

Maintenance Level 2. Assigned to roads open for use by high clearance vehicles. Passenger car traffic, user comfort, and user convenience are not considerations. Warning signs and traffic control devices are not provided with the exception that some signing, such as W-18-1 “No Traffic Signs,” may be posted at intersections. Motorists should have no expectations of being alerted to potential hazards while driving these roads. Traffic is normally minor, usually consisting of one or a combination of administrative, permitted, dispersed recreation, or other specialized uses. Log haul may occur at this level. Appropriate traffic management strategies are either to:

a. Discourage or prohibit passenger cars, or

b. Accept or discourage high clearance vehicles.

Maintenance Level 3. Assigned to roads open and maintained for travel by a prudent driver in a standard passenger car. User comfort and convenience are not considered priorities. The Manual on Uniform Traffic Control Devices (MUTCD) is applicable. Warning signs and traffic control devices are provided to alert motorists of situations that may violate expectations.

Roads in this maintenance level are typically low speed with single lanes and turnouts. Appropriate traffic management strategies are either "encourage" or "accept." "Discourage" or "prohibit" strategies may be employed for certain classes of vehicles or users.

Maintenance Level 4. Assigned to roads that provide a moderate degree of user comfort and convenience at moderate travel speeds. Most roads are double lane and aggregate surfaced. However, some roads may be single lane. Some roads may be paved and/or dust abated. Manual on Uniform Traffic Control Devices is applicable. The most appropriate traffic management strategy is "encourage." However, the "prohibit" strategy may apply to specific classes of vehicles or users at certain times.

Maintenance Level 5. Assigned to roads that provide a high degree of user comfort and convenience. These roads are normally double lane, paved facilities. Some may be aggregate surfaced and dust abated. Manual on Uniform Traffic Control Devices is applicable. The appropriate traffic management strategy is "encourage."

National Forest System Road A forest road other than a road which has been authorized by a legally documented right-of-way held by a State, county, or other local public road authority (36 CFR 212.1).

Open Roads A national forest system road open for vehicular use (*e.g.,* passenger cars, pickup trucks and commercial vehicles). National forest system roads are subject to administrative, seasonal, temporary, or permanent closure.

Public Roads Any road or street under the jurisdiction of and maintained by a public authority and open to public travel (23 U.S.C. 101(a)).

Riprap Foundation or wall of broken rock used to armor shorelines, streambeds, bridge abutments, pilings and other shoreline structures against scour, water or ice erosion.

Road A motor vehicle route over 50 inches wide, unless identified and managed as a trail (36 CFR 212.1).

Road Construction or Reconstruction Supervising, inspecting, actual building, and incurrence of all costs incidental to the construction or reconstruction of a road (36 CFR 212.1).

Road Decommissioning Activities that result in the stabilization and restoration of unneeded roads to a more natural state (36 CFR 212.1).

Road Maintenance the upkeep of the entire forest transportation facility including surface and shoulders, parking and side areas, structures, and such traffic-control devices as are necessary for its safe and efficient utilization (36 CFR 212.1).

Roads subject to the Highway Safety Act National forest system roads that are open to use by the public for standard passenger cars. This includes roads with access restricted on a seasonal basis and roads closed during extreme weather conditions or for emergencies, but which are otherwise open for general public use.

Stabilization - A process to slope, dip and waterbar travelways to reduce run-off concentrations and alleviate risk of erosion and landslides, should designed drainage structures fail to cant' storm event. This also includes grass seeding slopes. Unstable fill embankments that exceed the required travelway may be partially or fully removed.

Temporary road or trail A road or trail necessary for emergency operations or authorized by contract, permit, lease, or other written authorization that is nota forest road or trail and that is not included in a forest transportation atlas (36 CFR 212.1).

Unauthorized road or trail A road or trail that is not a forest road or trail or a temporary road or trail and that is not included in a forest transportation atlas (36 CFR 212.1).

Waterbar Berm or ditch and beret combination that cuts across roads (and trails) at an angle so that all surface water running on the road and in the road ditch is intercepted and deposited over the outside edge of the road. These normally allow high clearance vehicles to pass.

Bibliography

American Geological Institute. 1976. Dictionary of Geological Terms, revised edition. Prepared under the direction of the American Geological Institute.

Baker, H.G. 1986. Patterns of plant invasion in North America. Pgs. 44-57 in Mooney, H.A.; Drake, J.A. (eds.). **Ecology of biological invasions of North America and Hawaii**. New York: Springer-verlag.

Benda, L, et al. Unknown. Slope Instability and Forest Land Managers. Earth Systems Institute. Seattle, WA.

Ellis-Sugai, Barbara, Impact of the January 2012 flood event on Siuslaw national Forest Roads, 9 pages, 2012.

Forest Service Employees for Environmental Ethics. 1996. **Torrents of Change**, A Cedar Films Production for Forest Service Employees for Environmental Ethics (FSEE) in cooperation with the Siuslaw National Forest and the Pacific Northwest Forest and Range Experimental Station, approx. 25 minutes, copyright 1996, FSEE.

Torrents of Change is a dramatic examination of the relationship between forest management practices and the severity of landslides and debris flows, and the impacts on stream systems and fish, produced by FSEE.

Forman, R.T., and A.M. Hersperger. 1996. Road ecology and road density in different landscapes, with international planning and mitigation solutions. Pages 1-23 in Proceedings of the Florida Department of Transportation/Federal Highway Administration Transportation-Related Wildlife Mortality Seminar, G. Evink, D. Ziegler, and J. Berry, eds. Orlando, Florida, April 30-May 2, 1996.

Furnish, James R. 2002. From Despair to Hope: A Chronicle of Federal Old-Growth Forest Policy in the Pacific Northwest, *The Wilderness Society*, June 2002.

Laenen, A., ed. 1997. The Pacific Northwest Floods of February 6-11, 1996. Proceedings of the Pacific Northwest Water Issues Conference, Portland, OR, October 7-8, 1997. American Institute of Hydrology.

Luce, C.H. and Blackwell, T.A. 2001a. Effects of traffic and ditch maintenance on forest road sediment production. In Proceedings of the Seventh Federal Interagency Sedimentation Conference, march 25-29, 2001, Reno, Nevada, p. V67-V74.

Luce, C.H., et al. 2001b. Incorporating aquatic ecology into decisions on prioritization of road decommissioning. *Water Resources Impact*, v. 3, no. 3, p. 8-14.

Luce, C.H. and Blackwell, T.A. 2001c. Spatial and temporal patterns in erosion from forest roads. In Influence of Urban and Forest Land Uses on the Hdryologic-Geomorphic Responses of watersheds, edited by M.S. Wigmosta and S.J. Burnes. *Water Resources Monographs*, American Geophysical Union, Washington, D.C., p 165-178.

Luce, C.H. and Blackwell, T.A. 1999. Sediment production from forest roads in western Oregon, *Water Resources Research*, v. 35, no.8, p. 2561-2570.

Miller, G. 2002. Noxious Weed Specialist, Oregon Dept. of Agriculture, Personal communication.

Moll J.E. 1996. A Guide for Road Closure and Obliteration in the Forest Service, San Dimas Technology and Development Center, 49 pp.

Murcia, C. 1995. Edge effects in fragmented forests: implications for conservation. *Trends in Ecology and Evolution* 10:58-62.

Oregon State Department of Agriculture. 2001. Oregon Revised Statutes (ORS) Chapter 561.510 & 561.540.

Parendes, L. 1997. Dissertation: Spatial patterns of invasion by exotic plants in a forested landscape, Oregon State University, Corvallis, Oregon.

Reudiger, B. 1996. The relationship between rare carnivores and highways. In Proceedings of the Florida Department of Transportation/Federal Highway Administration Transportation-Related Wildlife Mortality Seminar, G. Evink, D. Ziegler, and J. Berry, eds. Orlando, Florida, April 30-May 2, 1996, pp. 24-38.

Soule, M. 1987. **Viable populations for conservation**. Cambridge University Press, Cambridge, England.

Steinmaus, S. 2002. Predicting Plant Invasion with Modeling. *California Exotic Pest Plant Council News* 10 (1): 5-9.

Stokes, E.V. Director of Engineering. 2002 (November 22). Letter to Regional Foresters, Station Directors, Area Director, IITF Director, Job corps, and WO Staff. Fiscal Year 2003 Deferred Maintenance Protocols. File Code 7100, on file with: Siuslaw National Forest, Corvallis, OR.

USDA Forest Service. 2008. Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings published by San Dimas Technology and Development Program, Forest Service National Technology and Development Program 7700—Transportation Management 0877 1801.

USDA Forest Service. 2006. Meeting the Challenge … Providing Ecosystem Services for our Communities. Siuslaw NF, Corvallis, OR. 12pp.

USDA Forest Service. 2009. Forest Service Manual 7700 – Transportation System. Chapter 7700 – Zero Code and Chapter 7710 – Engineering Management,

USDA. 2005. Pacific Northwest Region Invasive Plant Program Record of Decision. USDA Forest Service, Pacific Northwest Region, Portland, OR. October 2005, R6-NR-FHP-PR-02-05. 39 pp. + appendices..

USDA Forest Service. 1999. Roads Analysis: Informing Decisions about Managing the National Forest Transportation System, Washington Office, FS-643.

USDA Forest Service. 1997 (April 28). Assessment of the Effects of the 1996 Flood on the Siuslaw National Forest, Siuslaw NF, Corvallis, OR.

USDA Forest Service. 1995a. Assessment report: Federal lands in and adjacent to Oregon Coast Province. Two volumes. 200 p. Siuslaw National Forest, Corvallis, OR.

USDA Forest Service, 1995b. Forest Road Obliteration and Upgrade Guide. Siuslaw National Forest, Corvallis, OR.

USDA Forest Service. 1990. Siuslaw Land and Resource Management Plan, Siuslaw National Forest, Corvallis, OR.

USDA Forest Service and USDI Bureau of Land Management. 1994. Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl.

Wemple, B.C., et al. 1996. Channel extension by logging roads in two basins, western Cascades, Oregon, Water Resources Bulletin, v. 32, no. 6, p. 1195-1207.

WATERSHED ANALYSES REFERENCES

[USDA FS] USDA Forest Service. 2000. Beaver watershed analysis. Corvallis, OR: Siuslaw National Forest. 58 p.

[USDA FS] USDA Forest Service. 1997. Benton Foothills watershed analysis. Salem, OR: Salem BLM. 148 p., plus maps and appendices

[USDA FS] USDA Forest Service. 1995. Big Elk watershed analysis. Corvallis, OR: Siuslaw National Forest. 91 p., plus maps and appendices.

[USDA FS] USDA Forest Service. 1998. Coastal lakes watershed analysis. Corvallis, OR: Siuslaw National Forest. 125 p., plus maps and appendices.

[USDA FS] USDA Forest Service. 1994. Cummins-Tenmile watershed analysis. Corvallis, OR: Siuslaw National Forest. 130 p., plus maps and appendices.

[[USDA FS] USDA Forest Service. 1997. Drift Creek Alsea watershed analysis. Corvallis, OR: Siuslaw National Forest. 62 p., plus maps and appendices.

[USDA FS] USDA Forest Service. 1996. Drift Creek Siletz watershed analysis. Corvallis, OR: Siuslaw National Forest. 86 p., plus maps and appendices.

[USDA FS] USDA Forest Service. 1996. Indian-Deadwood watershed analysis. Corvallis, OR: Siuslaw National Forest. 86 p., plus maps and appendices.

[USDA FS] USDA Forest Service. 1997. Benton Foothills watershed analysis. Salem, OR: Salem BLM. 148 p., plus maps and appendices

[USDA FS] USDA Forest Service. 1998. Little Nestucca watershed analysis. Corvallis, OR: Siuslaw National Forest. 87 p. plus maps and appendices.

[USDA FS] USDA Forest Service. 1997. Lobster-Five Rivers watershed analysis. Corvallis, OR: Siuslaw National Forest. 108 p. plus maps and appendices.

[USDA FS] USDA Forest Service. 1999. Lower Alsea River watershed analysis. Corvallis, OR: Siuslaw National Forest. 123 p. plus maps and appendices.

[USDA FS] USDA Forest Service. 1998. Lower Siuslaw watershed analysis. Corvallis, OR: Siuslaw National Forest.

[USDA FS] USDA Forest Service. 1997. Lower Umpqua watershed analysis. Corvallis, OR: Siuslaw National Forest. 41 p. plus appendices.

2000 - Lower Yaquina

[USDA FS] USDA Forest Service. 2005c. Supplement to Marys River Watershed Preliminary Analysis. Corvallis, OR: Siuslaw National Forest. 53 p. plus maps and appendices.

[USDA FS] USDA Forest Service. 1996. Mercer-Berry watershed analysis. Corvallis, OR: Siuslaw National Forest. 129 p. plus appendices. -

USDA Forest Service. 1996. Nestucca watershed analysis. Corvallis, OR: Siuslaw National Forest. 113 p. plus maps and appendices.

[USDI BLM] USDI Bureau of Land Management. 1996. North Fork Alsea Watershed Analysis. Salem, OR: Bureau of Land Management, Salem District, 141 p. plus appendices and maps.

[USDI BLM] USDI Bureau of Land Management. 1996. Siuslaw watershed analysis. Eugene, OR: Eugene BLM. 92 p. plus maps and appendices.

Siuslaw Watershed Council. 2002. Siuslaw Basin watershed analysis. mapleton, OR: Siuslaw watershed Council. 130 p. plus maps and appendices.

[USDA FS] USDA Forest Service. 1994. North Fork of the Siuslaw River watershed analysis. Corvallis, OR: Siuslaw National Forest. 100 p. plus maps and appendices.

[USDA FS] USDA Forest Service. 1997. Smith River watershed analysis. Corvallis, OR: Siuslaw National Forest. 82 p. plus appendices and maps.

[USDA FS] USDA Forest Service., [USDI BLM] USDI Bureau of Land Management. 1999. Salmon-Neskowin watershed analysis. Corvallis, OR: Siuslaw National Forest. 113 p. plus maps and appendices.

[USDA FS] USDA Forest Service. 1998. Sand Lake watershed analysis. Corvallis, OR: Siuslaw National Forest. 113 p. plus maps and appendices.

[USDI BLM] USDI Bureau of Land Management. 1995. South Fork Alsea watershed analysis. Salem, OR: Bureau of Land Management, Salem District. 107 p. plus maps and appendices.

[USDA FS] USDA Forest Service. 1997c. Yachats-Blodgett watershed analysis. Corvallis, OR: Siuslaw National Forest. 83 p. plus maps and appendices.

[USDI BLM] USDI Bureau of Land Management. 1998. Deer Creek/PantherCreek/Williamina Creek/South Yamhill watershed analysis. Tillamook, OR, Tillamook BLM. 87 p. plus appendices and maps.

NEPA REFERENCES

[USDA FS] USDA Forest Service.1995. Environmental Assessment and Decision Notice, Big Ten Road Stabilization project. Corvallis, OR: Siuslaw National Forest.

[USDA FS] USDA Forest Service. 1996. Environmental Assessment and Decision Notice, Big Blue project. Corvallis, OR: Siuslaw National Forest. 47 p. plus appendices.

[USDA FS] USDA Forest Service. 1997. Environmental Assessment and Decision Notice, Big Elk project. Corvallis, OR: Siuslaw National Forest.

[USDA FS] USDA Forest Service. 1998. Environmental Assessment and Decision Notice, Deadwood project. Corvallis, OR: Siuslaw National Forest.

[USFS] US Forest Service. 1997a. Environmental Assessment and Decision Notice, Drift Home project. Corvallis, OR: Siuslaw National Forest. 39 p. plus appendices.

[USDA FS] USDA Forest Service. 1998a. Environmental Assessment and Decision Notice, Enchanted Valley Stream Restoration and Meadow Management Project. Corvallis, OR: Siuslaw National Forest. 87 p. plus appendices.

[USFS] US Forest Service. 2001. Environmental Assessment and Decision Notice, Peach/Fiddle Thin and Related Projects. Corvallis, OR: Siuslaw National Forest.

[USFS] US Forest Service. 2002a. Final Environmental Impact Statement and Record of Decision, Five Rivers Landscape Management Project. Corvallis, OR: Siuslaw National Forest. 113 p. plus appendices.

[[USDA FS] USDA Forest Service. 2002b. Environmental Assessment and Decision Notice, Lower Siuslaw landscape management project. Corvallis, OR: Siuslaw National Forest. 89 p. plus appendices.

[USDA FS] USDA Forest Service. 2004. Environmental Assessment and Decision Notice, Gauldy project. Corvallis, OR: Siuslaw National Forest.

[USDA FS] USDA Forest Service. 2005. Environmental Assessment and Decision Notice, Drift Key Watershed Roads Project. Corvallis, OR: Siuslaw National Forest.

[USDA FS] USDA Forest Service. 2005c. Environmental Assessment and Decision Notice, Yachats terrestrial restoration project. Corvallis, OR: Siuslaw National Forest. 114 p. plus appendices.

[USFS] US Forest Service. 2006a. Environmental Assessment and Decision Notice, Lobster landscape management project. Corvallis, OR: Siuslaw National Forest.

2007 – Little Nestucca

[USFS] US Forest Service. 2008. Environmental Assessment and Decision Notice, West Alsea Landscape Management project. Corvallis, OR: Siuslaw National Forest.

[USFS] US Forest Service. 2009. Environmental Assessment and Decision Notice, Siuslaw Travel Management Project. Corvallis, OR: Siuslaw National Forest.

[USDA FS] USDA Forest Service. 2010. Environmental Assessment and Decision Notice, Marys Landscape Management Project. Corvallis, OR: Siuslaw National Forest.

[USDA FS] USDA Forest Service. 2011. Environmental Assessment and Decision Notice, East Alsea Landscape Management Project. Corvallis, OR: Siuslaw National Forest.

[USDA FS] USDA Forest Service. 2011. Environmental Assessment and Decision Notice, Salmon/Neskowin Landscape Management Project. Corvallis, OR: Siuslaw National Forest.

[USDA FS] USDA Forest Service. 2012. Environmental Assessment and Decision Notice, Fivemile Bell Landscape Management Project. Corvallis, OR: Siuslaw National Forest.

[USDA FS] USDA Forest Service. 2012. Environmental Assessment and Decision Notice, NF Siuslaw Landscape Management Project. Corvallis, OR: Siuslaw National Forest.

[USDA FS] USDA Forest Service. 2012. Environmental Assessment and Decision Notice, Nestucca Roads Project. Corvallis, OR: Siuslaw National Forest.

[USDA FS] USDA Forest Service. 2013. Environmental Assessment and Decision Notice, North Nestucca Landscape Management Project. Corvallis, OR: Siuslaw National Forest.

[USDA FS] USDA Forest Service. 2002b. Environmental Assessment and Decision Notice, Karnowsky Creek Stream Restoration Project. Corvallis, OR: Siuslaw National Forest. 42 p. plus appendices.

[This page intentionally left blank.]