March 30, 2017

Kathleen Nelson, District Ranger
Almanor Ranger District, Lassen National Forest
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Chester, CA 96020
Submitted via email to comments-pacificsouthwest-lassen-almanor@fs.fed.us, janelmccurdy@fs.fed.us

Re: Scoping Comments on Proposed Rocks Restoration Project #49830

Dear District Ranger Nelson:

WildEarth Guardians respectfully submits these comments to the U.S. Forest Service concerning the agency's analysis under the National Environmental Policy Act (NEPA) of the Rocks Restoration Project. The Lassen National Forest is proposing fuels reduction, vegetation management, aspen and meadow habitat improvement, and reforestation of some areas burned in the Storrie fire (2000) and the Chips fire (2012).

WildEarth Guardians is a nonprofit conservation organization with offices in seven states. Guardians has more than 207,000 members and supporters across the United States. Guardians works to protect and restore wildlife, wild places, wild rivers, and the health of the American West. WildEarth Guardians and its members have specific interests in the management of our national forests. We believe that thoughtful management of the agency's road system and its associated impacts can improve the health of watersheds and wildlife on the Lassen National Forest. Please add our names and organizations to the contact list to receive any future public notices regarding this project.

We are very encouraged to see the Lassen National Forest taking efforts to trend the area toward a mosaic of healthy, diverse vegetation. We have several concerns with the Forest Service's analysis, outlined below.

1. **The Forest Service should consider efforts to create a resilient future road system.**

The Forest Service states the purpose of the Rocks project is to retain and restore ecological resilience of National Forest System lands within the project area. Identifying a resilient future road system is one of the most important endeavors the Forest Service can undertake to restore aquatic systems and wildlife habitat, facilitate adaptation to climate change, ensure reliable recreational access, and operate within budgetary constraints. And it is a win-win-win approach: (1) it's a win for the Forest Service's budget, closing the gap between large maintenance needs and declining funding through congressional appropriations; (2) it's a win for wildlife and natural resources because it reduces negative impacts from the forest road system; and (3) it's a win for the public because

removing unneeded roads from the landscape allows the agency to focus its limited resources on the roads we all use, *improving* public access across the forest and helping ensure roads withstand strong storms.

We are discouraged to see the Forest Service proposing additions to the road system (proposing to add both unauthorized roads and temporary roads to the official road system). We urge the agency to adopt a thoughtful, strategic approach to improving public access to the forest, reducing negative impacts from forest roads to water quality and aquatic habitats, and improving watersheds and forest resiliency that is in line with the Lassen's long-term funding expectations.

2. **As part of its analysis of the Rocks Restoration Project under NEPA, the Forest Service must consider the Lassen's travel analysis report, identify the minimum road system, and identify unneeded roads to prioritize for decommissioning or other uses.**

The Forest Service faces many challenges with its oversized, under-maintained, and unaffordable road system. The impacts from roads to water, fish, wildlife, and ecosystems are tremendous and well documented in scientific literature. The Lassen National Forest is no exception, with costs to maintain system roads exceeding its annual maintenance budget.

To address its unsustainable and deteriorating road system, the Forest Service promulgated the Roads Rule (referred to as "subpart A") in 2001. 66 Fed. Reg. 3206 (Jan. 12, 2001); 36 C.F.R. part 212, subpart A. Subpart A is meant to close the gap between the agency's limited resources and the maintenance required to keep up its oversized and deteriorating road system. It sets out two important obligations for the agency:

(1) Identify unneeded roads to prioritize for decommissioning or to be considered for other uses; and
(2) Identify the minimum road system needed for safe and efficient travel and for the protection, management, and use of National Forest system lands.

36 C.F.R. § 212.5(b). We urge the Forest Service to carefully evaluate the proposed Rocks Restoration action and each of the alternatives through this lens.

Direction from the Forest Service's Washington Office required all forests to submit travel analysis reports by the end of FY 2015 and then begin implementing the recommendations and working towards full compliance with subpart A.[1] The Lassen National Forest completed travel analysis reports in 2006 and 2008.[2] These reports need to be updated and revised to accord with the Washington Office's direction.[3]

[1] *See* Memorandum from Leslie Weldon to Regional Foresters *et al.* on Travel Management, Implementation of 36 CFR, Part 212, Subpart A (March 29, 2012) (hereafter 2012 Weldon Memo).
[2] *See, e.g.*, U.S. Forest Service, Lassen National Forest, Forest ObML 3-5 Roads Roads Analysis Process (July 28, 2006) (Attachment A). The Lassen's website also lists a Travel Analysis Process report for ML 1-2 roads, dated April 2008, but the link to that report was unavailable.
[3] *See, e.g.*, Attachment A at 8-9 (noting 739 miles of ML 3, 4, and 5 roads but omitting any analysis of long-term funding expectations to support future maintenance of those road miles).

Even more important, however, is the next step under subpart A: Consider the recommendations from the travel analysis reports to identify the minimum road system[4] and identify unneeded roads for decommissioning. Given that with this project you are considering changes to the transportation system, the project aim is to retain and restore ecological resilience, and given its large geographic scale, this is precisely the type of project to complete the next step.[5]

To identify the minimum road system, the Forest Service must consider whether each road segment the agency decides to maintain on the system is needed to meet certain factors outlined in the agency's own regulation.[6] Here, the Forest Service should consider whether each segment of the road system within the project area is needed to:

(1) Meet resource and other management objectives adopted in the relevant land and resource management plan;
(2) Meet applicable statutory and regulatory requirements;
(3) Reflect long-term funding expectations; and
(4) Ensure that the identified system minimizes adverse environmental impacts associated with road construction, reconstruction, decommissioning, and maintenance.

36 C.F.R. § 212.5(b)(1). In assessing specific road segments, the Forest Service should also consider the risks and benefits of each road as analyzed in the travel analysis report, and whether the proposed road management measures are consistent with the recommendations from the travel analysis report. To the extent that the final decision in this project differs from what is recommended in the travel analysis report, the Forest Service must explain that inconsistency. *See, e.g.*, *Smiley v. Citibank*, 517 U.S. 735 (1996) ("Sudden and unexplained change . . . or change that does not take account of legitimate reliance on prior interpretation . . . may be 'arbitrary, capricious [or] an abuse of discretion") (internal citations omitted).

Finally, the Forest Service must identify unneeded roads for decommissioning or other uses. 36 C.F.R. § 212.5(b)(2).[7] Here, the Forest Service proposes to improve designated motorized trails and roads, upgrade and add 0.3 miles of unauthorized routes to the road system, and construct or reconstruct 0.2 miles of temporary roads. *See* Proposal at 15-16.

Based on current natural resource conditions, assessed risks from the existing road network, the agency's limited resources, and long-term funding expectations, and the goal of retaining or improving ecological resilience, road decommissioning or closures are warranted. Road decommissioning can temporarily increase sediment to streams but has dramatic reductions in the long run. The Forest Service's Rocky Mountain Research Station has spent over a decade monitoring the effectiveness of road treatments. A 2012 report evaluating pre and post treatment of

[4] 36 C.F.R. § 212.5(b)(1) ("In determining the minimum road system, the responsible official must incorporate a science-based road analysis at the appropriate scale").
[5] 2012 Weldon Memo at 2 ("The next step in identification of the [minimum road system] is to use the travel analysis report to develop proposed actions to identify the [minimum road system]. These proposed actions generally should be developed at the scale of a 6th code subwatershed or larger.").
[6] *Id.* Weldon Memo at 2012 ("analyze the proposed action and alternatives in terms of whether, per 36 CFR 212.5(b)(1), the resulting [road] system is needed"); ("The resulting decision [in a site-specific project] identifies the [minimum road system] and unneeded roads for each subwatershed or larger scale").
[7] 36 C.F.R. § 212.1 (defining a road as "[a] motor vehicle travelway over 50 inches wide, unless designated and managed as a trail.").

roads showed an 80% reduction in sediment delivery to streams when roads were decommissioned. Nelson N., Black T., Luce C. and R. Cissel, U.S. Forest Service Rocky Mountain Research Station, LRT Monitoring Project Update 2012. In addition, the 20-year monitoring report of the Northwest Forest Plan confirmed that watersheds that showed the most improvement in condition were those that completed road decommissioning.

3. The Forest Service should prepare a robust environmental analysis under NEPA.

The Forest Service should prepare a robust environmental analysis of the Rocks Restoration Project. The agency may not ignore topics if the information is uncertain or unknown. Where information is lacking or uncertain, the Forest Service must make clear that the information is lacking, the relevance of the information to the evaluation of foreseeable significant adverse effects, summarize the existing science, and provide its own evaluation based on theoretical approaches. 40 C.F.R. § 1502.22.

a. The Forest Service should clearly articulate the statement of purpose to include its duty to identify the minimum road system and unneeded roads for decommissioning, and provide support for the claimed need.

Applicable statutory and regulatory requirements should shape a project's statement of purpose and need. When the agency takes an action "pursuant to a specific statute, the statutory objectives of the project serve as a guide by which to determine the reasonableness of objectives outlined in an EIS." *Westlands Water Dist. v. U.S. Dept. of Interior,* 376 F.3d 853, 866 (9th Cir. 2004). Under subpart A of its travel rule, the Forest Service has a substantive duty to address its over-sized road system. *See* 36 C.F.R. § 212.5. This underlying substantive duty must inform the scope of, and be included in, the agency's NEPA analysis. After more than 15 years since finalizing the subpart A rules, the Forest Service can no longer delay in addressing this duty.

b. The Forest Service must consider a broad array of impacts related to forest roads in its NEPA analysis.

NEPA requires Forest Service to "[e]ncourage and facilitate public involvement in decisions which affect the quality of the human environment." 40 C.F.R. § 1500.2(d). A critical part of this obligation is presenting data and analysis in a manner that will enable the public to thoroughly review and understand the analysis of environmental consequences. NEPA procedures must insure that environmental information is available to public officials and citizens before decisions are made and before actions are taken. The information must be of high quality. Accurate scientific analysis, expert agency comments, and public scrutiny are essential to implementing NEPA. Most importantly, NEPA documents must concentrate on the issues that are truly significant to the action in question, rather than amassing needless detail. 40 C.F.R. § 1500.1(b). The Data Quality Act expands on this obligation, requiring that influential scientific information use "best available science and supporting studies conducted in accordance with sound and objective scientific practices." Treasury and General Government Appropriations Act for Fiscal Year 2001, Pub.L. No. 106-554, § 515.

Impacts from Forest Roads

The best available science shows that roads cause significant adverse impacts to National Forest resources. A 2014 literature review from The Wilderness Society surveys the extensive and best

available scientific literature—including the Forest Service's General Technical Report synthesizing the scientific information on forest roads (Gucinski 2001)—on a wide range of road-related impacts to ecosystem processes and integrity on National Forest lands. *See* The Wilderness Society, *Transportation Infrastructure and Access on National Forests and Grasslands: A Literature Review* (May 2014) (Attachment B). Erosion, compaction, and other alterations in forest geomorphology and hydrology associated with roads seriously impair water quality and aquatic species viability. Roads disturb and fragment wildlife habitat, altering species distribution, interfering with critical life functions such as feeding, breeding, and nesting, and resulting in loss of biodiversity. Roads facilitate increased human intrusion into sensitive areas, resulting in poaching of rare plants and animals, human-ignited wildfires, introduction of exotic species, and damage to archaeological resources.

Climate Change and Forest Roads

Climate change intensifies the impacts associated with roads. A robust analysis under NEPA of the forest road system and its environmental and social impacts is especially critical in the context of climate change. The Forest Service should consider the risk of increased disturbance when analyzing this proposed project. For example, as the warming climate alters species distribution and forces wildlife migration, landscape connectivity becomes even more critical to species survival and ecosystem resilience. *Id.* at 9-14. *See also* USDA, Forest Service, *National Roadmap for Responding to Climate Change* at 26 (2011), *available at* http://www.fs.fed.us/climatechange/pdf/Roadmapfinal.pdf (recognizing importance of reducing fragmentation and increasing connectivity to facilitate climate change adaptation).

Climate change is also expected to lead to more extreme weather events, resulting in increased flood severity, more frequent landslides, altered hydrographs, and changes in erosion and sedimentation rates and delivery processes. Many National Forest roads are poorly located and designed to be temporarily on the landscape, making them particularly vulnerable to these climate alterations. Even those designed for storms and water flows typical of past decades may fail under future weather scenarios, further exacerbating adverse ecological impacts, public safety concerns, and maintenance needs. The Forest Service should analyze in detail the impact of climate change on forest roads and forest resources.

The Forest Service should consider the impacts of climate change and the cumulative impacts resulting from the project and climate change. Pursuant to final guidance issued by the Council on Environmental Quality (CEQ) on August 1, 2016,[8] all federal projects should consider:

(1) The potential effects of a proposed action on climate change as indicated by assessing greenhouse gas (GHG) emissions (e.g., to include, where applicable, carbon sequestration); and
(2) The effects of climate change on a proposed action and its environmental impacts.

CEQ's 2016 final guidance recommends agencies quantify a proposed agency action's projected

[8] *See* Council on Environmental Quality, Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews (2016) (noting that "[a]nalyzing a proposed action's GHG emissions and the effects of climate change relevant to a proposed action—*particularly how climate change may change an action's environmental effects*—can provide useful information to decision makers and the public.").

direct and indirect GHG emissions, taking into account available data and GHG quantification tools suitable for the proposed agency action. It suggests agencies use projected GHG emissions as a proxy for assessing potential climate change effects. And it recommends that where an agency does not quantify an action's projected GHG emissions because tools, methodologies, or data inputs are not reasonably available to support calculations for a quantitative analysis, it should include a qualitative analysis in the NEPA document and explain the basis for determining that quantification is not reasonably available.

The Forest Service should include existing and reasonably foreseeable climate change impacts as part of the affected environment, assess them as part of the agency's hard look at impacts, and integrate them into each of the alternatives, including the no action alternative. The Forest Service has a substantive duty under its own Forest Service Manual to establish resilient ecosystems in the face of climate change.[9] The Forest Service should analyze in detail the impact of climate change on forest roads and resources. The analysis here fails to address the cumulative impacts of climate change and forest roads on the landscape.

c. The Forest Service must consider a reasonable range of alternatives.

The alternatives analysis is the "heart" of NEPA, and therefore "an agency must *on its own initiative* study all alternatives that appear reasonable and appropriate for study at the time, and must also look into other significant alternatives that are called to its attention by other agencies, or by the public during the comment period afforded for that purpose." *Dubois v. Dep't of Agriculture*, 102 F.3d 1273, 1291 (1st Cir. 1996), *quoting Seacoast Anti-Pollution League, v. Nuclear Reg. Comm'n*, 598 F.2d 1221, 1231 (1st Cir. 1979) (emphasis from *Dubois* court) (internal citations omitted).

Conclusion

The Forest Service's current road system is over-sized and unaffordable. Identifying a sustainable future road system is one of the most important endeavors the Forest Service can undertake to restore aquatic systems and wildlife habitat, facilitate adaptation to climate change, enhance recreation, and lower operating expenses.

Sincerely,

Marla Fox, Rewilding Attorney
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[9] *See, e.g.*, FSM 2020.2(2) (directing forests to "[r]estore and maintain resilient ecosystems that will have greater capacity to withstand stressors and recover from disturbances, especially those under changing and uncertain environmental conditions and extreme weather events"); FSM 2020.3(4) ("[E]cological restoration should be integrated into resource management programs and projects . . . Primary elements of an integrated approach are identification and elimination or reduction of stressors that degrade or impair ecological integrity.").

Forest ObML 3-5 Roads
Roads Analysis Process

United States
Department of
Agriculture

Forest
Service

Pacific
Southwest
Region

July 28, 2006

Lassen National Forest

LASSEN NATIONAL FOREST

Forest RAP ML 3-5

JANUARY 2007

Acting Forest Supervisor **Jeff Withroe** _____

Steering Committee
Almanor District Ranger **Al Vazquez**_____

Ecosystems Staff Officer **Jeff Withroe**_____

Forest Engineer **Jack Walton**_____

Prepared by
Forest Transportation Planner **Tim Dedrick**_____

TABLE OF CONTENTS

Introduction

In fulfillment of:

1. Forest Service Miscellaneous Report FS-643, Roads Analysis: Informing Decisions About Managing the National Forest Transportation System, 1999.
2. Forest Service Manual Chapter 7700 – Transportation System – Zero Code 7700 – 7709.5 inclusive and specifically Federal Register Part 5 – Forest System Road Management Rule of January 12, 2001.
3. Forest Service Manual Chapter 7710 – Transportation System – Transportation Atlas, Records, and Analysis, 7712.1-7712.6 inclusive – Roads Analysis, December 16, 2003.

The Roads Analysis Process is a road management system set of recommendations that provides an integrated-science approach to Transportation Planning. The recommendations are specific dispositions for each road to guide the continued use, maintenance, improvements, and disposal of the Lassen N.F. transportation system in support of its administrative needs and functions.

This Forest roads analysis was directed to address the present, existing conditions of the transportation system, specifically the objective maintenance level 3, 4, and 5 roads within the Lassen National Forest. The product of this analysis effort is an interdisciplinary team's planning perspective, an inventory of the Forest's ML 3, 4, 5, roads which leads to a set of recommendations for each road. The inventory identifies risks (potential resource damage) and opportunities (resource enhancement) for improving the roads. At the Forest scale this inventory analysis will lead to the critique and review of road management objectives, but it will not identify the District specifics of a minimum transportation system. The District or Project level roads analysis process will determine recommendations for a minimum transportation system.

This area encompasses approximately 1,875 square miles or 1.2 million acres. The Lassen Volcanic National Park is situated within the central-western section of the Forest. The Forest Service administrative units occupied by this area include the Almanor, Eagle Lake, and Hat Creek Ranger Districts. The Lassen National Forest includes portions of Lassen, Plumas, Tehama, Shasta, Butte, Siskiyou, and Modoc Counties.

This roads analysis is based on the six-step scientific guideline format contained within publication – USDA Forest Service, Rocky Mountain Research Station FS-643, Roads Analysis: *Informing Decisions about Managing the National Forest Transportation System*, Washington DC 1999, and can be found in the project record.

The analysis is designed to be scaleable, flexible, and driven by road-related Resource Area concerns and opportunities. It uses a multiscale approach (subwatershed-project-forest) to ensure that these concerns and opportunities are examined in context. It provides a set of analytical questions to be used in fitting analysis techniques to individual situations. Roads analysis is intended to complement and integrate existing laws, policy, guidance, and practice into the analysis and

management of roads on the national forests. Roads analysis as described here is primarily a stand-alone procedure, but the conceptual framework and resources for analysis may be readily integrated into any analytical process in which roads are examined.

The detail of the analysis is appropriate to the intensity of the issues addressed. Where project specific ecosystem analyses or assessments are completed, roads analysis use that information rather than duplicating these efforts. Roads analysis is integrated as a component of watershed analysis, landscape assessments, and other analyses supporting the decision making processes.

Roads analysis neither makes decisions nor allocates lands for specific purposes. Line Officers, with public participation, make decisions. The roads analysis is not a NEPA analysis which requires a certain level of public scoping which will come later.

The Lassen National Forest Interdisciplinary Team for this Roads Analysis Process is composed of the following individuals:

Name	**Responsibility**
Brian Barns	Forest GIS Cartographer / SO
Susan Chappell	Fisheries Biologist / Aquatics / SO
Tim Dedrick	IDT lead – Report Production / SO
Dave Evans	Forest Silviculturist – Commodity / SO
Dan Ford	Forest Soils Scientist / SO
Terri Frolli	Forest Planner / NEPA Coordinator / SO
Tom Frolli	Forest Wildlife Biologist / SO
Jane Goodwin	Resource Officer-Alternate / Almanor Ranger District
Mike Holmes	Forest Fuels Planner / Officer SO
Melanie McFarland	Forest Fisheries Biologist / Aquatics SO
Elizabeth Norton	Forest Public Service Program Manager / SO
Chris O'Brien	Forest Archeologist / SO
Allison Sanger	Forest Botanist / SO
Mo Suarez	District Range Mgmt / Eagle Lake RD
Scott Tangenberg	Forest Hydrologist / SO
Al Vazquez	Almanor District Ranger/Steering Committee – ARD
Terrie Veliotes	Forest Road Manager / SO
Jack Walton	Forest Engineer / Steering Committee – SO
Christi Whitcome	Deputy Forest Fire Management Officer / SO
Jeff Withroe	Forest Ecosystem Officer / Steering Committee – SO

Roads analysis is intended to be based on science. Team members located, interpreted, and used relevant existing scientific literature in the analysis, disclosed assumptions made before/during analysis, and stated the sideboards on which the analysis was based.

The Six Steps of the Roads Analysis Process. Roads analysis comprises six steps aimed at producing needed information and maps. Line-Officer participation is

encouraged within the process. Although the analysis consists of six sequential steps, the process may require feedback and iteration among steps over time as the analysis matures. The amount of time and effort spent on each step will differ, based on specific situations and available information, including field season/time available or during which the roads analysis takes place.
The process produces a set of road-related concerns and questions, the answers to which can inform the recommendations made about future road systems. Line officers and interdisciplinary teams can determine the relevance of each question, incorporating public participation as deemed necessary.

Step 1 – Setting up the analysis. This roads analysis process was constructed to analyze all objective maintenance level 3, 4, and 5 roads which total 739 miles, within the Lassen National Forest's 3,375 miles of road.

Step 2 – Describing the situation. In compliance with FSM 7700, the thesis statement for this particular roads analysis process is to *"analyze for a minimum optimum road system to serve a variety of users and Resource disciplines."* The IDT has identified the following access-user needs by Resource:

- Recreation – campgrounds, water sports, recreation residences, trailheads, scenic corridors, driving for pleasure.
- Timber/Forest Products – capable, available, and suitable lands
- Range – facilities
- Fire Protection/suppression – wildland urban interface, defensible fuel profile zones, and lookouts
- Private Land – cost-share agreements
- Adjoining lands – county rights-of-way

The IDT has also identified the following Resource Area's which are affected by the existing road-access transportation system:

- Watershed
- Terrestrial Wildlife
- Soils
- Aquatics
- Visuals
- Safety
- Archeology
- Botany
- Forest Health

Step 3 – Identifying concerns. This interdisciplinary team developed and reviewed resource area indicators at the forest, project, and subwatershed analysis level. The ID Team reviewed and discussed each resource areas concerns and indicators in consecutive interdisciplinary group meetings. The developed indicators as shown in Appendix B were taken to the Steering Committee for review, discussion, revision and approved for use.

Step 4 – Assessing benefits, problems, and risks. After developing the resource-area specific indicators, each resource or a combination of resources, such as aquatics, hydrology, and soils, further processed the indicators into specifically

weighted factors for rating roads. The factors were weighted according to specific resource-sensitive factors within the environmental, social, economic, and political realms, and each road was given a combined opportunity and risk rating of high, medium, or low with associated Resource Area comments to explain the particular recommendation or combination recommendation. Each resource or resource combination rated and ranked each road within the project area for risk and opportunity by placing the word of high, medium, or low on a spreadsheet along with comments for resource area rationale. These spreadsheets represent the synthesis of each resource's ratings and rationale per road. Each resource utilized their spreadsheet for step 5 when the Interdisciplinary Team met to discuss and come to an agreement for a team road-rating for each road.

Step 5 – Describing opportunities and setting priorities. The interdisciplinary team met to review each team member's comprehensive resource-area road-rating spreadsheet from Step 4 above. Each road within the project area is represented on the spreadsheet by road number, length, and objective maintenance level, and each road has a rating of high, medium, or low by each resource area with associated rationale. The interdisciplinary team identified five primary road system considerations to analyze during this step, as listed below:

1. Redundant roads
2. Minimize resource impacts
3. Dollars spent on road deferred maintenance
4. Key roads to maintain and raise service level, commit to new maintenance level
5. Drop service level of those roads not key/essential to Forest management

Step 5 provides a recommendation for each objective maintenance level 3, 4, and 5 road in the Lassen N.F. transportation system, and included one of six recommendations;
A) Retain as is with no change – predominance of low risk and high opportunity.
B) Retain + Resource Area Concerns with no change - high risk identified and high opportunity, no viable alternative, budgetary constraints.
C) Opportunity for Resource Area road maintenance reconstruction and retain road – high opportunity and some risk identified.
D) Change maintenance level and retain road – raise or lower maintenance/service level.
E) Realign – high opportunity and high risk, need access.
F) Decommission – high risk identified and low opportunity.

Step 5 includes the attached map, Excel IDT road-rating spreadsheet and a table listing each road by identification number, segment length and team-consensus management recommendation.

Step 6 – Reporting. The interdisciplinary team produced this report that portrays management opportunities and supporting information important for making decisions about the future characteristics of the transportation system. This information sets the context for developing proposed actions to improve the road system and for future amendments and revisions of forest plans.

Key findings and recommendations -

The Lassen National Forest goal for this road analysis process is to provide each Resource Area Specialist with a vehicle to conduct an inventory of the transportation system within the affected area and how the roads interact with each resource's standards and guidelines as well as interrelated resources concerns. The interaction between the roads and the resource's management requirements has lead to Team recommendations for each road inventoried, determined by an assessment of risk and opportunity, tiered to a desired condition of the transportation system, displayed in Table 1, below.

- Table 1, lists the Interdisciplinary Team's Road Recommendations for all roads.
- Table 2 lists the road maintenance performed from 2001 – 2005 and value-added, by user-category.
- Appendix A displays the ID Team road-rating spreadsheet as a record, created by the ID Team during Step 5 – Describing Opportunities and Setting Priorities.
- Appendix B lists the ID Team Approved Indicators per Resource-Area.
- Appendix C lists the Glossary of Road Terms.
- Appendix D displays the Bibliography.
- Exhibit 1 is a GIS map displaying the ID Teams road recommendations.

Table 1
Synopsis of Interdisciplinary Team Road-Segment Recommendations

Type of Road	Miles
Retain road as-is with no change.	734.15
Change maintenance level and retain road, raise maintenance level.	3.20
Change maintenance level and retain road, lower maintenance level.	1.45
Total Miles of Forest Service ML 3,4,5 jurisdiction road	739.

Table 2
Synopsis of road maintenance performed on ML 3-5 roads,
Years 2001 – 2005, by –
DFPZ contracts,
Road Use Permittees,
Co-Operators, and
Lassen National Forest road crew - force account

Type of Road	Miles
DFPZ projects (45 projects)	212
Road Use Permitees (53 permits)	250
Co-Operators (3 Co-Operators)	113
Miles of ML 3-5 road receiving timber sale road-package maintenance	575 miles
Lassen Forest Road Crew	
Miles of ML 3-5 (2001-2006) road receiving annual maintenance	2,029 miles
Total ML 3-5 road miles maintained between 2001 and 2005	2,604 miles = 335% of ML 3-5

Road maintenance levels and rights-of-way are two critical components to factor into current fiscal year budgets and future project planning for ML 3-5 roads. Engineering and the Lands Officer have substantial records of rights-of-way for the Lassen

National Forest and have been combining the paper records with the GIS files for the previous eight years to build a database, many but not all records have been transferred to GIS. The acquisition of permanent easements for current and future projects is an agency priority and should be made a priority on the Lassen. Maintenance and the ability of the Forest to afford to maintain the current inventory of ML 3-5 roads has been an ongoing question. This IDT has researched Engineering Annual Road Reports for fiscal years 2001 – 2006 to determine that the Forest has been able to maintain 2,604 miles or 335% of the 739 miles of ***objective maintenance*** level 3, 4, and 5 ***road miles*** during the previous six years. The level to which the Forest has been able to maintain the roads is outlined below with brief definitions of the three different levels of road maintenance.

Engineering Design prepares a *road package* for all timber sale projects and the level of maintenance may include the following work; slide and slump repair – T801, ditch cleaning – T802, surface blading – T803 , surfacing repair – T804, drainage structures – T805, dust abatement – T806, roadway vegetation – T807, miscellaneous structures – T808, waterbars – T809, barriers – T810, and surface treatment – T811. Road packages are for travel efficiency of commodity transportation and is associated on the Lassen NF with either DFPZ Fuel Reduction Project's, Road-Use Permittee's, or Co-operators, with the contractor conducting the actual maintenance. Between 2001 – 2005 the Lassen has prepared road packages for sale units on 575 miles of ML 3 – 5 roads. Road surface augmentation may be a component of this package and consists of a selected thickness of installed aggregate wearing surface as a remainder on the travelway when the sale is completed

The *annual* level of maintenance is generally defined as what can be accomplished through the cleaning of drainage ditches and catch-basins, culvert cleaning, sign maintenance/replacement, re-shaping the road surface material/surface aggregate, watering the road material/aggregate, compacting the road surface/aggregate, minor earthwork related to the road to clear debris-flows and slumps, and minor aggregate replacement or supplementation. Annual maintenance does incorporate basic resource area protection concerns and supports compliance to road management objectives. This work is performed by the Forest road crew. During the field seasons of 2001 – 2006 the Lassen NF road crew performed annual maintenance on 437, 483, 368, 325, 141, and 275 miles of ML 3 – 5 forest road, respectively.

The *Deferred* level of maintenance is defined as work that includes replacing drainage structures such as culverts, survey-work, bridge-work, sign construction/replacement, earth-work to correct debris-flows/slumps, earth work to rebuild storm-damage, aggregate replacement, road-surface paving with asphalt-cement, and road-surfacing with bituminous chip-seal. This is a more comprehensive level of road maintenance although it is performed with much less frequency and with a greater planned span-of-time which contribute to a planned maintenance schedule, which is tied-into the planned life-cycle of road components, (i.e., culverts life cycle 30 years, bridge life cycle 50 years, paving life cycle 20 years). Deferred maintenance is the level of maintenance that conforms to and supports the road management objectives and resource area protection. Deferred maintenance items are being performed on the Lassen NF by a combination of funding sources including

Capital Investment Projects, Fish Passage funds, Federal Highway Administration funds, and Storm Damage Restoration funds.

The following is a list of deferred maintenance road projects that received funding or were completed during fiscal years 2001 – 2006, (not including timber sale road maintenance, cooperators and permittees);

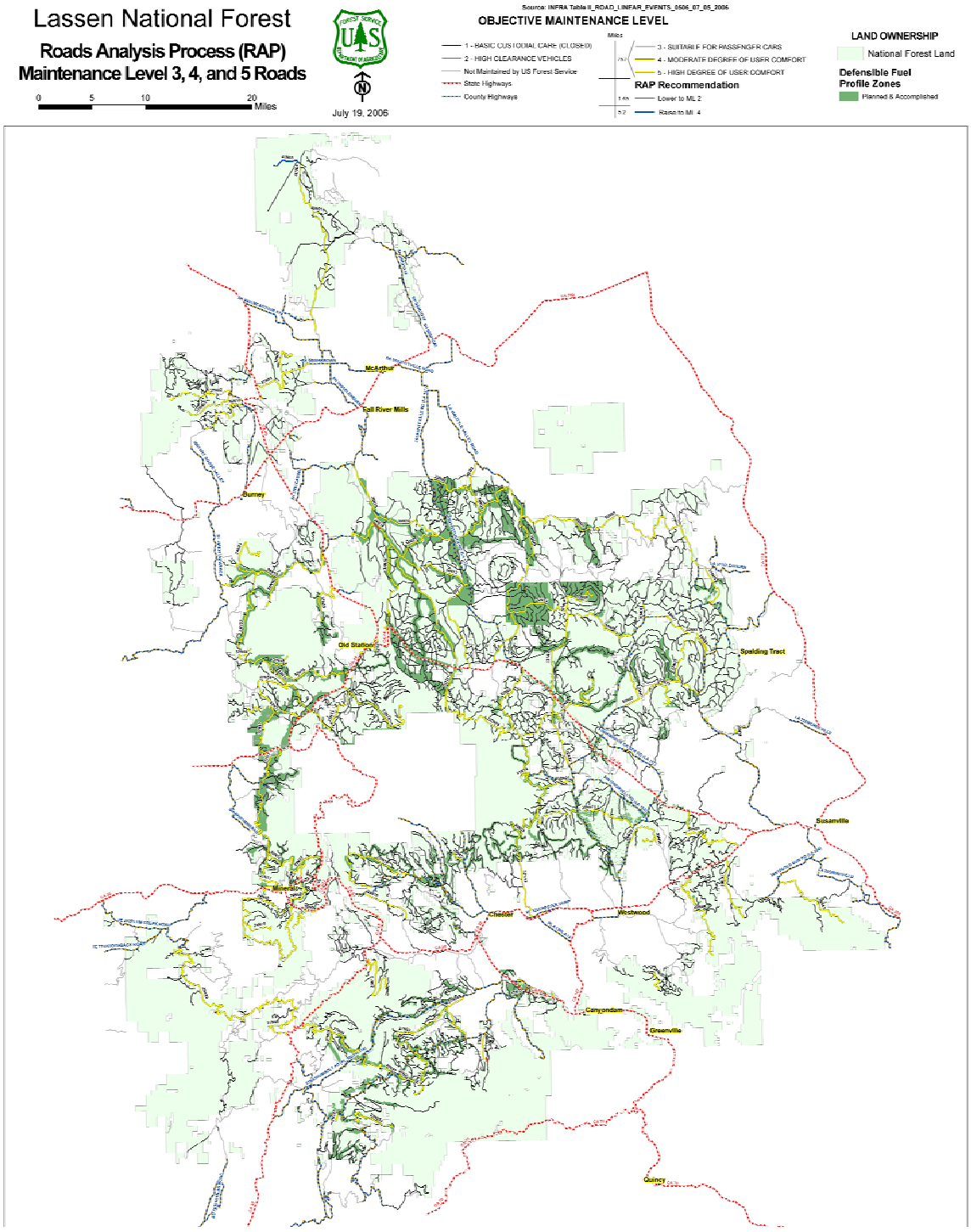
- 2006 – Swain Snowmobile Park, Eagle Lake Campground, North Antelope Arch, Deer Creek, Lockerman, Turner Mtn Loop, Battle Creek, Hole-in-the-Ground, Rocky Gulch, Fox Farm TS, Ursa TS, Castle TS, Yellow TS. 275 miles for a value of $790, 844.
- 2005 – Straylor, Warner, North 49, Merrill Campground, Potatoe Patch Campground, Mason Station, Fish Improvements, Browns Ravine, Waterhole, Eagle Lake Boatramp, Turner Mtn Loop, Pear Lake Loop, Cattleguards, Robbers. 141 miles for a value of $1,069,826.
- 2004 – McClure Trailhead Parking, Robber, Cattleguards, Deer, Mill, Antelope, Colby Mdws, Battle Crk, Butte Crk. 325 miles for a value of $810,465.
- 2003 – Corders Reservoir, Rd 28N97, Rd 28N29, Rock Crushing, 38N10-D-E, Wilson Lake Rd, Fredonyer-29N46, Willow Crk Fish Passage, Task Orders. 368 miles for a value of $707,000.
- 2002 – Chester Air Attack Base, Hat Crk Trailer Dump, Tamarack, Roxie Peconom, Hat Crk Rim, Onion Summit, Blacks Ridge, Yellow Crk, North Coble, Wilson Lake Rd, Soldier Crk, Deer Crk Trailhead, Gaither Campground, Hole-in-the-Ground, Mill Crk, Swamp Crk, Rattlesnake Crk, Burney-Butte-Deer-Mill-Antelope-Yellow-Eagle Lake-Susan River-Lake Britton-Horse-Hat Creek Watersheds. 483 miles for a value of $698,000.
- 2001 - Shanghai, Ruffa, Jonesville, Deer Creek, Blacks Ridge, Pegleg, Cattle Guards, Silver Lake, Turner Trailhead, Almanor Office, Coon Hollow, Deer Crk Mdws, Cold Springs, Hole in Ground, Keddie Ridge, Gurnsey Campground, Eagle Lake Office, Bogard Hole, Fredonyer Snowpark, Bizz Johnson Trail, Poison Lake, Murken HGP, Cypress Trailhead, Rock Crk, HC Work Center, Subway Cave, Corders Resv, Big Jacks Resv, Wiley Ranch, Jellico Pit, Diacolite Rd. 437 miles for a value of $150,480.

Regarding deferred maintenance, when the planned life-cycle replacements are calculated, the cost of such is listed as a deferred item for maintenance, to be completed at the time of planned component replacement. This is the amortization of a capital-cost-component with its replacement cost pre-calculated for accounting and planning purposes. This is a misleading term that has come to be incorrectly-defined as a backlog of maintenance that was not performed on schedule and is a liability to the Forest. This is not the case, the deferred maintenance term is accurately used as an INFRA accounting term to represent the complete total cost to bring a road up to new standards and then requiring no maintenance of any kind, until that is, a new life-cycle is established for the components of that road, and it again will incur a deferred maintenance cost in INFRA. The inaccuracy of this system to accurately represent the needed maintenance dollars is inherent and becomes tangible when the fact that all roads are not created equal and all roads do not weather or age with the same intensity, (different design standards, different

contractors, different quality of road material and/or application, different weather regimens & etc.).

Therefore, the terms of road package, annual, and deferred maintenance are defined and represent different treatments and functions. With this in mind it is clear from the above Table that the Lassen National Forest is performing maintenance on 335% of the ML 3-5 roads within a frequency of 5 years, which meets the transportation industry standard for frequency but not for complete adherence to road management objectives. Deferred maintenance is being performed on the ML 3-5 roads on an on-going basis through the road-repair programs funded by ERFO for storm damage. The Lassen engineering road shop has submitted in July 2006, applications for road repair funding worth $500,000 for the replacement of road culverts and the repair of road wash-outs. The Forest is also receiving funding through the Federal Highway Administration to reconstruct the Bailey Creek crossings on the 17 road, with a deferred maintenance value of approximately $500,000.

Exhibit 1


Lassen National Forest
Roads Analysis Process (RAP)
Maintenance Level 3, 4, and 5 Roads
0 5 10 20 Miles
July 19, 2006
Source: INFRA Table II_ROAD_I INFAR_EVENTS_0506_07_05_2006
OBJECTIVE MAINTENANCE LEVEL
1 - BASIC CUSTODIAL CARE (CLOSED)
2 - HIGH CLEARANCE VEHICLES
Not Maintained by US Forest Service
State Highways
County Highways
3 - SUITABLE FOR PASSENGER CARS
4 - MODERATE DEGREE OF USER COMFORT
5 - HIGH DEGREE OF USER COMFORT
RAP Recommendation
Lower to ML 2
Raise to ML 4
LAND OWNERSHIP
National Forest Land
Defensible Fuel Profile Zones
Planned & Accomplished
McArthur
Fall River Mills
Burney
Old Station
Spalding Tract
Susanville
Westwood
Chester
Greenville
Quincy

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Appendix B
Interdisciplinary Team Indicators Approved & Utilized per Resource Area

- ***AQUATIC SPECIES*** *- INDICATORS FOR ANALYSIS*

AQUATIC SPECIES –

Name of Indicator:

Presence of federally listed (Threatened or Endangered), and Forest Service Sensitive aquatic species habitat (current/historic).

Question Potentially Addressed:

How and where do roads affect federally listed and Forest Service Sensitive (TES) aquatic species and their habitat?
To what extent does the road system overlap with areas containing TES aquatic species?
How and where does the road system restrict the movement of TES aquatic organisms?

Description of Indicator:

This Indicator overlays the road system with TES aquatic habitat at the subwatershed level. This scale was selected, because (1 the extent of TES aquatic species occurrence/habitat is not easily defined at finer scales, and (2 cumulative effects of roads to aquatic habitats at the subwatershed scale can be analyzed. Presence of TES aquatic species within a subwatershed (7^{th} field).

Units of measure:

Yes = High Risk, the road, or any portion thereof, is located within a subwatershed where TES aquatic species are known to occur (either currently and/or historically).
No = Low Risk, the road is located outside any subwatershed where TES aquatic species are known to occur.

Data Source:

GIS layer identifying subwatersheds (7^{th} field) in which current/historic presence of TES species has been confirmed; GIS transportation layer identifying Forest ML 3-5 roads.

Note:

Professional judgment was used to interpret road risk within two subwatersheds. In both cases, the subwatersheds were relatively large, and the areas of TES aquatic species occurrences were limited to very small portions of the subwatersheds.

1. Subwatershed PR1 – This Pit River subwatershed encompasses the northernmost portion of the Forest. Road 40N04 is located within PR1, but miles away from where TES aquatic species occur, and on relatively flat, volcanic terrain. Risk of effects to TES aquatic species from this road is negligible; therefore, Road 40N04 was rater as “Low Risk” to TES aquatic species.
2. Subwatershed PR3 – This is another large Pit River subwatershed that encompasses a small portion of the Pit River where TES aquatic species occur. However, most of the subwatershed is located on the Hat Creek Rim, which is flat terrain with no direct hydrologic connectivity to the Pit River. All ML 3-5 roads within this subwatershed are also located on the Hat Creek Rim, miles away from the Pit River. These roads were therefore rater as “Low Risk” to TES aquatic species.

- ***BOTANY – RARE PLANT HABITAT*** - *INDICATORS FOR ANALYSIS*

ECOSYSTEM FUNCTIONS AND PROCESSES (EF)

Name of Indicators:

The Lassen Roads Analysis Report contains three indicators for Ecosystem Function; Presence of Noxious Weeds/Insects vectors. Collectively, the indicators will be used for noxious weeds to compare the conditions for one road with the conditions of another.

Question Potentially Addressed:

How is the road system affecting the spread and invasion of noxious weeds into unoccupied areas on the Forest? Which species of noxious weeds appear to be using the road systems as a directional vector?

Rationale: Cleared road right-of-ways provide the predominant conduit for directional spread of noxious weeds. Vehicles and livestock transport weed seeds and vegetative parts onto and around the forest from infested areas off pavement.

Units of Measure:

- Presence of individual species along roads, trailheads and stock unloading areas = High risk.
- Relative abundance of particular noxious weed species = High risk.
- Areas of low cover or high disturbance, which are vulnerable to the establishment of weeds = High risk.

Data Source:

- GIS Weed layer
- GIS layer of Forest 3,4, and 5 roads
- Noxious weed occurrence forms

- ***COMMODITY PRODUCTION –*** *INDICATORS FOR ANALYSIS*

COMMODITY PRODUCTION (TM)

(Indicator will be viable at Project Level analysis)

Name of Indicator:

1. Capable, Available, and Suitable (CAS) Forest Land

Question Potentially Addressed: How well does the existing road system serve commodity extraction (saw logs, chips, fuelwood, holiday trees, and special forest products)?

Description of Indicator:

1. CAS land denotes forest with a scheduled yield.

Rationale:

Level 3, 4, and 5 roads provide the primary access to a forest land for extraction purposes. The condition, grade, width, and road surface influence sale economics.

Each logging system has an "Achilles heal", typically the largest piece of equipment needed for product extraction. Access for chip vans is often the most limiting feature of a transportation system. Given the heavy loads associated with commodity extraction, bridges, culverts, and paved surfaces must be capable of carrying the weight.

Data Sources:

Timber Sale Appraisal Handbook
Lassen National Forest Land and Resource Management Plan
SNFPA
Past Economic Analyses
Practical Experience

- ***ENGINEERING*** – *INDICATORS FOR ANALYSIS*

ECONOMIC (EC)

In the Lassen Roads Analysis Report there are five indicators identified under Economics, Economic Efficiency, Annual Traffic Related Road Maintenance Costs, Deferred Road Maintenance Costs, Benefit of Surface Stabilization, and Annual Non-Traffic Road Maintenance Costs. In the evaluation of level 3, 4, & 5 roads all but one of the indicators has been combined. Benefit of Surface Stabilization, i.e. benefits by having a road rocked will be addressed in related indicators.

Question Potentially Addressed:

How does the road system affect the agencies direct costs and revenues and what if any changes in the road system will increase revenue to the agency by reducing costs, increasing revenue, or both?

Description of Indicator

Road maintenance costs will be analyzed as the most important item. The total costs for all ML 3-5 roads have been computed of annual traffic road maintenance, non-annual traffic road maintenance, and deferred maintenance costs to maintain the road to the current service/maintenance level. These costs will be used in conjunction with ADT, average daily traffic, which has also been mapped on the ML 3-5 network of forest roads, to determine the economic efficiency of the existing ML 3-5 roads.

Rationale:

Comparing the total cost of the maintenance per road against a forest average will show which roads are significantly higher and which if selected for reduction in service/maintenance level because of reduced resource need would reduce forest costs.

Units of Measure

We will measure both:

- the cost/mile (engineering produced spreadsheet for annual maintenance, non-traffic related maintenance, and deferred maintenance)
- cost/mile/ADT (engineering produced map of ML 3-5 roads average daily traffic 1990-2003)

Measuring by ADT will also show the effects of fixed costs.

- Roads < less than 25 ADT and High economic costs = Low opportunity rating
- Roads between 25 and 40 ADT and predominance of High to Medium economic costs = Medium opportunity rating
- Roads between 40 and 75 ADT and predominance of Medium to Low economic costs = High opportunity rating

Data Sources

INFRA costs gathered 1999 through 2003 for annual and deferred maintenance.
ADT will be based on past traffic count data and professional judgment/observations.

INDICATORS FOR ANALYSIS

GENERAL PUBLIC TRANSPORTATION (GT)

Name of Indicator: Community Access

Question Potentially Addressed: How does the road system connect to communities, recreation residences, and public access?

Description of Indicator: Direct connection into communities and integration with public roads into a seamless system.

Rationale:
Roads providing the only access or supporting county or state road access will receive a High rating and others will receive a Low rating.

Units of measure: Yes = High opportunity
No = Low opportunity

Data Source: GIS visual & tabular.

Name of Indicator: Shared Road Use

Question Potentially Addressed: How does the road system connect other land ownership to public roads. How does the road system affect shared use and cost share?

Description of Indicator: Public and private shared use and cost share.

Rationale: Private land access requires use of Forest Service roads and in areas of "checker board land ownership" there is benefit in cost share roads.

Units of measure: High/Low opportunity

- Road use permits indicate a need to use roads and thus are a benefit or roads needed to access the roads under a road use permit – rated High opportunity
- Cost share agreements – rated High opportunity
- Easements granted to private landowners – rated High opportunity
- If none of the above - rated Low opportunity

Data Source:

Road use permit files, and cost share files.

- ***FIRE PROTECTION – PREVENTION - SUPPRESSION*** – *INDICATORS FOR ANALYSIS* -

FIRE –

Name of Indicator:

Presence of DFPZ defensible fuel profile zones, WUI wildland urban interface, or LO lookout facility (current/planned).

Questions Potentially Addressed:

How and where do roads affect and effect the ingress and egress of Fire suppression, fuels management, protection, or prevention to a DFPZ, WUI, or LO?
To what extent does the road system overlap with these landscape features and facilities?

Description of Indicator:

These Indicators overlay the road system with planned and existing defensible fuel profile zones, wildland urban interface areas that surround recreation residences and rural forest communities, and the lookout facilities are located at the very end of road systems.

Units of Measure:

Presence of DFPZ's, WUI's, and Lookouts = High opportunity and Low risk.

High Opportunity – Low Risk:

The road provides critical access to one or more of these landscape features and the absence of this access is an unacceptable risk.

Low Risk – High Opportunity:

The road provides access to one or more of these landscape features already, and improvement to the road can improve fire and fuels management.

Data Used for Interpretation:

GIS layer identifying DFPZ's, WUI's, and Lookouts, as well as team member's professional long-term Forest experience and judgment in conjunction with the GIS transportation layer identifying Forest ML 3-5 roads.

- ***HERITAGE*** *- INDICATORS FOR ANALYSIS*

HERITAGE

(Indicator will be viable at Project Level analysis)

Name of Indicator:

Presence of cultural heritage site accessed by, on, or adjacent to road.

Questions Potentially Addressed:

Does presence of road offer access opportunity to site or to develop site for interpretation, or does presence of road present a risk to cultural site for destruction of site and cultural history?

Description of Indicator:

These indicators overlay the ML 3-5 road system at the Forest scale.

Units of Measure :

Road provides access to or adjacent to a cultural heritage site, Yes = High risk and/or High opportunity, No = Low risk and/or opportunity, must be dealt with on a case by case basis.

Units of measure:

Data Source:

GIS visual & tabular, as well as Lassen Forest archeology cultural heritage site records and professional experience/judgment.

- ***HYDROLOGY*** *- INDICATORS FOR ANALYSIS*

HYDROLOGY

Name of Indicator:

Presence of RCA on road, and road located in a 7th field subwatershed with a specific road density.

Questions Potentially Addressed:

How and where do roads affect the RCA's and at what density do roads currently exist within 7th field subwatersheds?

Description of Indicator:

These indicators overlay the ML 3-5 road system at the Forest scale.

Units of Measure :

1. Road located within an RCA?, Yes = High-Medium risk, No = Low risk.
2. Road located in a 7th field subwatershed with overall Forest Service Road Density of 0. – 2.5 =Low risk to watershed values, 2.5 – 3.5 = Medium risk to watershed values, and 3.5 and above = High risk to watershed values.

Data Source:
GIS visual & tabular, as well as Lassen Forest hydrology road logs and professional experience/judgment.

- ***RANGE*** *- INDICATORS FOR ANALYSIS*

RANGE USE –

(Indicator will be viable at Project Level analysis)
Name of Indicator:
Presence or absence of livestock facilities and ML 3-5 roaded access to them.

Question Potentially Addressed:
How does the road system affect semi-truck and trailer and stock-truck access needed for gathering, loading and disembarking of livestock?

Description of Indicator:
Is there a facility present on said road to support the viability of livestock operations and allotments?

Rationale:
Roads providing the only access or supporting county or state road access will receive a positive rating (High); others will be neutral (Low).

Units of measure:
Yes = High opportunity
No = Low opportunity

Data Source:
GIS visual & tabular, District Range Conservation Technician professional experience and judgment, and livestock allotment usage.

- ***RECREATION*** *– INDICATORS FOR ANALYSIS*

RECREATION (UR) (RR)

Name of Indicator - Recreation Access

Questions Potentially Addressed:

How will opportunities for road-access dependent recreation activities such as camping, either dispersed or organized, hiking and trailheads, recreation residences, water sports, woodcutting, driving for pleasure, OHV/OSV travel, bird watching, fishing, and hunting, etc., be affected by road maintenance levels?

Description of Indicator:

A GIS mapping exercise is conducted to geographically map the locations forest-wide of Forest Service trailheads, campgrounds, recreation residences, and water sport access and the ML 3, 4, and 5 roads that serve these recreation opportunities.

Rationale:

Roads on the Forest NFS ML 3-5 transportation system that currently provide the sole access routes to the recreation opportunities listed above are critical to maintain for Forest users according to the LRMP and the ROS.

Units of Measure:

Ratings of High, Medium, and Low opportunity are given to each ML 3-5 road which currently provides recreation access, more correctly High = provides sole access, Low = multiple access or no recreation site.

Data Sources:

- National Forest Service GIS corporate database survey for recreation sites.
- Lassen Forest employee knowledge and experience.

- ***TERRESTRIAL WILDLIFE*** *- INDICATORS FOR ANALYSIS*

TERRESTRIAL WILDLIFE

Name of Indicator:
Presence of Marten sightings, Bald Eagle territories, Spotted Owl nest, Goshawk nest.

Questions Potentially Addressed:
How and where do roads affect this four species and their habitat? To what extent does the road system overlap with areas containing TES species? How and where does the road system restrict the movement of TES species?

Description of Indicator:
These indicators overlay the road system with TES habitat at the Forest scale.

Rationale:
Presence within a road-corridor up to 100m and 200m distances from the road.
Within 100m = High risk,
200m =Medium risk.

Data Source:
GIS visual & tabular, as well as Lassen Forest field logs and professional experience/judgment.

Appendix C
Glossary of Road Terms

- **Annual Maintenance.** Work performed to maintain serviceability, or repair failures during the year in which they occur. Includes preventive and/or cyclic maintenance performed in the year in which it is scheduled to occur. Unscheduled or catastrophic failures of components or assets may need to be repaired as a part of annual maintenance. (Financial Health - Common Definitions for Maintenance and Construction Terms, July 22, 1998)

- **Area.** A discrete, specifically delineated space that is smaller and in most cases much smaller, than a Ranger District. (36 CFR 212.1, 261.2)

- **Average Daily Traffic.** The total number of vehicles passing a given point during a given time period divided by the number of days in that time period. (AASHTO, 2001, A Policy on Geometric Design of Highways and Streets)

- **Culvert.** A conduit or passageway under a road, trail, or other obstruction. A culvert differs from a bridge in that the top of a culvert does not serve as the road surface and is constructed entirely below the elevation of the traveled way. (Handbook of Steel Drainage & Highway Construction Products).

- **Decommission.** Demolition, dismantling, removal, obliteration and/or disposal of a deteriorated or otherwise unneeded asset or component, including necessary cleanup work. This action eliminates the deferred maintenance needs for the fixed asset. Portions of an asset or component may remain if they do not cause problems nor require maintenance. (Financial Health - Common Definitions for Maintenance and Construction Terms, July 22, 1998)

- **Deferred Maintenance.** This category is best described as the capital costs required to replace major road maintenance components which are on a scheduled life-cycle replacement and amortization schedule. Deferred maintenance needs may be categorized as critical or non-critical at any point in time. Continued deferral of non-critical maintenance will normally result in an increase in critical deferred maintenance. Code compliance (e.g. life safety, ADA, OSHA, environmental, etc.), Forest Plan Direction, Best Management Practices, Biological Evaluations other regulatory or Executive Order compliance requirements, or applicable standards not met on schedule are considered deferred maintenance. (Financial Health - Common Definitions for Maintenance and Construction Terms, July 22, 1998)

- **Forest Road.** A road wholly or partly within, or adjacent to, and serving the National Forest System that is necessary for the protection, administration, and utilization of the National Forest System and the use and development of its resources. (23 USC 101)

- **Forest Road or Trail.** A road or trail wholly or partly within or adjacent to and serving the National Forest System that the Forest Service determines is necessary

for the protection, administration and utilization or the National Forest System and the use and development of its resources. (36CFR 212.1, 251.5, 261.2)

- **Forest Trail.** A trail wholly or partly within, or adjacent to, and serving the National Forest System and which is necessary for the protection, administration, and utilization of the National Forest System and the use and development of its resources. (23 USC 101)

- **Forest Transportation System Management.** The planning, inventory, analysis, classification, record keeping, 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. (FSM 7705)

- **Four-Wheeled Drive Way (1).** A forest development road included in the Forest Development Transportation Plan and commonly used by four-wheel drive, high-clearance vehicles wider than 50 inches. (FSM 2353.05)

- **Heavy maintenance.** Work usually done by highway agencies in repairing damage normally expected from seasonal and occasionally unusual natural conditions or occurrences. It includes work at a site required as a direct result of a disaster which can reasonably be accommodated by a State or local road authority's maintenance, emergency or contingency program. (23 CFR 668)

- **Local Road (1).** A road that primarily provides access to land adjacent to collector roads over relatively short distances at low speeds. (AASHTO, 2001, A Policy on Geometric Design of Highways and Streets)

- **Local Road (2).** A forest road that connects terminal facilities with forest collector, forest arterial or public highways. Usually forest local roads are single purpose transportation facilities. (FSH 7709.54, no longer in print)

- **Maintenance (1).** The preservation of the entire highway, including surface, shoulders, roadsides, structures and such traffic-control devices as are necessary for its safe and efficient utilization. (23 USC 101)

- **Maintenance (2).** 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)

- **Maintenance (3).** The act of keeping fixed assets in acceptable condition. It includes preventive maintenance normal repairs; replacement of parts and structural components, and other activities needed to preserve a fixed asset so that it continues to provide acceptable service and achieves its expected life. Maintenance excludes activities aimed at expanding the capacity of an asset or otherwise upgrading it to serve needs different from, or significantly greater than those originally intended. Maintenance includes work needed to meet laws,

regulations, codes, and other legal direction as long as the original intent or purpose of the fixed asset is not changed. (Financial Health - Common Definitions for Maintenance and Construction Terms, July 22, 1998)

- **Maintenance Levels.** Defines the level of service provided by, and maintenance required for, a specific road, consistent with road management objectives and maintenance criteria. (FSH 7709.58, 12.3)

  - **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. Roads in this maintenance level are typically low speed, single lane with turnouts and spot surfacing. Some roads may be fully surfaced with either native or processed material. Appropriate traffic management strategies are either "encourage" or "accept." "Discourage" or "prohibit" strategies may be employed for certain classes of vehicles or users. (FSH 7709.58, 12.3)

  - **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. The most appropriate traffic management strategy is "encourage." However, the "prohibit" strategy may apply to specific classes of vehicles or users at certain times. (FSH 7709.58, 12.3)

  - **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. The appropriate traffic management strategy is "encourage." (FSH 7709.58, 12.3)

- **Motor Vehicle.** Any vehicle which is self-propelled, other than:
  - A vehicle operated on rails; and
  - Any wheelchair or mobility device, including one that is battery-powered, that is designed solely for use by a mobility-impaired person for locomotion, and that is suitable for use in an indoor pedestrian area. (36 CFR 212.1, 261.2)

- **National Forest System.** As defined in the Forest Rangeland Renewable Resources Planning Act, the ``National Forest System'' includes all National Forest lands reserved or withdrawn from the public domain of the United States, all National Forest lands acquired through purchase, exchange, donation, or other means, the National Grasslands and land utilization projects administered under title III of the Bankhead-JonesFarm Tennant Act (50 Stat. 525, 7 U.S.C. 1010-1012), and other lands, waters or interests therein which are administered by the Forest Service or are designated for administration through the Forest Service as a part of the system. (36 CFR 212.1)

- **National Forest System Land.** All lands, waters, or interests therein administered by the Forest Service. (36 CFR 251.51)

- **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, 251.51, 261.2)

- **National Forest System Trail**. A forest trail other than a trail 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)

    - **Critical Need.** A requirement that addresses a serious threat to public health or safety, a natural resource, or the ability to carry out the mission of the organization. (Financial Health - Common Definitions for Maintenance and Construction Terms, July 22, 1998)

    - **Emergency Need.** An urgent maintenance need that may result in injury, illness, or loss of life, natural resource, or property; and must be satisfied immediately. Emergency needs generally require a declaration of emergency or disaster, or a finding by a line officer that an emergency exists. (Financial Health - Common Definitions for Maintenance and Construction Terms, July 22, 1998)

    - **Health & Safety Need.** A requirement that addresses a threat to human safety and health (e.g. violations of National Fire Protection Association 101 Life Safety Code or appropriate Health Code) that requires immediate interim abatement and/or long-term permanent abatement. (Financial Health - Common Definitions for Maintenance and Construction Terms, July 22, 1998)

    - **Mission Need.** A requirement that addresses a threat or risk to carrying out the mission of the organization. Needs related to administration and providing services (transportation, recreation, grazing, etc.). Needs not covered by health and safety or natural resource protection. (Financial Health - Common Definitions for Maintenance and Construction Terms, July 22, 1998)

    - **Non-Critical Need.** A requirement that addresses potential risk to public or employee safety or health, compliance with codes, standards, regulations etc., or needs that address potential adverse consequences to natural resources or mission accomplishment. (Financial Health - Common Definitions for Maintenance and Construction Terms, July 22, 1998)

    - **Resource Protection Need.** A requirement that addresses a threat or risk of damage, obstruction, or negative impact to a natural resource. (Financial Health - Common Definitions for Maintenance and Construction Terms, July 22, 1998)

- **Objective Maintenance Level.** The maintenance level to be assigned at a future date considering future road management objectives, traffic needs, budget

constraints, and environmental concerns. The objective maintenance level may be the same as, or higher or lower than, the operational maintenance level. (FSH 7709.58, 12.3)

- **Passenger Cars.** These include passenger cars of all sizes, sport/utility vehicles, minivans, vans and pickup trucks. (AASHTO, 2001, A Policy on Geometric Design of Highways and Streets)

- **Permit.** A special use authorization which provides permission, without conveying an interest in land, to occupy and use National Forest System land or facilities for specified purposes, and which is both revocable and terminable. (36 CFR 251.51)

- **Reconstruction.** To construct again. (Webster)

- **Right-of-Way (1).** Land authorized to be used or occupied for the construction, operation, maintenance and termination of a project or facility passing over, upon, under or through such land. (36 CFR 251.51)

- **Right-of-Way (2).** A privilege or right to cross over or use the land of another party for egress and ingress such as roads, pipelines, irrigation canals, or ditches. The right-of-way may be conveyed by an easement, permit, license, or other instrument. (FSM 5460.5)

- **Road (1).** A motor vehicle route over 50 inches wide, unless identified and managed as a trail. (36 CFR 212.1)

- **Road (2).** A general term denoting a facility for purposes of travel by vehicles greater than 50 inches width. Includes only the area occupied by the road surface and cut and fill slopes. (FSM 2355.05)

- **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 Maintenance.** The ongoing upkeep of a road necessary to retain or restore the road to the approved road management objective. (FSM 7705)

- **Road Management Objectives.** Defines the intended purpose of an individual road based on management area direction and access management objectives. Road management objectives contain design criteria, operation criteria, and maintenance criteria. (FSH 7709.55, 33)

- **Roadway.** The portion of a highway, including shoulders and auxiliary lanes, for vehicular use. (AASHTO, 2001, A Policy on Geometric Design of Highways and Streets)

- **Routine Maintenance.** Work that is planned to be accomplished on a continuing basis, generally annually or more frequently. (FSH 7709.58, 13.41)

  Other than Routine Maintenance. Work that can be deferred without loss of road serviceability, until such time that the work can be economically or efficiently performed. The frequency of such work is generally longer than a year. (FSH 7709.58, 13.41)

- **Service Life.** The length of time that a facility is expected to provide a specified service. (FSH 7709.56b, 05)

- **Special Use Authorization.** A permit, term permit, lease, or easement which allows occupancy, use, rights, or privileges of National Forest System land. (36 CFR 251.51)

- **Traffic Service Level.** Describes the significant characteristics and operating conditions of a road. (FSM 7705). See also FSH 7709.56, Chapter 4.

- **Trail.** A route 50 inches or less in width or a route over 50 inches wide that is identified and managed as a trail. (36 CFR 212.1)

- **Trailhead.** The transfer point between a trail and a road, lake, or airfield. The area may have developments that facilitate the transfer from one transportation mode to another. (FSM 2353.05)

- **Trucks.** These include single-unit, tractor-semitrailer combinations and tractor-semitrailer in combination with additional trailers. (AASHTO, 2001, A Policy on Geometric Design of Highways and Streets)

- **Vehicle.** Any device in, upon, or by which any person or property is or may be transported, including any frame, chassis, or body of any motor vehicle, except devices used exclusively upon stationary rails or tracks. (36 CFR 261.2)

Appendix D

Bibliography

The components of this document are derived from the following USDA Forest Service strategy and planning documents, as well as Executive Orders:

- Department of Agriculture, Forest Service, 36 CFR Parts 212, 261, and 295, RIN 0596-AB67, Administration of the Forest Development Transportation System; Prohibitions, Use of Motor Vehicles Off Forest Service Roads, Final Rule, 2005.
- Department of Agriculture, Forest Service, 36 CFR Parts 212, 251, 261, and 295, RIN 0596-AC11, Travel Management; Designated Routes and Areas for Motor Vehicle Use, Final Rule, 2005.
- USDA Forest Service Chief's Four Threats – Unmanaged Recreation.
- USDA Forest Service - Lassen National Forest – 2002 Road Analysis Report.
- USDA Forest Service – Sierra Nevada Forest Plan Amendment, FEIS, January 2001.
- USDA Forest Service – Herger Feinstein Quincy Library Group Forest Recovery Act of October 12, 1998.
- USDA Forest Service Lassen National Forest – Land Resource Management Plan.
- Executive Order 11989, May 24, 1977, as amended E.O. 11644.
- Executive Order 11644, February 8, 1972, Use of Off-Road Vehicles on the Public Lands.

Transportation Infrastructure and Access on National Forests and Grasslands
A Literature Review
May 2014

Introduction

The Forest Service transportation system is very large with 374,883 miles (603,316 km) of system roads and 143,346 miles (230,693 km) of system trails. The system extends broadly across every national forest and grasslands and through a variety of habitats, ecosystems and terrains. An impressive body of scientific literature exists addressing the various effects of roads on the physical, biological and cultural environment – so much so, in the last few decades a new field of "road ecology" has emerged. In recent years, the scientific literature has expanded to address the effects of roads on climate change adaptation and conversely the effects of climate change on roads, as well as the effects of restoring lands occupied by roads on the physical, biological and cultural environments.

The following literature review summarizes the most recent thinking related to the environmental impacts of forest roads and motorized routes and ways to address them. The literature review is divided into three sections that address the environmental effects of transportation infrastructure on forests, climate change and infrastructure, and creating sustainable forest transportation systems.

I. Impacts of Transportation Infrastructure and Access to the Ecological Integrity of Terrestrial and Aquatic Ecosystems and Watersheds

It is well understood that transportation infrastructure and access management impact aquatic and terrestrial environments at multiple scales, and, in general, the more roads and motorized routes the greater the impact. In fact, in the past 20 years or so, scientists having realized the magnitude and breadth of ecological issues related to roads; entire books have been written on the topic, e.g., Forman et al. (2003), and a new scientific field called "road ecology" has emerged. Road ecology research centers have been created including the Western

Transportation Institute at Montana State University and the Road Ecology Center at the University of California - Davis.[1]

Below, we provide a summary of the current understanding on the impacts of roads and access allowed by road networks to terrestrial and aquatic ecosystems, drawing heavily on Gucinski et al. (2000). Other notable recent peer-reviewed literature reviews on roads include Trombulak and Frissell (2000), Switalski et al. (2004), Coffin (2007), Fahrig and Rytwinski (2009), and Robinson et al. (2010). Recent reviews on the impact of motorized recreation include Joslin and Youmans (1999), Gaines et al. (2003), Davenport and Switalski (2006), Ouren et al. (2007), and Switalski and Jones (2012). These peer-reviewed summaries provide additional information to help managers develop more sustainable transportation systems

Impact on geomorphology and hydrology

The construction or presence of forest roads can dramatically change the hydrology and geomorphology of a forest system leading to reductions in the quantity and quality of aquatic habitat. While there are several mechanisms that cause these impacts (Wemple et al. 2001 , Figure 1), most fundamentally, compacted roadbeds reduce rainfall infiltration, intercepting and concentrating water, and providing a ready source of sediment for transport (Wemple et al. 1996, Wemple et al. 2001). In fact, roads contribute more sediment to streams than any other land management activity (Gucinski et al. 2000). Surface erosion rates from roads are typically at least an order of magnitude greater than rates from harvested areas, and three orders of magnitude greater than erosion rates from undisturbed forest soils (Endicott 2008).

[1] See http://www.westerntransportationinstitute.org/research/roadecology and http://roadecology.ucdavis.edu/

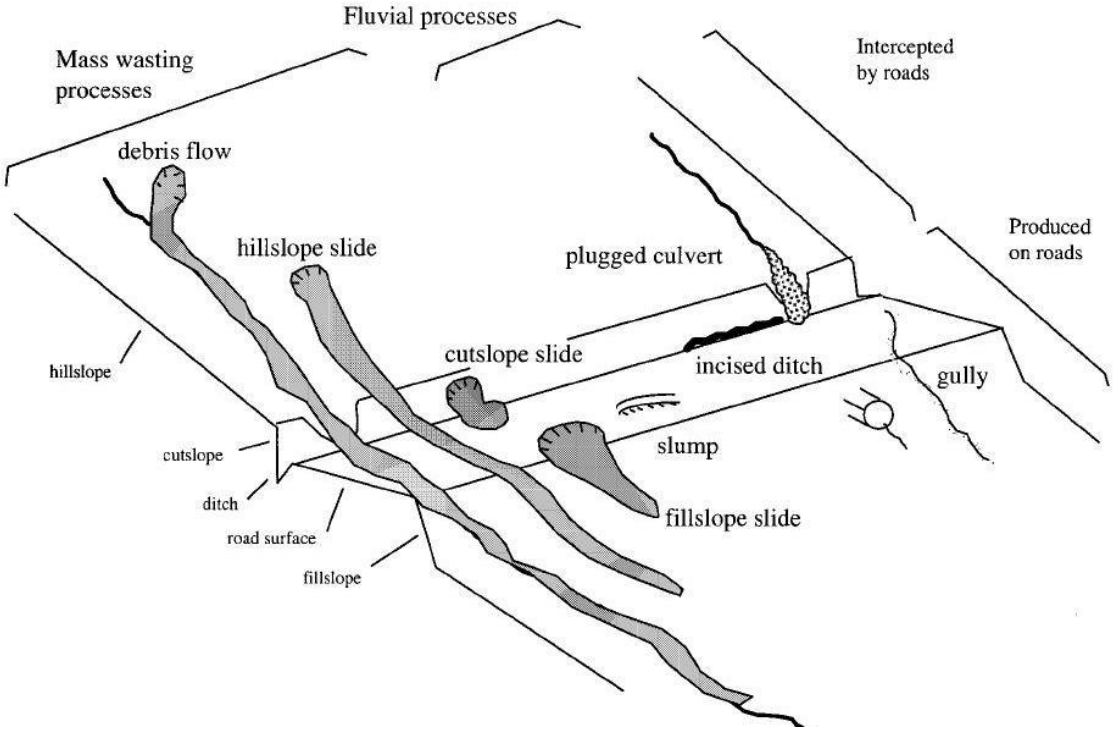

Figure 1: Typology of erosional and depositional features produced by mass-wasting and fluvial processes associate with forest roads (reprinted from Wemple et al. 2001)

Erosion of sediment from roads occurs both chronically and catastrophically. Every time it rains, sediment from the road surface and from cut- and fill-slopes is picked up by rainwater that flows into and on roads (fluvial erosion). The sediment that is entrained in surface flows are often concentrated into road ditches and culverts and directed into streams. The degree of fluvial erosion varies by geology and geography, and increases with increased motorized use (Robichaud et al. 2010). Closed roads produce less sediment, and Foltz et al. (2009) found a significant increase in erosion when closed roads were opened and driven upon. In drier landscapes, wind erosion following vehicle use can be a significant source of soil loss as well (Belnap 2003).

Roads also precipitate catastrophic failures of road beds and fills (mass wasting) during large storm events leading to massive slugs of sediment moving into waterways (Endicott 2008; Gucinski et al. 2000). This typically occurs when culverts are undersized and cannot handle the volume of water, or they simply become plugged with debris. The saturated roadbed can fail entirely and result in a landslide, or the blocked stream crossing can erode the entire fill down to the original stream channel.

The erosion of road- and trail-related sediment and its subsequent movement into stream systems affects the geomorphology of the drainage system in a number of ways. The magnitude of their effects varies by climate, geology, road age, construction / maintenance practices and storm history. It directly alters channel morphology by embedding larger gravels as well as filling pools. It can also have the opposite effect of increasing peak discharges and scouring channels, which can lead to disconnection of the channel and floodplain, and lowered base flows (Furniss et al. 1991; Joslin and Youmans 1999). The width/depth ratio of the stream changes which then

can trigger changes in water temperature, sinuosity and other geomorphic factors important for aquatic species survival (Joslin and Youmans 1999; Trombulak and Frissell 2000).

Roads also can modify flowpaths in the larger drainage network. Roads intercept subsurface flow as well as concentrate surface flow, which results in new flowpaths that otherwise would not exist, and the extension of the drainage network into previously unchannelized portions of the hillslope (Gucinski et al. 2000; Joslin and Youmans 1999). Severe aggradation of sediment at stream structures or confluences can force streams to actually go subsurface or make them too shallow for fish passage (Endicott 2008; Furniss et al. 1991).

Impacts on aquatic habitat and fish

Roads can have dramatic and lasting impacts on fish and aquatic habitat. Increased sedimentation in stream beds has been linked to decreased fry emergence, decreased juvenile densities, loss of winter carrying capacity, and increased predation of fishes, and reductions in macro-invertebrate populations that are a food source to many fish species (Rhodes et al. 1994, Joslin and Youmans 1999, Gucinski et al. 2000, Endicott 2008). On a landscape scale, these effects can add up to: changes in the frequency, timing and magnitude of disturbance to aquatic habitat and changes to aquatic habitat structures (e.g., pools, riffles, spawning gravels and in-channel debris), and conditions (food sources, refugi, and water temperature) (Gucinski et al. 2000).

Roads can also act as barriers to migration (Gucinski et al. 2000). Where roads cross streams, road engineers usually place culverts or bridges. Culverts in particular can and often interfere with sediment transport and channel processes such that the road/stream crossing becomes a barrier for fish and aquatic species movement up and down stream. For instance, a culvert may scour on the downstream side of the crossing, actually forming a waterfall up which fish cannot move. Undersized culverts and bridges can infringe upon the channel or floodplain and trap sediment causing the stream to become too shallow and/or warm such that fish will not migrate past the structure. This is problematic for many aquatic species but especially for anadromous species that must migrate upstream to spawn. Well-known native aquatic species affected by roads include Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*), the Threatened Greenback cutthroat trout (*O. c. stomias*), and Rio Grande cutthroat trout (*O. c. virginalis)*, as well as other native fishes and amphibians (Endicott 2008).

Impacts on terrestrial habitat and wildlife

Roads and trails impact wildlife through a number of mechanisms including: direct mortality (poaching, hunting/trapping) changes in movement and habitat use patterns (disturbance/avoidance), as well as indirect impacts including alteration of the adjacent habitat and interference with predatory/prey relationships (Wisdom et al. 2000, Trombulak and Frissell 2000). Some of these impacts result from the road itself, and some result from the uses on and around the roads (access). Ultimately, roads have been found to reduce the abundance and distribution of several forest species (Fayrig and Ritwinski 2009, Benítez-López et al. 2010).

Direct mortality and disturbance from road and trail use impacts many different types of species. For example, wide-ranging carnivores can be significantly impacted by a number of factors including trapping, poaching, collisions, negative human interactions, disturbance and displacement (Gaines et al. 2003). Road access has slowed the recovery of the Mexican Wolf (*Canis lupus baileyi*) with more than half of of mortalities due to illegal shootings (USDI FWS 2012). Hunted game species such as elk (*Cervus canadensis*), become more vulnerable from

access allowed by roads and motorized trails resulting in a reduction in effective habitat among other impacts (Rowland et al. 2005, Switalski and Jones 2012). Slow-moving migratory animals such as amphibians, and reptiles who use roads to regulate temperature are also vulnerable (Gucinski et al. 2000, Brehme et al. 2013). Several bird species are sensitive to disturbance on roads (Barton and Holmes 2007), and several authors have identified buffer zones (Table 1, Switalski and Jones 2008, Whittington and Allen 2008).

Habitat alteration is a significant consequence of roads as well. At the landscape scale, roads fragment habitat blocks into smaller patches that may not be able to support successfully interior forest species. Smaller habitat patches also results in diminished genetic variability, increased inbreeding, and at times local extinctions (Gucinski et al. 2000; Trombulak and Frissell 2000). Motorized trails and routes can also have cascading effects throughout the ecosystem. For example, on an intensively used ORV route in Idaho, native shrubs, bunch grasses, and microbiotic crust were greatly reduced close to the route and replaced with non-native cheat grass (*Bromus tectorum*) and the native shrub rabbitbrush (*Chrysothamnus* spp.; Munger et al. 2003). Because of these habitat changes, fewer reptiles were found alongside the route than were found 100 m away.

Table 1. A summary of raptor nest buffer zones recommended for areas associated with human disturbance (Reprinted from Switalski and Jones 2008)

Species		Median nest buffer (m) (range in parentheses)	Reference
American kestrel	Falco sparverius	125 (50-200)	Richardson and Miller (1997)
Ferruginous hawk	Buteo regalis	300	Hamann et al. (1999)
Bald eagle	Haliaeetus leucocephalus	400	Hamann et al. (1999)
Northern goshawk	Accipiter gentilis	450 (400-500)	Jones (1979)
Sharp-shinned hawk	Accipiter striatus	450 (400-500)	Jones (1979)
Cooper's hawk	Accipiter cooperii	525 (400-500)	Richardson and Miller (1997)
Prairie falcon	Falco mexicanus	650 (50-800)	Richardson and Miller (1997)
Golden eagle	Aquila chrysaetos	800 (200-1600)	Richardson and Miller (1997)
Peregrine falcon	Falco peregrinus	800 (800-1600)	Richardson and Miller (1997)
Red-tailed hawk	Buteo jamaicensis	800	Call (1979)
Mexican spotted owl	Strix occidentalis lucida	900	US Fish and Wildlife Service (1995)
Osprey	Pandion haliaetus	1000 (400-1500)	Richardson and Miller (1997)

Roads also change the composition and structure of ecosystems along buffer zones, called edge-affected zones. The width of edge-affected zones varies by what metric is being discussed; however, researchers have documented road-avoidance zones a kilometer or more away from a road (Table 2). In heavily roaded landscapes, edge-affected acres can be a significant fraction of total acres. For example, in a landscape area where the road density is 3 mi/mi^2 (not an uncommon road density in national forests) and where the edge-affected zone is estimated to be 500 ft from the center of the road to each side, the edge-affected zone is 56% of the total acreage.

Table 2: A summary of some documented road-avoidance zones for various species (adapted from Robinson et al. 2010).

Species	Avoidance zone m (ft)	Type of disturbance	Reference
Snakes	650 (2133)	Forestry roads	Bowles (1997)
Salamander	35 (115)	Narrow forestry road, light traffic	Semlitsch (2003)
Woodland birds	150 (492)	Unpaved roads	Ortega and Capen (2002)
Spotted owl	400 (1312)	Forestry roads, light traffic	Wasser et al. (1997)
Marten	<100 (<328)	Any forest opening	Hargis et al. (1999)
Elk	500–1000 (1640-3281)	Logging roads, light traffic	Edge and Marcum (1985)
	100–300 (328-984)	Mountain roads depending on traffic volume	Rost and Bailey (1979)
Black bear	274 (899)	Spring, unpaved roads	Kasworm and Manley (1990)
	914 (2999)	Fall, unpaved roads	

Roads and trails also affect ecosystems and habitats because they are also a major vector of non-native plant and animal species. This can have significant ecological and economic impacts when the invading species are aggressive and can overwhelm or significantly alter native species and systems. In addition, roads can increase harassment, poaching and collisions with vehicles, all of which lead to stress or mortality (Wisdom et al. 2000).

Recent reviews have synthesized the impacts of roads on animal abundance and distribution. Fahrig and Rytwinski (2009) did a complete review of the empirical literature on effects of roads and traffic on animal abundance and distribution looking at 79 studies that addressed 131 species and 30 species groups. They found that the number of documented negative effects of roads on animal abundance outnumbered the number of positive effects by a factor of 5. Amphibians, reptiles, most birds tended to show negative effects. Small mammals generally showed either positive effects or no effect, mid-sized mammals showed either negative effects or no effect, and large mammals showed predominantly negative effects. Benítez-López et al. (2010) conducted a meta-analysis on the effects of roads and infrastructure proximity on mammal and bird populations. They found a significant pattern of avoidance and a reduction in bird and mammal populations in the vicinity of infrastructure.

Road density[2] thresholds for fish and wildlife

It is well documented that beyond specific road density thresholds, certain species will be negatively affected, and some will be extirpated. Most studies that look into the relationship between road density and wildlife focus on the impacts to large endangered carnivores or hunted game species, although high road densities certainly affect other species – for instance, reptiles and amphibians. Gray wolves (*Canis lupus*) in the Great Lakes region and elk in Montana and Idaho have undergone the most long-term and in depth analysis. Forman and Hersperger (1996) found that in order to maintain a naturally functioning landscape with sustained populations of large mammals, road density must be below 0.6 km/km² (1.0 mi/mi²). Several studies have since substantiated their claim (Robinson et al. 2010, Table 3).

A number of studies at broad scales have also shown that higher road densities generally lead to greater impacts to aquatic habitats and fish density (Table 3). Carnefix and Frissell (2009) provide a concise review of studies that correlate cold water fish abundance and road density, and from the cited evidence concluded that "1) no truly "safe" threshold road density exists, but rather negative impacts begin to accrue and be expressed with incursion of the very first road segment; and 2) highly significant impacts (e.g., threat of extirpation of sensitive species) are already apparent at road densities on the order of 0.6 km/km^2 (1.0 mi/mi²) or less" (p. 1).

[2] We intend the term "road density" to refer to the density all roads within national forests, including system roads, closed roads, non-system roads administered by other jurisdictions (private, county, state), temporary roads and motorized trails. Please see Attachment 2 for the relevant existing scientific information supporting this approach.

Table 3: A summary of some road-density thresholds and correlations for terrestrial and aquatic species and ecosystems (reprinted from Robinson et al. 2010).

Species (Location)	Road density (mean, guideline, threshold, correlation)	Reference
Wolf (Minnesota)	0.36 km/km2 (mean road density in primary range); 0.54 km/km^2 (mean road density in peripheral range)	Mech et al. (1988)
Wolf	>0.6 km/km^2 (absent at this density)	Jalkotzy et al. (1997)
Wolf (Northern Great Lakes region)	>0.45 km/km^2 (few packs exist above this threshold); >1.0 km/km^2 (no pack exist above this threshold)	Mladenoff et al. (1995)
Wolf (Wisconsin)	0.63 km/km^2 (increasing due to greater human tolerance	Wydeven et al. (2001)
Wolf, mountain lion (Minnesota, Wisconsin, Michigan)	0.6 km/km^2 (apparent threshold value for a naturally functioning landscape containing sustained populations)	Thiel (1985); van Dyke et al. (1986); Jensen et al. (1986); Mech et al. (1988); Mech (1989)
Elk (Idaho)	1.9 km/km^2 (density standard for habitat effectiveness)	Woodley 2000 cited in Beazley et al. 2004
Elk (Northern US)	1.24 km/km^2 (habitat effectiveness decline by at least 50%)	Lyon (1983)
Elk, bear, wolverine, lynx, and others	0.63 km/km^2 (reduced habitat security and increased mortality)	Wisdom et al. (2000)
Moose (Ontario)	0.2-0.4 km/km2 (threshold for pronounced response)	Beyer et al. (2013)
Black bear (North Carolina)	>1.25 km/km^2 (open roads); >0.5 km/km2 (logging roads); (interference with use of habitat)	Brody and Pelton (1989)
Black bear	0.25 km/km^2 (road density should not exceed)	Jalkotzy et al. (1997)
Bobcat (Wisconsin)	1.5 km/km^2 (density of all road types in home range)	Jalkotzy et al. (1997)
Large mammals	>0.6 km/km^2 (apparent threshold value for a naturally functioning landscape containing sustained populations)	Forman and Hersperger (1996)
Fish populations (Medicine Bow National Forest)	(1) Positive correlation of numbers of culverts and stream crossings and amount of fine sediment in stream channels (2) Negative correlation of fish density and numbers of culverts	Eaglin and Hubert (1993) cited in Gucinski et al. (2001)
Macroinvertebrates	Species richness negatively correlated with an index of road density	McGurk and Fong (1995)
Non-anadromous salmonids (Upper Columbia River basin)	(1) Negative correlation likelihood of spawning and rearing and road density (2) Negative correlation of fish density and road density	Lee et al. (1997)

Where both stream and road densities are high, the incidence of connections between roads and streams can also be expected to be high, resulting in more common and pronounced effects of roads on streams (Gucinski et al. 2000). For example, a study on the Medicine Bow National Forest (WY) found as the number of culverts and stream crossings increased, so did the amount of sediment in stream channels (Eaglin and Hubert 1993). They also found a negative correlation with fish density and the number of culverts. Invertebrate communities can also be impacted. McGurk and Fong (1995) report a negative correlation between an index of road density with macroinvertebrate diversity.

Anderson et al. (2012) also showed that watershed conditions tend to be best in areas protected from road construction and development. Using the US Forest Service's Watershed Condition Framework assessment data, they showed that National Forest lands that are protected under the Wilderness Act, which provides the strongest safeguards, tend to have the healthiest watersheds. Watersheds in Inventoried Roadless Areas – which are protected from road building and logging by the Roadless Area Conservation Rule – tend to be less healthy than watersheds in designated Wilderness, but they are considerably healthier than watersheds in the managed landscape.

Impacts on other resources

Roads and motorized trails also play a role in affecting wildfire occurrence. Research shows that human-ignited wildfires, which account for more than 90% of fires on national lands, is almost five times more likely in areas with roads (USDA Forest Service 1996a; USDA Forest Service 1998). Furthermore, Baxter (2002) found that off-road vehicles (ORVs) can be a significant source of fire ignitions on forestlands. Roads can affect where and how forests burn and, by extension, the vegetative condition of the forest. See Attachment 1 for more information documenting the relationship between roads and wildfire occurrence.

Finally, access allowed by roads and trails can increase of ORV and motorized use in remote areas threatening archaeological and historic sites. Increased visitation has resulted in intentional and unintentional damage to many cultural sites (USDI Bureau of Land Management 2000, Schiffman 2005).

II. Climate Change and Transportation Infrastructure including the value of roadless areas for climate change adaptation

As climate change impacts grow more profound, forest managers must consider the impacts on the transportation system as well as from the transportation system. In terms of the former, changes in precipitation and hydrologic patterns will strain infrastructure at times to the breaking point resulting in damage to streams, fish habitat, and water quality as well as threats to public safety. In terms of the latter, the fragmenting effect of roads on habitat will impede the movement of species which is a fundamental element of adaptation. Through planning, forest managers can proactively address threats to infrastructure, and can actually enhance forest resilience by removing unneeded roads to create larger patches of connected habitat.

Impact of climate change and roads on transportation infrastructure

In addition to a much warmer climate, it is expected that climate change will be responsible for more extreme weather events, leading to increasing flood severity, more frequent landslides, changing hydrographs (peak, annual mean flows, etc.), and changes in erosion and

sedimentation rates and delivery processes[3]. Roads and trails in national forests, if designed by an engineering standard at all, were designed for storms and water flows typical of past decades, and hence may not be designed for the storms in future decades. Hence, climate driven changes may cause transportation infrastructure to malfunction or fail (ASHTO 2012, USDA Forest Service 2010). The likelihood is higher for facilities in high-risk settings—such as rain-on-snow zones, coastal areas, and landscapes with unstable geology (USDA Forest Service 2010).

Forests fragmented by roads will likely demonstrate less resistance and resilience to stressors, like those associated with climate change (Noss 2001). First, the more a forest is fragmented (and therefore the higher the edge/interior ratio), the more the forest loses its inertia characteristic, and becoming less resilient and resistant to climate change. Second, the more a forest is fragmented characterized by isolated patches, the more likely the fragmentation will interfere with the ability of species to track shifting climatic conditions over time and space. Noss (2001) predicts that weedy species with effective dispersal mechanisms might benefit from fragmentation at the expense of native species.

Modifying infrastructure to increase resilience

To prevent or reduce road failures, culvert blow-outs, and other associated hazards, forest managers will need to take a series of actions. These include replacing undersized culverts with larger ones, prioritizing maintenance and upgrades (e.g., installing drivable dips and more outflow structures), and obliterating roads that are no longer needed and pose erosion hazards (USDA Forest Service 2010, USDA Forest Service 2012a, USDA Forest Service 2011, Table 4).

Olympic National Forest has developed a number of documents oriented at oriented at protecting watershed health and species in the face of climate change, including a 2003 travel management strategy and a report entitled Adapting to Climate Change in Olympic National Park and National Forest. In the travel management strategy, Olympic National Forest recommended that 1/3rd of its road system be decommissioned and obliterated (USDA Forest Service 2011a). In addition, the plan called for addressing fish migration barriers in a prioritized and strategic way – most of these are associated with roads. The report calls for road decommissioning, relocation of roads away from streams, enlarging culverts as well as replacing culverts with fish-friendly crossings (USDA Forest Service 2011a, Table 4).

[3] http://www.epa.gov/climatechange/impacts-adaptation/southwest.html

Table 4: Current and expected sensitivities of fish to climate change on the Olympic Peninsula, associated adaptation strategies and action for fisheries and fish habitat management and relevant to transportation management at Olympic National Forest and Olympic National Park (excerpt reprinted from USDA Forest Service 2011a).

Current and expected sensitivites	Adaptation strategies and actions
Changes in habitat quantity and quality	• Implement habitat restoration projects that focus on re-creating watershed processes and functions and that create diverse, resilient habitat.
Increase in culvert failures, fill-slope failures, stream adjacent road failures, and encroachment from stream-adjacent road segments	• Decommission unneeded roads. • Remove sidecast, improve drainage, and increase culvert sizing on remaining roads. • Relocate stream-adjacent roads.
Greater difficulty disconnecting roads from stream channels	• Design more resilient stream crossing structures.
Major changes in quantity and timing of streamflow in transitional watersheds	• Make road and culvert designs more conservative in transitional watersheds to accommodate expected changes.
Decrease in area of headwater streams	• Continue to correct culvert fish passage barriers. • Consider re-prioritizing culvert fish barrier correction projects.
Decrease in habitat quantity and connectivity for species that use headwater streams	• Restore habitat in degraded headwater streams that are expected to retain adequate summer streamflow (ONF).

In December 2012, the USDA Forest Service published a report entitled "Assessing the Vulnerability of Watersheds to Climate Change." This document reinforces the concept expressed by Olympic National Forest that forest managers need to be proactive in reducing erosion potential from roads:

> "Road improvements were identified as a key action to improve condition and resilience of watersheds on all the pilot Forests. In addition to treatments that reduce erosion, road improvements can reduce the delivery of runoff from road segments to channels, prevent diversion of flow during large events, and restore aquatic habitat connectivity by providing for passage of aquatic organisms. As stated previously, watershed sensitivity is determined by both inherent and management-related factors. Managers have no control over the inherent factors, so to improve resilience, efforts must be directed at anthropogenic influences such as instream flows, roads, rangeland, and vegetation management….
>
> [Watershed Vulnerability Analysis] results can also help guide implementation of travel management planning by informing priority setting for decommissioning roads and road reconstruction/maintenance. As with the Ouachita NF example, disconnecting roads from the stream network is a key objective of such work. Similarly, WVA analysis could also help prioritize aquatic organism passage projects at road-stream crossings to allow migration by aquatic residents to suitable habitat as streamflow and temperatures change" (USDA Forest Service 2012a, p. 22-23).

Reducing fragmentation to enhance aquatic and terrestrial species adaptation
Decommissioning and upgrading roads and thus reducing the amount of fine sediment deposited on salmonid nests can increase the likelihood of egg survival and spawning success (McCaffery et al. 2007). In addition, this would reconnect stream channels and remove barriers such as culverts. Decommissioning roads in riparian areas may provide further benefits to salmon and other aquatic organisms by permitting reestablishment of streamside vegetation, which provides shade and maintains a cooler, more moderated microclimate over the stream (Battin et al. 2007).

One of the most well documented impacts of climate change on wildlife is a shift in the ranges of species (Parmesan 2006). As animals migrate, landscape connectivity will be increasingly important (Holman et al. 2005). Decommissioning roads in key wildlife corridors will improve connectivity and be an important mitigation measure to increase resiliency of wildlife to climate change. For wildlife, road decommissioning can reduce the many stressors associated with roads. Road decommissioning restores habitat by providing security and food such as grasses and fruiting shrubs for wildlife (Switalski and Nelson 2011).

Forests fragmented by roads and motorized trail networks will likely demonstrate less resistance and resilience to stressors, such as weeds. As a forest is fragmented and there is more edge habitat, Noss (2001) predicts that weedy species with effective dispersal mechanisms will increasingly benefit at the expense of native species. However, decommissioned roads when seeded with native species can reduce the spread of invasive species (Grant et al. 2011), and help restore fragmented forestlands. Off-road vehicles with large knobby tires and large undercarriages are also a key vector for weed spread (e.g., Rooney 2006). Strategically closing and decommissioning motorized routes, especially in roadless areas, will reduce the spread of weeds on forestlands (Gelbard and Harrison 2003).

Transportation infrastructure and carbon sequestration
The topic of the relationship of road restoration and carbon has only recently been explored. There is the potential for large amounts of carbon (C) to be sequestered by reclaiming roads. When roads are decompacted during reclamation, vegetation and soils can develop more rapidly and sequester large amounts of carbon. A recent study estimated total soil C storage increased 6 fold to 6.5 x 107g C/km (to 25 cm depth) in the northwestern US compared to untreated abandoned roads (Lloyd et al. 2013). Another recent study concluded that reclaiming 425 km of logging roads over the last 30 years in Redwood National Park in Northern California resulted in net carbon savings of 49,000 Mg carbon to date (Madej et al. 2013, Table 5).

Kerekvliet et al. (2008) published a Wilderness Society briefing memo on the impact to carbon sequestration from road decommissioning. Using Forest Service estimates of the fraction of road miles that are unneeded, the authors calculated that restoring 126,000 miles of roads to a natural state would be equivalent to revegetating an area larger than Rhode Island. In addition, they calculate that the net economic benefit of road treatments are always positive and range from US$0.925-1.444 billion.

Table 5. Carbon budget implications in road decommissioning projects (reprinted from Madej et al. 2013).

Road Decommissioning Activities and Processes	Carbon Cost	Carbon Savings
Transportation of staff to restoration sites (fuel emissions)	X	
Use of heavy equipment in excavations (fuel emissions)	X	
Cutting trees along road alignment during hillslope recontouring	X	
Excavation of road fill from stream crossings		X
Removal of road fill from unstable locations		X
Reduces risk of mass movement		X
Post-restoration channel erosion at excavation sites	X	
Natural revegetation following road decompaction		X
Replanting trees		X
Soil development following decompaction		X

Benefits of roadless areas and roadless area networks to climate change adaptation

Undeveloped natural lands provide numerous ecological benefits. They contribute to biodiversity, enhance ecosystem representation, and facilitate connectivity (Loucks et al. 2003; Crist and Wilmer 2002, Wilcove 1990, The Wilderness Society 2004, Strittholt and Dellasala 2001, DeVelice and Martin 2001), and provide high quality or undisturbed water, soil and air (Anderson et al. 2012, Dellasalla et al. 2011). They also can serve as ecological baselines to help us better understand our impacts to other landscapes, and contribute to landscape resilience to climate change.

Forest Service roadless lands, in particular, are heralded for the conservation values they provide. These are described at length in the preamble of the Roadless Area Conservation Rule (RACR)[4] as well as in the Final Environmental Impact Statement (FEIS) for the RACR[5], and include: high quality or undisturbed soil, water, and air; sources of public drinking water; diversity of plant and animal communities; habitat for threatened, endangered, proposed, candidate, and sensitive species and for those species dependent on large, undisturbed areas of land; primitive, semi-primitive non- motorized, and semi-primitive motorized classes of dispersed recreation; reference landscapes; natural appearing landscapes with high scenic quality; traditional cultural properties and sacred sites; and other locally identified unique characteristics (e.g., include uncommon geological formations, unique wetland complexes, exceptional hunting and fishing opportunities).

The Forest Service, National Park Service, and US Fish and Wildlife Service recognize that protecting and connecting roadless or lightly roaded areas is an important action agencies can take to enhance climate change adaptation. For example, the Forest Service National Roadmap for Responding to Climate Change (USDA Forest Service 2011b) establishes that increasing connectivity and reducing fragmentation are short and long term actions the Forest Service

[4] Federal Register .Vol. 66, No. 9. January 12, 2001. Pages 3245-3247.
[5] Final Environmental Impact Statement, Vol. 1, 3–3 to 3–7

should take to facilitate adaptation to climate change.[6] The National Park Service also identifies connectivity as a key factor for climate change adaptation along with establishing "blocks of natural landscape large enough to be resilient to large-scale disturbances and long-term changes" and other factors. The agency states that: "The success of adaptation strategies will be enhanced by taking a broad approach that identifies connections and barriers across the landscape. Networks of protected areas within a larger mixed landscape can provide the highest level of resilience to climate change."[7] Similarly, the National Fish, Wildlife and Plants Climate Adaptation Partnership's Adaptation Strategy (2012) calls for creating an ecologically-connected network of conservation areas.[8]

Roadless lands also are responsible for higher quality water and watersheds. Anderson et al. (2012) assessed the relationship of watershed condition and land management status and found a strong spatial association between watershed health and protective designations. Dellasalla et al. (2011) found that undeveloped and roadless watersheds are important for supplying downstream users with high-quality drinking water, and developing these watersheds comes at significant costs associated with declining water quality and availability. The authors recommend a light-touch ecological footprint to sustain the many values that derive from roadless areas including healthy watersheds.

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[6] Forest Service, 2011. *National Roadmap for Responding to Climate Change*. US Department of Agriculture. FS-957b. Page 26.

[7] National Park Service. *Climate Change Response Program Brief*. http://www.nature.nps.gov/climatechange/adaptationplanning.cfm. Also see: National Park Service, 2010. *Climate Change Response Strategy*. http://www.nature.nps.gov/climatechange/docs/NPS_CCRS.pdf. Objective 6.3 is to "Collaborate to develop cross-jurisdictional conservation plans to protect and restore connectivity and other landscape-scale components of resilience."

[8] See http://www.wildlifeadaptationstrategy.gov/pdf/NFWPCAS-Chapter-3.pdf. Pages 55- 59. The first goal and related strategies are:

> Goal 1: Conserve habitat to support healthy fish, wildlife, and plant populations and ecosystem functions in a changing climate.
>
> > Strategy 1.1: identify areas for an ecologically-connected network of terrestrial, freshwater, coastal, and marine conservation areas that are likely to be resilient to climate change and to support a broad range of fish, wildlife, and plants under changed conditions.
> >
> > Strategy 1.2: Secure appropriate conservation status on areas identified in Strategy 1.1 to complete an ecologically-connected network of public and private conservation areas that will be resilient to climate change and support a broad range of species under changed conditions.
> >
> > Strategy 1.4: Conserve, restore, and as appropriate and practicable, establish new ecological connections among conservation areas to facilitate fish, wildlife, and plant migration, range shifts, and other transitions caused by climate change.

III. Sustainable Transportation Management in National Forests as Part of Ecological Restoration

At 375,000 miles strong, the Forest Service road system is one of the largest in the world – it is eight times the size of the National Highway System. It is also indisputably unsustainable – that is, roads are not designed, located, or maintained according to best management practices, and environmental impacts are not minimized. It is largely recognized that forest roads, especially unpaved ones, are a primary source of sediment pollution to surface waters (Endicott 2008, Gucinski et al. 2000), and that the system has about 1/3rd more miles than it needs (USDA Forest Service 2001). In addition, the majority of the roads were constructed decades ago when road design and management techniques did not meet current standards (Gucinski et al. 2000, Endicott 2008), making them more vulnerable to erosion and decay than if they had been designed today. Road densities in national forests often exceed accepted thresholds for wildlife.

Only a small portion of the road system is regularly used. All but 18% of the road system is inaccessible to passenger vehicles. Fifty-five percent of the roads are accessible only by high clearance vehicles and 27% are closed. The 18% that is accessible to cars is used for about 80% of the trips made within National Forests.[9] Most of the road maintenance funding is directed to the passenger car roads, while the remaining roads suffer from neglect. As a result, the Forest Service currently has a $3.7 billion road maintenance backlog that grows every year. In other words, only about 1/5th of the roads in the national forest system are used most of the time, and the fraction that is used often is the best designed and maintained because they are higher level access roads. The remaining roads sit generally unneeded and under-maintained – arguably a growing ecological and fiscal liability.

Current Forest Service management direction is to identify and implement a sustainable transportation system.[10] The challenge for forest managers is figuring out what is a sustainable road system and how to achieve it – a challenge that is exacerbated by climate change. It is reasonable to define a sustainable transportation system as one where all the routes are constructed, located, and maintained with best management practices, and social and environmental impacts are minimized. This, of course, is easier said than done, since the reality is that even the best roads and trail networks can be problematic simply because they exist and usher in land uses that without the access would not occur (Trombulak and Frissell 2000, Carnefix and Frissell 2009, USDA Forest Service 1996b), and when they are not maintained to the designed level they result in environmental problems (Endicott 2008; Gucinski et al. 2000). Moreover, what was sustainable may no longer be sustainable under climate change since roads designed to meet older climate criteria may no longer hold up under new climate scenarios (USDA Forest Service 2010, USDA Forest Service 2011b, USDA Forest Service 2012a, AASHTO 2012).

Forest Service efforts to move toward a more sustainable transportation system

The Forest Service has made efforts to make its transportation system more sustainable, but still has considerable work to do. In 2001, the Forest Service tried to address the issue by

[9] USDA Forest Service. Road Management Website Q&As. Available online at http://www.fs.fed.us/eng/road_mgt/qanda.shtml.

[10] See Forest Service directive memo dated March 29, 2012 entitled "Travel Management, Implementation of 36 CFR, Part 202, Subpart A (36 CFR 212.5(b))"

promulgating the Roads Rule[11] with the purpose of working toward a sustainable road system (USDA 2001). The Rule directed every national forest to identify a minimum necessary road system and identify unneeded roads for decommissioning. To do this, the Forest Service developed the Roads Analysis Process (RAP), and published Gucinski et al. (2000) to provide the scientific foundation to complement the RAP. In describing the RAP, Gucinski et al. (2000) writes:

> "Roads Analysis is intended to be an integrated, ecological, social, and economic approach to transportation planning. It uses a multiscale approach to ensure that the identified issues are examined in context. Roads Analysis is to be based on science. Analysts are expected to locate, correctly interpret, and use relevant existing scientific literature in the analysis, disclose any assumptions made during the analysis, and reveal the limitations of the information on which the analysis is based. The analysis methods and the report are to be subjected to critical technical review" (p. 10).

Most national forests have completed RAPs, although most only looked at passenger vehicle roads which account for less than 20% of the system's miles. The Forest Service Washington Office in 2010 directed that forests complete a Travel Analysis Process (TAP) by the end of fiscal year 2015, which must address all roads and create a map and list of roads identifying which are likely needed and which are not. Completed TAPs will provide a blueprint for future road decommissioning and management, they will not constitute compliance with the Roads Rule, which clearly requires the identification of the minimum roads system and roads for decommissioning. Almost all forests have yet to comply with subpart A.

The Forest Service in 2005 then tried to address the off-road portion of this issue by promulgating subpart B of the Travel Management Rule,[12] with the purpose of curbing the most serious impacts associated with off-road vehicle use. Without a doubt, securing summer-time travel management plans was an important step to curbing the worst damage. However, much work remains to be done to approach sustainability, especially since many national forests used the travel management planning process to simply freeze the footprint of motorized routes, and did not try to re-design the system to make it more ecologically or socially sustainable. Adams and McCool (2009) considered this question of how to achieve sustainable motorized recreation and concluded that:

> As the agencies move to revise [off-road vehicle] allocations, they need to clearly define how they intend to locate routes so as to minimize impacts to natural resources and other recreationists in accordance with Executive Order 11644....[13]

[11] 36 CFR 215 subpart A

[12] 36 CFR 212 subpart B

[13] Recent court decisions have made it clear that the minimization requirements in the Executive Orders are not discretionary and that the Executive Orders are enforceable. See

- *Idaho Conservation League v. Guzman ,* 766 F. Supp. 2d 1056 (D. Idaho 2011) (Salmon-Challis National Forest TMP) .
- *The Wilderness Society v. U.S. Forest Service*, CV 08-363 (D. Idaho 2012) (Sawtooth-Minidoka district National Forest TMP).
- *Central Sierra Environmental Resource Center v. US Forest Service*, CV 10-2172 (E.D. CA 2012) (Stanislaus National Forest TMP).

> …As they proceed with designation, the FS and BLM need to acknowledge that current allocations are the product of agency failure to act, not design. Ideally, ORV routes would be allocated as if the map were currently empty of ORV routes. Reliance on the current baseline will encourage inefficient allocations that likely disproportionately impact natural resources and non-motorized recreationists. While acknowledging existing use, the agencies need to do their best to imagine the best possible arrangement of ORV routes, rather than simply tinkering around the edges of the current allocations.[14]

The Forest Service only now is contemplating addressing the winter portion of the issue, forced by a lawsuit challenging the Forest Service's inadequate management of snowmobiles. The agency is expected to issue a third rule in the fall of 2014 that will trigger winter travel management planning.

Strategies for identifying a minimum road system and prioritizing restoration

Transportation Management plays an integral role in the restoration of Forestlands. Reclaiming and obliterating roads is key to developing a sustainable transportation system. Numerous authors have suggested removing roads 1) to restore water quality and aquatic habitats Gucinski et al. 2000), and 2) to improve habitat security and restore terrestrial habitat (e.g., USDI USFWS 1993, Hebblewhite et al. 2009).

Creating a minimum road system through road removal will increase connectivity and decrease fragmentation across the entire forest system. However, at a landscape scale, certain roads and road segments pose greater risks to terrestrial and aquatic integrity than others. Hence, restoration strategies must focus on identifying and removing/mitigating the higher risk roads. Additionally, areas with the highest ecological values, such as being adjacent to a roadless area, may also be prioritized for restoration efforts. Several methods have been developed to help prioritize road reclamation efforts including GIS-based tools and best management practices (BMPs). It is our hope that even with limited resources, restoration efforts can be prioritized and a more sustainable transportation system created.

GIS-based tools

Girvetz and Shilling (2003) developed a novel and inexpensive way to analyze environmental impacts from road systems using the Ecosystem Management Decision Support program (EMDS). EMDS was originally developed by the United States Forest Service, as a GIS-based decision support tool to conduct ecological analysis and planning (Reynolds 1999). Working in conjunction with Tahoe National Forest managers, Girvetz and Shilling (2003) used spatial data on a number of aquatic and terrestrial variables and modeled the impact of the forest's road network. The network analysis showed that out of 8233 km of road analyzed, only 3483 km (42%) was needed to ensure current and future access to key points. They found that the modified network had improved patch characteristics, such as significantly fewer "cherry stem" roads intruding into patches, and larger roadlessness.

Shilling et al. (2012) later developed a recreational route optimization model using a similar methodology and with the goal of identifying a sustainable motorized transportation system for the Tahoe National Forest (Figure 2). Again using a variety of environmental factors, the model identified routes with high recreational benefits, lower conflict, lower maintenance and

[14] Page 105.

management requirements, and lower potential for environmental impact operating under the presumption that such routes would be more sustainable and preferable in the long term. The authors combined the impact and benefit analyses into a recreation system analysis "that was effectively a cost-benefit accounting, consistent with requirements of both the federal Travel Management Rule (TMR) and the National Environmental Policy Act" (p. 392**).**

The Wilderness Society in 2012 also developed a GIS decision support tool called "RoadRight" that identifies high risk road segments to a variety of forest resources including water, wildlife, and roadlessness (The Wilderness Society 2012, The Wilderness Society 2013). The GIS system is designed to provide information that will help forest planners identify and minimize road related environmental risks. See the summary of and user guide for RoadRight that provides more information including where to access the open source software.

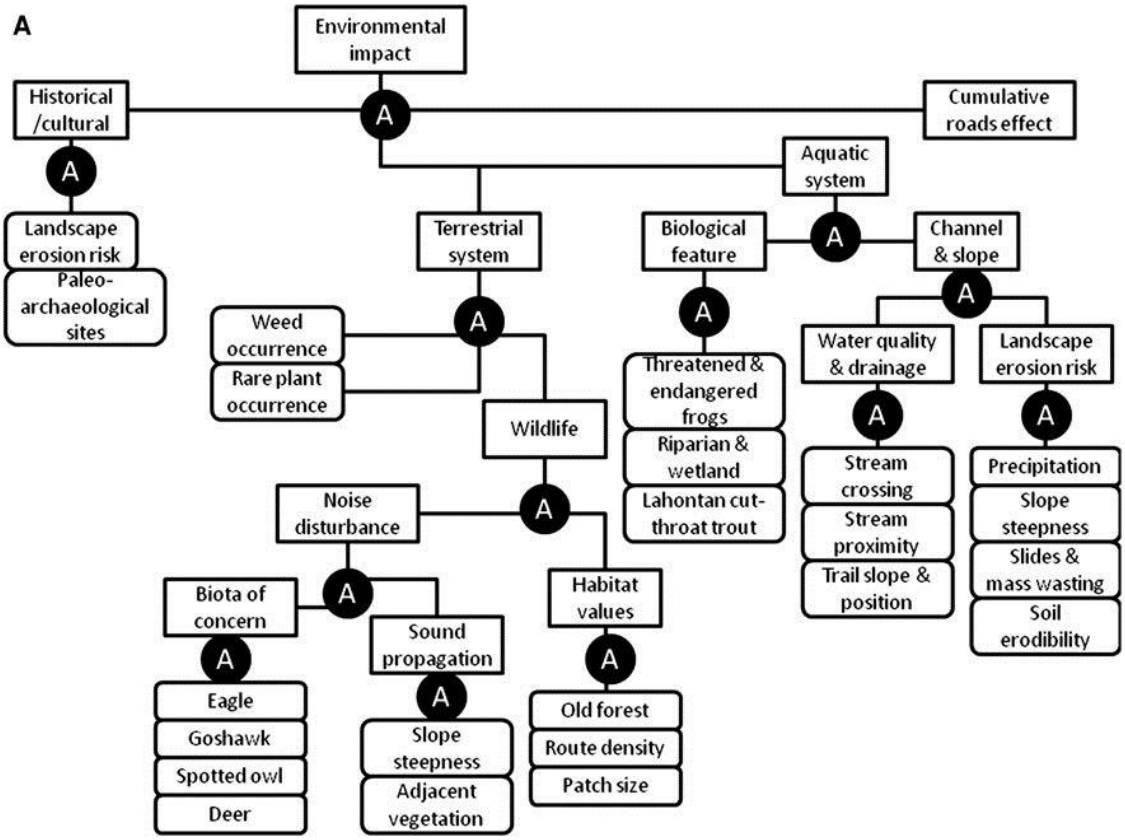

Figure 2: A knowledge base of contributions of various environmental conditions to the concept ''environmental impact'' [of motorized trails]. Rectangles indicate concepts, circles indicate Boolean logic operators, and rounded rectangles indicate sources of environmental data. (Reprinted from Shilling et al. 2012)

Best management practices (BMPs)

BMPs have also been developed to help create more sustainable transportation systems and identify restoration opportunities. BMPs provide science-based criteria and standards that land managers follow in making and implementing decisions about human uses and projects that affect natural resources. Several states have developed BMPs for road construction, maintenance and decommissioning practices (e.g., Logan 2001, Merrill and Cassaday 2003, USDA Forest Service 2012b).

Recently, BMPs have been developed for addressing motorized recreation. Switalski and Jones (2012) published, "*Off-Road Vehicle Best Management Practices for Forestlands: A Review of Scientific Literature and Guidance for Managers*." This document reviews the current literature on the environmental and social impacts of off-road vehicles (ORVs), and establishes a set of Best Management Practices (BMPs) for the planning and management of ORV routes on forestlands. The BMPs were designed to be used by land managers on all forestlands, and is consistent with current forest management policy and regulations. They give guidance to transportation planners on where how to place ORV routes in areas where they will reduce use conflicts and cause as little harm to the environment as possible. These BMPs also help guide managers on how to best remove and restore routes that are redundant or where there is an unacceptable environmental or social cost.

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Attachments

Attachment 1: Wildfire and Roads Fact Sheet

Attachment 2: Using Road Density as a Metric for Ecological Health in National Forests: What Roads and Routes should be Included? Summary of Scientific Information

Roads and Fire: A Proven Relationship

Photo: Lou Anegli Digital

Roaded Forests Are at a Greater Risk of Experiencing Wildfires than Unroaded Forests

- A wildland fire ignition is almost twice as likely to occur in a roaded area than in a roadless area. (USDA 2000, Table 3-18)
- The location of large wildfires is often correlated with proximity to busy roads. (Sierra Nevada Ecosystem Project, 1996)
- High road density increases the probability of fire occurrence due to human-caused ignitions. (Hann, W.J., et al. 1997)
- Unroaded areas have lower potential for high-intensity fires than roaded areas because they are less prone to human-caused ignitions. (DellaSala, et al. 1995)
- The median size of large fires on national forests is greater outside of roadless areas. (USDA 2000, Table 3-22)
- A positive correlation exists between lightning fire frequency and road density due to increased availability of flammable fine fuels near roads. (Arienti, M. Cecilia, et al. 2009)
- Human caused wildfires are strongly associated with access to natural landscapes, with the proximity to urban areas and roads being the most important factor (Romero-Calcerrada, et al. 2008)

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Human Activity and Wildfire

- Sparks from cars, off-road vehicles, and neglected campfires caused nearly 50,000 wildfire ignitions in 2000. (USDA 2000, Fuel Management and Fire Suppression Specialist Report, Table 4.)
- More than 90% of fires on national lands are caused by humans (USDA 1996 and 1998)
- Human-ignited wildfire is almost 5 times more likely to occur in a roaded area than in a roadless area (USDA 2000, Table 3-19).

There are 375,000 miles of roads in our national forests.

Roads and Fire: A Proven Relationship

Photo: USDA Forest Service, Coconino National Forest

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Attachment 2: Using Road Density as a Metric for Ecological Health in National Forests: What Roads and Routes should be Included?
Summary of Scientific Information
Last Updated: November 22, 2012

I. Density analysis should include closed roads, non-system roads administered by other jurisdictions (private, county, state), temporary roads and motorized trails.

Typically, the Forest Service has calculated road density by looking only at open system road density. From an ecological standpoint, this approach may be flawed since it leaves out of the density calculations a significant percent of the total motorized routes on the landscape. For instance, the motorized route system in the entire National Forest System measures well over 549,000 miles.[1] By our calculation, a density analysis limited to open system roads would consider less than 260,000 miles of road, which accounts for less than half of the entire motorized transportation system estimated to exist on our national forests.[2] These additional roads and motorized trails impact fish, wildlife, and water quality, just as open system roads do. In this section, we provide justification for why a road density analysis used for the purposes of assessing ecological health and the effects of proposed alternatives in a planning document should include closed system roads, non-system roads administered by other jurisdictions, temporary roads, and motorized trails.

Impacts of closed roads

It is crucial to distinguish the density of roads physically present on the landscape, whether closed to vehicle use or not, from "open-road density" (Pacific Rivers Council, 2010). An open-road density of 1.5 mi/mi² has been established as a standard in some national forests as protective of some terrestrial wildlife species. However, many areas with an open road density of 1.5 mi/mi² have a much higher inventoried or extant hydrologically effective road density, which may be several-fold as high with significant aquatic impacts. This higher density occurs because many road "closures" block vehicle

[1] The National Forest System has about 372,000 miles of system roads. The forest service also has an estimated 47,000 miles of motorized trails. As of 1998, there were approximately 130,000 miles of non-system roads in our forests. Non-system roads include public roads such as state, county, and local jurisdiction and private roads. (USFS, 1998) The Forest Service does not track temporary roads but is reasonable to assume that there are likely several thousand miles located on National Forest System lands.

[2] About 30% of system roads, or 116,108 miles, are in Maintenance Level 1 status, meaning they are closed to all motorized use. (372,000 miles of NFS roads - 116,108 miles of ML 1 roads = 255,892). This number is likely conservative given that thousands of more miles of system roads are closed to public motorized use but categorized in other Maintenance Levels.

access, but do nothing to mitigate the hydrologic alterations that the road causes. The problem is further compounded in many places by the existence of "ghost" roads that are not captured in agency inventories, but that are nevertheless physically present and causing hydrologic alteration (Pacific Watershed Associates, 2005).

Closing a road to public motorized use can mitigate the impacts on water, wildlife, and soils only if proper closure and storage technique is followed. Flow diversions, sediment runoff, and illegal incursions will continue unabated if necessary measures are not taken. The Forest Service's National Best Management Practices for non-point source pollution recommends the following management techniques for minimizing the aquatic impacts from closed system roads: eliminate flow diversion onto the road surface, reshape the channel and streambanks at the crossing-site to pass expected flows without scouring or ponding, maintain continuation of channel dimensions and longitudinal profile through the crossing site, and remove culverts, fill material, and other structures that present a risk of failure or diversion. Despite good intentions, it is unlikely given our current fiscal situation and past history that the Forest Service is able to apply best management practices to all stored roads,[3] and that these roads continue to have impacts. This reality argues for assuming that roads closed to the public continue to have some level of impact on water quality, and therefore, should be included in road density calculations.

As noted above, many species benefit when roads are closed to public use. However, the fact remains that closed system roads are often breached resulting in impacts to wildlife. Research shows that a significant portion of off-road vehicle (ORV) users violates rules even when they know what they are (Lewis, M.S., and R. Paige, 2006; Frueh, LM, 2001; Fischer, A.L., et. al, 2002; USFWS, 2007.). For instance, the Rio Grande National Forest's Roads Analysis Report notes that a common travel management violation occurs when people drive around road closures on Level 1 roads (USDA Forest Service, 1994). Similarly, in a recent legal decision from the Utah District Court , *Sierra Club v. USFS*, Case No. 1:09-cv-131 CW (D. Utah March 7, 2012), the court found that, as part of analyzing alternatives in a proposed travel management plan, the Forest Service failed to take a hard look at the impact of continued illegal use. In part, the court based its decision on the Forest Service's acknowledgement that illegal motorized use is a significant problem and that the mere presence of roads is likely to result in illegal use.

In addition to the disturbance to wildlife from ORVs, incursions and the accompanying human access can also result in illegal hunting and trapping of animals. The Tongass National Forest refers to this in its EIS to amend the Land and Resources Management Plan. Specifically, the Forest Service notes in the EIS that Alexander Archipelego wolf mortality due to legal and illegal hunting and trapping is related not only to roads open to motorized access, but to all roads, and that *total road densities* of 0.7-1.0 mi/mi² or less may be necessary (USDA Forest Service, 2008).

As described below, a number of scientific studies have found that ORV use on roads and trails can have serious impacts on water, soil and wildlife resources. It should be expected that ORV use will continue to

[3] The Forest Service generally reports that it can maintain 20-30% of its open road system to standard.

some degree to occur illegally on closed routes and that this use will affect forest resources. Given this, roads closed to the general public should be considered in the density analysis.

Impacts of non-system roads administered by other jurisdictions (private, county, state)

As of 1998, there were approximately 130,000 miles of non-system roads in national forests (USDA Forest Service, 1998). These roads contribute to the environmental impacts of the transportation system on forest resources, just as forest system roads do. Because the purpose of a road density analysis is to measure the impacts of roads at a landscape level, the Forest Service should include all roads, including non-system, when measuring impacts on water and wildlife. An all-inclusive analysis will provide a more accurate representation of the environmental impacts of the road network within the analysis area.

Impacts of temporary roads

Temporary roads are not considered system roads. Most often they are constructed in conjunction with timber sales. Temporary roads have the same types environmental impacts as system roads, although at times the impacts can be worse if the road persists on the landscape because they are not built to last.

It is important to note that although they are termed temporary roads, their impacts are not temporary. According to Forest Service Manual (FSM) 7703.1, the agency is required to "Reestablish vegetative cover on any unnecessary roadway or area disturbed by road construction on National Forest System lands within 10 years after the termination of the activity that required its use and construction." Regardless of the FSM 10-year rule, temporary roads can remain for much longer. For example, timber sales typically last 3-5 years or more. If a temporary road is built in the first year of a six year timber sale, its intended use does not end until the sale is complete. The timber contract often requires the purchaser to close and obliterate the road a few years after the Forest Service completes revegetation work. The temporary road, therefore, could remain open 8-9 years before the ten year clock starts ticking per the FSM. Therefore, temporary roads can legally remain on the ground for up to 20 years or more, yet they are constructed with less environmental safeguards than modern system roads.

Impacts of motorized trails

Scientific research and agency publications generally do not decipher between the impacts from motorized trails and roads, often collapsing the assessment of impacts from unmanaged ORV use with those of the designated system of roads and trails. The following section summarizes potential impacts resulting from roads and motorized trails and the ORV use that occurs on them.

Aquatic Resources

While driving on roads has long been identified as a major contributor to stream sedimentation (for review, see Gucinski, 2001), recent studies have identified ORV routes as a significant cause of stream sedimentation as well (Sack and da Luz, 2004; Chin et al.; 2004, Ayala et al.; 2005, Welsh et al;. 2006). It has been demonstrated that sediment loss increases with increased ORV traffic (Foltz, 2006). A study by

Sack and da Luz (2004) found that ORV use resulted in a loss of more than 200 pounds of soil off of every 100 feet of trail each year. Another study (Welsh et al., 2006) found that ORV trails produced five times more sediment than unpaved roads. Chin et al. (2004) found that watersheds with ORV use as opposed to those without exhibited higher percentages of channel sands and fines, lower depths, and lower volume – all characteristics of degraded stream habitat.

Soil Resources [4]

Ouren, et al. (2007), in an extensive literature review, suggests ORV use causes soil compaction and accelerated erosion rates, and may cause compaction with very few passes. Weighing several hundred pounds, ORVs can compress and compact soil (Nakata et al., 1976; Snyder et al., 1976; Vollmer et al., 1976; Wilshire and Nakata, 1976), reducing its ability to absorb and retain water (Dregne, 1983), and decreasing soil fertility by harming the microscopic organisms that would otherwise break down the soil and produce nutrients important for plant growth (Wilshire et al., 1977). An increase in compaction decreases soil permeability, resulting in increased flow of water across the ground and reduced absorption of water into the soil. This increase in surface flow concentrates water and increases erosion of soils (Wilshire, 1980; Webb, 1983; Misak et al., 2002).

Erosion of soil is accelerated in ORV-use areas directly by the vehicles, and indirectly by increased runoff of precipitation and the creation of conditions favorable to wind erosion (Wilshire, 1980). Knobby and cup-shaped protrusions from ORV tires that aid the vehicles in traversing steep slopes are responsible for major direct erosional losses of soil. As the tire protrusions dig into the soil, forces far exceeding the strength of the soil are exerted to allow the vehicles to climb slopes. The result is that the soil and small plants are thrown downslope in a "rooster tail" behind the vehicle. This is known as mechanical erosion, which on steep slopes (about 15° or more) with soft soils may erode as much as 40 tons/mi (Wilshire, 1992). The rates of erosion measured on ORV trails on moderate slopes exceed natural rates by factors of 10 to 20 (Iverson et al., 1981; Hinckley et al., 1983), whereas use on steep slopes has commonly removed the entire soil mantle exposing bedrock. Measured erosional losses in high use ORV areas range from 1.4-242 lbs/ft^2 (Wilshire et al., 1978) and 102-614 lbs/ft^2 (Webb et al., 1978). A more recent study by Sack and da Luz (2003) found that ORV use resulted in a loss of more than 200 lbs of soil off of every 100 feet of trail each year.

Furthermore, the destruction of cryptobiotic soils by ORVs can reduce nitrogen fixation by cyanobacteria, and set the nitrogen economy of nitrogen-limited arid ecosystems back decades. Even small reductions in crust can lead to diminished productivity and health of the associated plant community, with cascading effects on plant consumers (Davidson et al., 1996). In general, the deleterious effects of ORV use on cryptobiotic crusts is not easily repaired or regenerated. The recovery time for the lichen component of crusts has been estimated at about 45 years (Belnap, 1993). After this time the crusts may appear to have regenerated to the untrained eye. However, careful observation will reveal that the 45 year-old crusts will not have recovered their moss component, which will take an additional 200 years to fully come back (Belnap and Gillette, 1997).

[4] For a full review see Switalski, T. A. and A. Jones (2012).

Wildlife Resources [5]

Studies have shown a variety of possible wildlife disturbance vectors from ORVs. While these impacts are difficult to measure, repeated harassment of wildlife can result in increased energy expenditure and reduced reproduction. Noise and disturbance from ORVs can result in a range of impacts including increased stress (Nash et al., 1970; Millspaugh et al., 2001), loss of hearing (Brattstrom and Bondello, 1979), altered movement patterns (e.g., Wisdom et al. 2004; Preisler et al. 2006), avoidance of high-use areas or routes (Janis and Clark 2002; Wisdom 2007), and disrupted nesting activities (e.g., Strauss 1990).

Wisdom et al. (2004) found that elk moved when ORVs passed within 2,000 yards but tolerated hikers within 500 ft. Wisdom (2007) reported preliminary results suggesting that ORVs are causing a shift in the spatial distribution of elk that could increase energy expenditures and decrease foraging opportunities for the herd. Elk have been found to readily avoid and be displaced from roaded areas (Irwin and Peek, 1979; Hershey and Leege, 1982; Millspaugh, 1995). Additional concomitant effects can occur, such as major declines in survival of elk calves due to repeated displacement of elk during the calving season (Phillips, 1998). Alternatively, closing or decommissioning roads has been found to decrease elk disturbance (Millspaugh et al., 2000; Rowland et al., 2005).

Disruption of breeding and nesting birds is particularly well-documented. Several species are sensitive to human disturbance with the potential disruption of courtship activities, over-exposure of eggs or young birds to weather, and premature fledging of juveniles (Hamann et al., 1999). Repeated disturbance can eventually lead to nest abandonment. These short-term disturbances can lead to long-term bird community changes (Anderson et al., 1990). However when road densities decrease, there is an observable benefit. For example, on the Loa Ranger District of the Fishlake National Forest in southern Utah, successful goshawk nests occur in areas where the localized road density is at or below 2-3 mi/mi^2 (USDA, 2005).

Examples of Forest Service planning documents that use total motorized route density or a variant

Below, we offer examples of where total motorized route density or a variant has been used by the Forest Service in planning documents.

- The Mt. Taylor RD of the Cibola NF analyzed open and closed system roads and motorized trails together in a single motorized *route* density analysis. Cibola NF: Mt. Taylor RD Environmental Assessment for Travel Management Planning, Ch.3, p 55. http://prdp2fs.ess.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5282504.pdf.

- The Grizzly Bear Record of Decision (ROD) for the Forest Plan Amendments for Motorized Access

[5] For a full review see:Switalski, T. A. and A. Jones (2012).

Management within the Selkirk and Cabinet-Yaak Grizzly Bear Recovery Zones (Kootenai, Lolo, and Idaho Panhandle National Forests) assigned route densities for the designated recovery zones. One of the three densities was for Total Motorized Route Density (TMRD) which includes open roads, restricted roads, roads not meeting all reclaimed criteria, and open motorized trails. The agency's decision to use TMRD was based on the Endangered Species Act's requirement to use best available science, and monitoring showed that both open and closed roads and motorized trails were impacting grizzly. Grizzly Bear Plan Amendment ROD. Online at cache.ecosystem-management.org/48536_FSPLT1_009720.pdf.

- The Chequamegon-Nicolet National Forest set forest-wide goals in its forest plan for both open road density and total road density to improve water quality and wildlife habitat.

> *I decided to continue reducing the amount of total roads and the amount of open road to resolve conflict with quieter forms of recreation, impacts on streams, and effects on some wildlife species.* ROD, p 13.

Chequamegon-Nicolet National Forest Land and Resource Management Plan Record of Decision. Online at http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5117609.pdf.

- The Tongass National Forest's EIS to amend the forest plan notes that Alexander Archipelago wolf mortality due to legal and illegal hunting and trapping is related not only to roads open to motorized access, but to all roads, and that *total road densities* of 0.7-1.0 mi/mi² or less may be necessary.

> *Another concern in some areas is the potentially unsustainable level of hunting and trapping of wolves, when both legal and illegal harvest is considered. The 1997 Forest Plan EIS acknowledged that open road access contributes to excessive mortality by facilitating access for hunters and trappers. Landscapes with open-road densities of 0.7 to 1.0 mile of road per square mile were identified as places where human-induced mortality may pose risks to wolf conservation. The amended Forest Plan requires participation in cooperative interagency monitoring and analysis to identify areas where wolf mortality is excessive, determine whether the mortality is unsustainable, and identify the probable causes of the excessive mortality.*
>
> *More recent information indicates that wolf mortality is related not only to roads open to motorized access, but to all roads, because hunters and trappers use all roads to access wolf habitat, by vehicle or on foot. Consequently, this decision amends the pertinent standard and guideline contained in Alternative 6 as displayed in the Final EIS in areas where road access and associated human caused mortality has been determined to be the significant contributing factor to unsustainable wolf mortality. The standard and guideline has been modified to ensure that a range of options to reduce mortality risk will be considered in these areas, and to specify that total road densities of 0.7 to 1.0 mile per square mile or less may be necessary.* ROD, p 24.

Tongass National Forest Amendment to the Land and Resource Management Plan Record of Decision and Final EIS. January 2008. http://tongass-fpadjust.net/Documents/Record_of_Decision.pdf

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