

BEST MANAGEMENT PRACTICES FOR OFF-ROAD VEHICLE USE ON FORESTLANDS

*A Guide for Designating and Managing
Off-Road Vehicle Routes*

January 2008



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ABSTRACT

Forest management applies to a diversity of human uses, including the use of motorized vehicles by the public. Best Management Practices (BMPs) provide science-based criteria and standards that land managers follow in making and implementing decisions about human uses and projects that affect our natural resources. BMPs are usually developed based on legal obligations, pragmatic experience, and institutional practices, and should be supported by the best available scientific knowledge. However, while many land management activities rely on established Best Management Practices, until now no BMPs have been developed to manage off-road vehicles (ORVs) on forestlands. These BMPs, based on the best available scientific knowledge, fill this gap of forestland ORV management. This paper provides Best Management Practices to aid land managers in travel planning or in any decision making process related to off-road vehicle management on forested lands. They are not intended to provide guidance for desert lands, though there may be some applicability across landscapes.

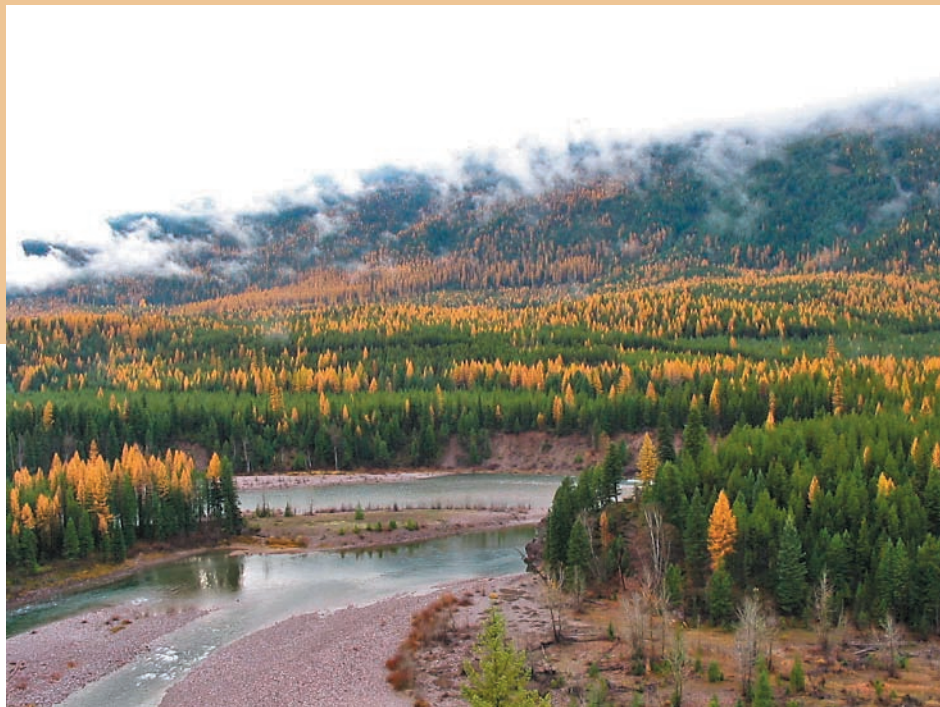


Photo by Magnus McCaffery.

PREFACE

It wasn't long ago that off-road vehicles were virtually unknown on public lands. When I began my Forest Service career in 1965, it was four-wheel pickups in summer and crude snow-machines in winter if you wanted to tour the backcountry. Now, motorized recreation on public lands has been totally transformed.

Off-road vehicles are cheap, powerful, come in all sizes, and it seems everybody needs one of their own - the days of the family all going somewhere in one vehicle are over. The negative consequences for the land and for the people craving quiet and solitude are profound. Public land agencies have lagged badly at managing the crush; basic stewardship of soil, water, and wildlife habitat is weak at best, and at worst, virtually non-existent.

The concept of best management practices (BMPs) has been around for decades. BMPs are intended to provide a science-based consensus view of what works best in dealing with specific management challenges. Their value is that they eliminate the need for everyone to invent the wheel over and over again. BMPs are tried and true, realistic, cost effective, and practical. They allow us to consolidate learning, and profit from the experience of others.

This guide lays out a structured approach for dealing with a comprehensive array of off-road vehicle problems. The guide should assist any land manager striving to do the right thing, and improve confidence that the actions chosen will work.

I believe off-road vehicle abuse of public lands has reached crisis proportions, and has unnecessarily made enemies of those who like machines and those who don't. But people who enjoy the outdoors all share affections for their public lands. Land managers need to act now to stop the abuse and help everybody minimize conflict.

Jim Furnish
Deputy Chief (Ret.), U.S. Forest Service

Photo by Laurel Hagen.



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Photo by Laurel Hagen.

INTRODUCTION

Management of off-road vehicles (ORVs) is becoming increasingly difficult as more people recreate on forestlands¹. The impact is so large that Forest Service Chief Bosworth has named the unmanaged recreation as one of the four “great issues” facing the Forest Service today (Bosworth 2003). ORVs have a disproportionate impact on the environment compared to many traditional forms of recreation. ORV users can cover much more ground per day than a hiker, mountain biker, or equestrian.

Technological advances have given ORVs more power and control, allowing even beginners to access remote wildlands. These advances have increased the amount of motorized activity in wildlife habitat and a variety of sensitive ecosystems. The result is an increase in impacts on the landscape and increased conflicts between off-roaders and non-motorized forest visitors. The ecological and physical impacts of their use have been well documented in hundreds of research articles and several literature reviews (e.g., Joslin and Youmans 1999, Schubert and Associates 1999, Gaines et al. 2003, Gilbert 2003, Hulsey et al. 2004, Kassir 2005; Davenport and Switalski 2006), and books (e.g., Knight and Gutzwiller 1995, Havlick 2002, Sutter 2002).

This document establishes a set of Best Management Practices (BMPs) for the planning and management of ORV routes on forestlands, consistent with current forest management policy and regulations. This document is not designed to address policy questions around off-road vehicle recreation and whether or not it is a legitimate use of public lands. Instead it is intended to guide managers in those situations where policy makers have decided that off-road vehicles will be allowed.

These guidelines will help managers designate appropriate routes, close inappropriate routes, and manage ORV use to reduce use conflicts and cause as little harm to the environment as possible. With a well-planned ORV route system that is fully enforced, use conflicts can be greatly reduced, and wildlife and their habitats can be protected. These BMPs were designed to be used by land managers on forestlands. They will help transportation planners place ORV routes in areas where they will do the least amount of harm. These BMPs will 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.

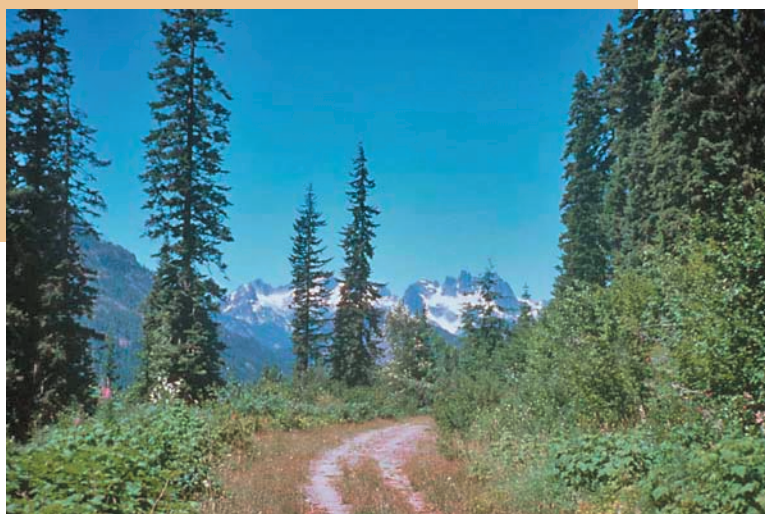
¹ In the context of this report, the term “Forestlands” refers to all landcover types that would typically be included in the U.S. National Forest System. While this would predominantly include areas dominated by evergreen/coniferous trees, it certainly can and does include grasslands, shrublands, and riparian habitats that can be found as inclusions in national forest. In addition to forest service lands, these BMPs are meant to be used on all forested areas in the western U.S., including state forests, county-owned forests, and private forestlands.

While these BMPs are based on and aided by the best available science, peer-reviewed studies relevant to all management standards do not always exist and there are some areas in which we are not certain of the specific ecological or social impacts of ORV use. In these cases, these BMPs provide guidelines that are based on expert opinion and management experience. It is in cases like this where one must invoke the Precautionary Principle. This principle recommends that if there is doubt (such as an absence of adequate scientific study), then the action that would cause the strongest protective measure should be chosen. Stewart (2002) recommends that activities that present an uncertain potential for significant harm should be prohibited unless the proponent of the activity shows that it presents no appreciable risk of harm. Management that follows the Precautionary Principle accounts for uncertainty by avoiding results that preclude future options. As scientists who acknowledge the inherently variable nature of the communities and systems we are studying, we underscore that transportation planners and managers need to make every effort to err on the side of caution, and incorporate wide margins of safety to guard against loss of healthy ecosystems or ecological processes.

We also underscore one important condition that must be met in order to successfully apply these BMPs: funding must be available at a level that allows for effective implementation of route designations, monitoring, scientific analysis, user education, and enforcement. While these BMPs will help prioritize the most environmentally and socially impacted routes, funding is necessary to implement management decisions. Of utmost importance is sufficient funding to enable adequate enforcement of designated routes and closures, and comprehensive education and outreach efforts ranging from readily available travel maps to rider education courses.

In the sections of this document that follow, we will first briefly discuss the pertinent laws and regulations that pertain to ORV use and management. Following that is the presentation of the BMPs themselves. The BMPs are broken down into the following major categories: (1) forest soils, (2) vegetation, (3) wildlife, (4) special ecosystems, and (5) quiet users. The actual BMPs are separated into "Planning and Decision-Making BMPs," "Implementation BMPs," and "Monitoring BMPs." Justification (such as references to the scientific literature) of the BMPs featured in this document immediately follows the BMP bullets in each major resource category. We close the document with a discussion of needed future research on the social and ecological impacts of ORVs.

Photo by William Vogel, courtesy of U.S. Fish and Wildlife Service.



LAWS AND REGULATIONS FOR OFF-ROAD VEHICLES

Numerous laws either directly or indirectly provide management guidance for off-road vehicle use. These laws include: Executive Orders 11644 and 11989, the National Forest Management Act (NFMA), the Federal Lands Policy Management Act (FLPMA), the Endangered Species Act (ESA), the National Environmental Policy Act (NEPA), the Clean Water Act (CWA) and more. Because many different explanations of these laws are already available, these BMPs do not go into detail regarding each law and how it is specifically applicable to off-road vehicles. In addition, legal requirements change frequently through the issuance of new agency directives and through the passage of new legislation.

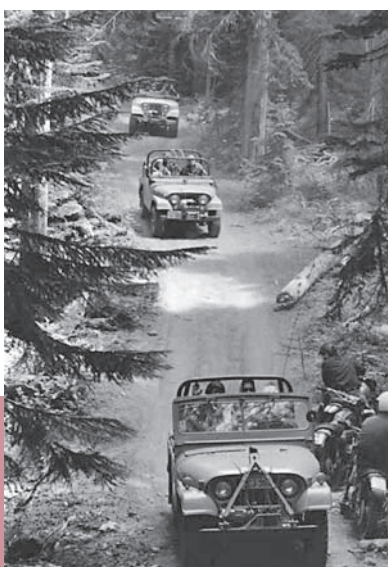


Photo by Paul Hart, U.S. Forest Service, 1976.

Advances in off-road vehicle technology over the past 30 years have greatly increased the potential for ecological impacts.

Federal Laws Regulating ORVs

- Executive Orders
- Forest Service Regulations
- Bureau of Land Management Regulations
- U.S. Fish and Wildlife Regulations
- National Park Service Regulations
- The National Environmental Policy Act
- Clean Water Act
- Endangered Species Act
- Wild and Scenic Rivers Act
- National Historic Preservation Act
- Multiple Use and Sustained Yield Act
- Federal Noxious Weeds Act



Photo by Laurel Hagen, 2006.

Executive Orders

Executive Order (EO) 11644, as amended by EO 11989, provides the most direct language applicable to all public land agencies regarding off-road vehicle management. EO 11644 was issued by President Richard Nixon in 1972, and was amended in 1977 by President Carter through EO 11989. The purpose of these EOs is to: “ensure that the use of [ORVs] on public lands will be controlled and directed so as to protect the resources of those lands, to promote the safety of all users of those lands, and to minimize conflicts among the various uses of those lands.” Executive Orders 11644/11989, § 1. Federal public land management agencies have promulgated specific regulations to implement the Executive Orders.

EO 11644/11989 Section 3:

“require(s) that the designation of such areas and trails shall be in accordance with the following:

(1) Areas and trails shall be located to minimize damage to soil, watershed, vegetation, or other resources of the public lands.

(2) Areas and trails shall be located to minimize harassment of wildlife or significant disruption of wildlife habitats.

(3) Areas and trails shall be located to minimize conflicts between off-road vehicle use and other existing or proposed recreational uses of the same or neighboring public lands, and to ensure the compatibility of such uses with existing conditions in populated areas, taking into account noise and other factors.

(4) Areas and trails shall not be located in officially designated Wilderness Areas or Primitive Areas. Areas and trails shall be located in areas of the National Park system, Natural Areas, or National Wildlife Refuges and Game Ranges only if the respective agency head determines that off-road vehicle use in such locations will not adversely affect their natural, aesthetic, or scenic values.”

EO 11989 added the following language, to strengthen Nixon’s order:

“Section 9. Special Protection of the Public Lands.

(a) Notwithstanding the provisions of Section 3 of this Order, the respective agency head shall, whenever he determines that the use of off-road vehicles will cause or is causing considerable adverse effects on the soil, vegetation, wildlife, wildlife habitat or cultural or historic resources of particular areas or trails of the public lands, immediately close such areas or trails to the type of off-road vehicle causing such effects, until such time as he determines that such adverse effects have been eliminated and that measures have been implemented to prevent future recurrence.

(b) Each respective agency head is authorized to adopt the policy that portions of the public lands within his jurisdiction shall be closed to use by off-road vehicles except those areas or trails which are suitable and specifically designated as open to such use pursuant to Section 3 of this Order.”



Executive Orders originate with Presidential action, bypassing the Congressional lawmaking process. The White House, photo by Ken Hammond, courtesy of U.S. Fish and Wildlife Service.



The 1972 and 1977 Executive Orders represent some of the most explicit direction for managing ORVs. Photo by Laurel Hagen.

Current National Forest Management Regulations for ORVs

On November 2, 2005, the U.S. Forest Service issued a change in travel management regulations governing Off-Highway Vehicles, or ORVs. Issued in draft in 2004, these proposed regulations drew more than 80,000 comments. The detailed regulations can be found in 70 FR 68264 (November 9, 2005). These new travel management regulations modified 36 CFR parts 212 (Designation of motorized vehicle use of routes), 251, 261 (National Forest System trails) and 295. For the first time, all national forests were now to designate which routes could be used by motor vehicles. Once the designation decision was made, motorized vehicle use off designated routes would be prohibited. These designations were to be done at either a forest-wide scale or the ranger district scale. Routes could be designated for use by specific types of vehicles (ATVs or motorcycles for example) or not designated as motorized. Public involvement with state and local governments was built into the process.



Occasionally, closing roads and trails is a necessary management option. Photo by Paul Shively.



U.S. Department of Agriculture complex. Photo by Ken Hammond, courtesy of U.S. Fish and Wildlife Service.

On March 9th, 2007, the Forest Service published several draft directives that cover travel route planning, travel plan decisions, and recreation management:

| | |
|----------------|----------------------|
| FSM 2350 | Recreation |
| FSM 7700 | Travel Management |
| FSM 7710 | Travel Planning |
| FSH 7709.55.20 | Travel Analysis |
| FSH 7709.55.30 | Engineering Analysis |

When final, these Forest Service Manuals will offer a consistent approach to making decisions on where vehicle use is allowed on national forests. Decisions made by the Forest Service will be required to be consistent with these guidance documents.²

² The BMPs presented below will be appropriate for a number of steps outlined in this most recent travel planning process. For example, the BMPs offer specific analysis tools to assist the Forest Service in meeting these new goals and regulations. They also provide specific tools for the required environmental analysis and design alternatives required by NEPA for ORV management. Finally, these BMPs offer specific direction in how to apply adaptive management in a way that meets ecological goals, minimizes the impacts of ORV use, and fits within the Forest Service decision processes.

Other Laws³

A multitude of laws have sections that are applicable to the management of off-road vehicles, and therefore also provide a foundation for the Best Management Practices described in this document. Below is a list of the most important of these laws, with a very brief description of how each may apply.

- The National Environmental Policy Act (NEPA) requires that agencies (1) include public participation in the decision making process, and (2) assess alternatives before carrying out an action that may significantly affect the integrity of the land and its uses (42 U.S.C. §§ 4321-4370f).
- The Clean Water Act (CWA) requires that route construction, maintenance, and use comports with, among other things, water quality standards (33 U.S.C. § 1251-1387). The CWA may also apply regarding route designation in wetlands.
- The Endangered Species Act (ESA) states that agencies must “ensure” that travel planning “is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification” of critical habitat of such species (16 U.S.C. § 1536(a)(2)).
- The Wild and Scenic Rivers Act provides protections against road construction and other similar activities that may be contrary to the purposes of that Act. (16 U.S.C. §§ 1271-1287)
- Section 106 of the National Historic Preservation Act requires national forests to protect historic sites from harm caused by transportation impacts (16 U.S.C. § 470f).
- The Multiple Use and Sustained Yield Act requires the Forest Service to manage lands for multiple uses. Off-road vehicle use needs to be managed such that the productivity of habitat, wildlife, recreation, and other uses is not reduced (16 U.S.C. §§ 528-539).
- The Federal Noxious Weed Act -- Public Law 93-629 enacted January 3, 1975, established a federal program to control the spread of noxious weeds (7 U.S.C. 2801 et seq.; 88 Stat. 2148).



Finding sufficient funding for law enforcement remains a central challenge. Wildlands CPR file photo.



U.S. Capitol building. Photo by Jonathon Arms, courtesy of US Fish and Wildlife Service.

³ Since regulations are regularly updated, the specific numerical citations listed here may change over time.

BEST MANAGEMENT PRACTICES FOR OFF-ROAD VEHICLES

The BMPs are broken down into four sections according to the natural resource affected: forest soil, vegetation, wildlife, and sensitive ecosystems. A fifth section focuses on use conflicts between motorized and non-motorized forms of recreation. A "General BMPs" category, which covers and summarizes all categories above, is included as Appendix A. Each section provides recommendations for the best management of those resources and, afterwards, reviews research on ORVs and their impacts to forest systems using the best available science. The BMPs are separated into "Planning and Decision-Making BMPs," "Implementation BMPs," and "Monitoring BMPs." This breakdown reflects the different decision-making processes that land managers often encounter.

These BMPs focus heavily on monitoring. It is important that the outcomes of monitoring tie into specific plans of action, based on whether management goals and objectives are being met. Each management objective should be essentially "tested" through monitoring methods that have been scientifically validated.

A central focus of this document is adaptive management. For the purposes of these BMPs, adaptive management can be thought of as a sequence of linked practices that ensures that specific ecological objectives, monitoring, analysis, and land uses over time lead to the maintenance, and where needed, restoration of the health of ecosystems. Adaptive management is a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs (Nyberg 1998).



Our experiences with forest and recreation management have taught us not to take clean water for granted. Photo by Ron Nichols, NRCS.



Adaptive management strategies recognize both the complexity of forest ecosystems and the dynamic nature of human impacts. Photo by Adam Switalski.

With ecological adaptive management, ecological goals are expressed in terms of measurable objectives that can be determined through monitoring. Monitoring, in turn, assesses indicators of wildlife viability and habitat function as well as human use. This monitoring is then linked to analysis that determines whether the occurring human use is consistent or not with ecological goals. This analysis in turn has thresholds that, when reached, call for management changes that will lead to meeting ecological objectives.

It should be stressed once more that perhaps the most critical requirement to ensuring that these BMPs are effectively used is that funding must be available for proper enforcement of decisions made on the ground. This ranges from monitoring of erected signs, to keeping ORVs on designated routes and out of closed areas. If this most basic aspect of management is not provided for, the effectiveness of these BMPs will be severely limited.



Wetlands are particularly sensitive, as well as important, ecological systems. Photo by Lynn Betts, NRCS.

1.0 FOREST SOILS

1.1 BEST MANAGEMENT PRACTICES FOR FOREST SOILS

1.1.1 Planning and Decision-Making BMPs for Forest Soils

- Locate routes only in areas with stable soils; avoid highly erodible soils.⁴
- Avoid locating routes in areas with biological crusts.
- Do not locate routes to climb directly up hillslopes. Route grades should be kept to a minimum and not exceed a 15% grade.
- Do not locate routes above treeline or in other high elevation areas that are ecologically significant and/or especially prone to erosion.
- Locate routes a minimum distance (as listed below) from waterbodies and wetlands:⁵
 - Fish-bearing streams and lakes - 300 ft.
 - Permanently flowing non-fish-bearing streams - 150 ft.
 - Ponds, reservoirs, and wetlands greater than one acre - 150 ft.
- Do not designate new routes requiring stream crossings and prioritize closure, re-routing or creating bridge crossings for existing routes that have stream crossings.
- Do not locate routes in areas with soils contaminated by mine tailings, or mine tailings reclamation sites, at least until they are recovered, fully stable and able to sustain safe ORV usage. If route construction is necessary, reclamation activities should be completed prior to route construction.
- Close and restore routes that cause high levels of erosion (e.g., raise sedimentation above Total Maximum Daily Loads (TMDL) and reduce native fish population potential).
- Require all motorized camping to occur in designated campsites. Reclaim undesigned motorized camping sites.



Forest Soil Impacts from ORVs

- Increased compaction
- Increased erosion
- Some soil types more susceptible to ORV impacts

*Healthy soils are the foundation for vegetative diversity.
Photo by Michael Smith, courtesy of U.S. Fish and Wildlife Service.*

⁴ See Soil Conservation Services NRCS guidance on determining erodible soils (<http://websoilsurvey.nrcs.usda.gov/app/>) or Forest Service Manual on soil classification.

⁵ These BMPs are based upon Forest Service Riparian Habitat Conservation Areas (RHCA) standards.

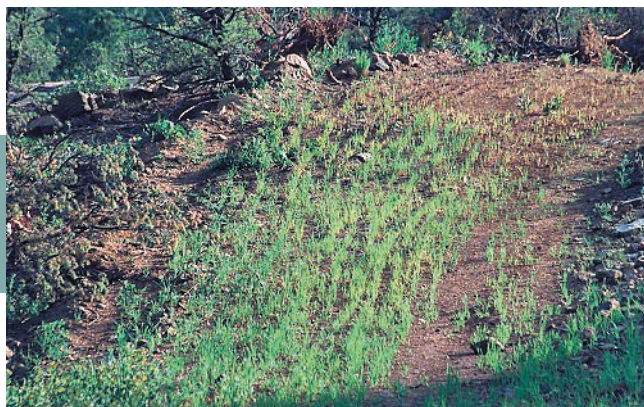
1.1.2 Implementation BMPs for Forest Soils

- Identify the type or types of soil and steepness in the area that is being affected by ORVs and use this information to prioritize mitigation efforts and create target management objectives to minimize erosion.
- Identify where waterbodies and wetlands are located, where routes cross them, and whether there are fish present.
 - Prioritize stream crossing closures and route relocations, and if necessary determine appropriate sites for upgrades and/or bridge crossings.
- Ensure adequate maintenance of bridges and culverts on routes to help prevent unauthorized stream crossings that might damage soils, streambanks, riparian vegetation, etc.
- Estimate the average soil loss for areas that are currently and obviously negatively affected by ORVs using the Universal Soil Loss Equation. Close and restore routes if the soils are determined to exceed standards for acceptable soil loss.⁶
- If closing or moving a particularly damaging route is not possible, mitigate erosion with waterbars or other erosion control measures.
- Close and restore areas that have become “mud bogging areas,” or are prone to “mud bogging.”
- Close and restore routes where it has been determined, through analysis, that cumulative impacts of erosive activities (e.g., ORVs combined with fire, livestock grazing, or other erosive stressors) are leading to a stream failing to meet erosion standards.
- Prioritize for closure renegade routes going directly up hillslopes, into wetland areas (including wet meadows), or adjacent to designated routes.
- Adaptively manage by closing or mitigating a damaging route if monitoring identifies that forest soil conditions are no longer in compliance with planning and decision-making BMPs.

1.1.3 Monitoring BMPs for Forest Soils⁷

- Monitor for the amount of erosion occurring on all routes (designated and renegade). Gather data needed for the Universal Erosion Soil Loss Equation.
- Regularly survey for and identify renegade off-route spurs.
- Map stream crossings without culverts or bridges and note stream sedimentation levels and visible soil/channel impacts in these areas.
- Identify areas of significant amounts of bare soil or route-widening along routes through photos and route width measurements.
- Monitor closed and restored routes to ensure the measures taken are effectively mitigating impacts to forest soils.

Seeding closed roads reduces erosion and facilitates recovery. Photo by Gary Kramer, courtesy of NRCS.

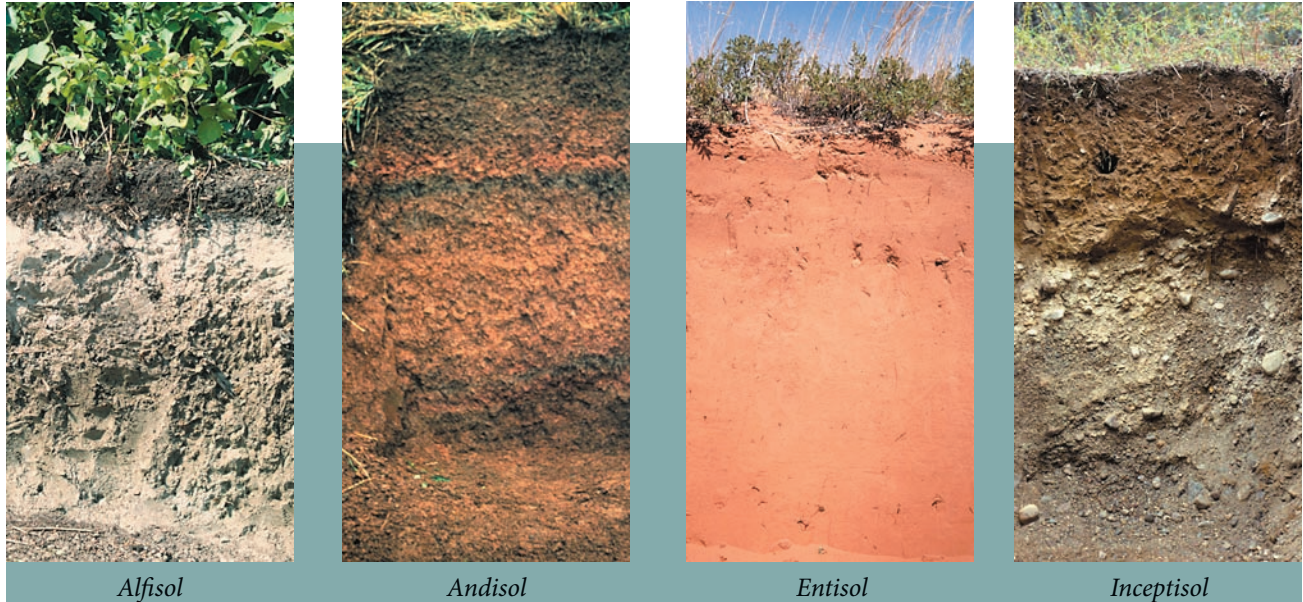


⁶ See page 14 for more information.

⁷ In order to be sure that monitoring BMPs are meaningful, it is important for forest managers to make quantitative measurements of erosion at reasonable time intervals (plus measurements following significant storm events), and there must be specified thresholds of erosion that require specific actions.

1.2 JUSTIFICATION FOR SOIL BMPs

Healthy forest soils provide nutrients and the physical foundation for plants. Soils are also home to many animals that burrow beneath the surface. One important characteristic of forest soil is that it contains pore space or tiny cracks and crevices that fill with air and water. Pore spaces allow rain and snowmelt to enter the soil, gases to escape, and tree and other plant roots to grow.



A few of the soil types found in the intermountain forest region. Photos courtesy of USDA Natural Resources Conservation Service (NRCS).

1.2.1 Compaction and Erosion

Off-road vehicles can cause compaction of soil pore spaces. 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), thus 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). Increased erosion due to ORVs also adds sediment to streams (Sack and da Luz 2003, Chin et al. 2004), which decreases water quality, buries fish eggs, and generally reduces the amount and quality of fish habitat (Newcombe and MacDonald 1991).

Trails that ascend directly up steep inclines can lead to rutting and erosion. Wildlands CPR file photo.



Erosion of soil is accelerated in ORV use areas directly by the vehicles and indirectly by increased runoff of precipitation, and by creating 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 150 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 of 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 off-road vehicle use resulted in a loss of more than 200 lbs. of soil off every 100 ft. of trail each year. Some soils, such as those supporting biological soil crusts, require decades to centuries to recover (Belnap 2003).

Most soils are vulnerable to compaction and erosion due to several factors. An analysis of more than 500 soils at more than 200 sites found that virtually all types of soils are susceptible to ORV damage (Schubert and Associates 1999). Some soils such as clay-rich soils, while less sensitive to direct mechanical displacement by ORVs, have higher rates of erosion than most other soil types, and when compacted can result in a strong surface seal that can increase rainwater runoff and increase gullying (Sheridan 1979). Sandy and gravelly soils are susceptible to direct excavation by ORVs, and when stripped of vegetation they are susceptible to rapid erosion processes - usually by rill and gully erosion. Compaction is also greater in wet, poorly drained soils than well-drained soils (Willard and Marr 1970, Burde and Refro 1986). Finely textured soils are more prone to erosion than coarser soils (Welch and Churchill 1986).

In addition to the chemical make-up of soils, location of ORV routes is a determinant to whether soils erode. Routes on steep slopes (about 150 or more) are more likely to cause erosion (Welch and Churchill 1986), as are routes in higher elevation alpine areas (Willard and Marr 1970, Marion 1994). Additionally, forests that receive higher precipitation are more susceptible to erosion than drier forests (Cole and Bayfield 1983, Burdet and Renfro 1986).

Deep ruts created by ORVs crossing a wet area. Photo by Adam Switalski.



ORV impacts on forest soils are compounded by the loss of vegetation following ORV use. It is well known that stable vegetation keeps soil in its place (Wilshire 1983, Belnap 1995), and once anchoring vegetation is removed, soil erosion increases. For example, soil exposure is increased when vehicles damage or uproot plants, thereby allowing the exposed soils to easily become wind blown or washed away by water. Wilshire et al. (1978) report on both the direct effects of ORVs on vegetation such as crushing and uprooting of foliage and root systems, as well as the indirect effects caused by the concomitant erosion. This includes undercutting of root systems as vehicle paths are enlarged by erosion, creation of new erosion channels on land adjacent to vehicle-destabilized areas due to accelerated runoff or wind erosion, burial of plants by debris eroded from areas used by vehicles, and reduction of biological capability of the soil by physical modification and stripping of the more fertile upper soil layers (Wilshire et al. 1978).

1.2.2 Measuring Erodibility of Soils

Universal Soil Loss Equation (USLE)

Conservation of soils necessitates the knowledge of soil types in the areas affected by ORVs. The USDA Natural Resources Conservation Service has set standards for tolerable soil loss for different types of soil. (A guide to the erodibility of different soils can be found at: <http://websoilsurvey.nrcs.usda.gov/app/>).

The Natural Resource Conservation Service developed a model called the Universal Soil Loss Equation (USLE) that provides erosion factors for wind and water erosion for each soil type it surveys. The erosion factor (K) indicates the susceptibility of soil erosion by water. It is one of six factors used in USLE to calculate the annual soil loss by water erosion (Figure 1). Values of K range from 0.05 to 0.69 with the higher values being associated with greater susceptibility to erosion.

The USDA manual on RUSLE (Revised Universal Soil Loss Equation) is the most detailed reference for predicting soil erosion by water (USDA 1996). This manual can be found at: <http://www.ott.wrcc.osmre.gov/library/hbmanual/rusle703.htm#downloadah703>. At the most basic level, however, the equation readily shows that as slope increases, ground cover decreases, and thus soil loss increases. The example in Figure 2 illustrating a graph of soil erosion as a function of slope and ground cover clearly indicates exponentially increased soil erosion as slope increases and cover decreases.



NRCS employees taking measurements for a soil inventory. Photo by Ron Nichols, NRCS.



Soil profile from Colorado. Photo by Gary Kramer, NRCS.

Revised USLE (RUSLE)

$$A = R * K * L * S * C * P$$

A = estimated average soil loss in tons/acre/year
 R = rainfall-runoff erosivity factor
 K = soil erodibility factor
 L = slope length factor
 S = slope steepness factor
 C = cover-management factor
 P = support practice factor

Figure 1. The Revised Universal Soil Loss Equation (RUSLE).

The Natural Resource Conservation Service (NRCS) has established standards that can be used to assess whether management activities lead to acceptable or unacceptable soil loss from erosion. Found in many completed NRCS soil surveys, the standard for the maximum rate of sustainable soil loss (in tons per acre per year) is identified as the tolerable factor or T Factor (USDA 2000a). This quantity is defined as the maximum annual rate of soil loss by erosion that can occur while allowing the productivity of the land to be sustained indefinitely on a given soil type. Specific T factors are identified in soil surveys for each NRCS soil map unit.

To apply the Universal Soil Loss Equation, surveys must be conducted in the area of interest to compile data needed for the equation. Once data are collected the equation should be applied. The resulting analysis will identify the specific erosion rates found in the area of interest. These results should then be compared with the T Factor for these sites to determine if the erosion exceeds the standards. If so, management options include closing routes that are causing significant damage, and/or ensuring that no new routes are designated in areas at or near the T-factor for that site.



Semi-arid conditions on this New Mexico ranch are indicative of much of the intermountain forest region. Photo by Jeff Vanuga, NRCS.

Water Erosion Prediction Project (WEPP)

Another model, the Water Erosion Prediction Project (WEPP) also models sediment and runoff on forested systems. WEPP was developed by an inter-agency group including the U.S. Forest Service, Agricultural Research Service, Natural Resource Conservation Service (NRCS), Bureau of Land Management (BLM) and the U.S. Geological Survey (USGS); it can be accessed on-line at: <http://forest.moscowfsl.wsu.edu/4702/wepp0.html>.

The website explains WEPP:

"The WEPP model is a complex computer program that describes the processes that lead to erosion. These processes include infiltration and runoff; soil detachment, transport, and deposition; and plant growth, senescence, and residue decomposition. For each day of simulation, WEPP calculates the soil water content in multiple layers and plant growth/decomposition. The effects of tillage processes and soil consolidation are also modeled."



Wildlands CPR volunteers sample water quality on the Clearwater National Forest.
Photo by Adam Switalski.

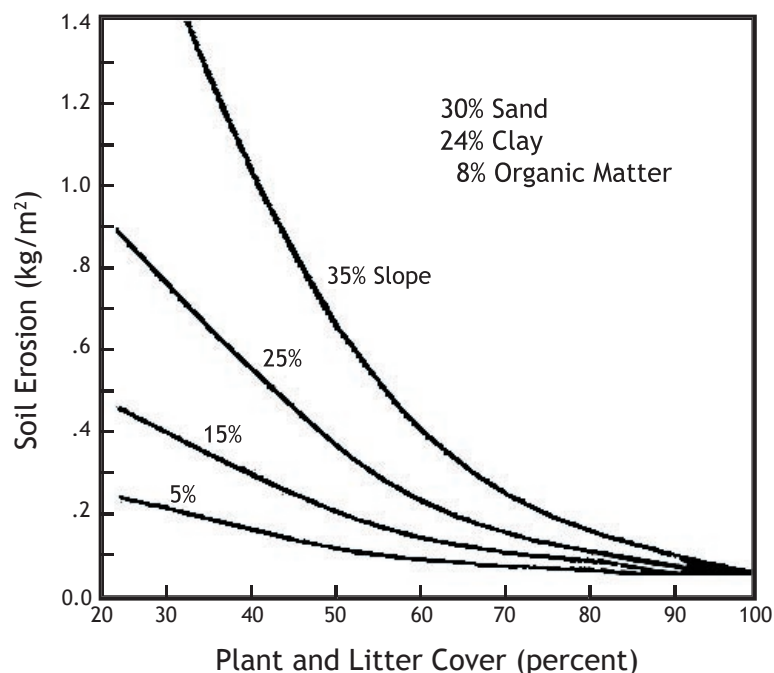


Figure 2. Relationship between vegetative cover, slope, and soil erosion (Reprinted from Packer 1998). In this particular example, a fairly common soil type was selected to use as an example (with 30% sand content, 24% clay, and 8% organic matter).

1.2.3 Impacts of ORVs on Cryptobiotic Soils.

While cryptobiotic soil crusts are more often associated with arid and semi-arid regions, they are important components of some western forests as well. Cryptobiotic crusts, which were historically widespread in western U.S. arid lands, are being rapidly depleted across rangelands today. These crusts increase the stability of otherwise easily erodible soils, increase water infiltration in a region that receives limited precipitation, and increase fertility of soils often limited in essential nutrients such as nitrogen and carbon (Johansen 1993, Belnap et al. 1994). ORVs are highly destructive to these fragile cryptobiotic crusts. A single pass of an ORV through cryptobiotic crusts will increase wind and water erosion of surface soils that were previously protected by the crusts (pers. Comm., Howard Wilshire, USGS-retired). This in turn can trigger rapid loss of the underlying topsoil, which can take up to 5,000 years to reform naturally in arid regions (Webb 1983).

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).

Additionally, radical reduction of soil biota, including bacteria and fungi, results from compaction. Soil microorganisms in desert soils exposed to ORV use are typically reduced from about 4 to less than 1 million/g, which in turn reduces the bacterial oxidation that makes nitrates available to plants (Liddle 1997). A severe loss of nitrates to plants is significant in typically nitrogen poor arid environments, and may even eventually lead to desertification (Belnap 1995).



Cryptobiotic soils are fragile and easily compacted.



While most common in the arid southwest, cryptobiotic soils are found throughout the West.

Photos courtesy of U.S. Geological Service.

1.0 VEGETATION

2.1 BEST MANAGEMENT PRACTICES PERTAINING TO VEGETATION

2.1.1 Planning and Decision-Making BMPs for Vegetation

- Locate routes in areas that do not have sensitive, threatened, or endangered plant species.
- Locate routes where there are no unique plant communities such as aspen stands, bogs, wetlands, riparian areas, and alpine habitat types.

2.1.2 Implementation BMPs for Vegetation

- Identify what sensitive, threatened, and/or endangered plants are in ORV use areas, as well as rare, fragile and/or unique plant communities (i.e., aspen stands, bogs, wetlands, riparian, alpine areas). Record the survey information into a GIS (Geographic Information System) database.
- Close areas where sensitive, threatened, and/or endangered plant species are at risk.
- Remove invasive non-native plants from routes when feasible.
- Prohibit motorized camping in areas where invasive plants are a problem.
- Control invasive plants in staging areas to avoid their spread onto routes.
- Identify areas where invasive plants present a problem and require that all ORVs using such areas wash vehicles when exiting such areas.
- Close and restore routes documented as contributing to the spread of non-native invasive plants into relatively weed-free areas.
- Use native species when revegetating a closed route.
- Modify livestock grazing practices or halt grazing in newly restored areas where routes have been closed.



Antioch Dunes Evening Primrose. Photo by Ivette Loreda, U.S. Fish and Wildlife Service.

2.1.3 Monitoring BMPs for Vegetation⁸

- Monitor routes for sensitive, threatened, and/or endangered plants in ORV use areas, as well as rare, fragile and/or unique plant communities.
- Monitor for unauthorized spur routes into areas with sensitive, threatened, and endangered plant species.
- Monitor routes for presence and spread of non-native species or the decline of native species.
- Monitor closed and restored routes to ensure effective mitigation for damaged vegetation is occurring.
- Monitor the success of revegetation projects.
- Adaptively manage by closing or mitigating a route if monitoring identifies that vegetation conditions are no longer in compliance with planning and decision-making BMPs.

⁸ In order to be sure that monitoring BMPs are meaningful, it is important for forest managers to make quantitative measurements of key vegetation parameters at reasonable time intervals, and to identify specified thresholds of vegetation condition that require specific actions.

2.2 JUSTIFICATION FOR VEGETATION BMPs

Trees, shrubs, and grasses hold soil in place and provide habitats for a broad diversity of wildlife. Wildlife health is intricately connected with the integrity of its associated plant communities.

Vegetation Impacts from ORVs

- Reduces plant density and diversity from trampling
- Spread of non-native invasive plants

2.2.1 Trampling Impacts

Riding a several hundred pound ORV off-route or cross-country can crush, break, and ultimately reduce overall vegetative cover (Wilshire 1983, Cole and Bayfield 1993). Vehicular impacts on vegetation range from complete denudation of large staging areas to selective kill-off of the most sensitive plants. Ultimately, web-like networks of ORV trails can coalesce into broad areas largely denuded of vegetation. Large shrubs and trees 15-20 ft. tall have been killed by root exposure caused by adjacent ORV traffic, and at one locality 10-foot junipers were destroyed by direct impact (pers. comm., Howard Wilshire, USGS-retired). Plants that survive are weakened, limiting their ability to grow upwards, and are more susceptible to disease and insect predation. One study found that there was half as much vegetation in an ORV use area than in a similar undisturbed site (Misak et al. 2002).

These trampling effects generally result in the simplification (e.g., decreased diversity) of vegetation communities either through direct mortality or by increasing seedling mortality, which can eventually lead to changes in species composition. Studies have found that in areas with high ORV use and repeated trampling, forb and grass communities generally replace shrub communities (Leininger and Payne 1971, Stout 1992). There is also an increased risk of local extinction of sensitive plant species in ORV use areas (Stensvold 2000, Brown and McLachlan 2002).

As mentioned in the previous section, the compaction and erosion of soil can greatly impact vegetation. Soil nutrient uptake by plants is decreased in compacted and eroded soils, root growth is reduced, and plant growth can be severely limited in compacted soils (Blackburn and Davis 1994). Trampling of soils by ORVs can also damage germinating seeds, and even seeds in the soil seed bank (Bury et al. 1977, CEQ 1979). Other indirect impacts on young plants include the reduction of water storage and soil infiltration rates, and alteration of thermal (temperature) characteristics of soils; these are all ORV related deficiencies that can disrupt seed germination and seedling growth (Davidson and Fox 1974). Moreover, soils left bare by the damage of ORVs offer excellent germination beds for aggressive weedy species. Lastly, when ORVs travel through exposed soil sites during dry periods, they often create dust, which settles on and can damage nearby plants. The dust can affect the plants' ability to photosynthesize, grow, and reproduce (MWLAP and GCC 2004).

ORVs can trample vegetation and compact soil, especially in sensitive meadows. Photo by Laurel Hagen.



2.2.2 Non-native Invasive Species

In addition to trampling effects, ORVs are a major vector for non-native (exotic) invasive plant species. When non-native plants invade areas, they tend to crowd out and outcompete native vegetation, and as a result, multiple aspects of that ecosystem can be impacted. The impact is so large that Forest Service Chief Bosworth has named the spread of invasive species as one of the four “great issues” facing the Forest Service today (Bosworth 2003). Weeds are spreading at an estimated 4,600 acres a day on western public lands and ORVs are cited as a key source of their spread (USDI 2000a).

With knobby tires and large undercarriages, ORVs can unintentionally take invasive non-native species deep into forestlands. For example, one study found that in just one trip on a 10 mi. course, an ORV dispersed 2,000 spotted knapweed seeds (MSU 1992). In Wisconsin, a survey of seven invasive plant species along ORV routes found at least one of these (exotic) plant species on 88% of segments examined (Rooney 2005). ORVs in roadless areas pose a particular risk of spreading invasive non-native species because roadless areas are often less weedy. Gelbard and Harrison (2003) found that ORVs are the chief vector for invasive species infestation in roadless areas, which were shown to be very important refuges for native plants.



St Johnswort. Photo by Jennifer Anderson, USDA-NRCS PLANTS Database



Leafy spurge. Photo courtesy of U.S. Forest Service.

Several noxious weeds found in the intermountain forest region.



Dalmatian toadflax. Photo courtesy of U.S. Forest Service.



Sulphur Cinquefoil. Photo by Jennifer Anderson, USDA-NRCS PLANTS database.



Purple Loosestrife. Photo by Robert Mohlenbrock, USDA-NRCS PLANTS database.

2.2.3 Plant community restoration

In some areas it may be determined that there are more routes than are necessary to accommodate ORV use. This may be due to illegal route creation, route redundancy, or the determination that the environmental or social cost is too great to continue ORV use in that area. In these cases, it is essential that routes are closed and an appropriate restoration plan be implemented.

The objectives of a plant community restoration plan should be to stabilize the area, prevent it from further degradation, and return it to its previous native condition. First the route must be effectively blocked or obscured to prevent further ORV use. Blocking the entrance of the route could include fencing, placing barriers or boulders, laying woody debris, planting trees, and/or fully recontouring the entrance of the route. In certain situations it even helps if not only the entrance is blocked, but the view of the actual line of sight is blocked. Once access is prevented, native seed should be used for revegetation. Incorporating local plant materials, duff, and woody material will help retain moisture, provide native plant seed, and speed the revegetation process. Lastly, some sort of educational and enforcement component is helpful as well - revegetation efforts tend to fail if there is further damage from ORV use while the plants are germinating and growing.



Montana Conservation Corps volunteers on a restoration project site. Wildlands CPR file photo.



Photo by Paul Shively.



Photos taken of closed area in 1990 (left) and 2004 (right) show dramatic recovery from the impacts of motorized vehicles. Photos © Mark Alan Wilson.

3.0 WILDLIFE

3.1 BEST MANAGEMENT PRACTICES PERTAINING TO WILDLIFE⁹

3.1.1 Planning and Decision-Making BMPs for Wildlife

- Set levels of acceptable disturbance that are compatible with maintaining species viability or recovery.
- Locate routes in areas that do not have critical habitat (formally designated or just important for survival) for sensitive, threatened, and or endangered wildlife species.
- Locate new routes where they are unlikely to significantly affect the populations of important native wildlife species specifically regarding reproduction, nesting, or rearing.
 - Do not locate routes in areas with concentrated or particularly important ungulate fawning or calving areas.
 - Do not locate routes inside buffer distances for nesting sites shown in Table 2.
- Locate routes a minimum distance (as listed below) from waterbodies and wetlands:¹⁰
 - Fish-bearing streams and lakes - 300 ft.
 - Permanently flowing non-fish-bearing streams - 150 ft.
 - Ponds, reservoirs, and wetlands greater than one acre - 150 ft.
- Locate routes as far as possible, but a minimum of 150 ft., from natural caves, tunnels, and mines where bat nurseries are commonly found.
- Locate routes in discrete, specified areas bounded by natural features (topography and vegetative cover) to provide visual and acoustic barriers and to ensure that secure habitat is maintained for wildlife.
- Locate routes in forest cover and not in open country. Long sight lines in open country make the visual effects of machines more pronounced.

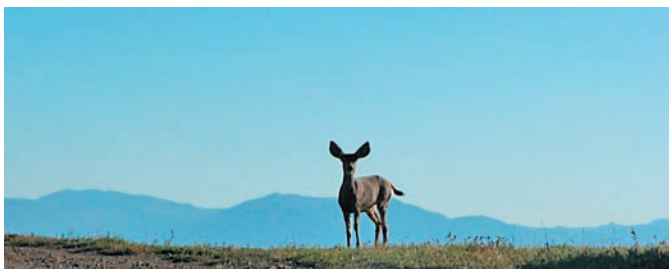


Photo by Laurel Hagen.



Threatened species require special measures to shield them from human impacts. Photo by Terry Tollefsbol, U.S. Fish and Wildlife Service.

⁹ In the wildlife section, many BMPs were adapted from existing science-based comprehensive reviews. These include: Effects of Recreation on Rocky Mountain Wildlife (Joslin and Youmans 1999), Interagency Rocky Mountain Front Wildlife Monitoring / Evaluation Program (USDI 1987), and other research reviews such as Richardson and Miller (1997).

¹⁰ These BMPs are based upon Forest Service Riparian Habitat Conservation Areas (RHCA) standards.

3.1.2 Implementation BMPs for Wildlife

- Survey for sensitive, threatened, and endangered animals, as well as critical habitat (formally designated or just important for survival), in ORV use areas. This survey information should be catalogued and regularly updated in a GIS database.
- Prohibit ORV use in critical habitat for sensitive, threatened, and endangered species.
- Maintain large unfragmented, undisturbed blocks of forestland where no routes are designated.
- Maintain and improve habitat security by protecting whole areas rather than individual route closures.
- Reduce road/route density to below 1mi./mi.² in important wildlife areas.
- Conduct adequate nest searches to identify raptor nest sites. Seasonally close ORV areas in raptor nesting territories during sensitive nesting phases (e.g., March through August in the Rocky Mountain West; see: Table 2 for buffer distances).
- If routes are already in important native wildlife habitat, seasonally close during sensitive seasons.
 - Calving/fawning period for known key ungulate calving/fawning areas (e.g., May 15 through June in the Rocky Mountain West)
 - Critical ungulate wintering habitat/winter concentration areas (e.g., December through March in the Rocky Mountain West)
 - Migration corridors during migrations.
- Do not allow the use of ORVs off designated routes for game retrieval.
- Develop public information and educational programs targeting ORV users to raise wildlife awareness, such as information about wildlife species in the focal area, key wildlife sign, and the impacts of ORVs to those species.
- Address recovering carnivores such as grizzly bears and wolves:
 - Prohibit ORV use in grizzly bear habitats that provide important food sources during spring and early summer (e.g., April 1 through July 15 in the Rocky Mountain West). These habitat components include riparian shrub types, aspen stands, wet meadows, and avalanche chutes.
 - In areas with established wolf packs where there is a desire to reduce the potential for disturbance and the risk of illegal killing, limit ORV route densities to less than 1 mi./mi.² (Table 1).



ORVs have become popular with some hunters. Wildlands CPR file photo.



Off-road vehicles have the potential to disturb wildlife. Photo by Paul Shively.

3.1.3 Monitoring BMPs for Wildlife¹¹

- Monitor routes for sensitive, threatened, and endangered animals in ORV use areas.
- Monitor routes to identify whether they are impacting the reproduction, nesting, or rearing of key indicator species.
- Monitor routes to identify whether there are unauthorized spur routes, especially if they approach waterbodies, wetlands, and bogs that are key habitats for amphibians and reptiles; or natural caves, tunnels, and mines where bat nurseries may occur.
- Monitor use concurrently with local wildlife populations to determine the impact on wildlife species.
- Monitor closed and restored routes to ensure they are effectively mitigating impacts to wildlife.
- Manage adaptively through closure, rerouting, or mitigation if monitoring identifies that wildlife conditions are no longer in compliance with planning and decision-making BMPs. ORV use in important wildlife habitats should only be allowed after peer-reviewed studies or data from wildlife and ORV monitoring conclude that wildlife populations will not be impaired.

Wildlife Impacts from ORVs

- Direct mortality
- Loss of security
- Increased disturbance
- Loss of habitat



Researchers have studied the response of elk to roads and motorized disturbance. Photo courtesy of National Park Service.

3.2 JUSTIFICATION FOR WILDLIFE BMPs

Forests are home to hundreds of species of fish and wildlife. Wildlife provide recreational opportunities for hunters, anglers, and wildlife enthusiasts. Millions of hunters and fishermen enjoy harvesting wildlife while increasing numbers of birders and photographers enjoy simply catching a glimpse of the diversity of forest life. In addition to recreational benefits, diverse wildlife are a sign of overall ecosystem health and integrity. While there are many threats to preserving wildlife ranging from global warming to development, the negative impacts from ORVs on wildlife have been well documented in the scientific literature. ORVs can impact wildlife through direct mortality, increased legal and illegal harvest, disturbance, and habitat loss.

¹¹ In order to be sure that monitoring BMPs are meaningful, it is important for forest managers to make measurements of key wildlife/habitat indicators at reasonable time intervals, and to identify specified thresholds that require specific actions.

3.2.1 Direct Mortality

One of the most apparent impacts of ORVs on wildlife is collisions and direct mortality. Direct impact will kill most species, but amphibians, reptiles, small mammals and ground nesting birds are most vulnerable (Wilkins 1982, Rei and Seitz 1990, Fahrig et al. 1995, Ashley and Robinson 1996, Gibbs 1998, DeMaynadier and Hunter 2000). With millions of ORVs traversing the landscape at high speeds (up to 60 mph), the number of animals being killed can be significant.

3.2.2 Habitat Security

Several studies have found that large animals such as elk, wolves, and bears are negatively impacted by the loss of habitat security resulting from increased motorized access. Depending on the species, some wildlife are more sensitive to disturbance during critical times of year, such as winter habitat for ungulates or areas important for grizzly bear food sources during spring (USDI 1987).

Elk have been the most extensively studied animal in relation to motorized access. While recent studies have made a direct connection between ORVs and impacts to elk (Vieira 2000, Wisdom et al. 2004, Wisdom 2007, Grigg 2007), most studies have looked more broadly at the impacts of motorized travel and roads on elk. It can be assumed that these impacts would be similar on ORV routes.¹² Many studies have found that increased motorized access results in decreased elk habitat and security (Lyon 1983; Figure 3), and increased elk mortality from hunter harvest both legal and illegal (Hershey and Legee 1982, Hayes et al. 2002, McCorquodale et al. 2003, see Rowland et al. 2005 for review).

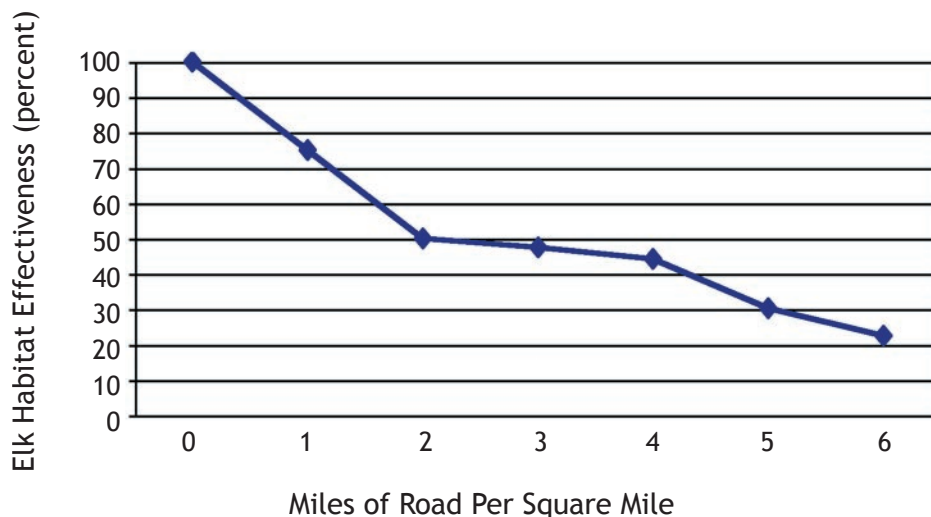


Figure 3. Average habitat effectiveness (a measure of forage quality and available cover) for elk in western Montana with road densities ranging from 0 to 6 miles per square mile (Adapted from Lyon 1983).

¹² While direct mortality and fragmentation caused by ORVs would be less than that of roads, the disturbance effects are assumed to be similar.

Closing or decommissioning roads has been found to decrease hunter induced mortality (Leptich and Zager 1991), increase elk survivorship (Cole et al. 1997), increase the number of bulls (Leptich and Zager 1991), extend the age structure (Leptich and Zager 1991), increase hunter success (Gratson and Whitman 2000), and allow elk to remain in preferred habitat longer (Irwin and Peek 1979). Studies have also recommended closing entire areas to motorized use— as opposed to individual roads— to best promote healthy elk populations (Hurley 1994, Burcham et al. 1998, Rowland et al. 2005).

ORVs can also allow access for illegal harvest of wildlife in areas that are difficult for game wardens to patrol. Weaver (1993) reported that increased ORV access increases the trapping vulnerability of American martin, fisher, and wolverine. For wolves, one study found that 21 of 25 human caused mortalities in the U.S. northern Rockies occurred within 650 ft. of a motorized route (Boyd and Pletscher 1999). Wolves often travel on roads and off-road vehicle routes where they risk increased poaching pressure. Several studies have found that wolf persistence is reduced when road density exceeds approximately 1 mi./mi.²; Table 1). Lynx are also thought to be sensitive to road density, but to a lesser extent than wolves (Singleton et al. 2001, 2002). Grizzly bears are at risk from poaching and have been found to be negatively affected by roads and to avoid open roads (Elgmork 1978, Zager et al. 1983, Archibald et al. 1987, Mattson et al. 1987, McLellan and Shackleton 1988, Kasworm and Manley 1990, Mace et al. 1996).



Yellow Warbler nest and eggs. Photo by Kristine Sowel, courtesy of U.S. Fish and Wildlife Service.

Table 1. Road density levels shown to be deleterious for wolves in the northern Great Lakes region.

| Road Density (mi/mi ²) | Study Location | Citation |
|--|-------------------------|-----------------------|
| 1.0 | Wisconsin | Thiel (1985) |
| 1.0 | Ontario-Michigan border | Jensen et al. (1986) |
| 0.9 | Minnesota | Mech et al. (1988) |
| 1.2* | Minnesota | Mech et al. (1989) |
| 1.1 (with ~6 humans/mi ²) | Minnesota | Fuller et al. (1992) |
| 0.8 (with ~12 humans/mi ²) | Minnesota | Fuller et al. (1992) |
| 1.0** | Wisconsin | Wydevan et al. (2001) |

*Adjacent roadless area allowed higher road density threshold
 **Changing attitudes allowed higher road density threshold

3.2.3 Disturbance

Probably the most widespread impact of ORVs is disturbance to wildlife. Within individual species, a number of factors can influence the degree of ORV impact, including the animal's breeding status, its size, and the size of the group it is with (Burger et al. 1995). Studies have shown a variety of disturbance is possible 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).

Again, elk are one of the most studied species in regards to disturbance by mechanized use. Vieira (2000) found that elk moved twice as far from ORV disturbance than they did from pedestrian disturbance, and Wisdom et al. (2004) found that elk moved when ORVs passed within 2,000 yards but tolerated hikers within 500 ft. Recently, 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 Legee 1982, Millspaugh 1995, Weber 1996). Additional concomitant effects can thus 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 (Cole et al. 1997, Millspaugh et al. 2000, Rowland et al. 2005).

Disruption of breeding and nesting birds is a particularly well documented problem. 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). Several authors have recommended spatial nest buffer zones from motorized recreation for raptors (Table 2). 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).

Table 2. Recommended spatial nest buffer zone for selected birds of prey.

| Species | Spatial Nest Buffer Zone (ft.) | Citation |
|---------------------|--------------------------------|------------------------------|
| American kestrel | 650 | Richardson and Miller (1997) |
| Bald eagle | 1300 | Hamann et al. (1999) |
| Northern goshawk | 1600 | Jones (1979) |
| Sharp-shinned hawk | 1600 | Jones (1979) |
| Cooper's hawk | 2000 | Richardson and Miller (1997) |
| Prairie falcon | 2600 | Richardson and Miller (1997) |
| Peregrine falcon | 2600 | Richardson and Miller (1997) |
| Red-tailed hawk | 2600 | Call (1979) |
| Mexican Spotted owl | 3000 | USFWS (1995) |
| Osprey | 4900 | Richardson and Miller (1997) |
| Golden eagle | 5200 | Richardson and Miller (1997) |

3.2.4 Loss of Habitat

The cumulative effect of loss of habitat security, soil erosion, vegetation loss, introduction of non-native invasive species, and forest fragmentation results in the loss of functional wildlife habitat that supports healthy individuals and populations of wildlife. Animals may be impacted directly and/or indirectly. A direct impact may be an ORV that collapses a small mammal burrow or runs an animal over. An indirect impact would be reduced habitat for cavity-nesting species caused by increased access for firewood collection (Bury 1980). Any additional habitat loss for sensitive, threatened, and endangered species is also of concern. Wilcove et al. (1998) reported that as many as 13 percent of endangered species are impacted by ORVs.

The indirect impacts of ORVs can have cascading effects throughout the ecosystem. For example, on an intensively used ORV route in Idaho, native shrubs, bunch grasses, and microbial crust were greatly reduced close to the route and replaced with non-native cheat grass (*Bromus tectorum*) and the native shrub, rabbitbrush (*Chrysothamnus* sp.; Munger et al. 2003). Because of these habitat changes, fewer reptiles were found alongside the route than were found 325 ft. away. Bury et al. (1977) demonstrated the direct impact of ORVs on species richness, abundance, and biomass. Areas of ORV use had significantly fewer species of vertebrates, greatly reduced abundance of individuals, and noticeably lower small mammal biomass. Bury et al. (1977) also showed that diversity, density, and biomass of small mammals are inversely related to the level of ORV use in an area.

An old road is kept open by continual use (below), while a restored roadbed contributes to habitat security (right). Photos by Adam Switalski.



4.0 SPECIAL ECOSYSTEMS

4.1 BEST MANAGEMENT PRACTICES FOR SPECIAL AREAS AND ECOSYSTEMS

4.1.1 Planning and Decision-Making BMPs for Special Ecosystems

- Do not locate routes in roadless areas, Research Natural Areas, citizen or agency proposed Wilderness, Wilderness Study Areas, and other lands with Wilderness character. Close and rehabilitate those routes that exist on the ground in these areas.
- Locate routes a minimum distance (as listed below) from waterbodies and wetlands:¹³
 - Fish-bearing streams and lakes - 300 ft.
 - Permanently flowing non-fish-bearing streams - 150 ft.
 - Ponds, reservoirs, and wetlands greater than one acre - 150 ft.
- Do not locate routes on cliffs, cliff edges, or along ridges.
- Locate routes as far as possible, but a minimum of 150 ft., from natural caves.
- Do not locate routes in alpine habitat.
- Avoid locating routes in areas containing archeological finds or other cultural and historic sites.

4.1.2 Implementation BMPs for Special Areas and Ecosystems

- Identify where routes come close to roadless areas, Research Natural Areas, citizen or agency proposed Wilderness, Wilderness Study Areas, and other lands with Wilderness character. Secure the boundaries of these areas and ensure that there is no proliferation of ORVs into protected areas. Increase signage, effectiveness of closures and enforcement at these areas.
- Close and restore unauthorized routes in special ecosystems.
- Identify and close where routes are near riparian areas, wetlands, cliff edges, natural caves, alpine habitat, and cultural and historic sites. If closure is not possible, secure the boundaries of these areas and ensure that there is no proliferation of ORVs into these sensitive areas. Increase signage, effectiveness of closures and enforcement at these areas.
- Ensure that bridges and culverts are present and fully functional on routes. Minimize the number of times a route crosses a riparian area.
- Do not allow travel in washes or perennial streambeds.

Dome Peak roadless area, Colorado. Photo courtesy of U.S. Forest Service.



¹³ These BMPs are based upon Forest Service Riparian Habitat Conservation Areas (RHCA) standards.

4.1.3 Monitoring BMPs for Special Areas and Ecosystems

- Monitor to identify whether there are unauthorized spur routes in roadless areas, Research Natural Areas, citizen or agency proposed Wilderness, Wilderness Study Areas, and other lands with Wilderness character.
- Monitor to identify whether there are off-route spurs in riparian areas, wetlands, cliff edges, natural caves, alpine habitat, and cultural and historic sites.
- Monitor closed and restored routes to ensure closures are effectively mitigating impacts to special ecosystems.
- Adaptively manage by closing or mitigating a route if monitoring identifies that special ecosystem conditions are no longer in compliance with planning and decision-making BMPs.

Sensitive wetlands require special management attention. Photo by David Smith.

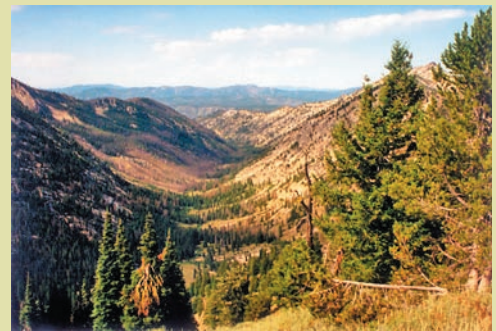


4.2 JUSTIFICATION FOR SPECIAL AREAS AND ECOSYSTEMS BMPs

Certain ecosystems are very rare, or are disproportionately ecologically or socially important. These “special ecosystems” need particular management attention because they are often more sensitive and more susceptible to damage from ORVs, or because the degradation of these areas by ORVs is more significant by virtue of their rarity. This section reviews the impacts of ORVs on roadless areas, riparian areas, and other special ecosystems.

4.2.1 Roadless Areas

Many forestlands have no roads and have not been significantly altered by motorized disturbances. These roadless areas maintain healthy soil, provide clean water, and act as a refuge for wildlife (USDA 2000b; DellaSala and Strittholt 2002). Roadless areas have remained unroaded primarily because they are remote and inaccessible. Today, most remote roadless areas can be accessed in just a few hours on an ORV. ORVs may negatively impact roadless areas by increasing legal and illegal harvest of wildlife, reducing hunter opportunity as seasons become more restrictive, fragmenting wildlife populations, and decreasing overall habitat quality and quantity. ORVs may also impact native fish and plant species by enabling non-native invasive species to travel and be transported deep into roadless areas.



Ten mile-Black Warrior roadless area, Boise National Forest. Photo courtesy of U.S. Forest Service.

Ecosystem Services Benefits of Roadless Areas

- Maintain healthy soil
- Provide clean air and water
- Act as a refuge for native plants and wildlife
- Contain fire resistant old growth

Roadless areas are very important for a variety of wildlife species. Roadless areas allow for landscape and regional connectivity, and can act as refugia for a host of wildlife. For example, one study in Idaho found that 75 percent of all elk harvested in a hunting unit were from roadless areas, which was just 25 percent of the forested portion of this drainage (Thiessen 1976). In Minnesota, researchers found that wolves could persist with higher road densities if there was an adjacent roadless area (Mech 1989). During a 10-year study of grizzly bears, Dood et al. (1983) recorded five of six illegally killed bears in roaded areas, although their home ranges included roadless areas.

Roadless areas have the potential to conserve sensitive, threatened, or endangered species (Loucks et al. 2003). Forest Service roadless areas are known aquatic strongholds for salmonids and other fish species (Quigley et al. 1997). Additionally, roadless areas are a significant refuge for native plant species (Gelbard and Harrison 2003). Roadless areas also generally have less fire risk and fewer insect outbreaks than heavily logged areas (DellaSala and Frost 2001).

4.2.2 Riparian Areas and Wetlands

Riparian areas are the vegetated areas adjacent to streams that are regularly flooded during high flows. Wetlands are areas with saturated soils that support deep rooted, or obligate wetland plants. While riparian areas and wetlands make up just a small percentage of forestlands, they are generally more productive in plant and animal biomass and higher in diversity than the surrounding areas. These areas are also vulnerable to ORV use. ORVs in riparian areas can disturb wildlife, cause bank erosion, and increase stream sedimentation. ORVs in wetlands can cause similar damage to sensitive wetland soils and plants.

Healthy, vegetated riparian areas provide cover, foraging, and nesting sites for a number of animals. In addition to providing habitat for resident populations, riparian areas have been shown to act as important corridors for wildlife (Naiman et al. 1993, Machtans et al. 1996, Burbrink et al. 1998). One study found that riparian areas contained up to 10 times the number of migrant birds per hectare than adjacent, non-riparian plots (Stevens et al. 1977). Healthy riparian zones and streams are also crucial for fish populations (Stevens et al. 2005 and references within).



For many ORV users, riding directly through live streams is an accepted practice. Photos by Adam Switalski.

Riparian areas also provide a number of ecosystem service functions including capturing, storing, and filtering water. Following a storm or snowmelt, riparian areas hold and store water and slowly release it back to the stream, resulting in healthy and normal hydrographs. Degraded riparian areas typically exhibit more stream flashing. Healthy riparian areas, through bankcover and root masses, also serve to stabilize stream banks. Stable stream banks have been shown to be very important for fish habitat (USDA 1985), water tables near the surface (Richards 1987, Stevens et al. 1995), and most importantly for preventing erosion (Stevens et al. 2005). Trimble (1997) found that up to 76% of total sediment entering creeks may come from creek bank erosion alone.

Wetlands provide similarly important ecosystem functions, such as improving water quality by filtering sediments, nutrients and contaminants from the water column (Meffe and Carroll 1994). They are also critically important habitats for an impressive variety of plants and both vertebrate and invertebrate species, including many federally threatened and endangered species.

Ecosystem Function of Healthy Riparian Areas and Wetlands

- Provide critical fish and wildlife habitat
- Act as a travel corridor for wildlife
- Control water flow by capturing surface and groundwater and slowly releasing it back to the environment
- Stabilize banks, thus reducing erosion
- Improve water quality by trapping pollutants

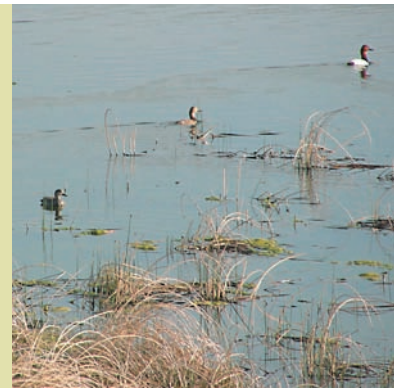


Photo by Dan Funsch.



Sedimentation of streams can threaten the spawning success of salmon, like these in Idaho's Clearwater River. Photo by Tim Brown (2001).

4.2.3 Other Special Places

Cliffs are unique features on a landscape that provide security for many nesting raptors. ORVs have the potential to disturb nesting birds when routes are located close to cliffs (Hamann et al. 1999). Caves are an important feature for breeding bats. Human disturbance can cause bats to abandon a roost and lead to population declines (Pierson and Rainey 1994). Caves and old mine tunnels are a lure for a number of forest visitors and recreationists. For many, simply seeing one from a trail is reason enough to explore, and some of those explorers will go on to vandalize the cave or mine. Unfortunately vandalism can sometimes mean purposely disturbing roosting bats, and sometimes even with means that include fireworks, shooting, and fire (pers. Comm., George Oliver, Utah Division of Wildlife Resources). Alpine meadows are also sensitive to human disturbance because of their short growing season and slow soil formation (Fitzgerald et al. 1994). Finally, much like other special areas, the increase of ORV use in remote areas is threatening archaeological and historic sites. Increased visitation has resulted in intentional and unintentional damage to many cultural sites (USDI 2000b, Schiffman 2005, Sampson 2007).

Other Special Places

- Cliff habitat
- Caves
- Alpine habitat
- Archaeological / historic sites



Cliffs provide security for nesting raptors. Photo by Robert Post, courtesy of U.S. Fish and Wildlife Service.



Caves can harbor breeding bats, and invite exploration from forest visitors. Photo by Kevin Bell, courtesy of U.S. Fish and Wildlife Service.



Alpine habitat on the Gunnison National Forest, Colorado. Photo courtesy of USDA, NRCS.

5.0 USE CONFLICTS

5.1 BEST MANAGEMENT PRACTICES FOR USE CONFLICTS

5.1.1 Planning and Decision-Making BMPs for Use Conflicts

- Designate motor-free Quiet Use Zones in both backcountry and front-country settings that emphasize wildlife needs and relatively low-impact recreational activities.
- Prioritize motorized route designations to protect public land resources, and the safety of all public land users, and to minimize conflicts with other recreational uses and nearby residences.
- Ensure that ORV use does not preclude meeting the demand for hiking, equestrian and other non-motorized recreational uses.
- Do not locate ORV routes on trails, areas, or watersheds primarily used by hikers, horseback riders, mountain bikers, hunters, birdwatchers, or other quiet recreationists and sportsmen, particularly those routes where unmanaged use has led to motorized encroachment on non-motorized trails.

5.1.2 Implementation BMPs for Use Conflicts

- Undertake proactive and systematic outreach to motorized and non-motorized visitors in order to facilitate mutual understanding of the preferences and desired experiences of public land visitors.
- Establish trails or recreational working group with both motorized and non-motorized stakeholders that meet regularly with land managers. These groups should work cooperatively to identify and resolve use conflict in a manner consistent with agency policy.
- Work with agency and local law enforcement to implement penalties and consequences for violating ORV regulations that will dissuade ORV users from such violations.
- Conduct surveys to establish the demand and opportunities for non-motorized recreation.
- Document use conflicts in a database that is shared with the public.
- Match ORV use to the available management and enforcement capacity (funding and staffing). This will assure that resources exist to guarantee adequate legal enforcement along all routes.

Minimizing use conflicts is an important management opportunity. Wildlands CPR file photo.



5.1.3 Monitoring BMPs for Use Conflicts

- Use monitoring to identify use conflicts on trails, areas, or watersheds traditionally used by hikers, skiers, horseback riders, mountain bikers, hunters, or other quiet recreationists and sportsmen.
- Monitor closed and restored routes to ensure that motorized use is not occurring.
- Use monitoring data to limit or prohibit ORV access on routes where its use is leading to trespass onto other non-motorized trails, areas, or watersheds.
- Require that motorized users have identification on vehicles equal in visibility to that found on highway vehicles.
- Monitor and enforce ORV noise violations by equipping law enforcement personnel with sound meters that can be easily calibrated and used in the field to test noise levels of ORVs at established trailheads and staging areas.



Wildlands CPR file photo.



Photo by Laurel Hagen.

5.2 JUSTIFICATION FOR USE CONFLICTS BMPs

Quiet recreational users include hikers, hunters, anglers, bird watchers, horseback riders and others for which “natural quiet” is an important element of the recreational experience. Despite significant growth during the 1990s, ORV use comprises only 3 percent of recreational visits to all U.S. national forests when such use is the primary activity and 6.6 percent of all visits where ORVs are used in concert with other activities such as hunting and fishing (USDA 2003). With few exceptions, quiet users comprise the vast majority of recreational visitation on public lands.

Conflict can be defined as an emotional state of annoyance with another group or person that can result in dissatisfaction with a specific experience (Yankoviak 2005). For example, a hiker seeking quiet in nature could experience conflict after encountering an ORV user on the same trail because the ORV use could be perceived as preventing the hiker from attaining his or her goal of a quiet, natural experience. Feelings of conflict often occur among quiet users when they hear motor vehicle noise, witness acts of great speed and/or reckless behavior, smell exhaust, and see visible environmental damage. This all can lead to the displacement of non-motorized recreationists from places they would normally frequent (Moore 1994, Gambill 1996, Stokowski and LaPointe 2000).

Use conflict often can be “asymmetrical” in that one user group is generally more impacted by conflict than another. For instance, cross-country skiers may be bothered by snowmobile riders but snowmobile riders are not generally bothered by cross-country skiers. This “asymmetrical conflict” is most likely to occur between motorized and non-motorized recreation activities, where ORV riding in particular is considered incompatible with every other land-based activity but snowmobiling (WDNR 2006). Consequently, non-motorized users often are disproportionately affected by the presence of motor vehicles (especially loud ones), which can cover a lot of ground quickly (Badarraco 1976, Webber 1995).



Photo by Ken Hammond, courtesy of U.S. Fish and Wildlife Service.



Photo by Erin Thompson.

The uses of public lands are as diverse as the American public.

Both motorized and quiet recreationists prefer that trails be managed for multiple uses but with motorized and non-motorized activities separated (Andereck et al. 2001). Where trails are designated as multiple-use, heavy motorized use tends to cause other trail users to pursue opportunities at other locations in order to realize the desired experiences (USDI 2004). There are numerous citations in the literature of non-motorized recreationists being displaced or leaving an area altogether where motorized use is frequent (Adelman et al. 1982, Moore 1994, Webber 1995, Stokowski and LaPointe 2000, Manning and Valliere 2002).

A non-invasive and cost-effective method for measuring and evaluating the level and extent of ORV-related conflict is required to adequately assess conditions on public lands, rather than reliance on the occasional reporting of conflict to Law Enforcement Officers or agency personnel. Before deciding which trails to designate for motorized recreation, managers must be able to ascertain whether any conflict exists or might exist, what groups are experiencing conflict and the degree or severity of the conflict. Thus, it is essential to undertake proactive and systematic outreach to both motorized and non-motorized visitors in order to facilitate mutual understanding of the preferences and desired experiences of public land visitors in conjunction with (as compatible with) the resource protection obligations of the agencies. Only through proactive outreach can the agency identify emerging conflicts before a critical flash point is reached that requires immediate management action.



Wildlands CPR file photo.



Photo by Ronald Laubenstein, courtesy of U.S. Fish and Wildlife Service.



Viewing wildlife is a popular way to enjoy public lands. Photo by Al Milliken, courtesy of U.S. Fish and Wildlife Service.

RESEARCH NEEDS

While most of the impacts of ORVs were identified in the 1970s, we identified some research needs that still remain pertaining to the environmental and social impacts of off-road vehicles. Most importantly, researchers need to revisit their results and conclusions in light of the increased number of ORV users and the technological advances that greatly increase ORVs' power and reach. In the 1970s ORVs were slower, smaller, less maneuverable machines that were operated in fewer places on forestlands. New studies need to be undertaken to address the impacts associated with both the increasing reach and increasing size of modern ORVs.

The impacts of ORVs on soil and vegetation have been well established and do not necessitate further investigation. However, we did not find many studies that compared the different types of ORVs. While Foltz et al. (2004) are currently examining the impact of different combinations of tire pressure and ORV type on soil erosion; studies are needed to see whether dirt bikes differ from four-wheeled ORVs in terms of their impacts to the soil, vegetation, and wildlife. Also, loop routes are a common request from the ORV community. Are loop routes more ecologically and socially friendly than a linear route?

Some species-specific investigations of ORV impacts on wildlife spatial use patterns and demography are needed to better understand how these impacts influence population viability. Much research documents the impacts of roads on a few groups of wildlife (e.g. ungulates, endangered carnivores). Also, how does the intensity of ORV use and associated noise influence the amount of disturbance? What is the extent of direct wildlife mortality from ORVs? Anecdotal evidence suggests that many wildlife species, especially small animals, collide with ORVs, yet no study has attempted to quantify the extent. Wildlife displacement may be the result of not only the presence of motorized vehicles, but also the kinds of wildlife users (poachers, hunters, predator control, etc.) that are facilitated by a route. How does ORV access lead to persecution of wildlife? Finally, Baxter (2002) and others found that ORVs were an ignition source for forest fires. What is the extent of ORV-started forest and range fires? Finally, little research exists on the impacts of large-scale jamboree events.

With most of the ecological data on ORVs collected, social science research is becoming increasingly important in agency decisions. A system is needed to measure and evaluate the level of use conflict. Displacement of non-motorized recreationists is a commonly cited impact from ORVs, however, little data has been collected to quantify this impact, or the natural resource impacts from displaced non-motorized recreationists. Similarly, few studies have quantified how non-motorized recreationists return to areas once ORVs are not permitted.

CONCLUSION

Because ORV use has a disproportionate impact on ecosystems compared to other forms of recreation, it is imperative that Best Management Practices are developed to inform and guide decision-making relating to ORVs. BMPs have been developed to guide oil and gas exploration and development, timber harvest, and fire management; it is only natural that BMPs are established for management of this forest use as well. Scientific literature has firmly established ORV use as a significant perturbation to natural forest systems and their ecology and wildlife, underscoring the need for widely adopted ORV management BMPs that are grounded in science. These Best Management Practices for ORVs on forestlands meet these requirements.

This peer-reviewed document has presented a set of BMPs, which, if followed, will help managers designate routes and manage ORVs with minimal harm to natural forests systems and the wildlife they support. However, we stress that, like all other science-informed management directions, the use and implementation of these BMPs must include adaptive management. And, above all, effective implementation of these BMPs must be accompanied by adequate funding and staff levels in order to ensure that necessary monitoring and legal enforcement are carried out.

If these BMPs are followed, forest managers will be able to determine over the long-term whether or not it is possible to accommodate off-road vehicle recreation while still protecting natural resources and quiet recreational activities. Land managers should be open to whatever the results of monitoring show; including the potential that long-term studies may show that off-road vehicle use is not an appropriate use of some forest lands.



Wyoming wetland restored. Photo by Tim McCabe, NRCS.

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APPENDIX A:

GENERAL BEST MANAGEMENT PRACTICES FOR MANAGING OFF-ROAD VEHICLES

There are a number of ORV management practices that are recommended for both the planning stage and post-implementation management (monitoring, enforcement, and maintenance management) that are relevant to all four resource categories covered in these BMPs.

GENERAL PLANNING AND DECISION-MAKING BMPs

- Close all unauthorized and/or illegal routes. When possible, recover the site with native species, vertical mulch or convert to non-motorized single track if appropriate.
- Close routes that have a history of unsuccessful enforcement of unauthorized off-road vehicle activity along or adjacent to the route, and associated resource damage.
- Avoid creating loop routes where so doing would open up large acreages to potential ORV impacts, legitimize unauthorized routes, or isolate wildlife habitat within interior loops.
- Reclaim administrative routes once the administrative purpose ends.
- Require all motorized camping to occur in designated campsites. Reclaim unauthorized motorized camping sites.
- Close routes that serve no needed, discrete purpose, have no definable destination (i.e. “cherry stemmed” routes in roadless areas) or are duplicative. It is the obligation of those promoting designation of a route to show that there is a public need that cannot be met by other routes or by other access means.

GENERAL IMPLEMENTATION BMPs

- The scope and scale of the designated route network should be limited by the fiscal capacity to monitor, enforce, and maintain that network (in addition to the ecological and social considerations detailed elsewhere in these BMPs).
- Prohibit cross-county travel.
- ORV use should occur only on roads and routes that are designated open.
- Off-road vehicle maps must indicate open routes, access points and access requirements, overall route mileage and density, season(s) of allowable use, and road/route conditions. Maps should also include a narrative plan that details the consequences of illegal off-route riding.
- Routes are designated for appropriate vehicles based on the commensurate level of engineering (e.g. single-track dirt bike routes are not designated for use by four-wheeled off-road vehicles). Design monitoring and enforcement programs to ensure that routes are not illegally converted for use by larger vehicles.
- Ensure that enforcement and management of hunters, and antler shed collectors, meets travel plan standards.
- BMPs related to ORV events:
 - ORV event permits shall ensure that the event does not lead to conditions that no longer meet desired ecological conditions. Event participants must be required to use those routes that can sustain such a level of use without leading to an increase in habitat degradation, wildlife displacement, conflict with pedestrians or other vehicle types, etc.

- There should be opportunity for public review/comment on the event application, and participation in the monitoring.
- Funding either from the agency or event promoter is sufficient to cover permit approval costs, event monitoring, event enforcement, and post-event reclamation. A bond sufficient to cover the costs described should be posted prior to the event. Such bond shall remain in place until post event reclamation has restored habitat, wildlife, and other uses to their desired condition.
- ORV event participants should only be allowed to camp in pre-determined or designated motorized campsites.
- Post ORV event restoration that requires actions on the ground shall be completed within six months of the event, or sooner if seasonal conditions require immediate action.

GENERAL MONITORING BMPs

- Tier ORV use to the available monitoring capacity (funding and staffing).
- Establish protocols for citizen (including ORV users) monitoring of motor vehicle use, conditions of roads/routes, and associated adaptive management to address identified problems.
- Make monitoring data, Geographic Information Systems (GIS) data and analysis (in a format that is useable and easily manipulated) readily available to the public.
- ORV events should have agency monitoring and enforcement staff in the field for the entire event. All monitoring and enforcement records shall be open to public review no later than one month after the event.
- Assess documented user-conflicts to identify trends or trouble areas where management should be reviewed. Implement adaptive management in response to monitoring results including closures, restoration, maintenance, etc.
- The following monitoring measures are the minimum, and should be recorded or measured annually:
 - Document the creation of renegade routes, unauthorized cross-country travel or off-route trespass, and the ecological and economic impacts of such illegal actions.
 - Monitor for impacts of ORV related camping. Monitor designated motorized campsites to ensure they are not increasing in size and that new dispersed motorized camp sites are not being illegally created.
 - Monitor system routes for widening, braiding and creation of parallel routes or creation of renegade routes.
 - Monitor whether signs and barriers prohibiting travel are abided by or ignored, and whether signs and barriers are vandalized, destroyed, or removed.
 - Monitor success of restoration projects and ecological recovery efforts along newly closed routes.
 - Monitor for change in condition of routes over time and resulting impacts (or enhancements).
 - Monitor for amount and change in motorized use, and wildlife use, along routes over time.

BEST MANAGEMENT PRACTICES FOR OFF-ROAD VEHICLE USE ON FORESTLANDS

A Guide for Designating and Managing Off-Road Vehicle Routes

Designed as a resource for public land management agency staff, law enforcement officials, and citizens groups, this document outlines Best Management Practices (BMPs) to aid land managers in travel planning or in any decision-making process related to off-road vehicle management on forested lands.

While many land management activities rely on established Best Management Practices, until now no BMPs have been developed to manage off-road vehicles on forestlands. These BMPs, based on the best available scientific knowledge, fill this gap of forestland off-road vehicle management, and covers the following topics: Laws and Regulations for off-road vehicles, Forest Soils, Vegetation, Wildlife, Special Ecosystems, Use Conflicts, and Research Needs.



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