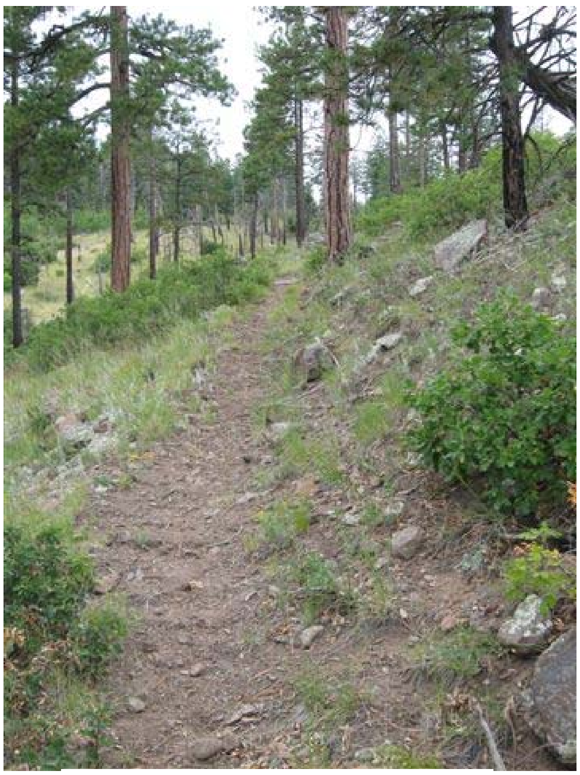
JEMEZ EMERGENCY PROTECTION ORDER

A CITIZEN PETITION

FOR NONDISCRETIONARY CLOSURE OF SELECTED ROUTES
IN THE JEMEZ RANGER DISTRICT, SANTA FE NATIONAL FOREST,
OWING TO CONSIDERABLE ADVERSE EFFECTS
FROM ALL MOTORIZED VEHICLES
C.F.R. §§ 261.50, 261.50(b) and 212.52(b)
Executive Orders 11644 and 11989

MARCH 30, 2009



Forest Trail 113 nonmotorized

Forest Trail 113 motorized

Submitted to:

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"I hope there is some way we could outlaw all off-road vehicles, including snowmobiles, motorcycles, etc., which are doing more damage to our forest and deserts than anything man has ever created. I don't think the Forest Service should encourage the use of these vehicles by even suggesting areas they can travel in…I have often felt that these vehicles have been Japan's way of getting even with us." *(From Senator Barry Goldwater's (R-AZ) 1973 letter to Southwestern Regional Forester William Hurst concerning motorized recreation in Arizona and New Mexico, as quoted in Sheridan (1979)* (emphasis added).

EXECUTIVE SUMMARY

This Jemez Emergency Protection Order ("Protection Order") is a citizen petition for nondiscretionary closure of 27 motorized routes (66.9 miles) in the Jemez Ranger District, Santa Fe National Forest (SFNF) owing to considerable adverse effects from motor vehicles. These routes were not designed for motorized recreation, but began haphazardly as poorly maintained logging roads, temporary roads that were never closed, and renegade routes that evolved illegally from tracks made by off-road vehicles. Each route is described in the section on specific protection orders.

These motorized routes require immediate closure because these routes and their use: (1) cause the direct loss of 24,395 acres of effective wildlife habitat; (2) impair water quality and damage aquatic habitat – there are 118 stream crossings and 4.36 miles of motorized routes in sensitive riparian habitats; (3) harm Essential and Occupied habitat of the state-listed Jemez Mountain salamander; (4) harass and fragment five federally listed Mexican spotted owl nesting areas and allow eight motorized routes to fragment and degrade designated Critical spotted owl habitat; (5) adversely affect three inventoried roadless areas that the state has petitioned the Forest Service to protect; (6) create a continuous motorized loop through an important wildlife diversity area, making it nearly impossible to apprehend poachers; (7) allow ten times greater road density in key big-game wildlife habitat than recommended by state game officials; (8) permit motorized travel on user-created renegade routes in areas where the SFNF specifically bars cross-country travel; and (9) permit motorized travel on routes that are causing irreversible damage to soil resources.

The SFNF supervisor has a nondiscretionary duty to immediately close motorized routes to off-road vehicles that are causing considerable adverse effects on soil, vegetation, wildlife, wildlife habitat and cultural or historic resources until such time as the responsible official determines that such adverse effects have been eliminated and that measures have been implemented to prevent future recurrence. 36 C.F.R. §§ 261.50, 261.50(b) and 212.52(b) Executive Orders 11644 and 11989. The SFNF supervisor's repeated failure to take effective action is a serious dereliction of duty that allows motorized access to virtually the entire 1.5-million acre SFNF.

It is well established by a large body of published scientific literature that motorized off-road vehicles[1] quickly strip vegetation and gouge ruts, leading to erosion of soil at rates much greater than are natural. Eroded soil that washes into streams and rivers can dramatically reduce the quality of habitat for native fish as well as that of most other aquatic life. Declining soil quality and quantity cannot support vegetation, thus harming wildlife and degrading entire ecosystems. The size, noise, terrestrial effect, speed, ability to travel long distances and pollutants associated with motorized recreational vehicles creates far greater effects on the environment than nonconsumptive recreational activities. (See photos of motorized vs. nonmotorized routes on the cover page of this Protection Order.)

Motorized off-road vehicles crush, bruise, shred and otherwise destroy trees, shrubs, and other plant life. Disturbance of soil and vegetation creates ideal conditions for exotic invasive plants to become established. Damage to native vegetation makes it easier for exotic invaders to out-compete native plants. Furthermore, off-road vehicles can spread invasive weeds across pristine wildlife habitat when traveling cross-country and along unauthorized renegade routes.

Motorized recreation jeopardizes wildlife by altering and disturbing habitat and directly killing wildlife. Such recreational vehicles sometimes strike animals, intentionally or unintentionally, causing their death. They can severely disturb and harass wildlife and motorized routes often fragment and degrade wildlife habitat. The noise of motorized recreational vehicles can directly reduce the ability of wildlife to find prey, avoid predators and reproduce successfully. Such noise can also dangerously disorient wildlife. Even at low intensity, continual motorized recreation adversely effects wildlife by reducing numbers, recruitment, and diversity (USDI/ BLM 1975; Byrne 1973).

The engines on off-road vehicles, especially two-stroke engines, are highly polluting. Emissions of carbon monoxide, polycyclic aromatic hydrocarbons (PAHs), methyl tertiary butyl ether (MTBE), particulate matter and other pollutants dangerously degrade the quality of the air, soil and water; adverse human health effects have also been demonstrated. In addition, off-road vehicles are the most common ignition source for wildfires.

Instead of acting decisively to control the spread and to address the enormous effects of motorized recreation, the SFNF has largely ignored the problem. It has even encouraged the massive expansion of motorized recreation by officially designating renegade routes in its travel management plans. Private landowners do not and would not allow motorized vehicles to destroy their land. Neither should the SFNF allow the continued destruction of our public lands heritage.

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[1] All forms of motorized vehicles, not exclusively "off-road vehicles", can damage resources. Therefore this petition uses the term "motorized vehicle" to include off-highway vehicles (OHV), passenger cars, motorcycles, all-terrain vehicles (ATV) and off-road vehicles (ORV), as defined in Executive Order 11644, as amended (1972): "any motorized vehicle designed for or capable of cross-country travel on or immediately over land, water, sand, snow, ice, marsh, swampland, or other natural terrain."

INTRODUCTION

Decades of official neglect have allowed a motorized menace to metastasize unchecked on the SFNF, leaving in its wake eroded soils, trampled vegetation, diminished wildlife, fragmented habitat, polluted air and water, deafening noise and shrunken wildlands. Instead of acting decisively to control the spread and address the enormous effects of motorized recreation, the SFNF has consistently failed to take substantive remedial action. Instead, it has allowed and even encouraged a massive expansion of motorized recreation.

The damage attributable to motorized recreation is not a new concern. In the Council on Environmental Quality's (CEQ) 1979 report entitled *Off-Road Vehicles on Public Land* (Sheridan 1979), then-chairman of the CEQ Charles Warren stated that the CEQ "sees the off-road vehicle problem as one of the most serious public land use problems that we face" (emphasis added). Similarly, the author of the report, David Sheridan, after reviewing the evidence, concluded "too few federal land mangers are effectively representing the interests of the land and the plants and creatures who live upon it."

Though the CEQ report was critical of the management of motorized recreation by the Forest Service, it expressed hope that the agency was "now integrating off-road vehicle use into their land use planning processes" in response to Executive Order 11644, as amended, which provides guidelines needed for intelligent management of off-road vehicles within the multiple use context. While this may have been wishful thinking at the time, thirty years later we know, based on the evidence, that the Forest Service has failed to comply with the spirit or intent of Executive Order 11644 or of federal statutes and regulations governing motorized recreation management on federal lands. Motorized recreation remains one of the most serious public land management issues facing the Forest Service and, without question, the problem has become substantially worse, not better, in the past three decades.

The SFNF published its first off-road vehicle management plan in 1977. This plan either banned, restricted to existing routes, or established seasonal closures for motorized use on nearly 382,000 acres to protect sensitive resources and reduce user conflicts (USDA/SFNF 1987:87). The SFNF Forest Plan ("Forest Plan") expanded these restrictions to 993,941 acres (USDA/SFNF 1987:133). At that time, the SFNF frankly admitted, "resolution of the conflicts between motorized and nonmotorized users has not been adequately addressed" (USDA/SFNF 1987:88). The Forest Plan provided additional authority to establish closures and restrictions based on the flawed assumption that management flexibility would resolve anticipated future conflicts (USDA/SFNF 1987:134). By 2006 the Jemez Ranger District alone had ordered twenty-five road and off-road closures and restrictions, including six in this Protection Order area.[2]

[2] These Jemez Ranger District closures and restrictions include Los Utes Road #288; Medio Dia Canyon Trail; Peralta Ridge Electronic Site 281; Obsidian Ridge Road 287; and Forest Roads 144, 376, 10, 268, 289, 378 and 269.

The problem has never been lack of adequate planning or willingness to issue orders. The problem is, and continues to be, a lack of institutional will to enforce needed restrictions and closures to protect ecological values. The reasons for the Forest Service's flaccid response is that agency policy and funding priorities have long been unduly swayed by a small but politically powerful cartel of manufacturers, dealers, trade associations, extractive industries and lobby groups (Viles 2000) despite the fact that according to the Forest Service, less than 5 percent of visitors to national forests and grasslands use off-road vehicles.[3]

In 1988 the Forest Service substantially altered its regulations and policies governing the management of motorized recreation by repealing the rule banning vehicles wider than 40 inches thereby allowing individual forest supervisors to determine whether motorized recreational vehicles wider than 40 inches would be permitted in their forests. Not only was this repeal made with no environmental effect analysis, despite the significance of the issue, the Forest Service did not provide a sufficient opportunity for the public to participate in this decision. The practical implications of this change have been substantial: with many national forests, including the SFNF, have constructed and reconstructed trails to accommodate the larger vehicles, thereby placating the motorized recreation industry to the detriment of our forest heritage.

Today, as motorized recreation technologies have advanced, off-road vehicles are able to travel greater distances and reach areas that were previously inaccessible, thereby exacerbating their effects on the environment. The consequence is an increasing number of motorized vehicles fanning out throughout our forests, on and off roads and trails, leaving a wide swath of destruction in their paths. Unauthorized routes created and repeatedly used by motorized users have produced a network of routes that are not part of the Forest Service roads or trails system. The upshot of these trends is a sevenfold increase in motorized use of public lands in the past thirty years. (USDA/Forest Service 2004a).

Former Forest Service chief Dale Bosworth belatedly recognized that "unmanaged recreation" is one of the four major threats to national forests. In response, the agency published a Travel Management Rule in November 2005 that establishes yet another planning process that will at some future date designate a system of motorized and nonmotorized routes. 36 C.F.R. 212. Like past efforts, this too will most likely fail because of institutional bias in favor of motorized interests and neglect of ecological concerns.

Accordingly, pursuant to the Right to Petition Government clause contained in the First Amendment of the United States Constitution[4] and the Administrative Procedure Act,[5]

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[3] *See* http://www.fs.fed.us/publications/policy-analysis/unmanaged-recreation-position-paper.pdf. [viewed February 5, 2009].

[4] U.S. Constitution, amendment I ("Congress shall make no law ... abridging ... the right of the people ... to petition Government for a redress of grievances."). The right to petition for redress of grievances is among the most precious of the liberties safeguarded by the Bill of Rights. United Mine Workers of Am., Dist. 12

the undersigned Petitioners submit this Jemez Emergency Protection Order ("Protection Order") a Citizen Petition for Nondiscretionary Closure of Selected Routes in the Jemez Ranger District, Santa Fe National Forest, to Motorized Vehicles Due to the Presence of Considerable Adverse Effects. *See* 36 C.F.R. §§ 261.50, 261.50(b) and 212.52(b) Executive Orders 11644 and 11989.

PROTECTION ORDERS: SPECIFIC ROUTES AND ROADS

This Protection Order seeks closure of the following motorized routes:

Forest Trail 113 is part of the pioneer-era Bland/Frijoles trail that connects Frijoles and Bland Canyons. FT 113 runs adjacent to Forest Road 289 (St. Peter's Dome road) then drops into Cochiti Canyon joining FR 89. As the photo shows, soil erosion on the steep portions of FT 113 is severe with gullies deeper than 2 feet or more in several places. The cover page of this petition contrasting motorized and nonmotorized portions of FT 113, testifies to the erosive force of motorized vehicles in this area. According to the SFNF Terrestrial Ecosystem Survey (TES), FT 113 is located on unstable soils where wheeled off-road vehicles cause severe erosion and significant loss of site productivity. FT 113 is a key connector in the frequently used loop route between FR 89 and FR 289. The New Mexico Game and Fish Department (NMGFD) has repeatedly warned that it is nearly impossible to catch game poachers and other lawbreakers on loop roads (NMGFD 2007:3; 2008:3). In addition, according to the NMGFD FT 113 creates a 512-acre wildlife effect zone resulting in a high degree of fragmentation that reduces habitat effectiveness for elk, deer, black bear and turkey. FT 113 allows motorized access into important wildlife habitat in Cochiti Canyon, fragments an owl Protected Activity Center (PAC), and is within owl Critical

Severe soil erosion on FT 113 from motorized use.

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v. Illinois State Bar Ass'n, 389 U.S. 217, 222 (1967). It shares the "preferred place" accorded in our system of government to the First Amendment freedoms, and has a sanctity and a sanction not permitting dubious intrusions. Thomas v. Collins, 323 U.S. 516, 530 (1945) ("Any attempt to restrict those First Amendment liberties must be justified by clear public interest, threatened not doubtful or remotely, but by clear and present danger."). *Id*. The Supreme Court has recognized that the right to petition is logically implicit in, and fundamental to, the very idea of a republican form of government. United States v. Cruikshank, 92 U.S. 542, 552 (1875).

[5] 5 U.S.C. § 553(e) (2005) ("Each agency shall give an interested person the right to petition for the issuance, amendment, or repeal of a rule.")

Habitat. To protect these important wildlife values the NMGFD recommends that FT 113 become nonmotorized (NMGFD 2008:8). Although the New Mexico Environment Department has not assessed the Rio Chiquito's water quality, sediment is clearly being transported directly into the stream channel from the adjacent deeply rutted motorized trail as well as from a stream crossing, impairing water quality and degrading aquatic habitat. FT 113 is designated open for motorized travel in the SFNF Travel Management Plan Proposed Action, but is not included in the SFNF minimum road system. Total length: 2.8 miles.

Forest Road 89 runs through Cochiti Canyon along the Rio Chiquito from FR 268 to Tent Rock Ranch. In 1988 the SFNF seasonally closed FR 89 from the junction of FT 424 at Medio Dia Canyon to its end at Tent Rock Ranch pursuant to 36 C.F.R. 261.50 and 261.54(a) (USDA/SFNF 1990). This Protection Order extends to yearlong the current seasonal closure of this section of FR 89 and stipulates that it be closed to all motorized vehicles until adverse effects have been identified and eliminated and effective measures implemented to prevent recurrence of resource damage. According to data provided by the SFNF, this section of FR 89 crosses the Rio Chiquito 35 times (18 percent of the SFNF's 198 total perennial stream crossings), significantly impairing water quality and degrading aquatic habitat. Motor vehicles have caused severe soil erosion in the riparian areas along the stream. According to the SFNF Terrestrial Ecosystem Survey, FR 89 lies on unstable soils, where wheeled off-road vehicles cause severe erosion and significant loss of site productivity. FR 89 is also a major leg of the frequently used motorized loop described under FT 113. In addition to threats from poachers and lawbreakers, FR 89 creates a 2029-acre wildlife effect zone producing significant fragmentation and reduced habitat effectiveness for elk, deer, black bear and turkey. Cochiti Canyon provides some of the most important Mexican spotted owl habitat in the Jemez. FR 89 runs through the middle of three Mexican spotted owl Protected Activity Centers within owl Critical Habitat. Despite these considerable adverse effects, this portion of FR 89 is designated seasonally open to all motorized vehicles in the SFNF's Travel Management Plan Proposed Action. Total length: 5.9 miles.

One of 35 stream crossings of Rio Chiquito by FR 89.

The Forest Road 188 complex is an interconnected system of unauthorized user-created motorized routes and old logging roads in upper Medio Dia Canyon. The complex includes **Forest Roads 188**, **188B**, **188BB**, **188D**, **188E**, **188F**, **188FA**, **188FB**, **188JA** and four unauthorized user-created motorcycle routes totaling 3.8 miles (all currently unnamed but included in the SFNF Travel Management Plan Proposed Action). The FR 188 complex is within an area marked on the SFNF recreation map as prohibiting all motorized use off forest development roads ("Circle A")[6]. The FR 188 complex is also in Management Area "N", which bans motorized cross-country travel. Despite this designation and Circle A restrictions, off-road motorized use is common in this area. According to data provided by the SFNF, the FR 188 complex of routes crosses streams and their tributaries in Bland and Medio Dia Canyons 40 times (20 percent of the SFNF's 198 total perennial stream crossings), significantly impairing water quality and degrading aquatic habitat, including habitat for a small population of Rio Grande cutthroat trout in Medio Dia Canyon. The FR 188 complex also occurs in Essential and Occupied Jemez Mountain salamander habitat that is crucial for the long-term persistence (i.e. survival) of viable salamander populations. According to the New Mexico Endemic Salamander Team, the FR 188 complex fragments terrestrial salamander habitat and contributes to degradation of habitat from erosion and soil compaction (NMEST 2008:2). The team's opinion is based on photographic evidence and the likely increased use of designated routes in salamander habitat (all FR 188 complex routes cited here are designated seasonally open to motorized use in the SFNF Proposed Action). The FR 188 complex creates a 2879-acre wildlife effect zone, resulting in significant fragmentation and reduced habitat effectiveness for elk, deer, black bear and turkey (624 acres of this total are created by the 3.8-mile unauthorized route). Motorized vehicles in the FR 188 complex are causing severe erosion. According to the SFNF Terrestrial Ecosystem Survey, the routes cited here occur primarily on unstable soils, with attendant severe erosion and significant loss of site productivity. In addition, several loop routes in the FR

Severe downcutting on FR 188.

[6] The SFNF defines Circle A as an area where "use of motorized vehicles on Forest Development Roads and Trails is permitted. Off-road use is prohibited . . ." (emphasis added). Despite the banning of cross-country travel, decades of lax enforcement has resulted in construction of dozens of unplanned and unauthorized routes that are not Forest Development Roads or Trails, especially in the FR 188 complex.

188 complex were included in the SFNF Travel Management Plan Proposed Action despite repeated warnings by the N.M. Game and Fish Department about the great difficulty of policing such areas (NMGFD 2007:3, 2008:3). Many of the FR 188 complex routes cited here were built as temporary logging roads more than ten years ago. The National Forest Management Act requires that temporary roads be closed within ten years of project completion unless it is determined that they are necessary for a minimum road system. 16 U.S.C. 1608(a). These temporary logging roads are not included in the SFNF minimum road system. Total length: 18.4 miles.

Cross-town Trail complex is bordered by FR 289 on the east, FR 268 on the west, Valles Caldera National Preserve on the north and Tent Rock Ranch on the south. It includes **Forest Roads 289D**, **500**, **36A** and a 6.7-mile unauthorized user-created motorcycle route (currently unnamed but included in the SFNF Travel Management Plan Proposed Action). The Cross-town trail complex is in Essential and Occupied Jemez Mountain salamander habitat that is crucial for long-term persistence of viable salamander populations. According to the New Mexico Endemic Salamander Team, this trail complex fragments terrestrial salamander habitat and contributes to degradation of habitat through erosion and soil compaction (NMEST 2008:2). The team's opinion is based on photographic evidence and the likely increased use of designated routes (the Cross-town trail complex is designated seasonally open to motorized use in the SFNF Travel Management Plan Proposed Action). The 6.7-mile unauthorized user-created motorcycle route is a loop on both sides of FR 36. Again, it is very difficult to police this area (NMGFD 2007:3; 2008:3). The Cross-town complex creates a 2029-acre wildlife effect zone. The result is significant fragmentation that reduces habitat effectiveness for elk, deer, black bear and turkey (1145 acres of this total are created by the 6.7-mile unauthorized route). In addition, FR 500 enters a Mexican Spotted Owl Protected Activity Center and is within

Severe erosion and downcutting on Cross-town trail caused by motorized use.

owl Critical Habitat. The soil erosion caused by motorized vehicles in portions of the Cross-town complex is severe. According to the SFNF Terrestrial Ecosystem Survey, much of the complex is located on unstable soils. Thus wheeled off-road vehicles cause severe erosion and a significant loss of site productivity. FR 289D crosses the stream in Silva Canyon, in degrading water quality and aquatic habitat. In addition, Forest Road 289D is a temporary logging road more than ten years old. The National Forest Management Act requires that temporary roads be closed within ten years of project completion unless they are necessary for a minimum road system. 16 U.S.C. 1608(a). Forest Road 289D is not included in the Santa Fe National Forest's minimum road system. Total length: 11.9 miles.

The Cochiti Mesa complex is bordered on the west by FR 286, on the east by Cochiti Canyon, on the north by Tent Rock Ranch and on the south by the southern end of Cochiti Mesa. It includes **Forest Roads 286F**, **286FA**, **286FAC**, **286FAD** and a 1.2-mile unauthorized user-created motorcycle route (currently unnamed but included in the SFNF Travel Management Plan Proposed Action). Soil erosion caused by motorized vehicles is severe. According to the SFNF Terrestrial Ecosystem Survey, these routes occur on unstable soils where wheeled off-road vehicles cause severe erosion and significant loss of site productivity. According to the NMGFD, the Cochiti Mesa complex collectively creates a 1685-acre wildlife effect zone in which habitat effectiveness is reduced for elk, deer, black bear and turkey. FR 286 crosses a tributary of the stream in Medio Dia Canyon 6 times, resulting in significant degradation of water quality and aquatic habitat. FR 286FAD also enters and provides access to a Mexican spotted owl Protected Activity Center. In addition, the 1.2 miles of unauthorized user-created motorcycle routes form a loop. According to the N.M. Game and Fish Department, loop routes make it nearly impossible to catch game poachers and other lawbreakers (NMGFD 2007:3; NMGFD 2008:3). FR 286FAD is a temporary logging road that is more than ten

Severe soil downcutting on trail to Cochiti Mesa trail caused by motorized use.

years old. The National Forest Management Act requires that such temporary roads be closed within ten years of project completion unless it is determined that they are necessary for a minimum road system. 16 U.S.C. 1608(a). None of the Cochiti Mesa complex of routes, including 286 FAD, is in the SFNF's minimum road system. Total length: 12.1 miles.

Forest Roads 268D and 268DD are accessed from the northern end of Forest Road 268 (Paseo del Norte Road). Both routes enter and provide motorized access to the Bearhead Peak Inventoried Roadless Area (IRA). FR 268DD also connects to FT 424, which runs through sensitive riparian habitat in Medio Dia Canyon. FT 424 was closed to motorized use by the SFNF in 1990 pursuant to 36 C.F.R. 261.50(b) and 261.55(b) and is marked "closed" on the SFNF recreation map. However, there are no signs indicating that FT 424 is closed and the gate is unlocked.[7] Therefore, unauthorized use of FT 424 via FR 268D is common. In 2006, the SFNF stipulated that FR 268D would be gated and closed to all but administrative use (USDA/SFNF 2006:35). However, the SFNF Travel Management Plan Proposed Action designates FR 268D as seasonally open to vehicles that are legal on paved highways. This Protection Order stipulates that FR 268D and 268DD be closed to all motorized vehicles until adverse effects have been identified and eliminated and effective measures implemented to prevent recurrence of resource damage. FR 268D is within an area marked on the SFNF recreation map as prohibiting all motorized use off forest development roads ("Circle A"). FT 424 is not a forest development road and is not included in the SFNF minimum road system. FR 268D and 268DD are also motorized entryways to valuable wildlife habitat on Oaks Mesa, West Mesa and Horn Mesa, where there are numerous unauthorized user-created routes.[8] According to data provided by the SFNF, FR 268D crosses the perennial stream in Colle Canyon 12 times and FR 268DD crosses a major tributary of the Colle Canyon stream 9 times (together amounting to 11 percent of the SFNF's 198 total perennial stream crossings), significantly impairing water

Motorized use on FT 424 through the stream channel in Medio Dia Canyon accessed by FR 268

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[7] Personal communication, Mark Watson, NMGFD.

[8] See A.J. Kron. 1993. *Hiking trails and jeep roads of Los Alamos County, Bandelier National Monument and vicinity*. Otowi Station Science Museum Shop and Book Store, Los Alamos, NM.

quality and degrading aquatic habitat. Motorized vehicles on both routes are causing severe erosion. According to the SFNF Terrestrial Ecosystem Survey, FR 268D and FR 268DD traverse unstable soils. Thus wheeled off-road vehicles cause severe erosion and significant loss of site productivity. FR 268D and FR 268DD create a 767-acre wildlife avoidance zone, resulting in a high degree of fragmentation and reduced habitat effectiveness for elk, deer, black bear and turkey. These routes also fragment two Mexican spotted owl Protected Activity Centers within owl Critical Habitat. Total length: 5.3 miles.

Forest Roads 268A and 268AB run from the head of Canon del Norte to private land and from 188B to private land. Motorized recreationists regularly use FR 268A and 268AB to trespass on private land. Soil erosion caused by motorized vehicles on both routes is severe. According to the SFNF Terrestrial Ecosystem Survey, both roads are on unstable soils, making them vulnerable to wheeled off-road vehicles and the attendant severe erosion and significant loss of site productivity. FR 268A crosses the stream in Canon del Norte 11 times significantly degrading water quality and aquatic habitat. Both routes are also in Essential and Occupied Jemez Mountain salamander habitat that is crucial for the long-term persistence of viable salamander populations. According to the New Mexico Endemic Salamander Team, FR 268A and 268AB (routes in the “Ridge Trail” complex) fragment terrestrial salamander habitat and contribute to degradation from soil erosion and compaction (NMEST 2008:2). In addition, according to NMGFD, a 443-acre wildlife effect zone is created by both routes producing a high degree of habitat fragmentation and reduced habitat effectiveness for elk, deer, black bear and turkey. Both are also within an area marked on the SFNF recreation map as prohibiting all motorized use off forest development roads (“Circle A”). An unauthorized user-created motorcycle route (currently unnamed) connects FR 268AB to FR 268. This unauthorized route is not a forest development road and is not included in the minimum road system. Total length: 3.7 miles.

Off-roader trespass into private property from 268 AB

Forest Road 282 from Forest Road 188D to end. FR 282 enters and provides motorized access to the Bearhead Peak IRA from the north. Motorized vehicles on FR 282 are causing severe soil erosion. According to the SFNF Terrestrial Ecosystem Survey, FR 282 is located on unstable soils and wheeled off-road vehicles are causing severe erosion and significant loss of site productivity. FR 282 is also in Essential and Occupied Jemez Mountain salamander habitat that is crucial for the long-term persistence of viable salamander populations. According to the New Mexico Endemic Salamander Team, FR 282 (routes in the "Ridge Trail" complex) fragments terrestrial salamander habitat, contributing to degradation from soil erosion and compaction (NMEST 2008:2). In addition, FR 282 creates a 579-acre wildlife avoidance zone and a high degree of fragmentation, reducing habitat effectiveness for elk, deer, black bear and turkey. FR 282 is within an area marked on the SFNF recreation map as prohibiting all motorized use off forest development roads ("Circle A"). FR 282 provides access to several unauthorized user-created motorized routes that are not forest development roads and are not included in the minimum road system. These include FT 290 into Bland Canyon and FT 132 ("Bearhead Peak Trail"), which provide access into the heart of the Bearhead Peak IRA.[9] Total length: 3.6 miles.

Severe Erosion on FR 282.

Forest Road 288 begins at FR 289 (St. Peter's Dome Road) and ends at Los Utes Springs in upper Capulin Canyon. In 1992 FR 288 was closed to motor vehicles less than 40 inches in width from the gate in section 16 to Los Utes Springs pursuant to 36 C.F.R. 261.50, 261.54(a) and 261.55(b) (USDA/SFNF 1992). As the photos clearly show, this closure has not been enforced and significant damage is occurring as a result. This Protection Order stipulates that FR 288 be closed to all motorized vehicles until adverse effects have been identified and eliminated and effective measures implemented to prevent the recurrence of resource damage. FR 288 is within the Dome Inventoried Roadless Area and provides access to sensitive heritage sites and to a population of Rio Grande cutthroat trout in Capulin Canyon. Soil erosion caused by motorized vehicles in this area is severe. According to the SFNF Terrestrial Ecosystem Survey, FR 288 is based on unstable soils, resulting in severe erosion and significant loss of site productivity caused by wheeled off-road vehicles. FR 288 crosses the stream in Capulin Canyon 4 times, with significant degradation of water quality and aquatic habitat. FR 288 is also

Ineffective closure of FR 288 to motorized use resulting in considerable resource damage.

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[9] See A.J. Kron. 1993. *Hiking* *and vicinity*. Otowi Station S

in Essential and Occupied Jemez Mountain salamander habitat crucial for the long-term persistence of viable salamander populations. According to the New Mexico Endemic Salamander Team, based on photographic evidence and increased use of designated routes (NMEST 2008:2), FR 288 is causing habitat fragmentation, loss and degradation. The upper portion of FR 288 is designated seasonally open to all vehicles in the SFNF Travel Management Plan Proposed Action. In addition, according to the NMGFD, FR 282 creates a 604-acre wildlife effect zone and a high degree of fragmentation that reduces habitat effectiveness for elk, deer, black bear and turkey. Total length: 3.4 miles.

AFFECTED AREAS AND THEIR VALUE

The SFNF nominally restricts motorized use on the 77,976 acres at the heart of this Protection Order, designated "Circle A" on the SFNF recreation map (*see* maps attached on streams and soils and wildlife values). The Circle A area is intended to protect imperiled species, key big-game habitat, fragile soils, roadless areas, aquatic ecosystems and riparian habitat and the quiet beauty of this rugged landscape. In reality, unauthorized motorized use is as prevalent in the restricted Circle A area as it is in unrestricted sections of the Protection Order.[10]

However, the intent of SFNF actions is clear – to protect outstanding natural resource values. These outstanding values include Jemez Mountain salamander (JMS) Essential and Occupied habitat, Mexican spotted owl Protected Activity Centers (PACs) and Critical spotted owl habitat, inventoried roadless areas (IRAs), riparian areas and aquatic habitats, key big-game habitat and the Jemez National Recreation Area. These important values are documented in the following paragraphs.

The **Jemez Mountain Salamander** (*Plethodon neomexicanus*) is a narrowly endemic, state-endangered lungless salamander that occurs only in the Jemez Mountains of New Mexico. More than 90 percent of the salamander population is found on the SFNF. In 1991, interagency conservation actions were taken to preclude the need for federal listing of JMS under the Endangered Species Act. This resulted in the *Memorandum of Agreement for the Conservation of the Jemez Mountain Salamander* (MOA). In 2000, the MOA signatory agencies agreed to a cooperative management plan with the mutual goal of ensuring the long-term persistence of all JMS populations through the maintenance of its habitat and the creation of an interagency management team.

In 2004, the JMS management plan was incorporated into the SFNF Forest Plan, identifying the Essential Zones most crucial for long-term persistence of viable populations. JMS Essential Zones are marked in yellow on the Wildlife Values map attached to this petition. All actions affecting JMS habitat, including the effects of motorized recreation in JMS Essential Zones, must be consistent with the management plan. 16 U.S.C. § 1604(i).

The JMS management plan generally does not allow motorized recreation and other actions adversely affecting the JMS in Essential JMS habitat. If motorized recreation is proposed in such habitat, the interagency management team that implements the JMS plan must provide a written evaluation of its effects.

The JMS management team wrote to the SFNF on February 6, 2008 opposing single-track motorcycle trails through Essential JMS habitat (NMEST 2008:3). The team's reasons were: (1) Increased erosion, soil compaction and habitat fragmentation in Essential JMS habitat is contrary to the plan's goal of ensuring the long-term persistence of viable JMS populations. (2) Travel management planning will greatly increase the ecological effects of motorized recreation by authorizing 57.3 miles of motorized routes in Essential JMS habitat while closing other routes – in effect funneling motorized recreation into sensitive habitat. (3) Effects within Essential JMS habitat will be magnified, owing to the cumulative effects of increased wildfire frequency and intensity, climate change, highway development and other human development (NMEST 2008:3).

The JMS management plan also requires surveys in six priority survey zones when motorized recreation and other habitat altering actions are proposed. The Cross-town complex (Forest Roads 289D, 500, 36A and a 6.7 mile unauthorized user created motorcycle route) is located between two JMS Essential habitat polygons in Priority Survey Area Number 3 (NMGFD 2008:7). JMS surveys have not been conducted despite on-going adverse effects documented here in photos. The management plan requires closing the Cross-town complex and other priority survey areas if JMS are found adjacent to trails (NMEST 2008:3).

A N.M. Game and Fish Department analysis found 124.5 miles of motorized routes within Essential JMS habitat in the SFNF (NMGFD 2008b:6), including five routes (FR 188, FR 188B, FR 268A, FR 268AB and FR 288) totaling 3.53 miles in this Protection Order area (WildEarth Guardians 2008:Appendix P). The SFNF has a nondiscretionary duty to immediately close these 3.53 miles of motorized routes until adequate surveys can be conducted and any adverse effects to the JMS and/or its habitat are eliminated.

The **Mexican spotted owl** (MSO) (*Strix occidentalis lucida*) was listed as a threatened species in 1993 (USDI/FWS 1993). The primary reasons for listing were the threat of even-aged timber harvesting, wildfire, grazing and recreation. On August 31, 2004, critical habitat for the Mexican spotted owl was designated. The U.S. Fish and Wildlife Service appointed a panel of experts in 1993 that produced a recovery plan for the Mexican spotted owl ("Recovery Plan") in 1995 (USDI/FWS 1995). The plan divided the U.S. range of the Mexican Spotted Owl into six recovery units, including the Southern Rocky Mountains – New Mexico Recovery Unit that encompasses the SFNF and surrounding suitable MSO habitat (USDI/FWS 1995).

The three MSO Protected Activity Centers in this Protection Order are adversely affected by routes 268 and 286. MSO Critical Habitat is adversely affected by routes 268A, 268AB, 268D, 268DD, 286F, 286FA, 286FAC, 286FAD, 288 and 289D.

Motorized recreation reduces the quality of MSO nesting, roosting, and foraging habitat and causes disturbance during the breeding season. The effects of motorized recreation are increasing on all forests, especially in meadow and riparian areas (USDI/FWS 2008:4). Research suggests that owls in heavily used recreation areas are much more erratic in their movement patterns and behavior (USDI/FWS 2008:4). In addition to direct disturbance by motorized recreation, MSO habitat is indirectly affected by damage to vegetation, soil compaction and disturbance (USDI/FWS 2005:138).

Population studies suggest that the MSO population is declining. Seamans et al. (1999) reported declining populations for two study areas in Arizona and New Mexico. Gutiérrez et al. (2004) updated information on estimated trends in owl numbers for these study areas from 1993 to 2000. In Arizona, this information indicated a stable population over this period. In contrast, the New Mexico population appeared to be declining by approximately 6 percent per year.

Despite these alarming trends, the SFNF is monitoring only seven MSO PACs (FOIA response, 12/22/06: SFE-2007-01) of its 48 MSO Protected Activity Centers (USDI/FWS 2005:140). None of the six PACs within the Protection Order area is being monitored (*see* attached Wildlife Values map). In addition, none of the required information on PAC occupancy has been conveyed to the Fish and Wildlife Service (FOIA response, 12/22/06: SFE-2007-01). Failure to monitor owl populations is contrary to the nondiscretionary terms and conditions of the Fish and Wildlife Service's June 10, 2005 Biological Opinion to monitor, track and report PAC occupancy (USDI/FWS 2005).

The Endangered Species Act prohibits the take of plant and animal species that are listed as endangered or threatened. *Id.* at Sec.1538(a)(1); 50 C.F.R. Sec. 17.21, 17.31. The term "take" is broadly defined to include "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct." 16 U.S.C. Sec.1532(19). Failure to monitor PAC occupancy makes it impossible to determine whether the SFNF has exceeded the limit of "incidental take" established by the Fish and Wildlife Service for the Southern Rocky Mountains – New Mexico Recovery Unit. The take limit for this Recovery Unit is four MSO over a ten-year period ending in 2015 (USDI/FWS 2005:176). The SFNF "take" cannot exceed 3 (75 percent of the ten-year total) in any one year, which is the maximum allowed for the entire Recovery Unit (USDI/FWS 2005:176). If, as appears likely, the Recovery Unit maximum of yearly incidental take is being exceeded, then the SFNF is required to immediately reinitiate consultation the Fish and Wildlife Service (USDI/FWS 2005:178).

Unregulated motorized recreation is currently degrading the six PACs in the Protection Order area either through direct harm to habitat and/or harassment of roosting and nesting sites (USDI/FWS 2005:138). The SFNF has proposed to mitigate these direct effects largely through seasonal closures at some future date.[11] Until these mitigation measures are in effect and adequately enforced, the SFNF has a nondiscretionary duty to

[11] Seasonal closure does not address the indirect and cumulative effects on MSO habitat, including soil compaction, accelerated soil erosion, denudation and loss of plant diversity, reductions in prey populations, and spread of invasive plants, resulting in diminished site productivity.

immediately close motorized routes in MSO PACs. To comply with the Endangered Species Act, the SFNF must also track and report the effects of motorized recreation (50 C.F.R. 402.14(i)(3)) and reinitiate consultation with the USFWS if excessive levels of "take" are occurring beyond the limit of the incident take permit (USDI/FWS 2005:178).

Inventoried Roadless Areas provide multiple ecosystem services, such as clean water and air, healthy soils, multiple recreational opportunities and core habitat for native fish and wildlife populations (NMGFD 2006:1). Recent ecological evidence suggests that motorized routes in unroaded areas cause substantial ecological effects, including stream sedimentation, introduction of non-native invasive plants, landslides, degraded water quality, increased human-caused wildfires and habitat fragmentation that adversely affects fish and wildlife populations (USDA/Forest Service 2001). The five IRA motorized routes in the Protection Order are 286F, 286FA, 286FAC, 286 FAD and 289D.

New Mexico has about 1.6 million acres of inventoried roadless areas, which represent 17 percent of the total acres in the state's six national forests. Forest plans allocate 1,101,000 acres to a prescription that does not allow road construction and reconstruction, and 430,000 acres to a prescription that allows road construction and reconstruction. In addition, 66,000 acres of inventoried roadless areas in the state are recommended for wilderness designation (New Mexico 2006:10). Thus there are 351,000 unprotected roadless acres in New Mexico's six national forests, including 54,000 unprotected roadless acres in the SFNF (NMGFD 2006:5).

In May 2006, the state petitioned the Forest Service to protect all of New Mexico's 1.6 million acres of inventoried roadless areas (New Mexico 2006). New Mexico also joined California, Oregon and Washington in litigation seeking to enjoin the repeal of the Clinton administration's 2001 roadless rule and its replacement with the state petition process. In September 2008, the N.M. Game and Fish Department wrote the SFNF requesting that isolated, high quality habitats be protected from motorized travel and broadening the state's opposition to road building to include opposition to all motorized access in the state's IRAs, stating:

> It is the Department's position that authorizing motorized trails within IRAs undermines the spirit and intent of the initial U.S. Forest Service Roadless Area Conservation Rule of 2000, and the desires of Governor Richardson and the State of New Mexico to protect these areas as identified in the Petition (NMGFD 2008:4).

Consistent with these efforts by the state, this Protection Order mandates that the SFNF immediately exercise its nondiscretionary authority to effectively close all motorized routes into and near the Bearhead Peak, Cochiti Mesa and Dome IRAs (see Wildlife Values map).

Riparian areas and aquatic habitats (wetlands, wet meadows, ephemeral ponds and shorelines) serve important functions that include water purification and storage and erosion reduction. Riparian vegetation removes toxins from streams, lowers water temperature, and improves water quality; it stores water in stream banks, increasing available water and duration of stream flow; and it improves stream bank stability, reducing erosion and its associated inputs of fine sediment (Brodie 1996). The fifteen riparian motorized routes in this Protection Order are 188, 188B, 188BB, 188D, 188E, 188F, 188FA, 188FB, 188JA, 268A, 268AB, 268D, 268DD, 282 and 286F.

Riparian areas and aquatic habitats are also essential for the survival of a majority of the wildlife species of New Mexico. Of the 867 species of vertebrates known to occur in the state, approximately 479 (55 percent) rely wholly or in part on aquatic, wetland or riparian habitat for their survival [Biota Information System of New Mexico (BISON-M) database Version 2.5, 1994]. A majority of the 96 species that are listed by the state as endangered or threatened are associated with these habitats (51 species, or 53 percent of the total). Almost half of the native fishes of New Mexico are either extinct or endangered.

The quantity and quality of aquatic habitats in New Mexico has significantly diminished (NMGFD 2008:2) owing in part to unacceptably high riparian road densities and numerous stream crossings. Riparian forests have the highest road densities (2.38 miles per square mile) of any vegetation community in the San Juan/Sangre de Cristo Bioregion (Talberth and Bird 1998:69). There are 76 miles of roads that are damaging riparian areas in the SFNF (USDA/SFNF 2008a:11), including at least 4.36 miles in this Protection Order (WildEarth Guardians 2008:54). As noted later, the failure to "protect the productivity and diversity of riparian resources" is inconsistent with the SFNF Forest Plan (USDA/SFNF 1987:79).

Roads and trails along rivers and streams destroy riparian vegetation, erode terraces, destabilize stream banks, create new channels, widen existing channels and function as conduits for sediment runoff into streams (USDI/FWS 2003:61). A good example is Peralta Canyon in the SFNF where, according to the Forest Service, "inappropriate vehicular use" on Forest Trail 140 has turned it into "a channel (that) is acting to deliver sediment directly to the adjacent stream with each precipitation event" (USDA/SFNF 2008:2). Native trout cannot persist in streams where widened channels and loss of riparian vegetation allow maximum temperatures to consistently exceed 21-22 degrees centigrade (Beknke and Zarn 1976).

The N.M. Game and Fish Department (NMGFD 2008:2) is concerned about the high number of stream crossings in the SFNF, including an estimated 198 perennial and 1726 intermittent or ephemeral stream crossings and 16 areas where roads intersect floodplains along streams (USDA/SFNF 2008b:30). There are at least 118 stream crossings, affecting 12 streams and tributaries in the Protection Order area (*see* Streams and Soils map). As noted earlier, FR 89 in Cochiti Canyon alone crosses the Rio Chiquito 35 times, and the FR 188 complex crosses numerous streams in Medio Dia Canyon and Bland Canyon 34 times.

The SFNF also has the highest road density of any national Forest in the Southwestern Region, exceeding the 2.5 miles/square mile density level that characterizes watersheds that are “not properly functioning” (USDA/Forest Service, 2004a:21).[12] The road density in this Protection Order area is twice this threshold (5.0 miles per square mile) according to a recent assessment of range allotments in the area (USDA/SFNF 2006:35). This estimate should be considered “the minimum known road density” because it does not include an estimated 1500 miles of maintenance level 1 and 2 roads, user-created routes or even known motorized trails[13] (USDA/Forest Service 2004:21).

The area of this Protection Order includes two management areas where road density exceeds the upper limits specified in the Forest Plan. Management Area “R” currently has 1.9 miles per square mile versus the 1.5 miles maximum allowed in the plan. In Management Area “N”, the Forest Plan prohibits all cross-county motorized travel and calls for “closing all unnecessary roads where they currently exist” (USDA/SFNF 1987:154). As documented here, cross-country motorized travel is frequent and well established in Management Area “N” and no unnecessary roads in Management Area “N” have been closed since the Forest Plan went into effect in 1988. As noted later, the failure to implement nondiscretionary protection standards is inconsistent with the SFNF Forest Plan.

The N.M. Environment Department is particularly concerned about water quality effects from user-created routes that were not formed according to best management principles, as well as and unmaintained high-clearance routes on steep slopes favored by motorized users. Both drain the watershed, increase erosion, and lead to increased sediment delivery and turbidity (NMED/SWQB 2008:2). In addition the Environment Department notes that closed substandard routes that are not successfully decommissioned will continue to affect water quality because of the long time it takes to revegetate disturbed sites in the arid Southwest (NMED/SWQB 2008:2).

The 66.9 miles of routes in this Protection Order were not designed for motorized recreation. They began haphazardly as (1) poorly maintained logging roads (2) temporary roads that were never closed, or (3) routes that evolved from tracks made by off-road vehicles (at least 11.7 miles). To meet water quality standards, the Environment Department proposes that such unplanned motorized routes be upgraded with surface drainage structures and road surfaces to ensure proper drainage (NMED/SWQB 2008:3). Fiscal constraints make it unlikely such measures will ever be funded, and inadequate funding will most likely continue in the foreseeable future (USDA/SFNF 2004:12). For these reasons, the Environment Department opposes the SFNF’s attempt to <u>increase</u> road density standards through the Travel Management Rule by amending the Forest Plan (NMED/SWQB 2008:3).

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[12] The U.S. Fish and Wildlife Service uses this standard to estimate watershed condition. However, many watersheds in the southwest have fewer than 2.5 miles/square mile and are not properly functioning (USDA Forest Service, 2004:21).

[13] The SFNF does not include motorized trails when calculating road density contrary to the New Mexico Environment Department’s recommendation (NMED/SWQB 2008).

Motorized recreation runs counter to the conservation and management of **Key big-game habitat** by causing habitat fragmentation at the landscape-level and resulting in a significant loss of effective habitat for elk, deer, black bear and turkey (NMGFD 2008:5). The N.M. Game and Fish Department recommends that all 708 miles of existing roads the SFNF identifies as sources of harassment to wildlife and significant disruption of wildlife habitat be immediately closed (NMGFD 2008:2). In addition, the department recommends that motorized routes be "deemphasized" in isolated, high-quality habitats and that motorized use be restricted in meadow habitats, such as the meadow at Evans-Griffin Place, to protect ungulate reproduction (NMGFD 2008:5).

The N.M. Game and Fish Department analyzed the loss of effective habitat for elk and mule deer using a 200-meter buffer around roads the SFNF proposes to keep open through its Travel Management Rule (NMGFD 2008:6). According to the department, motorized recreation "creates small island patches of habitat between motorized routes that are likely not suitable for maintaining resident large game animals such as elk, mule deer and black bears" (NMGFD 2008:6). The department estimates a loss of 264,317 acres of effective habitat on the west side of the SFNF alone (NMGFD 2008:6). The same buffer applied to general the Protection Order area results in 24,395 acres of lost effective habitat or 31 percent of the affected area. In the wildlife-rich Circle A area alone, 3445 acres of effective habitat are lost, a staggering 56 percent (*see* Wildlife Values map).

Another issue concerning the conservation and management of wildlife consists of the adverse effects of loop roads (NMGFD 2007:3; 2008:3). Loop roads are favored by motorized users, and there are several in the Protection Order area, including FT 113, FR 89 and FR 289, which form a continuous loop through Cochiti Canyon, an important area for wildlife diversity (*see* Wildlife Values map). The N.M. Game and Fish Department recommends closing of loop roads because of to the difficulty of apprehending game poachers and other criminals when there are several exits available (NMGFD 2007:3). Routes that form loops should be immediately closed to enable Game and Fish personnel to conduct effective law enforcement activities (NMGFD 2008:3).

Finally, road density in the SFNF is far in excess of the guidance provided in the 2006 Comprehensive Wildlife Conservation Strategy for New Mexico (NMGFD 2008:3). This document recommends a road density of less than 1 mile per square mile in elk calving and mule deer fawning habitat and less than 1.25 miles per square mile for elk and mule deer summer and winter range. When commenting on SFNF timber sales the N.M. Game and Fish Department recommended only 0.5 miles of road per section in big game winter range (NMGFD 2007:3). As noted earlier, road densities are 5 miles per square mile in the Protection Order area according to an SFNF range allotment analysis (USDA/SFNF 2006:35). The SFNF must immediately close motorized routes adversely affecting key big game habitat, such as meadow habitats identified in this Protection Order (*see* the Wildlife Values map).

The **Jemez National Recreation Area** (JNRA) was established in 1993 by Public Law 103-104, 107 Statue 1025 to "conserve, protect, and restore the recreational, ecological, cultural, religious, and wildlife resource values" of the JNRA. An estimated 1.6 million people visit the JNRA each year to enjoy its outstanding scenic features and opportunities for quiet-use recreation (USDA/SFNF 2002a:2). The East Fork Subunit of the JNRA is located in the northern portion of the area covered by the Protection Order.

The sixteen JNRA motorized routes in the Protection Order are 188, 188B, 188BB, 188D, 188E, 188F, 188FA, 188FB, 188JA, 268A, 268AB, 282, 286, 286D, 286F and 36A.

The JNRA is heavily roaded, with an average density of 2.5 miles of road per square mile (USDA/SFNF 2002a:55). As the environmental assessment for the JNRA management plan notes, "Even with high road density, off-road use continues to occur. This results in a network of user-created roads or trails that are not signed, maintained or patrolled" (USDA/SFNF 2002a:55). The JNRA management plan called for decommissioning 84 miles of road within five years (USDA/SFNF 2002b:3). Now, seven years later, this decommissioning goal is far from being achieved and resource damage continues unabated.

Closing the motorized routes specified in this Protection Order is consistent with the purposes for which the JNRA was established and would further the goals of the JNRA management plan to reduce road density and lessen "erosion, rutting, soil and vegetation loss and riparian damage" caused by motorized use (USDA/SFNF 2002a:55).

LEGAL BACKGROUND AND ARGUMENT SUPPORTING NONDISCRETIONARY CLOSURE

In 1972, recognizing the widespread and increasing effects of motorized recreation on federal lands, President Richard Nixon signed Executive Order (EO) 11644 (37 Fed. Reg. 2877) in an attempt to develop a unified federal policy to control motorized recreation on federal lands. This EO was amended in 1977 by President Jimmy Carter to provide federal agencies with greater ability to protect federal lands damaged by motorized recreation (*see* EO 11989, 42 Fed. Reg. 26959).

EO 11644 provided federal land managers with policies and procedures intended to:

> Ensure that the use of off-road vehicles 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. EO at Sec. 1.

To accomplish these objectives, the EO required federal agencies to develop regulations to designate areas and trails where motorized recreation would and would not be permitted. In rendering such designations, the agencies not only had to comply with the objectives specified in the E.O., but they also were required to ensure that (1) areas and trails were located to minimize damage to soil, watershed, vegetation, and other public land resources; (2) areas and trails were located to minimize harassment of wildlife and avoid significant disruption of wildlife habitats; (3) areas and trails were located to minimize conflicts between motorized recreation use and other uses of the same or neighboring land and to ensure the compatibility of such uses, taking into account noise and other factors; and (4) areas and trails were not located in Wilderness Areas or Primitive Areas. EO at Sec. 3(a)(1-4).

The EO also required the agency to involve the public in the promulgation of such regulations and the designation of areas and trails, to prescribe appropriate penalties for violations of regulations adopted pursuant to the EO and to monitor the effects of motorized recreation on federal lands.

While these policies and procedures were a substantial improvement from the complete lack of such guidelines previously, EO 11644 failed to provide federal agencies with the authority to protect lands damaged by motorized recreation activities. The 1977 amendment, EO 11989, authorized federal agencies to adopt a policy closing all areas to motorized recreation unless they were specifically designated as open. EO at Sec. 9(b).

Most important, the EO also requires the responsible official to exercise nondiscretionary authority to immediately close routes to any or all motorized recreation if it is determined that the use of motorized vehicles:

> [w]ill 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, <u>immediately close such areas or trails to the type of off-road vehicle causing such effects</u>, until such time as he determines that such adverse effects have been eliminated and that measures have been implemented to prevent future recurrence.
> EO at Sec. 9(a) (emphasis added).

The Forest Service promulgated revised travel management regulations on November 5, 2005 that closely follow the guidelines established in the executive orders for nondiscretionary closure. Fed. Reg. 70:68264. C.F.R. 36 Part 212. If it is determined that use of motorized vehicles:

> [i]s directly causing or will directly cause considerable adverse effects on public safety or soil, vegetation, wildlife, wildlife habitat, or cultural resources associated with that road, trail, or area, the responsible official shall immediately close that road, trail, or area to motor vehicle use until the official determines that such adverse effects have been mitigated or eliminated and that measures have been implemented to prevent future recurrence. 36 C.F.R 212.52(b)(2).

In the preamble to the final rule, the Forest Service states that it is a "practical impossibility in some situations" to met the EO requirement that nondiscretionary closures remain in place until adverse effects have been eliminated and their recurrence prevented. Fed. Reg. 70:68280. As a result, the final rule allows nondiscretionary closures to be lifted once the effects have been "mitigated" to the point "where they are not considerable adverse effects." This is a significant departure from the EO since mitigation is fundamentally different than elimination of effects. However, as this Protection Order clearly demonstrates, adverse effects have neither been eliminated nor mitigated on routes requiring immediate closure (*see* specific protection orders).

These regulations are part and parcel of a broader statutory and regulatory framework that addresses the management and conservation of national forest lands. These statutes and regulations are applicable to the management of motorized recreation on national forests.

The legal mandate and management authority for the Forest Service was established in 1897 with the passage of the Organic Act, 16 U.S.C. Sec. 471 et seq. This Act permitted national forests to be established to "improve and protect the forest within the reservation [national forest]" and to "secure favorable conditions of water flows." *Id.* at Sec. 475. Furthermore, Congress authorized the agency to "make such rules and regulations and establish such service as will insure the objects of such reservations, namely, to regulate their occupancy and use and preserve the forests thereon from destruction." *Id.* at Sec. 551.

The Multiple Use Sustained Yield Act of 1960 (MUSYA) broadened Forest Service authority and responsibility for administering the national forests to include "outdoor recreation, range, timber, watershed, and wildlife and fish purposes." 16 U.S.C. Sec. 528. Under this Act, the secretary of agriculture was required to "develop and administer the renewable surface resources of the national forests for multiple use and sustained yield." *Id.* at Sec. 529. While the MUSYA provided additional management direction for national forests, it provided no standards for regulating use of the forests. This guidance was provided in 1976 upon passage of the National Forest Management Act (NFMA). 16 U.S.C. Sec.1600 et seq.

In promulgating the NFMA, Congress declared that the "Forest Service ... has both a responsibility and an opportunity to be a leader in assuring that the Nation maintains a natural resource conservation posture that will meet the requirements of our people in perpetuity." 16 U.S.C. Sec.1600(6). The management and administration of renewable resources under the NFMA must be consistent with the multiple-use and sustained-yield concepts as required by the MUSYA. To do so, the Forest Service is authorized to install a "proper system of transportation to service the National Forest System ... to meet anticipated needs on an economical and environmentally sound basis," *Id.* at Sec. 1608(a), through the creation of a forest development road system plan. *Id.* at Sec. 1608(b). In addition, "roads constructed on National Forest System lands shall be designed to standards appropriate for intended uses, considering safety, cost of transportation, and effects on land and resources." *Id*. at Sec. 1608(c).

To protect the soil resource the NFMA mandates that management plans must "insure research on and (based on continuous monitoring and assessment in the field) evaluation of the effects of each management system to the end that it will not produce substantial and permanent impairment of the productivity of the land." 16 U.S.C. § 1604(g)(3)(C) (emphasis added) and *Id.* § 1604(g)(2)(B) (requiring collection of "inventory data on the various renewable resources, and soil and water, including pertinent maps, graphic material, and explanatory aids"). As documented in this petition's photos and supported by the scientific literature discussed later, SFNF management practices are causing irreversible damage to soil resources. In addition, the SFNF fails to observe, measure, inventory or monitor the effects of motorized recreation on soils or other resources.

Congress explicitly instructed that the national forest transportation system be properly maintained in an environmentally sound condition. These requirements apply to roads as well as unauthorized user-created routes the agency has allowed, in some cases encouraged, to be constructed and used in areas where motorized travel off forest development roads is specifically prohibited pursuant to 36 C.F.R. Sec. 261, subpart B.

The routes documented in this Protection Order do not meet the minimum legal requirements of the NFMA. They are not part of a "proper" system of transportation. They were not constructed and are not being maintained in an "environmentally sound" condition. Unauthorized user-created routes were not designed with considerations of effects on land or resources and are neither roads nor trails under the Travel Management Rule definition. The rule clearly states that a road or a trail is one "that the Forest Service determines is necessary for the protection, administration and utilization of the National Forest System and the use and development of its resources." 36 C.F.R. 212.1 (emphasis added). Aside from their considerable adverse effects, these routes clearly do not meet the criteria of being necessary for any aspect of forest protection, administration or utilization and therefore are inappropriate for inclusion in the Forest Transportation System.

The SFNF Transportation System also falls short of standards for safe use and resource conservation set forth in the SFNF Forest Plan. For example, the Forest Plan requires that "all roads will be maintained at the appropriate maintenance levels" (USDA/SFNF 1987b:91). Over 70 percent of the SFNF's higher standard maintenance level 2 and 3 roads are not being managed to the safety and environmental standards for which they were designed (USDA/Forest Service 2004:5). The SFNF told the N.M. Environment Department that only 1 percent of its "high clearance roads" were maintained in 2006 (NMED/SWQB 2008:2).

Lack of maintenance, according to the SFNF, has a host of negative consequences, including a high risk of illegal activities, serious degradation of wildlife habitat, watersheds and cultural resources; and aiding the spread of invasive plants (USDA/Forest Service 2004:5). The SFNF notes another problem – deferred road maintenance results in increased repair cost as road conditions deteriorate and require extensive repairs (USDA Forest Service, 2004:12 and 45). The SFNF's annual road maintenance needs are typically ten times more than appropriated funds (USDA/Forest Service, 2004:12).[14] As

[14] Nationally, the Forest Service acknowledges that "current funding mechanisms and levels are not adequate to maintain roads to the standards originally planned, to assure minimum ecological effects, as well as to ensure efficient and safe use." 63 Fed. Reg. 4351-4354 (January 28, 1998). Indeed, "the Forest

of 2003, nearly $27.5 million was needed just to meet minimum industry standards for safe travel on the existing transportation system. The SFNF predicts that inadequate funding will continue in the foreseeable future (USDA/Forest Service 2004:34).[15]

SFNF's management, or lack thereof, is clearly inconsistent with a host of nondiscretionary protection standards in the Forest Plan that restrict and close areas to motorized use to protect natural resources. This is contrary to the NFMA requirement that management actions be consistent with Forest Plans. 16 U.S.C. § 1604(i). The following inconsistencies not only violate the NFMA but indicate that considerable adverse effects caused by motorized recreation are an ongoing occurrence:

- Unauthorized routes have been constructed in an area with highly erodable soils, sensitive habitat and numerous stream crossings. This 6166-acre area is identified on the SFNF recreation map as "Circle A." Unauthorized off-road travel in the Circle A area is prohibited under the authority of the Forest Plan.[16] Several unauthorized renegade routes in the FR 188 complex are within Circle A and are designated open to motorized recreation in the SFNF Travel Management Plan Proposed Action (*see* attached maps: SFNF Circle A Region, Wildlife Values and Streams and Soils).

- The Forest Plan contains several riparian protection measures, including "locate roads away from watercourses . . . minimize the area of effect of new and existing roads and trails on riparian zones . . . protect the productivity and diversity of riparian-dependent resources . . . give preferential consideration to resources dependent on riparian areas over other resources when conflicts among uses arise" (USDA/Forest Service 1987: 77,79, 90). As documented earlier, the routes in this Protection Order cross streams a total of 118 times, including 35 crossings of the Rio Chiquito (FR 89) and 34 crossings in upper Medio Dia and Bland Canyons (FR 188 complex). FR 89 is adjacent to and within a perennial watercourse, fails to minimize crossings and effects (i.e. stream crossings are not located in stable areas, approach at right angles, etc.) and gives preference to motorized use instead of protecting riparian resources.

- The Jemez Ranger District issued twenty-five closures and restrictions on motorized use between 1984 and 2005 to protect wildlife, riparian areas, and public safety and aid in fire prevention under the authority of 36 C.F.R. §§

Service estimates that current funding allows only 40% of the roads to be maintained to the standards they were designed for. The current backlog of unmet maintenance needs exceeds $10 billion." *see* 19980224_road_html at http://www.fs.fed.us/news/roads.

[15] It should be noted that all the routes documented in this Protection Order, including unauthorized renegade routes, are designated <u>open</u> in the SFNF Travel Management Plan Proposed Action.

[16] The SFNF Plan on p. 91 states: "Road system operation will include . . . imposing user restrictions where appropriate and necessary."

261.50, 261.50(b) and 212.52(b) and the Forest Plan (USDA/SFNF 2006b). None of these closures and restrictions have been enforced and violations are routine. For example, FR 288 (Los Utes Road) was closed to motor vehicles less than 40 inches in width in 1992. Motorized users ignore this restriction, as documented in the photos here.

- ❖ Several unauthorized renegade routes are in Management Area "N", which is managed to protect the habitat of threatened and endangered species. Forest Plan direction for this area prohibit all "cross-country travel" and require "closing all unnecessary roads where they currently exist" (USDA/Forest Service, 1987:153,154). As documented earlier, the FR 188 complex in Management Area "N" is replete with cross-country routes that are not included in the minimum road system (therefore are unnecessary), but are designated open in the SFNF Travel Management Plan Proposed Action.

- ❖ Forest Plan direction for Management Area "R" emphasizes protection of cultural resources and wildlife habitat and timber management. Currently, numerous unauthorized routes contribute to road density beyond the upper limit permitted in the Forest Plan (see http://www.fs.fed.us/r3/sfe/travelmgt/pdfs/pa/Map_11_Road_Density.pdf).

The NFMA requires that temporary roads be closed within ten years of project completion unless they are determined to be necessary for a minimum road system. 16 U.S.C. 1608(a). However, as documented in this Protection Order, motorized users have turned many temporary logging roads into unauthorized routes that are illegally designated open in the SFNF's Travel Management Plan Proposed Action. 36 C.F.R. 212. In every case, the SFNF determined these routes were not needed or necessary (http://www.fs.fed.us/r3/sfe/travelmgt/pdfs/tap/Minimum_Road_System_Westside.pdf). It is illegal to designate temporary roads open for motorized travel because the NFMA mandates that unneeded, deteriorating roads be permanently closed within ten years after the end of a timber sale or other project.

Notably, the NFMA also mandates that the SFNF "provide for diversity of plant and animal communities based on the suitability and capability of the specific land area in order to meet overall multiple-use objectives." 16 U.S.C. Sec. 1604(g)(3)(B). The SFNF cannot provide for plant and animal diversity without exercising its authority to immediately stem the harm to imperiled species and their habitats caused by motorized travel as documented in this Protection Order.

The National Environmental Policy Act (NEPA) is the nation's basic charter for the protection of the environment. 40 C.F.R. Sec. 1500.1(a). The Council on Environmental Quality has promulgated regulations implementing NEPA that all federal agencies are required to follow. These regulations specify that "environmental information" relevant to federal actions must be "available to public officials and citizens before decisions are made and before actions are taken." *Id.* at Sec. 1500.1(b). Not only must the information be of "high quality," but "accurate scientific analysis, expert agency comments, and public scrutiny are essential to implementing NEPA." *Id.* federal actions subject to NEPA are broadly defined. An "action" includes "new and continuing activities, including projects and programs entirely or partly financed, assisted, conducted, regulated or approved by federal agencies." *Id.* at Sec. 1508.18(a).

The SFNF is currently preparing an environmental effect statement (EIS) for its proposal under the Travel Management Plan to close some environmentally sensitive roads and trails to motorized travel while designating others open. Until an EIS becomes final and a Record of Decision is issued, NEPA limits agency actions that have an adverse environmental effect or limit the agency's choice of reasonable alternatives. 40 C.F.R. Sec. 1506.1(a)(1) and (2).

It is indisputable that environmental harm is occurring. The petitioners argue that on-going degradation also limits the choice of a restoration alternative. For example, remedial action that achieves sustainability over time, such as protecting eroded trails from seasonal water flows by constructing barriers or channels, installing culverts at stream crossings and constructing effective vehicle barriers to protect resources is limited (i.e., becomes prohibitively expensive) by on-going degradation. On the other hand, this Protection Order, by immediately halting degradation, preserves restoration options so that they can be analyzed as a reasonable course of action in the EIS.

In addition to the statutes that broadly dictate planning and administrative processes for the national forests, the Forest Service must also comply with the Endangered Species Act (ESA) (16 U.S.C. 1531 et seq) and the Clean Water Act (CWA). 33 U.S.C. § 1313. In recognition that certain species of plants and animals "have been so depleted in numbers that they are in danger of or threatened with extinction," 16 U.S.C. Sec.1531(a)(2), Congress enacted the Endangered Species Act with the express purpose of providing both "a means whereby the ecosystems upon which endangered and threatened species depend may be conserved, [and] a program for the conservation of such endangered species and threatened species." *Id.* at Sec.1531(b). The ESA prohibits the "take" of plant and animal species that are listed as endangered or threatened. *Id.* at Sec.1538(a)(1); 50 C.F.R. Sec. 17.21, 17.31. The term "take" is broadly defined to include "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct." 16 U.S.C. Sec.1532(19). Section 7 of the Endangered Species Act requires federal agencies to both act and to refrain from acting for the benefit of listed species. On the positive side, Section 7(a)(1) mandates that all federal agencies work pro-actively toward the conservation of listed species. 16 U.S.C. § 1536(a)(1). Section 7(a)(2) prohibits federal actions that jeopardize listed species or degrade their habitats. 16 U.S.C. § 1536(a)(2).

As indicated, the Forest Service is "subject to" and must "comply with" the Clean Water Act. 33 U.S.C. § 1313. Importantly, the CWA provides a forward-looking objective "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." 33 U.S.C. § 1251. To achieve this objective, the CWA authorizes each state to develop water quality standards for the state's waters. 33 U.S.C. §§ 1311(b)(1)(C), 1313. Where waters fail to meet the quality standards, they are considered "impaired waters," listed in accord with 33 U.S.C. § 1313(d), and subject to total maximum daily loads (TMDL). Where water quality standards are being met, the Forest Service cannot allow degradation to occur to the point of impairment but must instead comply with antidegradation protections for water quality. 40 C.F.R. §§ 131.12(a)(1)-(3). As explained by the Environmental Protection Agency (EPA), "Anti-degradation implementation is an integral component of a comprehensive approach to protecting and enhancing water quality" (EPA 1994a:4-1). A TMDL plan to limit pollutants has not been prepared for the Rio Grande Basin, Santa Fe (HUC 3020201) where the routes in this Protection Order are located. In addition, the SFNF has failed to obtain a permit pursuant to the National Pollutant Discharge Elimination System to avoid "discharge of a pollutant" which arguably encompasses road features or activities intended to direct runoff. 33 U.S.C. § 1342.

Executive Order 11990 (1977) requires that federal agencies minimize the destruction, loss, or degradation of riparian areas and wetlands, and preserve and enhance the natural and beneficial value of wetlands. Further, all federally approved activities must include all practical measures to minimize adverse effects to wetlands and riparian areas. The Travel Management Plan regulations require that the SFNF consider and minimize damage to a broad range of natural resources when it is designating motorized routes. 36 C.F.R. Sec. 212.55. Therefore it is incumbent upon the SFNF to assess and document the effects that motorized recreation is having on wetlands and riparian areas. Until such an assessment is completed, closure of damaging routes to motorized vehicles is the most effective way of minimizing harm to wetlands and riparian areas.

Collectively, the foregoing statutes, regulations and executive orders, if implemented properly, would provide some control over the burgeoning use and environmental effects of motorized recreation in the SFNF. Tragically, the management of the SFNF has chosen to largely ignore this governing framework. This failure to properly execute the authorities and responsibilities delegated to the Forest Service through law and presidential order is reprehensible considering the substantial adverse effects of motorized recreation on soils, vegetation, wildlife and air and water quality that are documented in the scientific literature presented in the next section.

ENVIRONMENTAL EFFECTS OF MOTORIZED RECREATION

The scientific literature indisputably demonstrates that motorized recreation causes significant and severe direct, indirect and cumulative adverse environmental effects. These include soil compaction, accelerated soil erosion, denudation and loss of floral species diversity, reductions in animal populations, degradation of aesthetic and visual qualities and adverse effects on nonmotorized forest users.

Evaluating and interpreting the effects of motorized recreation involves a variety of factors that include terrain topography, soil moisture content, soil substrate, plant habitat type, types of vehicles, weight of vehicles, wheel configuration, types of tires or treads (i.e., low pressure, lugs, cleats, ribbed), time of year, and the amount and timing of motorized recreation (Ahlstrand and Racine 1993; Wooding and Sparrow 1979). Each of these factors may attenuate or amplify the environmental effects of such recreation.

POLLUTION

Pollution is a significant adverse effect of motorized recreation. The majority of motorized recreational vehicles use two-stroke engines that are highly polluting (White et al. 1993; Fritsch 1994). According to the Environmental Protection Agency, small engines account for 5 percent of total air pollution, with a significant proportion of this pollution being generated by motorized recreation (Fritsch 1994). The carbon monoxide (CO), polycyclic aromatic hydrocarbons, methyl tertiary butyl ether, particulate matter (PM) and other pollutants emitted by motorized recreational vehicles have devastating effects on the quality of the air, soil, and water and on human health.

Two-stroke engines create dangerous levels of airborne toxins that include nitrogen oxides, carbon monoxide, ozone, particulate matter, aldehydes, 1,3-butadiene, benzenes and extremely persistent polycyclic aromatic hydrocarbons. The EPA lists several of these compounds as “known” or “probable” human carcinogens. Benzene, for instance, is a known human carcinogen and several aldehydes, including butadiene, are classified as "probable human carcinogens." All are believed to cause deleterious health effects in humans and animals in doses that are well short of fatal (EPA 1994). In addition, two-stroke engines discharge 25 to 30 percent of their fuel mixture unburned, directly into the environment. Unburned fuel contains many toxic compounds, including benzene, toluene, xylene and the extremely persistent suspected human carcinogen MTBE.

CARBON MONOXIDE AND HUMAN HEALTH

Motorized recreational vehicles destroy the air quality in areas where they are used. According to emissions data from the California Air Resources Board, one hour of a two-stroke engine produces more smog-forming pollution than a modern car creates in one year. Dangerous levels of carbon monoxide and particulate matter are a primary concern. CO is extremely dangerous to humans and particulate matter is a confirmed human carcinogen. Motorized recreational vehicles emit dangerously high levels of carbon monoxide. A study conducted for the National Park Service in 1997 concluded that a single snowmobile produces 500 to 1000 times more carbon monoxide than a 1988 passenger car (Fussell-Snook 1997).

Carbon monoxide is also dangerous because it binds to the hemoglobin in blood (forming carboxyhemoglobin) and renders hemoglobin incapable of transporting oxygen (Fussell-Snook 1997). Elevated levels of carboxyhemoglobin can cause neural-behavioral effects at low levels (23 percent), headaches and fatigue (10 percent) and respiratory failure and death at higher levels. The general consensus among medical professionals is that the health risk from CO increases at high altitudes because risk is exacerbated by the richer fuel mixtures common at higher elevations. CO is particularly hazardous during pregnancy, and to the elderly, children, and individuals with asthma, anemia or other cardiovascular disease (EPA 1994). The National Ambient Air Quality Standards for CO of 35 ppm for one hour and 9 parts per million (ppm) for eight hours were established to keep blood levels of carboxyhemoglobin below 3 percent. Notably, some scientists have criticized these standards because of evidence of adverse health effects even at these levels (Watson 1995; Greek and Dorweiler 1990).

Pollutants generated by motorized recreation not only contain dangerous levels of airborne toxins, but can lead to the formation of additional ground-level ozone from the photochemical reaction of released nitrogen and hydrocarbons. Health risks associated with exposure to smog and nitrogen include respiratory complications such as coughing, chest pain, heart problems, asthma, concentration lapses and shortness of breath. Elderly individuals and children are particularly sensitive to ground-level ozone and nitrogen.

Impacts on Aquatic and Terrestrial Species

The pollution emitted by motorized recreational vehicles has severe direct, indirect and cumulative effects on aquatic and terrestrial species. The direct deposition of unburned fuel into soil and water, and the atmospheric deposition of airborne pollutants are far-reaching. For example, increased ground-level smog and nitrogen concentrations cause acid rain and water pollution. Direct effects include alteration of soil chemistries as a result of atmospheric pollutants. Indirect effects include effects to vegetation and aquatic systems that can produce adverse consequences for the varied assemblage of animals that occupy polluted sites.

The direct deposition of unburned fuel into the environment creates a substantial effect. As mentioned, two-stroke engines release at least 25 percent of their fuel unburned into the environment. Collectively, considering the number of motorized recreational vehicles, this represents a substantial amount of pollution. In Yellowstone National Park, for example, of the 220,000 gallons of gasoline and 11,000 gallons of lubrication oil sold for snowmobiling by service stations in 1995, up to 55,000 gallons of fuel and 2700 gallons of motor oil entered the environment as unburned, raw petrochemical pollution.

Motorized roads and trails near rivers, lakes and streams pose a serious threat to aquatic systems. Even if trails are constructed away from such sensitive areas, pollution remains a threat. Unburned fuel, for example, that is deposited on soil may bind with soil chemicals, leading to adverse effects on vegetation; it could also percolate into underground water supplies or be washed into aquatic systems.

Several studies have demonstrated that the survival, productivity and distribution of amphibians is drastically affected by increasing acidity (*see* e.g. Cooke and Frazier 1976; Beebee and Griffin 1977; Saber and Dunson 1978; Freda and Dunson 1985). Kiesecker (1991), for example, found that 60 to 100 percent of tiger salamander eggs were dead or unviable in ponds at pH levels of 5.0 or less; 40 percent were dead or unviable at pH levels between 5 and 6; and 20 percent were dead or unviable in water with a pH above 6.0. At pH levels below 6.0, a slower hatching rate, slower growth to maturity and a decreased ability of tiger salamanders to catch and eat tadpoles was observed. Pierce and Wooten (1992) also documented sublethal effects of lowered pH on amphibians (e.g., slower growth of larvae) that were pH above the levels that kill embryos. Increased acidity also may cause amphibians to avoid breeding in low pH ponds (Beebee and Griffin 1977).

The acidity of water also affected the survival of tiger salamanders. Harte and Hoffman (1989) studied a declining tiger salamander population in an acid-sensitive watershed in the Colorado Rockies. As a result of their research, they concluded that less than half as many tiger salamander embryos survived at pH 5.6 or less compared with those surviving at pH 6.1 or greater and that survival of zooplankton, a common food of the tiger salamander, was also drastically affected by increased acidity. Furthermore, they found that only a brief exposure to acid is needed to induce amphibian mortality and that acidifed water resulted in developmental abnormalities. They concluded that episodic acidification may have contributed to the decline in the salamander population. Based on their results, Harte and Hoffman (1989) theorized that there are at least five possible mechanisms by which episodic acidification reduces salamander populations: (1) by inhibiting egg development (2) by exerting a direct toxic effect upon the hatchlings (3) by exerting a direct toxic effect upon the adult population (4) by inhibiting reproductive activity and (5) by damaging the food chain (*see* also, Schindler et al. 1985). Other amphibians, including boreal toads, chorus frogs, and northern leopard frogs, also experience significant mortality when the pH of water is between 4.3 and 4.9 (Corn and Vertucci 1992).

In a study on the effect of two-stroke engine emissions on fish, Balk et al. (1994) demonstrated that hydrocarbons disrupt normal biological functions (e.g., DNA adduct levels, enzyme activity), including cellular and subcellular processes and physiological functions (e.g., carbohydrate metabolism, immune system responses). Serious disruption of fish reproduction and fry survival also seems likely (*see also*, Tjarnlund et al. 1995, 1996). Baker and Christensen (1991), for example, found that embryos and fry of rainbow trout have an increased mortality at about pH 5.5. In the eastern United States, where precipitation is more acid than in the West, and where some surface waters are chronically rather than just episodically acidified, fish populations have been severely depressed or eliminated in acidified lakes possibly because of adverse effects of acidification on the food chain (Schindler et al., 1985). Adams (1975) also found that the influence of lead and hydrocarbon on stamina, measured by ability to swim against a current, was significantly less in trout exposed to snowmobile exhaust than in control fish; the exposed fish made fewer tries to swim against the current and swam for shorter lengths of time before resting.

Vegetation can also be adversely affected by pollution. Vehicle exhaust contains a number of elements that are damaging to vegetation. While the amounts of pollutants emitted by a two-stroke engine are greater than those emitted by four-stroke engines, except for the unburned fuel emitted by two-stroke engines, the elements in the emissions are similar. They include (1) carbon dioxide which may act as a fertilizer and cause changes in the composition of plant species (Hunt et al. 1991; Ferris and Taylor 1995) (2) sulfur dioxide ,which is taken up by vegetation and can cause changes in photosynthesis (Winner and Atkinson 1986; Iqbal 1988; Mooney et al. 1988) (3) oxides of nitrogen, which may be harmful to vegetation or may act as a fertilizer, causing changes in species composition (Falkengren-Grerup 1986; Iqbal 1990; Wellburn 1990) (4) organic gases such as ethylene, to which plants may be extremely sensitive (Gunderson and Taylor 1988; Taylor et al. 1988) and (5) heavy metals, which may cause phytotoxic damage (Atkins et al. 1982). Ozone, which is formed by the photochemical reaction of released nitrogen and hydrocarbons, may also injure plants and affect the composition of species (Reich and Amundson 1985; Becker et al. 1989; Ashmore and Ainsworth 1995; Warwick and Taylor 1995).

As an example of the potential effects of pollutants on vegetation, in his study of the effect of roads on heathland vegetation in the United Kingdom, Angold (1997) found that changes in plant species composition were mainly a result of chemical pollution from vehicle exhausts. More specifically, he noted an increased growth rate in calluna (*Calluna vulgaris*) and molina plants (*Molinia caerulea*) near the roadway; there were higher concentrations of nitrogen and phosphorus in calluna plants and higher concentrations of phosphorus in molina plants. The increased rate of growth in calluna plants was likely due to an increased supply of nitrogen from exhaust gases, while increased phosphorus from soil litter may have benefited molina plants.

More broadly, Shaver et al. (1988) reported that the effects of pollutants can be both biological and ecological, and acute and chronic. Such effects on plants include foliar injury, reduced productivity, tree mortality, decreased growth, altered plant competition, modifications in species diversity and increased susceptibility to diseases and pests. Changes in the vegetative community also have implications for herbivores and other ecosystem components. In addition, ingestion by herbivores of trace elements deposited on leaf surfaces may lead to other effects on the individual organism and throughout the food chain.

POLYCYCLIC AROMATIC HYDROCARBONS

PAHs are by-products of fuel combustion that are found in high concentrations in unregulated two-stroke engine emissions. They are particularly hazardous because they are both carcinogenic and mutagenic and are extremely persistent in the environment. Studies by the Tahoe Regional Planning Agency (1997) have shown that PAHs can remain on the surface of the water, where fish and other species feed on phytoplankton and zooplankton. Heintz et al. (1998), in their nine-year study of the Exxon Valdez spill in Alaska, documented stunted salmon growth and reproductive problems from PAHs which may have adverse effects on long-term species survival and reproduction. Of further concern, Oris (1998) and Giesy (1997) found that PAHs at extremely low levels (parts per trillion, ppt) are toxic to zooplankton and inhibit not only zooplankton reproduction but also the reproductive success and general growth of fish. Moreover, natural ultraviolet light can increase the toxicity of PAHs on water surfaces by as much as 50,000 times under field conditions (Giesy 1997).

Such high concentrations are particularly alarming for the health of fish larvae, zooplankton and perhaps other marine organisms. Oris (1998) found that much lower PAH levels (570 parts per trillion compared with Graham's detections of 12,000 parts per billion, ppb) cause “a significant effect on fish growth ... photoactivated toxicity to fish and zooplankton as well as direct (no UV) toxicity to zooplankton.” Giesy (1997) demonstrated that only 19 ppb of another PAH compound (anthracene), under relatively low ultraviolet intensity (2500 microwatts per square centimeter of ultraviolet A), would kill all exposed zooplankton in thirty minutes. Furthermore, Heintz et al. (1998) concluded that sublethal levels of water contamination (as low as 1.0 ppb) stunted the growth of pink salmon and may not be low enough to protect fish embryos.

METHYL TERTIARY BUTYL ETHER

MTBE is a controversial fuel additive and suspected carcinogen that is contaminating water supplies nationwide. All 50 states use MTBE as an octane booster (23 percent MTBE), and 20 states are required to have gasoline with at least 11 percent MTBE. Although the additive is commonly regarded as a hazard to drinking water from leaking underground storage tanks and fuel spills, motorized recreational vehicles are also a significant source of MTBE.

MTBE is a concern in motorized recreational vehicles for two reasons: (1) these vehicles release large quantities of unburned fuel into the environment through their exhaust, up to 15 percent of which is MTBE; and (2) these vehicles produce very high emissions containing carcinogenic by-products of MTBE combustion. In Yellowstone, for example, snowmobiles can dump from one-third to three-quarters of a gallon of MTBE directly into the environment every two hours. Although no studies have addressed the sensitivity of wild animals to MTBE in the environment, humans are extremely sensitive to the chemical. The Association of California Water Agencies reports that humans can consistently smell the chemical in the water at 15 ppb (Pirnie 1998). Just one-third of a gallon of MTBE is enough to bring the drinking water consumed daily by 90,000 people to a contaminant level of 15 ppb. It is therefore safe to assume that even small amounts of raw MTBE released by recreational vehicles and leaching into watersheds in the Santa Fe National Forest are a threat to water quality and have serious implications for wildlife.

Although no data exist on the suspected human health risks of MTBE, the EPA confirms that in laboratory animals a lifetime exposure to MTBE in air causes cancer. Animals exposed to small amounts of MTBE show kidney damage and other adverse effects on the developing fetus. The toxic effects of MTBE on microorganisms, marine life and vegetation have also not been extensively studied. However, according to preliminary reports from researchers at the University of California at Davis, MTBE is acutely toxic to various aquatic organisms at concentrations as low as 44 parts per billion, and bacterial assays are most sensitive in terms of toxicity measured at 7.4 ppb over a relatively short forty-eight-hour period.

The combustion by-products and human metabolites of MTBE are also a concern for motorized users. MTBE reacts with natural oxygen and hydrogen molecules in the air to form tertiary butyl formate (TBF), a compound that is extremely destructive to tissues of the mucous membranes and the upper respiratory tract. MTBE combustion also increases airborne concentrations of formaldehyde, an EPA-listed "probable" human carcinogen and a confirmed suppressant of the immune system. Peter Joseph, professor of radiological physics at the University of Pennsylvania School of Medicine, believes these by-products of MTBE are responsible for major public health problems, including a national asthma epidemic. The EPA also confirms that the human metabolites of MTBE are tertiary butyl alcohol (TBA) and formaldehyde. TBA is listed as "harmful or fatal if swallowed," and also suppresses the immune system.

Permitting the virtually unregulated use of motorized recreation in the SFNF fails to safeguard public health and wildlife from astonishing amounts of water and air pollution. Such effects are inconsistent with provisions set forth in the Clean Water Act, the Clean Air Act amendments of 1990, applicable executives orders and Forest Service regulations and policies.

PUBLIC SAFETY

In addition to avoiding impacts on natural and cultural resources, the SFNF has a nondiscretionary duty to close motorized routes that are posing considerable threats to public safety. 36 C.FR. 212.52(2). Given the proliferation of unregulated motorized recreation use in the SFNF, it is indisputable that injuries and fatalities involving adults and children have and continue to occur.

According to the New Mexico Department of Health, the costs of off-road vehicle injuries requiring hospitalization range between $2 and $4 million per year (NM/EMNRD 2008:97). However, the department notes that a general lack of emergency room data in New Mexico means that at least 89 percent of ATV injuries and costs are <u>not</u> reported.[17] Children under age 15 accounted for about 20 percent of yearly costs (NM/EMNRD 2008:97).

Nationally, the annual Consumer Product Safety Commission (CPSC) report titled *All-Terrain Vehicle Exposure, Injury, Death, and Risk Studies* (CPSC 1998) provides an analysis of the safety issues involved in the operation of motorized recreational vehicles. According to the CPSC, 47 percent of ATV injuries documented in 1997 involved children. Ninety-five percent of the injured children were operating ATVs larger than recommended for their age. At least 22 percent of the total injuries (to children and adults) involved head injuries (i.e., concussions or other brain injuries) and 65 percent of those suffering such injuries were not wearing helmets. Overall, the CPSC estimates that there were 3200 ATV-related deaths from 1985 to 1997. More than 35 percent of the ATV deaths involved children, 87 percent involved males and 85 percent involved the ATV driver.

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[17] There was one exception to this general trend – a trauma center that reported 132 ATV injury patients were admitted in one year at a cost of $2.4 million in emergency treatment and hospitalization. Therefore, off-road vehicle injuries and costs in N.M. are considerably higher than Health Department estimates.

The CPSC's 2007 annual report on ATV-related deaths and injuries found that for the eighth year in a row serious injuries caused by ATVs increased. Children under 16 suffered 40,000 serious injuries in 2007, approximately 27 percent of all injuries. At least 542 reports of ATV-related fatalities were identified and serious injuries requiring emergency room treatment increased from 146,000 in 2006 to 150,900 in 2007. The total average annual cost of these injuries was $3 billion in 2004 dollars.

IMPACTS ON SOILS

The SFNF Terrestrial Ecosystem Survey (TES) identifies 158 soil map units where motorized recreation "will result in significant soil degradation" (USDA/Forest Service 2000: 75). In 47 of these 158 units, soil loss rates are predicted to be so severe that they exceed those "that can occur while sustaining inherent site productivity" (USDA/Forest Service 1983:11) (*also see* Appendix A).

Using this TES data, the Petitioners have created a spatial representation of these highly erodable soils for the area covered by this Protection Order. Soils with the potential for moderate or severe erosion are displayed as "erodable soils" in the attached Streams and Soils map. As can be seen, erodable soils (displayed in pink) occur over large swaths of the area, including an estimated 80 percent of the Circle A restricted area where the current prohibition on off-road use is not enforced and, as documented in the photos, on-going soil loss and degradation are significant.

The SFNF has long been aware of the hazards that motorized recreation poses to soil productivity in this area. A recent Jemez Ranger District grazing assessment of the area found that "43 percent of the soils are considered impaired" and in many cases "soil loss is exceeding tolerance levels" (USDA/Forest Service 2006a:36) (*see also* Streams and Soils map).

The effects of motorized recreation are devastating for all soil types – the thin layer of disintegrated rock and organic matter to which all life is connected – not just those the TES identified as susceptible to severe erosion. According to a Geological Survey study of motorized recreation effects on more than 500 soils from more than 200 sites in various climatic zones and with different vegetative cover, "all soil types examined are vulnerable to motorized recreation damage." There is not a single soil family that cannot be adversely affected by motorized recreation (Hendricks 1985).

Vehicles damage soils through shear and compaction (Harrison 1976, 1980). Shear is defined as slippage between strata or particles in planes parallel to the soil surface (Harrison 1976). Shear damage occurs because of wheel slip and is an inherent effect of motorized recreation since wheel slip is essential for forward propulsion. Compaction is caused by compression of the soil surface, which reduces the interstitial space between soil particles (Lull 1959; Davidson and Fox 1974). Compaction and shear are influenced by the amount of pressure on the substrate.

Motorized recreation causes an increase in soil bulk density, which is a measure of compaction (Iverson et al. 1981; Wilshire and Nakata 1976; Webb 1983; Raghaven et al. 1976; Sheridan 1979; Griggs and Walsh 1981). An increase in soil bulk density sets off a cascade of adverse environmental effects, including increased erosion and runoff, increased soil surface strength, reduced plant production, inhibition of seed germination, impairment of root penetration and growth, alteration in plant succession, reduced soil permeability to air and water, reduced soil moisture, reduction in soil depth and organic matter, reduction of groundwater recharge, alteration of hydrological flows, reduced nutrient cycling, increase in heat conductivity, a decrease in the heat capacity of soil and increased colonization by exotic species (Iverson et al. 1981; Wilshire and Nakata 1976; Sheridan 1979; Manning 1979; Wilshire et al. 1977; Mortensen 1989; Peters 1972; Veihmeyer and Hendrickson 1948; Buckman and Brady 1969; ShulÌgin 1965, Berry 1980; Griggs and Walsh 1981; Stebbins 1974a, Eckert et al. 1979; Liddle and Moore 1974; Liddle 1975; Liddle and Grieg-Smith 1975; Brown et al. 1977; Weaver and Dale 1978; Kuss 1986; Hall and Kuss 1989; Kuss and Hall 1991; Leung and Marion 1996).

These effects are both short and long term and can trigger even greater effects on habitat including adverse affects on the flora and fauna in an ecosystem (MacMahon 1987; Hendrix et al. 1992; Coleman et al. 1992; Wilshire et al. 1977). Because the effects of motorized recreation on soils can be synergistic and may occur over many years, cumulative effects may not be known for years or decades after the original disturbance (Vollmer et al. 1976).

Iverson et al. (1981) determined that soil bulk density increases logarithmically with the number of vehicle passes; that is, the largest increase per pass occurs during the first few passes (*see also* Webb 1982; Webb 1983). An increase in soil density is generally greatest a short depth below the surface (Parker and Jenny 1945; Arndt 1966; Snyder et al. 1976), but density changes have been measured to a depth of 1 meter (Snyder et al. 1976; Wilshire et al. 1977).

An increase in soil bulk density affects the permeability of soil by reducing the interstitial pore spaces thereby, reducing soil conductivity (Eckert et al. 1979; Webb 1983; Hillel 1980) while increasing runoff and erosion. The interstitial pore spaces are important for soil stability and infiltration and as microenvironments for soil biota (Dregne 1983a; Stolzy and Norman 1961). The magnitude of the decrease in soil conductivity depends on the soil moisture content, soil texture, compacting load (Akram and Kemper 1979) and the type and extent of motorized recreation. Decreased conductivity not only reduces the ability of the soil to retain moisture and causes existing soil moisture to be held more tightly, it also increases soil erosion caused by rainfall and affects hydrological processes. The rainfall intensity required to initiate runoff is less in compacted than in undisturbed soils.

Motorized trails at higher elevations generally experience more severe erosion than trails at lower elevations (Marion 1994). Trail depth is deeper (Burde and Renfro 1986) and erosion rates are greatest during the summer (Dale and Weaver 1974). These effects are caused by the higher precipitation rates and extended period of snowmelt in the mountains, resulting in muddy soils and a greater potential for erosion, more severe freeze-thaw cycles which result in more loose soil and higher erosion rates and increased susceptibility to erosion by wind (Leung and Marion 1996).

Tracks left by off-road vehicles facilitate and increase erosion (Bridge 1980). For example, vehicle tracks concentrate water runoff, increasing its power and thereby exacerbating erosion effects, even in the absence of on-going motorized recreational use (Hinckley et al. 1983). Such effects may include the rapid development of rilling and gullying. This is due to continuous water runoff at high velocities. The tracks of motorized vehicles, especially on erosion-sensitive soil surfaces, form continuous rills and, in the case of some soils, form continuous channels (Heede 1983). As a result of runoff, both rills and channels become continuous gullies. Since motorized recreation compacts the soil, leading to increased overland flow, the location of the damage and the formation of gullies may be spatially far apart from (Heede 1983).

Increased erosion results in a decline in water quality (Miller 1970), owing to an increase in sediment and dissolved matter, including plant nutrients (Wilshire et al. 1977), which not only may adversely affect aquatic systems and species, but also will reduce the fertility of the remaining soil for plant growth. In addition, a reduction in soil water as a result of compaction by motor vehicles also means that less water is locally available (Webb 1983, Wilshire 1983). This in turn influences soil biota activity, nitrogen cycle dynamics (Torbert and Wood 1992), vascular plant vigor and reproduction (Crawford 1979; Skujins 1984) and decomposition rates of soil organic matter (West 1981). As indicated soil disturbance caused by motor vehicles can also facilitate erosion by wind.

In addition to the multiple effects of motorized vehicles on soil structure and the properties identified here, these vehicles also adversely affect organic material and food webs. This in turn affects the supply and availability of soil nutrients, alters the soil’s water-holding capacity and alters the thermal structure (Buckman and Brady 1969; Davidson and Fox 1974; Luckenbach 1975; Vollmer et al. 1976; Wilshire and Nakata 1976; Ingham et al. 1989).

Belnap (1995) reported a reduction in soil nutrients as a result of motorized recreation in several ecosystems, including short-grass prairie, desert, mountain meadow and lodgepole pine. Soil nutrient availability is assumed to be low in severely compacted soils (Rutherford and Scott 1979, Kuss 1986). Hudson (1971), for example, documented a decrease in soil moisture, exchangeable calcium (a necessary nutrient for root tip development), and pH and a variable decrease in exchangeable magnesium.

Similarly, in a cold desert pinyon juniper and a grassland ecosystem in southern Utah, cyanobacterial-lichen crusts have been documented to be the dominant source of nitrogen in the soil (Evans and Ehlringer 1993). Beymer and Klopatek (1991) also found that these crusts were an important source of fixed carbon in sparsely vegetated areas. Disturbance of these crusts by hikers, mountain bikes, four-wheel drive trucks and tracked vehicles resulted in an immediate 40-80 percent reduction in nitrogenase activity (Belnap et al. 1994; Belnap 1995). Measurements taken 6-9 months after the initial measurements revealed that the nitrogenase activity had dropped even lower in the disturbed areas (Belnap et al. 1994, Belnap 1995). Plants growing on undisturbed sites consistently had a higher nitrogen content than those in adjacent disturbed sites (Belnap and Harper 1995; Harper and Pendleton 1993). Belnap (1995) found that concentrations of nitrogen and macronutrients in annual, biennial and perennial plants were significantly higher when the plants were grown on undisturbed crusted surfaces than on trampled areas. The disruption of nutrient cycles and availability adversely the productivity and abundance and ultimately the ecological productivity of an area.

Other researchers have found that the thermal changes in heat conductivity and capacity caused by compaction of soil and its associated effects (i.e., vegetation damage and removal) increase the diurnal temperature fluctuation in modified soils, which then affects seedling germination (ShulÌgin 1965; Luckenbach 1975; Davidson and Fox 1974; Vollmer et al. 1976; Wilshire and Nakata 1976). Although compaction itself will alter the temperature regime of the disturbed site, the destruction and removal of vegetation that occurs with motorized recreation will exacerbate these effects.

Similarly, when motorized recreation destroys and removes organic material, the soil absorbs more radiation and warms and thaws deeper and faster during the summer, usually becoming soggy (Wooding and Sparrow 1979). While such effects not only affect the composition, productivity and abundance of vegetation, they also facilitates compaction of the soil, which reduces its porosity and increases the potential severity of erosion. Soils that are high in organic matter are more susceptible to compaction (Stewart and Cameron 1992) as a result of thermal changes and effects and widening of trails because of muddy conditions (Bryan 1977).

Finally, as indicated in the following section, soil disturbance by motorized vehicles facilitates the colonization of exotic invasive species (Mooney and Drake 1986; Hobbs and Heunneke 1992; Pickett and White 1985; Kotanen 1997; Johnstone 1986) that can drastically alter the ecology of an area. This can cause the spread of soil-borne diseases. For example, Port Orford cedar root rot (*Chamaecyparis lawsoniana*) is a soil-borne disease spread by the movement of infected soil (Castello et al. 1995; Perry 1988; Cale and Hobbs 1991).

As the photos in this petition and sound science demonstrate, the SFNF is clearly failing to conduct its management activities in a way that prevents severe soil erosion and is in violation of 16 U.S.C. 1604(3)(E)(i) and *Id.* 1604(g)(3)(F)(v). In addition, the SFNF is in violation of the NFMA's implementing regulation 36 C.F.R. 219.10(b) since an eroding soil base cannot provide "ecological conditions to support diversity of plant and animal species. "

IMPACTS ON PLANT LIFE

VEGETATION GENERALLY

A number of researchers have shown that recreation activities adversely affect vegetation (see, e.g., Cole and Knight 1991; Knight and Gutzwiller 1995; Boucher et al. 1991; Cole 1988; Cole and Bayfield 1993; Ikeda and Okutomi 1990, 1992; Liddle 1975, 1991; Povey and Keough 1991; Sun and Liddle 1991, 1993a, b). These effects affect species composition, leaf litter cover and soil compaction in trampled areas, which in turn influence soil erosion, moisture content and temperature; microclimates, plant growth and vigor; and ultimately the ecological conditions of an area.

Effects on vegetation can be both direct and indirect and all plant species – from grasses to trees – can be affected. Such effects include crushing, breaking, trampling, and reducing vegetative cover; damage to germinating seeds; and increased erosional forces that alter the soil structure, weakening the plant and its root structure and causing impaired growth or death (Bury et al. 1977; Weaver and Dale 1978; Lathrop 1983; Wilshire et al 1977; Bury 1980; Griggs and Walsh 198; Cole 1983; Cole and Bayfield 1993; Cole and Knight 1990; Ikeda and Okutomi 1990, 1992; Kockelman 1983; Povey and Keough 1991; Sheridan 1979; Wilshire et al. 1978). These effects in turn, increase the susceptibility of plants to disease and insect predation.

Although there are individual species that appear to be more resilient to trampling than others (Speight 1973; Liddle 1975; Dale and Weaver 1974; Davidson and Fox 1974; Weaver and Dale 1978), depending on the type and amount of motorized recreation use any and all plant species can be adversely affected by such activity. There is not a single ecosystem where the floral community is immune to the effects of motorized recreation (*see*, e.g., Cole 1988; Dale and Weaver 1974).

Trampling generally results in simplification of vegetation (i.e., a reduced number of species and reduced cover, abundance and height) and compaction of soil, leading to an overall loss of habitat diversity (Speight 1973; Liddle 1975; Liddle and Greig-Smith 1975; Mortensen 1989). In general, depending on the structure and growth characteristics of individual plant species, vegetation on shallow, gravelly or cobbly soils is subject to greater injury from motorized recreation than vegetation growing on deeper, well-drained soils because the greater environmental stress in the former circumstance results in plants with weaker root systems (Wooding and Sparrow 1979). Damage to plants may also extend beyond the trail itself (Wilshire et al. 1978).

Cumulatively, when the direct and indirect adverse effects of motorized recreation are combined with the other adverse effects on soil, the result is fewer and less vigorous plants, reduced plant cover, lowered plant diversity, a reduction in plant biomass, adverse changes in plant species composition, increases in the density of exotic species, an increase in erosion (water and wind) effects as plant density declines, a reduction in fertile topsoil, increased sedimentation that buries vegetation, increased soil temperatures and often-severe disruptions to plant successional and nutrient cycling processes (Brodhead and Godfrey 1977; Cole and Knight 1990; Davidson and Fox 1974; Duck 1978; Henry 1978, Snyder et al. 1976; Webb et al. 1977; Allcock 1973; Bayfield and Brooks 1979; Buckhouse et al. 1973; Holmes and Dobson 1976; Rogova 1976; Griggs and Walsh 1981). The loss and damage of vegetation attributable to the direct and indirect effects of motorized recreation in turn adversely affect the food and cover needs of wildlife, resulting in decreasing populations (Bury 1980). Habitat selection by birds, for example, is adversely affected by loss of vegetation structure, diversity, and composition and by habitat patchiness (James and Wamer 1982; Rotenberry and Wiens 1978; Anderson and Shugart 1974; James 1971; Karr and Roth 1971).

Less tolerant species are adversely affected after only limited recreational use of an area. For example, Allcock (1973) documented a 70-80 percent reduction in vegetation biomass with only two trampling effects per week, while Bell and Bliss (1973) documented a 50 percent reduction in alpine plant productivity and cover with only 15 trampling passes per week for four weeks. The relationship between vegetation damage and user intensity has been demonstrated by a number of researchers. (*see* Boomsma and van der Ploeg 1976 (plant cover and height decreased as trampling increased) Boorman and Fuller 1977 (most vegetation damage occurred at low trampling levels) Hartley 1976 (15 tramples removed almost as much cover as 50 tramples).] Regardless of species-specific sensitivity, depending on the type and intensity of motorized recreation or recreational use, the morphology of plants and site-specific characteristics, motorized recreation adversely affects the composition, productivity and abundance of vegetation.

Furthermore, a decrease in nutrient uptake as well as a decrease in water and oxygen uptake in affected soils may also alter trailside vegetation, increasing the abundance of invader species, including exotic species, to the detriment of native plant and animal species. In his study of the ecological effects of trail use in Indiana, Adkison (1991) found that vegetation in trailside areas was greater in abundance and vigor although shorter in height than to vegetation in unaltered areas. Superior plant competitors are more likely to occur along motorized trails, adversely affecting native plant species and the overall diversity of vegetation.

EXOTIC INVASIVE PLANTS

Soil disturbance by motorized vehicles combined with the effects on edge habitat associated with roads and trails, permits the invasion of disturbance-tolerant weedy species, which compete with and displace native interior species (Brothers 1992; Cousens and Mortimer 1995; Kopecky 1988; Cale and Hobbs 1991; Sheley et al. 1997; Timmins and Williams 1991; Wein et al. 1992; Miller and Knight 1995; Harris and Silva-Lopez 1992; Wilshire et al. 1977; Amor and Stevens 1976; Tyser and Worley 1992; Reed et al. 1996; Benninger-Traux et al. 1992; Spridinov 1979). Such invasions may induce changes in vegetation and animal communities on a landscape scale (McClellan and Shackleton 1988; Eaglin and Hubert 1993) and can imperil species (Vohman 1997). Many predators of avian nests, for example, are more numerous near habitat edges, resulting in greater rates of predation (Gates and Gysel 1978; Whitcomb et al. 1981; Brittingham and Temple 1983; Hickman 1990; Rich et al. 1994; Miller and Knight 1996). Increased nest predation, in turn, reduces habitat effectiveness and alters the selection of nest sites (Miller and Knight 1995).

The disturbance characteristics of trails[18] which create edge effects also produces distinctive habitats and microclimates and biological changes (Dale and Weaver 1974; Hall and Kuss 1989; Noss and Cooperrider 1994) to the benefit of disturbance-resistant native and non-native species (Cole 1978, 1981, Forman and Gordon 1981; Bright 1986; Dale and Weaver 1974; Liddle and Greig-Smith 1975; Hall and Kuss 1989) which can exacerbate the effects of fragmentation (Timmins and Williams 1991). Microclimatic changes include increased evaporation, temperature and solar radiation and decreased soil moisture (Kapos 1989; Chen et al. 1992, 1993; Vaillancourt 1995; Cole and Knight 1990). Trails also function to facilitate the movement of plants, insects, diseases and animals (Wegner and Merriam 1979; Forman and Gordon 1986; Verkaar 1988; Harris and Gallagher 1989). This movement is enhanced as the number of pathways increases (Forman and Gordon 1981, 1986; Baudry 1984).

Trail impacts on the diversity and abundance of plant species have been documented in a number of systems, including coniferous forests (Dale and Weaver 1974; Cole 1978, 1981), deciduous forests (Hall and Kuss 1989), woodlands (Burden and Randerson 1972; Bright 1986), grasslands (Bates 1935; Chappell et al 1971, Burden and Randerson 1972), and sand dunes (Liddle and Grieg-Smith 1975). The differences in flora between trail corridors and off-corridor sites have been attributed to a number of causes. They include differences in light intensity (Bates 1935; Dale and Weaver 1974; Cole 1978; Hall and Kuss 1989), direct precipitation (Dale and Weaver 1974), grazing pressure (Dale and Weaver 1974; Cole 1981), soil density (Bates 1935), soil moisture (Bates 1935; Burden and Randerson 1972; Liddle and Greig-Smith 1975), and root competition (Dale and Weaver 1974).

In their study of trail corridors in Rocky Mountain National Park, for example, Benninger-Truax et al. (1992) documented the influence of trails on species composition. Of the 178 taxa sampled in their study, 52 were restricted to trail edges and were located within 5 meters of the trail. The taxa more abundant near the trail edge had growth characteristics, such as small ground-level leaves or vegetative reproduction at or below the ground, that facilitate survival in disturbed areas (Dale and Weaver 1974; Liddle 1975; Liddle and Greig-Smith 1975). Species more common in the interior habitats, away from trails, were characterized by large leaf area and supportive tissue, a growth form particularly susceptible to disturbance (Cole 1978).

Benninger-Truax (1992) found that species richness decreased as distance from the trail increased, whereas average species cover increased with greater distance from the trail. Of the seven exotic species identified, all were found on trail edges and three were entirely restricted to the edge position (Benninger-Truax 1992). The remaining four exotic species were found in the interior habitat, suggesting that trails can facilitate the invasion of exotic species into the forests of Rocky Mountain National Park. This finding supports the contention that trail corridors provide a microclimate that facilitates invasion

[18] The effect of hiking trails is the focus of the studies cited here. In should be kept in mind, however, that the effect of hiking trails pale to insignificance compared with the vastly more destructive effect of motorized routes.

and colonization by disturbance-resistant exotic species (Cole 1981, Kuss and Graefe 1985, Forman and Gordon 1986, Hammitt and Cole 1987).

Motorized recreation acts to transport and facilitate the colonization of an area by non-native weeds and other plants (Cousens and Mortimer 1995, Stout 1992). In the Canaan Valley of West Virginia, for example, Stout (1992) showed that motorized recreation facilitated the invasion of barnyard grass, milkweed and purple loosestrife. Similarly, knapweed, an exotic species that out-competes native grasses, damages wildlife habitat and leads to increased erosion (Lacey et al. 1997), is easily transported and deposited by motor vehicles. According to Lacey et al. (1997):

> Knapweed plants are often caught in the undercarriage of recreational vehicles, ranch machinery, trains and logging equipment. Vehicles driven several feet through a knapweed site can pick up nearly two thousand seeds, 10 percent of which may still be attached to the vehicle after 10 miles of driving. Thus, seed can spread rapidly over hundreds of miles. Off-road vehicles also damage existing vegetation and disturb the soil surface, making it easier for knapweed to invade.

The colonization of disturbed areas by weedy and non-native species that is facilitated by motorized activity and disturbance can severely effect the quality of winter and summer forage for wildlife, resulting in long-term effects on wildlife populations.

Motorized routes and vehicles also indirectly cause and accelerate weedy invasions . Humans are the suspected cause of at least 90 percent of wildfires in the United States, 50 to 80 percent of which can be traced back to motorized routes and vehicles (Shaw 1941). By increasing fire risk, they increase the risk of weedy invasion because recently burned habitats are exceptionally vulnerable to invasion (Milberg and Lamont 1995). Once motorized routes and vehicles facilitate an invasion by a flammable weed, the result is to further increase the risk of fire. More fire means still more weeds, plus the loss of fire-sensitive native plant and animal species (Mack 1981).

EFFECTS ON WILDLIFE

DIRECT MORTALITY AND ALTERATION OF HABITAT

Boyle and Samson (1985) concluded that motorized recreation poses the greatest threat to wildlife and wildlife habitat as a result of habitat alteration, disturbance and direct mortality. Many researchers have shown that motorized recreation poses great threats to wildlife (March and Adams 1973; Hoover 1973; Cole and Knight 1991; Knight and Gutzwiller 1995; Hicks and Elder 1979; Keller 1991; MacArthur et al. 1982; Mainini et al. 1993; Povey and Keough 1991; Schultz and Bailey 1978; Van der Zande and Vos 1984; Yalden 1992; Yalden and Yalden 1990). It does this in four fundamental ways: by harvesting or killing animals, modifying their habitat, polluting it and disturbing the animals (Gutzwiller et al. 1994).

Drivers of recreational vehicles may strike animals intentionally or unintentionally, causing their death. Although consumptive activities (i.e., hunting) have a greater direct effect on animal mortality, so-called “nonconsumptive activities” can also cause or facilitate animal deaths. For example, several researchers have documented deliberate harassment of wildlife by such recreationists (Curtis 1974; Baldwin 1970).

Collisions with wildlife often prove fatal to the animal. Predator populations are especially vulnerable to vehicle-caused mortality (Forman et al. 1996). Other wildlife can also suffer significant effects (Foster and Humphrey 1992; Smith et al. 1996; Aaris-Sorensen 1995; Jenkins 1996). For instance, small mammals and ground-nesting birds can be crushed when drivers run over them (Bury 1980). Wilkens (1982) and Rosen and Lowe (1994) observe that rodents are especially vulnerable. As noted earlier, direct mortality of the endemic Jemez Mountain salamander caused by motorized vehicles in its Essential and Occupied habitat is a significant concern.

Motorized recreation results in substantial modification of habitat as a result of soil erosion, damage to vegetation, trail construction and habitat fragmentation, all of which produce both short – and long – term effects on the ecology of the area. These effects may be direct and indirect and can influence a large number of terrestrial, avian and aquatic species and their habitats. For example, soil erosion caused by motorized recreation can result in increased stream siltation which degrades aquatic habitat by covering spawning sites, destroying benthic food sources and increasing turbidity (Moyle and Leidy 1992). The direct, indirect, and cumulative impacts of these effects are detrimental to a large number of aquatic species, including Rio Grande cutthroat trout, which needs an undisturbed aquatic ecosystem for nourishment and survival.

Motor vehicles collapse burrows, which are vital to the survival of animals that must avoid desiccation and the extremes of light and temperature. Motorized recreation maims and kills species that live at or just beneath the soil surface, depletes forage availability (Stebbins 1974b; Bury et al. 1977), and may destroy ground nests or vegetation used for nesting and cover (Bury et al. 1977). For example, ground disturbances that reduce soil interspaces and subsurface channels are detrimental to Jemez Mountain Salamanders (NMEST 2008:3). In addition to a direct effect on habitat, indirect impacts can also adversely affect habitat quality and use by animals. The destruction of vegetation and subsequent alteration of a site by motorized users (i.e., the collection of firewood or dispersed camping) can decrease the overall amount and quality of shelter, foraging area, perches, nesting materials and nesting sites (Luckenbach 1978, Bury 1980). Collectively, such damage adversely affects the sustainability of the entire food chain.

Trails and roads constructed to facilitate motorized recreation, whether authorized or unauthorized, also adversely affect wildlife populations and wildland habitat. The adverse effects of trails and roads on wildlife have been well documented (*see*, e.g., Cole and Landres 1995; Anthony et al 1995). These include fragmentation of habitat, displacement of wildlife, increased human access to previously unused or lightly used areas, increased susceptibility of wildlife to direct or indirect death and an increase in effects on habitat edges to the detriment of interior habitat and species.

The mere existence of trails and roads negatively affects the value of their habitat for a variety of organisms (Cole and Landres 1995; Anthony et al. 1995). Trails and other similar disturbances create microclimates with different temperatures, moisture levels, humidity levels, wind speeds and levels of solar radiation. Roads and trails can also increase sediment runoff, constrain and divert surface and subsurface flows, introduce toxic runoff, reduce wildlife habitat and displace wildlife (Adamus and Stockwell 1983; Zeedyk 1996). These effects, along with the disturbance caused by motorized recreation, change the vegetational composition of the edges of a habitat.

Roads and associated human activities may affect the behavior and survival of many populations of large mammalian carnivores (Thiel 1985; Thurber et al. 1994; Carbyn 1974; Jensen et al. 1986; Van Dyke et al. 1986; McLellan and Shackleton 1988; Mech et al. 1988; Brody and Pelton 1989; Lovallo and Anderson 1996). The increased road densities that often accompany human-caused forest fragmentation have adverse effects on wide-ranging species. Many species respond to road density and human use of roads by altering their movement or activity patterns or shifting home ranges. In North Carolina, Brody and Pelton (1989) that black bears shifted home ranges to avoid heavily roaded areas. Cougars in Arizona tended to concentrate their activities in areas where improved dirt roads and hard surface roads were less extensive (Van Dyke et al. 1986). In Wisconsin, Lovallo and Anderson (1996) showed that bobcats altered their movement patterns in relation to the paved roads that had the highest traffic levels and that were surrounded by a buffer zone containing less-preferred bobcat habitat (Lovallo 1993).

Czech (1991) studied the effect of human use of Forest Service roads on elk within the Mount St. Helens volcanic blast zone. When a Forest Service road previously used for logging was open to public access, the amount of human use substantially increased – from 2,200 to more than 60,000 vehicles – while elk use declined within a 500-meter corridor centered on the road. In addition to this decreased use, the maximum herd size also decreased.

In their study of elk and deer distribution in relation to roads, Rost and Bailey (1979) found that deer and elk avoid roads, particularly areas within 200 meters of heavily traveled roads. East of the Continental Divide, deer avoided heavily traveled roads more than less-traveled roads, but also avoided dirt roads used only by four-wheel drive vehicles, trail bikes and hikers (Rost 1975). Rost and Bailey (1979) concluded that deer and elk may avoid roads to an extent that is detrimental to their welfare because in response to the disturbance they move from important habitat to lower-quality habitat, with a concomitant decrease in nutrition. These effects can be exacerbated either by expanding the road system or through an increase in traffic volume. Other researchers have also found that human disturbances cause dislocation of elk from preferred foraging areas (Lieb and Mossman 1966) forcing them to forage in suboptimal areas, which can result in overgrazing (Morgantini and Hudson 1979) and the disruption of behavioral patterns (Lieb and Mossman 1966).

In Montana, Mace and Manley (1993) showed that grizzly bear home ranges, particularly for females, were disproportionately located in the least-roaded sections of their study area. Indeed, in a series of studies on the effects of roads on grizzly bears they found that female bears who were successful in raising litters chose home range locations that had substantial proportions devoid of roads (Mace and Manley 1993; Mace et al. 1996; Mace and Waller 1997). In female home ranges that included roads, the habitat nearest the roads was used less than it would have been had those roads been absent (Mace and Manley 1993; Mace et al. 1996), displacement increased with the level of use (Wittinger et al. 1998) and increased use invariably elevated the risk of death (Mace and Waller 1998).

Roads may also adversely affect other species, including small mammals and their habitats. Oxley et al. (1974) demonstrated that roads wider than 20 meters pose a travel barrier for small rodents. An increase in narrow roads may also present significant movement barriers for small mammals as shown by Mader (1984) for yellow-necked mice (*Apodemus flavicollis*) and by Mansergh and Scotts (1989) for the mountain pygmy-possum (*Burramys parvus*), while even tire tracks impeded the movement of prairie voles (*Microtus ochrogaster*) and cotton rats (*Sigmodon hispidus*) through a field (Swihart and Slade 1984). Some native species can be outcompeted by species better adapted to the road shoulder habitat (Goosem 1997). Getz et al. (1978), for example, found that meadow voles (*Microtus pennsylvanicus*) expanded their range and outcompeted the native prairie vole (Getz et al. 1978) along grassy highway shoulders. Not only can roads affect the structure and density of small mammal communities (Adams and Geis 1980, 1983), they also can result in increased predation of small mammals by coyotes (*Canis latrans*), dingos (*Canis dingo*) (May and Norton 1996), domestic dogs (*Canis familiaris*), and domestic cats (*Felis catus*) (Bennet 1990).

Habitat fragmentation and the associated effects of roads and trails have a significant effect on wildlife populations (Tyser and Worley 1992; Miller 1996; Miller and Knight 1995). Fragmentation reduces the overall suitability and availability of habitat for plants and animals and is therefore a major threat to biodiversity (Miller and Knight 1996; Talberth 1997). Fragmentation of their habitat affects animal populations in many ways; for example, it decreases species diversity and reduces the density of some animal species in the resulting smaller patches (Arnold et al. 1995, McIntyre 1995). According to Muller et al. (1992), habitat fragmentation is the primary factor jeopardizing populations of black-footed ferrets, Abert’s squirrels, black-tailed prairie dogs, boreal owls, flammulated owls and other sensitive animal species.

As for the case of trails and roads, fragmentation also increases the amount of edge affects on habitat while decreasing the availability and suitability of interior habitat (Matlack 1993; Thompson 1994; Haysmith and Hunt 1995; Reed et al. 1996) to the detriment of species that require interior habitat (Thompson 1994; Wilcove 1985; Talberth 1997). Miller and Knight (1995), for example, found that two grassland and five forest species increased in abundance with increasing distance from trails (*see also* Temple 1986; Wilcove and Robinson 1990). Hartley (1976) documented a reduction in species number, including the number of rare species, and less total cover and flower production on a trail subject to trampling in Glacier National Park compared with an undisturbed area.

DISTURBANCE AND HARASSMENT OF WILDLIFE

As the scientific literature demonstrates, motorized recreation produces substantial intentional or unintentional disturbance and harassment of a wide variety of species, resulting in displacement of habitat, abandonment of nests or dens, changes in distribution, alterations of movement, increased stress, elevated heart rates, increased energy expenditures, a reduction in energy input or acquisition, changes in species composition, increased susceptibility to mortality, disruption of predator-prey interactions, fragmentation of habitat, disruption of population dynamics, changes in habitat use and changes in behavior (i.e., disruption of resting, feeding, reproduction and young rearing) (Bury et al. 1977; Bartelt 1987; McLellan and Shackleton 1989; Aune 1981; Ward 1985; Kuck et al. 1985; Edge et al. 1985; Korschgen et al. 1985; Stalmaster and Newman 1978; Knight and Knight 1984; Knight and Cole 1991; Gese et al. 1989; Andersen et al. 1986; Schonewald-Cox and Buechner 1992; Snow 1973; Cole and Landres 1995; Haysmith and Hunt 1995; Gabrielsen and Smith 1995; Knight and Cole 1995).

Although some species may exhibit some level of habituation to motorized recreation activity under different circumstances and at different times of the year (Altman 1958; Knight and Cole 1991), such disturbance may directly or indirectly produce an increase in the risk of mortality for individual animals and a decrease in population viability and productivity (Knight and Cole 1991). If a disturbance event displaces animals from essential habitat needed for reproduction and survival or if it prevents an animal from foraging or breeding, these effects will likely result in a population decline (Knight and Cole 1991).

Disturbance during the breeding or nesting season, for example, may cause animals to abandon their nests; there may be a decline in parental care, shortened feeding times and increased stress (Klein 1971; Geist 1978; MacArthur et al. 1982; Hamr 1988) which may reduce an individual’s ability to produce young. Disturbance outside of the breeding season may affect an animal’s ability to forage and therefore its survival (Knight and Cole 1991).

In birds, the most common response to severe disturbance during the nesting season is abandonment of nests or young which can lead to total reproductive failure (e.g., White and Thurow 1985; Anderson and Keith 1980; Korschgen and Dahlgren 1992). Disturbance can also result in short or long-term abandonment of nest sites (Yalden and Yalden 1990; Penland 1976; Glinski 1976), disruption of feeding patterns (Korschgen and Dahlgren 1992; Henson and Grant 1991; Stalmaster and Kaiser 1998; Yalden and Yalden 1990), exposure of eggs or young animals to adverse environmental conditions (i.e., hyper or hypothermia) (Penland 1976; Anderson and Keith 1980), displacement of habitat (Henson and Grant 1991; Stalmaster and Kaiser 1998; Yalden and Yalden 1990), increased energy expenditures (Glinski 1976), reduced productivity (Glinski 1976), an increase in the susceptibility of eggs or young animals to predation (Verbeek 1982; Schreiber and Risebrough 1972; Glinski 1976; Bart 1977; Dwernychuk and Boag 1972; Anderson and Keith 1980; Henson and Grant 1991; Yalden and Yalden 1990), and increased intraspecific competition and aggression as disturbed animals temporarily or permanently attempt to occupy less-disturbed territories (Yalden and Yalden 1990; Yalden 1992; Anderson and Keith 1980; Gillett et al. 1975; Robert and Ralph 1975). As reported by Fernandez and Azkona (1993), even minor human disturbance may have long-term effects on the reproductive success of birds.

Reductions in reproductive success caused by disturbance have been documented in a number of species, including brown pelicans (Anderson and Keith 1980; Anderson 1988), harp seals (Kovacs and Innes 1990), wildebeest and zebra (Edington and Edington 1986), sea turtles (Edington and Edington 1986), Thomson's gazelles (Edington and Edington 1986), shore-nesting birds (Groom 1990), penguins (Kury and Gochfield 1975) and song birds (Gutzwiller et al. 1994; Reijnen and Foppen 1994).

The abandonment of a disturbed site for an undisturbed one may displace an animal from preferred to marginal habitat. This avoidance scenario has been shown for a number of species, including caribou and bighorn sheep (Geist 1978), deer (Kopischke 1972; Rost and Bailey 1979), elk (Rost and Bailey 1979; Pedersen 1979), many bird species (Yalden and Yalden 1990; Yalden 1992; Anderson and Keith 1980; Belanger and Bedard 1989). Although this effect may be short or long term, it can result in altered feeding ecology potentially affecting an animal's survival and mortality; it may require increased energy use and increase intra and interspecific competition and the susceptibility of an animal to predation.

As Gutzwiller (1995) reported:

> Species displacement caused by recreationists can alter species richness, abundance, and composition in wildlife communities. Displaced animals are forced out of familiar habitat and must then survive and reproduce in areas where they are not familiar with the locations of food, shelter, and other vital resources. They may also face conflicts with established con-specifics in these new areas. Displacement can alter community structure through immediate effects (via initial displacement of species from disturbed habitats) and long-term consequences (via lower persistence of individuals or species in unfamiliar or poor habitats). Species that are sensitive to the presence of people may be displaced permanently; accordingly, Hammitt and Cole (1987) ranked displacement of wildlife as being more detrimental to wildlife than harassment or recreation-induced habitat changes.

Animals in groups are more likely to respond to approaching threats sooner than individual animals (e.g., Altman 1958; Owens 1977; Madsen 1985) since the reaction of the group is most likely triggered by the individual behavior of its most nervous member

(Belanger and Bedard 1989). Groups that contain young animals (e.g., cow and calf groups) are less tolerant of threats than cow or bull groups (Singer and Beattie 1986).

Larger-bodied species tend to be more sensitive to disturbance than smaller-bodied animals (Cooke 1980, Skagen et al. 1991; Holmes et al 1993). This relationship is important since smaller-bodied species, including birds, have a greater surface area-to-body mass ratio meaning that they expend relatively more energy than larger-bodied species (Hayes and Gessaman 1980; Koplin et al. 1980; Wasser 1986). Since disturbance requires animals to spend more energy through avoidance behavior and reduce their foraging and feeding times, smaller-bodied species may be more energetically stressed if they are repeatedly forced to expend energy in avoidance reactions (Holmes et al. 1993).

Animals in poor physical condition (i.e., malnourished animals) show greater tolerance for threats than animals in good condition (e.g., Knight and Knight 1984; Hamr 1988). Similarly, birds have been found to be less likely to desert their nests during late incubation and hatching periods (Kury and Gochfeld 1975; Ellison and Cleary 1978; Tremblay and Ellison 1979; Anderson and Keith 1980; Safina and Burger 1983; White and Thurow 1985) than during the egg-laying or early incubation phase because of less time and energy invested in reproduction during the early phase (Safina and Burger 1983).

The amount of habitat cover also influences the reaction of wildlife reaction to disturbance by humans. In their study of the effect of such disturbance on grizzly bears, McLellan and Shackleton (1989) documented that human disturbance of bears in the open resulted in a far greater response than disturbance of bears in cover. Indeed, 37 percent of bears who encountered people on foot in open habitat fled more than 1 kilometer or left the immediate drainage. This reaction may not only force bears into less preferable habitat but also increase their expenditures of energy.

Unfortunately, the effects of disturbance, including displacement, lower reproduction and increased mortality, may not be evident for days, weeks, months or even years after the disturbances (Gutzwiller 1991). A delay in displacement effects, for example, may be caused by reluctance to leave a site, the quality of the habitat at the disturbed site or a lack of acceptable or suitable habitat nearby. Consequently, evidence that animals may remain in an area after motorized recreation activities is not necessarily indicative of the potential cumulative effect of such recreation use on wildlife.

The remaining discussion focuses on three broad areas of disturbance effects to wildlife; **noise, energetics** and **stress**. All of the disturbance effects discussed earlier may be caused by or are directly or indirectly related to these three factors, which either represent a type of disturbance or reflect a consequence of disturbance.

Animals exposed to high-intensity sounds suffer both anatomical and physiological damage, including auditory and nonauditory damage (Brattstrom and Bondello1983). At high intensities, sounds can have a deleterious effect on human hearing if they are sustained for certain lengths of time (Brattstrom and Bondello 1983). Intermittent sounds or startle noises have been shown to have many effects on humans, including annoyance, disruption of activity, increase in heart rate, vasoconstriction, increase in blood pressure, stomach spasms, headaches, stress, fetal convulsions, ulcers and coronary disease (Baldwin and Stoddard 1973; Brattstrom and Bondello 1983). However, the larger, more sophisticated, better-protected human ear is capable of withstanding high intensity sounds that easily damage smaller, more simpler ears, such as those of lizards, salamanders and other animals (Brattstrom and Bondello 1983), and thus animals may be more affected by noise than humans are (Borg 1981). Thus, noise guidelines for humans recommended by the Occupational Safety and Health Administration (OSHA) and the Environmental Protection Agency (EPA) may not provide protection of wildlife. In fact, a vehicle noise limit that is acceptable in urban areas may be capable of severely damaging the hearing of exposed wildlife populations (Brattstrom and Bondello 1983).

Indirectly, the noise generated by motorized recreation can adversely affect animals by impairing feeding, breeding, courting, social behavior, and the establishment and maintenance of territory and by increasing stress and/or by making animals or their young more susceptible to predation (Janssen 1978; Weinstein 1978; Luckenbach 1975; Wilshire et al. 1977; EPA 1971, Bury 1980; Jeske 1985; Batten 1977; Burger 1981; Vos et al. 1985; Baldwin 1970; Rennison and Wallace 1976). According to the EPA, noise acts as a physiological stressor, producing changes similar to those brought about by exposure to extreme heat, cold, pain, etc. (EPA 1971). The EPA (1971) states that:

> Clearly, the animals that will be directly affected by noise are those capable of responding to sound energy and especially the animals that rely on auditory signals to find mates, stake out territories, recognize young, detect and locate prey and evade predators. Further, these functions could be critically affected even if the animals appear to be completely adapted to the noise (i.e., they show no behavioral response such as startle or avoidance). Ultimately it does not matter to the animal whether these vital processes are affected through signal-masking, hearing loss, or effects on the neuro-endocrine system. Even though only those animals capable of responding to sound could be directly affected by noise, competition for food and space in an ecological niche appropriate to an animal's needs, results in complex interrelationships among all the animals in an ecosystem. Consequently, even animals that are not responsive to or do not rely on sound signals for important functions could be indirectly affected when noise affects animals at some other point in the ecosystem. The "balance of nature" can be disrupted by disturbing this balance at even one point.

Noise is particularly damaging for wildlife because they live in such relatively quiet environments. Increased hearing sensitivity is essential to avoid predators, to pursue prey, to breed and to find young. In a desert, for example, over 75 percent of natural sound pressure levels measured in 1977 and 1978 were below 40.5 dBA (decibels measured on an A-weighted scale) and 50.5 dBA, respectively, with 90 percent below 45.5 dBA and 60.5 dBA, respectively (Brattstrom and Bondello 1983). Peak sound pressure levels measured for off-road vehicles ranged from 82.0 to 110.0 dBL (decibels measured on a linear scale) for dune buggies, 80.0 to 92.0 dbl for pickup trucks, and from 76.0 to 110.0 dbl within 100 meters for motorcycles (Brattstrom and Bondello 1983).

Brattstrom and Bondello (1983) found that motorcycle and dune buggy noise definitely caused hearing loss in animals, interfering with their ability to detect predators and causing unnatural behaviors that could result in death. These studies also showed that even sound levels of lower intensity and shorter duration than those monitored for vehicles in the desert can disrupt and destroy essential features of desert wildlife. These effects are not limited in scope since improved technologies have allowed motorized recreationists to journey widely, thereby affecting a substantial amount of habitat and the many animals that live there. The acoustical effects of motorized recreation, therefore, "pose a clear and present danger to the well being of desert vertebrates" (Brattstrom and Bondello 1983).

Disturbance can also reduce the vigor of individual animals through elevated heart rates, increased energy expenditures during flight reaction to disturbance and decreased energy acquisition (Owens 1977; Korschgen and Dahlgren 1992; Stalmaster and Kaiser 1998). The effect of energetics on the survival and productivity of animals is critical. Energy is used during every phase of life. From resting to feeding, from walking to predator avoidance, from pursuing prey to reproduction, energy is a critical ingredient that affects affecting the survival, health and viability of individual animals and animal populations. When energy use exceeds energy reserves, the physical condition of the animal declines. This in turn results in starvation, increased susceptibility to predation or disease and a decrease in productivity.

Whether or not human-caused disturbance results in an overt behavioral response, it may adversely affect an animal's energy balance. To compensate for such an impact, the animal has to increase the time spent foraging or suffer the consequences of energy depletion. If an animal chooses to increase foraging time, this will likely reduce the time it spends on other important functions, such as resting and the protection of young. Disturbance, particularly if repeated and frequent, may force an animal to abandon preferred habitat for more marginal habitat to obtain needed energy. This too is likely to result in adverse effects since marginal habitats may not contain the forage resources necessary to sustain the animal.

The adverse energetic consequences of human-caused disturbance can occur at any time of the year. Depending on the species, time of year and habitat quality and quantity, the severity or degree of effect may differ, but few animals, if any, are entirely immune to adverse effects caused by motor vehicles. There are adverse impacts even at low levels of recreational use. Continuous disturbance from human recreation may eventually result in an increase in the susceptibility of an animal to illness or death or reduced reproduction as a consequence of a reduction in energy reserves.

Stress is another consequence of disturbance that can, particularly if it is prolonged, cause substantial adverse effects on individual animals. Stress may be caused by both physical and psychological factors, but in either case it results in physiological changes in an animal. Motorized recreation, for example, may cause both physical and psychological stress in a wide range of animals as a result of noise, pollution, activity patterns and direct and indirect harassment or disturbance. However, the effects of recreation-induced stress, including lower reproductive output (Geist 1978) may not be evident immediately but may only appear days, weeks, months, or years after disturbances (Gutzwiller 1991). Moreover, recreation-induced stress may exacerbate the effects of disease and competition and lead to higher mortality well after the disturbances occur (Gutzwiller 1991).

These effects, particularly if they are chronic, can ultimately result in increased sickness, disease, and death. They may cause a decrease in animal productivity (Knight and Cole 1991; Anderson and Keith 1980) and ultimately result in population declines (Anderson and Keith 1980). Harassment of mule deer by all-terrain vehicles, for example, resulted in reduced reproduction the following year (Yarmaloy et al. 1988). Common loons experienced reduced productivity with increased human contacts (Titus and VanDruff 1981).

Based on the foregoing evidence, it is indisputable that motorized recreation exerts an enormous direct, indirect and cumulative effect on wildlife. Whether crushing small animals, displacing animals from preferred to more marginal habitats, disrupting feeding patterns, altering predator-prey dynamics, increasing stress or forcing animals to use critical energy reserves, motorized recreation exerts a deadly effect on wildlife. Individual animals and/or entire populations can be harmed or even imperiled.

CONCLUSION

In light of the evidence presented here, petitioners stipulate by this Protection Order that Santa Fe National Forest managers immediately assume their responsibilities as stewards of public land to "functionally close" (construct effective barriers to motorized vehicles and monitor closure status) the 27 routes described in detail in this document that total 66.9 miles in the Jemez Ranger District. As this Protection Order makes abundantly clear with site-specific evidence and sound science, motorized recreation is causing considerable, unacceptable, undue and significant damage and impacts to air and water and wildlife and vegetation in the national forest.

At this time, petitioners also request that the SFNF promptly develop a restoration plan to identify and schedule remedial actions that are needed to restore all areas in the SFNF that have been damaged or degraded by motorized vehicles. Work on such a restoration plan could take place through Travel Management Planning. However, the most pressing matter before the agency is preventing further damage and degradation in sensitive and heavily effected areas like those described in detail here. Thus this Protection Order should be implemented immediately while a restoration plan is developed as expeditiously as possible.

In addition, the Petitioners request that the SFNF develop a monitoring and enforcement plan subject to full public notice and comment no later than one year following the completion of Travel Management Planning to ensure that adequate resources[19] are available to administer effective route closures, including the routes described in this Protection Order.

In accordance with 5 U.S.C. § 555(e), your response to this Protection Order should provide a complete and detailed statement of all grounds for denial, should this Protection Order be denied in whole or in part. To be assured this Protection Order receives prompt attention, the Petitioners request that you provide a complete and final answer to this Petition within 90 days of receipt of this petition, in accordance with 5 U.S.C §555(e). If we do not receive a response within 90 days, we will begin to investigate our litigation options. This is a reasonable time period for the agency to respond. Ongoing harm must be addressed within this period because of the increase in illegal motorized use during the summer months. If the SFNF begins to implement effective closures and remediate the harm documented here, Petitioners would consider additional time for the agency to respond.

If we do not receive a final response within 90 days, this will be viewed as a full denial. We are committed to using whatever legal avenues may then be necessary to halt the damage being done to the areas described in this petition by inappropriate motorized vehicle use and by the inaction of the Santa Fe National Forest managers.

In the end, the SFNF has a choice. They can exercise the functions and authorities that have been prescribed by law and rein in the motorized menace detailed in this petition. Or they can refuse their responsibility, yielding the future of a national forest to the greed and indifference of a small but power business cartel and its supporters.

Respectfully submitted,

/s/ Kevin Stillman

Kevin Stillman, for Petitioners

PETITIONERS

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[19] Ensuring that adequate resources are available is important since the Forest Service 2009 budget proposed a $16.5 million cut in law enforcement (Gilman 2008:3) and the number of Forest Service law enforcement officers has declined by 37 percent in the past decade (De Yoanna 2004).

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Aaris-Sorensen, J. 1995. Road-kills of badgers (*Meles meles*) in Denmark. Annales Zoologici Fennici. 32 (1): 31-36.

Adamus, Paul R. and L.T. Stockwell. 1983. A method for wetland functional assessment. U.S. Department of Transportation. Federal Highway Administration. FHWA-IP-82-23. Washington, D.C.

Adams, E.S. 1975. Effects of Pb and hydrocarbons from snowmobile exhaust on brook trout (*Salvenlinus foninalis*). Trans. Amer. Fish Soc. 104:363.

Adams, L.W., and A.D. Geis. 1980. Effects of highways on wildlife. Pub. by Urban Wildlife Center, Columbia, Maryland.

Adams, L.W., and A.D. Geis. 1983. Effects of roads on small mammals. Journal of Applied Ecology 20: 403-416.

Adkison, G.P. 1991. Ecological effects of trail use in three Indiana nature preserves. Thesis, School of Graduate Studies, Indiana State University, Terra Haute, Indiana, USA.

Ahlstrand, G.M., and C.H. Racine. 1993. Response of an Alaska, USA, shrub-tussock community to selected all-terrain vehicle use. Arctic and Alpine Research 25(2):142-149.

Akram, M., and W.D. Kemper. 1979. Infiltration of soils as affected by the pressure and water content at the time of compaction. Soil Science Society of America Journal 43:1080-1086.

Allcock, P.J. 1973. Treading of chalk grassland. Journal of Sports Turf Res. Inst. 49:21-28.

Altman, M. 1958. The flight distance in free-ranging big game. Journal of Wildlife Management 22 (2):207-209.

Ambuel, B., and S.A. Temple. 1983. Area-dependent changes in the bird communities and vegetation of southern Wisconsin forests. Ecology. 64:1057-1068.

American Academy for the Advancement of Science. 1974. ORV use. Science 18 (3): 500-501.

Amor, R. L., and P.L. Stevens. 1976. Spread of weeds from a roadside into sclerophyll forests at Dartmouth, Australia. Weed Research 16: 111-118.

Andersen, D.E., O.J. Rongstad, and W.R. Mytton. 1986. The behavioral response of red-tailed hawk to military training activity. Raptor Res. 20:65-68.

Andersen, D.E., O.J. Rongstad, and W.R. Mytton. 1990. Home-range changes in raptors exposed to increased human activity levels in southeastern Colorado. Wildlife Society Bulletin 18:134-142.

Anderson, D.W., and J.O. Keith. 1980. The human influence on seabird nesting success: Conservation implications. Biological Conservation 18:65-80.

Anderson, S.H., and H.H. Shugart, Jr. 1974. Habitat selection of breeding birds in an east Tennessee deciduous forest. Ecology 55:828-837.

Angold, P.G. 1997. The effect of a road upon adjacent heathland vegetation: effects on plant species composition. Journal of Applied Ecology 34:409-417.

Anthony, R.G., and F.B. Isaacs. 1989. Characteristics of bald eagle nest sites in Oregon. Journal of Wildlife Management 53(1): 148-159.

Anthony, R.G., R.J. Steidl, and K. McGarigal. 1995. Recreation and bald eagles in the Pacific Northwest. Pages 223-241 in R.L. Knight and K.J. Gutzwiller, editors. Wildlife and recreationists: Coexistence through management and research.

Arndt, W. 1966. The effect of traffic compaction on a number of soil properties, IV. Journal of Agri. Engr. Res. 11:182-187.

Arnold, G.W., J.R. Weeldenburg, and V.M. Ng. 1995. Factors affecting the distribution and abundance of western grey kangaroos (*Macropus fuliginosus*) and euros (*M. Robustus*) in a fragmented landscape. Landscape Ecology 10: 65-74.

Ashmore, M.R., and N. Ainsworth. 1995. The effects of ozone and cutting on the species composition of artificial grassland communities. Functional Ecology 9:708-712.

Atkins, D.P., I.G. Trueman, C.B. Clarke, and A.D. Bradshaw. 1982. The evolution of lead tolerance by *Festuca rubra* on a motorway verge. Environmental Pollution (series A). 27:233-241.

Aune, K.E. 1981. Effects of winter recreationists on wildlife in a portion of Yellowstone National Park, Wyoming. Thesis, Montana State University, Bozeman, Montana, USA.

Aust, W.M. 1994. Timber harvesting considerations for site protection in southeastern forested wetlands. Proc. of a workshop on water management in forested wetlands. U.S. Environmental Protection Agency and U.S. Dept. of Agriculture, Forest Service, Southern Region, Technical Publication R8-TP20.

Aust, W.M., M.D. Tippett, J.A. Burger, and W.H. McKee. 1992. Effects of skidder compaction and rutting on soil physical properties and water tables in a South Carolina wetland. Pages 131-135 in Paper presented at the Seventh Biennial Southern Silvicultural Research Conference. Mobile, Alabama, USA.

Baker, J.P., and Christensen, S.W. 1991. Effects of Acidification on Biological Communities in Aquatic Systems. In D.F. Charles, ed., Acidic Deposition and Aquatic Ecosystems -- Regional Case Studies. Springer Verlag. New York, New York, USA.

Baldwin, M.F. 1970. The off-road vehicle and environmental quality: A report on the social and environmental effects of off-road vehicles, particularly snowmobiles, with suggested policies for their control. Conservation Foundation. Washington, D.C., USA.

Baldwin, M. F. And D. Stoddard Jr. 1973. The off-road vehicle and environmental quality. Pages 8-27. Second Edition. The Conservation Foundation, Washington, D.C., USA.

Balk, L., G. Ericson, E. Lindesjoo, I. Petterson, U. Tjarnlund, and G. Akerman. 1994. Effects of exhaust from two-stroke outboard engines on fish. Institute of Applied Environmental Research, Laboratory for Aquatic Ecotoxicology, Stockholm University.

Barley, K.P., D.A. Farrell, and E.L. Greacen. 1965. The influence of soil strength on the penetration of a loam by plant roots. Aust. J. Soil Res. 3:69-79.

Bart, J. 1977. Effect of human visitations on avian nesting success. Living Bird 16:186-192.

Bartelt, G.A. 1987. Effects of disturbance and hunting on the behavior of Canada goose family groups in east-central Wisconsin. Journal of Wildlife Management 51(3):517-522.

Barton, H., W.G. McCully, H.M. Taylor, and J.E. Box, Jr. 1966. Influence of soil compaction on emergence and first-year growth of seeded grasses. J. Range Mange. 19:118-121.

Bates, G.H. 1935. The vegetation of footpaths, sidewalks, cartracks and gateways. Journal of Ecology 23:463-487.

Batten, L.A. 1977. Sailing on reservoirs and its effects on water birds. Biological Conservation 11: 49-58.

Baudry, J. 1984. Effects of landscape structure on biological communities: The case of hedgerow network landscapes. Pages 55-65 in J. Brandt and P. Agger, editors. Proceedings of the first international seminar of the International Association of Landscape Ecology, Vol. 1. Roskilde University Centre, Roskilde, Denmark.

Bayfield, N.G., and R.J. Lloyd. 1973. An approach to assessing the effect of use on a long distance footpath -- the Pennine Way. Recreation News Supplement 8:11-17.

Bayfield, N.G., and B.S. Brooks. 1979. Effects of repeated use of an area of heather *Callua vulgaris* Hull moor at Kindrogan, Scotland, for teaching purposes. Biological Conservation 16:31-41.

Bazzaz, F.A., and K. Garbutt. 1988. The response of annuals in competitive neighborhoods: effects of elevated carbon dioxide. Ecology 69:937-946.

Becker, K., M. Saurer, A. Egger, and J. Fuhrer. 1989. Sensitivity of white clover to ambient ozone in Switzerland. New Phytologist 112: 235-243.

Beebee, T.J.C. and J.R. Griffin. 1977. A preliminary investigation into nattarjack toad (*Bufo calamita*) breeding site characteristics. Great Britain Journal of Zoology 181:341-350.

Behnke, R.J. and M. Zarn. 1976. Biology and management of threatened and endangered western trout. USDA Forest Service, General Technical Report RM-28. Fort Collins, CO. 45 pp.

Belanger, L., and J. Bedard. 1989. Responses of staging greater snow geese to human disturbance. J. Wildl. Manage. 53(3):713-719.

Bell, K., and L. Bliss. 1973. Alpine disturbance studies: Olympic National Park, USA. Biological Conservation 5:25-32.

Belnap. J. 1993. Recovery rates of cryptobiotic crusts: Inoculant use and assessment methods. Great Basin Naturalist 53(1):89-95.

Belnap, J. 1995. Surface disturbances and their role in accelerating desertification. In: Environmental Monitoring and Assessment 37:39-57.

Belnap, J. and J.S. Gardner. 1993. Soil microstructure in soils of the Colorado Plateau: The role of the cyanobacterium *Microcoleus vaginatus*. Great Basin Naturalist 53(1): 40-47.

Belnap, J. and K.T. Harper. 1995. The influence of cryptobiotic soil crusts on elemental content of tissue in two desert seed plants. Arid Soil Research and Rehabilitation 9:107-115.

Belnap, J., K.T. Harper, and S.D. Warren. 1994. Surface disturbance of cryptobiotic soil crusts: Nitrogenase activity, chlorophyll content, and chlorophyll degradation. Arid Soil Research and Rehabilitation. 8:1-8.

Bennet, A.F. 1990. Land use, forest fragmentation and the mammalian fauna at Naringal. Australian Wildlife Research 17: 325-347.

Benninger-Truax, M., J.L. Vankat, and R.L. Schaefer. 1992. Trail corridors as habitat and conduits for movement of plant species in Rocky Mountain National Park, Colorado, USA. Landscape Ecology 6(4):269-278.

Berry, K.H., editor. 1973. Preliminary studies on the effects of off-road vehicles on the northwestern Mojave Desert: a collection of papers. Privately printed, Ridgecrest, California, USA.

Berry, K.H. 1979. The status of the desert tortoise in California. U.S. Dept. Of Int., BLM, California Desert Program, Riverside, California, USA.

Berry, K.H. 1980. The effects of four-wheel vehicles on biological resources. R.N.L. Andrews and P. Nowak, editors. Off-road vehicle use: A management challenge. U.S. Department of Agriculture, Office of Environmental Quality, Washington, D.C.

Berry, K.H., and L. Nicholson. 1979. The status of the desert tortoise in California. Unpublished report. U.S. Department of the Interior, Bureau of Land Management, California Desert Program. Riverside, CA.

Beymer, R.J., and J.M. Klopatek. 1991. Potential contribution of carbon by microphtic crusts in pinyon-juniper woodlands. Arid Soil Research and Rehabilitation 5: 187-198.

Blake, G.R., W.W. Nelson, and R.R. Allmaras. 1976. Persistence of subsoil compaction in mollisol. Soil Sci. Soc. Am. Jnl. 40:943-948.

Boeker, E.L., and T.D. Ray. 1971. Golden eagle population studies in the Southwest. Condor 73:463-467.

Boomsma, J.J., and S.W.F. van der Ploeg. 1976. Effects of three-year experimental trampling on a dune valley. Part I. Effects of trampling during one season. Working Paper 68. Free University, Institute of Environmental Studies, Amsterdam, Netherlands.

Boorman, L.A., and R.M. Fuller. 1977. Studies on the effect of paths on the dune vegetation at Winterton, Norfolk, England. Biological Conservation 12:203-216.

Boucher, D.H., J. Aviles, and R. Chepote. 1991. Recovery of trailside vegetation from trampling in a tropical rain forest. Enviro. Manag. 15 (2):257-262.

Boyle, S.A., and F.B. Samson. 1985. Effects of nonconsumptive recreation on wildlife: A review. Wildlife Society Bulletin. 13:110-116.

Brander, R.B. 1974. Ecological effects of off-road recreation vehicles. General Technical Report NC-9. Outdoor recreation research: Applying the results. U.S. Department of Agriculture, U.S. Forest Service.

Bratton, S.P., M.G. Hickler, and J.H. Graves. 1979. Trail erosion patterns in Great Smoky Mountains National Park. Environmental Management 3:431-445.

Brattstrom, B.H., and M.C. Bondello. 1983. Effects of off-road vehicle noise on desert Vertebrates in R.H. Webb and H.G Wilshire, editors. Environmental effects of off- road vehicles: Effects and management in arid regions. Springer-Verlag. New, York, New York, USA.

Bridge, G.S. 1980. The effects of four-wheel vehicles on biological resources. R.N.L. Andrews and P. Nowak, editors. Off-road vehicle use: A management challenge. U.S. Department of Agriculture, Office of Environmental Quality, Washington, D.C., USA.

Bright, J.A. 1986. Hiker effect on herbaceous vegetation along trails in an evergreen woodland of central Texas. Biol. Conserv. 36:53-59.

Brodhead, J.M.B., and P.J. Godfrey. 1977. Off road vehicle effect in Cape Cod National Seashore: Disruption and recovery of dune vegetation. Int. Journal Biometeor. 21(3):299-306.

Brodie, J. 1996. Bureau of Land Management. Environmental Education Homepage. http://www.blm.gov/education/riparian/define.html.

Brody, A.J., and M.P. Pelton. 1989. Effects of roads on black bear movements in western North Carolina. Wildl. Soc. Bull. 17:5-10.

Brothers, T.S. 1992. Postsettlement plant migrations in northeastern North America. American Midland Naturalist 128(1):72-82.

Brown, B.T. 1993. Winter foraging ecology of bald eagles in Arizona. Condor 95:132-138.

Brown, J.H., Jr., S.P. Kalisz, and W.R. Wright. 1977. Effects of recreational use on forested sites. Environ. Geol. 1:425-431.

Bryan, R.B. 1977. The influence of soil properties on degradation of mountain hiking trail at Grovelsjon. Geografiska Annaler 59A:49-65.

Buckhouse, J.C., G.B Coltharp, and P.A. Barker. 1973. Effect of simulated recreation on soil compaction as modified by site and management techniques. Utah Academy of Sciences Proceedings. 15:17-24.

Buckman, H.O., and N.C. Brady. 1969. The nature and properties of soil. Third Edition. The Macmillan Co., New York, New York, USA.

Buehler, D.A. 1990. Bald eagle disruption, abundance, roost use and response to human activity on the northern Chesapeake Bay, Maryland. Dissertation, Virginia Polytech. Inst. State University, Blacksburg, Virginia, USA.

Buehler, D.A., T.J. Mersmann, J.D. Fraser, and J.K.D. Seegar. 1991. Effects of human activity on bald eagle distribution on the northern Chesapeake Bay. Jnl. Wildlife Management 55 (2): 282-290.

Burde, J.H., and J.R. Renfro. 1986. Use effects on the Appalachian Trail. Pages 138-143 in R.C. Lucas, editor. Proc. national wilderness research conference: Current research. USDA Forest Service, Intermountain Res. Stn., Gen. Tech. Rpt. INT-212, Ogden, Utah, USA.

Burden, R.F., and Randerson, P.F. 1972. Quantitative studies of the effects of human trampling on vegetation as an aid to the management of semi-natural areas. J. Appl. Ecol. 9:439-457.

Burger, J. 1981. Effects of human disturbance on colonial species, particularly gulls. Colonial Waterbirds 4:28-36.

Bury, R.B. 1980. What we know and do not know about off-road vehicle effects on Wildlife. in Richard N.L. Andrews and Paul Nowak, editors. Off-road vehicle use: A management challenge. (Univ. Of Michigan Extension Service) Michigan League. The University of Michigan, School of Natural Resources. USDA The Office of Environmental Quality.

Bury, R.B., R.A. Luckenbach, and S.D. Busack. 1977. The effects of off-road vehicles on vertebrates in the California desert. Wildlife Res. Repts., No. 8, U.S. Fish and Wildlife Service, Washington, DC.

Bury, R.B., and R.A. Luckenbach. 1983. Vehicular recreation in arid land dunes: Biotic responses and management alternatives. Pages 207-221 in R.H. Webb and H.G. Wilshire, editors. Environmental effects of off-road vehicles: Effects and management in arid regions. Springer-Verlag. New York, New York, USA.

Bury, R.B., and R.W. Marlow. 1973. The desert tortoise: Will it survive? Natl. Parks Conserv. Mag. 47(6):9-12.

Busack, S.D., and R.B. Bury. 1974. Some effects on off-road vehicles and sheep grazing on lizard populations in the Mojave Desert. Biological Conservation 6:179-183.

Byrne, S. 1973. The effects of off-road vehicles in the Mojave Desert on small mammal populations. Pages 64-73 in K.H. Berry, editor. Preliminary studies of off-road vehicles on the northwestern Mojave desert. (Privately published), Ridgecrest, California, USA

Cale, P., and R. Hobbs. 1991. D. Saunders and R. Hobbs, editors. Nature conservation 2: The role of corridors. Surrey Beatty, New South Wales, Australia.

California Division of Forestry and U.S. Department of Agriculture, Forest Service, Region 5. 1968. Fire hazard reduction guide for roadsides. California Department of Conservation and U.S. Department of Agriculture, Forest Service.

Cameron R.E. 1969. Abundance of microflora in soils of desert regions. Tech. Report 32-1378, National Aeronautics and Space Administration-Jet Propulsion Laboratory, Pasadena, California, USA.

Cameron, R.E. and G.B. Blank. 1966. Desert algae: soil crusts and diaphanous substrata as algal habitats. Technical Report 32-971, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA.

Campbell, S.E., J.S. Seeler, and S.Golubic. 1989. Desert crust formation and soil stabilization. Arid Soil Research and Rehabilitation 3:217-228.

Carbyn, L. 1974. Wolf population fluctuations in Jasper National Park, Alberta, Canada. Biological Conservation. 6(2):94-101.

Castello, J. D., D.J. Leopold, and P.J. Smallidge. 1995. Pathogens, patterns and processes in forest ecosystems. Bioscience 45.

Chan, C.C., C.K. Nien, C.Y. Tsai, and G.R. Her. 1995. Comparing tail pipe emissions from motorcycles and passenger cars. J. Air & Waste Manage. Assoc. 45:116-124.

Chappell, H.G., J.F. Ainsworth, R.A.D. Cameron, and M. Redfern. 1971. The effect of trampling on a chalk grassland ecosystem. J. Appl. Ecol. 8:869-882.

Chen, J., J.F. Franklin, and T.A. Spies. 1992. Vegetation responses to edge environments in old-growth Douglas-fir forests. Ecological Applications 2(4): 387-396.

Chen, J., J.F. Franklin, and T.A. Spies. 1993. Contrasting microclimate among clearcut, edge, and interior of old-growth Douglas-fir forest. Agricultural and Forest Meteorology 63: 219-237.

Christensen, A.G., L.J. Lyon, and J. Unsworth. 1993. Elk management in the Northern Region: considerations in forest plan updates or revisions. USDA Forest Service, Intermountain Research Station. GTR INT-303. Missoula, Montana, USA.

Cole, D.N. 1978. Estimating the susceptibility of wildland vegetation to trailside alteration. J. Appl. Ecol. 15:281-286.

Cole, D.N. 1981. Vegetational changes associated with recreational use and fire suppression in the Eagle Cap Wilderness, Oregon: Some management implications. Biol. Conserv. 20:247-270.

Cole, D.N. 1983. Assessing and monitoring backcountry trail conditions. USDA Forest Service, Intermountain Res. Stn., Res. Pap. INT-303, Ogden, Utah, USA.

Cole, D.N. 1987. Effects of three seasons of experimental trampling on five Montana forest communities and a grassland in western Montana. Biol. Conser. 40:219-244.

Cole, D.N. 1988. Disturbance and recovery of trampled montane grassland and forest in Montana. USDA, Forest Service, Intermountain research station, res paper INT-389, Ogden, Utah, USA.

Cole, D.N., and N.P. Bayfield 1983. Recreational trampling of vegetation: Standard experimental procedures. Biological Conservation, 63 (3):209-215.

Cole, D.N., and R.L. Knight. 1990. Effects of recreation on biodiversity in wilderness. Proceedings of a symposium on wilderness areas: Their effects. April 19-20, Utah State University, Logan, Utah, USA.

Cole, D.N., and R.L. Knight. 1991. Wildlife preservation and recreational use: Conflicting goals of wildland management. Trans. N. American Wildlife and Natural Resource Conference 56:233-237.

Cole, D.N., and P.B. Landres. 1995. Indirect effects of recreation on wildlife. Pages 95-107 in R.L. Knight and K.G. Gutzwiller, editors. Wildlife and Recreationists: Coexistence Through Management and Research. Island Press, Washington, DC, USA.

Coleman, D.C., E.P. Odum, and D.A. Crossley Jr. 1992. Soil biology, soil ecology, and global change. Biology and Fertility of Soils 14: 104-111.

Coleman, R.A. 1981. Footpath erosion in the English Lake District. Applied Geography 1:121-131.

Cooke, A.S. 1980. Observation on how close certain passerine species will tolerate an approaching human in rural and suburban areas. Biol. Conserv. 18:85-88.

Cooke, A.S., and J.D.F. Frazier. 1976. Characteristics of newt breeding sites. Journal of Zoology of London 178:223-236.

Corn, P.S., and Vertucci, F.A. 1992. Descriptive risk assessment of the effects of acidic deposition on Rocky Mountain amphibians. Journal of Herpetology. 26:361-369.

Cousens, R., and M. Mortiner.1995. Dynamics of weed populations. Cambridge University Press. Cambridge, Massachusetts, USA.

Crawford, C.S. 1979. Desert detritivores: A review of life history patterns and trophic roles. Journal of Arid Environments 2: 31-42.

Curtis, S. 1974. How to track wildlife on skis. Backpacker 2 (4):40-45, 79-80, 83.

Czech, B. 1991. Elk behavior in response to human disturbance at Mount St. Helens National Volcanic Monument. Applied Animal Behavior Science 29:269-277.

Dale, D., and T. Weaver. 1974. Trampling effects on vegetation of the trail corridors of North Rocky Mountain Forests. Journal of Applied Ecology 11:767-772.

Davidson, E., and M. Fox. 1974. Effects of off-road motorcycle activity on Mojave Desert vegetation and soil. Madrono 22(8):381-412.

Dekker, D. 1967. Disappearance of the peregrine falcon as a breeding bird in a river valley in Alberta. Blue Jay 25: 175-176.

De Yoanna, M. 2004. Ghost roads. Colorado Springs Independent, August 12-18, 2004.

Dregne, H.E. 1976. Soils of arid regions. Elsevier Scientific Publishing Co., Amsterdam.

Dregne, H.E. 1983a. Physical effects of off-road vehicle use. Pages 15-30 in R.H. Webb and H.G. Wilshire, editors. Environmental effects of off-road vehicles: Effects and management in arid regions, Springer-Verlag, New York, New York, USA.

Dregne, H.E. 1983b. Desertification of arid lands, Harwood Academic Publishers, New York, pp 1-15.

Duck, T.A. 1978. The effects of off-road vehicles on vegetation in Dove Springs Canyon. In K. Berry, editor. Proceedings of the Symposium on the Physical, Biological, and Social Effects of Off-road Vehicles on the California Desert. So. Calif. Acad. Sci., Spec. Pub.

Dwernychuk, L.W., and D.A. Boag. 1972. How vegetative cover protects duck nests from egg-eating birds. J. Wildl. Manage. 36:955-958.

Eaglin, G.S., and W.A. Hubert. 1993. Effects of logging and roads on substrate and trout in the streams of Medicine Bow National Forest, Wyoming. North American Journal of Fisheries Management. 13: 844-846.

Eckert, R.E., Jr., M.K. Wood, W.H. Blackburn, and F.F. Peterson. 1979. Effects of off-road vehicles on infiltration and sediment production of two desert soils. J. Range Management. 32:394-397.

Edge, W.D., C.L. Marcum, and S.L. Olson. 1985. Effects of logging activities on home-range fidelity of elk. J. Wildl. Manage. 49:741-744.

Edington, J.M. and M.A. Edington. 1986. Ecology, recreation and tourism. Cambridge University Press. Cambridge, England.

Eisenberg, J.F., and D.E. Isaac. 1963. The reproduction of heteromyid rodents in captivity. J. Mammal. 44:61-67.

Ellison, L.N., and L. Cleary. 1978. Effects of human disturbance on breeding of double-crested cormorants. Auk. 95:510-517.

Environmental Protection Agency. 1971. Effects of noise on wildlife and other animals. Prepared by Memphis State University under Contract 68-04-0024, December 31, 1971.

Environmental Protection Agency. 1994. Measuring air quality: The pollutant standards index. Office of Air Quality Planning & Standards. EPA 451/K-94-001.

Environmental Protection Agency. 1994a. Water Quality Standards Handbook, 2d. Ed. at 4-1 (Aug. 1994).

Evans, D. and J.R. Ehlringer. 1993. Broken nitrogen cycles in arid lands: Evidence from 15N of soils. Oecologia 94: 314-317.

Falkengren-Grerup, U. 1986. Soil acidification and vegetation changes in deciduous forest in southern Sweden. Oecologia. 70:339-347.

Fernandez, C., and P. Azkona. 1993. Human disturbance affects parental care of marsh harriers and nutritional status of nestlings. Journal of Wildlife Management 57(3):602-608.

Ferris, R., and G. Taylor. 1995. Contrasting effects of elevated CO2 and water deficit on two native herbs. New Physiologist 131:491-501.

Forman, R.T.T., and M. Godron. 1981. Patches and structural components for a landscape ecology. Bioscience 31:733-740.

Forman, R.T.T., and M. Godron. 1986. Landscape Ecology. John Wiley & Sons, New York.

Forman, R.T.T., D.S. Friedman, D. Fitzhenry, J.D. Martin, A.S. Chen, and L.E. Alexander. 1996. Ecological effects of roads: Toward three summary indices and an overview for North America. In K. Canters, editor. Habitat Fragmentation and Infrastructure. Ministry of Transport, Public Works and Water Management, Delft, Netherlands.

Foster, M., and S.R. Humphrey. 1992. Effectiveness of wildlife crossings in reducing animal auto collisions on interstate 75, Big Cypress Swamp, Florida. Florida Department of Transportation.

Fraser, J.D., L.D. Frenzel, and J. E. Mathisen. 1985. The effect of human activities on breeding bald eagles in north-central Minnesota. Journal of Wildlife Management 49 (3):585-592.

Freda, J., and W.A. Dunson. 1985. The influence of external cation concentration on the hatching of amphibian embryos in water of low pH. Canadian Journal of Zoology 63:2649-2656.

Fritsch, A. 1994. Off-road ethics: Environmental resource assessment of recreational off-road vehicles. Appalachia-Science in the Public Interest. Mt. Vernon, Kentucky, USA.

Fussell-Snook, L.M. 1997. Exposure of snowmobile riders to carbon monoxide: Emissions pose potential risk. Park Science 17(1):1,8-10.

Gabrielsen, G.W., and E.N. Smith. 1995. Physiological responses of wildlife to disturbance. Pages 95-107 in R.L. Knight and K.J. Gutzwiller, editors. Wildlife and recreationists: Coexistence through management and research. Island Press. Washington, DC, USA.

Gates, J.E., and L.W. Gysel. 1978. Avian nest dispersion and fledgling success in forest-field ecotones. Ecology 59:871-883.

Geist, V. 1971. Bighorn sheep ecology. Wildlife Society News. 136:61.

Geist, V. 1978. Behavior. Pages 283-296 in J.L. Schmidt and D.L. Gilbert, editors, Big game of North America: Ecology and Management. Stackpole Books. Harrisburg, Pennsylvania, USA.

Gese, E.M., O.J. Rongstad, and W.R. Mytton. 1989. Changes in coyote movements due to military activity. J. Wildl. Manage. 53:334-339.

Getz, L.L., F.R. Cole, and D.L. Gates. 1978. Interstate roadsides as dispersal routes for Microtus pennsylvanicus. J. Mammal. 59:208-212.

Giesy, J.P. 1997. Testimony of John P. Giesy at the Tahoe Regional Planning Hearing on Boating Effects. February 26, 1997.

Gillett, W.H., J.L. Hayward, and J.F. Stout. 1975. Effects of human activity on egg and chick mortality in a glaucous-winged colony. Condor 77:492-499.

Gilman, S. 2008, Two Weeks in the West, High Country News, June 9, Vol. 40 No. 11.

Glinski, R.L. 1976. Birdwatching etiquette: The need for a developing philosophy. American Birds 30:655-657.

Goosem, M. 1997. Internal fragmentation: The effects of roads, highways, and powerline clearings on movements and mortality of rainforest vertebrates. Pages 241-255 in W.F. Laurance and R.O. Bierregaard, Jr., editors. Tropical forest remnants. University of Chicago Press, Chicago, Illinois, USA.

Greek, W.P., and V.P. Dorweiler. 1990. Regulation of carbon monoxide: Are current standards safe? Environmental Science and Technology 24:32.

Griggs, G.B. and B.L. Walsh. 1981. The effect, control, and mitigation of off-road vehicle activity in Hungry Valley, California. Environmental Geology. 3:229-243.

Grime, J.P. 1973. Control of species density in herbaceous vegetation. J. Env. Manag. 1:151-167.

Grimes, D.W., R.J. Miller, V.H. Schweers, B. Smith, and P.L. Wiley. 1972. Soil strength modification of root development and soil water extraction. Calif. Agri. 26:12-14.

Groom, M.J. 1990. Management of ecotourism in Manu National Park, Peru: controlling negative effects on beach-nesting birds and other riverine animals. Pages 532-540 in J. Kusler, editor. Proceedings from the Second International Symposium: Ecotourism and Resource Conservation. November 27 - December 2, 1990. Miami Beach, Florida: Association of Wetland Managers.

Gunderson, C.A., and G.E. Taylor. 1988. Kinetics of inhibition on foliar gas exchange by exogenous ethylene: an ultrasensitive response. New Phytologist 110:517-524.

Gutiérrez, R.J., M.Cody. S. Courtney, and D. Kennedy. 2004 Assessment of the potential threat of the northern barred owl. Page 1-51 (Chapter 7) in S.P. Courtney, J.A., Blakesley, R.E. Bigley, M.L. Cody, J.P. Dumbacher, R.C. Fleischer, A.B. Franklin, J.F. Franklin, R.J. Gutierrez, J.M. Marzluff, and L. Sztukowski. Scientific evaluation of the northern spotted owl. Sustainable ecosystems Institute, Portland, Oregon, USA.

Gutzwiller, K.J. 1991. Assessing recreational effects on wildlife: The value and design of experiments. Transactions of the 56th North American Wildlife and Natural Resources Conference. 248-255.

Gutzwiller, K.J. 1995. Recreational disturbance and wildlife communities. Pages 169-181 in R.L. Knight and K.J. Gutzwiller, editors. Wildlife and recreationists: Coexistence through management and research. Island Press, Washington, D.C., USA.

Gutzwiller, K.J., R.T. Wiedenmann, K.L. Clements, and S.H. Anderson. 1994. Effects of human intrusion on song occurrence and singing consistency in subalpine birds. Auk. 111:28-37.

Hall, C.N., and F.R. Kuss. 1989. Vegetation alteration along trails in Shenandoah National Park. Virginia. Biol. Conserv. 48:211-227.

Hammitt, W.E., and D.N. Cole. 1987. Wildland recreation: Ecology and management. John Wiley and Sons, New York. 341pp.

Hamr, J. 1988. Disturbance behavior of chamois in an alpine tourist area of Austria. Mountain Research and Development 8:65-73.

Harper, K.T. and R.L. Pendelton. 1993. Cyanobacteria and cyanolichens: Can they enhance availability of essential minerals for higher plants? Great Basin Naturalist 53(1): 59-72.

Harris, L.D. and P.B. Gallagher. 1989. New initiatives for wildlife conservation: The need for movements corridors. Pages 11-34 in G. Mackintosh, editor. In defense of wildlife: Preserving communities and corridors. Defenders of Wildlife, Washington, D.C.

Harris, L.D., and G. Silva-Lopez. 1992. Forest fragmentation and the conservation of biological diversity. Pages 198-237 in P.L. Fiedler and S.K. Jain, editors. Conservation biology: the theory and practice of nature conservation, preservation, and management. Chapman and Hall, New York, New York.

Harrison, R. 1976. Environmental Effects of Off-Road Vehicles. Engineering Technology. Information System. U.S. Dep. Agr. San Dimas Equipment Development Center. San Dimas, CA. Pp. 4-8.

Harrison, R.T. 1980. Environmental Effect of Off-Road Vehicles. In R.N.L. Andrews and P. Nowak, editors. Off-road vehicle use: A management challenge. U.S. Department of Agriculture, Office of Environmental Quality, Washington, DC.

Harte, J., and Hoffman E. 1989. Possible Effects of Acidic Deposition on a Rocky Mountain Population of the Tiger Salamander (*Abystoma tigrinum*). Conservation Biology. 3:149-158.

Hartley, E.A. 1976. Man's effects on the stability of alpine and subalpine vegetation in Glacier National Park, Montana. Dissertation. Duke Univ., Durham, NC, USA..

Hayes, S.R., and J.A. Gessaman. 1980. The combined effects of air temperature, wind and radiation on the resting metabolism of avian raptors. J. Therm. Biol. 5:119-125.

Haysmith, L., and J.D. Hunt. 1995. Nature tourism: Effects and management. Pp. 203-219 in R.L. Knight and K.J. Gutzwiller, editors. Wildlife and Recreationists: Coexistence through management and research.

Heede, B.H. 1983. Control of rills and gullies in off-road vehicle traffic areas. Pages 245-264 in R.H. Webb and H.G. Wilshire, editors. Environmental effects of off-road vehicles: Effects and management in arid regions. Springer-Verlag, New York.

Heintz, R.A., J.W. Short, and S.D. Rice. 1998. Sensitivity of fish embryos to weathered crude oil: Part II: Incubating downstream from weathered Exxon Valdez crude oil caused increased mortality of pink salmon (*Oncorhynchus gorbushcha*) embryos. Environmental Toxicology and Chemistry 18: 3.

Hendricks, D. M. 1985. The United States Soil Classification System and It's Application in Arizona. Pages 63-70 in Arizona Soils. University of Arizona, College of Agriculture. Tucson, Arizona.

Hendrix, P.F., D.C. Coleman, and D.A. Crossley Jr. 1992. Using knowledge of soil nutrient cycling processes to design sustainable agriculture. Journal of Sustainable Agriculture 2: 63-82.

Henry, M.A. 1978. A look at the effects of off-road vehicle use on Eureka Dune grass (*Swallenia alexandrae*). In The physical, biological, and social effects of off-road vehicles on the California Desert. Ed. by K.H. Berry. Southern California Academy of Sciences.

Henson, P., and T.A. Grant. 1991. The effects of human disturbance on trumpeter swan breeding behavior. Wildl. Soc. Bull. 19:248-257.

Hicks, D., A. Sanders, and A. Cooperrider. 1976. Effects of Barstow-Las Vegas motorcycle race on wildlife habitat. Bureau of Land Management, Washington, D.C. Unpubl. Rept., 46 pp.

Hicks, L.L., and J.M. Elder. 1979. Human disturbance of Sierra Nevada bighorn sheep. Journal of Wildlife Manage. 43 (4): 909-915.

Hickman, S. 1990. Evidence of edge species attraction to nature trails within deciduous forest. Natural Areas Journal. 10:3-5.

Hillel, D. 1980. Fundamentals of Soil Physics. Academic Press, New York. 413 pp.

Hinckley, B.S., R.M. Iverson, and B. Hallet. 1983. Accelerated water erosion in ORV-use areas. Pages 81-96 in R.H. Webb and H.G. Wilshire, editors. Environmental ethics of off-road vehicles: Effects and management in arid regions. Springer-Verlag, New York. Pp. 81-96.

Hobbs, R.J., and L. Huenneke. 1992. Disturbance, diversity, and invasion: implications for conservation. Conservation Biology 6 (3): 324-337.

Holmes, D.O., and H.E.M. Dobson. 1976. Ecological carrying capacity research: Yosemite National Park. Part 1: The effects of human trampling and urine on sub-alpine vegetation, a survey of past and present backcountry use, and the ecological carrying capacity of wilderness. U.S. Department of Commerce, National Technology Information Center. Report PB-270-955.

Holmes, T.L., R.L. Knight, L. Stegall, and G.R. Craig. 1993. Responses of wintering grassland raptors to human disturbance. Wildlife Society Bulletin 21:461-468.

Hoover, B. 1973. Off-road vehicle problems on Federallands. Proceedings of annual meeting- Association of Midwest Fish and Wildlife Committee 40: 37-39.

Horejsi, B.L. 1976. Some thoughts and observations on the harassment and bighorn sheep. Pages 149-155 in Proc. of the biennial symposium of the Northern Bighorn Sheep Council. Jackson, Wyoming. February 10-12, 1976.

Hudson, N. 1971. Soil Conservation. Cornell Univ. Press, Ithaca, New York. 320 pp.

Hunt, R., D.W. Hand, M.A. Hannah, and A.M. Neal. 1991. Response to CO2 enrichment in 27 herbaceous species. Functional Ecology 5:410-421.

Ikeda, H., and K. Okutomi. 1990. Effects of human trampling on multi-species competition on early-phase development of a tread community. Ecological Research 5:41-54.

Ikeda, H., and K. Okutomi. 1992. Effects of species interaction on community organization along a trampling gradient. Journal of Vegetative Science 3: 217-222.

Ingham, E.R., D.C. Coleman, and J.C. Moore. 1989. An analysis of the food-web structure and function in shortgrass prairie, a mountain meadow, and a lodgepole pine forest. Biology and Fertility of Soils 8: 29-37.

Iqbal, M.Z. 1988. Accumulation of sulfur in foliage of roadside plantation and soil in Karachi city (Pakistan). Tropical Ecology 298:1-5.

Iqbal, M.Z. !990. Influence of low-levels of sulfur dioxide and nitrogen dioxide on Holcus lanatus (L). Opulations at different sulfate and nitrate nutrients. Ekologia-CSSR. 9: 87-92.

Iverson, R.M. 1980. Processes of accelerated alluvial erosion on desert hills lopes modified by vehicular traffic. Earth Surface Processes 5(4):369-388.

Iverson, R.M., B.S. Hinckley, R.M. Webb, and B. Hallet. 1981. Physical effects of vehicular disturbances on arid landscapes. Science 212: 915-917.

James, Frances C. 1971. Ordinations of habitat relationships among breeding birds. Wilson Bulletin 83:215-236.

James, Frances C., and N.O. Wamer. 1982. Relationships between temperate forest bird communities and vegetation structure. Ecology 63: 159-171.

Janssen, R. 1978. Effects of noise on wildlife -- noise and animals: Perspective of government and public policy. Office of Noise Abatement and Control, U.S. Environmental Protection Agency, Washington, DC.

Jenkins, K. 1996. Texas Department of Transportation activities. Pub. by Florida Department of Transportation, Tallahassee, Florida. Report FL-ER-58-96.

Jeske, C.W. 1985. Time and energy budgets of wintering ring-necked ducks *Ayatha collaris* (L.) in north-central Florida. Thesis. University of Florida, Gainesville, FL, USA.

Johnson, R. F. 1963. The roadside fire problem. Fire control notes. V. 24, pp. 5-7.

Johnstone, I.M. 1986. Plant invasions without windows: A time based classification of invasion potential. Biological Reviews 61:369-394..

Kapos, V. 1989. Effects of isolation on the water status of forest patches in the Brazilian Amazon. Journal of Tropical Ecology 5:173-185.

Karr, J.R., and R.R. Roth. 1971. Vegetation structure and avian diversity in several new world areas. American Naturalist. 105:423-435.

Keller, V.E. 1991. Effects of human disturbance on eider ducklings (*Somateria mollissima*) in an estuarine habitat in Scotland. Biological Conservation 58: 213-228.

Kiesecker, J. 1991. Acidification and its effects on amphibians breeding in temporary ponds in Colorado. Thesis. University of Northern Colorado.

Klein, M.L. 1971. Reaction of reindeer to obstructions and disturbance. Science 173:393-398.

Knight, R.L. and S.K. Knight. 1984. Responses of wintering bald eagles to boating activity. Journal of Wildl. Manage. 48:999-1004.

Knight, R.L., D.P. Anderson, and M.N. Verne. 1991. Responses of an avian scavenging guild to anglers. Biological Conservation 56: 195-205.

Knight, R.L., and D.N. Cole. 1991. Effects of recreational activity on wildlife in wildlands. Trans. 56th North American Wildl. & Nat. Res. Conf.

Knight, R.L., and D.N. Cole. 1995. Wildlife responses to recreationists. Pages 59-80 in R.L. Knight and K.J. Gutzwiller, editors. Wildlife and recreationists: Coexistence through management and research. Island Press, Washington, DC.

Knight, R.L., and K.J. Gutzwiller. 1995. Wildlife and recreation: Coexistence through management and research. Island Press. Covelo, California. 348pp.

Knight, R.R. 1976. Yellowstone grizzly bear investigations -- Annual report of interagency study team, 1975. National Park Service, Washington, D.C., Misc. Report No. 9. 46 pp.

Knight, R.R., and L.L. Eberhardt. 1985. Population dynamics of Yellowstone grizzly bears. Ecology 66:323-334.

Knight, R.R., D.J. Mattson, and B.M. Blanchard. 1984. Movements and habitat use of the Yellowstone grizzly bear. U.S.D.I. Natl. Park Serv., Interagency Grizzly Bear Study Team Rep.

Knight, S.K., and R.L. Knight. 1983. Aspects of food finding by wintering bald eagles. Auk 100:477-484.

Kopecky, K. 1988. Influence of roads on the synanthropization of the flora and vegetation according observations in Czechoslovakia. Folia geobotanica et phytotaxonomica 23 (2): 145-171.

Koplin, J.R., M.W. Collopy, A.R. Bammann, and H. Levenson. 1980. Energetics of two wintering raptors. Auk 97:795-806.

Korschgen, C.E., and R. B. Dahlgren. 1992. Human Disturbances of Waterfowl: Causes, Effects, and Management. Waterfowl Management Handbook. Fish and Wildlife Leaflet 13.2.15.

Korschgen, C.E., L.S. George, and W.L. Green. 1985. Disturbance of diving ducks by boaters on a migrational staging area. Wildl. Soc. Bull. 13:290-296.

Kotanen, P.N.M. 1997. Effects of experimental soil disturbance on revegetation by natives and exotics in coastal California meadows. Journal of Applied Ecology 34:631-644.

Kovacs, K.M., and S. Innes. 1990. The effects of tourism on harp seals (*Phoca groenlandica*) in the gulf of St. Lawrence, Canada. Applied Animal Behavior Science 26:15-26.

Kuck, L., G.L. Hompland, and E.H. Merrill. 1985. Elk calf responses to simulated mine disturbance in southeast Idaho. Journal Wildl. Manage. 49:751-757.

Kury, C.R., and M. Gochfeld. 1975. Human interference and gull predation in cormorant colonies. Biol. Conserv. 8:23-24.

Kuss, F.R. 1986. A review of major factors influencing plant responses to recreation effects. Environ. Manage. 10:637-650.

Kuss, F.R., and A.R. Graefe. 1985. Effects of recreation trampling on natural area vegetation. Journal Leisure Research 17:165-183.

Kuss, F.R., and C.N. Hall. 1991. Ground flora trampling studies: five years after closure. Environ. Manage. 15:715-727.

Lacey, C.A., J.R. Lacey, P.K. Fay, J.M. Story, and D.L. Zamora. 1997. Controlling knapweed on Montana rangeland. Montana State University Extension Service Bulletin, Circular 311.

Leung, Y.F. 1992. A study of trail degradation along the Pat Sin Range, North New Territories, Hong Kong. Thesis, The Chinese University of Hong Kong, Hong Kong.

Leung, Y., and J.L. Marion. 1996. Trail degradation as influenced by environmental factors: A state-of-the-knowledge review. Journal of Soil and Water Conservation 51:130-136.

Liddle, M. 1975. A selective review of the ecological effects of human trampling on natural ecosystems. Biological Conservation 7:17-36.

Liddle, M.J. 1991. Recreation ecology: Effects of trampling on plants and corals. Trends in Ecology and Evolution 6(1):13-17.

Liddle, M.J., and P. Greig-Smith. 1975. A survey of tracks and paths in a sand dune ecosystem. J. Appl. Ecol. 12:909-930.

Liddle, M.J., and K.G. Moore. 1974. The microclimate of sand dune tracks: the relative contribution of vegetation removal and soil compression. J. Appl. Ecol. 11:1057-1068.

Lieb, J.W., and A.S. Mossman. 1966. Final progress report on Roosevelt elk in Prairie Creek Redwoods State Park. California Dept. Of Parks and Recreation. Interagency Agreement 4-050094-025. 8 pp.

Lovallo, M.J. 1993. Bobcat behavior and home range use in northwestern Wisconsin: In reference to censusing populations. Thesis. Univ. of Wisconsin--Stevens Point, WI, USA.

Lovallo, M.J. and E.M. Anderson. 1996. Bobcat movements and home ranges relative to roads in Wisconsin. 1996. Wildlife Society Bulletin 24(1):71-76.

Luckenbach, R.A. 1975. What the ORVs are doing to the desert. Fremontia 2(4):3-11.

Luckenbach, R.A. 1978. An Analysis of Off-road Vehicle Use on Desert Avifaunas. In Transactions of the 43rd North American Wildlife and Natural Resources Conference. Wildlife Management Institute, Washington, DC.

Luckenbach, R.A., and R.B. Bury. 1978. Off-road vehicle effect on desert vertebrates: A review. In Berry, K.H., editor. The physical, biological and social effects of off-road vehicles on the California Desert. Spec. Publ., So. Calif. Acad. Sci.

Luckenbach, R.A., and R.B. Bury. 1983. Effects of off-road vehicles on the biota of Algodones Dunes, Imperial County, California. J. Appl. Ecology 20:265-286.

Lull, H.W. 1959. Soil compaction on forest and range lands. U.S. Dep. Agr., Forest Serv. Misc. Pub. No. 768. Washington, DC. 33 p.

MacArthur, R.A., V. Geist, and R.H. Johnston. 1982. Cardiac and behavioral responses of mountain sheep to human disturbance. Journal of Wildlife Manage. 46:351-358.
.

MacArthur, R.H., and JW. MacArthur. 1961. On bird species diversity. Ecology 42:594-598.

Mace, R.D., and T.L. Manley. 1993. South Fork Flathead River Grizzly Bear Project: Progress Report 1992. Montana Department of Fish, Wildlife and Parks, Helena, MT. Unpublished data. 29 pp. + Appendices (Cited in Wittinger et al. 1998).

Mace, R.D., and J.S. Waller. 1997. Final Report: Grizzly bear ecology in the Swan Mountains, Montana. Montana Fish, Wildlife and Parks.

Mace, R.D., and J.S. Waller. 1998. Demography and trend of grizzly bears in the Swan Mountains, Montana. Conservation Biology 12:1005-1016.

Mace, R.D., T. Manley, and S. Riley. 1992. Grizzly bear response to forest road densities and timber management in a multiple use environment -- research update. Montana Department of Fish, Wildlife, and Parks.

Mace, R.D., J.S. Waller, T.L. Manley, L.J. Lyon, and H. Zuring. 1996. Relationships among grizzly bears, roads, and habitats in the Swan Mountains, Montana. Journal of Applied Ecology. 33:1395-1404.

Mack, R.N. 1981. Invasion of *Bromus tectorum* into Western North America: An Ecological Chronicle. Agro-Ecosystems 7:145-165.

MacMahon, J.A. 1987. Disturbed lands and ecological theory: An essay about a mutualistic association. Pages 221-238 in W.R. Jordan, M. Gilpin, and J.D. Aber, editors. Restoration ecology. Cambridge University Press, New York.

Mader, H.J. 1984. Animal habitat isolation by roads and agricultural fields. Biological Conservation 29:81-96.

Madsen, J. 1985. Effect of disturbance on field utilization of pink-footed geese in West Jutland, Denmark. Biological Conservation 33:53-63.

Mainini, B., P. Neuhaus, and P. Ingold. 1993. Behavior of marmots Marmota marmots under the influence of different hiking activities. Biological Conservation 64:161-164.

Manning, R.E. 1979. Effects of recreation on riparian soils and vegetation. Water Resources Bulletin 15(1):30-43.

Mansergh, I.M., and D.J. Scotts. 1989. Habitat continuity and social organization of the mountain pygmy-possum restored by tunnel. Journal of Wildlife Manage. 53(3):701-707.

March, D., and C. Adams. 1973. A front range concept: The need for the Noddles-Rampart-South Platte Recreation Area. Wildlife-2000. 112 pp.

Marion, J.L. 1994. An assessment of trail conditions in Great Smoky Mountains National Park. U.S. Department of the Interior, National Park Service, Southeast Region, Research/Resources Management Report, Atlanta, GA.

Matlack, G.R. 1993. Solid logical edge effects: spatial distribution of human effects in suburban forest fragments. Environmental Management 17:829-835.

May, S.A., and T.W. Norton. 1996. Influence of fragmentation and disturbance on the potential effect of feral predators on native fauna in Australian forest ecosystems. Wildlife Research 23(4):387-400.

Mayhew, W.W. 1965. Adaptations of the amphibian, *Scaphiopus couchi*, to desert conditions. Am. Midl. Naturalist 74:95-109.

Mayhew, W.W. 1966a. Reproduction in the arenicolous lizard, Uma notata. Ecology 47:9-18.

Mayhew, W.W. 1966b. Reproduction in the psammophilous lizard, Uma Scoparia. Copeia 114-122.

McIntyre, N.E. 1995. Effects of forest patch size on avian diversity. Landscape Ecology 10:85-99.

McLellan, B.N., and M. Shackleton. 1988. Grizzly bears and resource extraction industries: effects of roads on behavior, habitat use and demography. J. Applied Ecol. 25:451-460.

McLellan, B.N., and D.M. Shackleton. 1989. Immediate reactions of grizzly bears to human activities. Wildlife Society Bulletin. 17:269-274.

Mech, L.D., and L.D. Frenzel., Jr. editors. 1971. Ecological studies of the timber wolf in northeastern Minnesota. U.S. For. Serv. Res. Pap. NC-52. 62 pp.

Milberg P. and B.B. Lamont. 1995. Fire Enhances Weed Invasion of Roadside Vegetation in Southwestern Australia. Biological Conservation, 73:45-49.

Miller, C.K. 1996. Environmental effects of passive recreational trails in riparian areas. Paper prepared for city of Boulder Open Space Operations Center. Boulder, Colorado. Pp. 97-105.

Miller, P. 1970. Case study no. XVI: off-road recreational vehicle composite. National Technical Information Service. Environmental Problems on The Public Lands PB 196 170. Springfield, VA, 37pp.

Miller, S.G., and R.L. Knight. 1995. Recreational trails and bird communities. Final Report submitted to City of Boulder Open Space.

Miller, S.G., and R.L. Knight. 1996. Influence of recreational trails on breeding bird communities. Paper prepared for C.K. Miller, Boulder Department of Open Space. 33 pp.

Mooney, H.A., and J.A. Drake. 1986. Ecology of biological invasions of North America and Hawaii. Springer-Verlag, New York.

Mooney, H.A., M. Kuppers, G.W. Koch, J. Gorman, and C.C.Chu. 1988. Compensating effects to growth of carbon partitioning changes in response to SO2- induced photosynthetic reduction in radish. Oecologica 75: 502-506.

Morgantini, L.E., and R.J. Hudson. 1979. Human disturbance and habitat selection in elk. In Boyce, M.S., and L.D. Hayden-Wing, editors. North American elk: Ecology, behavior and management. Proceedings of a symposium on elk ecology and management. April 3-5, 1978. University of Wyoming, Laramie, WY.

Mortensen, C. 1989. Visitor use effects within the Knobstone trail corridor. Journal of Soil and Water Conservation. March/April. 156-159.

Mould, E.D., and C.T. Robbins. 1981. Nitrogen metabolism in elk. J. Wildl. Manage. 45:323-334.

Moyle, P.B., and R.A. Leidy. 1992. Loss of biodiversity in aquatic ecosystems: Evidence from fish faunas. In P.L. Fiedler and S.K. Jains, editors. Conservation biology: The theory and practice of nature conservation. Chapman and Hall, New York.

Muller, L.D., B. Johnston, P. Beeis, K. Houston, L. Stewart, J. Mastel, and D. Finch. 1992. Biological Diversity Assessment: a technical report used in amending the Rocky Mountain Regional Guide.

New Mexico. 2006. Petition of Governor Bill Richardson for State Specific Rulemaking to Protect Roadless Areas in New Mexico, May 31. Santa Fe, NM. 38 pp.

New Mexico/Energy, Minerals and Natural Resources Department. 2008. Off-Road Vehicle Recreation in New Mexico: Senate Joint Memorial Report. Santa Fe, NM. 194 pp.

New Mexico Endemic Salamander Team. 2008. Comment letter to SFNF Travel Management Planning and Jemez Mountain Salamander Conservation, February 6. 4 pp.

New Mexico Environment Department/Surface Water Quality Bureau. 2008. SWQB Comments and Recommendations for a Proposed Santa Fe National Forest Travel Management Plan. Santa Fe, NM. 5 pp.

New Mexico Game and Fish Department. 1994. Management Plan for the Jemez Mountain Salamander on the Santa Fe National Forest, New Mexico. New Mexico Endemic Salamander Team. Santa Fe, NM.

New Mexico Game and Fish Department. 2006. Wildlife, Habitat and Hunting: New Mexico's Roadless Areas. Santa Fe, NM. 42 pp.

New Mexico Game and Fish Department. 2007. Comment letter to Santa Fe National Forest Travel Management Planning Phase III, NMGF No. 11649. Santa Fe, NM, 4 pp.

New Mexico Game and Fish Department. 2008. Comment letter to Santa Fe National Forest Travel Management Proposed Action, NMGF No. Doc. 12188. Santa Fe, NM, 9 pp.

Noss, R.F., and A. Cooperrider. 1994. Saving natures legacy: Protecting and restoring biodiversity. Island Press, Washington, D.C.

Oris, J.T. 1998. Toxicity of ambient levels of motorized watercraft emissions to fish and zooplankton in Lake Tahoe, California/Nevada. Center for Environmental Toxicology and Statistics, Miami University, Oxford, OH. April 1998

Owens, N.W. 1977. Responses of wintering brent geese to human disturbance. Wildfowl 28:5-14.

Oxley, D.J., M.B. Fenton, and G.R. Carmody. 1974. The effects of roads on populations of small mammals. Journal of Applied Ecology 11:51-59.

Parker, E.R., and H. Jenny. 1945. Water infiltration and related soil properties as affected by cultivation and organic fertilizers. Soil Sci. 60:353-376.

Pedersen, R.J. 1979. Management and Effects of Roads in Relation to Elk Populations. In R. Ittner, D.R. Potter, J.K. Agee, and S. Anschell, editors. Recreational Effect on Wildlands -- Conference Proceedings. October 27-28, 1978, Seattle, WA.

Penland, S.T. 1976. The natural history and current status of the Caspian tern (*Hydroprogne caspia*) in Washington State. University of Washington, USA.

Perry, D.A. 1988. Landscape patterns and forest pests. Northwest Environmental Journal. 4.

Peters, J.E. 1972. The ecological implications of trail use, Cypress Hills, Alberta. Thesis. University of Alberta, Edmonton, Alberta, Canada.

Pickett, S.T.A., and P.S. White. 1985. The ecology of natural disturbance and patch dynamics. Academic Press, Inc.

Pierce, B.A., and D.K. Wooten. 1992. Genetic Variation in tolerance of amphibians to low pH. J. Herpetol. 26: 422-429.

Pirnie, M. 1998. Taste and odor properties of MTBE and implications for setting a secondary maximum contaminant level. Prepared for the Oxygenated Fuels Assoc., June 26, 1998.

Povey, A., and M.J. Keough. 1991. Effects of trampling on plant and animal populations on rocky shores. Oikos 61:355-368.

Raghavan, G.S.V., E. McKyes, I. Amir, M. Chasse, R.S. Broughton. 1976. Prediction of Soil Compaction Due to Off-Road Vehicle Traffic. Transactions of the ASAE. 610-613.

Reed, R.A., J. Johnson-Barnard, and W.L. Baker. 1996. Contributions of roads to forest fragmentation in the Rocky Mountains. Conservation Biology 10: 1098-1106.

Reich, P.R., and R.G. Amundson. 1985. Ambient levels of ozone reduce net photosynthesis in tree and crop species. Science 230: 566-570.

Reijnen, R., and R. Foppen. 1994. The effects of car traffic on breeding bird populations in woodland. I. Evidence of reduced habitat quality for willow warbler (*Pylloscopus tochilus*) breeding close to a highway. Journal of Applied Ecology 31:85-94.

Renninson, D.C. and A. Wallace. 1976. The extent of acoustic influence on off-road vehicles in wilderness areas. Department of Mechanical Engineering, University of Adelaide, Australia, 19 pp.

Rich, A.C., D.S. Dobkin, and L.J. Niles. 1994. Defining forest fragmentation by corridor width: the influence of narrow forest-dividing corridors on forest-nesting birds in southern New Jersey. Conservation Biology 8:1109-1121.

Robert, H.C., and C.J. Ralph. 1975. Effects of human disturbance on the breeding success of gulls. Condor 77:495-499.

Rogers, H.H., and J.C. Campbell. 1979. Nitrogen-15 dioxide uptake and incorporation by *Phaseolus vulgaris* (L). Science 206: 333-335.

Rogova, T.V. 1976. Influence of trampling on vegetation of forest meadow and whortleberry-moss-pine forest cenoses. Soviet Journal of Ecology 7:356-359.

Rongstad, O.J. 1980. Research needs on environmental effects of snowmobiles. In R.N.L. Andrews and P. Nowak, editors. Off-road vehicle use: A management challenge. U.S. Department of Agriculture, Office of Environmental Quality. Washington, D.C.

Rosen, P.C., and C.H. Lowe. 1994. Highway mortality of snakes in the Sonoran desert of southern Arizona. Biological Conservation 68:143-148.

Rost, G.R. 1975. Response of deer and elk to roads. Thesis. Colorado State University, Fort Collins, CO, USA.

Rost, G.R., and J.A. Bailey. 1979. Distribution of mule deer and elk in relation to roads. J. Wildl. Manage. 43(3):634-641.

Rotenberry, J. T., and J. A. Wiens. 1978. Nongame bird communities in northwestern rangeland. Pages 32-46 in Proceedings of the workshop: Nongame bird habitat management in the coniferous forests of the western United States. USDA Forest Service General Technical Report PNW-64. Pacific Northwest Research Station, Portland, Oregon.

Rutherford, G.K, and D.C. Scott. 1979. The effect of recreational land use on soil chemistry in a provincial park. Park News. 15:22-25.

Saber, P.A., and W.A. Dunson. 1978. Toxicity of bog water to embryonic and larval anuran amphibians. Journal of Experimental Zoology 204:133-142.

Safina, C., and J. Burger. 1983. Effects of human disturbance on reproductive success in the black skimmer. Condor 85:164-171.

Seamans, M. E. and R. J. Gutierrez. 1999. Diet Composition and Reproductive Success of Mexican Spotted Owls. Journal of Raptor Research. 33:143-148.

Schindler. D.W., K.H. Mills, D.F. Malley, D.L. Findlay, J.A. Shearer, I.J. Davies, M.A. Turner, G.A. Lindsay, and D.R. Cruikshank. 1985. Long-term ecosystem stress: The effects of years of experimental acidification on a small lake. Science 228:1395-1401.

Schonewald-Cox, C., and M. Buechner. 1992. Park protection and public roads. Pp. 373-395 in P.L. Fiedler and S.K. Jain, editors. Conservation biology: the theory and practice of nature conservation, preservation and management. Chapman and Hall, New York.

Schreiber, R.W. 1976. Growth and development of nestling brown pelicans. Bird-Banding 47:19-39.

Schreiber, R.W., and R.W. Risebrough. 1972. Studies of the brown pelican. Wilson Bull. 84:119-135.

Schultz, R.D., and J.A. Bailey. 1978. Responses of national park elk to human activity. Journal of Wildlife Manage. 42(1):91-100.

Seamans, M.E., R.J. Gutierrez, C.S. May and M.Z. Peery. 1999. Demography of two spotted owl populations, Conservation Biology, Vol. 13, No. 4, pp. 744-754.

Shaver, C., D. Morse, and D. O'Leary. 1988. Air quality in the National Parks. U.S. Department of the Interior, National Park Service, Air Quality Division. Report prepared by Energy and Resource Consultants, Inc., NPS Contract No. CX-0001-4-0054.

Shaw, S.B. et al. A Planning Basis for Adequate Fire Control on the Southern Forests. in Fire Control Notes 5 (1941), 59 pp.

Shay, R. 1979. Management Problems in Off-Road Vehicle Recreation. Proceedings of the Recreational Effect on Wildlands Conference. Seattle, WA. 1978, Conf. Proc., pp. 314-317. U.S. For. Serv. Region 6, R-6-001.

Sheley, R., M. Manoukian, and G. Marks. 1997. Preventing noxious weed invasion. Montana State University Extension.

Sheridan, D. 1979. Off-road vehicles on public land. Council on Environmental Quality, U.S. Government Printing Office. Report No. 041-011-00041-6.

Shields, L.M., C. Mitchell, and F. Drouet. 1957. Alga- and lichen- stabilized surface crusts as soil nitrogen sources. Am. J. Botany 44: 489-498.

ShulÌgin, A.M. 1965. The temperature regime of soil. Jerusalem, Israeli Prog. For Scientific Translations (translated from Russian). Available from NTIS. 218 pp.

Singer, F.J. and J.B. Beattie. 1986. The controlled traffic system and associated wildlife responses in Denali National Park. Arctic 39:195-203.

Skagen, S.K. 1980. Behavioral responses of wintering bald eagles to human activity on the Skagit River, Washington. Pages 231-241 in R.L. Knight, G.T. Allen, M.V. Stalmaster, and C.W. Servheen, editors. Proc. Of the Washington bald eagle symposium. The Nat. Conserv., Seattle, WA.

Skagen, S.K., R.L. Knight, and G.H. Orians. 1991. Human Disturbance of an Avian Scavenging Guild. Ecological Applications 1:215-225.

Skujins, J. 1975. Soil Microbiological and Biochemical Investigations. III. Tunisian Presaharan Project, Annual Report, 1974. United States/International Biological Program, Desert Biome. Utah State University Press, Logan, Utah.

Skujins, J. 1984. Microbial ecology of desert soils. Advances in Microbial Ecology 7: 49-91.

Smith, D.J., L.D. Harris, and F.J. Mazzott. 1996. A landscape approach to examining the effects of roads on the ecological function associated with wildlife movement and movement corridors: problems and solutions. Florida Department of Transportation, FL-ER-58-96.

Snow, C. 1973. Habitat management series for unique or endangered species, Report no. 7: Gold eagle *Aquila chrysaetos*. U.S. Department of Interior, Bureau of Land Management.

Snyder, C.T., D.G. Frickel, R.E. Hadley, and R.F. Miller. 1976. Effects of off-road vehicle use on the hydrology and landscape of arid environments in central and southern California. U.S. Geological Survey Water-Resources Investigations 76-99. 45 pp.
51: 564-570.

Sparrow, S.D., F.J. Wooding, and E.H. Whiting. 1978. Effects of off-road vehicle traffic on soils and vegetation in the Denali Highway region of Alaska. Journal of Soil and Water Conservation 33:20-27.

Speight, M. 1973. Outdoor Recreation and its Ecological Effects: a bibliography and review. Discussion Papers in Conservation No. 4, University College, London. 35 pp.

Spiridinov, V.N. 1979. Change in species composition of the herbage in herb birch forest under the effect of recreational stress. Soviet Journal of Ecology 9:377-379.

Stalmaster, M.V. 1976. Winter ecology and effects of human activity on bald eagles in the Nooksac River Valley, Washington. Thesis. West Washington University, Bellingham, WA, USA.

Stalmaster, M.V., and J.A. Gessaman. 1984. Ecological energetics and foraging behavior of overwintering bald eagles. Ecol. Monogr. 54:407-428.

Stalmaster, M.V., and J.R. Newman. 1978. Behavioral responses of wintering bald eagles to human activity. J. Wildl. Manage. 42:506-513.

Stalmaster, M.V., and J.L. Kaiser. 1998. Effects of Recreational Activity on Wintering Bald Eagles. Wildlife Monographs. No. 137. 46 pp.

Stalmaster, M.V., and R.G. Plettner. 1992. Diets and foraging effectiveness of bald eagles during extreme winter weather in Nebraska. J. Wildl. Manage. 56:355-367.

Stebbins, R.C. 1974a. Off-Road Vehicles and the Fragile Desert. The American Biology Teacher. Part 1. 36(4):203-208.

Stebbins, R.C. 1974b. Off-Road Vehicles and the Fragile Desert. The American Biology Teacher. Part 2. 36(5):294-304.

Stebbins, R.C., and N.W. Cohen. 1976. Off-Road Menace: A Survey of Damage in California. Sierra Club Bulletin. 61(7):33-37.

Stewart, D.P.C., and K.C. Cameron. 1992. Effect of trampling on the soils of the St. James Waldway, New Zealand. Soil Use and Management 8:30-36.

Stolzy, G. and A.G. Norman. 1961. Factors limiting microbial activities in soil. Archiv Mikrobiologie 40: 341-350.

Stout, B.M., III. 1992. Effect of off-road vehicle use on vegetative communities of northern Canaan Valley, West Virginia. Final Report of The Canaan Valley Task Force. Wheeling Jesuit College, Department of Biology, Wheeling, WV.

Sun, D., and M.J. Liddle. 1991. Field occurrence, recovery, and simulated trampling resistance and recovery of two grasses. Biological Conservation 57:187-203.

Sun, D., and M.J. Liddle. 1993a. Plant morphological characteristics and resistance to simulated trampling. Environmental Management 17(4):511-521.

Sun, D., and M.J. Liddle. 1993b. A survey of trampling effects on vegetation and soil in eight tropical and subtropical sites. Environmental Management 17(4):497-510.

Swihart, R.K., and N.A. Slade. 1984. Road crossing in *Sigmidon hispidus* and *Microtus ochrogaster*. Journal of Mammology 65(2):357-360.

Tahoe Regional Planning Agency. 1997. Motorized watercraft environmental assessment 5-4.

Talberth, J. 1997. Letter to the Forest Plan Revision Team. San Juan- Rio Grande National Forest. 12 pp.

Talberth, J. and B. Bird. 1998. State of the Southern Rockies: San Juan-Sangre de Cristo Bioregion, Forest Guardians, Santa Fe, NM. 103 pp.

Taylor, G.E., B.M. Ross-Todd, and C.A. Gunderson. 1988. Action of ozone on foliar gas exchange in Glycine max (L.) Merr.: a potential role for endogenous stress ethylene. New Phytologist. 110: 301-308.

Taylor, H.M., and E. Burnett. 1964. Influence of soil strength on the root-growth habits of plants. Soil Sci. 98:174-180.

Temple, S.A. 1986. Predicting effects of habitat fragmentation on forest birds: a comparison of two models. Pages 301-304 in J. Verner, M.L. Morrison, and C.J. Ralph, editors. Wildlife 2000, modeling habitat relationships of terrestrial vertebrates. University of Wisconsin Press, Madison, Wisconsin.

Thiel, R.P. 1985. Relationship between road densities and wolf habitat suitability in Wisconsin. American Midland Naturalist 113:404-407.

Theil, R.P. 1987. The status of the Canada lynx in Wisconsin, 1865-1980. Wisconsin Academy of Sciences, Arts and Letters 75:90-96.

Thomas, J.W., H. Black, Jr., R.J. Scherzinger, and R.J. Pedersen. 1979. Deer and elk. Pages 104-127 in Jack Ward Thomas, editor. Wildlife Habitats in Managed Forests: the Blue Mountains of Oregon and Washington, USDA Forest Service. Agricultural Handbook No. 553. Pacific Northwest Forest and Range Experiment Station. Portland, OR.

Thompson, R.W. 1994. Effects of Forest Fragmentation at Ski Areas on Breeding Neotropical Bird Guilds. In: 1992-1993, 1994 Baseline Wildlife Studies for Vail Ski Area's Proposed Category III expansion. Prepared for Vail Associates, Inc., by Western Ecosystems, Inc. 1994.

Thurber, J.M., R.O. Peterson, T.D. Drummer, and S.A. Thomasma. 1994. Gray wolf response to refuge boundaries and roads in Alaska. Wildlife Society Bulletin 22:61-68.

Timmins, S.M., and P.A. Williams. 1991. Weed numbers in New Zealand's forest and scrub reserves. New Zealand Journal of Ecology 15(2):153-162.

Titus, J.R. and L.W. VanDruff. 1981. Response of the common loon to recreational pressure in the Boundary Waters Cano Area, northeastern Minnesota. Wildl. Mongr. 79.

Tjârnlund, U., G. Ericson, E. Lindesjàà, I. Petterson, and L. Balk. 1995. Investigation of the biological effects of 2-cycle outboard engines' exhaust on fish. Marine Environmental Research. 39:313-316.

Tjarnlund, U., G. Ericson, E. Lindesjoo, I. Petterson, G. Akerman, and L. Balk. 1996. Further studies of the effects of exhaust from two-stroke outboard motors on fish. Marine Environmental Research 42(1):267-271.

Torbet, H.A. and C.W. Wood. 1992. Effects of soil compaction and water-filled pore space on soil microbial activity and nitrogen losses. Communications in Soil Science Plant Analysis 23: 1321-1331.

Tremblay, J., and L.N. Ellison. 1979. Effects of human disturbance on breeding of black-crowned nigh herons. Auk 96:365-369.

Tyser, R.W., and C.A. Worley. 1992. Alien flora in grasslands adjacent to road and trail corridors in Glacier National Park, Montana. Conservation Biology 6:253-263.

U.S. Consumer Product Safety Commission. 1998. All-terrain vehicle exposure, injury, death, and risk studies. 85 pp.

U.S. Department of Agriculture/Forest Service. 1983. Terrestrial Ecosystem Survey of the Santa Fe National Forest. Albuquerque, NM. 563 pp.

U.S. Department of Agriculture/Forest Service. 2001. 66 Federal Register 3244.

U.S. Department of Agriculture/Forest Service. 2004. Terrestrial Ecosystem Survey of the Prescott National Forest. Albuquerque, NM. 724 pp.

U.S. Department of Agriculture/Forest Service. 2004a. Forest Service Releases Draft Policy on Off-Highway Vehicle Use in National Forests and Grasslands. release no. FS-0418, Washington DC.

U.S. Department of Agriculture/Forest Service. 2004b. Biological Assessment for the Continued Implementation of the Land and Resource Plans for the Eleven National Forests and National Grasslands of the Southwestern Region. Albuquerque, NM. 817 pp.

U.S. Department of Agriculture/Santa Fe National Forest. 1987a. Environmental Effect Statement, Santa Fe National Forest Plan. Santa Fe, NM. 366 pp.

U.S. Department of Agriculture/Santa Fe National Forest. 1987b. Santa Fe National Forest Plan. Santa Fe, NM. 254 pp.

U.S. Department of Agriculture/Santa Fe National Forest. 1990. Special Closure Medio Dia Canyon Trail, 10-128. November 15, Santa Fe, NM. 1 pp.

U.S. Department of Agriculture/Santa Fe National Forest. 1992. Order Special Prohibition Road Closure Los Utes Road #288, 10-147. November 5, Santa Fe, N.M. 1 pp.

U.S. Department of Agriculture/Santa Fe National Forest. 2002a. Environmental Assessment for the Jemez National Recreation Area Forest Plan Amendment and Management Plan. Santa Fe, NM. 85 pp.

U.S. Department of Agriculture/Santa Fe National Forest. 2002b. Management Plan for the Jemez National Recreation Area. Jemez Springs, NM. 27 pp.

U.S. Department of Agriculture/Santa Fe National Forest. 2004. Santa Fe National Forest Forest Level Roads Analysis Report, Version: January 28, 2004. Santa Fe, NM. 51 pp.

U.S. Department of Agriculture/Santa Fe National Forest. 2006a. Environmental Assessment, Alamo, Bear Springs, Bland and Del Norte Range Allotment Analysis. May 30, Santa Fe, NM. 100 pp.

U.S. Department of Agriculture/Santa Fe National Forest. 2006b. Travel Management Planning: Existing Conditions, Road and Off-Road Closures and Restrictions. Jemez Ranger District, Jemez Springs, NM. 7 pp.

U.S. Department of Agriculture/Santa Fe National Forest. 2008. Scoping Letter for the Peralta Canyon Watershed Improvement Project, Jemez Ranger District. Jemez Springs, NM. 3 pp.

U.S. Department of Agriculture/Santa Fe National Forest. 2008a. Proposed Action for Managing Motorized Travel, MB-R3-10-5. Santa Fe, NM. 52 pp.

U.S. Department of Agriculture/Santa Fe National Forest. 2008b. Travel Analysis Report. Santa Fe, NM. 38 pp.

U.S. Department of Agriculture/Natural Resources Conservation Service. 1996. Soil Quality Information Sheet. Soil Quality Resource Concerns: Compaction.

U.S. Department of the Interior/Bureau of Land Management. 1975. Evaluation Report. 1975 Barstow-Las Vegas motorcycle race. 109 pp.

U.S. Department of Interior/Fish and Wildlife Service. 1993. 58 Federal Register 14248.

U.S. Department of Interior/Fish and Wildlife Service. 1995. Recovery Plan for the Mexican Spotted Owl: Vol. 1, Albuquerque, N.M. 172 pp.

U.S. Department of Interior/Fish and Wildlife Service. 2003. Biological Opinion for the Blue and San Francisco Rivers Prepared for 16 Grazing Allotments on the Apache-Sitgreaves National Forest. Phoenix, AZ.

U.S. Department of Interior/Fish and Wildlife Service. 2005. Programmatic Biological and Conference Opinion on the Continued Implementation of the Land and Resource Management Plans for the Eleven National Forests and National Grasslands of the Southwestern Region. Cons. #2-22-03-F-366. Phoenix, AZ. 1010 pp.

U.S. Department of Interior/Fish and Wildlife Service. 2008. Biological Opinion for the Authorization of Additional Activities at Elk Ridge Ski Area. AESO/SE 22410-2009-F-0053, Phoenix, AZ. 13 pp.

U.S. Department of Interior/National Park Service. 1983. Yellowstone National Park Natural Resources Management Plan and Environmental Assessment.

U.S. Forest Service/National Park Service. 1996. Regional Assessments -- What We Learned and How We are Using Them. Air Resource Management Quarterly Newsletter.

Vaillancourt, D.A. 1995. Structural and microclimatic edge effects association with clearcutting in a Rocky Mountain forest. Thesis. Department of Geography and Recreation, University of Wyoming, Laramie, WY, USA.

Van der Zande, A.N. and P. Vos. 1984. Effect of a semi-experimental increase in recreational intensity on the densities of birds in groves and hedges on a lake shore in The Netherlands. Biological Conservation 30:237-259.

Van Dyke, F.G., R. H. Brocke, and H.G. Shaw. 1986. Use of road track counts as indices of mountain lion presence. J. Wildl. Manage. 50:102-109.

Veihmeyer, F.J., and A.H. Hendrickson. 1948. Soil density and root penetration. Soil Sci. 65:487-493.

Verbeek, N.A.M. 1982. Egg predation by northwestern crows: Its association with human and bald eagle activity. Auk 99:347-352.

Verkaar, H.J. 1988. The possible role of road verge and river dykes as corridors for the exchange of plant species between natural habitats. Pages 79-84 in Karl-Friedrich Schreiber, editor. Proceedings of the 2nd International Seminar of the International Association for Landscape Ecology, Schoningh, Paderborn.

Viles, A. 2000. The BlueRibbon Coalition: Protector of Recreation or Industry? U.S. PIRG Education Fund, Washington DC.

Vohman, E.C. 1997. Effects of roads and trails on wildlife and ecosystems. A survey of relevant research for High Country Citizens' Alliance.

Vollmer, A.T., B.G. Maza, P.A. Medica, F.B. Turner, and S.A. Bamberg. 1976. The effect of off-road vehicles on a desert ecosystem. Environ. Manage. 1(2):115-129.

Vos, D.K., R.A. Ryder, and W.D. Graul. 1985. Response of breeding great blue herons (*Ardea herodias*) to human disturbance in north central Colorado. Colonial Waterbirds 8(1):13-22.

Ward, A.L. 1985. The response of elk and mule deer to firewood gathering on the Medicine Bow Range in southcentral Wyoming. Pages 28-40 in R.W. Nelson, editor. Proceedings of the 1984 western states and provinces elk workshop. Wildl. Branch, Fish and Wildl. Div., Edmonton, Alberta.

Ward, A.L., J.J. Cupal, A.L. Lea, C.A. Oakley, and R.W. Weeks. 1973. Elk behavior in relation to cattle grazing, forest recreation, and traffic. Proceeding of the Thirty-eighth North American Wildlife Conference. 38:327-337.

Ward, R.M., and R.C. Berg. 1973. Soil compaction and recreational use. Prof. Geogr. 25:369-372.

Warwick, K.R. and G. Taylor. 1995. Contrasting effects of five native herbs which coexist in calcareous grassland. Global Change Biology 1: 143-151.

Wasser, J.S. 1986. The relationship of energetics of falconiform birds to body mass and climate. Condor 88:57-62.

Watson, T.B. 1995. Evaluation of an intensive sampling and analysis method for carbon monoxide. Journal of the Air and Waste Management Association 45:29.

Weaver, T., and D. Dale. 1978. Trampling effects of hikers, motorcycles and horses in meadows and forests. J. Applied Ecol. 15:451-457.

Webb, R.H. 1978. The effects of off-road vehicles on desert soil in Dove Springs Canyon. In K. Berry, editor. Proc. of the Symposium on the Physical, Biological, and Recreational Effects of Off-Road Vehicles on the California Desert. So. Calif. Acad. Sci., Spec. Pub.

Webb, R.H. 1982. Off-road Motorcycle Effects on a Desert Soil. Environmental Conservation 9(3):197-208.

Webb, R.H. 1983. Compaction of Desert Soils by Off-Road Vehicles. Pages 31-80 in R.H. Webb and H.G. Wilshire, editors. Environmental effects of off-road vehicles: Effects and management in arid regions. Springer-Verlag, New York.

Webb, R.H. and H.G. Wilshire. 1980. Recovery of Soils and Vegetation in a Mojave Desert Ghost Town, Nevada, USA. Journal of Arid Environments 3: 291-303.

Webb, R.H., H.C. Ragland, and W.H. Godwin. 1977. Soil erodibility and erosion control recommendations, final report on Hollister Hills State Vehicular Recreation Area. Unpublished report to the Resources Division, Calif. Dept. Of Parks and Recreation. 17 pp.

Webb, R.H., H.C. Ragland, W.H. Godwin, and D. Jenkins. 1978. Environmental Effects of Soil Property Changes with Off-Road Vehicle Use. Environmental Management 2(3):219-233.

Webb, R.H., H.G. Wilshire, and M.A. Henry. 1983. Natural recovery of soils and vegetation following human disturbance. Pages 279-302 in R.H. Webb and H.G. Wilshire, editors. Environmental effects of off-road vehicles: Effects and management in arid regions. Springer-Verlag, New York.

Wegner, J.F., and H.G. Merriam. 1979. Movements by birds and small mammals between a wood and adjoining farmland habitats. J. Appl. Ecol. 16:349-358.

Wein, R.W., G. Wein, S. Bahret, and W.J. Cody. 1992. Northward invading non-native vascular plant species in and adjacent to Wood Buffalo National Park, Canada. Can. Field Nat. 106(2):216-224.

Weinstein, M. 1978. Effect of Off-Road Vehicles on the Avifauna of Afton Canyon, California. Bureau of Land Management. Department of the Interior. Final Report #CA-060-CT7-2734.

Wellburn, A.R. 1990. Tansley review no. 24: why are atmospheric oxides of nitrogen usually phytotoxic and not alternative fertilizers? New Fetologist 115: 395-429.

West, N.E. 1981. Nutrient cycling in desert ecosystems. Pages 301-324 in D.A. Goodall and R.A. Perry, editors. Arid land ecosystems: Structure, functioning, and management, vol. 2. Cambridge University Press, Cambridge.

Westhoff, V. 1967. The ecological effect of pedestrian, equestrian and vehicular traffic on vegetation. Proceedings and Papers of the Tenth Technical Meeting of I.U.C.N. 10:218-223.

Whitcomb, R.F., C.S. Robbins, J.F. Lynch, B.L. Whitcomb, M.K. Klimkiewicz, and D. Bystrak. 1981. Effects of forest fragmentation on avifauna of eastern deciduous forest. Pages 125-205 in R.L. Burgess and D.M. Sharp, editors. Forest dynamics in man-dominated landscapes. Springer-Verlag, New York.

White, C.M. and T.L. Thurow. 1985. Reproduction of ferruginous hawks exposed to controlled disturbance. Condor 87:14-22
.
White, J.J., J.N. Carrol, J.G. Lourenco, and A. Downing-laali. 1993. Baseline and controlled exhaust emissions from off-highway vehicle engines. Society of Automotive Engineers/Southwest Research Institute/California Air Resources Board. Pisa, Italy.

Wilcove, D.S. 1985. Nest predation in forest tracts and the decline of migratory songbirds. Ecology 66(4):1211-1214.

Wilcove, D.S., and S.K. Robinson. 1990. The effect of forest fragmentation on bird communities in eastern North America. Pages 319-331 in A, Keast, editor. Biogeography and ecology of forest bird communities. SPB Academic Publishers, The Hague, Netherlands.

WildEarth Guardians, 2008. Comments to Santa Fe National Forest Travel Management Planning Phase III, Draft Proposed Action. Santa Fe, NM. 97 pp.

Wilkins, K.T. 1982. Highways as barriers to rodent dispersal. Southwest Naturalist 27(4):459-460.

Willard, B.E., and J.W. Marr. 1971. Recovery of alpine tundra under protection after damage by human activities in the Rocky Mountains of Colorado. Biological Conservation 3(3):181 -190.

Wilshire, H.G. 1983. The effect of vehicles on desert soil stabilizers. Pages 63-66 in R.H. Webb and H.G. Wilshire, editors. Environmental effects of off-road vehicles: effects and management in arid regions. Springer-Verlag, New York.

Wilshire, H.G. and J.K. Nakata. 1976. Off-road vehicle effects on California's Mojave Desert. Calif. Geol. 29(6):123-132.

Wilshire, H.G., and J.K. Nakata. 1977. Erosion off the road. Geotimes. 22:27.

Wilshire, H.G., G.B. Bodman, D. Broberg, W.J. Kockelman, J. Major, H.E. Malde, C.T. Snyder, and R.C. Stebbins. 1977. Effects and management of off-road vehicles. The Geological Society of America. Report of the Committee on Environment and Public Policy.

Wilshire, H.G, S. Shipley, and J.K. Nakata. 1978. Effects of off-road vehicles on vegetation. Forty-Third North American Wildlife Conference. Pages 131-139 in K. Sabol, editor. Transactions of the 43rd North American Wildlife and Natural Resources Conference, March 18-22, Phoenix, AZ

Winner, W.E., and C.J. Atkinson. 1986. Absorption of air pollutants by plants and consequences for growth. Trends in Ecology and Evolution 1:15-18.

Wittinger, W.T., J.S. Waller, A. Vandehey, A.M. Soukkala, R.D. Mace, R.B. Harris, D. Godtel, P. Dolan, and K. Ake. 1998. Managing motorized access to grizzly bear habitat on multiple-use lands. Inter-Agency Grizzly Bear Committee.

Wooding, F.J., and S.D. Sparrow. 1979. An assessment of damage caused by off-road vehicle traffic on subarctic tundra in the Denali Highway area of Alaska. Pages 89-93 in R. Ittner, D.R. Potter, J.K. Agee, and S. Anscher, editors. Proceedings Recreation Effect on Wildlands Proceedings, Seattle. U.S. Forest Service, Pacific Northwest Region No. R-6-001-1979.

Wooley, J.B., and R.B. Owen. 1978. Energy costs and daily energy expenditure in the black duck. J. Wildl. Manage. 42:739-745.

Yalden, D.W. 1992. The influence of recreational disturbance on common sandpipers *Actitis hypoleucos* breeding by an upland reservoir, in England. Biological Conservation 61:41-49.

Yalden, P.E. and D.W. Yalden. 1990. Recreational disturbance of breeding golden plovers *Pluvialis apricarius*. Biological Conservation 59:243-262.

Yarmoloy, C., M. Bayer, and V. Geist. 1988. Behavior responses and reproduction of mule deer, *Odocoileus hemionus*, does following experimental harassment with an all-terrain vehicle. Canadian Field-Natur. 102:425-429.

Zarn, M. 1974. Habitat management series for unique or endangered species: Osprey. U.S. Department of Interior, Bureau of Land Management, Tech. Not. 254.

Zeedyk, William D. 1996. Managing roads for wet meadow ecosystem recovery. USDA Forest Service. Southwestern Region. USDOT. FHWA-FLP-96-016. Washington, D.C.

APPENDIX A

SUMMARY OF SFNF TERRESTRIAL ECOSYSTEM SURVEYDATA

Map Number Unit Component: **severe** erosion rating for wheeled off road vehicles

5	0.1
74	0.1
74	0.2
100	0.2
101	0.1
102	0.2
105	0.1
107	0.2
108	0.1
113	0.1
113	0.2
114	0.1
17	0.2
23	0.1
30	0.2
33	0.1
33	0.2
34	0.1
34	0.2
37	0.1
38	0.1
38	0.2
45	0.1
50	0.2
54	0.1
61	0.1

63	0.1
65	0.1
127	0.2
128	0.2
128	0.3
135	0.2
136	0.1
137	0.1
138	0.1
139	0.1
149	0.1
150	0.11

Map Number Unit Component: current soil loss greater than **tolerance**

2	0.1
74	0.1
74	0.2
100	0.2
101	0.1
105	0.1
108	0.1
111	0.2
113	0.1
113	0.2
17	0.1
17	0.2
23	0.1
27	0.1
30	0.1
30	0.2
61	0.1
63	0.1
64	0.1
64	0.2
65	0.1
127	0.2
128	0.2
128	0.3
159	0.1
159	0.2

Map Number Unit Component: **severe** erosion rating for wheeled off road vehicles

161	0.2
162	0.1
169	0.1
206	0.1
207	0.1
207	0.2
208	0.1
214	0.2
215	0.1
215	0.2
216	0.1
221	0.1
224	0.1
228	0.1
228	0.2
229	0.1
229	0.2
230	0.1
234	0.1
234	0.2
234	0.3
236	0.1
237	0.1
251	0.1
252	0.1
252	0.2
255	0.1
258	0.1
259	0.1
259	0.2
260	0.1
260	0.2
261	0.1
262	0.1

271	0.1
275	0.1
278	0.1
280	0.1
281	0.1
284	0.2
287	0.1
287	0.2

Map Number Unit Component:
current soil loss greater than **tolerance**

169	0.1
187	0.1
207	0.1
207	0.2
208	0.1
213	0.1
214	0.1
214	0.2
215	0.1
215	0.2
216	0.1
216	0.2
258	0.1
259	0.1
259	0.2
280	0.1
280	0.1

Map Number Unit Component:
severe erosion rating for wheeled off road vehicles

288	0.1
298	0.1
298	0.2
300	0.1
300	0.2
320	0.1
320	0.2
329	0.1
331	0.1
332	0.1
333	0.1
334	0.2
335	0.1
336	0.1
337	0.1
340	0.1
341	0.1
343	0.1
343	0.2
344	0.1
344	0.2
352	0.1
355	0.1
355	0.2
359	0.1
358	0.1
361	0.1
375	0.1
375	0.2
376	0.1
376	0.2
398	0.1
500	0.1
501	0.1

501 0.2
503 0.1
503 0.2
505 0.1
506 0.1
515 0.1
520 0.1
555 0.2

Map Number Unit Component:
current soil loss greater than **tolerance**

296	0.1
333	0.1
340	0.1
341	0.1
361	0.1
500	0.1
501	0.1
501	0.2
503	0.1
503	0.2
505	0.1
506	0.1
507	0.1
508	0.1
508	0.2
509	0.1
555	0.1
555	0.2

Map Number Unit Component:
severe erosion rating for wheeled off road vehicles

560	0.1
560	0.2
608	0.2
615	0.1
619	0.1
621	0.1
623	0.1
644	0.1
644	0.2
645	0.1
649	0.1
652	0.1
652	0.2
655	0.1
658	0.1
659	0.1
660	0.1
666	0.1
666	0.2
667	0.1
668	0.1
678	0.1
679	0.1
680	0.1
693	0.1
715	0.1
716	0.1
719	0.1
721	0.1
722	0.1

Map Number Unit Component:
current soil loss greater than **tolerance**

560 0.1

560	0.2
623	0.1
649	0.1
680	0.1
723	0.1

NOTES: The underlined map numbers/unit components in the **severe** column mean they are also in the **tolerance** column.

Severe limitation rating means OHV use "will result in significant soil degradation" (TES, Prescott NF, p. 75).

Tolerance is defined as the limit to "the rate of soil loss that can occur while sustaining inherent site productivity" (TES, Santa Fe NF, p. 11).