OUT OF CONTROL

THE IMPACTS OF OFF-ROAD VEHICLES AND ROADS ON WILDLIFE AND HABITAT IN FLORIDA'S NATIONAL FORESTS

Defenders of Wildlife

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Linda Duever of Conway Conservation, Inc. compiled and prepared the information for this report based on extensive research. Busy Shires assisted with information gathering and processing tasks. Several Defenders of Wildlife staff members worked on producing the final report: Christine Small supervised the project, coordinated field surveys of impacts on each forest and contributed to the writing and editing; Laura Watchman and Laurie Macdonald provided insight, and guidance; Kate Davies edited the report; Mary Selden and Lisa Hummon proofread and worked on the bibliography. Heather Nicholson and Chapman Stewart provided assistance with the appended species vulnerability tables. Cissy Russell designed the report and laid out the pages.

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About Defenders of Wildlife

Defenders of Wildlife is a leading nonprofit conservation organization recognized as one of the nation's most progressive advocates for wildlife and its habitat. Defenders uses education, litigation, research and promotion of conservation policies to protect wild animals and plants in their natural communities. Known for its effective leadership on endangered species issues, Defenders also advocates new approaches to wildlife conservation that protect species before they become endangered. Founded in 1947, Defenders of Wildlife is a 501(c)(3) membership organization with more than 450,000 members and supporters. Defenders is headquartered in Washington, D.C. and has field offices in several states including Florida.

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Preface

While there has been public outcry over the aesthetic affronts and obvious impacts of ORVs and roads in Florida's three national forests, the more complex and far-reaching impacts to Florida environments have not been adequately addressed. Defenders of Wildlife commissioned this report to begin to do so by providing a comprehensive compilation of the best available science-based information on ORV and road impacts, which the Forest Service, other federal and state agencies and concerned citizens need to fully understand the scope of ORV-related ecological impacts and to make intelligent decisions on motorized access to the Florida national forests.

In the following pages observations about roads and vehicles in Florida's national forests are interpreted in light of the current scientific knowledge of habitats, species, ecological processes and the impacts of roads, trails and ORVs in Florida and other areas. How the Forest Service has handled the problems created by roads and ORVs over the years is also examined.

The report concludes with specific recommendations for addressing these problems formulated in view of the Forest Service's mandated responsibilities to protect ecosystems and maintain biodiversity. An appendix summarizing the vulnerability to roads and ORVs of the plants and animals found in Florida's national forests that are listed in categories of concern under state, federal and/or Florida Natural Areas Inventory terms, and an extensive reference section covering literature cited and additional sources of information are provided for additional information.

We hope this report not only catalyzes change in the management of Florida's national forests, but also proves useful for citizens and public land managers eager to understand the impacts and assess and address the problem of roads, trails and ORVs on other public conservation lands.

CHAPTER ONE

ORVs and Roads:
A Growing Threat to America's Public Lands

Motorized vehicles first arrived on the landscape less than 100 years ago. Now they are everywhere. We rely on cars for basic transportation, trucks to haul our goods, tractors to cultivate our agricultural lands, heavy machinery to harvest timber from our forests, bulldozers to clear and grade our residential and commercial properties. Some 30 years ago off-road recreational vehicles (ORVs) joined the fleet of motorized vehicles in America and began blazing new trails.

ORVs allow us to take shortcuts through woods, streams, swamps and meadows and go where we have never gone before under motorized power. The vast category of ORVs includes pickup-truck and jeep-type four- wheel-drive (4WD) and other sport utility vehicles (SUVs), monster trucks, fat-tired swamp buggies, humvees, track vehicles, three-and four-wheel all-terrain cycles (ATCs or ATVs), snowmobiles, off-road motorcycles, airboats and any number of customized and homemade variations.

The highways and byways that accommodate America's motor vehicles are everywhere, too. Roads dissect the landscape (Forman 2000). The public lands where millions of Americans go to enjoy the outdoors are crisscrossed not only by state and county roads, access easements, designated ORV trails, service routes and other legitimate roads, but also with large numbers of unofficial roads and unmarked travelways.

In our national forests alone, thousands of miles of such travelways are not accounted for on Forest Service maps. Some do not even show up on geographic information system (GIS) layers (Hourdequin 2001). These so-called "ghost roads" typically originate as temporary logging roads, emergency vehicle and resource management access routes, firebreaks, utility corridors and nonmotorized user-created trails. More often than not, the vehicles plying these routes and creating new trails and travelways are ORVs.

ORVs are overrunning our national forests and other public lands, compounding the ecological problems associated with road density and otherwise threatening the integrity of our natural systems. Few wide-open public spaces remain where ORVs have not disturbed vegetation, crushed underground fauna and altered wetlands and soil structure and where their travelways have not destroyed, fragmented or degraded habitat.

More People, More ORVs

If national population and outdoor recreation trends are any indication, the proliferation of ORVs will continue. The U.S. population is growing fast and participation in outdoor recreation of all types is growing even faster (Cordell et al.1997; Cordell et al. 1999). The most recent National Survey on Recreation and the Environment (Cordell et al. 1997) showed that 94.5 percent of Americans enjoyed some form of outdoor recreation in 1994. By 2045, nationwide participation in outdoor recreation is projected to increase 64 percent.

Like other outdoor pursuits, off-road vehicle use has risen dramatically in recent decades (Hammitt and Cole 1987). In 1960, so few people used ORVs they were not even addressed in a nationwide survey on outdoor recreation (National Park Service 1984). By 1979, 5.3 million people were using wheeled ORVs (Feuchter 1980). Now, 28 million Americans ride ORVs roughly 685 million times per year (Bowker et al. 1999), and the number of ORVs on our public lands has increased severalfold (Schubert & Associates 1999).

As ORVs have gained in popularity, they have also gained in power. Technological advances have spawned ORVs powerful enough to tackle even the most challenging backcountry terrain, while the growth and profitability of the ORV business have given rise to a powerful industry lobby.

ORV trails fragment the longleaf pine-wiregrass ecosystem in the Ocala National Forest. Photo by Seeber Fowler

How Motorized Vehicles Overwhelm Ecosystems

Some ORV impacts such as mudholes, tire ruts and crushed vegetation are highly visible, but the more serious impacts of ORVs are much more insidious, taking place unseen at the chemical and genetic levels.

ORVs compact and destabilize soils and alter physical and chemical parameters that can affect long-term hydrological patterns, soil fertility, pH and toxicity. Crushing the surface layers of the land alters the population dynamics of subterranean organisms through both direct mortality and underground habitat fragmentation.

The animals and plants vulnerable to such impacts include ecologically critical groups that perform such important functions as fixing nitrogen, transporting micronutrients, breaking down organic debris and forming the base of the food chain.

Above ground, ORV noise and disturbance cause animals to abandon areas of valuable habitat and alter their movements and behavior, impairing reproduction and genetic diversity. These impacts reverberate throughout the ecosystem, affecting everything from predator-prey relationships to forage and seed production.

More ORVs, More Damage

Outdoor recreation generally fosters a sense of place and an appreciation for nature. However, unlike fishing, canoeing, wildlife watching and other nonmotorized forms of recreation traditionally pursued on public lands, ORV use involves powerful, heavy machinery that can inflict damage on the landscape and compromise the outdoor experience for others.

Webb and Wilshire (1983) reviewed the reasons why ORV use is prone to causing serious resource damage. One reason is that ORV users can move faster, cover much longer distances and have an impact on a much greater area in a single outing than nonmotorized recreationists. Another is simply that ORVs tend to be big and heavy. The strong forces exerted by spinning ORV tires and mechanical vibrations are extremely destructive to soil and vegetation.

ORV-created ruts such as these crisscross more than 22,000 miles of Big Cypress National Preserve. Photo by Preston Thompson

The psychology of the ORV user also factors into the potential for damage. Hammitt and Cole (1987) concluded, "...the individual who is motivated to visit an area for solitude and a passive form of recreation is likely to produce fewer impacts than the individual who is motivated to visit by a desire to affiliate with others in a motorized form of recreation." ORV users tend to be drawn to the steep slopes and sensitive boggy areas that other recreationists generally avoid. They also tend to travel off the beaten track, making law enforcement and monitoring difficult. ORVs are literally tearing up the landscape and getting away with it despite education efforts by conservation-minded ORV users and warnings sounded by scientists and others over the past few decades.

After conducting an extensive review of the relevant literature and research, Schubert & Associates (1999) concluded that "the scientific literature indisputably demonstrates that ORVs cause significant and severe direct, indirect and cumulative impacts on the environment." These impacts include:

- Wildlife disturbance, harassment, displacement and mortality;
- Vegetation and wildlife habitat destruction;
- Habitat fragmentation;
- Soil pulverization and compaction;
- Noise and chemical pollution;
- Introduction of exotic species.

Pica et al. (1998) underscore the complexity and interrelatedness of ORV impacts, noting that "they frequently interact synergistically, producing a 'whole' more damaging than the sum of the individual impacts."

More ORVs, More Roads, Even More Damage

Adding to the damage inflicted by ORVs themselves are the travelways they create. Like most roads, routes frequently traveled by ORVs are damaging to wildlife and habitat. Roads disturb wildlife, fragment habitat, degrade and pollute streams, cause erosion, serve as dispersal routes for the seeds of invasive exotic plants and open up access to previously remote sites. Large, remote forested areas of natural vegetation are especially degraded by factors associated with dissection by a road network (Forman and Hersperger 1996).

Unfortunately, many of the impacts of roads go unrecognized because they are cumulative and/or develop slowly over time and cannot be detected by casual observation or the focused short-term studies favored by research-funding programs (Noss 1996; Findlay and Bourdages 2000). Still, according to *Conservation Biology* editor Gary Meffe (personal communication 2001), "The literature is pretty clear that roads — no matter how small — are always damaging to something, and usually to lots of things."

Adding to the damage inflicted by ORVs themselves are the travelways they create.

Unauthorized ORV routes increase the road density of an area. Although not an impact or cause of an impact itself, road density suggests the relative amount of habitat sacrificed for road space and the extent of edge effects and related impacts on an area. As such it "appears to be a useful broad index of the ecological effects of roads in a landscape (Forman and Hersperger 1996)." Forest Service researchers have concluded that road densities also can serve as an index to a wide spectrum of human pressures on wildlife (Brocke et al. 1988). Reed et al. (1996) and Tinker et al. (1998) found that road density is a generally useful index to the ecologically critical parameters of patch sizes within the landscape and the amount of edge versus interior habitat.

The edge effects that originate from the exposed margins created when a road or trail cuts through an ecosystem include microclimate alterations, such as changes in moisture, sunlight, soil and air temperature gradients, wind speed and noise that can shift species composition and undermine the food chain.

Study after study has indicated that habitat quality is impaired where road densities exceed about one mile per square mile The literature on American black bears, grizzly bears, wolves, cougars, elk, large snakes and many other species suggests an impact threshold in this range (Hoctor personal communication 2001; Beringer et al. 1990; Noss et al. 1996; Van Dyke et al. 1986; Mladenoff et al.1995; Mattson et al. 1987; Lyon 1983; Mech et al. 1988; Printiss personal communication 2000).

The effects of road density can also be far-reaching. Findlay and Houlahan (1997) found that reptile and amphibian populations decreased in proportion to road density within a two kilometer (1.2 mile) buffer around a wetland. In summarizing a subsequent study, Findlay and Bourdages (2000) emphasized the long-term and cumulative implications of road density impacts, concluding that "…even if no new roads are constructed, wetland biodiversity will continue to decline in lagged response to historical increases in road densities."

Haskell (2000) summarized the implications of his own and many other significant studies in his important paper on forest road impacts: "If the goal of forest management is to maintain the function and diversity of forest ecosystems, then my results suggest that managers should minimize both the density of roads and the extent to which roads sprawl across the landscape."

Florida's National Forests: A Case in Point

Off-road vehicles and roads are wreaking habitat havoc everywhere, and Florida is no exception. According to Lieutenant Jeff Harr (personal communication 2000) of the Florida Fish and Wildlife Conservation Commission (FWCC), there has been a "tremendous increase" in ORV activity and associated resource damage and law enforcement problems, especially on the state's three national forests, the Apalachicola, Ocala and Osceola.

According to Forest Service botanist/ecologist Guy Anglin (personal communication 2000), it is "commonly accepted" that increasing ORV use is adversely affecting the dominant species in important ecological communities in the Florida national forests. Ecologist Robin Lewis (personal communication 2001) comments that the "…levels of vegetation damage and wildlife disturbance…are not sustainable by the stressed natural resources of the national forests in Florida." Doria Gordon (personal communication 2000), Florida state ecologist for The Nature Conservancy, agrees, emphasizing that the degree of ORV impact currently taking place on the Florida forests constitutes a "ludicrous abuse of our public lands."

Once trails are established, they tend to proliferate. For example, in the Paisley Area of the Ocala National Forest, trails made by horseback riders were taken over by mountain bikers and motorcyclists then ATV users (Sekerak personal communication 2000). An analysis of the area by Forest Service GIS coordinator Kathy Bronson (personal communication 2002) shows 12 to 14 miles of road and trail per square mile.

Recent Forest Service road and trail inventories identified thousands of miles of user-created ghost roads throughout the Florida national forests. As the number of user-created trails increases, natural recovery processes cannot keep up with the rate of ORV damage (Sobczak and Pernas 2001).

Core Reserves Threatened

The high road densities and extensive ORV damage in Florida's national forests are all the more alarming considering that these are the very lands identified as core reserves in a statewide plan for preventing fragmented wildlife populations and preserving the integrity of ecosystems most critical to the long-term biodiversity of the entire state.

Linked core reserves in which full complements of species and natural processes are allowed to function undisturbed are essential to maintaining a region's ecological viability over the long term. These core reserves serve as the region's genetic reservoirs and ecological reference systems. They are also crucial to the maintenance of interior habitat free of edge effects. Some of the only areas left in Florida that are large and undeveloped enough to meet the minimum requirements for core reserves are in the three national forests, the Ocala, Osceola and Apalachicola.

Reducing road densities and moderating road impacts are considered primary issues in designing reserve systems and managing conservation lands (Noss and Cooperrider 1994). Yet little research has been focused on the problem of ORVs and road density in Florida.

Even less has been done to address it. Florida's current State Comprehensive Outdoor Recreation Plan (SCORP) (Florida Division of Recreation and Parks 2001) notes that resource damage and user conflicts are widely associated with ORV recreation, but the plan does not present any data on ORV use trends.

Reducing road densities and moderating road impacts are considered primary issues in designing reserve systems and managing conservation lands

And, although it is evident that ORV use in the Florida national forests has increased dramatically, the Forest Service does not have meaningful data on the numbers of vehicles actually using these lands, much less the extent to which they are driven on roads and designated trails versus off-road, reports Forest Service planner Richard Shelfer (personal communication 2001).

Evidence Ignored

Perhaps the most distressing fact is that the Forest Service has known how destructive ORVs are and understood the basics of how they should be managed for decades. The literature includes dozens of Forest Service reports describing ORV impacts on various national forests (Harrison 1976; Brander 1974; Spolar 1979). Most of these studies have included reasonable recommendations for addressing the problem. Even the *The Record of Decision for the Revised Land and Resource Management Plan for the Florida National Forests* (U.S.D.A. Forest Service 1999) concedes that "The current permissive access policy has resulted in a maze of criss-crossed-crossing roads and travelways. Effects include user conflicts, erosion, compaction, and rutting of soils, sedimentation of streams and lakes, damage or destruction of heritage resource sites and disturbance of sensitive wildlife species including ground-nesting birds, Florida black bears and nesting vultures and wading birds."

Meanwhile, ORV users are pressuring natural resource agencies for even more access for even more vehicles. For example, motorcyclists are now asking for 400 to 500 miles of designated trail in Apalachicola National Forest, reports Jim Lyle retired Forest Service planner (personal communication 2000). ORV users and manufacturers are lobbying hard and succeeding, too. A bill passed in the state legislature in 2002 calls for establishing at least two more ORV areas on Florida's public lands. As this demand for forest recreation continues to grow, a finite number of roads and trails will most likely result in increased congestion, increased conflicts and lower user satisfaction (Gucinski et al. 2000).

The chapters that follow lay out the evidence long-ignored by the Forest Service in detail and make a case for the long-overdue changes in forest management necessary to protect wildlife and habitat and maintain ecosystems and biodiversity in the Florida national forests.

CHAPTER TWO

Hell on Wheels:
Damaging ORV Practices and Pursuits

Before getting into the details of the problems caused by roads and ORVs in Florida's national forests and the specific impacts on wildlife and habitat, a brief look at what it is that ORVers do that can be so damaging is in order.

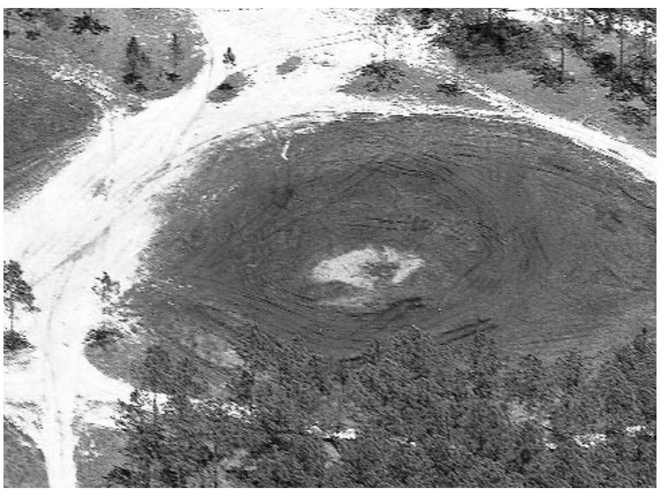
Trailblazing and Travel Patterns

Many people use their ORVs primarily as a means of transportation to pursue activities such as camping, hunting and fishing and do not intend to damage the landscape or offend other users. But simply by cutting corners, making wrong turns and taking detours off existing trails they can establish new travel patterns and blaze new trails that increase road density and habitat damage. Other ORVs will inevitability follow in their tracks, contributing to erosion and other problems and establishing deadend trails. Repeated detouring around flooded areas, downed trees and other obstacles, for example, often results in multiple "braided" trails. In wet soil or deep, sandy soil, such trails can broaden and multiply rapidly as vehicles avoid one mudhole or sandpit only to create another (McKnelly 1980).

The travel patterns ORVs tend to follow can also be problematic. For instance, ORVers usually try to maneuver around wetlands, skirting the edges or crossing at the narrowest and shallowest places. The trails they create tend to encircle ponds, lakes and cypress domes, denuding the margins of vegetation and often exposing sensitive reptiles and amphibians at critical stages of their life cycles. Then along come thrill-seeking ORVers who follow these trails, spinning their wheels and cutting deep ruts.

The zone of impact expands even farther in times of drought, according to professional naturalist and forest resident Guy Marwick (personal communication 2001). ORVs continue to travel close to the edges of the gradually shrinking pond, expanding the circle of disturbance around it inward.

Biologist Ed Keppner (personal communication 2001) studied 100 karst ponds on the Econfina Creek Wildlife Management Area in Florida's Bay and Washington Counties for the



Top: ORVs ruts such as these around Grassy Pond in Ocala National Forest have damaged 80 percent of the wetlands in restricted areas of the Ocala. Photo by Christine Small.
Bottom: An ephemeral wetland in the Ocala shows the denuded margins created by ORV traffic. Photo by Randy Cullom.

U.S. Fish and Wildlife Service (FWS) and found that every one had been seriously damaged by encircling ORV traffic. Aerial surveys of Ocala National Forest conducted by Defenders of Wildlife in April, 2000, showed that about 80 percent of the ponds in areas addressed by the Forest Service's Access Designation Process, a procedure that involves the public in determining road and trail use, had been impacted this way (Small personal communication 2001).

In upland habitats, ORVers prefer to go through the most open areas. In flatwoods and sandhills, drivers are attracted to open park-like areas with fire-maintained wiregrass groundcover. In scrub communities, they usually go through barren-looking areas with little groundcover other than algal crusts and lichens. Although they may not look it, these relatively open places are often the most ecologically sensitive areas, and trailblazing exacts a heavy toll.

Play Activities

ORVers who drive through and around wetlands and up and down steep hills and sinkhole margins for the fun and challenge of it do the most damage to Florida's national forests (Marion County Audubon Society 2000). These riders often look for places where they can jump off banks or sling mud off their tires, intentionally and illegally operating their vehicles in the most damaging ways in the most sensitive places.

The activities these thrill-seeking ORVers pursue for fun include:

- **Mudbogging**: Driving through ponds, bogs and mudholes for the challenge of not getting stuck and the fun of making mud fly and creating ruts. The end result is "pretty miserable for anything living in there," according to ecologist Ken Dodd (personal communication 2001).

- **Mudslinging**: Intentionally spinning tires through the muck to spray mud on the surrounding area, make noise and quickly create deep ruts.
- **Winching**: Attaching a winch to a nearby tree and using a rope or chain to pull a vehicle through an otherwise impassable mudhole.
- **Hill climbing**: Charging straight up hills at high speed in an attempt to climb higher and higher on steep slopes.
- **Playing in the pits**: Speeding up and down slopes, around turns and off banks, usually in and around an old mining pit or sinkhole.
- **Enduro racing** : Cross-country endurance racing, usually along a marked course full of challenges such as steep hills, mud pits and ramps, etc. Most popular with motorcycle competitions, but other types of ORVs participate in similar races and rallies under a variety of names.
- **Extreme Sports**: Challenging, physically demanding, adrenalin-charged activities pitting the ORVer against the terrain, inevitably causing substantial resource damage.

Group Events

Off-road vehicle clubs hold numerous widely publicized and heavily attended competitions and rallies in the Florida national forests, especially in the Ocala and Apalachicola. Popular events include endurance races, commonly referred to as "enduros," and competitions that fall into the category of extreme sports.

Many of these events pit man and machine against the environment — with serious ecological consequences as one might discern from the following description from the website promoting the 2000 Safari Triathalon in Ocala National Forest: "The event will consist of [sic] navigating 300 to 400 miles through water, desert-like sand, slick deep mud, sometimes in the dead of night, by compass, with longitude, latitude and dead reckoning skills… Both person and machine are tested to their limits throughout a wide variety of challenges that might include deep water, steep twisty trails, or battling mud-holes so deep the only way through is winching... yet in the next section the teams are in sand that's powder fine and measured in yards deep."

Trails broaden rapidly with repeated ORV traffic on deep, sandy soils such as these in the Springhill area of Apalachicola National Forest. Defenders of Wildlife Photo.

To make forest trails more challenging, event sponsors sometimes reroute or modify them. Such modifications have impacts of their own. Forest Service botanist Lorraine Miller

Organized ORV events such as this one in the Ocala pit man and machine against the environment. Photo by Seeber Fowler.

(personal communication 2000) expressed concern about erosion and sedimentation impacts from vehicles going over a streamside berm during the 1997 Hummer Challenge in Ocala National Forest.

Motorcycle enduros cause less damage than 4WD competitions, but they have created problems on at least one Florida tract, the Withlacoochee State Forest. The forest has a 1,700- acre designated sacrifice area for ORV use, but race routes often extend outside this designated area. Racing motorcyclists frequently cut corners or miss turns and create multiple trails at bends in the routes. Impacts documented include groundcover destruction, erosion, soil displacement, littering, cogongrass dispersal and user-created trail proliferation (Van Loan 1999).

Large gatherings organized primarily to foster comradery among ORVers can also have an impact. In 2000, Marion County Audubon Society documented severe ecological damage resulting from ORV rallies in the Ocala National Forest.

The publicity for organized ORV events also greatly increases ORV activity in the forest in general (Simons 2000; Miller 2001). People who hear about the event but don't attend often visit the forest at a later date. The people who do participate tend to make repeat visits to the forest to practice mudbogging or otherwise enjoy the challenges of traversing the forest landscape (Simons 2000).

The Forest Service monitors formal group events to some extent, but there is little supervision of subsequent visits or ORV use in general in Florida's national forests.

Inadequate Monitoring, Supervision and Law Enforcement

Group Use Permits are issued for nonpromotional and noncommercial events with fewer than 75 participants and no fee charged to participants or spectators. Applications for a noncommercial activity receive a simple denial or approval response from the Forest Service within 48 hours, and there is no monitoring of these "informal" events.

The Forest Service authorizes large, commercially sponsored group events through Special Use Permits. Before a Special Use Permit is issued, the forest wildlife biologist and botanist assess threats to proposed and federally listed species and to sensitive species. The district ranger then decides whether the event warrants an environmental assessment, an environmental impact statement or categorical exclusion under the National Environmental Policy Act (NEPA) and proceeds accordingly. An exclusion is granted if the district ranger determines that "the proposed action has not been and is not expected to be a controversial or sensitive issue" and "no extraordinary circumstances exist."

Extraordinary circumstances include the presence of steep slopes or highly erosive soils; threatened or endangered species or their critical habitat; flood plains, wetlands or municipal watersheds; congressionally designated areas such as wilderness, wilderness study areas or national recreation areas; inventoried roadless areas; research natural areas; and native American religious or cultural sites, archaeological sites, or historic properties or areas.

Turning a blind eye to the accumulation of ORV impacts, the Forest Service has never found extraordinary circumstances and has exempted hundreds of ORV events from public input and environmental analysis. Evidently, since events are supposed to take place only on numbered forest roads, special circumstances are nonexistent and "the likelihood of unreasonable damage is [presumed to be] negligible (Tooley personal communication 2001)."

The Forest Service acknowledges that there has historically been "...little documentation of monitoring the affected areas before and after [ORV] events (Shelfer 2000)." Additionally, even though most events provide funds for law enforcement, law enforcement officials often are not present at the events.

Forest Service planner Richard Shelfter reviewed the motorized event Special Use Permits issued for Ocala National Forest between March 3, 1997 and March 8, 2000. According to his report, only three events resulted in documented violations. One sponsor was assessed $200 for damage to a pine plantation, a motorcycle event was fined $50 for "...violating terms and conditions of the permit" in an unspecified way, and Superlift 4x4 Adventure 2000 organizers were fined $50 for mudbogging after the Forest Service was informed of natural resource damage by members of the Marion County Audubon Society who monitored the event (Bielling 2000). Subsequently, the Forest Service canceled two Superlift events and imposed a moratorium on ORV events.

A Lawless Frontier

Years of lax monitoring and law enforcement and low fines have made Florida's national forests an essentially lawless frontier for ORVs. Managing ORV use and enforcing regulations in the forests is nearly impossible due to the lack of law enforcement personnel.

The Forest Service has only two officers and one canine assigned to the heavily used 383,362-acre Ocala National Forest, only two officers on the 575,489-acre Apalachicola National Forest and just one on the 194,732-acre Osceola National Forest. These are the only law enforcement officers specifically assigned to enforce Forest Service regulations — not nearly enough to deal with recreation area issues much less the landscape-level abuses of ORVers. Their effectiveness in addressing current local resource abuse problems is additionally hampered by a policy known as "stovepiping" under which law enforcement officers receive their instructions directly from regional officials rather than through the district ranger like other Forest Service personnel.

The Forest Service law enforcement staff receives some support from the Florida Fish and Wildlife Conservation Commission (FWCC) officers, but in the Ocala National Forest only six are assigned to an area that includes all of Marion County east of U.S. 441 outside the forest (Harr personal communication 2000). Five FWCC officers and one supervising lieutenant are assigned to cover Liberty and Wakulla counties, including Apalachicola National Forest.

These officers spend a good deal of time in the national forest, but frequently get called to the coast, especially during the mullet run (Pridgen personal communication 2001). Six FWCC law enforcement officers and one supervising lieutenant are assigned to cover Columbia and Baker counties both inside and outside Osceola National Forest (Kay personal communication 2001).

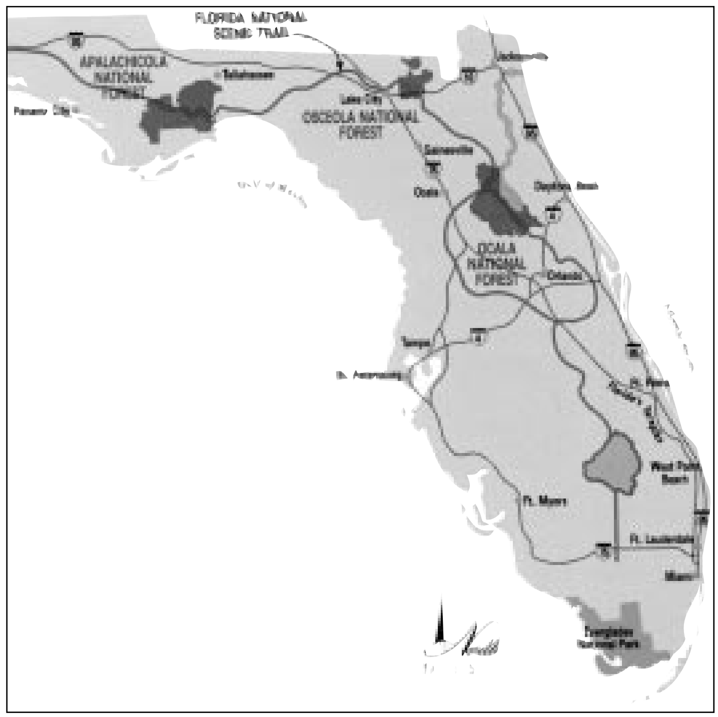
According to Lieutenant Jeff Harr (personal communication 2000), who supervises FWCC officers working in Ocala National Forest, the problem is that FWCC's few officers are seldom in the places where ORV damage is occurring. The FWCC's priority is patrolling hunting lands, and most inappropriate ORV activity takes place in "party areas" closer to urban areas. Local law enforcement officers will respond if they are called to a disturbance or are passing through the forest and see a problem, but the county sheriff's departments do not have staff assigned to patrol the backcountry.

This lack of law enforcement and failure to manage the increasing number of ORVs in the forests leads not only to more wear and tear on existing roads and trails, but also to the expansion of illegal travelways. According to Jim Lyle (personal communication 2000), the Forest Service has traditionally allowed roads and trails to be created by whomever wherever and the cumulative extent of these corridors has now become a serious problem. The Florida national forests simply have "too many roads — legal and

SECTION THREE

Kicking up Dirt:
Problems and Troublespots in Florida's National Forests

Too many roads, too many ORVs at play and not enough monitoring, supervision and law enforcement add up to serious trouble and specific problems on each one of the three Florida national forests.



Apalachicola National Forest

The 575,489-acre Apalachicola National Forest spreads across much of Florida's Franklin and Liberty Counties and extends eastward into Leon and Wakulla counties. The two ranger districts in the Apalachicola are based in Bristol on the west side of the forest and Wakulla, near Crawfordville, on the east side.

The Apalachicola is mostly a low, flat landscape of fire-maintained pine flatwoods and swamps with slightly higher areas of sandhills and sinkholes to the north. The northeast portion extends into the suburbs of Florida's capital city, Tallahassee, and is affected by urban fringe impacts. Though extensively managed for timber, the rest of the forest is generally wild country in a traditional rural landscape.

Compared to Florida's other two forests, the Ocala and Osceola, Apalachicola National Forest has a moderate road density. Still, 60 percent of the forest is above the one-mile-per-square-mile road density standard scientists recommend for ecological core habitat (Hoctor personal communication 2001).

Forest Road Systems

In addition to the state and county roads that cut through Florida's national forests, each forest has its own road system for forest management purposes.

Greenberg et al. (1997) describe the three types of unpaved roads constructed by the Forest Service in Ocala National Forest: limerock access roads, clay roads constructed to get heavy equipment into timber sale areas and sand roads built by simply clearing vegetation out of the way. These forest-management roads generally grid the forest along section boundary lines and serve as firebreaks around timber stands and burn units. The official road systems in the Osceola and Apalachicola are similar.

Pushing road density beyond acceptable limits in the forests are the thousands of miles of user- created ghost roads that are not officially recognized and roads that are closed to the public and do not appear on maps.

An Apalachicola savanna shows the deep ORV rutting from which savannas are slow to recover.Defenders of Wildlife Photo.

Four-wheel-drive vehicles cause most of the ORV problems on the Apalachicola, but there is also an organized annual enduro race and other motorcycle activity and ATV traffic, especially close to Tallahassee.

Illegal ATV activities in the forest near Tallahassee have damaged ecologically valuable sinkhole ponds and further degraded areas around borrow pits (Traylor personal communication 2000; Rohrbacher personal communication 2000). This is "the single most desperate situation" involving ORV damage to the Apalachicola, according to Forest Service wildlife biologist Jim Ruhl (personal communication 2000). Impacts are visible from the highway along the Springhill, Woodville and Crawfordville roads. Although the damage is most evident in the Woodville area, ORVs have also damaged much of the east side of the Apalachicola (Lyle personal communication 2000).

The Apalachicola's sensitive savannas draw additional ORV traffic from fish bait suppliers who use vibrating car springs to "grunt" earthworms to the surface (Anglin personal communication 2000). This is particularly damaging because recent burns are considered the best areas for worm collecting, and these are areas of sensitive new vegetation growth.

Savannas and seepages in other areas of the forest have been deeply rutted by ORVs. Mudholes and damage to areas around borrow pits can be seen along the horse trail north of Silver Lake Road off Forest Road (FR) 301 reports Forest Service forest technology specialist Ron Traylor (personal communication 2000). Ditches and savannas have been torn up along

FR 150 off State Highway (SH) 12 (Traylor personal communication 2000). Further down SH 12, four miles into the national forest along FR 105-K, mudboggers have created deep permanent ruts in the savannas (Traylor personal communication 2000). They have also run over wet savanna habitats in the Post Office Bay area in the western part of the forest (Anglin personal communication 2000) — including rare flatwoods salamander breeding ponds near the rural community of Sumatra, reports David Printiss (personal communication 2000), herpetologist with The Nature Conservancy.

Apalachicola National Forest's ecologically critical "ephemeral wetlands are magnets for ORVs (Printiss personal communication 2000)." Temporary ponds throughout the forest have been damaged (Ruhl personal communication 2000). Means et al. (1994) documented extensive ORV damage to specific ponds in the course of surveying striped newt habitat on the Apalachicola.

Upland areas have also been extensively damaged. In Munson Hills, a sandhill restoration area, the number of informal ORV trails is so great, the sheer area of road surface constitutes a significant loss of habitat (Ruhl personal communication 2000).

Ocala National Forest

The 383,362-acre Ocala National Forest covers eastern Marion County and parts of southern Putnam County and northern Lake County. There are two ranger districts in the forest: Lake George, based near Silver Springs in Marion County, and Seminole, based in Umatilla in Lake County.

The Ocala is rolling land with deep sandy soils. The world's largest contiguous sand pine forest covers most of the Ocala, but it also has substantial areas of oak scrub, sandhill, some mesic forest and numerous sinkholes, lakes, ponds, springs, streams and associated wetlands.

A dirtbiker seeks thrills in an off-limits area of Ocala National Forest popular with ORVers. Photo by Seeber Fowler.

Since the sand pine scrub habitat that dominates Ocala National Forest is an ecosystem maintained by catastrophic fires, the wildfire hazard is often extreme here (Snedaker and Lugo 1972).

Road densities are appallingly high in the Ocala. The Forest Service estimates that there are more than 1,300 miles of ORV-created trails on the Ocala National Forest (Bronson personal communication 2002). Hoctor (personal communication 2001) reports that 97 percent of the forest exceeds the the one mile per square mile standard scientists recommend for ecological core habitat. According to Hoctor, "All of the

Disappearing Roadless Areas

According to the *Revised Land and Resource Management Plan for National Forests in Florida* (U.S.D.A. Forest Service 1999), the Forest Service protects many species — including the wide-ranging Florida black bear, a state-listed endangered species, primarily by "maintaining blocks of habitat in remote condition and by acquiring further habitat lands, so that they can remain undeveloped."

"Habitat in remote condition" in national forests generally means "roadless area." Congressional designation as a Wilderness Study and Inventoried Roadless Area within the National Wilderness Preservation System is the best hope for protecting an area from road and trail development. To be considered for official Wilderness Area designation, an area must be on the list of proposed areas identified through the Roadless Area Review and Evaluation II (RARE II). Proposed Wilderness Areas must encompass 5,000 or more acres and meet a number of other criteria such as very low road density relative to size and limited human influence and disturbance.

In 1986, following a RARE II evaluation, 44,158 acres in the Florida national forests were officially designated to protect swamp and creek systems, longleaf pine wiregrass sandhills, pine flatwood lakes, bottomland hardwoods and many other rare communities. Fourteen more inventoried areas in the Florida national forests made the list of areas eligible for wilderness designation. But the Forest Service allowed road building, mining, commercial logging, utility right-of-ways and ORVs in some. By 1995 eight of the areas no longer met the criteria, and five of the six areas remaining on the list had been reduced in size. One new roadless area, 17,116 acres of the Pinhook Swamp in the Osceola, was recently acquired, but overall the Florida national forests have lost more than 48,901 acres of roadless area since 1986.

Roadless Areas Lost in the Florida National Forests

Apalachicola National Forest .... **28,679 acres**

Lost: Bay Creek, Black Creek Islands, Post Office Bay, Providence

Reduced: Gum Bay, Long Bay, Savannah

Ocala National Forest .... **14,242 acres**

Lost: Baptist Lake, Buck Lake

Reduced: Alexander Springs

Osceola National Forest .... **5,970 acres**

Reduced: Impassable Bay, Natural Area Wilderness Study

TOTAL ROADLESS AREA LOST: .... **48,891 acres**

literature suggests that under these conditions the Ocala National Forest should be suffering serious degradation of its ecological integrity."

Hannah (1992), considering only maintained roads and not jeep trails, calculated that 35 percent of the Ocala's "roadless area" is actually edge habitat and 30 percent is impacted by a bordering road. Hoctor (personal communication 2001) points out that this forest's dominantly high and dry scrub and sandhill ecosystems make the landscape readily accessible and subject to rapid road and trail proliferation. He goes on to comment that this process is exacerbated by increasing user pressures due to the forest's rapidly urbanizing setting and proximity to several major cities.

Ocala National Forest is east of and adjacent to the city of Ocala, within an hour's drive of Orlando from the south and readily accessible to the remainder of central Florida's large urban population, making it a popular weekend playground. The forest's 7,000 inholdings (10 percent of the forest area) add to the demands that make this "perhaps the most urbanized forest in the National Forest System" (Harris and Silva-Lopez 1992).

There is much more ORV pressure on the Ocala than on the other two [Florida national] forests put together," states former Forest Service wildlife biologist Art Rohrbacher (personal communication 2000). And the Forest Service realizes that "…the increased ORV usage is having a significant impact on the forest" says district ranger Jerri Marr (2001).

In 1999, the Forest Service estimated that there were 2.2 million visitor-days (one visitor day is one person for 12 hours or 12 people for one hour) in Ocala National Forest (Shelfer personal communication 2001). Only 126,500 of these forest users came to a visitor center where they might learn about Forest Service regulations and ecologically responsible behavior.

The Ocala's problems are compounded by the forest's popularity as a site for organized ORV rallies and races. These widely advertised events attract large numbers of users from

Once a pastoral sinkhole, this area in the Ocala is now eroded and ringed with ORV trails. Photo by Marcie Clutter.

Florida and all over the United States.

Extensive ORV play activity takes place in vital isolated wetlands in the Ocala (Marion County Audubon 2000; Simons personal communication 2000; Marwick personal communication 2001). This includes mudbogging, which Forest Service biologist Carrie Sekerak (personal communication 2000) describes as "extremely damaging."

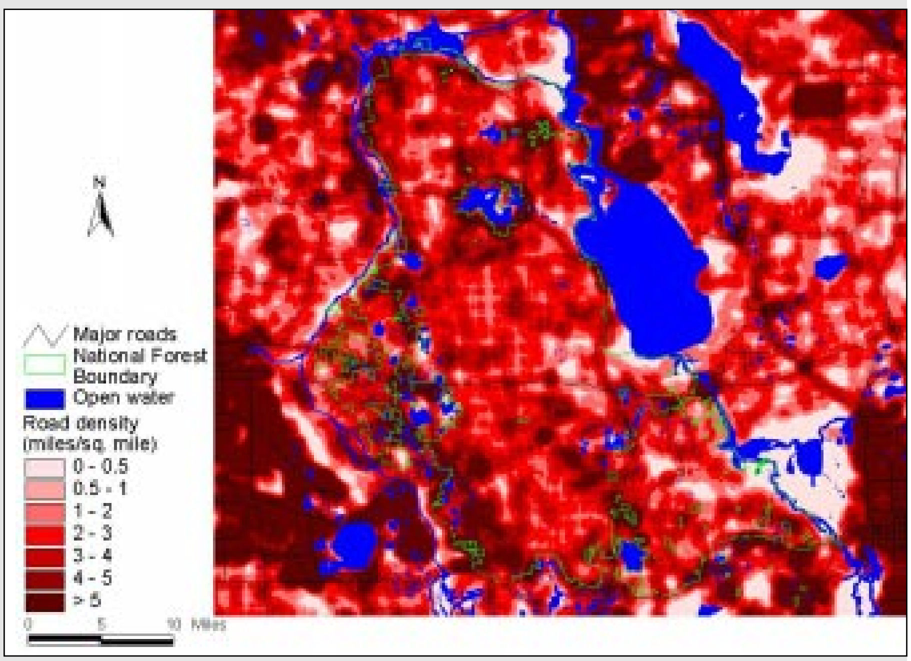
Vehicles are supposed to stay out of wetlands

Road Densities in the Florida National Forests

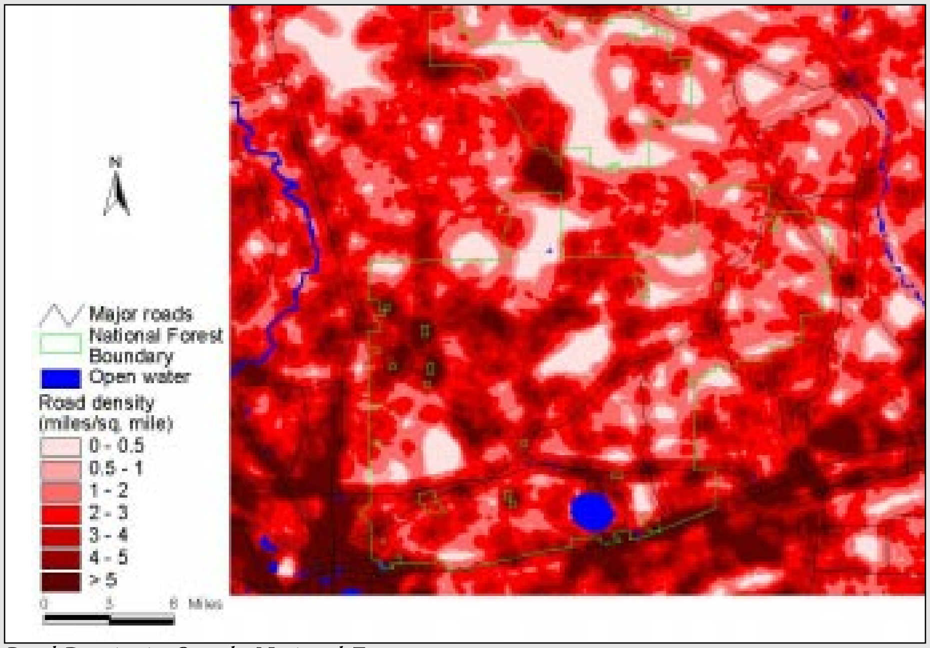
According to a recent study, none of the three Florida national forests has an overall road density below the one mile per square mile limit scientists believe is necessary to maintain high quality habitat.

University of Florida doctoral candidate and landscape ecologist Tom Hoctor (personal communication 2001) did a GIS road density analysis of the Florida national forests. He based his analysis on 1:24,000 digital line graph (DLG) road coverage from the U.S. Geological Service (USGS) and excluded areas of open water. His findings, summarized below and depicted on the accompanying maps, are alarming — all the more so considering that they are probably underestimates because some minor roads and ORV trails do not show up in DLG data.

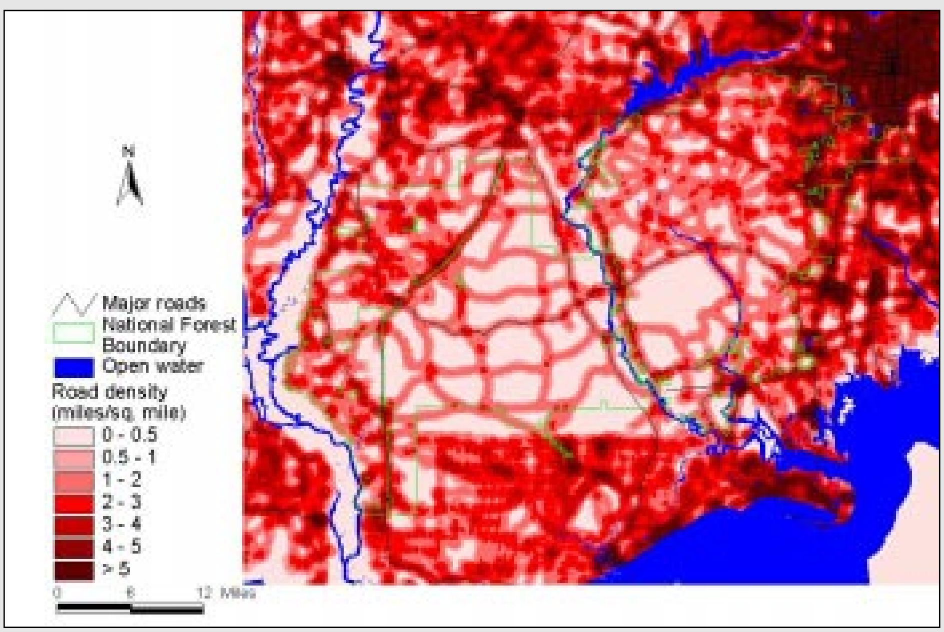
- Ninety-three percent of the Ocala National Forest has a road density greater than one mile per square mile.
- The Osceola National Forest (excluding the recently acquired Pinbrook roadless area) appears to be only marginally better with 87 percent of the area above an acceptable road density.
- Sixty percent of the Apalachicola National Forest has an overall road density greater than one mile per square mile, although the density varies from one part of the forest to another. The middle of the forest has large wetland wilderness areas and a much lower road density. The western, northwestern and northeastern sections have a higher road density. The northeastern section nearest Tallahassee has an extremely high road density.



Road Density in Ocala National Forest



Road Density in Osceola National Forest



Road Density in Apalachicola National Forest throughout the forest, and many of the affected areas have signage to that effect. Still, ORV impact surveys of the Ocala in 2000 and 2001 found 80 percent of the wetlands impacted, sometimes severely and probably irreparably (Small personal communication). Most of these impacts are in areas that are otherwise open to ORV use, not in areas closed to off-road traffic (Harr personal communication 2000).

A few of the affected areas have been documented. University of Florida doctoral candidate Steve Johnson (personal communication 2000) reports severe ORV impacts at a striped newt and gopher frog breeding site south of Salt Springs that he calls "Mud Bog Pond." Around 1998, Johnson found numerous dead gopher frog tadpoles in this pond. He also observed ORV damage to a likely striped newt breeding site north of Lake Delancy. The Forest Service has erected poles in this pond in an attempt to discourage mudboggers. Forest Service research sites have also been invaded and vandalized by ORVs traveling around or through study ponds (Greenberg personal communication 2001).

Barriers, such as these posts marking a closed area in the Ocala, are often ignored by ORVers. Photo by Marcie Clutter.

Biologist and Defenders of Wildlife Florida field staffer Christine Small's Ocala survey notes of June, 10, 2000, refer to problems in the pipeline area south of Lake Dorr and "trashed sinkholes" in the area. Other ORV-damaged ponds she recorded include Mud Pond, Bunch Ground Pond and many smaller depressions. Small also reported a population of hartwrightia that has been nearly extirpated on the powerline right-of-way in the Paisley Area.

Marcie Clutter, a Defenders volunteer and Florida Trail Association member, has documented extensive ORV impacts just south of Lake Delancy. She is particularly dismayed that a formerly pastoral sinkhole is now eroded and ringed with bare ground from ORV traffic.

The little ponds near Northeast 125th Terrace Road behind the Chippewa subdivision at the forest community of Lynne are all encircled by bare ORV impact zones, says professional naturalist and longtime forest community resident Guy Marwick (personal communication 2001). Mudbogging ORVs get stuck in the bottoms of the ponds and where the banks are steep, soil disturbance has resulted in extreme erosion, reports Marwick.

Damage is also evident along the string of ephemeral ponds from the east side of SH 19 almost to the edge of the forest, says Marion Audubon Society board member Margie Bielling (personal communication 2000).

At a January 2000 forest user access workshop, a citizen described a wetland in the scrub in the south central Ocala as "very heavily used and very damaged." In a 2001 letter to the Forest Service, Sandra Kokernoot, public lands chair for the Putnam County Environmental Council described ORV-damaged areas in the Ocala. She noted that the land between the Oklawaha River and FR 77-1 has been dissected by increasing numbers of north-south river access trails connected by a widening, potholed, east-west trail parallel to the river. She also reported that ATVs and motorcycles were going around a barrier blocking a closed road at the 90-degree turn with FR 77-G, damaging vegetation and impacting an area frequently used by Florida black bears.

Impacts also continue to spread across previously unaffected areas of the forest. Guy Marwick and Seminole Ranger District ranger Jim Thorsen recently observed miles of new ORV trails lacing Church Lake Prairie, an area south of State Road (SR) 40 that was virtually pristine just a few months before. Evidently, vehicles had followed firebreaks into the interior during drought conditions. This is especially distressing because the dense vegetation around this prairie is important bear habitat. Fourteen different Florida black bears have been observed there over the past year (Marwick personal communication 2001).

Although the public has expressed the greatest outrage over wetland impacts on the Ocala, some Forest Service biologists believe more damage has been done to wiregrass groundcover in the sandhills (Sekerak personal communication 2000). Marion County Audubon Society (2000) documented extensive ORV impacts to the wiregrass on Ocala National Forest's Riverside Island, an area long-recognized by the National Natural Landmarks program as one of the most outstanding examples of the disappearing longleaf pine community.

In the Osceola, heavy hunting season truck traffic does significant damage to wetlands such as this one. Photo by Judy Hancock.

There is also concern regarding ORV-related wildlife disturbance and harassment in Ocala National Forest. For example, ecologist Robin Lewis (2001) has formally requested that the Forest Service look into ORV activity around eagle nests. He also reports adverse impacts on endangered Florida scrub jays and on osprey nests on Lake Delancy, noting that airboaters sometimes flash floodlights into nests at night.

Osceola National Forest

The 194,732-acre Osceola National Forest in Baker and Columbia Counties is administered by the ranger district in Olustee, Florida. The Osceola is a low-relief landscape of flatwoods and swamps in a rural setting. The nearest large city is Jacksonville, an hour's drive to the east.

Unlike the Apalachicola and Ocala, which are located in regions of high endemism and serve as habitat to extraordinary concentrations of rare species, Osceola National Forest is characterized by widespread natural communities and a diversity of wetland communities that have not been extensively surveyed. Increasing hunting and other recreational pressures present challenges to land management in this forest, but much less so than in the Ocala and Apalachicola.

The number of vulnerable rare plant species in the Osceola is probably underestimated. Systematic botanical surveys looking at likely swale and pond habitats have not been conducted in this forest says U.S. Fish and Wildlife Service biologist Jane Monaghan (personal communication 2000). Also, a long history of fire suppression and winter-only prescribed burning has suppressed floral diversity in the Osceola, but rare plants are beginning to reappear in areas now managed under an ecologically appropriate fire regime (Hancock personal communication 2000).

Road densities are already high in Osceola National Forest where the situation is "only marginally better" than in the Ocala (Hoctor personal communication 2001). Indeed, Hoctor concedes that both forests "would benefit greatly from large-scale road closures."

Road densities are already high in Osceola National Forest and "only marginally better" than in the Ocala.

The forest is heavily fragmented by logging roads and a huge number of ghost roads, such as firelanes that have become ORV trails and routes parallel to the main road created by ORVs when the established roads have been muddy or flooded (Hancock personal communication 2000). This fragmentation may account for the failure of experimental reintroduction of the Florida panther in the forest (Smith et al. 1996).

The current use pattern on Osceola National Forest is typical of the early phases of ORV activity on a forest distant from population centers. "There is traffic close to houses and inholdings — mostly kids with ATVs and that sort of thing. Otherwise, it's just hunters," Osceola forester Tommy Spencer (personal communication 2000) explains: "There is not much traffic on the Osceola yet, but it's going to happen. Now is the time to plan."

There has been some impact on wetlands, however (Lyle personal communication 2000; Monaghan personal communication 2000). Judy Hancock (personal communication 2000), public lands issues chair for the Florida Chapter of the Sierra Club, says that heavy hunting season traffic of trucks with oversize tires does substantial rutting and vegetation damage to wetlands in many parts of the forest. Few of the Osceola's wetlands have been altogether spared from the scars.

This heavy hunting season use leaves Osceola National Forest vulnerable to the kind of cumulative damage that has so severely impacted the Big Cypress National Preserve. Twenty years ago, Duever et al. (1981) predicted the expansion of ORV impacts that have spread across that similar mosaic of flatwoods and wetlands in the Big Cypress. They documented that places damaged by ORVs take several years to heal and explained that recovery cannot possibly keep pace with the additional disturbance caused each year by hunters traversing their old trails and a few new places each season.

Many of the problems in Osceola National Forest are around ponds created by old borrow pits (areas excavated for landfill). Recurring ORV damage to vegetation has made it difficult to manage such ponds as fish habitat (Monaghan personal communication 2000). Another troublespot is the road through Impassable Bay to the recently acquired Summers Tract, where ORV users repeatedly tear down the gate the Forest Service installed to prevent vehicle access to this designated roadless site (Hancock personal communication 2000).

More Research Needed

Unfortunately, very little specific ORV or road impact research has been conducted in Florida forests. Wildlife biologists and conservation ecologists concede that we do not have data to define the relationship between road density and wildlife survival in Florida (Kautz 2001; Hoctor personal communication 2001). The Florida Division of Forestry has inventoried roads in Blackwater River State Forest and begun analyzing road functions, but ecological factors have not yet been examined in any depth (Vowell personal communication 2001).

Hoctor (personal communication 2001) voices the sentiments of most Florida ecologists: "It is clear that roads have many impacts on ecological integrity. To assume that may not be the case here in Florida because there has not been as much research would be unwise at best."

The next four chapters affirm the need for much more research. These chapters highlight the habitat and wildlife at risk in the Florida national forests, assess the damages inflicted by ORVs and roads and identify the most pressing problems based on the research that has been conducted in Florida and elsewhere.

CHAPTER FOUR

Crushing the Vulnerable:
Sensitive Habitats and Wildlife

Certain habitats and species in the Florida national forests are more sensitive to roads and ORVs than others. Wetland and aquatic systems, upland scrubs and sandhills, rare plants and many species of amphibians, fish, birds and mammals are especially vulnerable.

Sensitive Habitats

Wetlands and Aquatic Systems

Wetlands and aquatic systems are particularly sensitive to roads and ORV traffic (Schubert & Associates 1999; Pica et al. 1998; Aust 1994; Cusic 2000). Wet organic soils cannot bear heavy weights, so "use of areas with organic soils rapidly creates wide, muddy quagmires" (Hammitt and Cole 1987).

ORVs tear up the terrain. Photo by Seeber Fowler.

Liddle and Scorgie (1980) review the processes whereby recreational activities affect the biota of freshwater ecosystems. Vehicles going through pools and streams disrupt hydrologic processes, stir up sediments, destroy aquatic vegetation and degrade habitat for invertebrates, fish and amphibians that play key roles in the food chain (Bury 1980). Rare species that depend on such habitats are at risk of extirpation where ORVs use these areas (Sheridan 1979).

Zeedyk (1996) discusses how a road's position in the landscape affects its impact on a wetland. Even simple jeep trails must be thoughtfully designed when they pass through or near wetlands because the ruts formed by vehicles on ORV routes affect flows and alter hydrology.

Generally, the longer the hydroperiod, the more vulnerable the wetland. Duever et al. (1981) identified flooding a the most important risk factor in landscape vulnerability to ORV damage. Sobczak and Pernas (2000) documented increased ORV impacts as a result of longer periods of flooding in Big Cypress National Preserve.

Taking another perspective, Hammitt and Cole (1987) describe how boggy meadows are hydrologically damaged by recreational use, explaining that wet soil is easily churned and compacted, which breaks the sod into a "honeycombed topography" leading to increased erosion and lowered water tables. They cite the observations of DeBendetti and Parsons (1979) that consequential drying of such habitats can allow woody species to invade and replace herbaceous vegetation. And during a dry period, a sensitive wetland can be mistaken for another open field by even the most responsible recreationists. Wet or dry, wetlands are highly susceptible to damage by ORVs.

Ephemeral Ponds

Many scientists have pointed out the ecological significance of ephemeral ponds in the southeastern coastal plain (Hart and Newman 1995; Dickinson 1949; Gibbs 1993; Moler and Franz 1987; Means 1990). Temporary ponds are extremely important amphibian breeding sites in north Florida (Dodd and Cade 1998; Franz personal communication 2000). A small insignificant-looking pool may provide important habitat for 15 to 20 amphibian species (Moler and Franz 1987; Cash 1994; O'Neill 1995).

University of Florida, Florida Natural History Museum herpetologist Dick Franz (personal communication 2000) explains that fishless temporary ponds support complex communities of amphibian larvae with each species exploiting specific habitat niches and prey items. Much research is still needed to define these relationships, but it is clear that some tadpoles stay in the mud near the bottom, whereas others require the shelter of certain types of vegetation structure. Barking treefrog tadpoles, for example, are pelagic and live beneath waterlily pads. Turbidity affects the phytoplankton at the base of the food chain and alters the pond's fauna. Vegetation destruction exposes larvae to predation.

Florida Natural Areas Inventory zoologist and turtle expert Dale Jackson (personal communication 2001) points out that oil and gas leakage from ORVs might contaminate critical turtle breeding sites in isolated ponds and affect the tadpoles and small aquatic organisms that form the food base for turtles and other larger animals. Chicken turtles, mud turtles and striped mud turtles are the species most likely to

ORVs wreak habitat havoc in fragile riparian areas such as this one in the Ocala. Photo by Seeber Fowler.

be affected because they rely most heavily on isolated ponds.

Bruce and Ryan Means (2001) are assembling data on ORV impacts to isolated wetlands. Based on amphibian surveys of 300 Apalachicola National Forest ponds they have conducted over the last four years, they believe these ponds are resilient enough to recover from an occasional mudbogging incident. However, they caution that the situation is serious if a pond is subjected to heavy mudbogging over a long period of time. The fauna in such a pond is likely to suffer, especially if the habitat is altered by vegetation removal and rutting (Means and Means 2001). Means (1996) also points out that, since amphibians must move in and out of the pond in response to water levels, the barrier and roadkill hazards presented by a road within the adjoining upland buffer zone becomes "a large problem facing animals inhabiting temporary ponds."

This wetland in the Apalachicola has been devastated by ORV traffic. Defenders of Wildlife Photo.

There are places in Ocala National Forest where ORVs traveling closer and closer to ponds as the water level has dropped during recent droughts have destroyed all the marginal vegetation and left ponds formerly used by gopher frogs, wood storks and sandhill cranes encircled by 100-foot swaths of bare sand (Marwick personal communication 2001). The same situation occurs in Apalachicola National forest.

Sinkholes

Sinkholes that hold water year-round are sensitive in different ways. Many sinkholes function as drains, pouring surface runoff directly into aquatic caverns inhabited by delicate rare invertebrate species — and subsequently into the aquifers that feed our springs and wells.

The Florida Department of Environmental Protection advises landowners to keep vehicles off the slopes of sinks and springs to protect the vegetation that stabilizes the slopes (Stevenson personal communication 2001). They also recommend maintaining a buffer of natural vegetation around sinks to filter runoff. Stevenson says that no set width has been defined for such buffers, but "more is better." He explains that the appropriate buffer dimensions depend on the character of the surrounding upland plant community and the likelihood of runoff. Fire-maintained pine-lands with intact wiregrass filter runoff very effectively, so only a narrow buffer is necessary in such habitats. Where the shade of a hardwood canopy minimizes groundcover, a wider buffer is necessary.

Savannas

Duever et al. (1981) found that cypress savannas and marl or peat-based marshes and prairies were the communities most sensitive to

ORV traffic in the Big Cypress National Preserve. Sand-based prairies were damaged to a somewhat lesser extent and pine flatwoods were most resilient. Based on an analysis of GIS data, Welch and Madden (1998) observed that many Big Cypress National Preserve prairies had been so heavily damaged that the ORV trails had coalesced into large impact areas where distinct routes were no longer discernable.

The savannas in Apalachicola National Forest seem to be similarly vulnerable and slow to recover (Ruhl personal communication 2000). Rutting and vegetation changes are evident where such areas have been damaged by ORV traffic. Although Apalachicola National Forest scientists have not done scientific studies of these impacts, they have observed that St. John's wort becomes more abundant and several protected species of pitcher plants do not come back (Traylor personal communication 2000).

Rutting and vegetation damage are evident in this savanna/bayhead in the Apalachicola. Defenders of Wildlife Photo.

Other Wetlands and Aquatic Systems

Biologist Susan Carr (personal communication 2001) comments that "the worst ORV damage to native ground cover in southern national forests occurs in seepage bogs and bayheads." She explains that the hydrological patterns there are easily disrupted by rutting and recommends protecting them from ORV traffic because many listed plant species occur in such wetlands.

Coastal marshes also appear to be very sensitive. Needlerush, for example, appears to recuperate poorly from ATV damage, reports soil scientist Lyn Coultas (personal communication 2001). To protect the Cape Sable seaside sparrow, vulnerable coastal marsh habitat has been closed to airboats in southern Florida (Pernas personal communication 2000).

Streams are impacted wherever roads or trails cross them. Even if the road simply crosses at a natural ford, subsequent traffic will disturb bottom communities and cause downstream siltation. More often than not, the crossing will be stabilized with gravel and/or synthetic materials, or a bridge or causeway will be built, resulting in destruction of a substantial area of bottom and streambank and disturbance of an even greater area. Exotic species invasion often follows such disturbance and expands into downstream riparian areas (Gregory et al. 1991; Pyle 1985; Parendes and Jones 2000; Pysek and Prach 1993). Numerous reports have documented these


ORV is damage is painfully evident in Florida's national forests: Left: Silted-in Fisher Creek in the Apalachicola (Photo by Walter Tschinkle); right: Devastated Penner Ponds in the the Ocala. Photo by Marcie Clutter.

processes and associated sedimentation impacts (Kochenderfer et al. 1997). Although most of these studies have been conducted in mountainous regions where the problems tend to be more dramatic than they are in Florida, the principles are still generally applicable, says National Biological Survey aquatic ecologist Jim Williams (personal communication 2001).

Some ORV users travel in and out and along streambeds intentionally. Williams says he has seen ATVs stirring up sediment and crushing mussel beds. He is concerned about the way the resulting streambank ruts grow into gullies and channel sediment-laden runoff directly into a stream and about the toxic fuels and lubricants released when reckless operators overturn their vehicles going up or down steep streambanks.

Upland Scrubs

Sand pine and oak scrubs are sensitive desert-like habitats that are quickly denuded by ORV traffic and heal slowly. The sparse grasses and forbs in such communities are easily dislodged as vehicles loosen the dry sand. On the Lake Wales Ridge National Wildlife Refuge, scrub lupines and other rare plant species have been virtually eliminated from a number of scrub sites due to ORV activity, says ecologist Doria Gordon (personal communication 2000).

Plant ecologist Eric Menges (personal communication 2001) is concerned about ORV impacts on the lichens that characterize many areas of scrub groundcover. Lichens are easily crushed by even foot traffic and are extremely slow to recover. They are also very sensitive to air pollution from vehicle emissions. Angold (1997) documented sparse Cladonia (reindeer lichen) growth near a road and attributed it to exhaust fumes.

Greenberg et al.'s (1995) study of vegetation response to disturbance in Ocala National Forest suggests that moderate ORV traffic might inhibit the growth of larger shrubs and trees and favor development of a pioneer-type rosemary scrub characterized by widely spaced rosemary bushes and extensive areas of bare sand. Such "bare areas" may have more vegetation than is apparent, since algae and some higher plants can photosynthesize in the bright light just beneath the surface of these sunny white-sand habitats, reports Archbold Biological Station associate research biologist Mark Deyrup (personal communication 2001). These algal crusts, which are believed to be important in nutrient cycling, would surely be damaged by ORV traffic. Although they would probably recover in a matter of months, rather than the decades it takes the algal crusts of desert regions to heal, frequent ORV traffic would inhibit their recovery and affect soil nutrients.

The way ORVs tend to travel through these seemingly barren areas threatens the many scrub organisms that prefer these habitats. Several scrub reptiles, including the gopher tortoise, Florida scrub lizard, sand skink, race runner, mole skink and Florida crowned snake, use open scrub habitat with extensive areas of bare sand (Jackson 1973). Gopher tortoises frequently burrow in open upland scrub where they feed on mosses and other emergent vegetation (Macdonald and Mushinski 1986). Scrub wolf spiders and certain other invertebrates are also attracted to such places (Deyrup personal communication 2001). For example, ground-nesting bees and wasps seek out these open sunny areas as breeding sites (Minno personal communication 2001).

Scrub sands are not subject to the compaction that has such serious long-term implications for soil fauna in other habitats (Ponomarenko personal communication 2001; Carlisle personal communication 2001). However, Ken Dodd (personal communication 2001) warns that there may be places where there is enough compaction in the actual tread area to inhibit sand-swimmers, such as sand skinks, antlions and certain beetles and fragment underground habitat. This is likely to be the case in areas where clay or limerock was used to stabilize the trail surface. University of Florida soil scientist Mary Collins (personal communication 2001) acknowledges that scrub sands are not likely to be compacted by ORV traffic. However, she believes that ORV activity would likely destroy soil structure, alter bulk density, and remove organic material on sandhill sites.

ORVs do loosen and destabilize scrub sands. According to herpetologist Dick Franz (personal communication 2000), destabilization results in incidental mortality of burrowing animals and increases the incidence of burrow collapse. Caved-in gopher tortoise burrows, for example, have been observed in areas where burrows have been run over by ORVs (Macdonald personal communication 2001). Although the smaller commensal species that share the burrows may be fatally smothered, most tortoises manage to dig out of collapsed burrows. However, escaping drains energy and subjects them to exposure.

ORV traffic also removes the sparse leaf litter from the scrub soil surface, eliminating the cover that many reptiles and other small organisms rely on for predator evasion, resting and breeding. Vehicles are likely to crush organisms that live in the top few inches of the soil such as pygmy mole crickets (Deyrup personal communication 2001). Disturbance-dependent plant species may reseed on scrub habitat destabilized by ORV activity, but are subject to damage by subsequent traffic (Christman personal communication 2000; Menges personal communication 2000).

The evidence suggests that scrub habitat takes a long time to heal. For example, although jeep roads through scrub on the Lake McLeod Unit of the Lake Wales Ridge National Wildlife Refuge have rarely been used in the last 10 years, vegetation has not yet become re-established in these areas (Stout 2001). The few plants that have reinvaded are mostly annuals. The same is true of old motorcycle trails on Camp Blanding, says biologist Phil Hall (personal communication 2001).

Upland Sandhills

Many sandhill plants are slow growing and/or adapted to reproduce under very specific conditions and thus tend to be negatively impacted by ORV traffic and other ground disturbances. For example, ORVs are very damaging to the wiregrass groundcover characteristic of Florida's sandhill habitat (McPherson personal communication 2001; Clewell personal communication 2001; Sekerak personal communication 2000; Anglin personal communication 2000; Hardin personal communication 2001).

Where there is repeated light ORV traffic, weedy plants gradually replace species characteristic of the original wiregrass community. Regularly used trails turn into bare sand. There are places in the Apalachicola and Ocala sandhills where the actual area covered by the barren treads of densely interlaced ORV trails has replaced significant percentages of the sandhill groundcover (Ruhl personal communication 2000; Marion County Audubon 2000).

Botanist and restoration ecologist Andy Clewell (2001) believes that longleaf pine-wiregrass lands can absorb the ecological impacts of vehicular traffic but only if the site is not so wet that tires compact or rut the soil, not so dry that tires disrupt the soil or dislodge plants from it, and not driven over repeatedly. "Only a few repetitions cause ecological damage," says Clewell. "Once an intact longleaf pine-wiregrass ecosystem is damaged by ORVs, it will not recover for many years, even if the site is sensitively managed with growing season fires."

Florida A & M University entomologist Will Flowers (personal communication 2001) says he is aware of no empirical data on ORV impacts to the wiregrass community, but echoes the viewpoint of many other experts that vehicular traffic "can't be good for the groundcover." He studies springtails, the most abundant insects in wiregrass, and speculates that their habitat might be significantly fragmented by ORV trails because they have trouble crossing dry dusty surfaces. Motorcycles have seriously damaged (Minno personal communication 2001) lop-sided Indian grass in sandhill habitat on Riverside Island in Ocala National Forest, an area where the rare Arogos skipper lays its eggs.

Sensitive Species

"Nothing is worse for sensitive wildlife than a road (Noss 1996)." Indeed, many scientists consider road density an important indicator of habitat quality for sensitive species (Noss 1990; Forman et al. 1997; Frederick 1991; Mladenoff et al. 1995; Ruediger 1996). ORVs traveling on roads and off them forging new travelways, intensify the threat roads pose to sensitive plants and animals.

Appendix A addresses the vulnerability to roads and ORVs of plants and animals in Florida's national forests that are listed by the state of Florida, the U.S. Fish and Wildlife Service and the Florida Natural Areas Inventory (FNAI). Listed species, of course, are not the only species being affected, and certain groups of plants and animals are more sensitive than others. A few of the especially vulnerable groups are discussed briefly below.

Plants

About 90 percent of Florida's rare plant species grow in areas attractive to ORV traffic such as roadsides and forest openings, says University of Florida botanist Walter Judd (personal communication 2000). Plants vulnerable to this kind of ORV traffic include Florida bonamia, Florida skullcap and Drummond's yellow-eyed grass. Scrubs, savannas, seepages and isolated wetlands are prime rare plant habitat — and frequent sites of ORV damage, reports Florida Natural Area Inventory botanist Linda Chafin (personal communication 2000). Even the few rare plants that favor disturbed soils are at risk from heavy ORV activity.

Reptiles and Amphibians

Some reptiles are highly vulnerable to roads and ORVs. Snakes often end up as roadkill victims on the backroads frequented by ORVs. Turtles and tortoises that lay their eggs in the loose soil of an unpaved ORV route and turtles that nest near ponds where ORVers play are also at risk.

Amphibians are doubly susceptible to the impacts of roads, ORVs and landscape alteration because they require two healthy habitats, wetland and upland, to complete their life cycles. For a salamander, tire ruts around the edge of a wetland can be the equivalent of an impassable mountain range, preventing larvae from moving up and down slopes as water levels rise and fall. Larvae get trapped in these ruts and die as the water recedes (Means personal communication 2001).

Pollution and siltation within a pond and rutting around the margins damage habitat characteristics important to amphibians such as the flatwoods salamander, gopher frog, one-toed amphiuma and striped newt. They are particularly susceptible because mudbogging activities are so widespread in the isolated wetlands so critical to their life cycle.

According to Means and Means (personal communication 2001), another reason ORVs have especially severe impacts on amphibians is because most species utilize the shallowest parts of ponds exactly where mud-bogging usually takes place. They explain that this shallow habitat is crucial because these species are adapted to breathe normally only in the highly oxygenated water near the surface. Moving away from the edges leaves them highly vulnerable to predators in deeper water. Means and Means also believe that shallow pond edges may be attractive to amphibians because these areas tend to be warm during the day, cool at night and teeming with microscopic animals to eat.

Amphibians such as spadefoot toads and gopher frogs that mass metamorphose may be more vulnerable to ORV traffic around a breeding pond than those that emerge from the wetlands a few at a time (Greenberg personal communication 2001).

The type of road is also a factor. Salamanders, for example, are more reluctant to cross wider and more heavily used logging roads than lesser roads (de Maydadier and Hunter 2000).

Protecting the terrestrial areas peripheral to wetlands is also critical to maintaining viable populations and communities of amphibians. Amphibians are difficult to track, but Semlitsch (1998) summarized data on terrestrial habitat use by pond-breeding salamanders and estimated that a buffer zone would have to extend 164.3 meters from a wetland edge into the adjoining terrestrial habitat to protect 95 percent of the population. Semlitsch explains that data on movements of other amphibians suggests that a similar buffer zone would protect a wide range of species. Dubois (1991) recommended 100 to 500-meter wetland buffers for amphibian protection.

"ORV use of ponds is part of the bigger problem of habitat alteration and loss. Hopefully, we can start correcting the bigger problem by getting ORV destruction of ponds stopped on our relatively pristine public lands."

Florida species probably need even wider buffers. On the Katharine Ordway Preserve, Putnam County, Florida, striped newts have been found as much as 709 meters from breeding ponds and eastern narrow-mouthed toads as far away as 914 meters (Dodd 1996). Brown et al. (1990) suggested that 223-meter buffers be established to protect wildlife around central Florida sandhill ponds, but Dodd and Cade (1998) believe this width would be inadequate for amphibians. Ken Dodd of the U.S. Geological Service (personal communication 2001) emphasizes that wetland buffers may help, but they are not the answer, especially in sandhills. He explains that Florida pond- breeders often travel 300 to 400 meters away from wetlands, so a large area of upland habitat is also critically important.

Long-term viability of metapopulations also demands that amphibians occasionally move between ponds and not be confined to permanently separated pockets of habitat (Dodd personal communication 2001). As Means and Means (personal communication 2001) explain, "The loss or improper management of native upland habitat surrounding breeding ponds is as devastating to amphibian populations as is the loss of the ponds that they breed in. Ephemeral pond-breeding amphibians spend well over half their lives in the uplands surrounding their breeding ponds." They concluded that "ORV use…should be stopped, especially on state and federal protected lands and definitely where rare amphibians such as the gopher frog, barking treefrog, mole salamander, ornate chorus frog and striped newt occur…We don't need any more negative impacts on already reduced amphibian populations…ORV use of ponds is part of the bigger problem of habitat alteration and loss. Hopefully, we can start correcting the bigger problem by…getting ORV destruction of ponds stopped on our relatively pristine public lands."

Fish

Sedimentation caused by road runoff or ORV activity can seriously degrade fish habitat (Williams personal communication 2001; Burkhead personal communication 2001; Harr and Nichols 1993). Burkhead and Jelks (2001) point out that "Excessive sedimentation of rivers and creeks has been linked to increasing levels of imperilment in the diverse fish fauna of the southeastern United States." They explain that sedimentation leads to increased predation on fish eggs by sediment-dwelling invertebrates, increased vulnerability of adult fish to predators, reduced reproductive success, physiological stresses, gill damage, slower feeding rates and consequent weight loss, impeded ability to detect prey, decreased prey availability, increased parasitism and simplification of community structure. They cite supporting research by Berkman and Rabeni (1987), Newcombe and MacDonald (1991), Lenat and Crawford (1994), Newcombe and Jensen (1996), Wood and Armitage (1977) and others.

Aquatic ecologist Jim Williams (personal communication 2001) is particularly concerned about fish that prefer small streams, such as the goldstripe darter, a very rare small fish that occurs in the Apalachicola drainage but has not yet been documented on Apalachicola National Forest. Means and Means (personal communication 2001) note that fish species dependent on little ponds that nearly dry up seasonally are very vulnerable to ORV impacts, but there have been no studies of this specific problem. Their observations suggest that pygmy sunfish, golden topminnow, dollar sunfish, mosquitofish, pygmy killifish and other such species "…are severely impacted by mudbogging."

Birds

Forest interior songbirds and wading birds appear to be the avian groups most affected by roads and ORV activities. Populations of both are decreasing, and the influences of roads and vehicles are contributing to these losses.

Although the factors behind songbird declines undoubtedly include unrelated pesticide effects and, in the case of neotropical migrants, hunting and habitat loss in their wintering ranges, roads certainly compound the problem (Robbins et al. 1989; Terborgh 1989; Askins et al.1990; Faaborg et al. 1996; Rolstad 1991). And nest predation and mesopredators such as foxes, racoons and rat snakes make road corridors population sinks for many interior species (Wilcove 1985).

Interior songbirds such as Bachman's sparrow are displaced from roadsides when there are changes in habitat character, alterations in microclimate, and disturbance and noise impacts (Whitcomb et al. 1981; Wilcove and Robinson 1990; Noss 1988; Kroodsma 1984). Soil compaction also reduces the invertebrate soil fauna on which these birds feed (Haskell 2000).

A variety of wetland loss and degradation processes are contributing to the decline of wading birds such as the wood stork, snowy egret, white ibis and little blue heron. Apalachicola National Forest biologists attribute the scarcity of wading birds in ORV-damaged ponds to declines in the prey base (Traylor personal communication 2000). Road runoff and vehicle emissions contaminate wetlands and sediments stirred up by mudbogging ORVs smother aquatic invertebrates, kill amphibians, degrade fish habitat, and interfere with foraging, roosting and nesting.

Groundcover damage by ORVs decreases red-cockaded woodpecker habitat quality by interfering with the uniformity of burns and permitting greater oak survival (Carter personal communication 2001). This leads to increased predation by rat snakes and flying squirrels and other problems for this endangered species (DeLotelle personal communication 2001).

Vegetation degradation and disturbance from sporadic vehicle activity affect the habitat value of a 200 to 300-acre foraging area around each red-cockaded woodpecker nesting colony (Carter personal communication 2000). ORVs can also affect invertebrate abundance (DeLotelle personal communication 2001; Flowers personal communication 2001), an essential food source for red-cockaded woodpecker. ORV damage to cavity trees via root or trunk injury, soil compaction and erosion is another concern because these trees are potential woodpecker nesting sites. (Carter personal communication 2001).

Mammals

According to Harvard University road ecology expert Richard Forman (Forman and Hersperger 1996), a road density of approximately one mile per square mile appears to be the maximum to maintain a naturally functioning landscape with sustainable populations of large mammals. At three, four or five miles of road per square mile, undisturbed habitat is greatly reduced, and the numerous effects of roads may have synergistic negative effects (Hourdequin 2001).

Pelton (1985) calculated that American black bear populations in the Southern Appalachians cannot maintain viability once road density exceeds 0.8 mile per square mile. Forman et al. (1997) explain that, as road density increases, thresholds may be exceeded such that certain species are extirpated from the region, with larger animals being extirpated at lower road densities.

In the West, Mace and Manley (1993) found that grizzly bears did not use habitat with a road density greater than one to two miles per square mile. In Idaho's Targhee National Forest, grizzly bears are absent from areas with a road density of three to six miles per square mile.

CHAPTER FIVE

Infiltrating the Landscape:
The Immediate Impacts of Enhanced Access

Many road and ORV impacts are the result of enhanced human access (Trombulak and Frissell 2000; Clark et al. 1993; Young 1994; Stankey 1980; Buckley and Pannell 1990; Hoctor personal communication 2001; Kuss et al. 1990; Mychasiu and Hoefs 1988). More roads, trails and vehicles greatly increase accessibility, which greatly increases the related impacts on an area such as as damage to vegetation and habitat, wildlife mortality and injury and changes in wildlife behavior. Increased access also brings increased illegal activities such as poaching, collecting and harassing animals, littering, setting fires and introducing exotic species.

Damage to Vegetation and Habitat

Off-road vehicles tend to crush, uproot and tear plants as they drive over them. Many studies have documented serious vegetation damage resulting from ORV activity (Snyder et al. 1976; McKnelly 1980; Florida Division of Recreation and Parks 2001; Berry 1980; Pica et al. 1998; Schemnitz and Shortemeyer 1972; Westhoff 1967; Wilshire et al. 1978) such as:

- Fewer plants;
- Altered hydrology;
- Reduced vegetation cover;
- Less vigorous growth;
- Less diversity;
- Exotic species invasion and other undesirable changes in species composition;
- Alteration of successional and nutrient cycling processes.

Routes used repeatedly may have little or no vegetation regrowth. Laessle (1942) studied plants growing along roads and trails at the Welaka Reserve in Putnam County, Florida. He distinguished and described vegetation characteristic of firelanes, shell roads, clay roads and sand roads, noting that "Ordinarily, dry sand roads have no vegetation in the tracks because the dry sand is agitated too much for any plants to become established."

Root breakage and soil compaction caused by ORVs may eventually kill trees and other perennials that initially appear to have suffered little damage. All-terrain vehicles tend to dis-

ORVS and Habitat Change in Big Cypress National Preserve

In Big Cypress National Preserve in southwest Florida, Duever et al. (1981) confirmed that ORV traffic alters the structure and composition of marsh and prairie plant communities. They found that the average height of the understory was the vegetation parameter initially most affected by ORV traffic. Percent cover was least affected and biomass was intermediately affected. Over the first growing season, height and biomass recovered to a greater degree than percent cover did. Species composition was altered in virtually all significantly impacted plots (other than those damaged by airboats), with the greatest changes in the cypress savanna habitat and on marl soils and the least on pinelands and sandy soils.

One year after impact, the researchers observed reductions in sawgrass, hairgrass and maidencane in experimental ORV lanes on marsh and prairie sites. Lemon bacopa and bladderwort had proliferated in rutted areas, apparently in response to extended flooding in the tire ruts and increased sunlight because of damage to the shrub canopy. Seven years later, Asiatic coinwort and grasses had become more abundant and sawgrass more sparse in the ORV trails as compared to similar nearby sites (Duever et al. 1986).

In the pine flatwoods, there was less change in species composition. After one year of regrowth, only slight increases in sawgrass, coinwort and longspike musky mint and slight decreases in maidencane and wiregrass were observed on the ORV plots compared to undisturbed sites. Seven years later, St. John's wort, primrose willow and yellow-eyed grass were more abundant in ORV trails than in comparison areas, while marsh fleabane and sawgrass were less so (Duever et al. 1986).

place loose soil and injure exposed tree roots used as anchors for winching out ORVs stuck in mud. McKnelly (1980) documented root damage to trees at stream crossings. Hammitt and Cole (1987) explain that trees growing in thin or dry soils and trees with thin bark or a particular susceptibility to decay tend to be the most seriously affected by the impacts of recreation.

Shrubs and small trees seem to be at greater risk than smaller woody plants or larger trees. Duever et al. (1986) noted that cypress less than three feet or more than 10 feet in height tended to survive ORV encounters, whereas intermediate-size trees were often killed. A shrub cover reduction of 90 percent was observed on one California ORV area (Hammitt and Cole 1987). Archbold Biological Station plant ecologist Eric Menges (personal communication 2001) suspects that shrubby species like scrub plums and pawpaws may be particularly vulnerable to ORV activities in scrub communities.

ORV traffic can also change the habitat characteristics on which various species depend. For example, the loss of wetland trees and shrubs can affect nesting or roosting wading birds. The disappearance of grasses can discourage Florida sandhill crane nesting. This can result in increased mortality and decreased reproductive success, as animals are forced to rely on suboptimal habitat or to exert precious energy in an effort to locate and compete for alternate habitat (The Wilderness Society 2000).

Damage to Wildlife

Direct Hits: Mortality and Injury

Numerous reports have documented and discussed roadkill impacts on wildlife populations as a major conservation problem (Drews 1995; Noss 1996; Lalo 1987; Kline and Swann 1998; Bennett 1991; Forman and Alexander 1998). The problem may be even more extensive than currently recognized as some scientists believe that road mortality impacts are still underestimated (Mumme et al. 2000).

Roads are attractive to animals (Noss 1996; Adams and Geis 1981). Some large mammals use lightly traveled unpaved roads as travel corridors. Snakes and other heat-loving animals bask on warm sunny road surfaces (Whitford 1985). Birds use dirt roads for dust baths. Butterflies, frogs, and other creatures congregate around mud puddles in ruts and potholes. Environmental scientist and Florida butterfly expert Marc Minno (personal communication 2001) has observed thousands of skipper and other butterflies gathering around ruts on Ocala National Forest roads in the spring. Herbivores graze on the lush herbaceous vegetation that characterizes sunny road edges.

In the Appalachians, black bears are attracted to roadsides by the abundance of foods like blackberries and pokeberries in these disturbed habitats (Noss 1996). The same behavior by bears in the Ocala National Forest is observed annually as acorns become abundant on roadside oaks (Small personal communication 2001). Predators also come to hunt the rodents that exploit roadside habitat, and scavengers come to eat the remains of those killed by the traffic (Van Der Zande et al. 1980). Because they present a dangerous attraction, roads are considered "mortality sinks" inclined to lure animals to their deaths (Noss 1996). Larger roads with heavier and faster traffic are worse, but even jeep trails function this way to some extent.

Paved Roads

On paved roads, roadkill is the leading known cause of death for large mammals in Florida (Noss 1996). According to the Florida Fish and Wildlife Conservation Commission (FWCC), the state-listed species most vulnerable to roadkill in Florida are the Florida panther, Florida black bear, key deer and American crocodile (Kautz 2001). Noss (personal communication 2001) also notes that scrub jays and loggerhead shrikes are highly prone to roadkill.

Much more research is needed to determine the relationship between road density and frequency of roadkills in Florida. However, it is interesting to note that black vultures, turkey vultures and other scavengers that feed on "flattened fauna" along roads preferentially establish home ranges in areas with higher road densities (Coleman and Fraser 1989).

Harris (personal communication 2001) believes that intensity of use is an extremely important factor in determining the impact a road has on wildlife, but he emphasizes that we cannot assume that wildlife response to road use is a linear relationship. He explains that lightly used roads may have positive values for wildlife that to some degree counterbalance their negative impacts. Harris also points out that busy roads generally do not have proportionately greater habitat impacts or higher roadkill rates than roads with moderate traffic volumes.

Reactions to traffic level may also be species or region-specific. McLellan and Shackleton (1988) noted that traffic volume was irrelevant to grizzly bear avoidance of roads in Montana. The bears they studied avoided zones along frequently traveled routes and also along busier roads. However, in a study of radio-collared black bears in the southern Appalachians, Brody and Pelton (1989) found that the frequency with which black bears crossed roads was inversely related to traffic volume

In Florida's national forests, vehicle-caused mortality for the black bear, scrub jay and bald eagle is primarily on paved roads through the forests rather than unpaved roads. Mumme et al. (2000) concluded that "...roadside habitat constitutes a population sink of a particularly insidious and destabilizing nature for Florida scrub jays." They explain that the young birds attracted to territories vacated by collision victims are the birds most vulnerable to being struck and most valuable to the breeding population.

Organisms that live on or just beneath the surface of the soil are extremely vulnerable to ORV traffic.

Unpaved Roads

Unpaved roads and trails may be even more treacherous than paved ones.

ORVs running cross-country run over and crush birds, reptiles, amphibians and other creatures (Barnwell 2000; Bury and Marlow 1973; Ruhl personal communication 2000). Fahrig et al. (1995), Ashley and Robinson (1996), deMaynadier and Hunter (2000) and Langton (1989) noted that low-traffic roads and jeep trails are more dangerous for amphibians than for larger animals.

Organisms that live on or just beneath the surface of the soil are extremely vulnerable to ORV traffic. As Kuss et al. (1990) point out, "Recreational use exerts profound effects on microhabitats…with invertebrate species associated with the soil or ground flora more likely to be affected…."

Florida Department of Environmental Protection biological scientist Dan Pearson (personal communication 2001) explains the dangers of unpaved roads: "Grassy vegetation along unimproved roads obscures the driver's view of the ground surface and prevents the driver from seeing and avoiding animals on the road surface. To make matters worse, animals on unimproved roads may be less likely to flee an oncoming vehicle since they are more secure within a vegetated surface than on open pavement. To compound this even further, in fire-suppressed areas of sandhills, scrub or flatwoods, unimproved road corridors may be attractive to certain species such as gopher tortoises and other reptiles seeking open grassy areas for feeding and basking sites. The overgrown nature of adjacent areas causes these species to seek out openings in the canopy such as powerline right-of-ways and roads."

Pearson (personal communication 2001) reports that there have been a number of documented deaths of listed species on unimproved roads on Florida's Paynes Prairie State Preserve over the past decade. These are infrequently traveled roads open only to park vehicles. Several gopher tortoises and at least one Florida pine snake have been hit or killed by preserve service vehicles. Gopher tortoises and pine snakes have also been killed by vehicles in Lake Louisa State Park, where most roadkills occur along a dirt road (Bard 1993).

Biologist Mary Barnwell (personal communication 2000) has recorded numerous gopher tortoise roadkills, as well as deaths and near-misses of a number of species (black rail, barn owl, bobwhite, box turtle, yellow rat snake, black racer, coral snake, cottonmouth, ground skink, oak toad and southern toad) along jeep trails open only to Southwest Florida Water Management District vehicles.

Florida Division of Recreation and Parks biologist Erik Johnson (personal communication 2001) notes that although Florida state park staff throughout the state have reported large numbers of animals killed on park roads, this data has not been compiled. What records there are do not consistently note if the fatalities occurred on paved or unpaved roads (Charest 1994).

Roadkill on unpaved roads may be most significant to the mortality rates for snakes (Wilson and Porras 1983; Rosen and Lowe 1994; Enge personal communication; Bernadino and Dalrymple 1992) and other smaller, less noticeable animals (Evink et al. 1996). Forest Service biologists studied the relationship between roads and snake populations on Angelina National Forest in eastern Texas and found that populations of large species were reduced by 50 percent within 450 meters of a road (Rudolph et al. 1999). They observed little difference in the effect of a heavily traveled state highway versus Forest Service and county roads with much lower traffic volume. They concluded that, on the Angelina National Forest, a forest with habitats similar to those of the Florida forests, "…a substantial proportion of the expected snake fauna has been eliminated across the landscape due to road-related mortality."

Fahrig et al. (1995), Ashley and Robinson (1996), deMaynadier and Hunter (2000) and Langton (1989) noted that low-traffic roads and jeep trails are more dangerous for amphibians than for larger animals. Amphibians may be especially vulnerable because their life histories often involve migration between wetland and upland habitats, and individuals are inconspicuous and sometimes slow-moving (Trombulak and Frissell 2000). Of the 22,000 roadkills documented on Paynes Prairie State Preserve in 1991, 21,000 were frogs (Pearson 1993). Palis (1994) reported high frog mortality along a secondary road next to a breeding pond near Apalachicola National Forest. Wyman (1990) pointed out that salamanders are especially at risk because they tend to "freeze" on the approach of a vehicle.

Habitats such as the pools that form in rutted ORV trails pose problems as well. These pools can function as "ecological traps" by encouraging animals to live in places where their chances of survival and reproduction are low (Wederkinch 1988). Adams and Lacki (1993), Phelps (1993), Semlitsch (1987), de Maynadier and Hunter (2000), biologist John

Disturbance Factors

Macdonald (1998) identified the following factors affecting the short-term impact of recreational trail disturbance on wildlife:

- type of species and flushing distances,
- type and intensity of human activity,
- time of year and time of day;
- type of wildlife activity (feeding, nesting, roosting, migrating).

He points out that human disturbance of breeding animals can cause nest abandonment, decline in parental care, shortened feeding times, increased stress and lower reproductive success. Animals representing different populations of the same species may respond to the same human behaviors differently, based on previous experience with people. Animals living in areas where there is hunting, for example, are more likely to be disturbed by other human activities.

Palis (personal communication 2000) and others report observing amphibians breeding in ruts, potholes and roadside ditches where they are highly susceptible to ORV traffic. FWCC herpetologist Paul Moler (personal communication 2000) has seen tiger salamander larvae in ruts on Blackwater River State Forest. Oak toads, striped newts and other small animals are sometimes trapped in ruts and unable to escape approaching vehicles (Barnwell personal communication 2000; Traylor personal communication 2000). DiMauro (1998) explains how the relatively short hydroperiod in these pools may contribute to breeding failures.

Turtles and tortoises can fall into a similar "ecological trap" by selecting the loose sand of an ORV route or access road as a place to lay their eggs (Jackson personal communication 2001; Stout 2001; Berish 2001; Jones 1994), prolonging vulnerability of adult females to vehicle collisions and putting their nests and offspring at risk of being crushed by subsequent traffic. ORVs also might uncover nests or compact soils to the point hatchlings have trouble exiting the nest (Berish 2001).

Turtles that nest near ponds are also at risk from ORV traffic. Turtle experts Burke and Gibbons (1995) studied aquatic turtle nest patterns in sandy upland habitats around ponds on the South Carolina coastal plain and calculated that it would be necessary to protect buffers extending 73 meters beyond the edges of wetlands to prevent damage to the nests of 90 percent of the turtle population. A 273-meter buffer would have been required to protect all the turtle nests in their study area.

Changes in Predator-Prey Relationships

When top predators are eliminated by vehicle-related accidents and other causes, populations of opportunistic predators such as foxes, raccoons and opossums increase, leading to declines of the songbirds and ground-dwelling reptiles and amphibians on which they feed (Noss 1990). Thus off-road vehicle impacts may have far-reaching implications for the food chain and species composition.

Roads and trails can also give predators an unnatural advantage. On the Southwest Florida Wildlife Management District's Potts Preserve, biologists have observed increased predation on apple snails and hatchling stinkpot and mud turtles by hogs accessing the marsh via airboat trails (Barnwell personal communication 2000). Ecologist Jack Stout (2001) notes that raccoons readily locate and raid turtle nests along sand roads. Virtually all the turtle nests along Wakulla Springs State Park roads are destroyed by raccoons and fish crows (Whitehouse 1993). On Apalachicola National Forest, cottonmouths have been observed preying on striped newts and other small amphibians in tire ruts (Traylor personal communication 2000).

Wildlife Disturbance

Disturbances caused by noise, intentional harassment or less obviously intrusive human activities can increase stress levels and energy expenditures for wild animals. Such wildlife disturbance is one of the primary concerns associated with ORV impacts (Boyle and Sampson 1983; Florida Division of Recreation and Parks 2001).

Stress from fear or vehicle noise may cause animals near roads to have faster heart rates, hence higher metabolic rates and energy expenditures even when traffic is minimal

Stress from fear or vehicle noise, may cause animals near roads to have faster heart rates, hence higher metabolic rates and energy expenditures, even when traffic is minimal (MacArthur et al. 1979). "Prolonged resistance to intrusion can lead to neurosis, weight loss, assumption of secretive habits, reduced reproductive success, voluntary spatial or temporal withdrawal from available habitat, and subsequent reduction in the local carrying capacity for the wildlife species (Kuss et al. 1990)."

Newman (personal communication 2001) explains how complicated it is to assess wildlife disturbance impacts: "It depends upon the species, the importance of the behavior that is disrupted, the timing of the disturbance, whether the disturbance is 'truly threatening,' whether the effects are important, temporary or permanent, whether the animals are acclimated or can acclimate, whether there are appropriate buffers from both the visual and auditory perspective, etc. My research on disturbance and the disturbance literature indicates all these factors need to be evaluated in looking at effects whether they be from ORVs or other human activities or inventions."

Human Intrusion

Bennett and Zuelke (1999) did an extensive survey of the pertinent literature and summarized that disturbance related to human recreation clearly affects the behavior and movement of birds on at least a short-term basis.Flushing birds from a nest , for example, exposes eggs or young to potentially lethal heat, cold or predation (Larkin 1996). The critical factor is how long the birds are kept away from the nest. With most raptors, devastating results are likely if the parents are away for only a short period of time (Awbrey and Bowles 1990; Call 1979). Portnoy (1974) documented that red-shouldered hawks may abandon nests in response to human disturbance. Similar problems occur when people or vehicles disturb wading bird rookeries (Hoctor personal communication 2001; Rodgers 1991; Klein 1993).

Richardson and Miller (1997) reviewed the literature on raptor flushing behavior and recommended nest buffer zones for a number of species: osprey, 400 to 1,500 meters; Cooper's hawk, 400 to 600 meters; red-tailed hawk, 800 meters; bald eagle 250 to 800 meters; peregrine falcon, 800 to 1,600 meters; American kestrel (50 to 400 meters). They reported that bald eagles flushed from vehicles at 50 to 990 meters and American kestrels at 12 to 115 meters.

Klein et al. (1995) documented species-specific waterbird responses to vehicles on Ding Darling National Wildlife Refuge in southwest Florida. Although many species acclimate to continuous highway traffic, they found increasing levels of waterbird disturbance with increasing numbers of vehicles along a lightly traveled road on the refuge.

According to Rodgers (1991), the recommended disturbance buffers for wading birds range from 69 to 100 meters. He suspects that upland songbirds would require less and estimates that 45 to 60 meters would be an effective buffer to protect most bird species from vehicle-related disturbances

Noise

Noise can have serious consequences for wild animals. Many species rely on sensitive hearing for survival. Vehicular noise can prevent such animals from locating prey, detecting predators, finding mates or doing other things essential to survival. Since many species hear noise at different levels and frequencies than humans, even sounds that seem reasonable to us can be very disturbing to wildlife.

Behavioral responses to noise may decrease an animal's chances of surviving and reproducing (Larkin 1996). Noise may cause an animal to retreat from favorable habitat. It may also cause an animal to reduce the time it spends feeding. The resulting depletion of energy can decrease reproductive success. Noise can also interfere with communication essential for reproduction and decrease responsiveness.

Some wild animals may suffer long-term hearing loss in response to short-term noise exposures that would not affect humans. Bondello et al. (1979) documented hearing loss in Mohave fringe-toed lizards after only short periods of ORV noise. Road noise has been found to affect nesting birds up to 1,000 meters away (Forman and Alexander 1998). Brattstrom and Bondello (1983) confirmed Weinstein's (1978) observations that ORV noise caused long-term hearing loss in some species that resulted in abnormal behavior and difficulty detecting predators.

Weinstein reported that the sound of an approaching ORV flushed birds out of vegetated riparian corridors and into the air over open areas even with the vehicle as much as 3.2 kilometers away and not visible. Stalmaster and Newman (1978) observed that bald eagles seemed less disturbed by noises when they could not see the source.

Several studies have reported that frogs may avoid calling in response to other noises (Barrass 1985; Gerhardt 1988; Larkin 1996). Popp

ORVs and the Endangered Red-Cockaded Woodpecker

The red-cockaded woodpecker, an endangered species with critical primary core populations in the Apalachicola and Osceola National Forests and an important support population in the Ocala, can be sensitive to ORV noise disturbance, especially during the breeding season. Thus the U.S. Fish and Wildlife Service's red-cockaded woodpecker recovery plan calls for a 200- foot buffer around each cluster of cavity trees. No road construction or ORV use is allowed within buffer areas because excessive noise and other disturbances caused by ORVs and motorized logging equipment may disrupt nesting activities, decrease feeding and brooding rates and lead to nest abandonment. Such problems led to a court order that forced the Forest Service to close many ORV trails to reduce disturbance to red-cockaded woodpeckers in the Sam Houston National Forest in Texas (Schubert & Associates 1999).

The endangered red-cockaded woodpecker. Photo by Todd Engstrom.

No cavity tree damage or cluster abandonment has been documented in ORV areas in the Florida forests (Rohrbacher personal communication 2000), indicating that red-cockaded woodpeckers can adapt to noise under certain circumstances, but the frequency, intensity, duration and seasonality of disturbance is critical. In the Apalachicola, for example, red- cockaded woodpecker populations nesting within 200 feet of roads have actually increased (Rohrbacher personal communication 2000). However, there is concern about red- cockaded woodpecker colonies dissected by roads in the Ocala (Marwick personal communication 2001). The Forest Service is considering a ban on motorcycle trails in the vicinity of nesting colonies (Sekerak personal communication 2000) because, as biologists discovered on the Croom Motorcycle Area on Withlacoochee State Forest, extensive motorcycles trails make prescribed burning for habitat maintenance impossible. The fact that motorcycles are louder than other ORVs is also a concern, but data on the extent of this impact is lacking.

(1989) documented similar behavior in songbirds. Barrass also found that fewer egg masses were produced in ponds where male frogs called less frequently during periods of road noise, which implies that this change in behavior has reproductive consequences.

Habituation

Habituation occurs when animals get used to a predictable disturbance and learn to ignore it. Pica et al. (1998) point out that habituation generally seems to take place only when ORV activities occur along a predictable path at predictable times. Where ORVs are driven off-trail, animals are unable to predict their activity patterns and consequently do not have the opportunity to become habituated (Schubert & Associates 1999).

If visitors stay on the trail, animals perceive them as relatively predictable and therefore less of a threat (Macdonald 1998). However, reactions may be species or situation specific. Hammitt and Cole (1987) point out that many animals develop a tolerance for predictable events, but are affected by unpredictable types of disturbance, whereas others tolerate infrequent disturbance but not more frequent activity.

For example, former Florida Fish and Wildlife Conservation Commission biologist David Maehr (personal communication 2001) believes that ORV trail disturbance of Florida bears and panthers is negligible because such trails are predictably used during the day and the animals get used to this activity pattern.

Poole (1981) observed that osprey can become accustomed to "fairly continuous activity" near their nests and reproduce at normal rates. Plumpton and Lutz (1993) found that burrowing owls generally ignored the sound of nearby traffic and reproduced normally near a regularly traveled road. Blodget (1978) found that where nesting areas were well-marked and effectively protected, least terns developed a similar tolerance for nearby ORV activity.

Although habituation may initially appear to decrease impacts, it may actually increase them. Habituated animals are more vulnerable to hunting, harassment and collisions and more likely to become involved in human-wildlife conflicts leading to euthanasia or removal as "nuisance animals."

Poaching, Collecting and Harassment

Off-road vehicle drivers sometimes harass wildlife (Hoover 1973; Neil et al. 1975). "The access that roads provide to hunters, poachers and collectors is one of the biggest problems of roads in Florida" (Noss personal communication 2001). Research has established that few hunters walk very far from a road and therefore most hunting — both legal and illegal — occurs close to roads (Harris personal communication 2001; Noss and Harris 1986). Hunting success is directly correlated with road density (Brocke et al. 1988).

Road-associated illegal shooting has been documented to be one of the primary causes of grizzly bear mortality in the West (Noss 1996; McLellan and Mace 1985; Dood et al. 1986; Knick and Kasworm 1989). Northern researchers have documented dramatically greater wolf mortality rates in areas where road density exceeds about one mile per square-mile. Although different studies have suggested somewhat different road density thresholds, all authors have attributed the magnitude of wolf losses in roaded landscapes to the increased accessibility of these areas to people inclined to shoot wolves (Peterson et al. 1984; Theil 1985; Jensen et al. 1986; Mech et al. 1988; Thurber et al. 1994).

ORV-aided turkey poaching is a problem on Apalachicola National Forest (Ruhl personal communication 2000). Vehicular access also makes it easier for people to bring dogs into the forest, and these pets often harass wildlife. ORV access facilitates hunting with dogs, too, both legally and illegally (Anglin personal communication 2000) and illegal collecting activities.

Animals are collected for the pet trade in natural areas throughout Florida. There is particular concern about potential impacts of commercial collecting of scarlet kingsnakes and Apalachicola kingsnakes on Apalachicola National Forest (Ruhl personal communication 2000). According to FWCC biologist Kevin Enge (personal communication 2001), springtime snake collectors strip the bark off every dead pine visible from a road on Apalachicola National Forest to look for kingsnakes, eliminating microhabitat for other organisms in the process.

Roads facilitate and intensify both permitted and illegal collection of rare plants, timber poaching and the removal of ecologically valuable snags and logs for firewood (Bird 1999). They also increase harvesting of a wide array of other potentially significant forest materials including wood, pinecones, mushrooms, herbs, butterflies, berries, earthworms, wildflowers, pinestraw, fetterbush "dragonwood", Spanish moss, sphagnum moss, ferns, Christmas trees, wax myrtle and turkey oak, palmetto berries, aquatic plants, palm fronds and lighter pine. Most of these gathering activities impact forests to a minor degree, but some could become real problems if expanded. For example, FWCC Bear Section leader Thomas Eason (personal communication 2001) worries about the potential impact of vehicle-facilitated palmetto berry harvesting on Florida black bear food availability.

Unauthorized ORV trails make it easy to dispose of trash illegally in Ocala National Forest. The dumpsite at top is in an endangered red-cockaded woodpecker colony in the Ocala. Photos by Christine Small.

Littering

ORVs make it easier for people to bring more trash into the forest. By the same token, they should make it easier to pack that trash back out again, but this doesn't always seem to be the case. Areas of heavy ORV use, which are generally those closest to urban areas, tend to have more trash than other places. Compounding the problem are people who use 4WD vehicles to dump household garbage in the forests and other natural areas. This has become a problem along ORV trails in areas of Apalachicola National Forest close to Tallahassee, reports Florida State University professor Walter Tschinkel (personal communication 2001) and Means et al. (1994).

Defenders' Christine Small (personal communication 2001) reported many trash sites in sections of the Ocala National Forest. Dumping facilitated by roads and ORVs is of particular concern because household garbage often includes yard waste containing the propagules of invasive exotic plants. Discarded tires collect water and facilitate an increase in mosquito- borne diseases.

Increased Wildfire and Arson

Most of the wildfires in the United States originate close to roads (Pica et al. 1998; Noss 1996; Shaw et al.1941; Johnson 1963; California Division of Forestry and U.S.D.A. Forest Service 1968; Wilson 1979). Fires are ignited both by vehicles (from sparks, hot exhaust manifolds, etc.) and the activities of their passengers (building campfires, smoking, etc.). Records on file at the Big Cypress National Preserve document that ORVs have started numerous backcountry wildfires there (National Park Service 2000). "The precise contribution that ORVs and their riders make to the incidence of human-caused fires in the United States is unknown, but it is likely significant" (Pica et al. 1998).

Increased incidence of wildfire would be a concern in any forest, but is especially so in Ocala National Forest because the sand pine scrub that dominates the landscape is highly flammable and it is the most urban and heavily used of Florida's national forests.

Exotic Species Introduction

Roads serve as corridors for exotic plant invasion (Wilson et al. 1992; Cowie and Warner 1993; Lonsdale and Lane 1994; Parendes and Jones 2000; Rich et al. 1994; Gates and Evans 1998; Amor and Stevens 1976). The construction of roads encourages the expansion of exotic populations by altering habitat to favor weedy species, removing or stressing the native vegetation and importing propagules with construction materials (Trombulak and Frissell 2000; Willard et al. 1990). Upon completion, roads facilitate the movement of dispersal agents such as ORVs and other vehicles carrying exotic plant seeds in their tire treads, bumpers and elsewhere.

The construction of roads encourages the expansion of exotic populations by altering habitat to favor weedy species, removing or stressing native vegetation and importing propagules with construction materials

Soils disturbed by road construction (Greenberg et al. 1997) or long-term road use and maintenance activities are ideal habitat for many exotic plants (Wester and Juvik 1983; Henderson and Wells 1986; Tyser and Worley 1992; Wein et al. 1992). Greenberg et al. (1997) studied exotic plant invasion along roads in

Ocala National Forest. They found that the clay and limerock used in construction of many forest roads favored invasion of exotic species as well as native plants atypical of the sandy scrub communities the roads traversed. They also observed increased abundance of exotic and uncharacteristic species along sand roads where imported construction materials were not used, attributing this to road-enhanced propagule dispersal. Cale and Hobbs (1991) found more exotic species in roadside soils with enhanced phosphorus levels from vehicle emissions. McIntyre and Lavorel (1994) documented more invasive exotics and fewer native species in disturbed roadside habitats that received increased runoff.

Harris and Silva-Lopez (1992) estimated that around 200 exotic plant species already occur on Ocala National Forest. At present most of these are limited in distribution, but could spread widely as ORV use continues to grow.

The potential for ORVs to spread exotic propagules is underscored by a Montana study showing that one ATV is capable of distributing 2,000 exotic knapweed seeds in the course of a 10-mile trip (Lacey et al. 1997). Stout (1992) documented ORV dispersal of several exotic species in West Virginia. Noss (1996) noted that Brazilian pepper and other exotics readily invade disturbed areas along Florida ORV trails. The National Park Service (2000) reports that ORV activity appears to have spread Brazilian pepper, melaleuca and old world climbing fern in the Big Cypress National Preserve. According to Big Cypress resource management specialist Tony Pernas (personal communication 2001) there is a strong correlation between melaleuca infestations and ORV trails in the preserve. He explains that a number of the ORVs used in the preserve were stored in a melaleuca-shaded parking area where seeds fell onto them and is concerned that grasses (including extremely invasive cogongrass) and other species with wind-dispersed seeds or readily-rooting rhizomes could just as easily be spread by ORVs.

Well-meaning ORV users can sometimes inadvertently complicate exotic plant problems by trying to help, says Pernas. In the Big Cypress, for example, ORV drivers often attempt to kill melaleuca trees by running over them. However, this triggers seed release and causes the species to spread more rapidly. Sometimes, fallen trees pushed into the mud by ORVs sprout all along the trunk, making them more difficult to kill or remove.

Off-trail, ORVs can remove competing vegetation, disturb the soil to create a seedbed, introduce seeds, then pack and rut the substrate so that seeds are firmly in contact with the soil and situated in moisture-retaining depressions where conditions for germination are optimal (Mooney and Drake 1986; Hobbs and Heunneke 1992; Pickett and White 1985; Kotanen 1997; Johnstone 1986). On a regularly used trail, subsequent vehicles would probably crush most ORV-facilitated seedlings and limit the extent of actual exotic species establishment. However, off the beaten track, such seedlings have a better chance of surviving and are less likely to be detected before reproducing. Plant ecologist Menges (personal communication 2001) believes this is cause for concern in Florida scrub habitats. Florida Park Service environmental special-

ROADS, ORVS AND THE SPREAD OF EXOTIC DISEASES

Road corridors can serve as conduits for the spread of diseases (Dawson and Weste 1985; Gad et al. 1986; Pantaleoni 1989; Schedl 1991). For example, *Aedes* mosquitoes, vectors for many dangerous tropical diseases, have spread through the southeastern United States along roads where abandoned tires provide optimum breeding sites (Center for Disease Control 1999). Add uncontrolled ORV access, which facilitates illegal dumping, and the result is numerous dumpsites full of tires and other trash that can hold water and harbor *Aedes* larvae. ORVs have also been implicated in the spread of an exotic root fungus that has killed hundreds of rare Port Orford cedars in Oregon's Siskiyou National Forest (Castello et al. 1995; Perry 1988; Cale and Hobbs 1991). Spores picked up by ORV tires enter streams at water crossings and infect roadless areas downstream (Zobel et al. 1985).

ORV access facilitates illegal dumping of tires and other trash that can hold water and harbor disease-carrying mosquitoes. Photo by Christine Small.

ist Kelly McPherson (personal communication 2001) expresses similar concerns about sandhills, observing that ORV disturbance accelerates invasion of intact systems by invasive exotics.

Louisiana State University biologist and former Forest Service botanist Susan Carr (personal communication 2001) has observed the replacement of perennial grasses by annual and weedy forbs in ORV tracks through a variety of habitats on southern national forests, as Florida Department of Forestry forest ecologist Dennis Hardin (personal communication 2001) has on Florida state forests. Carr notes that ORV traffic through seepage bogs and bayheads can promote invasion of Chinese tallow tree, Japanese climbing fern and other troublesome exotics. McPherson (2001) reports that natal grass, a widespread exotic weed that has aggressively dispersed into natural areas from firelanes, has taken over extensive areas of fragmented sandhill around Bok Tower Gardens in Lake Wales, Florida in just a few years.

CHAPTER SIX

Taking a Toll on Ecosystems:

The Long-term Impacts of Habitat Loss, Fragmentation and Degradation

The rise of ORVs and dense networks of roads has been so recent and rapid, ecosystems and the species within them have not had time to adapt and develop effective healing mechanisms. These ecosystems are far better prepared to deal with the effects of a massive wildfire or a major hurricane.

Scientists have not had time to study how ecosystems and natural resources are responding either. How long it will take for landscapes to recover from the impacts of roads and ORVs—or whether recovery is even possible remains unknown. But by assessing and interpreting the information that is available on the impacts of roads, road density and ORVs on ecological processes nationwide and in Florida, we can begin to address these unknowns and encourage further research.

Habitat Loss

The most direct impact of roads in natural areas is the loss of the habitat they replace (McLellan and Shackleton 1988; Reed et al. 1996). For example, the construction of a typical logging road sacrifices about 10 acres of habitat for each mile of road (Noss 1996). In a heavily roaded forest, this adds up to a substantial degree of "invisible" habitat loss.

Soil Impacts

ORVs are particularly devastating to soil (Schubert & Associates 1999). Numerous impacts have been noted (see Webb et al.1978), including destabilization of the soil surface, fragmentation of the underground habitat, erosion and vegetation changes alongside ORV trails. Soil type and moisture content are the primary factors affecting the nature and severity of these impacts. Extensive ORV damage to plants also affects the soil. The removal of overlying vegetation can increase soil temperatures with consequences for soil fauna, soil fertility, nutrient cycling and hydrologic processes (Pica et al. 1998).

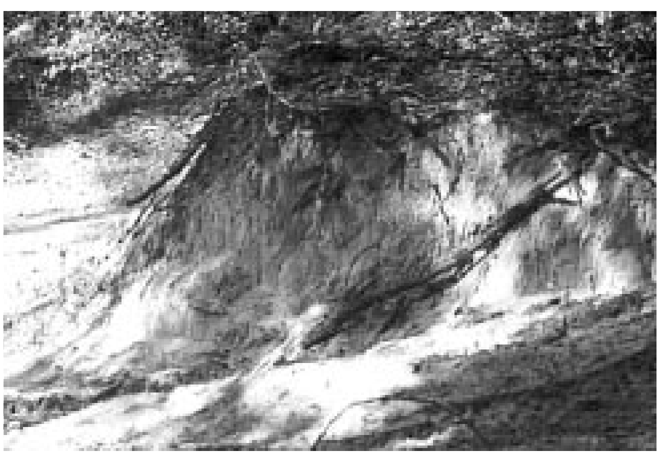
The most obvious and damaging impacts of ORVS and roads on soil are erosion, compaction, destabilization and rutting.

Erosion

Studies have documented accelerated erosion on lands subjected to ORV traffic (Florida Division of Recreation and Parks 2001; Knott 1978; Iverson et al. 1981; Webb and Wilshire 1983; Schubert & Associates 1999). Soils with a consistent fine texture are most vulnerable to recreation-related erosion, especially on slopes where litter and vegetation have been removed (Leung and Marion 1996).

ORVs alter soil structure and topography in ways that lead to overall depletion of the soil resource through oxidation and erosion (Yamataki 1994). They encourage sheet, rill and gully erosion, particularly on soils that are highly organic, loose and sandy or moist or wet (Kuss et al. 1990).

Once recreational activities initiate erosion, wind and water carry on the process (Hammitt and Cole 1987). Water is the primary agent of soil erosion in most situations, although wind erosion is an important factor on peaty or sandy soils (Hammitt and Cole 1987). Both wind and water erosion are potentially problematic where ORVs have disturbed the groundcover of scrub habitats such as those in Ocala National Forest (Collins personal communication 2001).



In the Ocala, ORVs have caused severe erosion and root exposure such as this. Photo by Marcie Clutter.

Dunes denuded by ORVs in Topsail Hill Preserve State Park in Destin, Florida, were essentially leveled by Hurricane Opal. Untouched vegetated areas withstood the storm much better, leading park officials to attribute much of the hurricane's devastation to vegetation removal by ORV traffic, reports Eric Johnson of the Bureau of Natural and Cultural Resources (personal communication 2001).

Erosion, especially gully erosion of trails, typically continues even after recreational use is discontinued. Unused abandoned roads also continue to capture and divert both surface and subsurface flows (Zeedyk 1996; Noss 1996) and contribute to erosion.

Compaction

ORVs are likely to compact the soil wherever they are driven (Raghavan et al. 1976; Webb 1983). The weight and vibration of ORVs give them much greater soil compaction potential than nonmotorized forms of recreation, says hydric soils specialist Victor Carlisle (personal communication 2001).

Compaction is seldom detected more than five to six inches beneath the surface on other types of recreation sites (LaPage 1962), but researchers have found soil compaction extending more than three feet down on sites used by ORVs (Wilshire et al. 1978). Airboats compact the soil less than other ORVs whose weight bears directly on the ground, but Yamataki (1994) noted that they do produce compaction effects through hull and water pressure.

Compaction typically causes the soil to become less porous, which decreases its permeability to water and air. The hydrologically critical differences can be dramatic. Wilshire et al. (1978) reported infiltration rates almost 40 times slower on motorcycle tracks than on adjacent undisturbed ground at a California ORV area.

Soil compaction has even more far-reaching ecological implications (Hammitt and Cole 1987; Ponomarenko personal communication 2001; Coleman et al. 1992; Rutherford and Scott 1979; Webb et al. 1978). These include:

- lower soil moisture-holding capacity and increased vulnerability to drought stress;
- changes in soil temperatures that can contribute to plant stress;
- decreased seepage and increased surface water flow volumes and velocities;
- interference with root penetration;
- limits to subsurface animal movements;
- inhibited seed germination;
- alterations to soil chemical balances;
- toxin accumulation;
- habitat degradation for macrofauna critical to the food chain;
- microfauna damage which can affect soil fertility.

Loamy soils with a wide range of particle sizes, low organic content and moderate to high moisture level are the most vulnerable to compaction, particularly where vegetation and litter have been removed (Leung and Marion 1996). Hammitt and Cole (1987) explain that dry sandy soils cannot be compacted to a very great degree because the particles are too large to be packed together very closely. However, on such soils, ORV traffic may reduce soil pore size so that the soil is actually able to hold more water, rather than less (Liddle and Grieg-Smith 1975). This could make scrubs and sandhills vulnerable to invasion by mesic plant species. Loosened surface sand may also function as mulch to conserve water in the deeper layers of the soil (Ponomarenko personal communication 2001).

Greacen and Sands (1980) calculated that it would take more than 50 years for the sandy soils of Australian pine forests to recover from compaction. Soil genesis processes and long-term ORV impacts have not been studied in Florida, so there is no way to know how long compaction effects will persist here (Carlisle personal communication 2001; Collins personal communication 2001). Root action and other biological processes would probably heal the effects of one or two ORVs traveling across a typical Florida upland site within a few months if there was no further ORV traffic (Carlisle personal communication 2001). Although impacts would be minimal on scrub sands, sandhill soils might take decades to recover (Collins personal communication 2001). Soil scientists Vic Carlisle and Mary Collins concur that damage to soft wetland soils such as those of the Apalachicola savannas would persist for a very long time.

Destabilization

Dry sandy soils such as those that dominate Ocala National Forest may not be particularly susceptible to compaction (Ponomarenko personal communication 2001; Collins personal communication 2001), but they are very vulnerable to displacement. ATV trails through the scrub often become steeply banked as the vehicles push sand to the outside of the curves (Marion County Audubon Society 2000). On hillsides, such loose soil can bury downslope vegetation. Stout (2001) reports that high sand mounds persist on the outside of scrub jeep road curves on the Lake McLeod Unit of the Lake Wales Ridge National Wildlife Refuge even though these trails have not been used to any extent for the past 10 years. Duever et al. (1981) reported that destabilization was more of a problem on wet sites in Big Cypress National Preserve. In some places, the substrate was still a loose slurry a year after experimental ORV runs.

“In seepage bogs and bayheads, even occasional ORV traffic can create ruts that affect hydrology and plant composition for years.”

Rutting

Off-road vehicle routes typically become heavily rutted with water pooling in or flowing through the ruts (Kuss et al. 1990). In the Big Cypress, Duever et al. (1981) observed that rutting was the greatest impact of ORVs on soils. Ruts were deepest where established ORV trails passed through swamps. Such trails were typically worn down to bedrock and filled with standing water.

Duever et al. (1986) found that the depth of the ruts on experimental plots decreased rapidly, but they persisted indefinitely where tire gouging had dug into and displaced the soil. Duever (personal communication 2000) confirmed that “…if there is soil disturbance, there will be a long-term impact.” He explained that rutting injures the roots of the existing vegetation so that the original plants do not grow back vigorously. New vegetation becomes established in the troughs and on the ridges and tends to further stabilize them. He stressed that “This applies to all rutting, not just deep ruts.”

Carr (2001) notes that “In seepage bogs and bayheads, even occasional ORV traffic can create ruts that affect hydrology and plant composition for years.” The soils of the Apalachicola savannas appear to be particularly slow to heal (Traylor personal communication 2000). Forest Service biologists speculate it might take 100 years for ORV ruts there to disappear (Ruhl personal communication 2000).

Clewell (2001) observes that the loose dry sand typical of scrub habitats is “subject to severe rutting after only a few passes by vehicles.” Although scrub sands are not very prone to compaction, motorcycle ruts remain visible eight years after closure of a motocross area on a scrub site at Camp Blanding near Starke in north-central Florida (Hall personal communication 2000). Apalachicola National Forest horseback riders report that deep rutting by motorcycles leads to erosion that creates maintenance problems on horse trails (Noyes personal communication 2001).

Habitat Fragmentation

Numerous authors have addressed the insidious long-term ecological degradation resulting from habitat fragmentation (Askins 1994, Harris 1985; Soulé 1986; Forman and Godron 1986; Forman 1995; Mader 1984; Saunders et al. 1991; Andrews 1990; Salisbury 1993; Reed et al. 1996; Bennett 1991; Zuidema et al. 1996; Wilcox and Murphy 1985, Wilcove 1988; Noss and Cooperrider 1994; Soulé et al. 1992). Harris and Silva-Lopez (1992) point out that “Roads are perhaps North America’s number-one fragmenting force.” They explain that “Clearings such as logging roads…have the net effect of fragmenting otherwise expansive tracts of closed-canopy forest and facilitating colonization by common, weedy species.”

User-created ORV trails have the same habitat fragmentation effects as planned roads do, but their greater density often causes worse cumulative impacts, reports Forest Service botanist Guy Anglin (personal communication 2000). The way these networks of roads crush and fragment the habitat for soil fauna is frequently overlooked, although it may have enormous ecological implications (Marwick personal communication 2001; Ponomarenko (personal communication 2001). Their comments are corroborated by Harris (personal communication 2001); Mahoney (1976) and Kuss et al. (1990).

Barrier Effects

Bennett (1991) explains that there are at least three aspects of a road that can act as a barrier to animal movements: the bare surface of the roadway itself, the altered roadside habitat and the noises, emissions, movements and lights associated with traffic.

For various physical and psychological reasons, some rodents, reptiles, spiders, insects, snails and other sensitive species will not cross even narrow unpaved roads with light traffic (Noss 1996; Mader 1984; Swihart and Slade 1984; Merriam et al.1989; Mansergh and Scotts 1989; Baur and Baur 1990; Oxley et al. 1974; Stamps et al. 1987; Barnett et al. 1978; Bakowski and Kozakiewicz 1988; Mader et al. 1990; Gibbs 1998). In the Big Cypress, female bobcats rarely cross roads, and define their ranges by road boundaries (Foster and Humphrey, unpublished data reported in Hannah 1992). To such animals, a road effectively becomes a prison wall, and a network of roads can, in effect, place groups of animals in separate cells. This disrupts behavior and habitat-use patterns and leads to long-term effects on population dynamics and genetics (Trombulak and Frissell 2000; Andrews 1990; Soulé et al 1992; Yanes et al. 1995; Vos and Chardon 1998; Wilkens 1982; Shaffer 1981; Gilpin and Soulé 1986).

This fragmentation has serious implications because scientists view extinction as a function of forest fragment size. “We lose the wide-ranging critters as patch size declines (Maehr personal communication 2001).” Such population effects may be significant even for species that do cross roads to a limited extent.

Populations of amphibians and other animals that must migrate between breeding, foraging, and/or overwintering habitats may be particularly vulnerable to fragmentation impacts (Reh and

Seitz 1990; Ashley and Robinson 1996). Differences in the responses of various species may be subtle. In Maine, deMaynadier and Hunter (2000) observed that forest roads appeared to be barriers to salamanders but not to frogs.

It is important not to overlook the underground barrier imposed by a compacted roadbed. As Harris (personal communication 2001) explains: "Sand skinks and amphiuma simply are not going to burrow under a well developed and maintained road. Probably, not even a pocket gopher would do it often. The underground effects may very well prove to be the most insidious."

Greenberg et al. (1997) point out that roads with different types of surfaces could serve as selective filters for different scrub reptiles. Paved or clay roads function as barriers to sandswimmers such as the Florida crowned snake, sand skink and mole skink but could serve as corridors for species that move above ground such as Florida scrub lizard or race runner.

Noss (1996) calls attention to the often overlooked long-term impacts of habitat fragmentation on vegetation: "To the extent that various plant species depend on road-averse animals for dispersal, roads fragment plant populations as well." Thus, roads inhibit the spread of plants with seeds that are dispersed by attaching to an animal's fur, by being ingested and eliminated by an animal or by being buried as part of an animal's food stash.

Fragmentation not only interrupts the complex mechanisms of seed dispersal but also interferes with pollination. The effects on species relatively dependent on vegetative reproduction (such as stoliniferous groundcovers) or on wind-dispersal over short distances might be even greater.

Fragmentation can also facilitate the spread of diseases. In Utah, Mackelprang et al. (2001) found three times the expected incidence of hantavirus in rodent populations living in habitat fragmented by ORV trails. They hypothesize that mice forced into small habitat patches fought with each other more often and hence had more opportunities to spread the infection through blood and saliva. The researchers believe that this increased incidence of the virus in rodents presents increased risk of human infection. (The hantavirus is found in Florida rodents.)

Edge Effects

Trombulak and Frissell (2000) identified eight characteristics of the physical environment that are altered along a road corridor: soil density, temperature, soil moisture, light, dust, surfacewater flow, runoff and sedimentation. Related ecological processes are often affected along an "edge" far wider than the actual roadway (Harris 1988; Saunders et al. 1991; Murcia 1995; Reed et al. 1996; Noss and Cooperrider 1994; Williamson 1975; Wilcove et al. 1986).

The resulting "edge effects" ecologists refer to include vulnerability to predators and invasion by exotic species and reductions in soil richness and invertebrate populations.

Predators entering from road corridors may affect wildlife far into the forest (Whitcomb et al. 1981; Rich et al. 1994; Yahner 1988; Reese and Ratti 1988). Wilcove (1985) documented that increased nest predation by edge opportunists such as raccoons and opossums can reach up to 600 meters into a natural area. Cowbirds may parasitize nests up to 100 meters into the forest (Brittingham and Temple 1983). Increased herbivory by edge species such as white-tailed deer can dramatically alter vegetation over a surprising distance (Alverson et al. 1988), although Bratton's 1979 work in the southern Appalachians suggests that the greatest impacts would be within one kilometer of the road. Findlay and Bourdages (2000) detected long-term effects on herpetofauna one to two kilometers away from wetlands impacted by roads.

Numerous studies have documented increased nest predation and parasitism along forest edges (Wilcove 1985; Laudenslayer 1986; Andren and Angelstam 1988). Hannah (1992) noted that raccoons, opossums, gray foxes, bobcats and skunks are probably causing increased nest predation near roads in Ocala National Forest. Roads have also been linked to increased predation by dogs and cats (May and Norton 1996; Bennett 1990). Gates and Gysel (1978) explained how edges can function as "ecological traps" by attracting nesting birds whose young then fall victim to predators, preventing enough successful reproduction to sustain populations.

THE EDGE: ZONE OF INFLUENCE

In terms of ecological function, a forest edge is not just the outer line of trees, but a zone of influence manifested as edge effects extending well into the forest. According to ecologist Reed Noss (1996), "A narrow logging road with no maintained verge would not be expected to generate substantial edge effects, particularly if surrounded by a tall forest canopy." These narrow roads may have far-reaching underground effects (Haskell 2000), but edge effects are most dramatic and serious along bigger roads that cut a wide swath through the canopy and increase the extent to which wind and sunlight are admitted into the forest.

Obvious microclimatic effects and vulnerability of trees to wind damage may extend two to three tree heights back from the visible edge (Noss 1996; Grace 1977; Moen 1974; Lovejoy et al. 1986). Wind profile alterations can be detected much further. An extensive review of the edge effect literature shows that "the most intense effects associated with roads occur within 100 meters of the road and most other effects are attenuated by 300 meters" but that there still could be substantive effects up to 1,000 meters into a natural area (Hoctor personal communication 2001).

The negative impacts caused by edge effects include:

- Disruption of habitat used by sensitive species;
- Alteration of native vegetation and introduction of invasive exotic plant species;
- Declines in populations of interior-forest species newly exposed to opportunistic edge predators;
- Increased poaching and illegal collection of forest resources facilitated by improved access.

Nest parasitism by brown-headed cowbirds that have moved through the landscape along road verges has had serious impacts on migratory songbirds (Wilcove 1985; Brittingham and Temple 1983; Noss 1996; Evans and Gates 1997), including implication in the demise of the Bachman's warbler (Harris 1988). Brown-headed cowbirds have already moved into Ocala National Forest and the population appears to be increasing (Harris and Silva-Lopez 1992). The more tropical shiny cowbird is expanding its range northward and similarly threatening Florida's avifauna (Wiley 1988; Harris and Silva-Lopez 1992).

Haskell (2000) found leaf litter reduction and decreases in soil macrofauna richness and abundance extending 200 meters from logging roads in Cherokee National Forest. These impacts are particularly disturbing because soil macroinvertebrates are critical to many ecological processes (Coleman and Crossley 1996; Springett 1976; Anderson et al. 1985; Ingham et al. 1986) and important in the diets of many birds, amphibians and other animals. Haskell points out that birds for whom this food source is particularly significant include black-and-white warblers, worm-eating warblers, ovenbirds, wood thrushes and Kentucky warblers (Nicholson 1997), all of which are declining species (Sauer et al. 1997). He cites corroborating studies (Burke and Nol 1998; Rich et al. 1994) and concludes that "…reduction in bird abundance may be caused partly by reduced food availability near roads."

Hannah (1992) estimated that edge effects penetrate as far as 600 meters into Ocala National Forest habitats. Noting the abundance of crows, bluejays and other edge species, he comments that "In spite of the lack of edge effect research on wildlife in scrub and longleaf pine communities, there is considerable reason to believe that edge effects are at work in Ocala National Forest."

Hannah (1992) estimated that edge effects penetrate as far as 600 meters into Ocala National Forest habitats.

Noss (1988) and Harris and McElveen (1981) described edge effects on bird populations in Florida forests, noting that edge effects favor common species and others adapted to human disturbance over rare species and those that require forest interior habitat, such as the black-and-white warbler, ovenbird, parula warbler, summer tanager, blue-gray gnatcatcher, redstart and yellow-throated vireo.

Landscape ecologist Dan Smith (1995) points out that "Roads and development within and around the [Ocala National] forest threaten area-sensitive interior species and those species requiring large uninterrupted territories." Recognizing that animals exhibit individual response to habitat conditions, Smith et al. (1996) categorized the Florida panther, red-cockaded woodpecker and Florida scrub jay as among these "interior specialists sensitive to edge and ecotones." Hannah (1992) expressed particular concern for hairy woodpeckers in the Ocala, citing Whitcomb et al.'s 1981 categorization of this bird as an interior species and noting that they breed in sand pine and/or longleaf pine forests.

Avoidance Zones and Displacement

Many animals avoid areas near roads (Harris personal communication 2001; Tracy 1977; Van der Zande 1980; Frederick 1991). These are most likely to be individuals from populations subject to hunting (whether legal or not) that have learned to associate humans, vehicles and guns (Noss 1996). Batcheler (1968) found that deer displaced from preferred habitat by human activity became nocturnal, lost weight, reproduced poorly and failed to return after the disturbance ceased. In the Ocala National Forest, a decline in the deer herd has been noted (Sekerak personal communication 2000). Black bears also avoid roads in areas open to hunting (Brody and Pelton 1989; Reiffenberger 1974; Hamilton 1978; Brown 1980; Villarrubia 1982).

Preliminary research shows that Florida black bear in the Chassahowitzka population north of Tampa avoid the first 304.8 meters from paved or unpaved road edges, reports University of Kentucky Master's candidate Mike Orlando (personal communication 2000).

Mace and Manley (1993) found that grizzly bears tended to avoid areas within 100 meters of a road and preferred habitat 500 meters or more away from one. This supported findings by Kasworm and Manley (1988), who observed that areas within 500 meters of a road were used less than statistically expected, whereas areas over 1,000 meters away were used more. They also confirmed that grizzlies used areas near closed roads more than they did areas near open roads and were more frequently found in areas reserved for nonmotorized use than in places where vehicles were allowed.

In a subsequent study (Kasworm and Manley 1991), they found that grizzly bears used habitat within 914 meters from an open road, or 122 meters from a trail, less than would be expected. McLellan and Shackleton (1988) calculated that grizzlies tended to avoid habitat within 100 meters of a road and preferred areas 250 to 1,000 meters away. Ruediger (1996) suggested a rule of thumb for estimating generic habitat loss due to avoidance or displacement: one kilometer on either side of the road in a forested landscape road or three kilometers in an open area.

The amount of habitat abandoned through avoidance is probably more significant than is commonly recognized. As Larkin (1996) points out, "Because of the continuing exponential growth of human numbers and shrinking of relatively undisturbed habitat for wildlife, exclusion of wildlife from suitable habitat via disturbance is often equivalent to human- caused mortality."

Firebreak Effects

Both designated roads and trails and "outlaw" ORV tracks can serve as firebreaks and impede the prescribed burning needed for habitat management and wildfire prevention in pinelands and savannas (Anglin personal communication 2000). In Ocala National Forest, ORV- created breaks in the wiregrass groundcover interfere with sandhill burns (Lowery personal communication 2000; DeLotelle personal communication 2000; Marion County Audubon Society 2000), as do even minor trails in the light groundcover on the sandhills at Archbold Biological Station (Deyrup personal communication 2001). This problem has also been noted in a number of other Florida natural areas (Small personal communication 2001; Hardin personal communication 2001; Clewell 2001). On the Potts Preserve, Southwest Florida Wildlife Management District land managers have had problems with airboat-created firebreaks preventing normal fire spread from marshes into scrub islands (Barnwell personal communication 2000).

According to the National Park Service (2000), prescribed burning teams usually consider the firebreak effect of trails and attempt to use multiple ignition points to compensate for it. How trails affect the behavior of natural fires has not been studied, but land managers have observed that multiple travelways negatively influence the spread of low intensity fires.

Channelization

Roads not only channel the movement of vehicles, but also of dispersing animals and plant propagules. Numerous organisms move along roadways (Wegner and Merriam 1979; Forman and Godron 1986; Verkaar 1988; Harris and Gallagher 1989). Pocket gophers, meadow voles, prairie dogs and other rodents have been documented to extend their ranges along roadsides (Noss 1996; Huey (1941); Adams and Geiss 1981). Anderson and Tiebout (1993) pointed out that reptiles might use low-traffic roadways to move from one patch of open scrub habitat to another. Vermuelen (1995) discussed how road verges serve as corridors for certain beetles. Florida black bear and panther sometimes use travelways as movement corridors making them more vulnerable to ORV facilitated poaching and habituation to humans.

The use of minor roads as hunting lanes by predators has been shown to dramatically increase predation rates in some situations (Harris personal communication 2001). Several observers have noted predators such as crows and broad-winged hawks focusing on amphibian prey along linear right-of-ways (de Maynadier and Hunter 2000; Langston 1989; Knight and Kawashima 1993).

Habitat Degradation

Hydrological Impacts

ORV use can also disrupt hydrological regimes (Adamus and Stockwell 1983). In the Big Cypress, Duever et al. (1981) found that water flowed two to four times faster in ORV trails than in the surrounding wetland and that water continued to flow in some trails after overland flow had ceased.

Pernas et al. (1995) found that surfacewater flow always followed airboat trails, even when they were not oriented parallel to the general direction of surface flow. Flow rates in these trails averaged about five times faster than those in the adjacent marsh. Airboats have changed hydrological patterns in Lake Tsala in Potts Preserve by running on dry marshes and thus displacing soil and creating erosion channels

(Barnwell personal communication 2000).

Duever et al. (1986) hypothesized that deeply rutted ORV trails oriented parallel to the direction of overland flow could drain water from a nearby wetland and shorten the local hydroperiod. Such processes may have regional hydrological implications in the Everglades (Lodge 1994).

Ruts can also redirect both surface and subsurface flow and alter the hydrology of seepage wetlands (Moler personal communication 2000; Clewell 1985; Wunderlin 1982; Yarlett 1996; Kale and Maehr 1990; Carr personal communication 2001; Hardin personal communication 2001; Stoeckeler 1965; Darnell 1976). Drainage and erosion resulting from such impacts have been observed in Apalachicola National Forest (Traylor personal communication 2000; Anglin personal communication 2000) as well as in similar pitcher plant habitats on Tar Kiln Bayou State Preserve near Pensacola (Johnson personal communication 2000), on Lake Wales Ridge and Blackwater River State Forests (Hardin personal communication 2001) and on other southern national forests (Carr personal communication 2001).

The two-stroke engines used on many ATVs emit such toxins as nitrogen oxides, carbon monoxide, ozone, particulate matter, aldehydes, butadieness, benzenes and polycyclic aromatic hydrocarbons in concentrations far greater that those produced by automobiles

ORV damage to a pitcher plant bog on a hillside seepage site on Angelina National Forest in east Texas led to such damaging erosion that the Forest Service had to resort to sandbagging to prevent the bog from actually washing away (McRoberts et al. 1999). Extensive ecological restoration work was required on this bog and another ORV- impacted Angelina seepage area (McRoberts personal communication 2000).

Pollution

The virtually unregulated use of ORVs in national forests fails to safeguard these public lands from the astonishing amounts of water and air pollution that threaten forest resources, including wildlife and forest users.

Air Quality Impacts

Schubert & Associates (1999) review the ways in which a variety of vehicles contribute to air pollution and related impacts. They emphasize that many types of ORVs release far greater quantities of pollutants than do vehicles not intended for off-road use. Forest Service researchers have found that some types vent 25 to 30 percent of their oil and gas into the air unburned (Harrison 1976; The Wilderness Society 2001). The two-stroke engines used on many ATVs emit such toxins as nitrogen oxides, carbon monoxide, ozone, particulate matter, aldehydes, butadieness, benzenes and polycyclic aromatic hydrocarbons in concentrations far greater that those produced by automobiles (The Wilderness Society 2001). According to the California Air

Resources Board (1996), motorized trailbikes and ATVs with two-and four-stroke engines produce 50 times as many smog-forming pollutants per mile as automobiles. U.S. Environmental Protection Agency (EPA) emission expert Alan Stout (2001) has pointed out that such ATVs emit over 4,000 times more carbon monoxide (His most recent data is posted at www.epa.gov/otaq/ recveh.htm.). Under current laws, this means that people playing with these machines in the forest are permitted to introduce vastly more pollution into the atmosphere than commuters carpooling to work.

Under current laws, people in ORVs playing in the forest are permitted to introduce vastly more pollution into the atmosphere than commuters carpooling to work.

Water Quality Impacts

After reviewing the research on visitor impacts, Kuss et al. (1990) summarized that "… it would appear reasonable to assume that water resources will be impacted by ORVs under most field conditions." Parameters affected include 1) nutrients; 2) suspended sediments; 3) dissolved oxygen; 4) temperature; 5) flow; 6) pH; 7) fecal contamination; 8) dissolved solids; and 9) transparency (Kuss et al. 1984).

According to Hammitt and Cole (1987), wildland recreation impacts water quality primarily through nutrient enrichment, increased turbidity (suspended solids), reduced dissolved oxygen, and/or fecal contamination. They explain that water quality impacts are worse where temperatures are warm and water flows slowly and that recreational impacts such as the removal of streambank vegetation can increase water temperatures and thereby exacerbate the problem. Looking at ORV impacts on water quality in the Big Cypress, Duever et al. (1986) observed localized changes in water temperature and salinity, chemical pollution and increased sedimentation and turbidity, which decreased sunlight penetration and thereby decreased primary productivity of aquatic vegetation.

Use of ORV trails near water bodies causes increased sedimentation (Kuss et al. 1990). ORVs particularly disturb streambanks and bottom sediments when they cross streams, but these impacts are generally not that significant where moderate numbers of vehicles are using a limited number of defined crossings (Hammitt and Cole 1987). Mudbogging activities and numerous heavily used crossings that spread up and down a stream cause more damaging impacts.

The resulting concentrations of suspended sediments can kill aquatic organisms and profoundly impact aquatic systems (Newcombe and Jensen 1996). U.S. Geological Survey's Noel Burkhead expresses great concern for ORV-induced sedimentation impacts (personal communication 2001) and explains that "excessive sedimentation destroys habitats by reducing habitat complexity and diversity" which similarly decreases fish diversity (Burkhead et al. 1997). Thus, "faunal decline caused by sedimentation diminishes trophic web complexity and the efficiency of nutrient cycling within the aquatic community." He cites supporting research by Ellis (1936), Cordone and Kelley (1961), Chutter (1969), Brusven and Prather (1974), Fuller (1974) and others.

Activities that stir up bottom sediments may release concentrations of phosphorus and other pollutants, particularly where oil and/or detergents have found their way into the sediments (Kuss et al. 1984). This increased nutrient load can be washed downstream where it can increase eutrophication of lakes. These processes have even worse impacts on still, confined ponds than they do on moving waters.

Biologists netted ponds in the Crawfordville area of Apalachicola National Forest and found far fewer fish species than would otherwise be expected. They attributed this to ORVs stirring up the mud (Ruhl personal communication 2000). Researchers Bruce and Ryan Means (personal communication 2001) suspect that more toxic pollutants may also be involved in many such situations. They comment that "Vehicular activity in temporary ponds often leads to pollution from oil, hydraulic fluids and gasoline that leaks from cars' motors and crankcases into the water." They also note there may be spills of antifreeze and other vehicle cooling system liquids, a potentially lethal problem for pond-breeding amphibians.

In areas with extensive and heavily used ORV trail networks, sedimentation effects may influence entire watersheds (Kuss et al. 1990). According to Beardsley (1995), the cumulative effects of localized water quality changes could result in regional impacts in southern Florida. Vegetation damage from ORV use could inhibit nutrient uptake and interfere with filtering effects and thereby affect ecological processes over broad geographic areas. This level of damage is found in Big Cypress National Preserve and has potential implications for efforts to restore the Everglades.

CHAPTER SEVEN

Spoiling it for Others:

The Aesthetic and Economic Impacts

In addition to disrupting wildlife and ecosystems, ORVs seriously disturb many of the people who visit natural areas (Florida Division of Recreation and Parks 2001; McCoy and Moeller 1976; Indiana Department of Natural Resources 1972; Badaracco 1976; Schubert & Associates 1999). "Direct encounters with ORV machines simply are not compatible with the quality of outdoor experience being sought by a majority of Americans (Sheridan 1979). "Discussions with "rockhounds, birders, hikers, hunters, botanists, biology classes and similar visitors have pointed up the basic incompatibility of ORV use with nearly any other type of activity (Weinstein 1978)."

> *"It ruins my experience of outdoor solitude when I encounter those horrible machines."*
>
> *—Marcie Clutter, Florida Trail Association*

Noise is one of the major reasons why ORV use is incompatible with other types of recreation. In a densely forested setting, the noise from the average motorcycle is audible to the human ear 7,000 feet away (Harrison 1974). In an open environment, it may be detectable at two to three times that distance (Badaracco 1978 in Sheridan 1979). One motorcyclist can disrupt the serenity of hundreds of square miles of wildlands in the course of a day, whereas dozens of hikers or birdwatchers within the same area could be unaware of one another's presence .

The noise characteristic of ORVs makes even responsible ORV users an aggravation to almost everyone else: "...silence is a resource. The sounds which man typically associates with the pristine natural environments are perceived as solitude. … The noise of an ORV punctures that solitude (Sheridan 1979)."

Off-road vehicle users are a highly vocal, aggressive and influential minority (Pica et al. 1998; Schubert & Associates 1999, citing data from the Recreation Roundtable, a project supported by ORV interests). However, even if the total number of ORV users increases over the coming years as predicted (Florida Division of Recreation and Parks 2001), ORVers represent a relatively small percentage of forest users. But if current trends and policies continue, they will continue to ruin the outdoor experience for many other users who seek peace and quiet in nature.

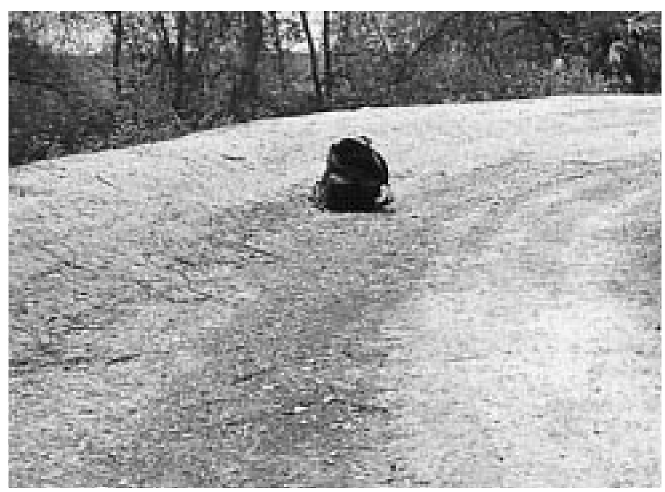
Hikers and Campers

Hikers and campers are often annoyed by ORVs and sometimes very emotionally so — especially when they encounter them in otherwise wild and remote places. Horror stories of noisy motorcycles and ATVs racing through campsites abound. When this sort of thing goes on late into the night, campers become increasingly irate. Although noise and aesthetic affronts are the most common complaints, hikers' concerns include resource impacts, trail damage, safety and crime risk.

"The Florida Trail Association (FTA) has had problems with ATVs using their hiking-only trails in Ocala National Forest," reports FTA president Richard Schuler (personal communication 2001). Hikers seldom report close encounters with ORVs, but frequently complain that ATVs have loosened the trail tread and banked the edges. Not only is walking in the resulting deep sand unduly tiring, but the sand banks degrade the natural aesthetic and ecological qualities of the trail verge. FTA has tried to curb ORV use of the Florida Trail by putting up barriers at various access points, but the ORV operators just tear them down or find a way around them (Marion County Audubon Society 2000; Clutter 2001). FTA has mapped Ocala National

The ORV Takeover

Noisier, more consumptive and less contemplative recreationists such as ORVers tend to drive out quieter, less consumptive, and more contemplative users (Badaracco 1978 in Sheridan 1979). Badaracco (1978) describes a disturbing progression of ORV dominance over other uses that he calls "ISD" (Impair, Suppress, Displace). ORVs tend to first impair other activities, then suppress, then displace them, thereby shrinking the amount of land available for non-ORV recreation. "The irony of the ISD syndrome is that administrators and managers tend to measure recreational demand on the basis of current participation rates, says Badaracco."Thus the administrator may allocate additional opportunities to a group which has suppressed or displaced a former traditional group" and "change the character of outdoor recreation despite the intense feelings of a broader public" (Badaracco 1978 in Sheridan 1979). This is exactly what is happening in the Florida national forests.



ORV intrusion to the Florida Scenic Trail leaves it scoured and widened into a road. Photo by Marcie Clutter.

Forest hiking trail sections subject to ORV damage, and Marion County Audubon Society (2000) has photographed some of them.

Sandra Kokernoot (2001), of the Putnam County Environmental Council complains that "The old section of the Florida National Scenic Trail, now known as the Penner Ponds trail, and the edges of the ponds have been seriously damaged over the last three years by ORVs. The Putnam County Environmental Council alerted the Forest Service about this problem three years ago, when the [public scoping] workshops were being held on the forest management plan. But, we were told to be patient; the problem would be addressed in the trail designation process. In the meantime the damage is tenfold."

Wildlife Watchers

Those who visit the forests for nature study have objections similar to those voiced by hikers. Noise and wildlife disturbance are of even greater concern to this group, however, since ORVs directly interfere with their ability to see and hear the things they come to enjoy. These people also tend to be more aware of and more upset by evidence of resource abuse (Marion County Audubon Society 2000).

Ann Hodgson's (2001) comments to the Forest Service are typical. She complains about disturbance

One Hiker's Experience

Hiking the Florida Trail in Ocala National Forest used to be one of Marcie Clutter's favorite pastimes. But sometime between 1994 and 1995, Clutter started to notice changes. ORV tracks were running through the wet prairies, and the the trail from Lake Delancy south was "beginning to look like a speedway."

In 1997, Clutter and her husband took a backpacking trip that made them vow never to hike certain sections of the trail until something is done about the ORV problem. Hiking along the trail from Salt Springs to Rodman Dam they were "subjected to ORV users racing up and down the Florida Trail from Grassy Pond to Lake Delancy, " recalls Clutter. "There were so many illegal ORV trails running off the trail that I couldn't begin to count them all. The ORV users threw up dirt and dust, polluted the air with their fumes and two-stoke engine whining, and completely ruined our experience."

Ever since, Clutter has been helping to document ORV troublespots in the Ocala where she has counted 20 crossovers of the Florida Trail by ORV trails. "The ORV users have literally turned the Ocala Forest into a series of dusty roads, says Clutter. She has seen "pond after pond impacted by ORV use with ruts up to 20-inches deep. It is truly disheartening to see every habitat in the Ocala Forest impacted by these machines."

Today Clutter wistfully recalls the " beauty and quietness" that filled her soul on the stretch of the Florida Trail from Lake Delancy to Juniper Prairie as "wet prairies opened up like magic after hiking through dense hammocks of oak and sand pine." Now, says Clutter, "all the reasons I loved to hike and birdwatch in the Ocala Forest, to gain serenity and peacefulness of spirit as I listened to and watched nature are gone, ruined by the noise and the hundreds of illegal ORV trails that have cut through the forest."

by ORV users "whose recreational objective seems to be to ride rapidly through the forest and manhandle their ORV over varied terrain. On numerous occasions, I have been involved in passive scientific study or recreation such as observing the endangered Florida scrub jay, studying native plants, wildlife observation or photography when an ORV has disrupted my activity."

Off-road vehicle transportation also facilitates the illegal collection of rare plants, pillaging of archaeological sites, vandalizing of research areas and other raids on the resources that many visitors come to study and enjoy.

Horseback Riders

An unexpected encounter with any type of ORV may frighten a horse and cause a serious accident. Most horseback riders therefore find it too nerve-wracking to ride in places where there is much ORV activity.

Generally speaking, those who do venture forth on horseback report few problems with hunters in 4WD vehicles in the backcountry. Most user conflict problems appear to relate to motorcycles and ATVs recklessly and inconsiderately operated in urban interface zones.

Motorcycles are exceptionally hazardous to horses because they tend to go fast and roar right past a horse without seeing the animal in time to slow down or exhibit trail courtesy. Apalachicola National Forest trail riders report seeing a number of dangerous runaways resulting from such incidents (Noyes personal communication 2001). The action of motorcycle tires also creates a washboard effect in the treadway that is out of sync with the footfall patterns of a horse's gait and make it likely to stumble. An Apalachicola National Forest horseback rider describes such a trail surface as "like a roller coaster—except the hills are 12 to 18-inches high) and they go on and on and on" (Noyes 2001).

Horseback riders also complain that ORV use of sandy Ocala National Forest trails leaves the trail surface so deep and loose that it is excessively tiring for horses (Wonser personal communication 2001).

Mountain Bikers

Mountain bikers often object to ORV activity, particularly to the damage it does to trails. Motorcyclists and ATV users often take over trails designed for mountain biking. This leads to increased erosion and soil displacement which degrade the trail and make it more labor-intensive to maintain.

Hunters

Although some hunters use ORVs for transportation, surveys have documented that a large majority of hunters feel that ORV traffic in hunting areas degrades their recreational experience (The Wilderness Society 2001). There have been ongoing problems with conflicts between ORV users and still hunters in Ocala National Forest (Harr personal communication 2000). The hunters want ORVs confined to specific areas so they know where they can hunt without being disturbed or having game flushed prematurely.

Orlando Sentinel writer Mike Archer (2002) interviewed hunters about the problems they encounter in Ocala National Forest. Fox hunter Paul Yates reported camping at Farles Prairie and losing a favorite dog to a hit and run by an ORV. Another hunter complaint is ORVs driven at night. "The noise makes it tough to sleep in camp and the constant pressure makes game nervous. The ORV drivers sometimes stay out until 3 or 4 A.M., come back to camp to sleep in the daytime, then fire up their ORVs again for another wild night in the woods," said Lake County native and lifelong hunter Robert Collins. "The loud racket keeps deer on edge all the time; there's no time for them to settle down. With all that noise, they're always moving."

Robin Lewis (personal communication 2001) expressed the opinions of many hunters when he told the Forest Service that weekend ORV "thrill-riding…is not compatible with my use of the forest for passive uses such as wildlife observation, photography and active licensed fishing and hunting. Use of ORVs during hunting season by a licensed hunter to travel to a designated hunting area is the only kind of OHV/ORV use that should be allowed in the forest and should be one of the alternatives considered."

Forest Neighbors

People who live in the residential areas adjacent to Florida's national forests or forest inholdings are also frequently disturbed by ORV activity. Ocala forest resident Debra Britt reports that "They run in and out of the forest all night long, throw their garbage (mostly alcohol containers) on our corner, and spin their wheels and tires when they leave FR 573 for SR 19 in the wee hours of the morning."

Guy Marwick (personal communication 2001), a resident of the west central Ocala near Church Lake Prairie, laments the loss of what until 2001 was a 200-acre virgin prairie with a natural clear pool. Now it is "rutted a foot deep for almost 100 feet," he says . "It's churned to death, and the ORVers have been out here on weekend nights partying and chewing up the wetlands and keeping me up until 3 A.M."

Economic Impacts

ORV activity on the national forests can be costly to taxpayers who help subsidize the basic construction, maintenance and management of the required infrastructure and the restoration and repair of damaged lands and who pay the price for ecotourism opportunities lost because of degraded habitat. The Forest Service has already spent considerable resources repairing ORV damage to bogs in Angelina National Forest in Texas (McRoberts personal communication 2000), and will have to spend an estimated $990,000 — $1,800 per acre — to repair 550 miles of illegal trails on the Chattahoochee/Oconee National Forest in Georgia. The costs of similar repairs in the Florida national forests could be staggering.

Pineland expert Andy Clewell (personal communication 2001), a past president of the Society for Ecological Restoration, is concerned about the enormous cost of restoring areas impacted by vehicular activity. He explains that ORV-damaged wiregrass groundcover is unlikely to recover without lengthy and costly ecological restoration effort. Clewell cites Kent et al.

(2000) and goes on to explain the economic implications: "Dozens of ecological restoration projects are being conducted in Florida, some of them on federal lands at public expense. For example, large areas of longleaf pine-wiregrass ecosystem on sandhills are being restored at Eglin Air Force Base."

Clewell notes that "Little longleaf pine-wiregrass ecosystem remains in the Southeast, relative to what existed a century or more ago. Only a small portion of the remaining acreage can be considered ecologically healthy, and most of that acreage occurs on public lands. This acreage deserves protection and careful management. It would make no sense to condone harmful ecological impacts to intact parcels of this ecosystem on public lands. On the contrary, since public tax dollars are already dedicated to restoring this ecosystem on federal lands, the allowance of any land use that threatens the ecological health and integrity of this ecosystem would represent fiscal irresponsibility."

Once pristine Church Lake Prairie in the Ocala National Forest now damaged by ORVs. Photo Guy Marwick.

CHAPTER EIGHT

Idling and Stalling:
The Forest Service Response

"In the conflict between motorized and nonmotorized recreationists, both sides invoke what they feel are their fundamental rights. Nonmotorized recreationists, especially the ones who seek peace and quiet, demand freedom from these machines while motorized recreationists demand a place to enjoy their machines. But there is a third party involved in the conflict — the land, specifically, the land which is held in trust for all U.S. citizens by our agent, the federal government. Of course, the land is silent. It cannot speak for itself. At the end of my research, I reached one inescapable conclusion: Too few federal land managers are effectively representing the interests of the land and the plants and creatures who live upon it."

David Sheridan—*Off-Road Vehicles on Public Lands,* (1979 report for the U.S. Council on Environmental Quality)

Two Executive Orders (EO) govern ORV use on federal lands: EO 11644 signed by President Nixon in 1972 and EO 11989 signed by President Carter in 1977. These EOs not only empower, but require, land managers to immediately close areas where wildlife habitat, soil or cultural resources are suffering adverse effects from ORV use.

However, the Forest Service has failed miserably in complying with the spirit or intent of these EOs or with federal statutes and regulations governing ORV management on federal lands. Off-road vehicles remain 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 two decades. Instead of attempting to address this expanding scourge, the Forest Service continues to largely ignore the problems posed by virtually uncontrolled and expanding ORV use on national forests (Schubert & Associates 1999).

The minority group of ORV enthusiasts and the vehicle manufacturers who support their protests would like us to believe that limiting ORV access to public lands is some kind of land-grab ploy devised by environmental extremists. The truth is preventing degradation by rampaging vehicles has long been a concern of Americans of all political stripes who love the land. As noted conservative Barry Goldwater put it in 1973, "I hope there is some way we could outlaw all off-road vehicles, including snowmobiles, motorcycles, etc., which are doing more damage to our forests and deserts than anything man ever created. I don't think the Forest Service should encourage use of these vehicles by even suggesting areas they can travel in." The even harder truth is that despite federal mandates and the adoption of science-based, long-range adaptive management plans devised for each individual forest, the Forest Service has failed to address the problem of ORVs and roads in any meaningful way.

Revised Land and Resource Management Plan Procedures

Since 1976, national forests have been required to maintain forest plans and update them every 10 to 15 years. In 1999, the Forest Service revised the 1986 plan for the Florida national forests. The resulting Revised Land and Resource Management Plan for the National Forests in Florida is intended as "a guide for the overall management of National Forests in Florida for the next decade."

To develop this plan, the Forest Service first obtained a broad range of scientific information and public input, then chose "Alternative E," an overall management strategy emphasizing "adaptive management in restoring and maintaining native ecosystems, while providing for balanced human use." This is a science-driven approach, which requires research and monitoring to "test predictions and assumptions in management plans" and the use of the resulting information to improve the plans (U.S.D.A. Forest Service 1999).

Corruption of "Restricted Areas"

The *Revised Land and Resource Management Plan for Florida National Forests* (U.S.D.A. Forest Service 1999) changed access for motorized vehicles and bicycles in two ways. First, cross-country travel on land with no roads or trails is now prohibited anywhere in the forests. Second, travel within "Restricted Areas" is limited to designated roads and trails. Restricted Areas were also expanded on all three national forests (Richard Shelfer personal communication 2001). Outside of Restricted Areas, ORV travel is still permitted on any road, trail or travelway currently in use. This leaves plenty of territory open to ORVs — two-thirds of the Ocala National Forest, for example.

According to the draft management plan devised in 1997, "A system of motorized use trails will be identified, marked and maintained for motorized recreation. User conflicts would be decreased by designated trails for specific types of use. Hikers, bicyclists and horseback riders would travel cross-country and use old roads and trails. This would have a positive effect by reducing the maze of trails across the woods and providing trails designed to meet user needs. Negative effects would include an overall loss of riding area, reduced sense of freedom from exploration, and heavy or concentrated uses in some areas." However, in the final plan issued in 1999, this goal is applied only to Restricted Areas, not forestwide, thus severely limiting a "forestwide reduction" in ORV access.

The Access Designation Process

To identify the roads and trails to be maintained in Restricted Areas, the 1999 plan authorized the Forest Service to conduct a two-year "Access Designation Process" through which consensus decisions were to be reached through a series of workshops involving groups and individuals representing recreationists, such as ORV users, mountain bikers, hikers, horseback riders and conservationists.

The environmental representatives in the working groups immediately recognized that the process was fundamentally flawed. The basic premise of grandfathering ORV-created trails through areas identified as unsuitable for motorized access was distressing. The workshops were focused on meeting recreation user group objectives and resolving conflicts among them and did not seriously address the protection of biodiversity and ecological integrity. Conservationists and ecologists attempted to remind the Forest Service of the scientific and legal facts regarding the agency's responsibilities for the protection of ecological resources, but motorized vehicle interests were allowed to dominate the so-called consensus process.

When it became evident that the Access Designation Process was not going to create a plan based on sound scientific and ecological information, the environmental representatives withdrew from the working groups for all three national forests, citing 1) flaws in the consensus process (poor facilitation and changing the rules of consensus during the process to favor the ORV representatives); 2) the absence of sound scientific and ecological information in the development of an access plan; and 3) the Forest Service's failure to make a serious attempt to address broad natural resource issues during the working group process.

As a result, the working group access proposals for all three national forests recommended an extensive network of ORV trails, new ORV staging areas (parking lots) and a system of "open" woods roads that would seriously degrade the ecosystems.

The working group proposal designated motorized trails and marked, numbered roads grandfathers in thousands of miles of non-ORV designated trails, woods roads and travelways that ORVs could access and perpetuates landscape level ORV impacts by allowing ORV access to thousands of miles of travelways in Restricted Areas. It misses the point of "Restricted Area" designation: to protect ecologically sensitive areas from unlicensed vehicles such as ORVs.

Travel within "Restricted Areas," which by definition was limited to the use of licensed motor vehicles on numbered forest roads, would include ORVs on woods travelways designated as permanent ORV access routes. The proposal for Apalachicola National Forest calls for five new staging areas and nearly 500 miles of designated ORV trails, primarily in sensitive longleaf pine-wiregrass systems! These working group proposals were in direct conflict with the Forest Service's mandate to protect ecosystems and maintain biodiversity.

In addition to perpetuating the increasingly widespread impacts of designated ORV trails, roads endorsed by the proposals would fragment rare plant communities (including sensitive longleaf pine-wiregrass systems), encourage mudbogging in delicate wetlands, and facilitate disturbance and habitat degradation damaging to federally listed animals such as the red-cockaded woodpecker and eastern indigo snake.

Forest Service personnel defend the Access Designation Process by explaining that it calls for addressing ecological concerns through an Environmental Assessment (EA) or Environmental Impact Statement (EIS) conducted after completion of the access proposals. Unfortunately, similar Forest Service assessments have often proven to be nothing more than superficial reviews to rubberstamp predetermined agency positions.

Inserting ecological concerns into a recreation plan as an afterthought will not adequately protect resources. A process committed to the preservation of biodiversity would begin with an assessment of resource management needs and existing ORV and road density impacts and a road inventory, then proceed to incorporate recreational uses into a plan designed around ecological systems.

Current Policies in Conflict with the Revised Forest Management Plan

The current level of road development and ORV use in the national forests of Florida is not compatible or in compliance with the Forestwide Desired Future Conditions, Forestwide Goals or Forestwide Objectives stated in the *Revised Land and Resource Management Plan. for the National Forests in Florida* (U.S.D.A. Forest Service 1999). Specific examples of undermined conditions and objections in the plan are given below.

Undermined Forestwide "Desired Future Conditions"

Page 2-1. "The national forests in Florida recognize and embrace the Florida Greenways system and the role the forest plays as a major hub of greenspace in the statewide plan for greenways."

Page 2-2. "Water quality in streams, ponds, wetlands and riparian areas reflects healthy, functioning aquatic systems. Soil productivity is maintained. Nutrient levels and nutrient-cycling processes continue to function."

"Adequate habitat is provided for threatened, endangered and sensitive species so populations are no longer considered at risk."

"Significant botanic, cultural/historical, geological, and scenic sites are protected, managed and interpreted."

"Forests provide a tranquil retreat from the fast pace of city life. Evidence of human activities exists in most areas of the forests, although most activities remain subordinate to the characteristic landscape. National forest landscapes show less evidence of human disturbance compared to adjacent private forestland."
"Additional areas are added to the wilderness system."

Page 2-3. "Management of forest vegetation focuses on maintaining or restoring the natural range of diversity in age, species and conditions for ecosystem health."
"New road construction is minimal. A higher proportion of roads are closed to motorized travel than in previous decades."

Undermined Forestwide Goals

Page 2-3. "Maintain or, where necessary, restore ecosystem composition, structure, and function within the natural variability of all ecosystems, with emphasis on longleaf pine-wiregrass, sand pine-oak, pine flatwoods, hardwood/cypress, oak hammock ecosystems, and other imperilled specialized communities."

Page 2-4. "Manage floodplains, groundwater, lakes, riparian areas, springs, streams, and wetlands to protect or enhance their individual values and ecological functions."
"Conserve and protect important elements of diversity — such as endangered and threatened species habitat, declining natural communities, and uncommon biological, ecological, or geological sites."
"Manage for habitat conditions to recover and sustain viable populations for all native species, with special emphasis on rare species."
"Protect, enhance and, where necessary, restore the forests' scenery resource values."
"Provide a system of marked recreational trails and support facilities that will promote a variety of experiences for both motorized and nonmotorized trail users."

Undermined Forestwide Objectives

Page 2-4. "Implement surveys for determining public satisfaction with National Forests in Florida programs."

Page 2-5. "Provide habitat capability to support an increasing population of red-cockaded woodpeckers."
"Maintain a dynamic system of at least 45,000 to 55,000 acres of habitat capable of supporting scrub jays on the Ocala NF."

CHAPTER NINE

Taking the High Road:

Recommendations for Moderating ORV and Road Impacts

In a 1987 Forest Service study of vehicle issues Lennon et al. found that successful ORV management programs involve 1) a well-designed network of roads and trails incorporating a variety of experiences and different challenge levels; 2) vehicle control structures, such as fences and barriers; 3) adequate numbers of trained Forest Service patrol personnel with appropriate vehicles and equipment; 4) good information made readily available through maps, brochures, signs, etc.; 6) cooperative relationships with users, government agencies and industry groups; 7) major volunteer programs; 8) funding from ORV registration fees; and 9) training programs for the public and Forest Service employees.

Fifteen years later, the information presented in this report underscores the need to implement a management program. The Forest Service must address the impacts of ORV and roads in Florida's national forests to prevent further damage.

The recommendations that follow are offered as a starting point.

MODERATING ORV IMPACTS

1. Conduct a road and trail inventory and a natural resources inventory for each of the Florida national forests.

An inventory of all existing roads and trails should be conducted to provide the baseline information needed to develop an ORV access and management plan for the Florida national forests.

To lay the foundation for devising a sound science-based plan, a natural resources inventory that describes the distribution and abundance of plants and animals, pinpoints the location of landscape cover types and habitat features, such as sinkholes, elevated areas and ephemeral ponds, and addresses the needs of endangered and threatened species and other natural resource concerns should be prepared.

An ecological assessment based on the road and trail and natural resources inventories should be made available for public review.

2. Develop an ORV access and management plan and monitoring programs.

An ORV management plan for the Florida national forests should be developed based on an inventory of existing roads and an inventory of ecological and cultural resources.

The *Forest Service Manual* and related *Forest Service Handbooks* codify the Forest Service's authority and responsibility "to develop and implement the National Forest program for the use of vehicles on and off of roads and trails"[1] and "to monitor and evaluate the effects of the off-road vehicles on National Forest System lands,[2] and Forest Service should be held accountable for these mandates.

Monitoring programs should truly measure short-term and long-term ORV and road impacts on forest ecosystems rather than merely document wear on the trail system as most "trail impact" monitoring efforts do. If the monitoring determines that the use of one or more ORVs is causing or will cause considerable adverse effects[3]" on Forest resources then the area or trail must be immediately closed[4] to one or more types of ORVs until the adverse effects have been eliminated and measures have been taken to prevent a recurrence.

[1]Forest Supervisors must: develop and implement the National Forest program for the use of vehicles on and off of roads and trails; establish monitoring intervals, criteria, practices, and standards against which the effects of ORV use shall be evaluated and reported; solicit involvement of interested individuals and groups and other parties in planning, implementing and obtaining compliance with ORV use regulations; and close areas and trails immediately when vehicle use is causing or is likely to cause considerable adverse effects. *Forest Service Manual* §2355.04d-1,4,6, 8.

[2]The USFS Director of Recreation Management is required to identify, develop, and test the methods necessary to "monitor and evaluate the effects of the off-road vehicles on National Forest System lands and on user's expectations, characteristics, and desires." *Forest Service Manual* §2355.04b - 2. Monitoring activities on trails include the volume of use, type of use, and the effects of use on trail management objectives. *Forest Service Handbook* §2309.18 - 4.1. The Regional Forester is required to ensure that monitoring is applied consistently among National Forests under his or her jurisdiction and to "issue guidelines and standards for providing off-road vehicle use opportunities and monitoring effects on resources." *Forest Service Manual* §2355.04c - 1 and 4.

[3]An "adverse" ORV effect includes any effect that does not meet the standards for the maintenance of the long-term productivity capacity of the land, air and water quality, wildlife habitat and stable and balanced populations of wildlife, existing and proposed uses of the Forest, and preservation of cultural and historical resource values. *Forest Service Manual* §2355.05 - 7. A "considerable adverse effect," is any effect that will not meet the trail or area designation criteria contained in *Forest Service Manual* §2355.14 and "that is or may become irreparable because of the impossibility or impracticability of performing corrective or remedial measures." *Forest Service Manual* §2355.05 - 3. Other factors which can also be considered to make this determination include: the availability of funding and manpower to prevent or correct adverse effects; physical and biological conditions, such as slope, vegetation, soil erodibility and compaction, surface and subsurface hydrology, and a site's natural rehabilitative capability; and those natural, historical, and cultural resources and areas that are susceptible to irretrievable resource damage. *Forest Service Manual* §2355.05 - 3.

[4]Traffic restrictions are appropriate when unacceptable resource damage or other trail management objectives have not been met. *Forest Service Handbook* §2309.18 - 4.12. Roads and trails can also be closed seasonally to prevent unacceptable resource damage and to reduce conflicts between users. Emergency closures can also be enacted for up to 1 year without public participation to address unsafe conditions or to prevent considerable adverse effects to resources. *Forest Service Manual* §2355.3 - 1,2.2.

Management plans and monitoring programs must also be structured to assess the success of restoration and repair efforts and provide feedback loops for adaptive management.

3. Include strict measures for reducing ORV impacts in the access and management plan:

- **Close Restricted Areas of the forests to ORVs with the exception of a few already impacted ORV play areas such as clay and borrow pits located well away from sensitive areas.**
- **Close any designated trails and roads in Unrestricted Areas that cannot be adequately patrolled and monitored to prevent ecological damage.**
- **Avoid rest-rotation schemes.**

Recognizing that ORVs are damaging by nature and that ORVers already have uncontrolled, unregulated access to up to two-thirds of the Ocala and Apalachicola national forests and "restricted" access to the other one-third, ORV access throughout the Florida national forests should be limited to designated ORV play areas in Restricted Areas and to a limited number of miles of well-chosen ORV-designated trails in Unrestricted Areas.

If a trail goes near a sensitive area such as a shallow pond, ephemeral wetland, prairie, savannah, sinkhole, roadless area, red-cockaded woodpecker colony, bald eagle nest or restoration site, an ORVer might be tempted to leave the trail and explore.

The only way to avoid potential harassment of wildlife and harm to sensitive areas is not to let ORVers get near them in the first place, says Florida Fish and Wildlife Conservation Commission officer Gene Newman (personal communication 2001). What is too "near" depends on the nature of the landscape. Certainly a sensitive area immediately adjacent to or in plain view of an ORV trail is seriously at risk as is one located near a popular mudbogging destination or other attraction that draws ORV traffic hundreds of yards off a trail.

Enforcing prohibited area regulations presents legal problems, too. The courts have demanded that signs be in place to inform users of the boundaries of prohibited areas, but often these signs are torn down by problem visitors who continue to do as they please, says the Forest Service recreation specialist Kathy Briggs (personal communication 2000). The solution is not to repeatedly put stopgap signs on every little wetland and nesting site, but to permanently prohibit vehicular access to Restricted Areas and make it very clear with large signs, barriers and maps located in highly public locations where users are unlikely to be able to remove them undetected.

Restricted Areas: No ORVs Except in Designated ORV Play Areas

Ideally all roads and trails in the ecologically sensitive regions of the national forests that the Forest Service has designated as Restricted Areas should be closed. However, some Forest Service employees feel that carefully selecting, setting aside and managing already impacted ORV "sacrifice areas" for ORV play is a practical way to divert impacts from more sensitive areas (Briggs personal communication 2000).

This has not been regarded as a viable management alternative because of the liability problems inherent in designating sites as suitable for the potentially dangerous activities many ORVers enjoy (Monaghan personal communication 2000). The popular claypits in Ocala National Forest, for example, have been closed to ORV activity for liability reasons, according to Seminole district ranger Jim Thorsen (2001).

Florida Division of Forestry (FDOF) recreation coordinator John Waldron (personal communication 2001) feels that designating substantial tracts of land specifically for ORV use has worked well for FDOF. On the Croom Motorcycle Area in Withlacoochee State Forest, users spend most of their time playing in already disturbed sandpits on an abandoned mine site, but are free to travel through the surrounding 1,700 acres reserved for ATV and motorcycle use. This portion of the forest is obviously impacted, but not to the extent that it does not continue to have some wildlife value.

ORV problems on nearby FDOF lands are minimal. User fees bring in management funds and volunteer ORV groups help with maintenance. FDOF land managers feel that having such areas around the state would decrease ORV impacts on other lands (Waldron personal communication).

However, FDOF forest ecologist Dennis Hardin (personal communication 2001) believes that such sacrifice areas should be chosen very conservatively. He points out that half of the Croom area is what would otherwise be good longleaf pine habitat. Since the density of trails and ORVer preferences for dense vegetation have precluded prescribed burning there, this ecosystem cannot be maintained. Hardin is also concerned that the courses for motorcycle enduros and other events held in the Croom area are allowed to spill over into state forest lands outside the designated ORV area.

Some Forest Service employees feel that carefully selecting, setting aside and managing already impacted ORV "sacrifice areas" for ORV play is a practical way to divert impacts from more sensitive areas

Sacrifice areas are controversial. The Forest Service should confer with ORV users and other recreationists and closely examine the legal possibilities, management and law enforcement implications and ecological feasibility of establishing controlled ORV play areas and associated access routes and staging areas around clay-pits and other highly disturbed sites in Restricted Areas. The Forest Service should also collaborate with other agencies to divert ORV activity to play areas on private lands that are open to ORVers by identifying such areas and directing ORVers to them.

Unrestricted Areas: ORVs on Designated and Patrolled Travelways Only

All travelways other than public roads and designated, mapped and signed ORV trails should be closed to motorized recreational vehicles. Vehicle operation on these designated trails should be restricted to daylight hours.

ORVs traveling nondesignated, user-created trails do the most damage. Off-trail ORV use impacts previously pristine areas, undermines restoration efforts, damages vegetation, disturbs soils, displaces other recreational users, poses a greater roadkill risk for small animals and is more disturbing to wildlife in general. Uncontrolled access allows these impacts to spread over the landscape, facilitates damaging and illegal activities and complicates law enforcement. Indeed, opening large areas to ORV use with a qualification such as ORVs must stay on existing trails or roads is "largely unmanageable (Luckenbach 1975)." Good planning and adequate law enforcement are essential to prevent natural resource damage and to keep ORVers on carefully chosen designated trails in a limited area.

No Rest-Rotation Schemes

The practice of rotating recreational activity from one area to another periodically to allow a tract of land rest and recover should not be part of an ORV management strategy because it has the ultimate negative effect of spreading significant levels of impact over greater areas of the landscape.

Such a rest-rotation scheme was proposed by the Access Designation Working Group for Apalachicola National Forest. However, as National Park Service recreation impact specialist Jeff Marion (1998) points out, such schemes tend to be impractical because trail recovery rates are substantially slower than initial impact rates and closing abused areas is more inclined to deflect impacts than to prevent them. "Unless additional measures are implemented to prevent the reoccurrence of the impacts, an area closure has the short-term effect of resolving the problems only to have them reoccur in new locations at a later date (Marion 1998)."

4. Significantly improve law enforcement in the forest:

- **Create a law enforcement task force and enforcement plan for each forest.**
- **Establish a toll-free number citizens can call to report violations.**
- **Implement a permit system.**
- **Increase penalties for violations and funding for law enforcement.**
- **Institute a volunteer ranger program.**

Improving law enforcement in the national forests should be a top priority. If the Forest Service cannot implement and enforce regulations to protect our natural and cultural resources from ORVs, then the forests should be closed to ORVs.

The consensus among responsible ORVers, other forest recreationists and most Florida Forest Service employees is that the real ORV management challenge is building the Forest Service's capacity to enforce restrictions and regulations and monitor ORV activity (Small personal communication 2001). Meeting the challenge will require the serious commitment of

Forest service leaders to adopting and implementing bold and creative policies that require steeper penalties, substantial increases in funding and staffing and better interagency cooperation. This is particularly true for Ocala National Forest where increasing ORV use and shrinking budgets make adequate law enforcement especially difficult, according to Lake George district ranger Jerri Marr (2001).

A Task Force and Plan for Each Forest

Local and state law enforcement agencies should be included on a Forest Service task force to develop cooperative strategies for effectively monitoring ORV use in each of Florida's three national forests. For example, to expand and improve coverage and raise the visibility of law enforcement, local, state and regional Forest Service enforcement personnel could team up for law enforcement "blitzes." Initially, regional law enforcement officials could spend several weeks leading the team as it rotates through each forest, ticketing rule-breaking ORVers, enforcing regulations in ORV impact problem hotspots and handing out educational materials and maps.

A Toll-Free Number

A toll-free number citizens can call to report ORV violations should be established. Local, FWCC and Forest Service law enforcement personnel are rarely available by phone, especially after hours on weekdays and on weekends. A staffed, 24/7, toll-free number for reporting ORV abuses and other violations could help direct on-the-ground law enforcement efforts and significantly improve enforcement overall.

ORV operators cannot be expected to effectively police each other, but other forest users with cell phones could report violations if they were provided with a number to call and encouraged to use it.

An ORV Permit System

Fee-based or not, an ORV permit system that requires an identification decal to be visibly displayed on ORVs using the forests should be implemented. Such a system would help law enforcement personnel and citizens identify offenders and allow the Forest Service to make permit revocation and steep fines a consequence of abusive ORV activity.

Funding for law enforcement should be increased enough to provide an adequate number of staff on the ground to patrol and enforce regulations. Penalties for violations should also be raised significantly to help defray the costs of law enforcement and natural resource restoration. Penalties for resource damages related to group events, for example, should cover the cost of natural resource restoration.

Law enforcement funding should be based less on the acreage of a management unit and more on the people pressures exerted on it. Ideally, increased penalties and recreation funding objectives should be linked so that those who break the rules and damage the forests bear the costs of enforcing regulations and restoring degraded areas.

A policy of confiscating the ORVs of the most serious offenders and converting these vehicles to resource management service would send a powerful message and channel equipment in the right direction.

A Volunteer Ranger Program.

Responsible local trail users should be trained to patrol and monitor problem areas. Establishing such programs would extend the "eyes and ears" of law enforcement and land management personnel, create a mechanism for fairly offering special access privileges to responsible forest users and provide opportunities to educate and communicate with adjoining landowners. Volunteer programs can turn many of those most actively concerned with the forest from complainers into supporters who are part of the solution, rather than part of the problem.

5. Educate users.

ORVers should be taught to understand the impacts they have on the Florida landscape and how they can alleviate them. Studies have shown that most recreationists are unable to recognize ecological impacts (Hammitt and Cole 1987). It is unrealistic to expect people to behave responsibly until they are taught how appropriate behavior helps protect resources.

Educating forest users can directly decrease resource abuse, but it must have two distinct components: informing users of the rules and teaching them to understand the forest.

Informing visitors of the rules is critical to law enforcement and resource protection. This includes providing them with maps that clearly show where they can and cannot go. "I didn't know" cannot be a legitimate excuse.

Giving users a sense of ecosystem dynamics and sensitive resources and the potential destructiveness of their activities can foster a sense a responsibility. Some Forest Service employees advocate promotion of the common-sense principles of the "Tread Lightly" program (see box above), which is oriented toward all trail users (Tread Lightly 2001). ORV groups have a history of pledging to follow the Tread Lightly Principles, then blatantly ignoring them (Marion County Audubon Society 2000). ORVers should be provided with Florida-specific ORV guidelines as well.

Rules For Trail Users:
The Tread Lightly Principles

1. Stay on the trail.
2. Don't speed or engage in other wreckless activities.
3. Don't feed or harass wildlife.
4. Don't pick flowers or collect anything.
5. Don't leave trash or waste along the trail.
6. Don't release toxic fumes or fluids.
7. Don't smoke, start fires or generate sparks.
8. Know where you are and what the rules are.
9. Obey all signage.
10. Make your child/horse/dog follow the rules too.
11. Clean seeds and dirt off your equipment before each trip.
12. Report trail maintenance problems and rule violations promptly.
13. Be courteous to other users.
14. Give back to the land — volunteer for trail work.

Source: Tread Lightly 2000

MODERATING ROAD AND TRAIL IMPACTS

1. To reduce overall road and trail density and to adequately protect roadless core habitat, eliminate or close unnecessary roads and trails.

Measures should be taken immediately to begin significantly reducing high road densities in the Florida national forests. "Closing and/or removal of roads to minimize motorized vehicle access is the most effective solution (Forman and Hersperger 1996)." This applies not only to official roads, but to all travelways or "woods roads." Establishing authorized ORV routes in very limited areas on the periphery rather than in the interior of the national forests, preferably in Unrestricted Areas versus Restricted Areas would help to maintain the ecological health of the Florida national forests.

Numerous studies of the relationship between ecosystem integrity and road density have concluded that a road density of one mile per square mile is an ecologically acceptable road density standard.

Numerous studies of the relationship between ecosystem integrity and road density have concluded that a road density of one mile per square mile is an ecologically acceptable road density standard. Forest road densities should be limited to this level forestwide to minimize the ecosystem impacts of habitat loss, edge effects, disturbance and road-associated mortality.

As landscape ecologist Tom Hoctor (personal communication 2001) explains, "The Ocala National Forest should be the highest priority for engaging in dialogue and planning for significantly reducing road densities…The fact that nearly 93 percent of the Forest has road densities greater than one mile per square mile should be the cause of much concern and action."

Designated and protected roadless areas are essential to the maintenance of the true wilderness conditions that allow ecological processes to operate naturally and "reduce harassment and persecution of sensitive wildlife (Noss personal communication 2001)." Yet between 1986 and 1995 Florida's national forests lost six of the 14 Roadless Areas potentially qualified for Wilderness Area designation, a total of nearly 50,000 acres. These areas should be restored in part through a systematic reduction of road density.

The size of the roadless area necessary to minimize edge effects and maintain or restore natural conditions varies according to ecosystem type and landscape context. In some regions, The Nature Conservancy's ecologists have used 10,000 acres as a roadless core area threshold for ecoregional planning (Hoctor personal communication 2001). Noss (personal communication 2001) suggests 5,000 acres as the minimum viable size for ecological core habitat in Florida.

Based on an extensive review of the literature on edge effects, Hoctor (personal communication 2001) suggests establishing core natural areas consisting of at least 5,000 to 10,000 roadless acres beyond an also roadless 1,000-meter peripheral buffer zone. He points out that the intensity of many edge effects is related to road type and the actual critical buffer zone width might be narrower for low intensity roads (maybe 100 to 300 meters). He further cautions that human activity patterns would need to be taken into account because, in some situations, a crude jeep trail might actually support more intrusive human access than a typical country road.

Obliterate, Close and Convert

Throughout the forests all unnecessary travelways accessible to motorized traffic, whether planned and officially recognized or not, should be removed. Unnecessary travelways include access trails for old projects, dead-end roads and trails, parallel and redundant routes and user-created exploratory trails. All but genuinely critical roads should be removed from some management areas and resource buffer zones.

Simply closing the roads is not enough; complete obliteration is the only way to effectively erase a road from the landscape (Walder 1996).

Complete obliteration of an improved road usually means ripping down to three feet below the ground surface, restoring drainage patterns and replacing the discarded road fill with the bottom layer (the original topsoil) on top. “Ripping” breaks up compacted layers, increases infiltration and enhances revegetation (Luce 1997; Bagley 1998). Partial obliteration, which generally involves some soil ripping, installation of water bars and/or some outsloping may not adequately restore the original drainage patterns. It also leaves enough of a hint of the route to attract recreationists and require continued maintenance.

Although complete obliteration is costly up front, it is often less expensive than partial closure over the long-term. If ecological benefits and costs are added into the equation, complete obliteration is probably the most cost-effective approach to eliminating roads (Walder 1996).

Areas from which roads are removed should be replanted with appropriate native vegetation and restored to natural habitat condition. *Forest Service Manual 7703.1* requires the Forest Service to “reestablish vegetative cover on any unnecessary roadway or area disturbed by road construction on National Forest system lands within 10 years after the termination of the activity that required its use and construction.” No sign of the former route should remain to tempt users.

If they cannot be obliterated all together, all nonessential roads — including unofficial ORV travelways — should be effectively closed to motorized access, especially roads and firelanes into sensitive areas such as the Apalachicola savannas (Traylor personal communication 2000).

Effective road closure requires heavy barricades at strategic points. Simply erecting ordinary signs and barriers will not work because renegade users will tear them down or go around them (Lowery personal communication 2000; Miller personal communication 2000; Briggs personal communication 2000; Marion County Audubon Society 2000; Weaver and Hagan 1990). Dirt mounds are not sufficient barriers because ORVs can drive over them. Even gates and tank traps are often ineffective because they can be easily vandalized.

To make sure that barriers have not been breached and the roads are not being used, roads that have been closed should be carefully monitored. In many national forests, numerous supposedly closed roads have remained passable. For example, Hammer (1986) documented that 38 percent of the "closed" roads on Flathead National Forest in Montana could still be accessed by passenger vehicles.

Roads that serve important non-ORV recreational functions should be converted to nonmotorized trails wherever possible. This may involve constructing barriers to bar motorized vehicles. Although studies have shown that even narrow dirt roads and trails will limit movement of certain animals and fragment soil fauna, converting roads to well-managed nonmotorized trails would significantly decrease many impacts.

Road closure and conversion are not equivalent to road removal, but are a step in the right direction. To keep roads closed, clear signage, up-to-date maps, good user orientation, active patrol and enforcement and strong penalties for violations are necessary.

2. Limit the number of new roads and trails and route them carefully.

No new roads should be constructed in the national forests unless they are absolutely necessary and have been ecologically evaluated and justified in a carefully developed plan subjected to scientific and public review. No new roads into the few pristine roadless areas remaining in the forests should be constructed for any reason. The Forest Service has prepared a useful set of guidelines to facilitate evaluation of road proposals (U.S.D.A. Forest Service 1999), but they do not specify the ecological detail necessary to assure that good decisions will always result from their application.

The activities of forest visitors, easement holders and neighboring landowners should also be carefully controlled to ensure that they do not create new unauthorized roads on forest lands.

Roads — including all types of travelways used by motorized vehicles — should be carefully routed to avoid sensitive areas such as rare plant locations, sinkholes, roadless areas, important foraging areas or critical breeding sites. Poorly planned roads in close proximity to sensitive areas should be obliterated or rerouted.

The appropriate buffer zone between a sensitive area and a road will depend primarily on the nature of the site to be protected. Florida scientists have suggested buffer zones based on wildlife flushing distances and nesting and life-cycle requirements.

The location of roads and trails is also critical in determining the likelihood of soil erosion (Leung and Marion 1996). Various types and combinations of use will affect erosional processes in particular landscape situations. For example motorcycles cause more damage going uphill than downhill (Weaver and Dale 1978), so motorcycle trails should go up gentle and more stable slopes and down steeper and more fragile ones.

Wetland crossings should be planned very carefully to minimize hydrological impacts. Constructing a road or travelway or designating an ORV trail through a wetland typically alters hydrological patterns. Roadside drainage ditches also drain adjoining swamps and marshes. Raised roadbeds function as dams to impound surfacewater. Ample culverts in appropriate locations may minimize associated problems, but seldom eliminate them altogether (Duever et al. 1979). On damp slopes, poor road layout and/or inadequate culverting can result in higher groundwater levels upslope and a lower downslope (Stoeckeler 1965).

New roads through disturbed landscapes should be designed to follow historic travel corridors wherever possible.

3. Plan ORV access points wisely.

ORV access to the forests should be through designated entryways and checkpoints at the periphery of the forest only. To monitor users and have opportunities to orient and educate them, ORVs should not be permitted to simply take off into the woods from along a highway or out of a backyard.

Staging areas should be carefully situated well away from sensitive wildlife or old growth habitat. Placing high-use staging and trail areas at the periphery of the national forest is good landscape-level conservation planning (Noss and Cooperrider 1994).

The Forest Service should work with the residents of inholdings and neighboring lands on access issues. Many of these people have habitually driven their vehicles across forest lands to get to nearby destinations. Others are accustomed to conveniently accessing forest trails at places that are inappropriate for public entry.

A system for granting special access privileges for neighboring residents should be established. Privileges should be granted only if: 1) the proposed access point can be controlled so that it does not become an entry for outlaw users; 2) ecological resources will not be significantly affected; 3) the user has demonstrated willingness to stay on the trail, behave responsibly and follow other regulations; and 4) the user takes responsibility for the behavior of any visitors he/she allows to use that access point. The user should also be encouraged to participate in a volunteer ranger program that includes training in the basics of resource management. These trained volunteers could provide much needed assistance in reporting irregularities, helping educate other users, monitoring for exotic plants, assisting with fire management, etc.

Special access privileges should not be granted to allow juveniles to play in the forest unsupervised, to allow motorized vehicles in forest interior areas where they are otherwise prohibited, to permit unrestricted off-trail activity or to allow users to create play areas or unauthorized trails on Forest Service lands.

4. Reduce road widths.

Roads that serve important access functions should be narrowed as much as possible. This may involve placing logs or rocks along the roadsides, not mowing road shoulders and not removing trees from roads and road shoulders.

The wider a road and its adjoining right-of-way, the greater the edge effect it will have. On

South Carolina barrier islands, Gaddy and Kohlsaat (1987) measured lower vegetation disturbance indices along narrow jeep trails compared to wider roads. Rich et al. (1994) examined how forest-dividing corridor width affects nesting birds. Numerous studies have suggested that narrow trails shaded by the forest canopy are less likely to promote exotic plant invasion or seriously disrupt the movements of many animal species than broader open corridors.

5. Keep roads and trails properly signed and maintained.

All roads and trails should be monitored and maintained regularly. Trail broadening often results from users detouring around mudholes or fallen logs, so regular inspection and maintenance is vital to controlling road width in open landscapes. Road and trail maintenance is often more critical than type and amount of use in determining the extent of soil erosion problems (Leung and Marion 1996).

Drainage problems should be corrected before gullies begin to develop. Steep slopes should be stabilized with water bars, and various types of web mats can be used to stabilize routes. Geoweb has been used successfully for this purpose on St. Johns River Water Management District lands in Osceola County, reports Division of Land Management director Steve Miller (personal communication 1998). Stream crossings stabilized with matting and gravel are also working well on shared-use trails on Goethe State Forest, says trail association president Helen Koehler (personal communication 2000).

Although proper maintenance of roads can reduce erosion and siltation impacts, pollution may result if dust control chemicals or herbicides are used. Such substances should not be applied to forest roads unless there is a special need and their ecological effects have been carefully evaluated and determined to be negligible.

Clear signage to direct visitors on to the correct routes and remind them of regulations is also essential. Road and trail maintenance must involve prompt identification and replacement of damaged or missing signs and timely installation of new signage whenever visitor confusion or misbehavior becomes evident. An easy way for visitors to report maintenance problems should also be established.

6. Control traffic on problematic roads and trails by restricting use to daylight hours and establishing and enforcing strict speed limits.

Consideration should be given to reducing traffic on problematic routes where roadkills or user-volume impacts are observed or anticipated. The potential value of this strategy will have to be evaluated on a case-by-case basis because reducing traffic will not necessarily help minimize road impacts.

It would seem logical that roads and trails with more traffic would do more damage, but the relationship between road and trail use and degree of impact appears to be more complicated than that. Lowering traffic volume and limiting the number of vehicles might be expected to decrease roadkill rates and pollution, but thresholds of tolerance and avoidance and habituation behaviors complicate predictions of the correlation between road use and wildlife impacts.

Since a disproportionate number of roadkills and poaching incidents occur at night, nighttime access to trails and some interior forest roads should be limited. Kline and Swann (1998) documented decreased roadkill rates on park roads closed at night. Nighttime trail and road closures could provide much benefit for relatively little cost (Wuerthner 1993).

Speeding and racing should be prohibited Forest Roads and trails. Appropriate speed limits will depend on the nature of the landscape, but recreational travel should always be held to a pace much slower than that of highway traffic.

The faster a vehicle is driven, the more difficult it is for the driver to avoid hitting an animal in the roadway ahead or to maintain control when trying to avoid a collision. Gunther et al. (1998) found that speed was the primary contributing factor in vehicle-wildlife collisions. Christoffer (1991) documented higher roadkill rates on roads with faster traffic in Florida state parks.

ORVs wrecklessly driven at top speed on trails pose a safety hazard to other users as well as to wildlife and are also more likely to damage trails and adjacent lands. Van Loan (1999) documented how speeding motorcyclists repeatedly cut corners and miss turns on Withlacoochee State Forest and expand their zone of impact.

An Urgent Message

These recommendations and the wealth of information presented in this report come with a strong and urgent message: If the Forest Service cannot meet its mandate to protect our natural resources by developing an ORV management and monitoring program with adequate funding for implementation and law enforcement, the Florida national forests should be completely off-limits to ORVs.

"Recreational development is a job not of building roads into lovely country, but of building receptivity into the still unlovely human mind." The ultimate objective is to foster appreciation for the wondrous complexity of the web of life. When people begin to grasp this, they will be more inclined to listen to the frogs and watch the birds than to move at high speeds in loud machines. They will understand exactly what is at risk when the landscape is abused by roads and vehicles."

—Aldo Leopold, 1921