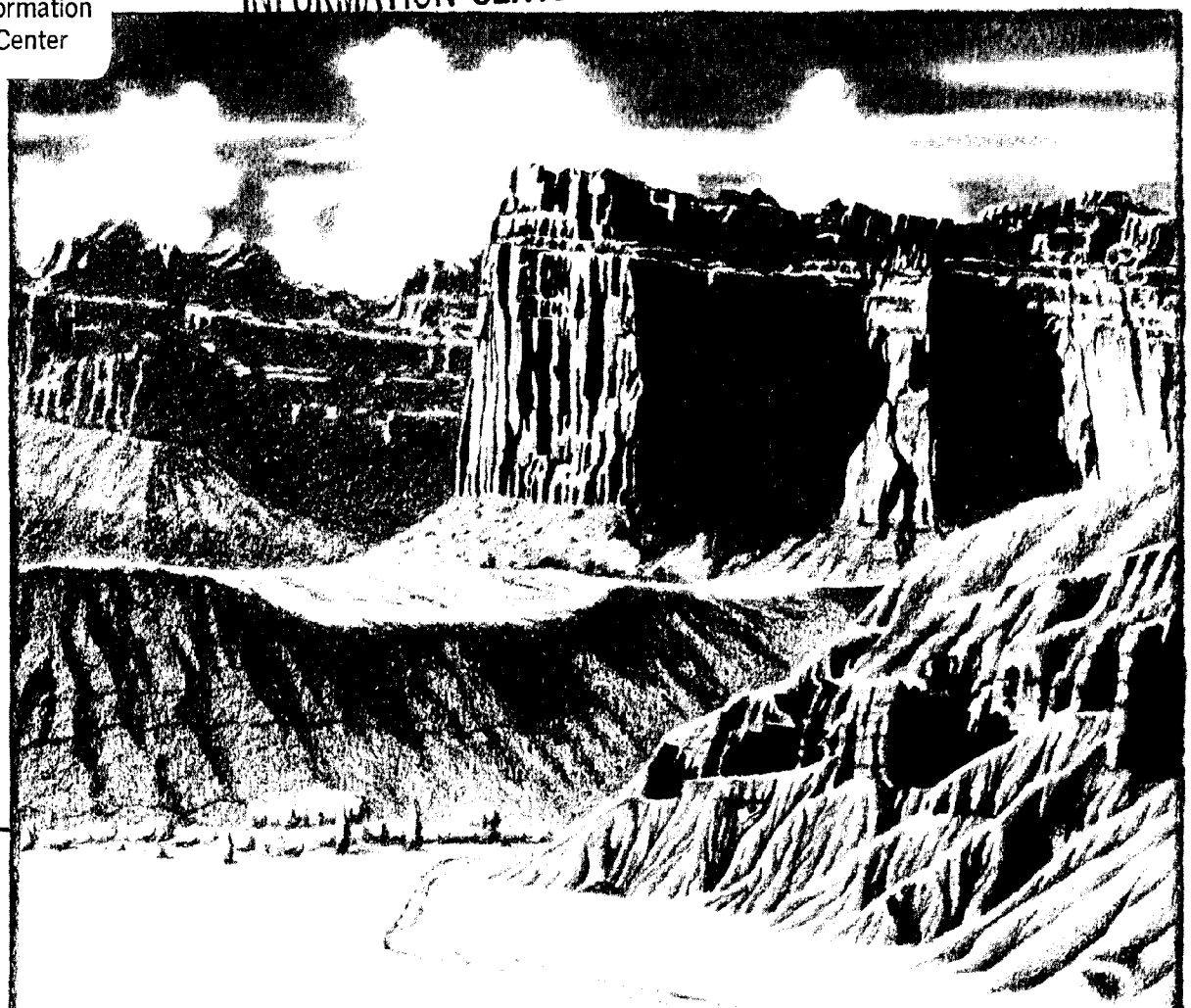
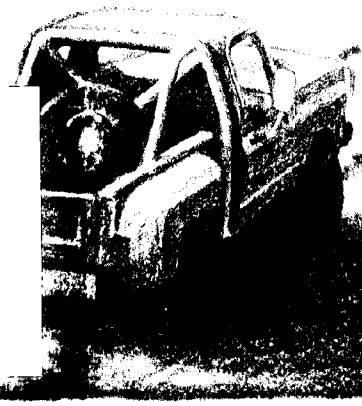


Off-Road Vehicles on Public Land

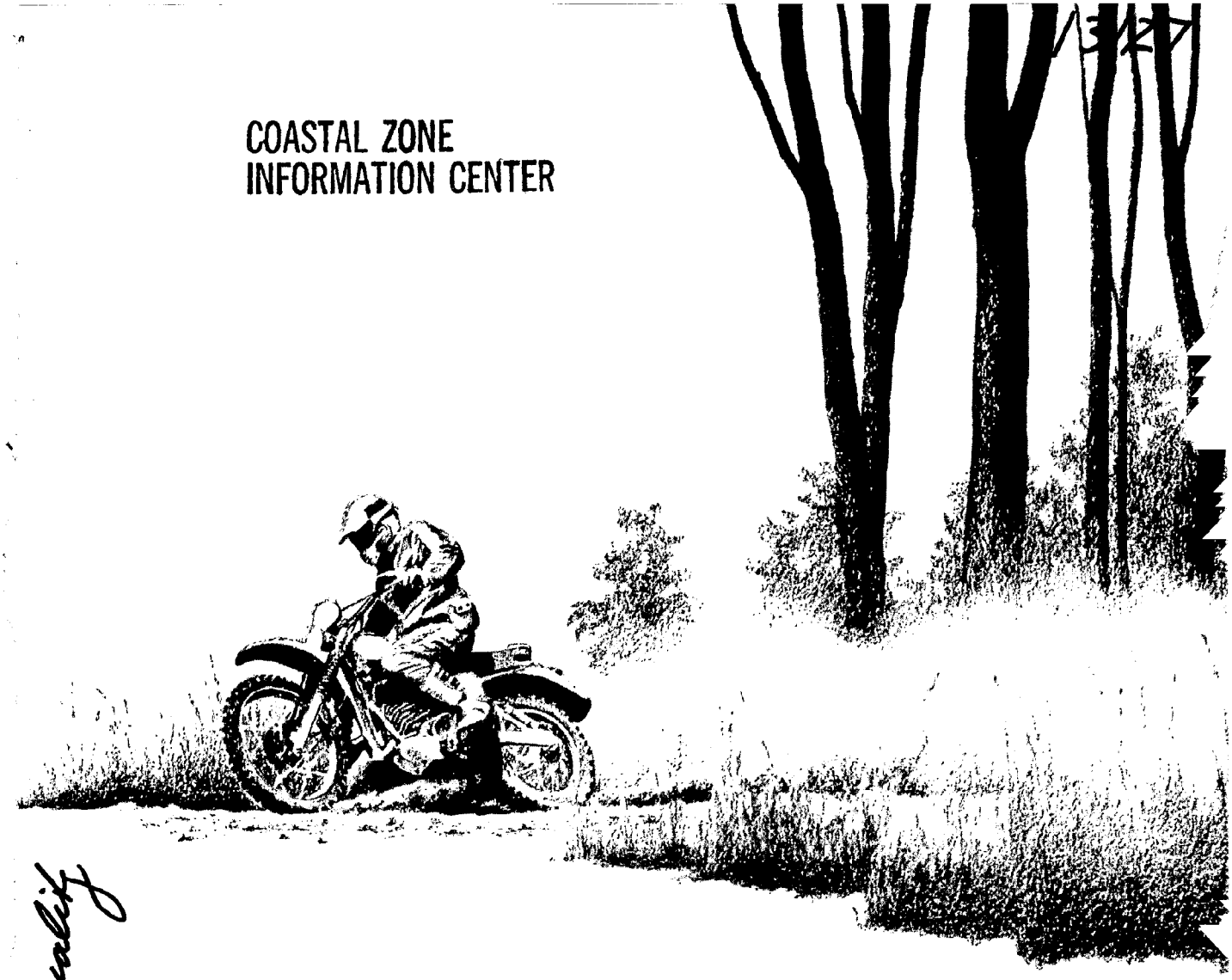


Council on
Environmental Quality
1979

Allen Carroll

Council on Environmental Quality

COASTAL ZONE
INFORMATION CENTER



Off-Road Vehicles on Public Land

Written by David Sheridan
Illustrated by Allen Carroll

Council on Environmental Quality
1979

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Foreword

Off-road vehicles are here to stay. The reason is simple: they provide recreation to millions of Americans. But off-road vehicles also damage natural resources—soils, vegetation, wildlife, and watersheds. This report shows that these vehicles continue to disturb other people such as picnickers and hikers, who constitute the majority of outdoor recreationists, according to the statistics of the Heritage Conservation and Recreation Service. Of course, the extent of off-road vehicle damage and conflict with other users of the land varies greatly from place to place across the nation, but overall, the Council on Environmental Quality sees the off-road vehicle problem as one of the most serious public land use problems that we face.

Therefore, ways must be found to accommodate off-road vehicles *without* sacrificing the integrity of the natural environment or the rights of those who choose nonmotorized forms of recreation.

Federal agencies began to control off-road vehicles on the public land seven years ago in response to growing concern about their adverse effects. As this report from an independent consultant makes clear, the federal government still has a long way to go before the off-road vehicle use of land under its care is in harmony with other uses.

The report states that the two major federal land management agencies—the Bureau of Land Management and the Forest Service—have been slow to grapple with the off-road vehicle problem. But they are now integrating off-road vehicle use into their land use planning processes in response to two Presidential Executive orders, which have provided guidelines needed for intelligent management of off-road vehicles within the multiple use context. Some particularly fragile areas of the public land have in fact been closed to off-road vehicles. Most crucially, we now possess a much firmer scientific base of facts for understanding the long-term environmental consequences of off-road vehicle use than we did seven years ago, thanks to the research efforts of several federal agencies—especially the U.S. Forest Service, the U.S. Geological Survey, and the Fish and Wildlife Service.

More study is needed, but not as a substitute for action. Section 9 of Executive Order 11989 unequivocally states that

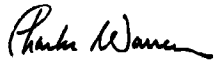
> the respective agencies head shall, whenever he determines that the use of off-road vehicles will cause or is causing considerable adverse effects on the soil, vegetation, wildlife, wildlife habitat or cultural or historic resources of particular areas or trails of the public lands, immediately close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

Full compliance with the Executive order will require cooperation from the off-road vehicle industry and the goodwill and cooperation of the off-road vehicle user organizations as well. And land management agencies responsible for areas of intensive off-road vehicle use will need to make new efforts to monitor impacts and enforce necessary restrictions.

Positive policy commitments by the federal land management agencies are essential. Two examples of successful off-road vehicle management programs are found in the State of Washington and the Tennessee Valley Authority. In both instances separate trail systems specifically designed for off-road vehicles have been developed. For the major federal land management agencies, a key question is who should pay for the maintenance and rehabilitation of such special off-road vehicle facilities. Mr. Sheridan, at the close of his report, recommends that the off-road vehicle owners themselves should pay, much as fishermen and hunters pay for resources which they use through the Dingle-Johnson and Pittman-Robertson programs. We think this suggestion merits careful consideration.

Today's conflict over off-road vehicle use of public lands typifies our times. As our population

expands, as we pave more open land, and as demand for outdoor recreation mounts, the competition for recreational land grows keener. At times the conflict has been bitter, with interest groups on both sides jostling for more space. But we think that the problem is soluble. The keys are patience, broadly based public participation in government planning and decisionmaking, adequate separate facilities for off-road vehicles, and strong but fair enforcement of off-road vehicle regulations. The Council on Environmental Quality stands ready to help government agencies and the public achieve these objectives.



CHARLES WARREN
Chairman

Preface

Off-road vehicles are an extremely touchy issue. In fact, of the several issues which arise out of public land use decisions—grazing, surface mining, water diversion, forest cutting, and wilderness designation—none, in this author's experience, is as volatile as off-road vehicles.

Even the term itself, off-road vehicles or ORVs, is subject to controversy. More often than not the term is used to cover all motorized vehicles which travel off-road for recreational purposes—motorcycles of various sorts (minibikes, dirt bikes, enduros, motocross bikes, etc.), four-wheel drive vehicles such as Jeeps, Land Rovers, or pickups, snowmobiles, dune buggies, and all-terrain vehicles. Snowmobilers, however, object to being lumped into a general category labeled ORVers. They have a point. Because snowmobiles are usually driven on a layer of snow, their environmental effects are qualitatively different than those of off-road vehicles which come into direct contact with the ground. Also, snowmobiles operate in the winter, when the competition for space among recreationists is generally less than in other seasons.

Therefore, in this report, the term off-road vehicle or ORV does *not* include snowmobiles. It does include those vehicles which are designed primarily for off-road use and whose tires or treads run on the ground—motorcycles, four-wheel drive vehicles, dune buggies, and so on. In the few instances where it has been necessary to discuss ORVs and snowmobiles as one statistical group, the term "motorized recreation" is used. This is not to say that snowmobile use of the public land is ignored or that it is without problems. From a national perspective, however, it does not pose the same magnitude of problem for the public land as does ORV use.

Before I embarked on this project, my previous encounters with the subject were limited to covering the 1965 Winnipeg to St. Paul, Minnesota, Snowmobile Race for the *Minneapolis Tribune* and 2 days of dirt biking in Mexico in 1971. My opinions on the subject were confined to those two experiences: I thought 400-mile snowmobile races in the dead of the northern winter a truly masochistic idea but found dirt biking almost as exhilarating as downhill skiing or hang gliding. Somehow, the environmental implications of ORVs and snowmobiles had escaped my notice.

In the course of reviewing the available ORV and snowmobile literature, I have sought to achieve an objective analysis, realizing, however, that this is extremely difficult in a subject as value laden as ORVs and snowmobiles. When a draft of this report was sent for comment to land managers, environmentalists, and off-road vehicle enthusiasts, special care was taken to evaluate each criticism in light of the available scientific facts. Revisions were made where the facts dictated. The report benefited from these critiques, although controversy about ORVs is so hot that many are bound to take issue with the report's conclusions. At the very least, I hope that I have fairly aired the differing points of view.

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.

However, there are some strong-minded civil servants who have worked conscientiously to protect the public lands from damage by off-road vehicles and in the process have incurred the displeasure of special interest groups and sometimes even their own agencies. They deserve acknowledgment:

Robert J. Badaracco, Bureau of Land Management
Brian Booher, Bureau of Land Management
Stew Branson, Bureau of Land Management
Kristin H. Berry, Bureau of Land Management
Allen Copperrider, Bureau of Land Management
Gary Cummins, Bureau of Land Management
Mark A. Dimmitt, Bureau of Land Management
Paul Farrens, Bureau of Land Management
A. Claude Ferguson, Forest Service
Robert Gilmore, Fish and Wildlife Service
John A. Hall, Bureau of Land Management
Arthur J. Hayes, Bureau of Land Management
John Heywood, Bureau of Land Management
Dennis Holland, Fish and Wildlife Service
Richard Kuehner, Bureau of Land Management
Randall P. Legler, Jr., Bureau of Land Management
Monty E. Montagne, Forest Service
John K. Nakata, Geological Survey
William Radtkey, Bureau of Land Management
J. V. Remsen, Jr., Bureau of Land Management
Craig Taggart, Bureau of Land Management
Craig Tocher, Bureau of Land Management
Howard Wilshire, Geological Survey

Contents

PART 1: The Issue

GROWTH OF A PHENOMENON

Thus far, development and production of off-road vehicles has moved faster than our regulatory, management and legislative machinery.[1]

J.R. Penny,
California State Director,
Bureau of Land Management,
1971

It began, oddly enough, in a bomb-shattered section of Hamamatsu, Japan, in 1947. There, in a board shack, Soichiro Honda, a 41-year-old mechanic and college dropout, removed a small motor from a war surplus field generator and strapped it to a bicycle. He sold enough of these improvised motorbikes to exhaust the supply of surplus generator engines. He was soon designing his own motorbike and motorcycle. Throughout the 1950s, Honda and his employees advanced the art of making and selling lightweight, high performance, and economical motorcycles.[2]

By 1960, Honda was marketing in the United States a 50 cc motorcycle for less than $300 when most motorcycles cost $1,500 or more. People riding the Honda "dream" machine could travel 55 miles per hour for 180 miles on 30 cents worth of regular gas.[3] Or, if the spirit moved them, they could cut off the road and drive the open countryside; unlike the big motorcycles being built by American, British, and German firms at the time, the Honda was light and durable enough to take over rough terrain, and unlike the motorbike, it was powerful enough. In 1961, the director of a prominent British motorcycle manufacturer reported: "When we stripped the machine (Honda), frankly, it was so good it frightened us. It was made like a watch and it wasn't a copy of anything."[4] By 1971, Honda had captured over half of the growing U.S. motorcycle market.[5]

But Honda's success involved much more than good technology. Honda recognized that if large numbers of Americans were going to buy a motorcycle, it would be for recreation rather than transportation. The trouble was that motorcyclists had a bad image in the United States. The public mind associated them with leather-jacketed thugs such as the Hell's Angels. Hollywood reinforced this image with popular movies such as "The Wild One" (1953), starring Marlon Brando. So Honda mounted a massive advertising campaign, depicting well-scrubbed, respectable people riding motorcycles for the pure fun of it. In 1964 and 1965, Honda cosponsored the Academy Awards ceremonies on national television.[6] Never before had a motorcycle sales pitch been made to such a broad audience. There they were, youthful, definitely middle-class Americans climbing on their motorcycles and barreling down highways, which always seemed to be empty, and down lonely country roads and crossing fields, splashing through streams, and hurdling hilltops.

Motorcycles took hold fast in the 1960s. At the beginning of the decade, there were fewer than 400,000 registered motorcycles in the United

States. Registrations jumped 279 percent during the next 10 years, compared to a 40 percent rise in automobiles.[7] By 1976, there were 8.3 million motorcycles in use in this country.[8] Some 5.4 million, or 66 percent, were used off-road at some time.[9] Honda still ranks first, with 38 percent of the market, but today there are more than 50 motorcycle manufacturers and hundreds of different models. The Japanese dominate the market—Yamaha, 20 percent; Kawasaki, 17 percent; and Suzuki, 12 percent. Harley-Davidson (U.S.) has 7 percent; BMW (German) and Triumph (British) less than 1 percent.[10]

Today's motorcycle advertisements stress either the sex appeal of youthful motorcyclists—male or female but usually male—or wholesomeness of the family-oriented, outdoorsy motorcyclist. In the latter category, a recent Suzuki ad is fairly typical. It shows a man, a woman, and a young boy all riding their own Suzukis along a dirt trail against a green backdrop. The headline reads: "How to beat around the bush with your family." And beneath this is the copy:

> Just put your gang on Suzuki's DS trail bikes. And head for the boonies. Doesn't matter where you go. Peaks or valleys, it's all the same to these rugged off-road machines. Tractoring up a hillside or going flat-out on a dry lake is no sweat. . . . [T]hese fun-bikes are very affordable. Which means your family can beat around the bush without beating up the family budget.[11]

In a recent Kawasaki ad, three young women and two young men relax in a woods clearing. Their Kawasakis are parked around them. Behind a tree in the background, a black bear peers out. The headline reads: "Does a Kawasaki go in the woods?" The copy has a familiar ring:

> It's a jungle out there. And sometimes it's a desert. Or a mountain pass. Or just a cow trail. But it's all home to us. Kawasaki enduro bikes are built to cope with the only thing you can expect in the boonies. The unexpected. . . . Whether you're a pro. Or just a babe in the woods.[12]

The refinement in the 1950s in Germany of the relatively light, 2-stroke internal combustion engine which produces more horsepower per pound of engine weight than the traditional 4-stroke engine made the mass production of snowmobiles practical.[13] Heretofore, snowmobiles had been large, expensive, and custom made for special uses. J. Armand Bombardier of Quebec seized the opportunity and built the first commercial snowmobile. In 1959, Bombardier, Ltd., sold 259 vehicles. Other manufacturers soon joined the field and business boomed. In the 1968–69 season, some 265,000 were sold throughout North America; the 1970–71 season saw sales of 572,000.[14] The snowmobile explosion had ignited. Today, there are an estimated 2.2 million snowmobiles in operation in the United States and about 1 million in Canada.[15]

These machines spread swiftly throughout the snowbelt, especially in the smaller cities and towns. An elaborate advertising effort to stimulate demand was not necessary—apparently a built-in demand already existed. The snowmobile soon became *the* social outlet during the long winter, *the* business venture in such places as St. Johnsbury, Vermont; Boonville, New York; Eagle River, Wisconsin; Fergus Falls, Minnesota; Ironwood, Michigan; and West Yellowstone, Montana. "These are the towns that froze up and shut up back in the old days."[16] In fact, the snowmobile's popularity advanced so rapidly that the carcasses of wornout and abandoned snowmobiles became a more common summertime sight in the rural northland than junked cars.[17]

The phenomenal growth in motorcycles and snowmobiles peaked in about 1973. Since then, new registrations have either declined from the previous year or increased more gradually than before 1973. The absolute number of motorcycles and snowmobiles in operation continues to rise, however.

Figures on other types of off-road vehicles are less certain. There are probably about 250,000 dune buggies in operation in the United States. The number of four-wheel drive vehicles (4x4s) is not known, but there certainly must be more than 3 million. Of this number, perhaps half are used regularly for off-road driving. Other off-road vehicles include half-tracks and air boats (for swamp travel), all terrain vehicles, and minibikes (not included in the motorcycle figures). All together, there are probably 10 million off-road vehicles and snowmobiles in the United States today. Of course, conventional vehicles such as automobiles and 2-wheel drive pickup trucks are driven off-road at times as well. The focus here is on those vehicles whose primary purpose is off-road travel.

Four-wheel drive vehicles are the hottest items on the ORV market today. In the last 4 years, the sales of American-made 4x4s have increased 96 percent, with 776,808 sold in 1977.[18] Mass media advertising of 4x4s has expanded, too, and it has followed the path blazed by the motorcycle industry. The vehicle's ability to scale hills, cross streams, and traverse rough open land is trum-

peted. In a current television ad for an International Harvester Scout, for instance, we see this big machine perform remarkable feats. It makes 90 degree turns at full speed on loose dirt—throwing up a cloud of dust in its wake. It wades through axle-deep water. It ascends steep, boulder-strewn slopes. It even jumps the crests of hills, with all four wheels actually leaving the ground. A current Dodge truck commercial shows its vehicle in a somewhat less acrobatic light than the Scout but capable of just as much environmental havoc—churning up soils on wet hillsides, plowing through wild streams, etc. In another TV ad, a 4-wheel drive Subaru chases mountain sheep across a rocky landscape.

From the standpoint of public land management, the initially important characteristic of the motorcycle, 4x4, and snowmobile boom was that it struck without warning. Recreational planners and economists who specialize in the use of natural resources for recreation did not anticipate the phenomenon; nor did they fully grasp its far-ranging significance once it was underway. For example, in Resources for the Future's *Land and Water for Recreation*, published in 1963 and considered the *magnum opus* on the subject, there is no mention of these vehicles nor recognition of the very difficult land use conflicts which their use entails. Motorized recreation is not included in the Bureau of Outdoor Recreation's (Department of the Interior) *Selected Outdoor Recreation Statistics*, 1971, not even in the section on projected recreation activities through the year 2000. The Department of the Interior's *Outdoor Recreation*, the first nationwide outdoor recreation plan, released in 1973 with considerable fanfare, barely mentions motorized recreation.

In other words, the public land managers were ill prepared for the onslaught. This was particularly unfortunate because over half of all the off-road motorcycle, 4x4, and dune buggy driving in the nation takes place on federal land. Indeed, over half occurs on land managed by one federal agency—the Bureau of Land Management (BLM).[19]

According to a recent survey commissioned by the Heritage Conservation and Recreation Service, some 43.6 million Americans engaged in some form of ORV activity in 1977, including snowmobiling. Although this statistic, along with the others previously cited, is certainly impressive, it is important to keep it in perspective. Motorized recreationists represent 25 percent of the population. Motorized recreation now surpasses some more traditional outdoor activities such as sailing—19.1 million or 11 percent of the population—and yet hiking with a backpack is more popular than motorized recreation—48.1 million or 28 percent. Walking or jogging attracted 116.1 million, or 68 percent of the American public. Or to look at a specific activity: some 13.8 million Americans (8 percent) went snowmobiling, more than went downhill skiing, for example—11.9 million or 7 percent—but a traditional wintertime activity, sledding, attracted 35.5 million people (only persons over 12 years old were counted in the survey), or 20 percent of the population. Moreover, snowmobiling is no longer the fastest growing wintertime recreational activity; cross-country skiing is, and some recreational planners expect that it might surpass snowmobiling in popularity within the next decade, although it still accounts for less than 1 percent of the population.[20]

In sum, motorized recreation continues to grow but within a social context that features the growth of many other recreational activities, new and old. Americans appear to be spending an increasing proportion of their leisure time outdoors. They are riding off-road motorcycles, 4x4s, and snowmobiles more than ever, but they are hiking more than ever as well. Motorized recreation is riding the crest of an even larger wave—recreation.

ORV BENEFITS

Dirt biking is the last haven for those contemporary young men and women who feel that golf and bowling and television baseball are poor excuses for exercise, a boring and feeble kind of fun.[21]

Lee Gutkind, writer
and motorcyclist, 1973

For many ORV users, the ORV experience presently provides the *only* method by which they can escape the tedium of modern urban living. Frequent escape from urban existence is . . . a necessity that many people find essential to maintaining a reasonable standard of mental health.[22]

R.D. Morgenthaler,
President, Trail Division,
Northwest Motorcycle
Association, 1976

Motorized recreation gives pleasure to millions of Americans. That is its greatest benefit. There are also certain economic benefits derived from

ORV and snowmobile recreation. For the most part, these benefits accrue to the people and firms who make the equipment and those who sell them. In addition, communities in areas which attract riders enjoy a certain influx of dollars. For example, gas stations, restaurants, and motels in communities such as Gorman, California, or Webb, New York, benefit from money spent by people who visit those areas for motorized recreation. The overall economic benefits of this recreation have never been determined. In considering the national economic benefits of motorized recreation, we have to remember that large numbers of ORVs are imported and therefore represent a negative factor in the nation's balance of payments. A few efforts have been made to assess the regional economic benefits of motorized recreation.[23]

One study of ORV and snowmobile economic impacts in the Upper Great Lakes region (Minnesota, Wisconsin, and Michigan) concluded that "the current state of knowledge is still too fragmented and contradictory to make economic analysis at the regional level possible."[24] The authors did observe, however, that within the upper tier of counties in the region, a prime snowmobiling area, "[p]eople are spending hundreds of millions of dollars in the enjoyment of this new form of recreation. The increase in the overall level of business activity is modest, but significant, especially in a region which is concerned about a lack of employment opportunities and slow economic growth. . . . Snowmobiling is particularly interesting. . . . This activity utilizes many facilities, including everything from eating establishments to recreation land, which would otherwise be only infrequently used . . . and occurs at a time when seasonal unemployment is likely to be highest."[25]

What is it that people enjoy about motorized recreation? When asked this question in polls, ORV enthusiasts most often answer: family togetherness, escape from civilization, and comradery with their fellow ORVers.[26] Surveys in the field have demonstrated that the majority of ORV recreationists are with members of their family.[27] ORV enthusiasts also say that the "sights, sounds, and smells of nature" are important to them. For example, in one California survey, off-road motorcyclists consistently expressed an appreciation for the beauties of nature.[28] ORVers, however, do not value solitude and quiet as highly as non-ORV recreationists, especially hikers.[29] The nature of the ORV experience seems to be less contemplative, less aesthetic and more gregarious, more visceral, although ORVers appear to share with hikers and other nonmotorized recreationists a desire to get away from confining jobs and urban life and into wilderness and open spaces.

According to a theory at least as old as Immanuel Kant, a purely aesthetic experience is possible only in the presence of something which provokes no reaction other than contemplation. By this measure, ORV riding is not primarily an aesthetic experience—its pleasures lie elsewhere.

Perhaps, though, this is too narrow a perspective. A trail bike rider in a forest, for example, may stop to enjoy the sight of a mountain waterfall before barreling up a 20 degree incline for the sheer muscle-throbbing sensation of it. To him, it is the combination of the two different experiences which make trail riding pleasurable. Another off-road motorcyclist may be content to roar about in an abandoned quarry doing "wheelies," figure eights, and so on, completely oblivious to his natural surroundings. A four-wheel drive owner may take his vehicle off-road solely as a means of transport into the backcountry for hunting or fishing. For him, the trip itself in the 4x4 may be simply a matter of getting from here to there and back as quickly and conveniently as possible. The rewards and motivations of ORV riding or snowmobiling are sufficiently varied that one should be wary of the generalization of social scientists who seek to pigeonhole the experience.

It is true, however, that popular authors who have sought to evoke the joys of ORV and snowmobile riding have emphasized the physical sensations of the experience. Sally Wimer, for example, wrote:

> Use your body to maneuver your machine up the side of a mountain or around a sweeping turn. It's the skill of the driver that makes the snowmobile perform, makes it glide and drift and speed.
>
> It's maneuvering the snowmobile that makes you feel young, that gives you a new involvement outside of yourself and your work.[30]

Author Lee Gutkind provides this account of an off-road motorcycle romp near Red Lodge, Montana:*

> Suddenly, he was flying and his shoulders were so light he could hardly feel them. The Indian [a brand of motorcycle] bellowed as it bounced over the sage, and folded down the yellow grass on either side of the wheels.

* Reprinted by permission. Copyright © Follett Publishing Company.

. . . He felt the breath of the wind. He felt the hard rubber handle grips scratch his palms. . . . He jetted off across the prairie for a while, breathing in the red dust that the wind and his wheels were kicking up, and then coughing it out again. He trampled the sagebrush at first and then started playing loop games around each clump. . . .

Before he knew it, he had run into some "whoop-de-do" jumps—a series of brief hills, about 25 feet apart. He cranked on, climbed the hill, and disconnected from the ground, landing about four or five feet down on the other side of the next hill. He stood up on his pegs and wedged his hands tightly against the handlebars, so that his arms shot straight out from the handgrips, and cranked it on some more. Each time he hit the top of a hill, his wheels left the ground and his stomach ricocheted into his throat. . . . [H]e saw himself streaking through the sky, floating silently through that part of the universe where there was no gravity nor civilization to build gates and tall buildings or concrete roads.

The hills ran out and he was over the prairie again, grounding down the sagebrush with the wheels of his machine.[31]

When ORVers are asked what kind of terrain they prefer, they invariably say hilly and rolling terrain. More than anything else, they like land that will challenge them and their machines, land that is varied and allows the greatest freedom of movement.[32]

In considering the benefits of ORVs or of the nonmotorized forms of recreation with which ORVs sometimes clash, this report takes the view of the National Academy of Sciences 1968 Conference on Recreation: "[T]he traditional view that human activities in the pursuit of recreation are a form of indulgence having marginal status among the concerns of society is no longer tenable."[33] In other words, recreation is a basic human need.

The verb "recreate" comes from the Latin *recreare,* which means create anew, restore, refresh. In more primitive societies, fulfillment of this need is woven into the very fabric of everyday life so that it becomes an unconscious part of almost every human activity—food gathering, healing, worship, decisionmaking, etc. The more advanced a society becomes, as sociologist Jacques Ellul has observed, the more each human activity becomes rationalized, that is, it is made a separate entity and consciously structured to achieve a primary purpose.[34] In such a society, therefore, specific times have to be set aside to recreate so that this human need does not interfere with the fulfillment of other social functions, especially economic ones.

The Industrial Revolution greatly accelerated this process of specialization. In so doing, it created an even greater need to recreate. As Karl Marx warned: "Constant labor of one uniform kind destroys the intensity and flow of a man's animal spirits."[35] Even the drudgery of farm work afforded a person some variety and therefore some refreshment. Factory and office work offered almost none. But the Industrial Revolution actually reduced the time available for recreation. With increasing prosperity and labor militancy, however, this situation began to change, at least within the United States. More time was allotted to refresh human "strengths and spirits after toil." The problem then became how to fill that time.

There came a cornucopia of relatively new diversions for people: mass entertainment and spectator sports on a scale unequaled since Roman times, hobbies such as photography, and participant athletics such as skiing, tennis, golf, indoor bowling, ORV riding. These, combined with the more ancient forms of recreation such as angling, cards, and dancing, provide present day Americans of moderate income with an astonishing range of choices.

To fill part of their allotted time for recreation, 43.6 million Americans choose ORV riding or snowmobiling. By all accounts it revitalizes "the intensity and flow of a man's animal spirits." That ORV riding is less or more an aesthetic experience than some other form of recreation does not diminish or enhance its value as a source of recreation for people. Indeed, in today's pluralistic society, who is to say which forms of recreation are superior to others? Is planting tulips in your backyard a more worthy endeavor than playing bingo at the parish church? Is it better to listen to Conway Twitty or a Mozart string quartet? These are clearly choices for the individual to make.

Of course, income distribution in a society determines to a large extent the recreational options open to different individuals. Society may intervene more directly when it decides that a certain form of recreation is morally repugnant. Dog fighting, for example, which is no longer tolerated, was a major form of recreation in Victorian England.

In regard to recreation today, our society's principal concern is utilitarian: the greatest good for the greatest number. And as John Rawls has made clear, much more is involved in the application of this principle than crude arithmetic.[36] Society must be concerned, for example, with the allocation of scarce resources, in terms of both efficiency and fairness. A major utilitarian concern with ORV recreation is the destruction of natural resources caused by these vehicles. An-

other is the infringement of other people's rights to recreate. Another is the alternatives available to ORV users. These are questions which occupy the bulk of this report.

MOTORIZED RECREATIONISTS —WHO ARE THEY?

You have to be very careful about elitism on an issue like [ORVs] . . . these are the blue-collar people, the beer drinkers, the football fans. This, for them, is a major form of entertainment.[37]

Two upper level Nixon Administration officials, quoted by John Fialka, *Washington Star*, 1972

Political scientist Ralph Maughan, Idaho State University, and social factors analyst David Duncan, Bureau of Reclamation, recently studied the socioeconomic characteristics of motorized and nonmotorized recreationists in Idaho. They found that the commonly held view that backpackers, nature hikers, tent campers, cross-country skiers, etc. are younger, richer, more urban, and more likely to be single than motorcyclists, four-wheelers, and snowmobilers was unsupported by the facts. The one major socioeconomic difference between the two groups in Idaho is that the nonmotorized recreationists have a considerably higher level of formal education. Maughan and Duncan actually found that ORVers have a slightly *higher* income level than the nonmotorized recreationists. Otherwise, in terms of age, marital status, place of residence, there were no discernible statistical differences.[38]

Maughan and Duncan concluded: "The argument that those who prefer to visit the outdoors in a jeep, on a motorcycle or snowmobile are somehow more 'average,' 'common,' 'real American,' or some other such phrase should be recognized for what it is—a bit of political rhetoric. In Idaho, at least, this argument has little basis in fact."[39] In the previously mentioned study of ORV recreation in the Upper Great Lakes Region, there also appeared to be little difference between ORV owners and non-ORV owners in terms of age, marital status, income, or occupation. The study did reveal, however, that in this region at least, ORV owners (snowmobilers were included) are more likely to live in small towns and rural areas.[40]

Political scientist A.E. Keir Nash, who has surveyed ORVers in California and Washington, emphasizes the educational differences between nonmotorized "wilderness users" and off-road riders. The former are "distinctly more educated, and either in higher status occupations or in college, and preparing for such occupations, than the riders."[41]

Nash adds: "If there is a modal rider (a much more satisfactory term to use than 'average'), it is, at least in Washington and Southern California, a high-school graduate, in his twenties, engaged in a mechanical but fairly skilled occupation or in the construction-trade."[42]

This much can be said about the "modal" or typical ORVer. The typical ORV rider is more likely to be male than female. He is most certainly white—black or Hispanic participation in ORV recreation is thought to be extremely low. He is probably married and earns an income of between $10,000 and $20,000 per year. He has a high school education, and perhaps some college. The average ORVer's occupation and place of residence (urban or rural) remain unknown. His age is somewhere between 20 and 40, although large numbers of ORVers well below and above these ages have been noted. Some regional demographic studies have shown that motorcycle off-roaders tend to be somewhat younger than four-wheelers. The four-wheelers are considered to be the more affluent.[43]

A survey by *Motorcyclist Magazine* showed its readers to be young (median age 23), male (97 percent), reasonably affluent (median household income—$17,400). Some 63.5 percent owned their own homes. They had an average education (33.2 percent attended college).[44]

The *Motorcycle Statistical Annual* of the Motorcycle Industry Council gives the following profile of the motorcycle owner:

90 percent male
median age 28
60 percent are married
30 percent attended college
median household income—$14,260.[45]

The most common occupations for motorcyclists are "student" (22.5 percent) and "professional/technical" (20.2 percent).[46]

The West has the highest per capita ownership of motorcycles—5.1 per 100 persons, with Idaho having the highest for any state—9.6 per 100

persons. National per capita ownership is 3.9 per 100. California, with 4.5 motorcycles per 100, has the largest total number of any state—950,000.[47]

Of the 8.3 million motorcycles in the United States, two-thirds were made for off-road use or a combination of off-road and on-road use. In 1976, some 5.4 million motorcycles were used off-road at some time. Of these, 651,500 were in California, 329,600 in Texas, 300,900 in Michigan, 244,400 in Pennsylvania, and 229,900 in Ohio.[48]

Over 70 percent of the snowmobiles in the United States are found in the Northeast and the states of Michigan, Minnesota, and Wisconsin.[49] The regional distribution of 4x4s is not known, although the West is thought to have a higher per capita ownership.

In sum, the demographic picture of ORVers is spotty. The available evidence suggests that the typical ORVer is definitely not a middle-aged wife of a machinist in Dayton, Ohio, as Scammon and Wattenburg described the average voter in *The Real Majority*. The profile of the typical ORVer, or for that matter of the snowmobiler, is yet to be filled in. Perhaps it is not all that relevant. The important thing is that a large number of citizens are ORVers or snowmobilers, that many of them have invested a share of their incomes in the pursuit of this form of recreation (some as much as 10 percent according to one study[50]), and that the use of their machines can cause serious land management problems.

ENVIRONMENTAL COSTS

The widespread use of off-road recreational vehicles (ORVs) is causing significant impacts on the nation's land and water and its native plants and animals.[51]

The Geological Society of America, 1977

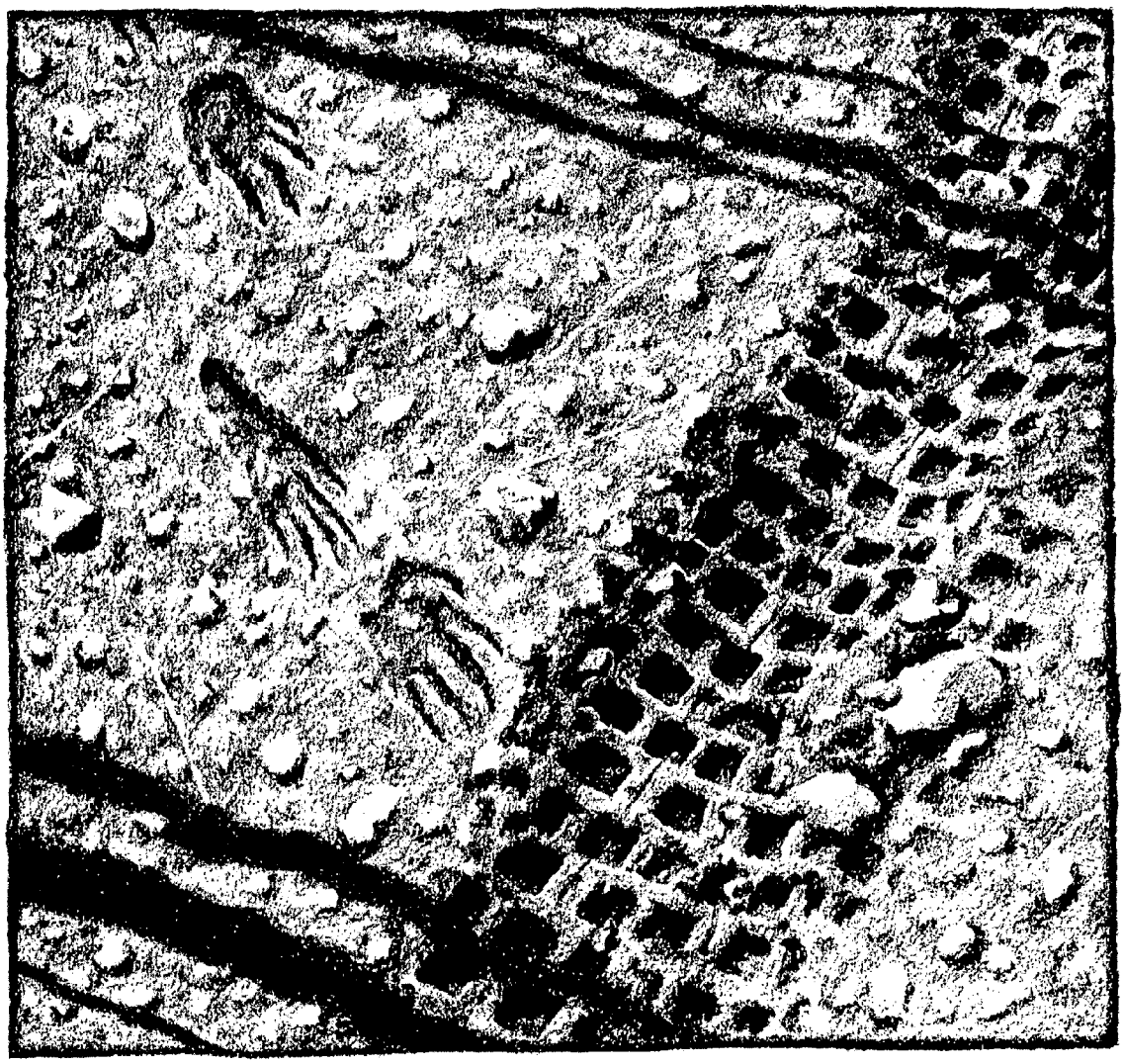
ORVs have damaged every kind of ecosystem found in the United States: sand dunes covered with American beach grass on Cape Cod; pine and cyprus woodlands in Florida; hardwood forests in Indiana; prairie grasslands in Montana; chaparral and sagebrush hills in Arizona; alpine meadows in Colorado; conifer forests in Washington; arctic tundra in Alaska. In some cases, the wounds will heal naturally; in others they will not, at least for millennia.[52]

Remnant wild and semiwild areas near urban environments in the West have been particularly hard hit by ORVs. One scientist reports: "The desert countryside in the immediate vicinity of the Las Vegas and Phoenix airports is marked with ORV tracks that look like a tangled skein of yarn. From the air, hillsides, vacant lots, streamborder growth, and other patches of nature are becoming scarred with ORV trails. Nearly every town now in the West seems to have its motorcycle shop and scarred hills and valleys."[53]

Federal lands have borne a disproportionate share of the damage. State lands are far less extensive; in addition, some states have either prohibited ORV use on their lands (Indiana) or have restricted their use to designated trails (Massachusetts). And the federal government has been more willing to open the lands which it manages for the American public to ORVs than have private landowners. For example, in Texas public land is relatively rare, so tens of thousands of Texans travel 2 or 3 hours to New Mexico, where public land is abundant, in order to drive their ORVs.[54] In southern California, private landowners in San Bernardino and Riverside Counties successfully lobbied for ordinances requiring ORVers to get their permission before riding on their land.[55] No such requirement exists on the BLM-managed land in these counties. Similar ordinances have been passed in counties in the snowbelt.[56] The National Forests in the region, however, are open to snowmobiles unless otherwise designated, which means in most cases that they are open.

Off-road motorcyclist Thierry Sagnier notes that "virtually every county, every area, and every town that sells motorcycles has at least one if not more 'secret places' where bikers and others trash their machines in relatively wild abandon, heedless of any threat save that of an occasional police raid when the noise gets too loud for the good citizens."[57] If the area is in the West, then the place is probably not very secret, and more likely than not it is publicly owned land. In the East, it is probably private and the bikers are probably trespassing.

Snowmobiles may be the exception. In the early years of snowmobiling, trespassing on private land was epidemic.[58] One report noted that the making of "No Trespass" signs had become a growth industry in the snowbelt because of snowmobiling.[59] In recent years, however, large



numbers of snowmobilers have organized into clubs, and the clubs negotiate permission from landowners for the rights of passage along a particular route. In some cases, the landowners charge a fee; sometimes they do not. Some snowmobile clubs throw banquets for cooperative landowners at the end of the season. Studies have shown that landowners are much more likely to grant permission to an organization of snowmobilers than to individuals.[60] Trespass by snowmobile has declined of late, and it is considered much less of a law enforcement problem than it once was.[61]

The ready availability of federal land has profoundly shaped the ORV phenomenon. Per capita ownership of ORVs is significantly higher in areas that possess a lot of public land.[62] The reason is simple: a person is more likely to buy an ORV if he has some place to drive it; the presence of federal land, especially BLM- or Forest Service-managed land, in the vicinity of a would-be ORV consumer assures him that there will be open space upon which he is free to roam. Thus federal land policy has been an important stimulant to ORV growth. Because the federal government has allowed ORVers to consume public resources free of charge, the general public has in a sense subsidized the ORV phenomenon.

A second consequence of federal land policy has been to discourage private enterprise from meeting ORVers' demand for land. Commercially developed ORV areas are extremely rare. Even in the Los Angeles area, where the greatest

concentration of ORVs anywhere in the United States is found, there are less than half a dozen commercial ORV parks.

Environmental damage of public land by ORV recreationists is an external cost. The general public pays for the benefits enjoyed directly by the quarter of the populace who partake in ORV riding. Of course, the general public probably gains some indirect benefits when such a large segment of the populace fulfills its recreational needs. It has not been proven, but maybe there is less absenteeism, divorce, juvenile delinquency, alcoholism, and drug addiction because of the refreshment provided by ORV recreation. R.D. Morganthaler and other ORV enthusiasts argue that ORV recreation strengthens family ties and that without it, these ties would be weakened in a significant number of cases, or, in the extreme, even shattered.[63] Of course, ORVs are not the only recreational outlets available. If, for whatever reason, the opportunity for ORV riding diminishes, people will, to a certain extent, turn to other recreational pursuits. But the questions are whether they will enjoy comparable physical and psychological rewards from those alternative pursuits and at what social and economic costs. The research to date on the whole matter of "substitutability" among recreational activities and its effects is inconclusive. Much more needs to be known before we can draw any conclusions.

Is there a trade-off involved here? Is society gaining social benefits at the expense of certain of its natural resources? Probably. Then the question is: Are the benefits worth it? This is an impossible question to answer because the full social benefits of ORV recreation are unquantifiable. And the environmental costs are only partially quantifiable—in terms such as tons of soil lost or acres of land denuded—because the value of certain natural resources is beyond estimation. Say, for example, that ORV use in an area obliterates a species of grass. The genetic information contained in that plant is gone and its value cannot be quantified.

After consideration of the benefits of ORV recreation, the next step, therefore, in trying to cope with the difficult questions raised by this phenomenon is to assess the nature of the damages wrought by ORVs and ascertain their extent.

First and foremost, ORVs eat land. (The environmental effects of snowmobiles will be covered in a later section.)

It is because ORVs attack that relatively thin layer of disintegrated rock and organic material to which all earthly life clings—soil—that they can have such a devastating effect on natural resources.

The U.S. Geological Survey has conducted an 18-month study of the physical response of the land to ORV use. More than 200 ORV sites have been examined in three states (California, Utah, and Nevada), in climatic zones ranging from arid to temperate, with corresponding variations in vegetative cover. The Geological Survey documented the physical response of at least 500 types of soils and rock to vehicle use by photographic methods, by several thousand soil strength measurements, and by several hundred bulk density, soil moisture, soil temperature, and erosion profile measurements. U.S.G.S. found that all the soil types examined are vulnerable to ORV damage, except certain dry-lake deposits (if not driven on after a rain) and some clay-rich soils on low slopes (less than 10 degrees).[64]

There seem to be two basic soil responses to ORV use. One, sandy and gravelly soils are susceptible to direct quarrying by ORVs, and when stripped of vegetation they are susceptible to rapid erosion processes—usually by rill and gully erosion.[65] Near Santa Cruz, California, for example, ORV trails used for about 6 years are now gullies 8 feet deep.[66] Two, more clay-rich soils are less sensitive to direct mechanical displacement by ORVs, but the rates of erosion of stripped clay-rich soil are much higher under ORV use than under natural conditions. Furthermore, ORV pounding of clay-rich soil causes strong surface seals to form, thereby reducing the infiltration of water. This, in turn, leads to greater rainwater runoff, which causes gullying lower in the drainage.

Once massive soil erosion begins, it will stop only after ORV riding stops and the native vegetation has had a chance to reestablish itself and stabilize the soil. In arid and semiarid areas, recovery is very slow. The same holds true for hilly or mountainous areas which receive heavy rainfall, such as Appalachia or northern California.

And what happens when ORVs strip away the entire soil mantle, leaving exposed bedrock, as they have done in numerous spots in California? Then recovery will take millennia. To regenerate soil over hard bedrock requires thousands of years; softer rock provides inorganic soil matter faster, but the productivity will depend on the

nutrient content of the rock and of the remaining plants. Topsoil is the organic-rich culmination of this very slow process. Even under optimum conditions, it may take nature 500 years to generate an inch of topsoil. In addition, it is well to remember that some soils are so old that their character was formed by climatic conditions which no longer exist. Therefore, these soils cannot be replaced.[67]

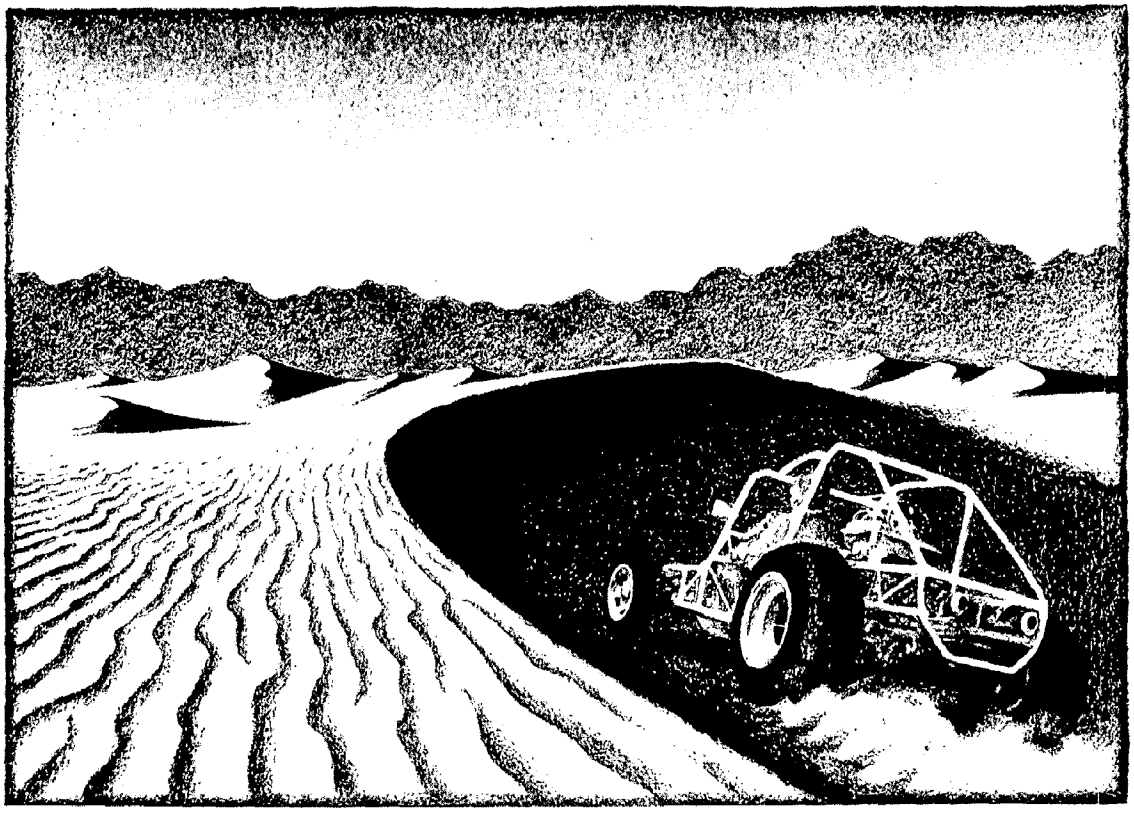
In flat, dry areas ORVs expose the soil to another powerful erosional force—the wind.[68] In damp flat areas such as wet prairies or meadows, ORV ruts can turn into drainage ditches—siphoning off water held in the surrounding area.[69]

While ORVs are pulverizing the surface layer, they are also compressing the soil beneath. As a consequence, it takes on some of the qualities of concrete. Under ORV pounding, the subsurface soil's ability to absorb water is greatly diminished. Hence there is much less moisture available to nourish plants and far less water gets through to replenish the groundwater supply. In addition, the subsurface soil experiences greater temperature extremes—becoming hotter during the day and cooler at night than it would under normal conditions.[70]

Soil compaction by ORVs is sometimes dramatic. In the Mojave Desert, when a scientist tried to shove a knife blade into the ground in an area used by ORVs, it penetrated only half an inch, the ground was so hard. Yet, in a nearby area not used by ORVs but of the same soil type, the knife went in to the hilt with ease.[71]

ORVs destabilize sand dunes, making them more vulnerable to wind erosion and, in the case of coastal dunes, to sea erosion. Destabilized inland dunes spill into adjacent nondune areas and windblown sand from them covers land well beyond the area of direct ORV impact. Destabilized coastal dunes tend to break down as the sea and wind eat away at them. Hence the land behind them becomes more subject to saltwater flooding.[72] ORVs driven along beaches displace sand seaward and cause increased erosion of the foreshore as well.[73]

In addition, it appears that ORV use causes desiccation of sand deposits, *i.e.*, the deprivation of moisture. So far, the evidence of this effect is observational and not yet quantified. Biologist Robert Stebbins reports: "In virtually all sand deposits that I have examined which have not been disturbed by off-road vehicle activity there



is a trapped moisture layer from several inches to several feet in width beneath the dry outer surface. The moist zone may be at a depth of a foot or so and is crucial to the survival of plant and animal life of sand deposits."[74]

No type of land in the United States can withstand sustained ORV use without some damage. However, certain areas are particularly sensitive. Ecologist Shaun Bennett pinpointed such areas in *A Trail Rider's Guide to the Environment,* published by the American Motorcycle Association.[75]

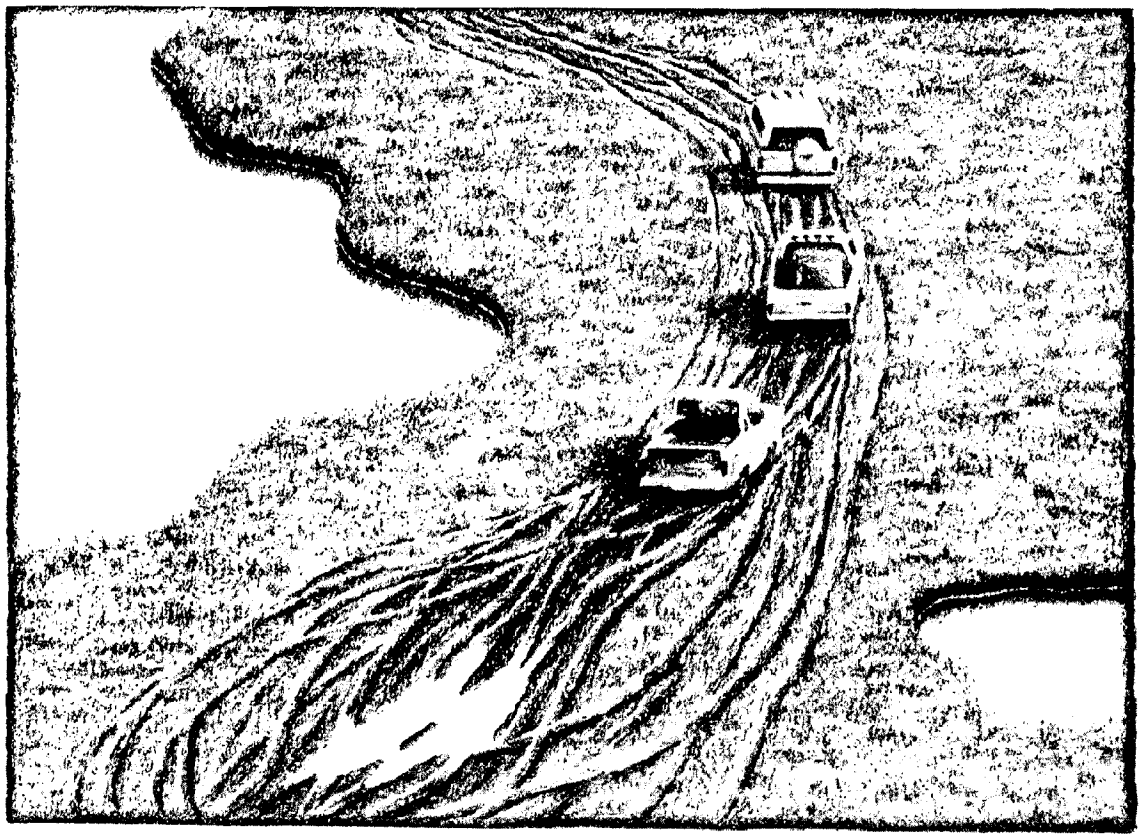
In the Northeast, for example, he warns ORVers away from bogs. These "uncommon" environments, he notes, support an unusual community of plants and animals which are the delight of wildflower enthusiasts and birdwatchers.[76]

He urges ORVers to stay away from alpine tundras wherever they are found—New England, Appalachia, the West—because of the very thin layer of soil in these areas. If an ORV breaks the tundra plant cover, the scar will not heal for many years.[77]

In the South, Bennett says that ORVers should avoid special wildlife habitats such as those for the wild turkey.[78] In Florida, he cites the grasslands which surround lakes as places to stay out of. Here ORVers leave tracks which last for years and which disrupt wildlife, a serious problem because these areas serve as feeding and nesting grounds for wading birds and other animal species. In addition, endangered species such as ospreys might very well nest nearby.[79]

In the Rockies, Bennett reports that alpine meadows are especially vulnerable to ORV attack. He reports that random rides in these lush areas destroy the plants along with the animals that inhabit them—pikas, marmots, and ground-nesting birds. He also notes that ORVers could cause severe problems in areas inhabited by game animals—pronghorn antelope, moose, mule deer, and elk—during the critical calving period in the spring and early summer. The females are under considerable physiological stress at this time. "The last thing you want to do is to send the female and her new calf running pell-mell down the trail away from wunderwheel."[80]

ORVs on the arctic tundra of Alaska are "a potentially colossal disaster," according to Bennett. The passage of a vehicle over the arctic tundra—that thin layer of plants and soil over the



permanently frozen ground (permafrost)—changes its reflective properties. As a result, the tundra absorbs more sunlight which causes the upper permafrost to melt. Then the surface subsides because water takes up less space than ice. The sunken ORV tracks fill with water and the unusual arctic plants and animals can no longer survive.[81]

These areas do not constitute a definitive list of all the natural areas most sensitive to ORVs. Rather, they are intended to give an idea of the range of ecosystems most threatened by ORVs. There are others. For example, ORV riding on and along river banks has caused serious erosion in Kentucky and Missouri, according to published reports.[82] The resulting sedimentation can damage the gills of fish and smother their eggs and food organisms.[83]

A major difficulty with ORVs, as the Geological Survey points out, is that the terrain which "truly challenges the capability of these machines, and which is therefore most attractive to many ORV operators, is exactly that which is most highly sensitive to erosional degradation. This open contradiction between machine capability and land sensitivity is a key issue."[84]

Aside from tearing up soils, ORVs also damage vegetation. They kill plants in several ways. By direct contact—the ORV runs over the plant or brushes against it, breaking off limbs or branches. Sometimes ORV use around a plant so badly erodes the soil that the plant simply collapses from lack of anything to hold onto. Also, ORV soil compaction injures root systems and larger perennials eventually die. In addition, ORVs crush seedlings beneath their wheels or treads as well as seeds germinating on or within the ground. Lastly, on slopes the soil eroded because of ORV use washes to the bottom where it smothers plants that are growing there.[85]

ORVs also disrupt animal life, as has already been indicated. They collide with animals, especially smaller mammals and reptiles. By destroying vegetation, they are also destroying animal food and shelter.[86] In addition, ORVs afford hunters and fishermen access to remote, heretofore untouched areas, thereby dramatically increasing the fish and game kills in those areas.[87]

The effects of ORV noise on animals, although imperfectly understood, is thought to be very damaging. Scientists have found that ORV noise impairs the hearing of at least one species of reptile—the desert iguana—and they think that many other animal species may suffer the same fate. Hearing is a faculty that is acutely important in the survival of most animals, both in avoiding predators and in finding a mate.[88]

The unnatural amounts of noise produced by ORVs place most species under stress, although not all species are as skittish as elk and wild turkeys. Noise aggravates a sick animal's condition during periods of hunger or disease.[89]

Eventually, a few species, such as the white-tailed deer or the coyote, seem to adapt to ORV use; others die—especially those that assemble in small areas, such as salamanders and frogs. Most naturalists think that when wild animals are displaced from their natural areas because of noise or destruction of vegetation, the displaced individuals are as good as dead. Or, if they succeed in reestablishing themselves in other suitable wild areas, they displace resident individuals who then have greatly reduced survival.

It is instructive to look at the recent history of four specific areas in terms of ORV use: Back Bay Wildlife Refuge on the Virginia coast; Land Between the Lakes in western Kentucky; the Panoche Hills, southeast of San Francisco; and Dove Springs Canyon in the Mojave Desert. These areas have two things in common: they have been invaded by ORVs, and they are owned by the public.

Back Bay National Wildlife Refuge

The refuge comprises 4,608 acres of beach, dunes, marsh, woodlands, and open water along the Virginia coast, just north of the North Carolina state line. It is managed by the U.S. Fish and Wildlife Service.[90]

ORV use of the refuge was light until the late 1960s. Then came the invasion of dune buggies, scooters, motorcycles, and other types of off-road vehicles. By 1969, the environmental effects were very evident, particularly along the 4.2 miles of beach and sand dunes. The tern nesting colonies were gone. The ghost crabs were rapidly disappearing. So were the sanderlings, once the fastest-moving creatures on the beach. In the 1950s, 30,000 of these agile shore birds inhabited the area. By 1969, their numbers had dwindled to 5,000. They were victims of the ORV boom.

Farther south, in the Cape Romain National Wildlife Refuge, South Carolina, it was observed

that the rare loggerhead sea turtle found ORV-compacted sand too hard to dig a nest in and lumbered back to the Atlantic, or its young were crushed beneath ORV tires or were easy prey for predators (gulls, raccoons, etc.) when they became entrapped in ORV ruts.[91]

The Fish and Wildlife Service was particularly concerned about ORV damage to the refuge's sand dunes which protect the Back Bay from ocean storm tides and excessive amounts of saline water. Back Bay is a prime waterfowl wintering area—species such as the whistling swan, greater snow goose, as well as puddler and diving ducks are found there. In addition, the dunes provide wintering habitat for the rare Ipswich sparrow.[92]

ORVs quickly and effectively kill the American beach grass which holds these dunes in place.[93] An ORV path scars the dune and makes the sand vulnerable to wind erosion. The Fish and Wildlife Service has observed that vehicle tracks perpendicular to and over a dune line can eventually result in a major cut through the dune.[94]

The irony of this ORV damage to these dunes is that they were restored in 1939 and 1940 by the Civilian Conservation Corps, and since then the federal government has spent an estimated $500,000 to stabilize them.[95] The newly formed Youth Conservation Corps will be working on these dunes again this summer in fact.[96]

In 1970 the federal government in cooperation with the city of Virginia Beach sought to regulate ORV use on the refuge, establishing speed limits, closing certain sections to ORVs, and setting up one-way traffic flows. The number of ORVs continued to mount. In 1971, the regulations were tightened because of widespread noncompliance by ORVers. Still more ORV riders came and more violations of the regulations were observed. On one Sunday in June 1971, some 875 vehicles were counted along the refuge beach and 410 violations of refuge regulations were also observed.[97] Commercial fisherman Marshall Belanga reported that he was nearly run down, on more than one occasion, by machines chasing birds along the beach. Some of the vehicles even plowed right over his nets.[98]

In 1972, the Fish and Wildlife Service sought to close the refuge to ORVers except for commercial fishermen and people living south of the refuge and using the beach to get to their homes. After considerable political controversy and some legal skirmishes, the new controls finally went into effect.[99]

Today, about 150 homeowners using the refuge hold permits to drive in the refuge—some permits allow 2 round trips per day and others as few as 30 per year. By the end of 1979, all permits are supposed to terminate and the refuge will be entirely closed to ORVs. Three Fish and Wildlife Service employees currently patrol the refuge on a regular basis. They find that illegal ORV intrusions average about five per week during the winter and more during the summer.[100]

Since effective control over ORVs has been in force over the past 3 years, there has been no study of refuge wildlife and vegetation; therefore it is not known whether or not they are recovering from the ORV onslaught. Refuge Manager Glen Bond hopes that the ecological damage done to the refuge in the future will be by nature rather than ORVs. He would like to see the refuge closed to all ORVs. "It's too fragile an environment for those machines."[101]

Land Between the Lakes

This 170,000-acre peninsula between two man-made lakes (Kentucky and Barkley) in western Kentucky and Tennessee is managed by the Tennessee Valley Authority (TVA) as a recreation area. In years past, the area's hardwood forests were heavily lumbered.[102]

By 1972, ORV use was growing throughout the region, unrestricted by the TVA.[103] That year, so as to minimize the environmental damage and ORV interference with the recreation of others (campers, hunters, anglers, etc.), the TVA established a 2,350-acre ORV area within Land Between the Lakes and closed the rest of the area to ORVs.[104] The site selected for the ORVs was Turkey Creek, a rolling area of second growth forest, primarily oak and hickory, with approximately 75 acres of open land. There are five ponds within its boundaries, and the soils are derived mainly from shallow loess over gravel and chert beds.[105]

The area was chosen for ORVs because it had received the greatest use by them in the past.[106] In laying out the ORV trails, TVA sought the aid of the American Motorcycle Association and the Motorcycle Industry Council. An effort was made to keep ORV riding areas away from campgrounds. Normal facilities such as unloading ramps, toilets, and parking lots were added.[107] The TVA also developed a monitoring plan for

systematically assessing the impact of ORVs on the environment and on the other recreationists near or in the area.[108] No other federal land management agencies have gone to these lengths to control and monitor ORV activity.

Since the ORV area opened, there has been a steady increase in the number of persons visiting it. The area's visitors average more than 1,000 per week and slightly less than half of them are ORVers. Of these an estimated 79 percent are trailbike riders and 21 percent drive 4x4s. The percentage of 4x4s is increasing significantly.[109]

It is interesting to note that one survey of the ORV riders in the area found that rain did not deter them. (Rainfall here averages more than 50 inches per year.) "Off-road vehicle riding continued to take place on days when rainfall was quite heavy. Four-wheel drive operators appear to find added challenge in making their way through muddy places," the study reported.[110]

Another study of ORVers in the Turkey Creek area found that they are attracted to the area because of its rugged terrain (slopes as steep as 45 degrees); very few riders voiced a preference for open field riding over trails. Although some non-ORV campers in the area expressed annoyance with the ORV noise, most felt that the riding areas were a desirable feature because cyclists rode there rather than in the camping areas.[111]

Thus the system appears to be working in human terms. What of the effects on the environment?

The impact upon vegetation has been heavy on the trails and insignificant off. In other words, ORVs are killing plants by running them over, but indirect impact on vegetation from ORV fumes or soil disruption has not been detected. The bare portion of the trails is increasing at an annual rate of about 7.5 percent. As measured by the amount of land denuded of plant life, direct ORV impact on the area increased from 0.58 percent in 1973 to 1.03 percent in 1975.[112]

ORV-caused soil erosion has been serious in certain sections of the area's trails, even though the high gravel and chert content of these soils was thought to make them very ORV-resistant. Overall, erosion depth along the trails increased 52.8 inches or 26 percent between 1973 and 1974 (the most recent available figures). Only 8 of the 20 monitoring sites showed increased erosion, but this apparent discrepancy is easily explained: almost all the increased erosion occurred at the monitoring sites located on slopes of 15 degrees or greater. TVA reports that "[s]oil movement and siltation are very much in evidence below steep, heavily used slopes." Maintenance work to grade and divert water is needed. In addition, TVA reports that there is "evidence of a great deal of potholing and rutting on low, level areas particularly in the winter, but the soil [does] not appear to be washing away. There was some damage to roots, particularly at creek crossings."[113]

Wildlife monitoring is, by TVA's own admission, the weak link in its monitoring system.[114] So the ORV impact upon wildlife remains a question. To date, the area's white-tailed deer and squirrel (gray and fox) populations seem to be doing well, according to the hunters who use the area. Other mammals sighted in the area between 1973 and 1975 included raccoons, skunks, opossum, and woodchucks. It is not known whether wild turkey still inhabited the area when the ORV site was established, or if they do today.[115] A bird survey in the spring of 1975 counted 48 species of birds either resident or visitors. They ranged from several species of warbler to green herons, indigo buntings, and red-tailed hawks.[116] It is not known whether any bird species have abandoned the area since 1972, or what effect ORVs have had on the populations of the bird species there today.[117]

TVA notes: "[A]bout all we can say from the various wildlife observations is there is some significance to the fact that the species still inhabit and venture into the area. Any other conclusions would be premature at this time.[118]

So far, TVA is pleased with this experiment of setting aside a specific area within a much larger recreation area for ORV use, despite the greater than expected erosion on slopes of 15 degrees or more. TVA ranger Scott Seber thinks that much of Turkey Creek's success as an ORV area is due to the fact that ORVers chose their own trails instead of having them dictated by someone else. He also notes that complaints about ORVs from non-ORV recreationists, especially hunters and campers, which were once quite frequent, have become uncommon.

Seber adds: "I used to hate ORVs. Now I feel they can be worked with. We have demonstrated that they don't have to be running amuck everywhere."[119]

Panoche Hills

This site is in the Diablo Range southeast of San Francisco. The vegetation is a semiarid community dominated by filaree, rabbitbrush, Mormon Tea, fescue, and brome. It is managed by the BLM.[120]

Motorcycles and four-wheel drive vehicles began using the area in 1968. ORV use continued through 1970 and then was prohibited because of the serious soil erosion problems. Since then, there has been considerable trespass by ORVers. The Geological Survey reports that "there has been a highly visible expansion of use for a 12-mile stretch between Tuney Gulch and Arroyo Honda to the south."[121]

After closure, an area of about one-tenth of a square kilometer was fenced off to prevent illegal ORV use and cattle grazing. Part of the area had been intensively used by ORVs but part had not. Then the two sections of the fenced area were studied to learn about their recovery. At the outset, 55 percent of the soil was exposed in the ORV-used portion, compared with 31 percent in the other portion. From 1971 to 1975, the plant cover, mostly filaree (a European weed), improved 19 percent in the used area and 9 percent in the unused area. However, this rate of recovery has not persisted since then. Aerial photographs of the area show that large swaths of the ORV-used area are still denuded of small plant cover. Indeed, the ORV trails cut into the hills 6 years ago remain quite distinct today.[122]

The rate of soil erosion is still severe. Scientists found that 4 years after closure, the land used by ORVs was losing soil at an annual rate of 1,580 metric tons per square kilometer while the soil erosion from the land undisturbed by ORVs was too small to measure.[123] The accelerated erosion continues today. No erosion control devices have been installed at this site by the BLM.[124]

The ORV impacts on the wildlife of the Panoche Hills have not been assessed, although the area does represent a sizable portion of the range of an endangered species, the Blunt-nosed Leopard Lizard.

The erosion rates measured in the Panoche Hills are not uncommon in ORV-used areas in semiarid regions. For example, south of San Francisco in the Hollister Hills is an ORV area where the soil erosion is even worse. The terrain here bears some resemblance to the Panoche Hills—steep slopes and shallow soils—but the vegetation is more varied, ranging from grass and chaparral to walnut orchards and oak. ORVs have used the area for about 20 years, first when it was privately owned and now as a State Vehicular Recreation Area.[125]

The area is currently losing soil at the rate of 6,400 tons per square kilometer a year, 26 times the "tolerance" level suggested by the Soil Conservation Service for soils of these types.[126] A geologist who studied the area reports that "drainages are heavily choked with sediment, and riparian habitat has been severely modified. Previous efforts to mitigate erosion (water bars and diversions) have either not successfully coped with massive runoff or have created problems of plant burial and erosion by successful diversion to unused slopes."[127]

Dove Springs Canyon

The canyon comprises about 5,000 acres of BLM land in the northwestern Mojave Desert. Its plant community is primarily creosote bush at the bottom and on the sides and a Joshua tree woodland beyond the rim. But there are a great many other plants as well in this desert canyon. In almost any 1-acre plot, it is possible to identify 15 to 20 species of perennial shrubs and grasses—from California buckwheat to apricot mallow. The same 1-acre plot may have 40 to 80 different species of annual wildflowers in the spring. Altogether, there are probably 250 different species of plants in Dove Springs Canyon.[128]

The fauna is also diverse: 24 known species of reptile inhabit the area, including the leopard lizard, rosy boa, and the rare desert tortoise. About 30 species of birds visit the canyon on a regular basis or nest there. Among the visitors are raptors such as the golden eagle and the prairie falcon; the nesters include Gambel's quail, horned larks, and burrowing owls. The mammal species of the canyon number 22 and include many rodents such as the long-tailed pocket mouse and the Mojave ground squirrel plus some larger predators—kit foxes, badgers, and the ringtailed cat.[129]

ORV riders, motorcyclists and four-wheel drive operators, began coming to Dove Springs Canyon about 10 years ago. In that time, they have denuded 543 acres and heavily damaged another 960 acres. BLM biologist Kristin Berry calculates that at the present rate of destruction

over 1,629 acres of Dove Springs Canyon will be denuded within 15 years.[130]

There is a definite pattern to the ORV use here. The ORVers started in the lower part of the canyon, the part closest to the highway, and after they stripped the canyon floor bare of plants and rutted and gullied the walls, they then moved up canyon, somewhat like mechanical locusts, to surroundings that were more pleasant (less dust) and more drivable (deep ruts make steering very difficult). Here the process was repeated.[131]

The rate of soil erosion has not been measured in Dove Springs Canyon, but must be severe, judging from the debris which has washed down the walls and been deposited on the canyon floor and in the washes. In nearby Red Rock Canyon, geologists have examined a hillside used by ORVs for about 5 years. They calculated that the hillside, which is about 1 mile long and a couple hundred yards wide, with a slope of about 18 to 28 degrees, has lost 11,000 metric tons of soil.[132]

Sheila Byrne, a biologist at the University of California at Berkeley, studied the impact of ORVs upon the small mammals of Dove Springs Canyon and concluded that "areas disturbed by ORV use support a lower density and diversity of small mammal populations."[133] She added: "The disturbed areas show both a gross reduction in numbers of plant species present and simplification of plant structure—the ground cover and subshrub layers are severely damaged, if not destroyed, Thus, the lower animal species diversity in the disturbed area is not surprising."[134]

Specifically, Byrne found that disturbed areas had a species diversity index of 1.28 and averaged 3 rodents per plot; in contrast, the undisturbed areas had a species diversity of 2.72 and averaged 9 rodents per plot. The only species that seems to thrive in ORV areas is the deer mouse, which

Gambel's quail

is considered the animal equivalent of Russian thistle, that is, a weed.[135]

The long-term ecological consequences of widespread destruction of the small mammals will be profound. These creatures form an important part of the area's food chain. (The transfer of food energy from its source in plants through the consumer groups—the herbivores and carnivores—is termed a food chain.) Raptors, large mammals, and some reptiles depend on the small mammals for nourishment.[136]

Although no study of the bird life of the canyon has yet been completed, Berry notes the absence of such species as the ladder-backed woodpecker, Scott's oriole, and the cactus wren—species usually found in Joshua tree woodlands. Ground nesting birds such as quail, doves, and horned larks are considered very vulnerable to ORV destruction.[137]

Before the ORVs, Dove Springs Canyon was a popular spot for hikers, campers, birdwatchers, and fossil hunters. Today, ORVs dominate the canyon. On a Memorial Day weekend, there may be as many as 500 machines at play in the once tranquil canyon.[138]

The Destruction of the California Desert

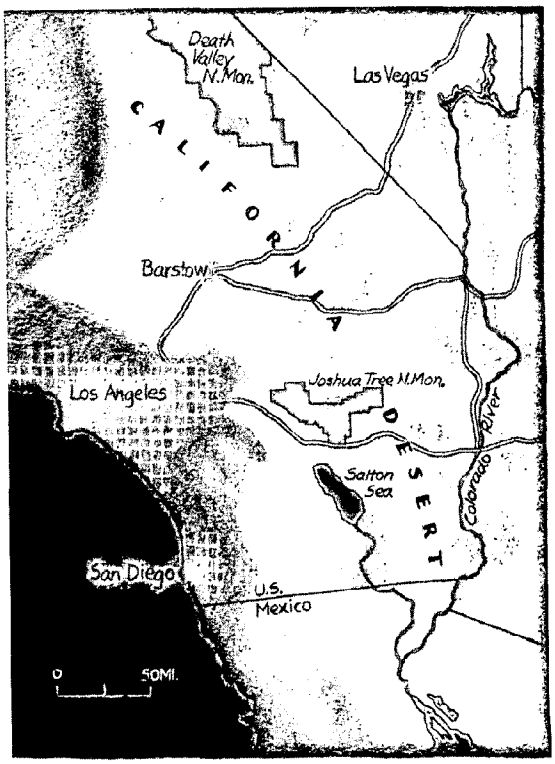
> Once an inhospitable wasteland to early explorers and settlers, the California Desert now is a recreation mecca for millions of Americans. The paradox is not yet fully understood, even by Federal agencies attempting to manage those arid lands. . . . [I]t is the use of off-road vehicles that generates most of the enjoyment, most of the accidents, most of the economic spin-off. . . .[139]
>
> Jerry Harrell, "Desert Lands Serve Many Needs," *Our National Resources: The Choices Ahead,* U.S. Department of the Interior, 1974

Dove Springs Canyon is not an exception. ORVs are tearing up other places in the California Desert. Jawbone Canyon, Johnson Valley, Stoddard Valley, Horse Canyon, Sage Canyon, Rainbow Basin, the Spangler Hills, Rand Mountains, the Ricardo fossil beds, the Salton Sea marshes are some of the places scarred by motorcycles, dune buggies, and four-wheel drive vehicles.[140]

The California Desert was the first area in the United States to feel the full brunt of the ORV explosion. For this reason, and because the federal government has presided over the degradation of perhaps one million acres of the desert's land, the fate of the California Desert will be examined in some detail here.[141]

Twenty-four million acres of land—mountains, basins, dry lake beds, hills—11 million of which are Natural Resource Land owned by the public and managed by the BLM. That is the California Desert.[142] The term California Desert is administrative rather than geographical. Congress has designated this area the California Desert Conservation Area.[143] In reality, the desert stretches east beyond the California state line and the Colorado River into Nevada and Arizona and south beyond the Mexican border into Baja.

The California Desert represents one of the largest, relatively unbroken sections of wild land in the United States outside Alaska.[144] It is also at the back door of one of the nation's largest urban sprawls—the Los Angeles-San Diego megalopolis, population about 11 million. On any weekend when the weather is not too hot, literally tens of thousands of ORV enthusiasts fan out from Los Angeles-San Diego and environs to play on their machines. Some of the



desert's choicest spots are within an hour or two drive.

The California Desert possesses a remarkably rich and varied animal and plant life. As the description of Dove Springs Canyon suggests, it is not the dead wasteland so often associated with the word "desert."

Actually, the California Desert Conservation Area is two major desert types: the lower third is a Sonoran or low desert and is referred to as the Colorado Desert; the upper two-thirds is the Mojave or high desert. The Colorado Desert generally stays warmer in the winter due to its lower elevation and southerly location. It features such vegetation as the fan palm, smoketree, palo verde, ocotillo, teddybear cholla cactus. (The vegetation found in Dove Springs Canyon is typical of the Mojave.)[145]

When scientists grew concerned about ORV damage to the California Desert in the early 1970s, they began to document the effects of ORVs on the desert environment. These efforts are now bearing fruit. Although more research remains to be done, an impressive body of facts is accumulating.

The question that scientists are asked most often in the field by ORV enthusiasts is: "ORV damage? So what? This land isn't good for anything else anyway."

And that is where the ORVers are wrong, say the scientists. The desert is good for something, many things, as a matter of fact.

To begin with, the desert contains an invaluable storehouse of genetic information which humankind can ill afford to lose. The different plants and animals found in the desert are the result of a millenia-long struggle for survival under very harsh circumstances. In addition, these species have undergone genetic modification in isolated ecological systems within the desert—in springs, stream remnants, oases, playas, and sand deposits. Dr. Robert Stebbins likens the desert's isolated ecological systems to a series of archipelogos, each possessing its own distinctive characteristics and biota.

"Perhaps some of the desert grasses harbor genes potentially useful in breeding disease-resistance or other desirable traits, perhaps the ability to grow in salty soils, into our cereals," says Stebbins. "The Indians gathered the seeds of the desert rice grass. What may be the potential of the many plants and animals that have not been studied?"[146]

Just 5 years ago a new species of lungless salamander was discovered in the California Desert—only the second desert salamander ever found. Preliminary study suggests that this discovery will clarify the origin and evolution of the largest group of living salamanders. Study also indicates that the species or its ancestor may have been living in this area in the Miocene age, 70 million years ago, before the major upthrust of the Sierra Nevada and the formation of the desert.[147]

Stebbins, a zoologist, a curator at the University of California at Berkeley's Museum of Vertebrate Zoology, and author of the reknowned *Field Guide to Western Reptiles and Amphibians,* states that the desert and its adjoining arid lands "rival the famous Galapagos Islands in their potential for shedding light on evolutionary processes."[148]

The California Desert is also a place of extraordinary beauty. The aesthetic values of many different locations in the desert have inspired visitors for years. Consider, for example, Stebbins' description of the Imperial Sand Hills after runoff water from storms in the nearby Chocolate Mountains has formed ponds hundreds of feet across and several feet deep:

> The water brings forth a surge of life. . . . The ponding area is a biologist's paradise. The stark, buff-colored dunes and stands of yellow-green paloverde are reflected in the glassy waters. There are giant creosote bushes reaching heights of 12 feet. The waters soon teem with fairy shrimps and spadefoot tadpoles. At this time, birds from the Salton Sea to the northwest drop in and one may witness the charming sight of long-billed curlews and other water birds moving about among the dunes as they work the edges of the ponds. I have travelled many parts of the world, but have found no place more fascinating.[149]

Ecologist Raymond Dasmann has pointed out that the desert's very starkness gives it the sharp outlines and vivid colors not to be found where the influence of running water has smoothed the landscape and the humidity of the air has modified the clear tones.[150]

In prehistoric times, the California Desert was a lush savannah with broad lakes, and today it contains a wealth of fossils. Paleontologists have unearthed prehistoric camels, sabre-toothed cats, three-toed horses, and other species from the desert's fossil beds. Indeed, fossil mammal discoveries from the desert have played an important part in establishing a correlation between North American and European fauna of the Pleistocene age, 65 thousand years ago.[151]

The desert is also rich in archaeological re-

sources. Artifacts of human occupancy can be traced back about 12,000 years. There are hints that man may have been present 50,000 to 80,000 years ago. The desert contains the largest concentration of prehistoric art anywhere in the world, including petroglyphs (carvings on rock), pottery, and intaglios, the rarest form of prehistoric art. People living in the desert thousands of years ago created vast designs (intaglios) by scraping aside a layer of dark pebbles at the surface and exposing lighter material beneath. Some of these intaglios are geometric designs or mazes—up to 2 miles in diameter; others are human and animal figures, the longest of which is 489 feet. Almost all the desert's known intaglio sites have been crosscut by ORV tracks.[152]

ORV riders have caused serious damage to the other cultural resources of the desert as well. Vandalism of other archaeological sites has accelerated with the onslaught of ORVs because of the increased access to remote areas these machines provide.[153] Petroglyphs are being carried off as souvenirs.[154]

ORVs are also obliterating the surface evidence which both paleontologists and archaeologists rely upon in searching for new sites. A small bone fragment wedged between two rocks or a tiny shell lodged in a sedimentary rock face may be the clue which leads to further discoveries.[155] Indeed, if ORVs had gotten to Olduvai Gorge in Tanzania before Dr. L.S.B. Leakey, we might very well know a good deal less than we do today about prehistoric man.

ORV damage to the desert's natural resources, in a relatively brief time—less than 20 years—has been great. Geologist Dr. Howard Wilshire of the Geological Survey estimates that ORVers have scarred perhaps 1 million acres of public land in the California Desert. By comparison, it took strip miners a century and a half to "orphan" 2 million acres of land across the entire country.[156]

Desert soils have proven exceptionally vulnerable to ORV attack. The soil breaks down very rapidly under ORV tires on desert slopes. They do not have to be very steep either. Wilshire reports that even flat surfaces denuded by ORVs are vulnerable to accelerated erosion because wind erosion is independent of slope.[157] Many desert soils are fairly loose to begin with, and as soon as ORVs strip away the vegetative cover, they become very susceptible to wind, water, and mechanical erosion. In some spots, such as

Intaglios, Blythe, California

Jawbone Canyon, ORVs have completely removed the thin soil mantle and now they are actually quarrying the more pliable forms of bedrock.[158]

In some flat areas of the desert, a thin layer of rocks of varying sizes called "desert pavement" protects the soft, fine-grained materials underneath from wind erosion. But the desert pavement cannot withstand more than one or two passes by an ORV.[159] ORVs also demolish

the crust which forms over many other nondisturbed parts of the desert, exposing the fine soil particles underneath. This desert crust is created after rains or flooding when the surface soil particles bind chemically together. Where organic material is sufficiently great in the surface layers, fungal filaments further bind the soil particles. Other biological components of the crust may include algae and lichens.[160]

Desert winds attack these exposed soils. Some dust pollution in the air is, or course, natural, especially during periods of high wind. However, man's disruption of the desert surface greatly increases the dust in the air. For example, a 1-day motorcycle race across BLM land in 1974 produced more than 600 tons of airborne dust.[161]

Analysis of a satellite photograph of the western Mojave shows that ORV-denuded land is now one of the sources for dust storms in the region. The photograph, taken on January 1, 1973, a day which featured a strong Santa Ana wind, showed six dust plumes in the western Mojave. Investigating these plumes to locate their sources on the ground, researchers found that in each case the dust originated from "man's destabilization of the natural surface." Each plume was traced to a specific dust source: roadbuilding in one area, stream channelization in another, and so on. One of the dust plumes came from a 10-kilometer-long area along the south edge of El Mirage Dry Lake to the south tip of the Shadow Mountains—an area "severely destabilized by off-road vehicle activity," that is, the plants which anchored the fine grained surface material had been destroyed by ORVs.[162]

Dust pollution poses a number of problems. It damages crops and property. It reduces visibility and therefore the aesthetic value of the desert. It is considered a health hazard because it aggravates certain respiratory ailments such as allergic bronchitis and asthma. In cases where ORVs expose soil and rock with a high asbestos content to wind erosion, which has happened in at least one semiarid area in the San Francisco area, then dust pollution could potentially be carcinogenic.[163] Another possible health hazard associated with dust pollution in the California Desert is valley fever or coccidioidomycosis. This sometimes fatal lung disease is caused by a dust-borne fungus which is endemic to much of the desert.[164]

Desert land heals slowly. Some of the tracks made by General Patton's tanks and jeeps in the eastern Mojave during training maneuvers more than 35 years ago are still clearly visible. Even the paths cut by the wagons of pioneers more than a hundred years ago can still be seen today in the north Mojave.[165]

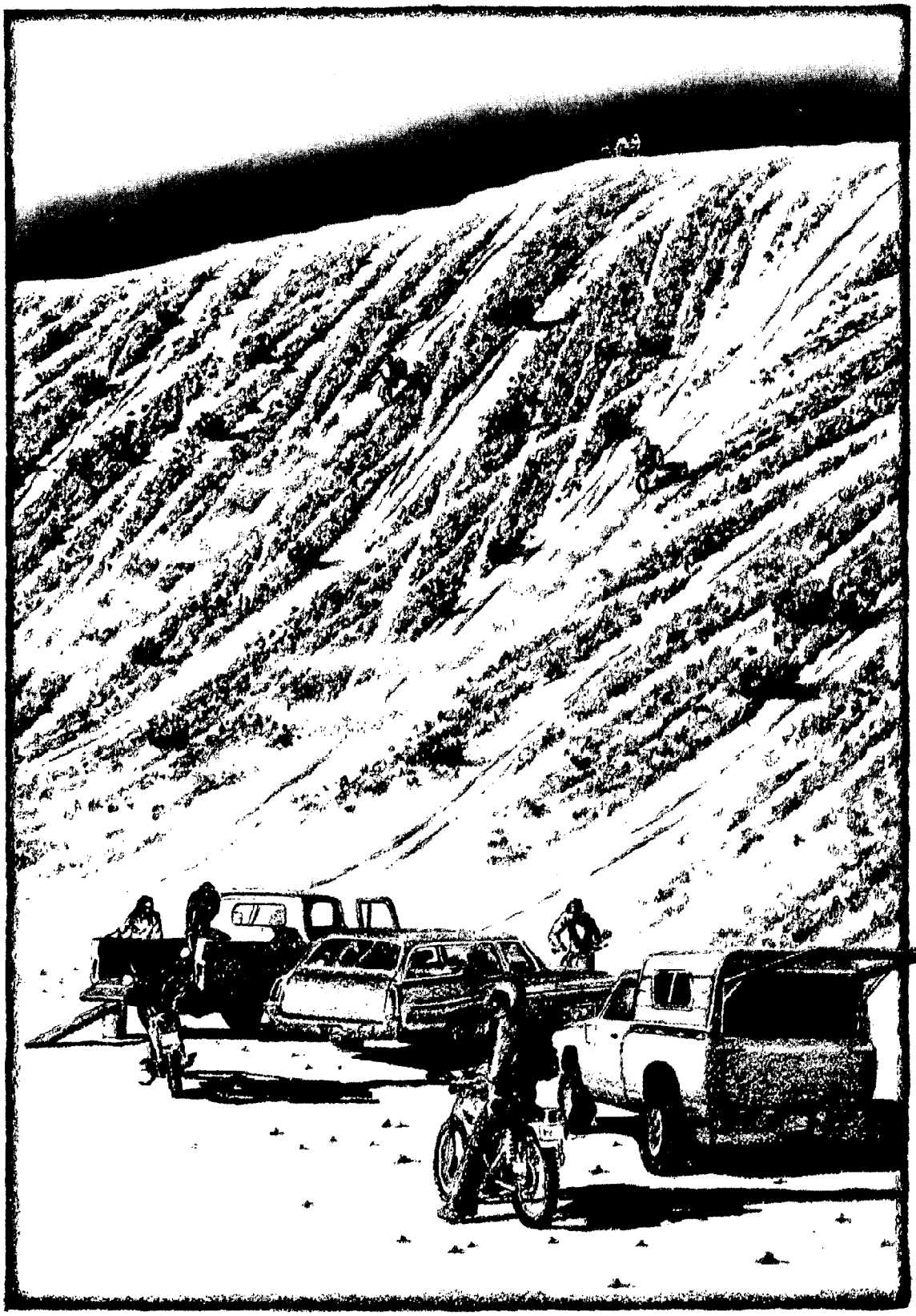
So long as ORV use continues in a particular area, the native vegetation does not recover. Once ORVers abandon an area, as they eventually do, the plant life slowly returns *if* there is at least some soil mantle left in which to sustain life. However, it is not the native vegetation, for the most part, which comes back. It is the noxious weeds such as Russian thistle or tumbleweed. A specific area may have once contained a number of different grass and shrub species, but one or two invaders (weeds) dominate the recovery, and once established, the invader species push out the remaining native species which survived the ORVs. Thus, a complex plant community gives way to a highly simplified one.[166]

F.R. Fosberg, curator of botany, U.S. National Museum of Natural History, and a recognized authority on alien plant species, has warned the BLM that "unless you are in favor of changing the character of the vegetation, and hence of the whole landscape of the desert areas under BLM jurisdiction . . . you must limit vehicular traffic to established roads and open the desert areas only to hiking and other less ecologically destructive forms of recreation."[167]

The damage done by ORVs to desert vegetation is well documented by R. Bruce Bury, Roger Luckenbach, and Stephen D. Busack in work sponsored by the Fish and Wildlife Service.[168] Examining 16 sites in the desert, Bury et al. discovered that "moderate" ORV use reduced the shrub biomass by about 50 percent; in heavy use areas shrub biomass declined 70 percent. In those areas where ORV users congregate, parking their trucks, cars, and campers—the so-called "pit areas"—shrub biomass was reduced by about 95 percent from comparable undisturbed areas.[169]

The most common shrub in both the Mojave and the Colorado deserts is the creosote bush; therefore it is the ORVs' number one victim. These shrubs are surprisingly long lived and durable, but once damaged by ORVs take years to recover. Bury et al. note that "the creosote shrub community is an ancient, diverse assemblage of plants and animals. The shrubs themselves may require decades to mature, and even partial damage to the plants, particularly the root systems, may subject them to stress in dry years or drought."[170]

Photographs of desert vegetation taken from the same sites near the Arizona border in 1894



and 1965 reinforce this view. They reveal little change in the stature and arrangement of some of the perennials, especially the creosotes. Some of the same plants appear to have persisted for more than 70 years. A creosote bush appearing in one of the 1965 photographs must have been at least 80 years old because it was already of mature stature in 1894.[171]

In fact, recent studies suggest that 80 years may be extreme youth in the lifespan of some creosote shrubs. Radiocarbon dating showed that decayed wood at the center of some creosote bush rings was approximately 580 to 700 years old. As the center of the shrub dies, new growth develops around the periphery forming a kind of ring. Botanists speculate that some of these rings date back to the time when the creosote bush first established itself in the desert. This means that in places such as Johnson Valley some of the creosote shrub rings demolished by ORVs may have been there since the end of the last ice age—some 10,000 years ago.[172]

Not too surprisingly, Bury et al. discovered that extensive reduction in the wildlife accompanied the destruction of plant life wrought by ORVs. They found that "moderate" ORV use sharply reduced the biomass of an area's terrestrial vertebrates—by almost 60 percent. Heavy ORV-use areas suffered a 75 percent decline in vertebrate biomass, a 45 percent decline in the number of such animals, and about a 10 percent drop in the species present.[173]

Bury et al. point out that certain desert animals have a "low recruitment rate or a long maturation rate." The desert tortoise, for example, may require 15 to 20 years to reach sexual maturity in the field. The leopard lizard has a lifespan of at least 7 to 8 years and the western whiptail lizard of at least 7 years; females of both species usually do not reproduce until 1.5 to 2 years of age. "Death or removal of these long-lived animals will result in a loss of not only these individuals but also their reproductive potential for a relatively long time. Recovery of desert communities would be slow, even where there are no further ORV activities."[174]

Preliminary studies indicate that bird life fares just as badly in ORV-use areas. In Anderson Valley, an undisturbed area had twice the bird biomass and number of species and 1.5 times the number of birds as a similar area of "moderate" ORV use.[175]

Bury et al. conclude that desert vegetation and wildlife are "depauperate, if not obliterated," in areas of intensive ORV use.[176]

Scientists such as Stebbins and Dr. Nathan Cohen, a biologist at the University of California at Berkeley, are particularly concerned about the propensity of ORVers to drive their machines down or across desert washes. Wash banks provide homes for burrowing animals and wash brush and trees provide food and cover for all manner of creatures.[177] Many of the bird species which inhabit the desert nest in wash areas. In the Colorado desert, for example, smoketree washes represent a unique habitat, supporting high concentrations of birds and other vertebrate species, often 10 to 50 times higher than in surrounding areas of desert. Many bird species are concentrated in these washes: verdins, black-tailed gnatcatchers, and Costa's hummingbird, for example.[178]

"Contrary to popular opinion," Stebbins and Cohen report, "washes are fragile natural environments containing many plants and animals, some of which are particularly attracted to wash habitats." In their survey of ORV use of washes along state or federal highways in the desert, they found the "growing incidence of ORV damage truly alarming."

Assessing overall ORV damage to the desert environment, Stebbins and Cohen conclude that "ORVs are steadily destroying (essentially for the foreseeable future) some of the most attractive and fragile natural areas [in the desert]." They point out that natural areas severely damaged by ORVs, of which there are now an abundance in the desert, cannot really be reclaimed in the sense of restoring the original natural ecosystem. It is not humanly possible to reconstruct the complex and delicate interrelationships that have developed over a vast stretch of evolutionary time. Hence a reclaimed area will probably always be something less desirable than that created by historic processes.[179]

Damage Beyond the Desert

Because the documentary evidence of ORV damage in the California Desert is so overwhelming, there is a tendency to ignore the damage done elsewhere. In fact, the problem doesn't

Blunt-nosed leopard lizard

belong exclusively to deserts but is ubiquitous on federal lands in California. Nor is it just a BLM problem.

Take, for example, Hungry Valley on the western rim of the desert in the foothills of the San Gabriel Mountains, a rolling grassland spotted with clusters of oak and juniper in addition to some chaparral; it is a patchwork of private, state, and federal (Forest Service) ownership. About 2,000 acres of land within this semiarid area have been severely damaged by ORVs over the last 6 years. Besides direct vehicle stripping of vegetation, productive grazing soils have been buried by debris washed from ORV hill climbs.[180]

Here, in 1969, Los Angeles County sank three benchmarks into the crest of a hill. The benchmarks were embedded in concrete and inserted to depths of 1 to 2 feet. A strange thing happened to them: by 1977 they were gone. The ground around them was so eaten away by ORVs that there was nothing left to hold them in place, and the markers, concrete and all, rolled to the bottom of the hill.[181]

ORV use has increased the erosion rate in the Hungry Valley subbasin eight times—from 1,800 cubic yards per square mile per year to 14,700. The erosion rate in the entire watershed of which Hungry Valley is a part has increased 33 percent as a result of the current level of ORV use. Scientist J.M. Knott reports: "The most serious impact of ORVs on the environment of Hungry Valley is the establishment of major gully networks which, if not corrected, might lead to the reduction of recreation and alternative land uses in upper Hungry Valley. . . . Downstream impact, such as stream-channel migration and erosion, may be significant over the long term."[182]

Ballinger Canyon is in the Los Padres National Forest in the foothills which surround the San Joaquin Valley. It is one of the last refuges for hybrids of the Blunt-nosed Leopard Lizard, an endangered species. (Rare hybrid populations are of great interest to evolutionary biologists and in many respects are more important to protect than populations of pure stock.) The vegetation is mixed—grass, juniper, and sagebrush.[183]

The semiarid area has been popular with ORVers, primarily motorcyclists, for about 8 years. They have driven pellmell across the canyon's floor and up its slopes much in the manner observed in Dove Springs Canyon, doing great damage in that time—severely affecting an area of nearly a thousand acres.[184] In the summer of 1978, the Forest Service restricted ORV use to trails in the canyon, although at this writing signs had not been posted to announce the change nor has there been any evidence of Forest Service enforcement, i.e., keeping ORVers off the canyon's hillslopes.

The desolation of Ballinger Canyon is obvious to the naked eye. ORVs have cut notches in the ridge line 3 to 6 feet deep. They have scattered cobbles and boulders from a gravel layer at the top along the lower portions of the slopes. At the base of the ORV-used hillsides, sand, eroded from beneath the gravel layer higher up, forms a thick fan, burying vegetation and soils. Many of the slopes are gullied and bare. On the steeper slopes (more than 15 degrees), junipers are especially hard hit because the vehicles expose their root systems and eventually the whole tree topples over. The canyon floor is totally denuded of grass, shrubs, and trees in many places.[185]

Researchers find that in the heaviest ORV-use

zones of Ballinger Canyon, erosion rates are now more than five times greater than the natural erosion rates for the area. The total loss of soil from hillslopes adjacent to the ORV campground averages 54,000 tons per square mile per year, exceeding the soil loss tolerance standards used by the Soil Conservation Service for nonrenewable upland soils of the Ballinger Canyon types by a factor of 70.[186]

In the La Panza-Pozo region of Los Padres Forest, ORV trails show all the signs of serious erosion—deep gullying and debris choking natural drainage courses at the base of slopes.[187]

These chaparral-grass landscapes scarred by ORVs bring to mind one of the oldest ORV areas in California—Chabot, a regional park east of San Francisco Bay. This chaparral- and grass-covered area features slopes of 11 to 22 degrees. After 20 years of ORV use, it is losing soil at the rate of about 32,800 tons per square mile a year—thereby exceeding the tolerance level suggested by the Soil Conservation Service 46 times. One-time ORV paths are now 6-foot gullies. Are the ORV-used areas in Los Padres National Forest headed for such ruinous rates of erosion? Chabot's annual rainfall is somewhat heavier (24 to 26 inches per year), so it will probably take longer, but parts of Los Padres are definitely headed in that direction.[188]

Observers have documented ORV damage in several districts within the 1.1 million acres of Sequoia National Forest, including Hume Lake, Cannell Meadow, Greenhown, Hot Springs, and Tule River.[189] Analyzing ORV damage in the southern part of the Sequoia, Wilshire reports: "The soils in the area . . . are shallow and are underlain by granitic bedrock. That the grass cover provides no significant protection against vehicles is amply illustrated by the fact that single 2- and 4-wheel vehicle passes are sufficient to completely strip the grass and expose the soil surface. These observations are consistent with those made at more than 300 sites of off-road vehicle use in 7 western states, and clearly indicate that designation of any similar land in Sequoia National Forest as open to vehicle use is an invitation to rapid degradation of the soil mantle."[190]

The 2-million-acre Shasta-Trinity National Forest in northern California has steep slopes and plentiful rainfall, ranging from 30 to 70 inches per year. One of the reports of "extensive" ORV damage to this National Forest comes from Jennifer Whipple, a botanist at Humboldt State University: "The meadows near the Deadfall Lakes in the vicinity of Mount Eddy are spectacular. Regretfully, they are rapidly being permanently damaged by muddy (ORV) ruts running across them. There are extensive colonies of several rare and/or interesting plants such as *Darlingtonia Californica, Veronica copelandii,* and *Gentiana newberryi* in these meadows."[191]

Although the ORV impacts in Sequoia and Shasta-Trinity National Forests have been observed and, in some instances, photographed, they have yet to be quantified in terms of rate of soil erosion or loss of plant or animal populations.[192]

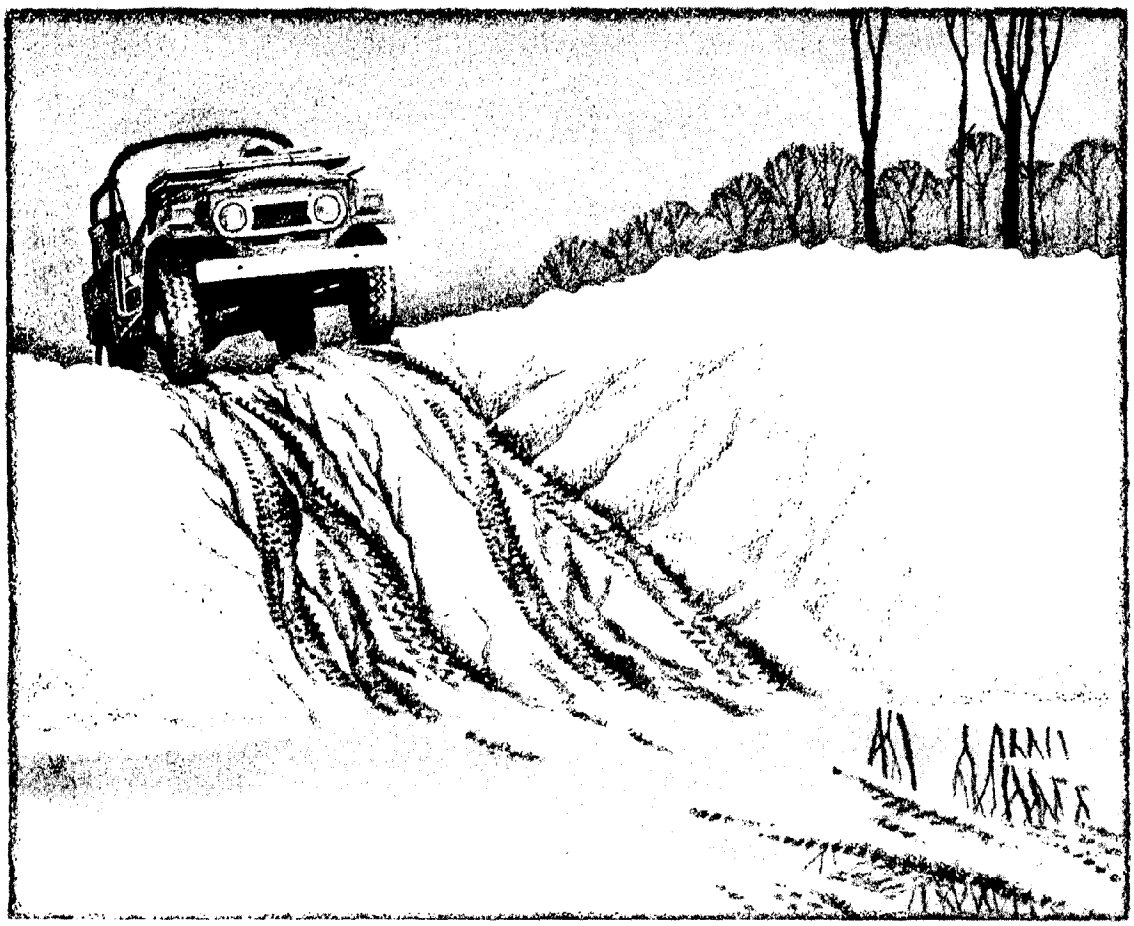
Off-road motorcycle, four-wheel drive, and dune buggy driving does not stop at the California state line. Nor does the environmental damage. As ORVs grow in number and spread out in search of challenging terrain and open space, many other western states find themselves where California was 8 years ago.

For example, ORV-caused erosion, siltation, and destruction of vegetation, including unusual and rare flora along ridge trails, have been observed in the Red Buttes area of the Rogue River National Forest in Oregon.[193]

From the Forest Service's Intermountain Region, director of recreation Robert L. Safran reports: "The two most common environmental problems from ORV use have been from soil erosion (gullying and rutting of hillsides) and disturbance to wildlife. These have not been universal problems, but occur frequently throughout the Region."[194] (The Intermountain Region consists of 16 National Forests in Utah, Nevada, major parts of Idaho and Wyoming, and a small part of California.) Along the Wasatch Front near Salt Lake City, for instance, four-wheel drive vehicles have severely damaged a number of canyons such as Mill Creek and Big Cottonwood by cutting new roads through thick growths of brush into the mountains. The 4x4s have felled fences and trees which got in their way. Portions of this land are managed by the Forest Service and others by Salt Lake County or private owners.[195]

Harold Ramsbaches, acting director of the BLM in Arizona, reports: "We believe that ORV use is increasing in Arizona, probably faster than the rate of population growth."[196]

Daniel P. Baker, the BLM director in Wyoming, also reports that ORV use is increasing. Asked to describe the environmental effects of ORVs on BLM lands in the state, Baker said:



"The findings [from a study in the Casper District] indicate that ORV use is detrimental to watershed values where moderate to steep slopes are involved. There is also an impact on environmental education values by destruction of fragile plant species and visual effects of vehicle tracks on otherwise natural appearing areas. Proliferation of roads by other resource programs such as logging or fire control has contributed to the ORV impact."[197]

Reports of increasing ORV use of public land also come from New Mexico, Idaho, Montana, Colorado.[198]

Indications are that ORVers are following mineral prospectors into certain wild areas. A case in point is Ferris Mountain in Wyoming on the northern rim of the Great Divide Basin. Here, on BLM land, uranium prospectors have cut roads into the area and this, in turn, has opened "the de facto wilderness to off-road recreational vehicle[s] . . . and is hampering efforts toward wilderness designation."[199] There have been similar occurrences on public land in Alaska; only there the roads were first cut by prospectors for oil and natural gas.[200]

But why single out ORV users for special attention? Hikers, after all, disturb the natural environment, too. Every human activity in a natural area alters it in some way or other. The trouble with ORVs is that they are a multiplier of man. It takes 2 to 3 days for a walker to travel as far as motorcyclists or four-wheel drivers can in 2 to 3 hours. In addition, a motorcycle or 4x4 wheel exerts greater shear-stress upon the ground than the human foot. A typical motorcycle, driven very carefully so as to leave the smallest mark on the land, affects 1 acre of land for every 20 miles it travels. A four-wheel drive vehicle driven in a similar manner affects 1 acre in only 6 miles of travel. A person walking has to travel 40 miles to affect 1 acre of land.[201]

The growing popularity of 4x4s is especially unfortunate in this regard. These are rugged and powerful machines, and people drive them deep

into wild areas for distances and over terrain that motorcyclists would never try to traverse. For instance, 4x4s have been observed driving deep in the Absaroka Bear Tooth Wilderness, north and east of Yellowstone National Park.[202]

In the past, tall, thick vegetation was the major natural barrier to 4x4s. Now, however, 4x4s are made with higher clearances so they can, for example, crash through dense coyote chaparral where individual plants are as high as 12 feet.[203]

The Impact Of Snowmobiles

"Controlled snowmobile use has no discernible adverse effect on the environment so long as it is kept out of sensitive environments such as winter yarding areas for ungulates or stands of saplings."[204] That is the position of the International Snowmobile Industry Association (ISIA), one of the most energetic groups within the ORV lobby. Unfortunately, the facts suggest a somewhat different conclusion: snowmobiles driven on an adequate snow cover (about 6 inches) do affect soils, plants, and animals, but far less extensively than motorcycles, dune buggies, and 4x4s.

As far as public land is concerned, trailbound snowmobiling is much more common on National Forests in New England and the Upper Great Lakes States. Cross-country snowmobiling is more common on National Forests and National Resource Lands in the Rocky Mountain and Northwest Regions as well as in California. Snowmobiles are also run on snow-covered gravel or surfaced roads in forests and parks in many parts of the country. In these instances, of course, their effects on plants and soils are negligible.

When a 400-pound snowmobile treads over a snow-covered landscape, its number one environmental effect is to compact the snow, despite the fact that snowmobiles exert surprisingly little downward pressure. The downward pressure of a 400-pound snowmobile averages one-half pound per square inch (psi); in contrast, a four-wheel drive vehicle exerts 30 psi and a hiker 5 psi.[205] Nonetheless, snow compaction occurs, especially on well-traveled snowmobile routes. In Minnesota, for example, scientists observed that during spring thaw an ice layer nearly 2 inches thick was present in the areas traversed and compacted by snowmobiles but was totally absent from areas not used. The soils of the snowmobile areas thawed 1 week later than the others.[206]

Ecologist Shaun Bennett explains the environmental implications of snow compaction by snowmobiles:*

> Compacted snow, which is mostly ice, is a relatively good thermal conductor (poor insulator) and the soil beneath it freezes readily. Where the plant roots are not resistant to freezing, they are not likely to survive the compaction of snow. The effect may be minimal in a forest where the roots of the dominant plants (trees) are so deep and extensive that freezing due to snowmobile activity would affect only a small part of the total root system. In places where plants grow in a low mat or "lawn" as in bogs, alpine tundra, and some fields, soil is shallow. When the small individual plants are covered by a single snowmobile path, compaction-induced freezing is much more likely to be deleterious. . . .
>
> A potentially disastrous effect of the soil being compacted and frozen is the possibility of "heaving" upon freezing and subsequent serious soil erosion when the earth moves. The stabilizing plant cover is disrupted when snowmelt makes the probability of severe erosion high. . . .
>
> Compaction may also be important to the well-being of small mammals like mice, moles, shrews, and voles which are an important part of most ecosystems and which are active all winter. These little [animals] move about in the "interface" between the snow and soil. The thousands of intertwining runways and tunnels which are apparent in the grass after the spring melt are clear evidence of their extensive travels.
>
> Compaction of snow not only encourages the freezing of the soil in which these animals find sustenance, but it may also effectively "wall them off" with an impenetrable barrier of ice and frozen soil. . . . [A]n adverse effect at the level of rodent survival is likely to be felt throughout the ecosystem. Rodents feed on certain plants (thereby controlling their numbers) and also serve as the major dietary items for many hawks, owls, and mammals like foxes and coyotes.
>
> . . . The unplowed permanent logging roads of lumber companies make excellent snowmobile trails and they get intensive use. But alas, compaction of their snow cover leads to frost heaving, erosion during spring thaw and [a] later thawing season. All this spells losses for the loggers in terms of increased maintenance costs and decreased annual usable period.[207]

Dr. Wallace J. Wanek and his colleagues at Bemidji State University studied the impact of controlled snowmobiling on soil and plant life in northern Minnesota. Their research is the most definitive on the subject. From data collected over 5 years of work, they have reached certain conclusions:

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1. The environment beneath the snow compacted by snowmobiles is substantially colder than that under natural snow cover. Even during comparatively mild winters, plant growth and flowering are retarded. During winters of average severity, large numbers of perennial herbs such as Jerusalem artichoke, smooth blue aster, and wild sarsaparilla, which have fleshy subterranean organs, are likely to perish where snowmobiles travel. This mortality is due to significantly colder soil temperatures producing intracellular ice crystals which cause cytolysis, dehydration, and other tissue disruptions.
2. Alfalfa winter kill can be expected in areas traversed by snowmobiles, the amount of mortality being directly correlated with traffic intensity. With one or two traverses per season, alfalfa productivity usually declines 20 percent or less, but under higher intensities alfalfa productivity declines as much as 75 percent. Mild winter temperatures and heavy snowfall tend to reduce the impact of snowmobiling. The causes of alfalfa winterkill are manifold. There are indications that the ice layer which forms under compacted snow traps some carbon dioxide in the root zone and toxic concentrations could be attained. In addition, the colder soil temperatures reach and disrupt alfalfa root tissues.
3. Many woody plants are particularly vulnerable to physical damage by snowmobiles. Young conifers such as Norway pine or white pine are severely harmed by only minimal amounts of traffic, many of them perishing from the damage. Deep snow tends to protect small trees and decrease mortality. Deciduous trees which do not readily form sucker shoots may be eliminated quite quickly where snowmobiles travel. Hence, species such as the large-toothed aspen are virtually annihilated in snowmobile paths. Even species such as red oak that do form sucker shoots will also decline if snowmobiling continues through several winters. However, most shrub species increase where snowmobiles travel, probably because of reduced competition for sunlight. Low-growing shrubs such as honeysuckle and blueberry are the exceptions—their numbers decline in snowmobile areas.[208]

Wanek notes that "[t]he damage to plant communities reported during this five-year study should in no way be considered maximal. In all cases snowmobile traffic was begun after 6 inches of snow had accumulated, a condition which is usually not met during normal snowmobiling activity."[209]

Fred W. Cowan, resident manager of the St. Regis Paper Company, West Stewartstown, New Hampshire, corroborates Wanek's findings about damage to trees: "It is the devious way in which snowmobiling can be detrimental to growth, management, and harvest of the forest which is causing considerable consternation to timberland owners." What he is referring to is that snowmobiles break the tops of trees, thereby making them grow crooked and reducing their timber value. Also, snowmobiles break open tree limbs or trunks, making the trees vulnerable to fungi and insect damage.[210] Nonetheless, St. Regis and other lumber companies do allow public snowmobile trails on their lands in states such as New Hampshire, where snowmobilers have demonstrated a willingness to stay on the trails.

Are there detrimental effects of snow compaction by snowmobiles on frozen bodies of water? Here the testimony is both scanty and contradictory.

Biologist Dr. Gale Gleason reports that a study conducted at Lake Superior State College shows that the compaction of snow over an ice surface results in an increased percentage of light transmission. "This increase in light transmission could help alleviate 'winter kill' so common to the smaller eutrophic lake systems that abound in Ontario, Michigan, Wisconsin, and Minnesota. It was found that any compaction down to eight centimeters provided sufficient transmission to induce photosynthesis during normal daylight periods."[211]

Yet Wisconsin's Department of Natural Resources has reported that winter fish kill brought about by the heavy compaction of lake snow by snowmobiles is becoming more alarming all the time. The Department reports that ice beneath the compacted snow becomes opaque so that less sunlight gets through, and even less plant life than usual grows under the lake ice. Therefore food supplies for fish, and consequently the fish population, are being sharply reduced.[212]

There is no disagreement that snowmobiles make heretofore remote lakes and ponds accessible to fishermen.[213] For example, Jack Hope reports: "At 80-acre Pierz Lake in Minnesota, where summer canoeists were once rewarded for their six-hour paddle with a catch of a two-pound trout, a troop of 120 snowmobiles virtually

cleaned out the lake in a single winter's day, packing out 556 pounds of fish."[214]

Nothing as conclusive as the work of Wanek et al. exists on the subject of the impact of snowmobiling upon wildlife.[215]

Early snowmobile literature reflected a widespread concern about harassment of animals by snowmobilers. One survey in the winter of 1971-72 found that 62 percent of Minnesota game and fish enforcement personnel thought snowmobiling was either very harmful or moderately harmful to wildlife through such activities as: "disruption of daily activity patterns, increased stress and energy expenditure, and chasing deer either intentionally or inadvertently by curious snowmobilers. Driving snowmobiles through deer yards or winter concentration areas was mentioned as a serious effect along with establishing packed trails that allow dogs or wolves to chase deer."[216] The wildlife managers in Minnesota thought the most harassed species were white-tailed deer, foxes, pheasants, and rabbits.[217]

Another survey of conservation officials in 31 snow states by *National Wildlife* in 1974 indicated that wildlife harassment was still considered a problem: "In at least 15 of those states recently, there have been specific instances of wildlife harassment and killing by snowmobilers. In all, 20 states report that snowmobilers definitely pose a general problem for wildlife and habitat alike. And despite claims that steps have been taken to reduce abuses, only 6 of the 31 states responding to the survey report that the situation has improved."[218]

ISIA contends that there has been a drastic reduction in wildlife harassment by snowmobilers in the last several years. They attribute the improvement to three factors:

- the increased number of established trails which are now available to snowmobilers reduces the possibility that they will strike out across country;
- snowmobilers have become more conscious of the harm that they can do to wildlife and seek to avoid it;
- a growing number of snowmobilers belong to snowmobile clubs which actively discourage wildlife harassment.[219]

There is no direct evidence to confirm ISIA's contention, but the incidence of reports in the popular and scientific literature of deliberate harassment of wildlife by snowmobilers has dropped sharply in the last 3 years.

More recent studies of snowmobile impact on wildlife have produced contradictory results, especially regarding the impact on large and medium-sized animals. The impact of snowmobile compaction on smaller animals which inhabit the subnivean space between the snow and ground surface is more definite, however. A study found that the winter mortality of small animals in the subnivean space "markedly increased under snowmobile compaction"—perhaps as much as 100 percent. The high mortality is attributed to a number of factors, including extreme physical modification of the subnivean space, the reduced insulation from colder temperatures provided by compacted snow, and perhaps some toxic increase in subsnow carbon dioxide levels.[220]

A study of the impact of snowmobiling on radio-collared white-tailed deer found that light snowmobile traffic displaces deer from areas immediately adjacent to the snowmobile trails, but further snowmobiling had little effect on deer movement, and in fact they became habituated to snowmobile traffic. Some wildlife experts now suspect that the reaction of deer to snowmobiles will vary from area to area, depending upon whether or not the deer are used to human activity of other kinds—logging, summertime ORV riding, mineral exploration, etc.[221]

In White Mountain National Forest, Forest Service biologists monitored the effects of snowmobile traffic on a road in the proximity of a deer yard. They concluded: "The degree of snowmobile use on the Rob Brook Road did not appear to have any effect on the travel patterns of deer which winter in the Rob Brook deer yard. The physiological effect on the deer is unknown. However, no evidence of winter mortality could be found in this yard. Based on information from New Hampshire Fish and Game personnel, New York State, and personal observations, significant increases in either the number of machines per hour or the length of the machine-use day from present levels will probably have an adverse effect on deer travel and physiology, especially during more severe winters." They recommended that the Forest Service be prepared to reroute winter ORV traffic if it increases significantly.[222]

Much less work has been done on the impact of snowmobiles upon other ungulates such as elk or moose, but they are thought to be more sensitive to the sights and sounds of snowmobiles.

The response of medium-sized animals to snowmobiles seems to vary greatly. Snowshoe hares avoid snowmobile trails but red foxes are active near them. Snowmobiles apparently have

little effect on red, grey, and fox squirrels. Again, snowmobiles provide hunters and trappers with increased access to wildlife in remote areas. As a result, the population of beavers, for example, has been reduced in certain areas.[223] Snowmobile-caused mortality of smaller mammals will undoubtedly affect predator populations (owls, eagles, hawks, bobcats, wolves, etc.), but to what extent has yet to be determined.

Obviously, conclusions about the environmental impacts of snowmobiling must be cautious. The environmental impacts of snowmobiles driven on an adequate snow cover and on trails specifically designed to bypass fragile locations might very well be insignificant. On the other hand, the environmental impacts of snowmobiles that roam at will across country could be serious.

More conclusive statements concerning the environmental consequences of snowmobiling must await further research into a number of poorly understood issues, such as:

1. Does snowmobile use in fact create toxic buildups of carbon dioxide beneath the snow and if so, what are the long-term effects on animals and plants?
2. What effect do snowmobile pollutants like lead have on frozen bodies of water and the plant and animal life within them?
3. Snowmobiles manufactured today are considerably quieter than they were 5 to 10 years ago when many of the studies were conducted. What are the physiological effects of these lower sound levels on wildlife, especially birds, ungulates (nondeer species), predators, and smaller mammals?

CONFLICTS WITH OTHER USERS

Just before I arrived at the Coral Dunes [in southern Utah] a local newspaper announced the coming invasion of a fleet of sandbuggies which proposed to race up and down over the dunes. . . . [H]ere is another example of the fallacy of "multiple use." You cannot use the Coral Dunes (now an undeveloped state park) for both sand-buggy racing and the quiet enjoyment of their aesthetic, ecological and geological interest.[224]

Joseph Wood Krutch, 1969

. . . [O]ne ORV operator can effectively restrict a large public area to his own use through the emission of loud engine noise, obnoxious smoke, gas and oil odors and dangerously high speeds. Whereas previously many persons of all ages and wealth could observe the beauty of unspoiled land, now a single ORV can reign supreme.[225]

Gary A. Rosenberg
Environmental Affairs, 1976

Consider the snowmobile . . . and the often-heard argument that this machine makes it possible to "get way back in there, away from it all." There are, of course, several other ways to "get back in there," including snowshoes and skiis. Maybe if you need an engine to get there, you don't belong there in the first place! To my mind, "getting away from it all" means, foremost, getting away from our society's overdependence on the combustion engine.[226]

Jerry Buerer, professor of sociology, Marquette University and organizer of a group to protect the rights of non-ORVers, 1975

I lived in Hampden, Maine for four years. My home backed onto a wild area. There was a narrow footpath there which wound around the moss-covered rocks and through the blueberry bushes. I saw deer, bear and moose there. Then came the snowmobiles. Wherever they passed over a thin snow cover, they scalloped the land—leaving depressions which in the summer turned very muddy. They scared away the big animals; after a couple of years, I never saw them again. They crushed smaller plants and saplings—flattened them like pancakes. And the snowmobiles turned that footpath into a 10-foot-wide hog wallow. They ruined that land for me. It was never the same again.[227]

Edgar A. Imhoff,
Environmental Planner,
Resource and Land Investigation
Program, U.S. Geological
Survey, 1977

[We need to] provide some place on God's green earth for man to spend some time without hearing a damned motor.[228]

Ben Huffman, Vermont
Department of
Forests and Parks, 1974

Yes, ORV and snowmobile use of the land conflicts with other human uses of the land. As the foregoing quotations suggest, the conflicts engendered by these machines can be quite bitter.

Reports from public land managers in nine western states indicate that conflict occurs, upon occasion, between commercial users of the land, such as ranchers, and ORV recreationists.[229] The conflict with grazing, in fact, seems to be more common than with logging or mining. For example, New Mexico BLM director Arthur W. Zimmerman notes that complaints from ranchers

have been received concerning trespass, cut fences, broken gates, polluted livestock water, new jeep roads, noise, gully erosion caused by hill climbs, and interference with their livestock operations.[230] The less frequent complaints received from loggers and miners usually concern vandalism of their equipment and property by ORVers.

The most serious conflict arises between ORV operators and nonmotorized picnickers or campers, hikers, backpackers, sightseers, and so on—or between ORVers and persons using the land for educational purposes—students, teachers, researchers.

Nonmotorized recreationists do not enjoy their encounters with motorcycles, dune buggies, and four-wheel drive vehicles, numerous studies have shown.[231] The ORV operator, on the other hand, is often quite tolerant, even oblivious of the person on foot or horseback.[232]

ORVs, in other words, impair other people's enjoyment or understanding of the outdoors on public land. In terms of public policy, this is a problem equal in importance to ORV damage of the environment.

What is it that non-ORVers find so bothersome about these machines? Noise, dust (in arid and semiarid areas), gas fumes, oil on trails, disruption of wildlife, and destruction of plants are the most oft-cited complaints. Occasionally, there is a more sinister cause for complaint—lawlessness. The vast majority of ORVers are law-abiding and courteous citizens. But there are exceptions, and encounters with them can be nightmarish. Biologist Michael Weinstein recounts such an experience during a recent weekend outing to Afton Canyon (BLM land) in the California Desert:

> Among the campers present at that time were several groups of off-roaders. One group of about ten individuals . . . arose at 7 Saturday morning, made a large fire out of mesquite which they chopped down, and turned on a very loud tape deck. Neither the fire nor the music was extinguished until 2:30 in the morning in spite of several complaints by other campers.
>
> Trail bikes were driven up and down the campground at all hours of the day and night, as well as in every conceivable spot in the canyon. A total of five guns were used, three 22's, a 12-gauge shotgun, and a 38 caliber pistol. They were fired near and actually in the campground. I was on one side of a bush only a hundred yards from the campground while one person shot a 22 at a bird from the other side. It is a miracle that neither I nor the bird was hit. In spite of being told of the restrictions on shooting within a half mile of the campground and that hunting season was over, shooting continued until they left Sunday. At midnight Saturday night guns were shot off drunkenly until even the blaring rock music seemed a pleasant interlude.[233]

Weinstein notes that another camper tried twice to get a sheriff or highway patrolman but did not succeed because it was the weekend. He concludes: "It is clear to anyone with eyes, even in the absence of quantitative data, that the canyon cannot long survive the abuses to which it is currently being subjected."[234]

Federal land managers call ORVers like those in Afton Canyon "bad apples" and note that "there are a few bad apples in every group." The difficulty is that many land managers receive more complaints about motorized "bad apples" than nonmotorized ones—hikers, anglers, and so on. Only a tiny fraction of all ORVers across the country are "bad apples," so incidences of this kind are not typical, but there are enough "bad apples" that they are not unusual either.

Idaho BLM director William L. Mathews argues that "the *number one factor* that determines the level of environmental impacts and user conflicts is the human element: the operator himself. Skilled, courteous operators with properly tuned equipment can operate vehicles with minimal effect on the environment and little conflict with other users.[235] This is a widely held view among federal land managers and Heritage Conservation and Recreation Service officials, and it is largely wrong. St. Francis of Assissi himself while driving an ORV on wild land could not avoid diminishing the recreational experience of many non-ORVers in the same area. (Nor could he prevent much of the environmental degradation.)

Why? Because, as a BLM Environmental Impact Statement noted: "Silence is a resource. These sounds which man typically associates with the pristine natural environments are perceived by the senses as solitude. The solitude of the desert is one of its . . . valuable resources."[236] Substitute the word forest or prairie or mountain or meadow for desert and the truth of this statement still stands. The noise of an ORV punctures that solitude. Hikers and campers, for example, do not trek miles into the wilds to hear a chorus of internal combustion engines, however polite the drivers, however well-tuned their engines, although certainly a good muffler and a courteous driver make the experience less unpleasant than it would be. Direct encounters with ORV machines simply are not compatible with the quality of outdoor experience being sought

by a majority of Americans. For example, a study of forest trail users in Ohio found that the majority enjoyed meeting trail users traveling by less mechanized means. Sixty-six percent of the sample felt that meeting motorcyclists on a trail was undesirable. A study of campers in a Washington State Park revealed that 74 percent indicated a strong dislike for motorcycles in campgrounds.[237]

Forest Service engineer Robin Harrison, who has pioneered much of the research into ORV noise, states that "annoyance with ORV noise is not solely a function of the level of the noise. Listener attitude is one of many important parameters in the determination of annoyance."[238]

Harrison concludes:

> Some people associate dust, odor and rowdy conduct with motorcyclists. Much of the dissatisfaction expressed with motorcycle noise may not be directly attributable to the noise itself, but to other unpleasant characteristics of motorcycles and motorcycle operation. Since noise is the most easily identifiable unpleasant characteristic of motorcycles, motorcycle noise is likely to continue to be a prominent source of complaint from the public as long as motorcycle noise is heard.
>
> It, therefore, seems apparent that no matter what sound level is achieved by the motorcycles, if indiscriminate operation in campgrounds and other places of visitor concentration continues, motorcycle noise complaints will continue to plague forest managers. However, . . . the extent of the area disrupted by motorcycle noise would be reduced if the loudness of individual motorcycles were reduced. Thus, it seems logical to limit the noise from motorcycles.[239]

Weather and terrain are both important in the attenuation of sound (though the effect of terrain by itself is not well-understood). For example, the noise from a four-wheel drive vehicle in a forest may be audible a mile away on a relatively still day, but only a quarter of a mile away if the wind is howling. The sound of an ORV will definitely carry farther under colder, dryer, and stiller weather conditions although wind direction and intensity are the most important factors.[240] Or, for another example, a four-wheel drive vehicle roaring along a ridge may not be audible in the valley below, but it might be quite loud to someone on an adjacent ridge.[241]

Vegetation by itself is not nearly as effective a barrier to ORV sound as recreational planners once assumed. Harrison found that the sound attenuation of meadow or brush conditions averaged only 1 decibel at 100 feet after atmospheric absorption and spherical divergence were taken into account. Mature conifer or oak forests are even less effective in attenuating sound. In fact, under certain forest conditions—widely spaced trees and a high canopy of foliage—sound carries farther than in the open where the atmosphere is subject to greater vertical wind movement and differences in temperature.[242]

Motorcycles are getting quieter. The Motorcycle Industry Council urges its members to manufacture cycles that emit no more than 86 dBA at 50 feet. Harrison thinks that most models made today are now in compliance.[243]

Some states have set ceilings for ORV sound output. For example, Section 38370 of the California Vehicle Code mandates that all ORVs manufactured on or after January 1, 1975, emit no more than 86 dBA at 50 feet. It should be emphasized, however, that not all ORVs now in the field meet such standards. Some machines are older and therefore noisier. Others are noisier because their owners have removed the machine's muffler or souped up its engine. There is no evidence that the states are systematically monitoring ORV noise in forests, deserts, or anywhere in the countryside. What percentage of ORVs in operation are actually in compliance with legal noise levels? It is impossible to tell at this time.

Harrison estimates that under forest conditions, the noise from an average motorcycle is detectable 7,000 feet away. A quiet motorcycle is detectable 4,000 feet away and a loud one at 11,500 feet. "[T]hese numbers are generally conservative, and probably represent distances which would not be exceeded in more than 25 percent of the cases."[244]

In the Oregon dunes, Harrison found that the sound level of dune buggies at 50 feet ranged from 91 to 100 dBA and that they were detectable from 2 to 4 miles away. Four-wheel drive vehicle sound ranged from 77 to 81 dBA and was detectable from four-tenths of a mile to one and a half miles away.[245]

Snowmobile manufacturers have made the greatest progress in reducing the noise output of their vehicles. Early commercial snowmobiles averaged about 102 dBA at 50 feet away. Now almost all meet the ISIA's standard of 78 dBA or less at full throttle. At 15 miles per hour, all new snowmobiles emit less than 73 dBA. By comparison, the average accelerating automobile emits about 84 dBA at 50 feet.[246]

The fewer decibels emitted by new snowmobiles have helped to lower the decibel level of the snowmobile-nonmotorized recreationist conflict, especially with the growing numbers of

cross-country skiers. But to say, as ISIA does, that "conflict among winter recreationists today is isolated and disappearing" is overly optimistic.[247] The political battle which has raged in Minnesota over whether or not to allow snowmobiles in the Boundary Waters Canoe Area suggests otherwise. So do the last 3 years' back issues of such periodicals as *Audubon, National Wildlife, The ORV Monitor, National Parks and Conservation Magazine,* Jack P. Maloney, Chairman of the Nordic Trails Development Committee of the United States Ski Association, believes that the key to solving the conflict between snowmobilers and "people who enjoy quiet, non-motorized outdoor recreation" is for public land managers to provide separate facilities for both—and to keep them separate. He adds: "Snowmobilers were on the scene first and they have resisted giving up any trails to cross-country skiers. We have had to fight tooth and nail for places to ski."[248]

Generally, the noisier, more consumptive, and uncontemplative recreation activities, such as ORV riding, preempt and drive out the activities that are quieter, less consumptive, and more contemplative, according to BLM recreational planner Robert Badaracco.[249] He cites as evidence the case of Lark Campground, situated east of San Diego "in a broad and beautiful valley where coast and desert meet."

"Constructed about 1967, the quiet and isolated campground was in the beginning frequented by traditional outdoor recreationists, weekend family campers, older couples enjoying the sun. . . . Gradually, the motorcyclists came, at first just one or two now and then, and eventually more and more. Upset by the noise, dust, and commotion, traditional weekend users began to complain, then disappear. Today, 50 percent or more of the former user types have been displaced . . . ."[250]

Badaracco calls this phenomenon the ISD syndrome—that is, the progression from impairment of satisfactions to suppression of use to eventual displacement. "The irony of the ISD syndrome is that administrators and managers tend to measure recreational demand on the basis of current participation rates," Badaracco points out. "If a resource supervisor sees a given recreational activity prevailing at a certain site, he interprets this

as a reflection of public recreational demand. If the site he observes is used to capacity, he may plan additional sites or programs for the same purpose, even though the previous users have been displaced. Thus the administrator may allocate additional opportunities to a group which has suppressed or displaced a former traditional group. In effect, the administrator, perhaps unwittingly, assists in the suppression and displacement of additional traditional users. Enough managers following the same course could well set into motion recreational evolutionary processes which change the character of outdoor recreation despite the intense feelings of a broader public."[251]

Badaracco suggests that the ISD syndrome, already well-advanced in the California Desert and such places as the Los Padres and Sequoia National Forests, is now spreading to other public land areas, especially in the West.[252]

ORVs thus invade the attitudinal and physical space of non-ORV recreationists. Badaracco notes: "In an exceptionally quiet wildland environment, such as the desert, sound from a loud motorcycle is readily perceptible for great distances, often 1,500 meters or more. In such a situation, a motorcyclist traveling 120 kilometers in a day would extend his audible presence 1,500 meters on either side of his route of travel and thus into 360 square kilometers of adjacent terrain. On the other hand, 150 hikers, bird watchers, or photographers could easily utilize such an area with few encounters or no awareness of another's proximal presence. Loudness and mobility magnify the presence of the individual motorcycle rider in a logarithmic way and diminish the aesthetic satisfactions of other recreationists who may be present over an extensive area."[253]

In effect, ORVs shrink the amount of land available for non-ORV recreationists. If the ORVers stay on specific trails, then the amount of shrinkage is confined to the trails and the land immediately adjacent to them—the corridors of ORV noise. If they roam anywhere in an area, then the amount of land available to the quiet-seeking non-ORV recreationists in that area shrinks to zero.

In this regard, ORVs could not have come at a more inopportune time. Recreational land is an

increasingly scarce resource. The supply is dwindling in absolute terms—as the nation paves over land for roads, housing, parking lots, shopping centers, and other urban developments at the rate of more than 1 million acres per year—and in relative terms because of the great upsurge in outdoor recreation demand. In other words, ORVs are making a scarce resource even scarcer for the growing number of non-ORV recreationists.

There is another kind of conflict generated by ORV use of public land. It involves something resource planners have come to call "the existence factor."[254] Millions of Americans who have never seen and will never see in the flesh a blue whale are still concerned about its continued existence. The same holds true for resources affected by ORVs. People who have never hiked a desert canyon derive satisfaction from the thought that it remains a wild place where a carpet of wildflowers will bloom after a spring rain or where golden eagles still wheel through the sky in search of prey.

The "existence factor" played a part in the recent controversy over snowmobiling in Grand Teton National Park. When the Park Service announced its intentions to leave open certain trails and cross-country areas for snowmobilers during periods of adequate snow cover, the public response was surprising. As might be expected, non-ORV user groups such as the National Parks and Conservation Association protested: "Snowmobiles are a raucous irritation to many park visitors."[255] But some letters also came from people who have never used the park in the winter but who disliked the very idea of snowmobiles violating this otherwise pristine area. About 600 letters from throughout the country came in, 57 percent of which were opposed to continued use of trails and open areas by snowmobilers. The Park Service revised its policy—restricting snowmobiles to existing roads in the park.[256] In the winter of 1978–79, however, due to political pressure from local snowmobilers, the Park Service planned to allow cross-country snowmobiling in the 2,000-acre Pot Holes area of Grand Teton. Normally, cross-country snowmobiling is not allowed in National Parks.[257]

An often overlooked use of public land is education—teaching and research. A recent survey commissioned by BLM of educational use of the California Desert suggests that it is far more extensive than previously imagined. During one school year, college and university teaching accounted for 47,617 person days of desert use; research accounted for 12,522. Elementary and secondary school use of the desert totaled an estimated 183,271 user days. (Because only educational institutions in southern California were surveyed, these figures are no doubt low.) The teachers and researchers were asked to identify the disturbance to the desert which interfered with study or research. They ranked ORVs number one. Vandalism and urban expansion ranked a distant second and third, followed by road construction, overgrazing, and mining.[258]

It is no wonder that 145 scientists from throughout California petitioned the BLM in 1975 to protect the desert from further ORV damage. They warned that if the present rates of ORV destruction continue, "opportunities for the study of native flora and fauna and natural interrelationships will be reduced," and "the future of arid lands teaching and research will be compromised."[259]

Biologist Bruce Bury, contemplating the increased use of ORVs across the U.S. but especially in western states such as Colorado and Arizona, says: "Biologists are in a race with the ORVs. We have to go out and count the wildlife before the ORVs get to it. I can't believe how many ORVs are out there now."[260]

MOTORIZED RECREATION AND THE ENERGY CRISIS

Many environmental groups have emphasized that ORV and snowmobile use should be curtailed as an energy saving measure. However, ORV and snowmobile use represents such a small fraction of the nation's energy consumption that even if they were entirely eliminated, the energy saved probably would not be worth the effort. In addition, off-road motorized recreationists might spend more time in their automobiles if their ORV and snowmobile use is curtailed, further reducing the net amount of energy saved.

Americans are projected to consume 112.7 billion gallons of gasoline in 1978, and gasoline consumption accounts for about 20 percent of the nation's total energy consumption.[261] Some rough calculations (see Appendix 3) suggest that motorized recreationists consume about 1,040 million gallons of gasoline per year—less that 1 percent of the nation's total gasoline consumption.[262] There may be 10 million of these vehicles in operation, but the two most numerous types of motorized recreational vehicles—snowmobiles and motorcycles—average only about 53 and 30 gallons per vehicle a year respectively.[263] Of course, many ORV and snowmobile riders also burn energy getting to and from the areas where they ride. Indeed, there are indications that many dedicated ORVers are willing to drive more than 2 hours to reach a suitable place to ride.[264] There are no reliable estimates of what this additional energy expenditure comes to. It is possible that ORVers and snowmobilers consume more fuel getting to and from riding sites than they do while they are there, but it is hard to imagine that this consumption is sufficient to push their total gasoline demand beyond the 3 billion gallon a year mark—still less than 3 percent of total gasoline consumption.

For those interested in saving energy in the transportation-recreation sector, air travel would seem a far better prospect. To transport one passenger from Detroit to Miami on a Boeing 727 takes about 136.6 gallons of fuel—enough to run the average snowmobile for a little over 2 years or an off-road motorcycle for 4½ years.[265] Making more efficient automobiles would seem to promise an even greater energy saving payoff. Automobiles are still the primary recreational vehicles in the United States, not motorcycles, snowmobiles, dune buggies, or four-wheel drive vehicles.

Only in the event of a national energy emergency could ORV energy consumption be considered a major issue.

PART 2: ORV Policy

THE FEDERAL RESPONSE

We recognize that off-road recreational vehicle use is one of many legitimate uses of federally-owned lands.[266]

Rogers C.B. Morton,
Secretary of Interior,
1971

In the land use planning process, the question should not be, should we close an area to ORV use? but—can ORV use, in some form, be permitted on the area? One of the primary questions . . . is generally—How much resource impact can we live with in providing for a recreation activity such as ORVs?[267]

U.S. Forest Service, 1974

The federal government's first concerted effort to come to grips with the ORV phenomenon was in 1968 when the California state office of the BLM and the Western Regional office of the National Park Service published *The California Desert.* This document warned that "the uncontrolled use of off-road vehicles has caused considerable damage to the desert environment."[268] It urged that "the California Desert recreation resource be brought under immediate protection"[269] and suggested that the BLM develop specially designed centers for ORVs.[270] It expressed the hope that by rotating use of the terrain within these centers, "the desert surface can be conserved" and the ORVers would not be continually searching for new areas in the desert to use.[271]

It was another 5 years before BLM issued an ORV use plan for the California Desert. As will be seen, the BLM has yet to bring the environmental damage caused by ORVs under effective control, some 10 years after its report sounded this alarm:

The desert is limited. Its resources are exhaustible. In truth, the desert is fragile. The struggle for existence is harsh, and the delicate balance between soils, plants, animals, water, and air can be damaged for decades or destroyed by thoughtless exploitation.[272]

In 1969, the BLM in California convened the Off-Road Vehicle Advisory Council (ORVAC), a group comprised of ORV organization representatives, environmentalists, ranchers, and businessmen. Despite the members' many differences, this group reached a consensus on a number of issues. It urged BLM to develop a plan in which ORV use could be effectively accommodated and controlled.[273] E. Lamar Johnston of the California Cattlemen's Association summarized what seemed to be ORVAC's principal conclusion:

We should all try to make this recreation thing work—programming and management and money, of course, are going to come in the picture. You just can't turn them loose. They did that 100 years ago but we have come to the point where we have run out of land and a place to put them. It is going to take management by the Government and private enterprise—everyone put together.[274]

ORVAC wrote 24 specific criteria for defining areas where ORV use should *not* be allowed.

These included, for example, "areas where soils are classified as highly susceptible to erosion," or "sites with scientific values such as historical, biotic, archaeological and paleontological where damage would occur," or "known, potential and existing camp and picnic grounds or other appropriate recreation development."[275] Today ORV riding regularly occurs in all such places, either because they are not protected by the BLM or because of the BLM's inadequate enforcement of its ORV regulations in the desert.

Interior Department Task Force

In 1971 the Secretary of Interior formed a special task force to study the ORV problem—the first attempt at the national level by the federal government to assess the ORV phenomenon which was, by this time, a full-fledged public land management problem.

The task force never directly confronted the key question of how the federal government is to manage ORV use of the public land while still meeting its responsibility to maintain "resource productivity in harmony with an enjoyable, healthy environment."[276] In other words, how are the Forest Service and the BLM to make ORVs compatible with the land's other multiple uses?

The task force found that "to eliminate or minimize much of the environmental damage through regulations and commonsense use, will require a much greater knowledge than we now have about long-range irreparable effects of ORRV use."[277]

It noted that studies were underway to assess the environmental effects of ORVs. "Results, however, will not be available for several years."[278] And in the meantime? According to the task force, the federal government should proceed with a land classification system specifically designed to protect the resources and to provide "a place for the motorized vehicle user on public lands."[279] The difficulty with this approach is: How does the government prevent long-term and irreparable damage to the public's natural resources by ORVs while the studies and the land classification process is going on? The task force ducked this pivotal issue.

Instead, it urged that "the Federal Government should assume the role of coordinator and catalyst in assisting the States to stimulate the efforts of local levels of government and the private sector to evaluate, encourage, and promote all recreational activities . . . ."[280] It also suggested that the federal government promote motorized recreation on public land, noting with approval that "the Carson National Forest in New Mexico has been using news releases to publicize the new sport of snowmobiling."[281]

The Interior Department task force saw ORVs as primarily a state responsibility: "[T]he States can insure that adequate provisions are made for the use of these vehicles, and will be able to maintain this recreation activity as a complement to the total outdoor recreation picture."[282] This emphasis on the states' role is puzzling; the federal government administers 743.2 million acres of land, and all state lands together comprise less than half that amount.

The task force also foresaw the increasing use of privately developed facilities for ORV recreation. "It is gratifying to see the emphasis the private sector is placing upon accepting the challenge of providing a place for the motorized recreation vehicle."[283] In fact, no such private sector response has occurred, as already noted, because the private sector cannot compete with the free facilities provided by the public sector, especially public land managed by the BLM and Forest Service.

The task force was correct, however, about one development: the "indiscriminate free use" of private land by ORV drivers has declined, primarily because either private landowners and managers have enlisted the aid of local law enforcement agencies in keeping them off their land or they are now charging the ORVer for the use of their land.[284]

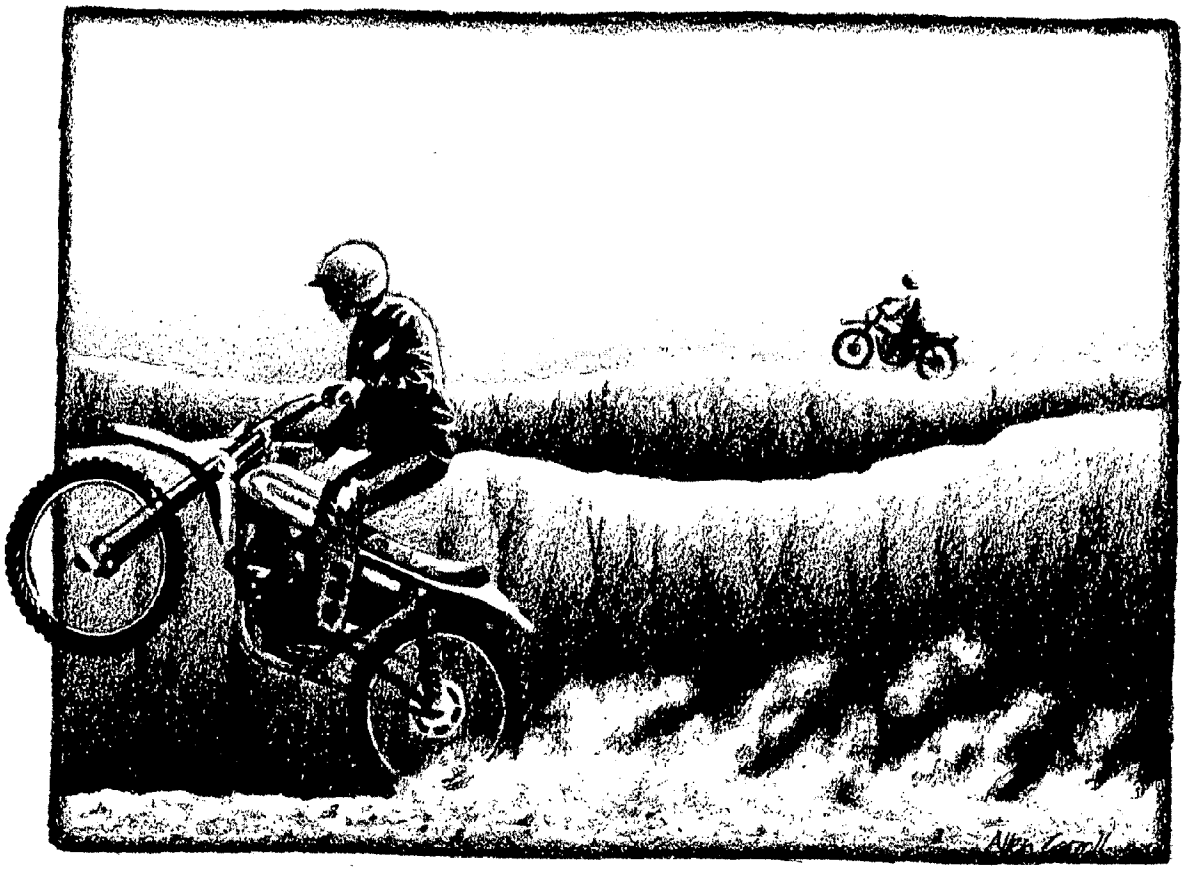
Lastly, the task force stated:

> Wilderness and primitive areas have been set aside to insure that some lands in the country would be preserved in their natural habitat and that peace and serenity would prevail and be available to the particular users that frequent such areas. By the same token, the off-road vehicle user deserves similar consideration as the backpacker in the selection of places to enjoy his outdoor endeavors.[285]

This statement, more than any other, reveals confusion in the Interior Department's thinking on public land use decisions.

First of all, backpackers' use of wilderness areas is secondary; the primary reason these areas were set aside is to preserve nature unimpaired for future generations.[286]

Secondly, the statement suggests that any time



a group of people develops an interest in a particular outdoor recreational pastime, the federal government is obliged to provide them public land on which to do it. If, for example, the power chain saw becomes a recreational tool, must the federal government provide RCSers (recreational chain sawers) with public trees and shrubs to cut down?

Although most land use decisions in the United States are commercial ones, i.e., they are governed by the profit motive, land use decisions on the public domain must by law take into account values which benefit all but provide profits to no one—aesthetic, wildlife, watershed, and scientific values.

Thirdly, the task force failed to distinguish between the consumptive use of a limited resource such as recreational land and relatively nonconsumptive uses (hiking, etc.). The relative scarcity of a public resource must be taken into account in making trade-offs. When it comes to meeting recreational needs, nondestructive uses of the land are more efficient. Moreover, consumptive use of the resource often precludes its use by the majority of recreationists and, in some cases, by future generations as well.

Despite these deficiencies, however, the Interior Department task force report did accomplish something—it points out the need for a broad federal policy on ORVs.[287] In February 1972, President Richard Nixon signed Executive Order 11644. (For the full text, see Appendix 1).

This Executive order provides a framework within which the various federal land management agencies could begin to cope with the ORV phenomenon in a systematic manner. It calls upon the agencies to designate specific areas and trails on public lands where ORVs will be permitted and areas and trails where they will not. It requires that the ORV areas and trails be located so as to minimize:

- damage to soil, watershed, vegetation, and other resources of the public's land;
- harassment of wildlife or disruption of wildlife habitats;
- conflicts between ORVs and other existing or proposed recreational uses of the same or neighboring public lands.

It also requires the agencies to "monitor the effects of the use of off-road vehicles on lands under their jurisdiction," and "[o]n the basis of the information gathered, they shall from time to time amend or rescind designations of areas or other actions taken pursuant to this order . . . ."

Executive Order 11644 prohibits ORV use in Wilderness Areas or Primitive Areas (except for official use—firefighting, law enforcement, etc.). And in regard to the National Park System, Natural Areas, or National Wildlife Refuges and Game Refuges, ORV trails are allowed "only if the respective agency head determines that off-road vehicle use in such locations will not adversely affect their natural, aesthetic, or scenic values."

BLM's Response

The process of designating areas or trails open or closed to ORV use is a laborious undertaking for an agency such as the BLM, which administers 474 million acres of public land. The task is compounded by the fact that almost no control over ORV uses was exercised prior to Executive Order 11644, and hence behavior patterns of millions of ORV recreationists had already become established. In addition, BLM has fewer men and women per acre than the other land management agencies.

In response to Executive Order 11644, the BLM issued land designation regulations in April 1974. These regulations were noteworthy in two respects. First, the BLM declared that all the lands under its stewardship would remain open to ORV use (with the exception of those few areas previously closed or restricted) until specific designations are made. In other words, the BLM regulations made the status quo official. Second, the BLM failed to set a date for completing the designation of its lands, as required by Executive Order 11644.

The proposed BLM regulations came under sharp attack from non-ORV users of the public land, especially environmentalists. Tom Stoel of the Natural Resources Defense Council, for example, wrote:

> BLM's action in waiting over a year to issue proposed regulations substantially less protective of the environment than Executive Order 11644 itself, without the slightest indication that the environmental impacts of alternative approaches have been weighed, makes a mockery of BLM's role as trustee for the public.[288]

The National Wildlife Federation, the nation's largest membership conservation organization, sued the Secretary of Interior for not complying with Executive Order 11644. In May 1975, the Federal District Court of the District of Columbia ruled that the BLM's regulations were in violation of Executive Order 11644 and directed BLM to issue regulations meeting the requirements of 11644 "after consideration of alternatives as required by the National Environmental Policy Act."[289]

In his decision, District Judge William B. Jones ruled that the BLM, by declaring its land open to ORV use while specific designations are made, had done more than maintain the status quo:

> [T]his designation, being an official governmental act, changes the character of the land use policy, tilting it in favor of ORV use. Future designations will not be made in the context of applying the required criteria to decide whether specific areas and trails should be opened or closed to ORV use. Instead, authorized officers will be required to employ the criteria in determining whether a specific area or trail's existing "open" status should be *changed* to "closed" or "restricted." This distinction creates a subtle, but nevertheless real, inertial presumption in favor of ORV use.[290]

Judge Jones also found that the BLM had "significantly diluted" the criteria detailed in Executive Order 11644. For example, where the Executive order directs that "[a]reas and trails shall be located to minimize damage to soil, watershed and vegetation or other resources of the public lands," the BLM regulations stated that designation will be based on "[t]he ability of the land . . . to withstand and sustain off-road vehicle impacts" and "[c]onsideration of the scenic qualities of the land, and its cultural, ecological and environmental values." Noting that the "Executive Order sets forth in unambiguous and mandatory language the criteria that are to be employed in the designation of areas and trails for use or non-use of ORVs," the Judge concluded that the BLM had "not adhered to them in their regulations."[291]

The court provided only limited guidance as to how the BLM should proceed. The Judge suggested that the plaintiff's proposal to "close BLM lands to off-road vehicles pending a review of specific areas" was "deficient" for the same reason that a blanket opening of the land was—it constituted designation without evaluation. Judge Jones added:

> At the very least, BLM lands could be left undesignated pending evaluation and designation. A variable time could be considered, *i.e.*, expedition of the review process. A variable

keyed to the areas themselves could be infused, *i.e.*, requiring consideration on a priority basis linked to the sensitivity of various areas to ORV use . . . . Another variable could be tied to ORV usage—considering first those lands most widely and heavily used by off-road vehicles. Numerous combinations of these variables are possible. Other variables or completely different reasonable alternatives probably exist.

The Court does not presume to dictate those alternatives which should or must be considered. It does find, however, that defendants have failed to study, develop and describe appropriate and reasonable alternatives to the recommended course of action and include those alternatives in their Final Environmental Statement.[292]

It took the Interior Department over a year to propose another plan for implementing Executive Order 11644. Under the new plan, the designation of all BLM lands in terms of ORV use or nonuse is to be completed by December 31, 1987; however, the "most critical geographical regions" are supposed to be designated by 1981. These include southern California, southern Nevada, western Arizona, central Utah, and selected parts of Alaska—areas which receive up to 60 percent of the ORV use of public lands, according to the Department of the Interior. Those areas not already designated closed or restricted are to remain "undesignated" until they are specifically designated. That means they are *de facto* open areas. Furthermore, "identified resource-sensitive lands" will be, where necessary, closed under authorized emergency procedures.[293]

The final Environmental Impact Statement, prepared by Interior's Heritage Conservation and Recreation Service, on this plan was released to the public on April 21, 1978—more than 5 years after Executive Order 11644 and almost 1 year after a new Executive Order, 11989, was issued on the subject.

A key element in implementing Executive Order 11644 is designating which lands are suitable for ORV use and which are not. The California Desert ORV Plan, issued on November 1, 1973, is the first attempt by the BLM to apply the designation process. The plan provides scant protection for the area's natural and cultural resources but abundant opportunities for ORV recreation.

It designates 3 percent of the National Resource Lands as "closed" to ORVs, 6 percent as "open," and the remainder as "restricted," which means that ORV drivers are supposed to stay on existing roads and trails.[294]

The major flaw in this scheme is that it does not take into account BLM's lack of presence in the field. A person can drive all day in the desert on a motorcycle or in a four-wheel drive vehicle and never see a BLM sign or enforcement officer. Indeed, the BLM has only slightly more than a dozen rangers to patrol 12 million acres of land. BLM exercised virtually no control over ORV use before 1974. Therefore, use patterns became established in the absence of controls; moreover, it was not until late 1976 that BLM employees gained statutory enforcement powers, comparable to those already held by Forest and Park Rangers. Prior to the passage of the Federal Land Policy and Management Act of 1976 (Public Law 94-579), sometimes referred to as the "BLM Organic Act," the BLM had to rely on local law enforcement officers to enforce its regulations.

For all of these reasons, the California Desert ORV Plan looks much different on the ground than it does on paper. According to a BLM staff estimate, about 15 percent of the public land in the desert—about 1.8 million acres—is completely open *de facto*.[295] In addition, less than 100 miles of the desert's 30,000 miles of mostly dirt roads have been closed to ORV use.[296] And ORV drivers riding these roads leave them to travel cross-country with impunity, regardless of whether the BLM has designated the land "restricted" or "closed." While the ORV Plan does protect some sensitive areas such as the northern portion of the Algodones dunes, it has wholly failed to stem the tide of ORV destruction of desert resources, as Dr. Stebbins and other scientists have made clear.

The Forest Service's Response

How has the Forest Service, steward of some 188 million acres of public land, implemented Executive Order 11644? In general, the Forest Service continued its traditional policy of allowing National Forests to remain open to ORV recreation unless designated closed.

In its instructions to Regional Foresters concerning the ORV planning process, the Washington office of the Forest Service stressed that "the legitimate use of ORVs on the National Forests is recognized as a valid recreation pursuit" and reiterated that "our basic philosophy is that National Forests . . . are open to the public for

all legitimate uses." Therefore, "restrictions and closures are to be used only as a last resort."[297]

Throughout the ORV planning process, a seemingly innocuous paragraph (2351.6) from the *Forest Service Manual* loomed very large and was frequently evoked:

> The marking of areas and trails is necessary for public identification. This can be accomplished either by marking areas and having restricted or prohibited use or by marking areas and trails that are open to off-road vehicle use. The recommended procedure is to mark those areas or trails having restricted or prohibited use.

The Forest Supervisor of Olympic National Forest in Washington, for example, was chided by his superior, the Regional Forester, for seeking to close the entire forest to "cross-country travel by motor vehicles," limiting ORVs to certain trails and roads. He was reminded that "restrictions and closures are to be used only as a last resort."[298]

To date, ORV plans have been completed for 150 of the nation's 154 National Forests. Some 40.7 million acres have been designated "closed" and 31.3 million "restricted" to specific vehicles or seasons of use; 115.9 million are open to ORV use.[299]

The Sierra Club and the California Native Plants Society have challenged the ORV plans for five California National Forests through the Forest Service's administrative appeal process. These include Lassen, Shasta-Trinity, Sequoia, Six Rivers, and Los Padres National Forests. As of this writing, the Forest Service has refused to hear the Los Padres appeal on procedural grounds, and it has considered the Sequoia appeal and rejected it; decisions are still pending in the other cases. Also, the Sierra Club appealed the ORV plans for the Rogue River National Forest in Oregon (decision pending) and the Santa Fe in New Mexico (ORV plan recalled). In addition, the Sierra Club and the Wilderness Society appealed the ORV plan for the four National Forests in North Carolina, but the Forest Service (specifically, the Chief of the Forest Service, John R. McGuire) has upheld the ORV plan.

Although the facts of each case are unique, there is a common thread that runs through each of the Sierra Club briefs: the Forest Service has failed to follow "any of the scientifically-recognized procedures" which are "necessary to an adequate assessment of the impact of ORV activity as required by the Multiple Use Act and the National Environmental Policy Act."[300]

In each of these disputed cases, the Forest Service performed an Environmental Analysis Report (EAR) on the ORV plan. The Forest Service justified not doing Environmental Impact Statements (EISs) on the grounds that, one, the ORV plans did not constitute a major federal action significantly affecting the environment since there was *no irreversible or irretrievable* commitment *of resources* and, two, the ORV plans were *not highly controversial.* Given the available data on the impact of ORVs on many different types of soils (a resource) and the voluminous literature on the reaction of nonmotorized recreationists to ORVs, these arguments are puzzling.

In addition, the city of Pocatello, Idaho, is challenging the Caribou National Forest ORV Plan on the grounds that it will endanger the water quality of its municipal watershed area.

No Forest Service ORV plans have been challenged by ORV interest groups.

In one case—the Wayne-Hoosier National Forest in southern Indiana—the ORV plan has been withdrawn by the Forest Service. The history of ORV use on this National Forest is an interesting one. ORV riding on the Wayne-Hoosier has occurred for years. But in the early 1970s, it became heavy and the Forest Service grew concerned because of the complaints from non-ORV recreationists and because of the effect on the environment of the area. So the Forest Service, with technical assistance from the American Motorcycle Association, designed a 168-mile trail system for the Forest and did an EIS on it. Using funds earmarked for road and highway construction, the Forest Service began building the system in June 1974. But in October of that year, the Indiana Izaak Walton League Endowment (later joined by the Indiana Conservation Council and the Sassafras Audubon Society) filed a suit in Federal Court against construction and use of the project. The plaintiffs charged that the Forest Service violated three federal laws governing National Forests—the Organic Act of 1897, the Weeks Law of 1911, and the Multiple Use-Sustained Yield Act of 1960. They also charged that the ORV plan was in violation of Executive Order 11644. In an unusual action, Forest Service employee Claude Ferguson filed an affidavit with the court in support of the suit. He charged that the trails were not being built according to the specifications set forth in the EIS and hence were unsafe to ride and environmentally unsound. The Court issued a temporary restraining order 48 hours before the planned opening of the first 17

miles of trail.[301] The Court, however, never rendered a final decision on the case because the federal government withdrew the ORV plan in 1977 before the case was tried. Today the Wayne-Hoosier remains closed to all ORVs, the only National Forest to be so. It is not known what the Forest Service plans next.

Soil erosion and wildlife harassment are the two principal ORV-related concerns of environmentalists in the Wayne-Hoosier case. Ironically, it was concern over soil erosion that first moved the federal government to begin purchasing land to put together this National Forest over 30 years ago under authority of the Weeks Act: "for the purpose of conserving the forests and the water supply." Soil erosion in the area was severe because the major soil type is loess, the rainfall is about 60 inches a year, and the terrain is rolling with many steep slopes and sinkholes. The Civilian Conservation Corps did considerable land reclamation work in the area—planting trees and building gully controls. In the past, ORV trails eroded badly after heavy rains—with trenches 6 inches deep forming on slopes as slight as 2 degrees. Wildlife-related improvements in the Forest, such as woods clearings and pond development, were paid for with funds collected from sporting equipment excise taxes—the Pittman-Robertson Program. The ORV trail system ran through or near many of these wildlife improvement areas.[302]

Dr. Wilshire has reviewed 62 Forest Service EARs done in conjunction with the proposed ORV plans for National Forests. He has found all but two of them "virtually worthless when it comes to assessing the impact of ORV use on soils due to their lack of specific criteria and data."[303] Commenting, for instance, on the ORV plan for the Sequoia National Forest, Wilshire notes:

> "Considerable," "minimal," and "excessive" are not criteria for damage. Criteria are, for example, centimeters of soil lost relative to the amount of soil originally present; productivity of residual soils compared to a specific standard (such as U.S.D.A.'s T values); centimeters of soil lost relative to soil regeneration rates; physical and chemical changes in the soil relative to accelerated erosion rates and altered water quality. Whether the damage incurred is considerable, minimal, or

excessive can be judged only by such criteria. The basic information needed to make these judgments, and others relating to plants, wildlife, and wildlife habitat, were not provided by the ORV plan or EAR nor were systems for monitoring adequately specified.[304]

In the case of the North Carolina forests, the Forest Service designates over half the area of these four forests as open to ORV use, specifically, 599,161 acres.[305] Yet data on the degree of slope, the hydrology, and the type of soils found within these 599,161 acres are not provided in the EAR. These are basic facts which will determine the severity of the ORVs' environmental impact. It is unclear whether the data are simply not known to the Forest Service or whether they were considered in the preparation of the EAR but not made available to the public. Moreover, the EAR continually refers to "ORV routes" when, in fact, "ORV areas" would be more accurate because cross-country ORV travel is quite possible in many of the locations open to ORV use.

In short, it is extremely difficult to evaluate the Forest Service EARs because of their vague terminology and inadequate data base. The ORV Plan for the Sequoia National Forest's 1.1 million acres designates 47 percent of the Forest as open to these vehicles. Indeed, the only areas within the Forest actually excluded from ORV use are those already prohibited by law (Wilderness Areas, National Scenic Trails, etc.). Is this decision based on something more concrete than "management experience"?[306] Is it based on a thorough inventory of the Forest's resources—soil, water, vegetation, and wildlife? Is it based on an objective analysis of the damage already done to these resources in 10 years of moderate to heavy ORV use of the Forest? The public has no way of knowing from this document. In fact, it appears that in drawing up its ORV Plans, the Forest Service may have simply legitimatized the status quo. That is, already existing ORV routes and areas were designated open, already prohibited areas were declared closed, and seldom used areas restricted—without a systematic analysis of present and future ORV impacts on the resources.

Other Federal Agencies

How have other federal land management agencies responded to Executive Order 11644?

Generally, they have taken an opposite approach from BLM and the Forest Service. They have declared their lands closed to ORVs unless specifically designated open.

The Department of Defense, for instance, administers about 26 million acres of land in the United States. It decided that all its lands and water "will be closed to off-road vehicle use, except those areas and trails specifically designated for such use in accordance with policies and procedures established for ORV use."[307] Areas are categorized as open to the general public for ORV use only if access and "manageable quotas" can be maintained.[308]

The Department of Defense decision was based on a number of factors. First, there was a realistic assessment of the ORV phenomenon: "Off-road vehicles are manufactured, advertised, sold and purchased within the concept that the purpose and sport of operating these vehicles lies in operation over rugged, undeveloped terrain. . . . Practically no area on Department of Defense land would be free from potential damage by ORV use."[309] Second, there was a fundamental understanding of the environmental consequences of ORV use: "Through soil erodibility appraisals, and evaluations of compaction and displacement hazards, areas that could suffer irreversible damage of long duration from machines can be identified. By identifying areas susceptible to such deterioration, damage could be minimized by prohibiting ORV use."[310] Finally, the Department of Defense took into account the management problems experienced by the BLM and Forest Service: "[U]se of these vehicles has reached such proportions, on other Federal agency lands, that some land managers charged with stewardship of the public resources are finding themselves in untenable positions as regards their primary responsibilities."[311]

This report focuses on BLM- and Forest Service-managed lands, i.e., the vast majority of public lands. The implementation of ORV policies on lands managed by agencies such as the Department of Defense, the Corps of Engineers, and the Bureau of Reclamation has not been analyzed. Overall, ORV use of these lands has generated less controversy than on BLM- and Forest Service-managed lands. (Some exceptions were noted earlier.) Certainly within the Interior Department, the Bureau of Reclamation, the Fish and Wildlife Service, and the National Park Service have made a smaller percentage of their lands available for ORV recreation than has the BLM.

Legislative Background

The guidance provided the land management agencies by the Congress has either been very general or has been ignored.

In 1974, the Congress passed Public Law 93-452, or the Sikes Act. The first part of this legislation concerns military reservations—fish and wildlife habitat improvement, range rehabilitation, and control of off-road vehicles. The oft-overlooked second part calls upon the Secretaries of Interior and Agriculture to "develop, in consultation with State agencies, a comprehensive plan for conservation and rehabilitation programs to be implemented on public land" under their jurisdiction. Each state may enter into a cooperative agreement with them to implement the conservation and rehabilitation objectives of the Act. In any such agreements, "the control of off-road vehicle traffic" is required. The Sikes Act represents the first official acknowledgment by the Congress that ORVs pose a special public land management problem.

(The Act does not apply to public lands in Nevada, Utah, Idaho, and Alaska.) There is no evidence, however, that the cooperative agreements between the states and the Departments of Agriculture and Interior consummated under this law have actually affected "the control" of ORV traffic.

The main body of the BLM Organic Act (1976), like the Multiple Use-Sustained Yield Act of 1960 after which it was patterned, contains no specific reference to ORVs. The Act declares that it is the policy of the United States that:

> the public lands be managed in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archeological values; that, where appropriate, will preserve and protect certain public lands in their natural condition; that will provide food and habitat for fish and wildlife and domestic animals; and that will provide for outdoor recreation and human occupancy and use . . . .

But, in the case of ORVs, the land management agencies have not been able to "provide for outdoor recreation" *and* to "protect the quality of" the various environmental and scientific values of specific public lands areas. Under the Act, the agencies are instructed to manage the public lands "on the basis of multiple use and sustained yield unless otherwise specified." Multiple use, however, is defined all-inclusively as:

> the management of the public lands and their various resource values so that they are utilized in the combination that will best meet the present and future needs of the American people; making the most judicious use of the land for some or all of these resources or related services over areas large enough to provide sufficient latitude for periodic adjustments in use to conform to changing needs and conditions; the use of some land for less than all of the resources; a combination of balanced and diverse resource uses that takes into account the long-term needs of future generations for renewable and nonrenewable resources, including, but not limited to, recreation, range, timber, minerals, watershed, wildlife and fish, and natural scenic, scientific, and historical values; and harmonious and coordinated management of the various resources without permanent impairment of the productivity of the land and the quality of the environment with consideration being given to the relative values of the resources and not necessarily to the combination of uses that will give the greatest economic return or the greatest unit output.

The Act does contain a section on the California Desert Conservation areas. It states that "the California desert environment is a total ecosystem that is extremely fragile, easily scarred, and slowly healed" and says:

> [T]he use of all California desert resources can and should be provided for in a multiple use and sustained yield management plan to conserve these resources for future generations, and to provide present and future use and enjoyment, particularly outdoor recreation uses, including the use, where appropriate, of off-road recreational vehicles.

The Congress, in other words, has not provided specific guidelines for settling the kinds of land use conflicts caused by ORV use.

Executive Order 11989—Controversy and Confusion

In March 1977, the Council on Environmental Quality (CEQ) circulated an issue paper on ORVs to various federal agencies. In it, CEQ proposed the following addition to Executive Order 11644:

> Each respective agency head shall be authorized to adopt the policy that all or portions of the public lands within its jurisdiction shall be closed to use by off-road vehicles except those areas and trails which are suitable and specifically designated as open to such use under subsection (a) . . . .

The purpose of the amendment was to make clear that the land management agencies had the

authority to close to ORV or snowmobile use as much land as necessary under their stewardship. A copy of the CEQ issue paper was given to William Jobe, an officer of ISIA. He, in turn, announced publicly that CEQ was seeking the ban of all ORVs (including snowmobiles) from all federal lands, thereby catapulting the ORV use on the public lands onto the national political stage.[312]

CEQ and the Interior Department issued denials that a total ban of ORV use was being contemplated, and the issue paper was released publicly but it was too late. By not releasing the issue paper publicly at the same time it was circulated to other agencies, CEQ fueled the worst suspicions of ORV and snowmobile enthusiasts. An uproar ensued. The Motorcycle Industry Council authorized $100,000 to generate protests. The American Motorcycle Association advanced $25,000 for mailings and hired a former Congressman to lobby against executive action on ORVs. The American Motors Corporation sent letters to Jeep owners asking them to write letters protesting the proposal. The ISIA urged its members to get snowmobile owners to protest.[313]

In all, the White House, Interior Department, and Forest Service received over 80,000 letters, telegrams, or other messages on the subject of ORVs on the public lands—78,000 of which favored the continuation of the lenient policy toward ORV use of the public land. Numerous inquiries also poured in from Congress.[314]

Nevertheless, President Carter's Environmental Message to Congress on May 23, 1977, did single out ORVs for special attention:

> While off-road vehicles provide enjoyment and recreation for many, their indiscriminate use poses a threat to our public lands. Uncontrolled, they have ruined fragile soils, harassed wildlife, and damaged unique archaeological sites.
>
> In 1972, federal agencies began to control the use of such vehicles on the public lands under Executive Order 11644. While these regulations have achieved some measure of protection for the soil, vegetation, and other values of the public lands, environmental damage has continued in certain areas. Accordingly, I am today amending this Executive Order to exclude off-road vehicles from certain portions of the public lands where their use has caused (or seems likely to cause) considerable environmental damage.[315]

Executive Order 11989 (see Appendix 1 for full text), signed by President Carter, adds a new section to Executive Order 11644. It requires that whenever a land management agency head "determines the use of off-road vehicles *will cause* or *is causing considerable adverse effects* on the soil, vegetation, wildlife, wildlife habitat or cultural or historic resources of particular areas or trails of the public lands," he must immediately close such areas or trails to the type of ORV causing the effects. (Emphasis added.) It also authorized each respective land management agency head "to adopt the policy that portions of the public lands within his jurisdiction shall be closed to use by off-road vehicles except those areas or trails which are suitable and specifically designated as open . . . ."

While Executive Order 11989 cleared away any lingering doubts about the responsibilities and authority of the land management agencies, it did not resolve the issue of ORV use of the public lands.

Two days after President Carter signed Executive Order 11989, the Interior Department issued a press release which raised questions about how the order would be carried out. (For full text, see Appendix 4.) Departing from the plain unambiguous language* of the order, the press release introduced qualifications. It said that "the new Executive Order governing off-road vehicles on Federal lands will be applied to fragile areas which are actually threatened with serious damage."[316]

The word "fragile," which does not appear in the Executive Order, gives the impression that ORV damage is highly localized. As noted earlier, the U.S. Geological Survey has found almost all arid and semiarid soils quite vulnerable to ORV destruction. Fish and Wildlife Service studies suggest that the same holds true for wildlife. In land use planning, the word "fragile" has come to mean unique or rare areas such as endangered species habitat or known archaeological sites.[317] But almost all lands are "fragile" when subjected to sustained ORV use.

The press release stressed the importance of the "voluntary actions of off-road vehicle users, who . . . could prevent many problems by respect for land and its resources."

The point has already been made that ORVs have done considerable damage to every kind of

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*The one key word in the Executive order open to widespread interpretation is "considerable" in the "will or is causing considerable adverse effects" sentence and, as F. Leroy Boyd, Associate Deputy Chief of the Forest Service, points out: "There is no direction from the White House or the Council on Environmental Quality as to what constitutes 'considerable adverse effects.' " (Memorandum to Regional Foresters, July 28, 1977)

ecosystem found on the public land not, in the main, because the drivers are irresponsible but because their machines are inherently destructive.

The press release went on to say that "there is no new broad grant of authority to close off large blocks of land . . . . The agency head can close off 'portions' of the lands his agency manages, and we interpret that to mean limited areas."

The Executive order does not limit the size of areas to be closed. It says, in effect, that the agency heads must do what is necessary to protect the public's resources on "particular areas or trails." If ORV use will cause or is causing "considerable adverse effects" in a particular area, be it portion-sized, whatever that is exactly, or large block-sized, the land management agency has a responsibility to close that area to ORV use.

In the next paragraph, the public is assured that the Interior Department "will continue to protect the resources of the lands it manages, using its authority at times and places where it becomes necessary."

Yet under the Interior Department's care perhaps 1 million acres of land in the California Desert have been orphaned. Is it reassuring to hear that the same level of protection against ORV damage will continue in the future?

Then the press release expressed the hope that "user groups and the industries producing off-road vehicles would take part in public discussions leading to planning the uses of federal lands, educate their members about the issues, develop and enforce good codes of conduct, and cooperate with federal land managers on the ground."

The fact is that most ORVs are promoted and sold by the industry on the basis of their ability to break new ground across wild land, to scale steep slopes, to ford natural streams—all of which can be ruinous to the environment.

ORVs are impairing many people's enjoyment of the outdoors on public lands, and they have already done irreparable harm to some public resources. These facts are not acknowledged in the Interior Department's statement, nor is there much indication of how the federal government intends to bring the ORV phenomenon under control on the public lands.

Several federal land management agency officials voiced the opinion to this author that the Interior Department press release was a signal to go easy in the implementation of Executive Order 11989. Whether true or not, that is how many persons inside and out of the government seem to have interpreted the press release. As one Interior Department employee noted: "This issue is a political hornet's nest. The Executive Order refers to '*considerable* adverse effects,' that's the operative phrase, but what does it mean really? You can bet the BLM and Forest Service are going to interpret it very narrowly until they get clear signals to the contrary. In other words, not much has changed."[318]

Joe Thomas, attorney for the National Wildlife Federation, was even blunter: "It looks like this Administration has decided not to do much about the ORV problem. That outpouring of protests over the fake ORV ban story gave them a political scare."[319]

Have the Executive Orders Been Implemented?

In 1971 the Interior Department task force observed: "[L]ittle if any structured and coordinated monitoring of environmental impacts has been undertaken."[320] In 1972, as noted, the Executive order required land management agencies to "monitor the effects of the use of off-road vehicles on lands under their jurisdictions." In 1977, the Interior Department said: "Unfortunately, hard documented evidence of ORV impacts is not in voluminous supply. . . . Allegations or opinions concerning the effects of ORVs, pro or con, are readily available; documentation is not."[321] But if the public land management agencies have been monitoring ORV effects since 1972 as required, why is there such a paucity of hard evidence today? When asked this question, Len Shaw, coordinator for the Department of Interior's EIS on implementation of Executive Order 11644, replied: "I don't think the land management agencies have done much monitoring, unless you consider casual observation monitoring. A more systematic study is needed."[322]

Actually, a considerable body of facts has been unearthed concerning ORV environmental effects. It is true, however, that the "monitoring" efforts of the BLM and Forest Service have yielded very little. Most of the facts now available have been gathered by other government agencies, especially the Geological Survey and the Fish and Wildlife Service, or by nongovern-

mental scientists such as Wanek, Cohen, Stebbins, etc. In a few cases, land management agencies have sponsored outside studies—for example, the National Park Service funded research on the impact of ORVs upon Cape Cod dune vegetation.

Both the Interior Department and the Forest Service are reluctant to extrapolate from the fact-based conclusions reached in one area, say, for example, the semiarid Panoche Hills, and apply them to another area which has not yet been studied. Of course, no two areas are exactly alike, but the ORV effects on a sufficient variety of vegetation, terrain, and soil types have been examined to apply in the management of similar areas. The Interior Department insists that the great bulk of the existing studies refer to narrow classes of off-road vehicles in specific kinds of situations.[323] And in responding to the appeals of the Forest ORV Plans, the Regional Foresters have argued that the evidence of ORV environmental impacts does not apply to nonstudy sites. Unquestionably, the site-specific approach is an effective one. But when carried to the extreme of refusing to draw reasonable deductions derived from the scientifically observed ORV experience at other similar sites, it becomes absurd. For then each site on the public land must be affected by ORVs and those effects must be recorded and analyzed before the land management agency can act to protect the site. By that time, of course, it may be too late.

The Interior Department and Forest Service's reluctance to apply the available facts may arise in part at least from a reluctance to take actions which are necessary to protect public resources but would cause all manner of political headaches.

Dr. Stebbins has observed from first-hand experience that "the political and economic power of the ORV interests is sufficiently great to exert strong pressures on public agencies. The general public, unorganized and with varied interests, speaks in a weak voice."[324]

In late 1976, 18 specialists with the BLM in California charged their agency with catering to special interests. In a remarkably candid and eloquent memorandum, they said:

> Our discontent derives from our belief that in the management of California Desert lands the Bureau has not kept faith with the American public, whom it is charged to serve, but has often served itself and special interests. This organizational self-aggrandizement and special-interest catering has had serious effects upon fragile desert resources . . . . In the California Desert stockmen and off-road vehicle recreationists elicit special considerations which are excessive in terms of resources degraded or lost, expenditures of Bureau effort, services foregone to other programs and other desert users.[325]

The BLM investigated the charges made by its 18 employees and found a communications problem between management and staff but no evidence of "improper actions" in the relationship of BLM management to ORV groups.[326]

"Improper actions" suggests corruption—the co-option of civil servants by interest groups through nefarious means. But something far less sinister is likely. In many areas, legitimate ORV interest groups exercise their constitutional right to petition the government with great vigor. For the public land manager, who is on the receiving end, this means aggravation—answering congressional inquiries, writing special reports to superiors, and responding to a barrage of citizen protests. Perhaps it is because the land managers are seeking to avoid such aggravations that the BLM has not acted to prevent further damage to Dove Springs Canyon, for example, or the Forest Service has not taken the action necessary to prevent further serious erosion in the La Panza-Pozo region of Los Padres National Forest or the ruin of the meadows near Mount Eddy. Limited resources, of course, could be another reason.

Recreational specialist Dr. Diana Dunn sees the land manager-ORV relationship in sequential terms—she calls it the "Dismal Cycle":

First, ORV sales produce a small, identifiable group of owners of a particular vehicle and they share one common problem: no land of their own.

Two, the ORV owners begin to use public or private land, with or without permission.

Three, the group grows, damage occurs, and initial conflict develops.

Four, either (A) users are prohibited completely and no alternative site is offered (return to two), or (B) some informal agreement is reached, usually with public land managers.

Five, the existence of an approved site is publicized by the users (to friends) and by vehicle dealers (to potential customers): more sales, more users.

Six, "bad apples" emerge to jeopardize the initial agreement; conservationists, neighbors, other non-ORV users form a coalition which forces a "shotgun wedding" between recreation vehicle users and the manager. More sales, more users, and more outsiders begin to come.

Ballinger Canyon, Los Padres National Forest, California

Seven, "self-organization and policing" as well as explicit management controls are initiated. Subtle co-optation of a public agency has occurred, and the manager feels compelled to make the "marriage" work.

Eight, publicity about favorable features is distributed; *equilibrium* is attained; more sales, more users.

Nine, too many "bad apples," too much damage, too few "police," and the *saturation point* is reached. The anticoalition reactivates. A "final straw" event occurs.

Ten, the manager declares total elimination of ORVs from the area. If alternate site is offered, go to four-B, if not, go to two and repeat cycle.

Dr. Dunn maintains that "camelot-like claims" for any particular ORV-approved site, say, for example, the TVA's Turkey Creek area, occur only because the cycle is at the *equilibrium* state.[327]

This analysis provides an extremely useful view of the evolution of ORV use of public lands, although the real world may not fit the pattern exactly. For instance, the BLM and Forest Service land managers have proven very reluctant to take step ten. The Interior Department offers this explanation: "[I]t may be wiser to designate areas already severely degraded by vehicle use as 'sacrifice areas' where concentrated ORV use would be accommodated—rather than to attempt rehabilitation. Pressure on less severely impacted areas would thus be relieved."[328] The trouble with this position is that it treats a dynamic phenomenon as if it were static. The ruin of Ballinger Canyon or Hungry Valley, for example, is progressive—the acres of land being damaged are constantly increasing. ORV drivers are restless, always searching for new areas to ride. Therefore, the "sacrifice areas" are ever expanding. In addition, this approach is contrary to Executive Order 11989, which requires the public land manager to close an area when ORVs are "causing or will cause considerable adverse effects . . . ." It is clear that this order has not, for

the most part, been enforced by BLM or the Forest Service in the western United States; the justification cited most frequently is that "if we close this area, they (the ORVers) will just go somewhere else," to quote a BLM ranger, and under current land management policies, he is right.[329]

To summarize, Executive Orders 11644 and 11989 have been poorly implemented by the major land management agencies; hence ORV environmental damage and impairment of other recreationists' enjoyment of the resources are still out of control.

THE STATES' RESPONSE

> The competition for use of public lands and recreation facilities has become very keen.[330]
>
> Robert Rasor, American Motorcyclist Association (AMA), 1977

Over the past 10 years, state legislatures have enacted a multitude of laws governing ORV and snowmobile use.

New Hampshire, for a more or less typical example, now has six statutes affecting snowmobiles. The state law requires snowmobile owners to pay a $9 per year registration fee ($15 per year for out-of-staters). And under New Hampshire law, snowmobiles must have an "efficient" muffler and they must meet specific noise emission standards: 82 dBA or less at 50 feet; after September 1978 it drops to 73 dBA and in 1983 to 70 dBA. Among other things, New Hampshire law forbids use of snowmobiles within 150 feet of ice fishermen, and it provides landowners with liability protection against snowmobiles. Of the funds collected from registration fees, 45 percent are earmarked for use by the Bureau of Off-Highway Recreational Vehicles, 40 percent for the Fish and Game Department, and 15 percent for the Department of Safety. The state makes grants-in-aid to local governments and to ORV clubs for the construction and maintenance of snowmobile trails.[331]

California, in common with five other states, uses a fraction of its state gasoline tax revenues for ORV facilities. The difficulty with this approach is estimating how much fuel is actually used in off-road driving, to determine the ORV owners' fair share of the revenues. The state of California, where unregistered ORVs outnumber registered ORVs by perhaps two to one, is spending over $200,000 surveying ORV users to obtain their estimated gasoline consumption.[332] The state is using most of the ORV gasoline tax funds to acquire Off-Road Vehicle Recreational Parks such as the previously mentioned Hollister Hills.

In general, most states now require registration of ORV and snowmobile vehicles (minibikes are the major exception), and many states now have maximum sound level standards. Other measures to manage ORV use on state-owned lands differ widely and no attempt will be made here to catalogue them all. Instead, two very different—but apparently successful—approaches will be examined.

The state of Washington has probably done as much as any state to accommodate ORV users on its state lands. Under the state's Off-Road Vehicle Act of 1969, the Department of Natural Resources has developed ORV facilities at several sites. These include developed trailheads, camping, sanitation, picnic facilities, and trails built especially for the ORV recreationist, especially trail bikers. Robert Rasor of the AMA thinks that Washington has "the most progressive state-level approach to off-road motorcycling in the United States."[333]

Cross-country ORV or snowmobile travel is generally prohibited on the state's 5 million acres of land—vehicles must stay on designated roads or trails. The state does, however, provide facilities, such as abandoned gravel pits, for those ORVers seeking to "bust loose and drive wide open." For the most part, the ORV routes are either old logging roads which have been cleared or specially constructed trails. The cost of constructing ORV trails varies from $3,000 to $18,000 per mile. Construction costs have been paid for by state bond issues, ORV permit fees, and gasoline tax revenues. Maintenance is paid for by the permit fees and gas tax revenues. Under this program, hundreds of miles of ORV trails are provided by the state and paid for mainly by the ORV recreationists. Snowmobilers are allowed to use the 13,000 miles of roads on state lands.[334]

Unlike TVA's Turkey Creek ORV area, Washington does not operate a monitoring system to measure the ongoing environmental effects of ORV use. "Frankly, we haven't thought

it necessary," said Joseph Wernex, ORV supervisor for the state's Department of Natural Resources, "because we haven't seen any great adverse effects." Wernex also notes that conflicts with nonmotorized recreationists have not been a serious problem. The state also provides separate trails for hikers.

Wernex attributes the success of Washington's ORV program to a number of factors, including adequate funding, the close cooperation of ORV organizations, and the environment itself—"Many of our ORV routes are in heavy rainfall areas where vegetation recovers and grows back rapidly." Overall, however, Wernex believes that management is the key. "You have to manage recreation. You cannot let the motorized recreationist be the exclusive chooser of his terrain. You must disperse use so ORVers and other forest users are not meeting each other around every corner. You must try to keep the intensity of use on any one trail down because beyond a certain level the quality of the recreational experience diminishes for everyone—ORVers, hikers, horseback riders." He adds that through trial and error the state has learned to design ORV trails so as to minimize environmental damage, especially soil erosion. "The first trail I designed 7 years ago is a mess. Today, we know what to look for. The volume and velocity of surface water runoff are crucial, for example. We try to minimize their impact by changing trail grades, building culverts, and so on. We bypass very vulnerable soil types or, where necessary, surface soft spots with crushed rock. You have to be particularly careful in designing and building four-wheel drive vehicle trails because those machines are harder on the land." The state also closes trails on a seasonal basis. "For example, a clay-soil trail on a steep grade will be closed during spring thaw."

Wernex thinks that the state needs to do a better job of managing ORV noise on its land. "We need to develop field tests for ORVs that are quick and will stand up in court. It's really our job to identify the unmuffled or poorly muffled machine and get it off the land."[335]

The Washington ORV experience is certainly a hopeful one. But before it is adopted as a model, a scientific assessment of ORV environmental impacts, especially on wildlife, soils, and water quality, is needed to test the evidence gathered through observation. A thorough survey of the recreationists using state lands (motorized and nonmotorized alike) to determine their views would also be useful.

Indiana, on the other hand, has banned ORVs from all state lands since late 1972. The decision was based on an 8-month study of ORV use by the Department of Natural Resources.[336] (The study included snowmobiles in the term "ORV," but its major focus was upon off-road vehicles which come in direct contact with the land.) The study is distinguished by its clarity and directness. In contrast with the Interior Department's task force study done a year earlier, the Indiana study pointed out that "it is very difficult for the private entrepreneur to compete with a public agency which builds its facilities (for ORVs) with tax money and charges only minimal user fees."[337]

Indiana also faced squarely the problem of enforcing ORV regulations, something the federal government has yet to do. (In responding to comments on its plan to implement Executive Order 11644, the Interior Department declined to elaborate specifically about whether the plan could be enforced, stating that "[e]nforcement will depend on levels of funding and manpower . . . of each land-managing agency.")[338]

In its study, the Indiana Department of Natural Resources asked its land managers whether they had the personnel necessary for additional ORV supervision and maintenance. (At the time, ORV use on almost all state lands was restricted to established roads and parking lots—although over half the managers reported violations of these rules by ORVers.) Forty-six said they did not, four said they did, and one did not respond. Asked the same question, 76 enforcement officers said they did not, 17 said they did, and 20 did not respond. In addition, many state land managers indicated that they would also need more equipment if ORV activities were expanded on their areas.[339]

The Department of Natural Resources concluded that it simply did not have the personnel to supervise or maintain ORV trails or areas on its lands: "Maintenance of quality in recreational environment is related closely to constant and efficient management of all facilities. Poor maintenance, whether in high-use areas or in natural settings, encourages further vandalism, litter, and the destruction of many native plants . . . ."[340]

The on-the-ground observations of the land managers were sought concerning the environmental effects of ORV use. They were asked the types of environmental damage which they attributed directly to ORV use on state lands. Noise pollution was first on their list, followed closely by wildlife harassment, vegetation damage, and

soil erosion.[341] After considering this evidence and surveying the available scientific literature on the subject, the Department concluded that "[t]here are many documented types of harmful environmental impact . . . [that result from] ORV activities."[342] It stressed the long-range effects of ORV-caused soil erosion on vegetation, surface water quality, and on groundwater supply, which leads to abnormal watershed wear and tear.[343] The impact of ORV noise upon wildlife was also cited as an important consideration:

Some of life's functions are dependent on quietness. Many animals and birds depend upon it to find their mates, and to protect themselves from attack. Some embryos still in the egg communicate with siblings in adjacent eggs and synchronize their hatching. Some birds lean down to the ground to listen for a worm. The radar of bats, the trilling of toads, and the prolonged symphonies of thrushes can be affected if their home range is invaded by man-made noise.

It is known that the pileated woodpecker, the broad-winged hawk, Cooper's hawk, sharp skinned hawk, great horned owl, and barred owl are very sensitive to sound disturbances. These species are thought to be extremely important to the stability of complex systems because of their effect in regulating the overall energy and material processing of the system.[344]

"[T]he real problem," the Department of Natural Resources noted, "is how to find a suitable riding place where this activity can be enjoyed without greatly affecting the natural resources of the area, if such a place exists."[345]

What about the compatibility of ORV use with other forms of recreation? Of the state's 51 land managers, 43 expressed the view that ORV activities would be incompatible with other activities already being enjoyed, such as hunting, fishing, camping, hiking, canoeing, swimming, picnicking, and horseback riding.[346] "Because of [ORVs'] speed, range, and versatility, these vehicles can quickly dominate a large acreage since competition of recreation uses is inherently unequal."[347]

The Department of Natural Resources concluded:

ORV riding can be a form of recreation, but it is only one of many types of outdoor recreation demands on the Department's properties. Since ORV use is incompatible with a wide majority of other recreation activities, entirely separate riding lands would have to be set aside for this activity. The promotion of ORV riding at the expense of the established recreation activities does not make the most judicious use of the Department's land.[348]

Ever since, Indiana's 267,752 acres of state land have remained closed to ORV use. The state is, however, using snowmobile registration fees to lease private lands (at $2 per acre) for snowmobile trails. "This fulfills our obligation to the citizens of Indiana and at the same time allows use to adhere to our policy as stated in the 1972 report," notes John T. Costello, deputy director of the state's Department of Natural Resources.[349]

WHAT IS TO BE DONE?

The off-road-vehicle mania would be pitiable if its adherents were not so skillful at ravaging landscapes. Try as we might, we cannot think of a single function these diabolical creations serve—beyond a kind of noisy restlessness.[350]

Editorial,
The Washington Star, 1977

To believe and hope that the off-road movement is simply a passing fad is as blind as it is silly. When men, women, and children have sunk their hard-earned wages and allowances into a dirt machine, it's highly unlikely that even strict legislation will keep them from enjoying both their investment and their hobbies. Had the legislation been enacted a few years sooner, it might have come off, but it's now much too late.[351]

Thierry Sagnier,
Motorcyclist and author, 1974

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 has ever created. I don't think the Forest Service should encourage the use of these vehicles by even suggesting areas they can travel in . . . . I have often felt that these vehicles have been Japan's way of getting even with us.[352]

Senator Barry Goldwater, 1973

[W]e object to the continual enhancement of non-ORV recreation at the expense of the off-road vehicle enthusiast. We do not feel that all compromises should be made at the expense of off-road motorcyclists.[353]

Robert Rasor, AMA, 1976

H.L. Mencken wrote: "For every problem there is a solution—simple, neat and wrong." For those not familiar with the sport of snowmobiling . . . , it is quite possible to reach conclusions and solutions that are "simple, neat, and wrong."[354]

M.B. Doyle, President,
International Snowmobile
Industry Association, 1976

The Society of American Foresters recommends that public agencies and private landowners make use of their authority to insure the proper use of off-road vehicles. In order that control be effective, *off-road vehicles should be allowed only on forest roads, trails and areas, either new or existing, which are explicitly designated for such use.* Experience shows this approach to be less costly and easier to enforce than a restriction in which off-road vehicles are allowed on all forest roads, trails, and areas except where designated to the contrary.[355]

Society of American Foresters, 1978

What really concerned me is that the same mistakes are not made in recreation as were made in range management. In the history of range management, control of livestock numbers or intensity of use came after vegetation and soil destruction. I suspect you will agree that a history of range land use is already repeating itself in modern recreational problems.[356]

Dr. Harold Heady
University of California and
adviser to BLM

There are approximately 120,000 visitor days of motorcycle use each year on lands we administer in New Mexico (13 million acres). Use by other forms of ORVs, such as jeeps and pick-ups, constitutes an additional 115,000 visitor days. This unregulated use has caused conflicts with other land uses which we have not been able to control with our existing limited staff.[357]

Arthur W. Zimmerman,
BLM State Director for
New Mexico, 1978

(1) Recognize Magnitude of Enforcement Problem

First and foremost, the federal government must recognize the magnitude of the problem, especially as it affects enforcement of regulations. It is not enough to publish maps which show areas open to ORVs in white, areas "restricted" in yellow, and areas "closed" in red. The public land management agency must be able to enforce these designations. To announce ORV restrictions which are unenforceable under current personnel and resource conditions merely gives the illusion of control. If a public land management agency cannot increase its personnel and resources either because of budget restraints imposed by the executive branch or because Congress will not appropriate the funds, then it must adapt its regulations to fit its enforcement capabilities. In the opinion of many land managers, it takes a greater effort to enforce the open-unless-designated-closed approach than the closed-unless-designated-open. However, the latter approach is no panacea. To close a large area to ORVs, especially if it has been previously used by them, requires a presence in the field. If the land management agencies adapt their ORV regulations to their enforcement capabilities and are still unable to control ORV environmental damage and conflict with other users, then the agencies should publicly acknowledge the dilemma. If Congress or the executive branch chooses to accept the damage instead of providing the resources for adequate enforcement, that fact should not be obscured. The public ought to know what the choice is, who made it, and why.

The U.S. Geological Survey points out:

The interaction of vehicles and soils is a physical phenomenon that does not distinguish lawful from unlawful or proper from improper use. In the San Francisco Bay area, more than 80 ORV sites are being monitored, of which about 75 are used in trespass. The condition of the land is no different in the lawfully used areas than in the areas used in trespass. The adverse impacts, therefore, will generally reflect only the vehicle load and cannot be predicted to be light merely because the use is not sanctioned.[358]

Thus enforcement is indissolubly linked to plans for protection. When the Interior Department refuses to discuss in the EIS how its plan for implementing Executive Order 11644 will be enforced, the omission is crucial. Nor does it make sense for the Forest Service to designate 599,161 acres on the four National Forests in North Carolina as open and 543,193 acres closed, and then to add that "[f]unding for the purpose of law enforcement, trail reconstruction, and/or maintenance is not expected to increase considerably beyond the present token level during the time frame for which this management direction was developed (1985)."[359] It is no wonder that one district ranger (Bob Carey, Unharrie National Forest) observed that the ORV plan is "inadequate and offers practically no control at all." How can the Forest Service keep ORV riding, an increasingly popular sport in North Carolina—especially four-wheel drive vehicles—out of "closed" areas and on designated "routes" in open areas with only "token level" funding?

There is abundant evidence that the BLM and Forest Service's past efforts to control ORV use, even though not very extensive, have run into severe enforcement problems. Some examples have already been cited. There are many others, such as the Barstow-to-Las Vegas motorcycle

race. Held for many years on the Saturday after Thanksgiving across National Resource Land, this event attracted as many as 3,000 motorcyclists. In 1974, before the eighth race, the BLM did an EIS on the event.[360] Although the EIS provided considerable evidence of adverse environmental effects, including damage of historical or cultural resources, the BLM permitted the race to be held that year. An Evaluation Report done afterwards by the BLM showed that the EIS had, if anything, underestimated the damage.[361] Thereafter, the BLM refused to issue a permit for the race. This, however, has not deterred some motorcyclists. Consider the following account in *Cycle World* of the 1977 "unorganized" Barstow-to-Las Vegas motorcycle race across BLM land:

> Once again our semi-legendary friend, the Phantom Duck of the Desert, has pulled it off: The annual unorganized trail ride from Barstow, California to Las Vegas, Nevada took place without major incident, or harassment . . . .
>
> [W]hen the Barstow-to-Las Vegas race, formerly the best and most famous of the desert races, was shut down because the BLM denied the use permit, the Duck didn't give up. He decided that every year there would be a ride across the desert, using public land already open for riding. The ride isn't organized because while there's no rule against motorcycles, there are firm rules against motorcycle events, which is how the race was stopped in the first place. So. Although there was no organization, there were volunteers to mark the trail. There were maps. There were reminders to close gates where the ride went across land owned by friendly ranchers. There was a Jeep riding sweep (and handy it was, too. We picked up one guy who'd fallen . . . .)
>
> About 200 people, all ages and equipment and experience, rode the 130 miles. At the site of the former finish line, there was good spirits, even finisher pins. . . .
>
> The Duck has his detractors. There weren't many serious racers on the ride. Some of the racing clubs in the area believe that riding the old course will offend BLM. They schedule races elsewhere on the day of the ride to keep people away.
>
> We don't agree. . . .
>
> Because the ride isn't organized one cannot issue invitations to it. But in case any readers have their bikes east of Harvard Road on the north side of Interstate 15 about 8 a.m. on the Saturday after Thanksgiving, why, you're probably riding the same direction we are, so let's go riding together. . . .[362]

A chronic problem for the BLM is its lack of presence in the field. In this regard, the BLM Organic Act of 1976 has changed very little. Only in the California Desert does the BLM now have rangers (14) who regularly patrol the land. (As of this writing, these desert rangers have relied on persuasion to enforce ORV and other regulations; if need be, however, they can initiate

criminal action against any persons who persist in violating the regulations after being notified that they are committing an offense.) On all other BLM lands, the agency still depends on its periodic meeting with the public (either in the field or elsewhere) to encourage compliance with its regulations. If further action against a specific violator is necessary, the BLM calls upon local law enforcement authorities. Whether they respond depends on a variety of factors such as their available manpower and the nature of the offense, i.e., does the local law enforcement agency consider it serious?

The continued growth of the ORV phenomenon adds to the enforcement problem. ORVs may not be multiplying as rapidly as in the 1965-72 period, but they are definitely still increasing. Public lands within a day's drive of high population growth areas in the Sunbelt and Rocky Mountain states can expect a flood of ORVs.

Recall, however, that the Interior Department has set 1987 as the final deadline for designating all BLM lands closed or open to ORVs. In his review of the EIS, James R. Huntoon, Director of the Bureau of Environmental Impact for Wisconsin's Department of Natural Resources, charges: "Rather than seeking the monetary and manpower resources necessary to achieve effective compliance, the BLM has decided to limp along for the next ten years doing the very least the court decided it could accept."[363]

Several other reviewers of the EIS found BLM's designation process too slow, even allowing for the earlier 1981 deadline set for some heavy use areas. Vernon E. Robinson, Chief, Environmental Relations, Louisiana Forestry Commission, for example, noted:

> This is an unsatisfactory solution, since within five years, it is possible that the life support systems of many acres of BLM forest lands could be so altered and damaged that there would be no potential for recovery within reasonable periods of time.[364]

A similar fate could overtake BLM desert, brush, and grasslands before BLM's land designation process is finished. On the other hand, the Forest Service's designation process is practically complete; yet ORV damage in places like the La Panza-Pozo region of Los Padres National Forest continues to spread, which means that the Forest Service's designation process is not giving adequate protection to the land under its care.

(2) Determine How Public Wants Land Used

A second important step in the control of the phenomenon is to find out how the American people want their land managed. Public land use decisions cannot be based solely on the latest public opinion polls. Public opinion can be quite transitory and sometimes the public wants conflicting things. The government needs to take a longer view and manage the land so that future generations of Americans can use the resources as well. But polls can provide useful information for consideration during decisionmaking when conflicting uses are at issue.

To date, neither the Forest Service nor the BLM has taken a systematic reading nationally of how the public wishes to see the public lands managed relative to conflicting recreational uses. The BLM did, however, commission a national opinion poll on management of the California Desert. The results of this Gallup Poll, released in January of this year, showed that 81 percent of the people who responded wanted *more* protection of wildlife and the ecology; 73 percent wanted more scenery and natural character protection; 67 percent more historical and archaeological site protection. Only 23 percent wanted more places for off-road vehicles. Forty-six percent wanted *fewer* places for ORVs.[365]

In its analysis of the results of the poll, the Gallup Organization noted:

> The prevalent attitude among those interviewed is support for the type of land use that would preserve the natural environment. This sentiment is held by a majority of people regardless of their sex and socio-economic background, and regardless of the region of the country in which they live.[366]

In terms of income, the greatest opposition to ORVs came, interestingly enough, from households with an annual income of $7,000 to $9,-999.[367]

The results of this poll are sufficiently illuminating to encourage doing more in order to learn how Americans want the National Forests and other National Resource Lands managed. This is not to suggest that *all* public land should be given over to the uses favored by the majority of citizens. Rather, the results of a national poll on recreational uses of the land could be used to indicate whether the amount of land provided for a given pursuit, ORV riding, for example, is proportionate to public support for that pursuit.

BLM also sponsored a poll among Californians. It revealed that 45 percent of the state's adults visited the desert in the past year. The most popular recreational activities were sightseeing and camping, followed by picnicking, fishing, photography, hiking. Twenty-one percent expressed interest in motorcycle riding, 9 percent in dune buggy driving, and 7 percent in four-wheel drive vehicle driving.[368] In addition, the great majority of Californians surveyed are united in wanting *more* protection of desert environmental and archaeological resources. And a majority of those with an opinion disapprove of open areas for ORVs.[369]

A Forest Service survey in the midlands area (Illinois and Indiana) revealed considerable opposition to motorized recreation on the National Forests among both the general public and Forest Service employees. Some 58 percent of the public opposed motorized use of National Forest trails while 20 percent were in favor. Sixty-six percent of the Forest Service employees opposed motorized use of the trails and 6 percent favored it. The National Forests of this area are the Shawnee and the Hoosier.[370]

(3) Stiffen the Federal Land Managers' Backbones

From the vantage point of the public land manager, the ORV issue looks tumultuous. A Forest Service issue paper observes:

> Highly vocal factions have developed. On one side, the snowmobilers, cyclists, and four-wheel drivers react when any attempt is made to restrict their activities or use of the land. On the other side are those who dislike any form of motorized recreation and protest attempts to provide opportunities for this leisure time activity.
>
> Administrators of public lands are in the middle of this controversy in carrying out their management duties.[371]

This reaction is natural, but one wonders whether the sound and fury of competing user groups sometimes drown out the interests of the general public. The loudest voice does not necessarily represent the greatest good for the greatest number. The land management agencies are supposed to manage these lands for all Americans—not just those who happen to live in the vicinity of a particular area but for everyone, even those who will never set foot on the land. On the deserts (BLM) and National Forests of the West, the interests of all the citizens, who own these lands, seem to have given way to the vociferous demands of a minority.

To manage the public land fairly is exceptionally difficult and is getting more so every day as the resources grow scarcer and the competition among different users mounts. The lengthy definition of multiple use cited earlier gives some idea of the complexity of the task facing the public land management agencies.

Conflict means aggravation for public land managers. They can and should try to alleviate conflict through seeking the views of people outside the government before reaching final land use decisions. Still, there is inevitably going to be conflict, and if the public land managers are fulfilling their responsibility to the public, as trustees of its resources, they are bound to be unpopular with someone. In the past 20 years the Forest Service has toughened its control over lumber companies who are using public resources; so has the BLM in its management of grazing rights. The time has come for a tougher approach in dealing with ORV recreation, too.

(4) Separate Motorized Recreation from Other Uses

More specifically, Executive Orders 11644 and 11989 form a sound basis for action. The BLM and Forest Service should implement them. In designating trails for ORV and snowmobile use, they should exercise care to separate that use from other recreational pursuits. This was one of the primary lessons learned in the White Mountain National Forest in New Hampshire and Maine—one of the few bright spots in the federal effort to cope with ORV and snowmobile use on the public land.

White Mountain National Forest receives intensive recreational use throughout the year—perhaps 3 million visitor days per year. In the winter, cross-country skiers, hikers, snowshoers vie for space with snowmobilers. In the summer, hikers and campers are the most numerous users, although there are trail bikers and four-wheel drivers as well. Snowmobilers represent the largest group among the motorized recreationists. Overall, the motorized recreationists are in the minority. In years past, there has been considerable animosity between them and other recreationists. But over the past 4 years, the level of

conflict has diminished significantly. Paul Weingart, Forest Supervisor during this period, attributes the decline to a number of factors:

- Before devising an ORV and snowmobile plan, the Forest Service actively sought the diverse views of the interested public and incorporated worthwhile suggestions into the plan.
- Wherever possible, ORV and snowmobile use were separated from other nonmechanized uses. "This resolved a lot of the conflict, especially between cross-country skiers and snowmobilers. Most importantly, it cut down the noise in areas used by the non-ORVers," Weingart reports.
- The Forest Service reviewed the plan after each season of use, again with advice from the public, and made the necessary adjustments either to reduce further conflict among users or to prevent environmental damage. For example, it was observed that four-wheel drive vehicles were doing serious damage to certain trails; these trails were closed to 4x4s the next season.
- The Forest Service tackled the enforcement problem by increasing its presence in the field and by working closely with local law enforcement agencies and magistrates as well as with the U.S. Attorney's office. In addition, user groups such as snowmobile clubs were encouraged to police themselves.
- Beginning with the winter of 1974, Weingart closed the Forest to ORVs and snowmobiles except for trails specifically designated as open. "This proved a great psychological help," he explains. "The non-motorized recreationists were very pleased and the ORVers and snowmobilers felt less animosity directed toward them."

Weingart concludes: "I think some of the ORV plans for other National Forests would never have been appealed if the Forest Supervisor had not waited until the last minute to come out with a plan. The other way—public involvement during the development of the plan—takes more time initially but in the long run probably is more expeditious. Of course, there are some instances where the ORVers and the non-ORVers are already so polarized that the ORV plan would have been challenged whatever was done."[372]

Special care should also be exercised by the BLM and Forest Service in designating whole areas open to ORVs or snowmobiles. There are, in reality, very few natural areas suitable for cross-country motorized recreation—that is, areas where the machines will either not cause "considerable adverse effects on the soil, vegetation, wildlife" or will not impair the recreational experience of others. *Trails* specifically designed and maintained for ORVs and snowmobiles will cause the fewest user-conflict and environmental problems.

The Geological Society of America suggests that lands already severely damaged by surface mining or by ORV use probably are the most likely candidates from an environmental point of view for ORV areas.[373] But further ORV damage must be confined to the so-called "sacrifice area." Old surface mine sites which have been abandoned and never reclaimed account for over 2 million acres of land in the United States, and they might make excellent open ORV areas. The trouble is that they are not always found where the ORVers are. A good share, for instance, is in remote areas of Appalachia. Another difficulty is that however badly ravaged a piece of land may be, it is still part of a natural system. Runoff from the site can still pollute adjacent streams not only with sediment but also with poisonous chemicals such as sulfuric acid, iron, and aluminum salts exposed during surface mining. ORV use might well exacerbate such problems.

Still, abandoned surface mine sites are worth considering for ORV areas. Florida, for example, has opened the 2,600-acre Buttgenbach Recreation Area in Withlacooche State Forest to ORVs. The area was extensively mined for phosphate in the late 19th century and was closed about 1917. Today the large phosphate pits are favorite spots for motorcyclists. The soils of the area have a high sand content and the vegetation is second-growth pine, oak, and hickory. Division of Forestry officials believe that opening Buttgenbach to ORVs has relieved ORV pressure on unauthorized areas. Photographs of the area suggest that some portions of it are beginning to suffer severe soil erosion due to ORV use, expecially 4x4s, and this may pose a future management problem.[374] The state of Missouri has acquired strip-mined (coal) land in the center of the state to demonstrate "reclamation for recreation," and ORV facilities are being designed for the area.[375]

(5) Monitor ORV Effects

In order to implement the Executive orders, the Forest Service and BLM need to monitor the

effects of ORV use much more closely and systematically than they have done to date. In areas used regularly by ORVs, a monitoring system should be employed so that the land managers can assess the impact of ORVs on wildlife, soil, and vegetation. Under such a system, soil loss at key check points would be measured on a regular basis (a relatively simple matter), wildlife counts would be undertaken periodically, and changes in vegetation biomass, species, and area of coverage would be tracked. The eyeball inspections of land managers on the ground are still vital, but a basic monitoring system would provide objective data on which to base further land use designations and adjustments in existing ORV use plans. The land management agencies, with the exception of the TVA, have balked at systematizing the monitoring of ORV effects because of their limited personnel and resources. Perhaps model systems should be tried first in ORV use areas, say, for example, on the Los Padres National Forest and on BLM lands in New Mexico or Arizona to determine relative costs.

Implementation of the Executive orders will not, however, bring the ORV phenomenon on public lands under full control. More must be done or the problem of "if I close this area to ORVs, they'll just go somewhere else" will continue to bedevil public land managers.

(6) Develop Facilities Through Pittman-Robertson Kind of Approach

A program equivalent to the Pittman-Robertson program is needed for developing separate ORV and snowmobile areas or trails. In other words, the federal government should tax ORV and snowmobile equipment. There are a number of ways this could be accomplished. For example, all ORVs and snowmobiles driven on public lands could require a sticker purchased from the land management agency. Or a special tax could be levied on the machines at the time of purchase. In the former instance, the burden of collecting and enforcing the tax would fall on the public land management agencies and, in the latter, on the Internal Revenue Service. Revenues should be earmarked for the following uses:

- purchase of land for ORV or snowmobile use, especially abandoned surface mine sites or other ravaged areas for ORVs;
- development of state or local government lands for ORV and snowmobile use—through some form of shared cost arrangement;
- the building of ORV and snowmobile facilities—trails, parking lots, etc., at carefully selected sites on existing public lands;
- the reclamation of areas damaged by ORVs. (Reclamation of snowmobile areas should not be necessary if the machines are required to stay on designated trails with adequate snow cover.)

(7) Reclaim ORV-Damaged Land

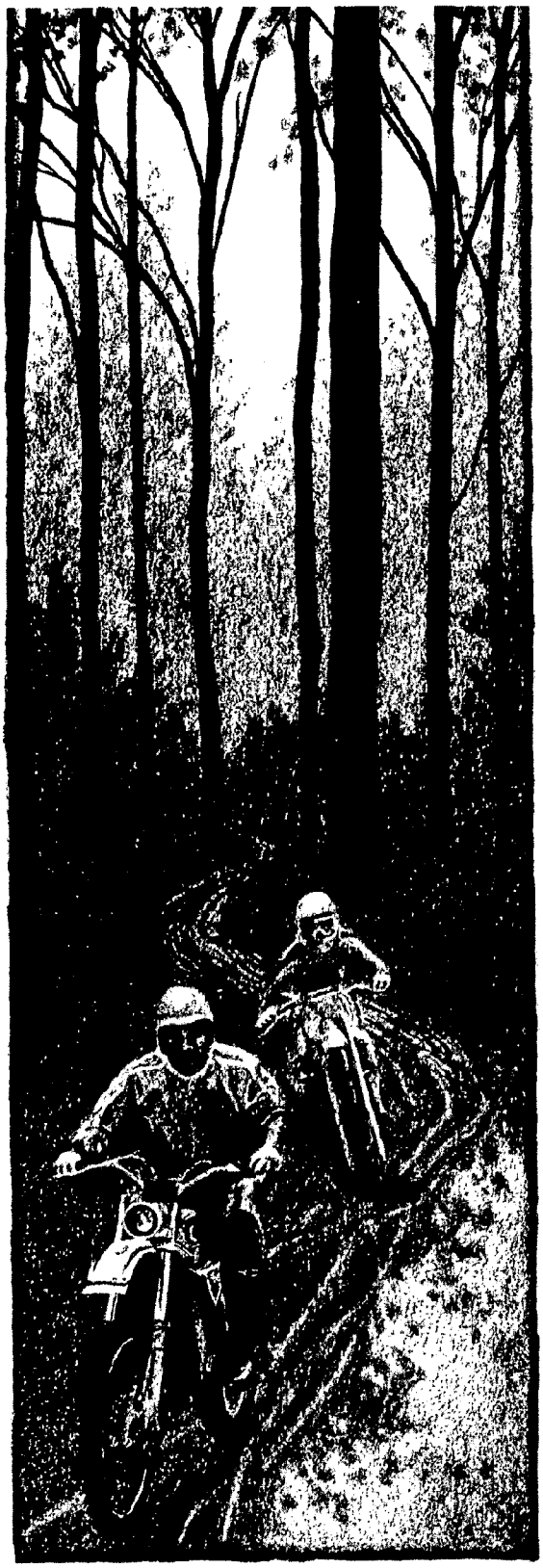
The last point needs elaboration. There is no reason why the same rigorous environmental standards which are now supposed to be applied to coal surface-mined lands under the Surface Mining Control and Reclamation Act of 1977 (Public Law 95-87) should not be applied to ORV-stripped lands as well.

It is too late in the day to rely on federal government assurances such as the following:

> Left to themselves, plants will reestablish themselves, soils reform and the ecosystem heal.[376]

Too much irreversible damage to soils and vegetation has been recorded. Positive action is clearly required. In the case of coal surface mining, the Act requires the specific coal company which does the mining to reclaim the land. In the case of ORV-stripped public lands, the land management agencies will have to be responsible for the actual reclamation and the ORV users should pay for it.

There are different ways of approaching reclamation of ORV-stripped lands. The Environment and Public Policy Committee of the Geological Society of America, for example, recommends that "ORV areas in which resources have become conspicuously degraded, and in which the start of reclamation efforts is considered to be timely, should be closed. Reclamation costs should be paid entirely from revenues generated by ORV use . . . ."[377] It also proposed that:



[s]ome ORV areas, depending on their nature and size, could be divided into parcels for sequential use and reclamation, thus providing the least inconvenience to the ORV users. The use and reclamation of successive land units could allow reclamation plans to be modified as experience is gained. This practice also could ensure that the success of reclamation efforts is evaluated before use of another land parcel is permitted.[378]

By what criteria should ORV-stripped land reclamation be measured? The federal government should be required, at the very least, to reestablish "a diverse, effective and permanent vegetative cover of the same seasonal variety native to the area . . . affected and capable of self-generation and plant succession at least equal in extent of cover to the native vegetation of the area . . . ."[379]

Reclamation of ORV-stripped land will not be cheap—perhaps $2,000 to $6,000 per acre where a whole area has been crisscrossed by ORVs.[380] If reclamation is not technically or economically feasible, then the public land management agency should not allow ORV use in the first place.

Nor should ORV use be allowed if it will cause material damage to the hydrologic balance outside the ORV area. (The hydrologic balance is the equilibrium established between the groundwater and surface water of an area, between the recharge and discharge to and from that system. Some of the measurable indicators of hydrologic balance include: flow patterns of groundwater within aquifers; the quantity of surface water as measured by the volume, rate, and duration of flow in streams; the erosion, transport, and deposition of sediment by surface runoff and stream flow; the quality of groundwater and surface waters, including both suspended and dissolved materials.[381])

A final word. The scientific community, including the American Association for the Advancement of Science, the Environment and Public Policy Committee of the Geological Society of America, and well over a hundred distinguished life and earth scientists, have found the BLM and Forest Service's management of public lands too lax in controlling ORV-caused damage to the environment.[382] In addition, an increasing number of ordinary citizens have found the BLM and Forest Service's management too lax in protecting their right to enjoy the environment on public lands, free of internal combustion engines. This

discontent is voiced directly to land managers or in letters to the editor, public opinion polls, or comments on federal environmental impact statements, and some have been quoted in the course of this report.

The history of BLM and Forest Service management of ORV use of the public lands is largely one of failure. The American public has every reason to demand of the BLM and Forest Service the same measure of land care that it now demands of coal mining companies operating on public or private lands. The public has every reason to ask motorized recreationists to pay the acquisition and maintenance costs of resources which they consume, much as hunters have done for years.

This approach is also within the long-term interest of the ORV and snowmobile enthusiasts because it assures them that some public facilities will be set aside for their benefit. Under the current, haphazardly implemented federal policy, it is impossible to say what will be available to ORV and snowmobile users in the years to come—especially if the BLM and Forest Service's ORV plans are challenged in the courts.

Perhaps the Wayne-Hoosier experience is a harbinger. The ORV and snowmobile interests could do a lot worse than a policy which combines a Pittman-Robertson kind of program with implementation of Executive Orders 11644 and 11989, even though it will increase their costs and reduce the acreage open to them. Garrell E. Nicholes, a recreational psychologist and consultant for the motorcycle industry, reports: "Most ORVers will listen to reason about closing areas if they are assured there are alternatives."[383]

The Jeep Corporation, in cooperation with members of the Outdoor Writers Association of America, developed a "Code of Environmental Ethics for Drivers of Off-Road Vehicles," which includes the following:

> I will appreciate the solitude and beauty of our natural environment, and respect the feelings of others toward it . . . . I will not drive where I cannot leave the land essentially the same as before I drove across it.[384]

If these two principles guided the ORV manufacturers when they advertised their products and the Forest Service and BLM when they managed ORV use of the land, then off-road vehicles on the public lands would not be the issue it is today.

Notes

1. Michigan State University, Department of Park and Recreation Resources, *Proceedings of the 1971 Snowmobile and Off the Road Vehicle Research Symposium*, Tech. Rep. 8 (East Lansing, Mich., 1971), p. 110.
2. Andrew H. Malcolm, "Honda—One Man's Drive," *The New York Times Biographical Edition* 1:249-51 (1977).
3. Lee Gutkind, *Bike Fever* (Chicago: Follett Publishing Co., 1973), p. 160.
4. *Ibid.*
5. Motorcycle Industry Council, Inc., *1977 Motorcycle Statistical Annual* (Newport Beach, Calif., 1977).
6. L. Gutkind, *supra* note 3, at 161.
7. *Id.* pp. 157-58.
8. *Annual, supra* note 5, at 4.
9. *Id.* p. 30.
10. *Id.* p. 14.
11. *Cycle World* 17(3):110-11 (1978).
12. *Motorcyclist*, March 1978, pp. 66-67.
13. Morten Lund and Bea Williams, *The Snowmobiler's Bible* (New York: Doubleday and Co., 1974), p. 14; Lyle Kenyon Engel, *The Complete Motorcycle Book* (New York: Four Winds Press, 1974), p. 19.
14. Malcolm F. Baldwin and Dan H. Stoddard, Jr., *The Off-Road Vehicle and Environmental Quality* (2d ed.; Washington, D.C.: The Conservation Foundation, 1973), p. 2.
15. Derrick A. Crandall, Director of Government Affairs, International Snowmobile Industry Association, interview with the author, January 12, 1978.
16. Sally Wimer, *The Snowmobiler's Companion* (New York: Charles Scribner's Sons, 1973), p. xi.
17. *Bible, supra* note 13, at 10.
18. Stanley Roe, American Motor Vehicle Manufacturers Association, interview with the author, April 18, 1978.
19. Department of the Interior, Heritage Conservation and Recreation Service, Environmental Impact Statement, "Departmental Implementation of Executive Order 11644, as Amended by Executive Order 11989, Pertaining to Use of Off-Road Vehicles on the Public Lands" (final, April 17, 1978).
20. Paul Solomon, Heritage Conservation and Recreation Service, Department of the Interior, interview with the author, March 14, 1978.
21. L. Gutkind, *supra* note 3, at 201.
22. Environmental Impact Statement, *supra* note 19, at 406.
23. Richard L. Bury, Robert C. Wendling, and Stephen F. McCool, *Off-Road Recreation Vehicles—A Research Summary, 1969-1975*, MP-1277 (College Station: The Texas Agricultural Experiment Station, 1976), pp. 32-35.
24. University of Wisconsin, School of Natural Resources, Center for Resource Policy Studies and Programs, *Off-Road Recreation Vehicles in the Upper Great Lakes States* (Madison, 1975), p. 78.
25. *Id.* p. 77.
26. Environmental Information Service, "A Study of Organized Recreational Group Use of the California Desert," prepared for the Department of the Interior, Bureau of Land Management, September 1977, pp. 28-126.
27. Kenneth C. Chilman and David Mize, "A Systematic Sampling of Visitors to Turkey Bay Off-Road Vehicle Riding Area July 1, 1975 to June 30, 1976," prepared for the Tennessee Valley Authority, Golden Pond, Ky., undated pp. 11-14.
28. A.E. Keir Nash, "Offroad Riding on Forest Lands as a Public Policy Problem," prepared for the U.S. Forest Service, 1976, pp. 57-60.
29. Robert Badaracco, Recreational Planner, Bureau of Land Management, Department of the Interior, interview with the author, January 11, 1978; *Research Summary, supra* note 23, at 29-31.
30. S. Wimer, *supra* note 16, at x.
31. L. Gutkind, *supra* note 3, at 211-13.
32. Richard L. Bury and Edgar R. Fillmore, "Motorcycle Area Design and Location: Impacts on the Recreational Experiences of Riders and Nonriders," presented at a Southern Illinois University and Tennessee Valley Authority workshop for outdoor recreation researchers and cooperators, Golden Pond, Ky., March 1975, p. 4; *Research Summary, supra* note 23, at 21-25; *Upper Great Lakes, supra* note 24, at 72.
33. National Academy of Sciences, *A Program for Outdoor Recreational Research* (Washington, D.C., 1968), p. 1.
34. Jacques Ellul, *The Technological Society* (New York: Alfred A. Knopf, 1964).
35. Karl Marx, *Capital* (New York: Modern Library, Inc., 1936), p. 374.
36. John Rawls, *A Theory of Justice* (Cambridge, Mass.: Harvard University Press, 1971).
37. John Fialka, "Rules Left in Dust," *Washington Star*, November 27, 1972.
38. Ralph Maughan and David Duncan, "Motorized vs. Non-Motorized Forms of Outdoor Recreation: Socio-Economic Correlates," 1976, pp. 10-11.

39. *Id.* p. 13.
40. *Upper Great Lakes, supra* note 24, at 8-15.
41. A. Nash, *supra* note 28, at 19; A.E. Keir Nash, memorandum to the author, August 25, 1978.
42. *Ibid.*
43. See *Upper Great Lakes, supra* note 24, at 8-15; *Research Summary, supra* note 23, at 29; "Turkey Bay," *supra* note 27, at 14.
44. "1977 *Motorcyclist* Magazine Reader Survey," 1978, p. 3.
45. *Annual, supra* note 5, at 42-43.
46. *Id.* p. 43.
47. *Id.* p. 6.
48. *Id.* p. 30.
49. D. Crandall, *supra* note 15.
50. A. Nash, *supra* note 28, at 92.
51. The Geological Society of America, Committee on Environment and Public Policy, "Impacts of Off-Road Vehicles," Boulder, Colo., May 1977, p. 2. Reprinted with permission.
52. See Appendix 2 for a bibliography on the environmental effects of ORVs.
53. Robert C. Stebbins, letter to Edward Strohbehn, Jr., Council on Environmental Quality, August 25, 1978.
54. Arthur W. Zimmerman, New Mexico State Director, Bureau of Land Management, letter to the author, February 24, 1978.
55. Philip Fradkin, "Sands of Time Running Out for State's Desert?" *Los Angeles Times*, February 13, 1972.
56. Gary A. Rosenberg, "Regulation of Off-Road Vehicles," *Environmental Affairs* 5(1):194 (1976).
57. Thierry Sagnier, *Bike! Motorcycles and the People Who Ride Them* (New York: Harper & Row, 1974), p. 102.
58. M. Baldwin and D. Stoddard, *supra* note 14, at 36-37.
59. Jack Hope, "The Invasion of the Awful ORVs," *Audubon*, January 1972, p. 39.
60. John J. Lindsay, *Snowmobiling in Vermont, 1975*, Res. Rep. SNR-RM3 (Burlington: University of Vermont, 1976), p. 17.
61. Quincy Dadisman, "Taming the Snowmobile," *American Forests*, September 1974, pp. 38-41.
62. Based on a comparative analysis by the author of the estimated per capita ownership of off-road motorcycles and 4x4s in four states with abundant public lands—Wyoming, Idaho, Utah, and Alaska—versus the comparable figures in four states with few public lands—Texas, Oklahoma, Kansas, and Nebraska.
63. Environmental Impact Statement, *supra* note 19, at 405-407.
64. *Id.* pp. 78-86.
65. C.T. Snyder, D.G. Frickel, R.F. Hadley, and R.F. Miller, *Effects of Off-Road Vehicle Use on the Hydrology and Landscape of Arid Environments in Central and Southern California*, U.S. Geological Survey Water Resources Investigation 76-99 (Denver, 1976); R. Webb, H.C. Ragland, B. Godwin, and D. Jenkins, *The Effects of Off-Road Vehicle Use on Soil Physical and Chemical Properties*, special volume (Los Angeles: Southern California Academy of Sciences, 1977); Howard G. Wilshire and J.K. Nakata, "Erosion Off the Road," *Geotimes*, July-August 1977, p. 27; Howard Wilshire, letter to Edward Strohbehn, Jr., Council on Environmental Quality, August 28, 1978.
66. H.G. Wilshire, J.K. Nakata, Susan Shipley, and Karen Prestegaard, "Vehicle Impacts on Natural Terrain at Seven Sites in the San Francisco Bay Area," in press, p. 4.
67. Environmental Impact Statement, *supra* note 19, at 81.
68. J.K. Nakata, H.G. Wilshire, and G.G. Barnes, "Origin of Mojave Desert Dust Plumes Photographed from Space," *Geology* 4(11):644-48 (1976).
69. Edgar A. Imhoff, Environmental Planner, U.S. Geological Survey, interview with the author, March 6, 1977.
70. Snyder *et al.*, *supra* note 65; Webb *et al.*, *supra* note 65; "Seven Sites," *supra* note 66.
71. Robert C. Stebbins, "Off-Road Vehicles and the Fragile Desert," *The American Biology Teacher* 36:294-95 (1974).
72. "Impacts," *supra* note 51, at 3-4; J.M. Brodhead and P.J. Godfrey, "Off Road Vehicle Impact in Cape Cod National Seashore: Disruption and Recovery of Dune Vegetation," *International Journal of Biometeorology* 21:299-306 (1977).
73. Christopher Visco, "The Geomorphic Effects of Off-Road Vehicles on the Beach, Fire Island, New York," unpublished master's thesis, State University of New York at Binghampton, 1977, p. 1.
74. R. Stebbins, *supra* note 53.
75. Shaun Bennett, *A Trail Rider's Guide to the Environment* (Westerville, Ohio: The American Motorcycle Association, 1973).
76. *Id.* pp. 43-44.
77. *Id.* p. 44.
78. *Id.* p. 45.
79. *Id.* p. 47.
80. *Id.* pp. 48-49.
81. *Id.* p. 47.
82. "ORV 'Ban'," *The ORV Monitor* 2(5):3 (1977); Environmental Impact Statement, *supra* note 19, at 176.
83. *Id.* p. 65.
84. *Id.* pp. 78-79.
85. "Impacts," *supra* note 51, at 4-5; "Fragile Desert," *supra* note 71, at 295-97.
86. *Ibid.* Also see Kristin H. Berry, ed., *Preliminary Studies of Off-Road Vehicles on the Northwestern Mojave Desert: A Collection of Papers* (privately published, 1973), especially Stephen Busack, "Off-Road Vehicles and Their Effect upon Lizard Populations," p. 59; Sheila Byrne, "The Effect of Off-Road Vehicle Use in the Mojave Desert on Small Mammal Populations," pp. 64-73; and Kristin Berry, "The Effects of Off Road Vehicles on the Fauna at Dove Springs Canyon," pp. 78-91; Stephen D. Busack and R. Bruce Bury, "Some Effects of Off-Road Vehicles and Sheep Grazing on Lizard Populations in the Mojave Desert," *Biological Conservation* 6(3):179-83 (1974).
87. *Research Summary, supra* note 23, at 43-47; M. Baldwin and D. Stoddard, *supra* note 14, at 20-26.
88. Michael C. Bondello, "The Effects of High-Intensity

Motorcycle Sounds on the Acoustical Sensitivity of the Desert Iguana, *Dipsosaurus dorsalis*," unpublished master's thesis, California State University, Fullerton, 1976, pp. 34-35; Robert C. Stebbins, Curator in Herpetology, Museum of Vertebrate Zoology, and Professor of Zoology, University of California, Berkeley, interview with the author, November 17-18, 1977.

89. M. Baldwin and D. Stoddard, *supra* note 14, at 21-22; *Trail Rider's Guide*, *supra* note 75, at 48; Indiana Department of Natural Resources, *Off the Road Vehicle Study* (Indianapolis, 1972), pp. 5-6 and Appendix E.
90. Department of the Interior, Bureau of Sport Fisheries and Wildlife, Environmental Impact Statement, "Proposal Relating to Restriction of Vehicular Use on the Back Bay National Wildlife Refuge, Virginia" (final, December 29, 1972).
91. *Id.* p. 12; Glen Bond, Refuge Manager, interview with the author, April 6, 1978.
92. "Back Bay," *supra* note 90, at 14-15.
93. "Fragile Desert," *supra* note 71.
94. G. Bond, *supra* note 91.
95. "Back Bay," *supra* note 90, at 16.
96. G. Bond, *supra* note 91.
97. "Back Bay," *supra* note 90, at 1-5.
98. John Fialka, "Running Wild," *National Wildlife*, February-March, 1975, p. 36.
99. G. Bond, *supra* note 91.
100. *Ibid.*
101. *Ibid.*
102. Department of the Interior, Bureau of Outdoor Recreation, Tech. Bull. 1, *Land Between the Lakes—Experiments with ORV's* (Washington, D.C., 1974), pp. 2-3, 6.
103. Actually, TVA had prohibited motorcycle riding within campgrounds after receiving many complaints from campers, but the prohibition was ineffectual. See Edgar R. Fillmore, "Motorcycle Riding Areas in Campgrounds: Impact on Riders and Non-Riders," in Donald F. Holecek, ed., *Proceedings of the 1973 Snowmobile and Off the Road Vehicle Research Symposium*, Tech. Rep. 9 (East Lansing: Michigan State University, Department of Park and Recreation Resources, 1973), p. 43.
104. *Ibid.*
105. Tennessee Valley Authority, "Monitoring Report for ORV Area Land Between the Lakes 1974-1975," Golden Pond, Ky., 1975, p. 1.
106. *Ibid.*
107. *Experiments*, *supra* note 102, at 3-5; "Monitoring Report," *supra* note 105.
108. Tennessee Valley Authority, "Monitoring Plan for the Off-Road Vehicle in Land Between the Lakes," Golden Pond, Ky., 1972.
109. "Monitoring Report," *supra* note 105, at 1; "Turkey Bay," *supra* note 27.
110. *Ibid.*
111. R. Bury and E. Fillmore, *supra* note 32, at 3-5.
112. "Monitoring Report," *supra* note 105, at 2, 7.
113. *Id.* pp. 2, 5, 8.
114. *Id.* p. 5.
115. Scott Seber, Ranger, Tennessee Valley Authority, interview with the author, January 25, 1978.
116. "Monitoring Report," *supra* note 105, at 9.
117. S. Seber, *supra* note 115.
118. "Monitoring Report," *supra* note 105, at 4.
119. S. Seber, *supra* note 115.
120. H.G. Wilshire, "Study Results of 9 Sites Used by Off-Road Vehicles That Illustrate Land Modifications," looseleaf, 1977, p. 15.
121. *Ibid.*
122. "Land Modifications," *supra* note 120, at 15-17.
123. "Seven Sites," *supra* note 66, at 17-18.
124. "Land Modifications," *supra* note 120, at 16.
125. *Id.* pp. 9-12.
126. "Seven Sites," *supra* note 66, at 17.
127. "Land Modifications," *supra* note 120, at 11.
128. K. Berry, *supra* note 86, at 80.
129. *Id.* pp. 80-86.
130. Joseph Keefe and Kristin Berry, "Effects of Off-Road Vehicles on Desert Shrubs at Dove Springs Canyon," in *Preliminary Studies*, *supra* note 86, at 51-52.
131. Onsite observations of the author, November 11, 1977.
132. H. Wilshire and J. Nakata, *supra* note 65, at 27.
133. S. Byrne, *supra* note 86, at 70.
134. *Ibid.*
135. *Id.* pp. 69-71.
136. K. Berry, *supra* note 86, at 86-88.
137. *Id.* pp. 83-84.
138. R. Stebbins, *supra* note 88.
139. Jerry Harrell, "Desert Lands Serve Many Needs," *Our National Resources: The Choices Ahead*, U.S. Department of the Interior Yearbook (Washington, D.C.: U.S. Government Printing Office, 1974), pp. 84-87.
140. See "Fragile Desert," *supra* note 71; P. Fradkin, *supra* note 55; Staff, Museum of Vertebrate Zoology, University of California, Berkeley, letter to Neil Pfulb, California Desert Plan Program, Bureau of Land Management, September 25, 1973; David P. Whistler, Senior Curator, Vertebrate Paleontology, Los Angeles County Museum of Natural History, letter to Edward Hastey, California State Director, Bureau of Land Management, January 3, 1978; H.G. Wilshire and J.K. Nakata, "Off-Road Vehicle Effects on California's Mojave Desert," *California Geology*, June 1976, pp. 123-32; Richard E. Gutting, Jr., "The Environmental Costs of ORVs in America," *Environmental Defense Fund Newsletter*, Special Supplement, "Off-Road Vehicles," May 1974; Robert C. Stebbins and Nathan W. Cohen, "Off-Road Menace," *Sierra Club Bulletin*, July-August 1976; Luther J. Carter, "Off-Road Vehicles: A Compromise Plan for the California Desert," *Science* 183:396-99; Department of the Interior, Bureau of Land Management, *Yuha Desert Management Framework Plan* (El Centro, Calif., 1975), p. 41.
141. Howard G. Wilshire, "Orphaning Desert Lands," *Cry California*, Winter 1977-78, p. 6.
142. California State Office, Bureau of Land Management, and Western Regional Office, National Park Service, *The California Desert* (Sacramento, 1968), pp. 19-25.

143. Pub. L. 94-579, 90 Stat. 601, 43 U.S.C. § 1781 (1976).
144. "Fragile Desert," *supra* note 71, at 204.
145. Cathy Klinesteker, *Desert Awareness*, prepared for the Department of the Interior, Bureau of Land Management (Washington, D.C.: U.S. Government Printing Office, 1977), pp. 20-23.
146. "Fragile Desert," *supra* note 71, at 298-99, 301.
147. *Id.* p. 297.
148. *Id.* p. 298.
149. Robert C. Stebbins, letter to the author, January 12, 1978.
150. Raymond F. Dasmann, *The Last Horizon* (New York: The MacMillan Co., 1963), p. 159.
151. "Fragile Desert," *supra* note 71, at 204, 300.
152. *Id.* p. 300; Special Supplement, *supra* note 140.
153. *Desert Awareness, supra* note 145, at 45.
154. "Fragile Desert," *supra* note 71, at 300.
155. *Id.* p. 300.
156. "Orphaning," *supra* note 141, at 5-6.
157. Howard Wilshire, John Nakata, Norman Prime, Annie Allison, and Lowell Kohnitz, "Field Guidebook to Off-Road Vehicle Recreation Areas," looseleaf, prepared for the U.S. Geological Survey and the California Department of Conservation, November 16-18, 1977, p. 4.
158. Onsite observations of the author, November 11, 1977.
159. H. Wilshire and J. Nakata, *supra* note 140, at 125.
160. *Id.* p. 129; "Fragile Desert," *supra* note 71.
161. Environmental Impact Statement, *supra* note 19, at 84.
162. "Dust Plumes," *supra* note 68, at 644-48.
163. Environmental Impact Statement, *supra* note 19, at 79-80.
164. "Fragile Desert," *supra* note 71, at 301.
165. "Land Modifications," *supra* note 120, at 14; H. Wilshire and J. Nakata, *supra* note 140, at 130.
166. "Fragile Desert," *supra* note 71, at 203-304.
167. F.R. Fosberg, letter to Neil Pfulb, California Desert Plan Program, Bureau of Land Management, October 2, 1973.
168. R. Bruce Bury, Roger A. Luckenbach, and Stephen D. Busack, *Effects of Off-Road Vehicles on Vertebrates in the California Desert,* Department of the Interior, Fish and Wildlife Service, Wildlife Res. Rep. (Washington, D.C., 1977), pp. 2-19.
169. *Id.* pp. 4-7, 14.
170. *Id.* p. 16.
171. "Fragile Desert," *supra* note 71, at 296.
172. Robert C. Stebbins, Theodore J. Papenfuss, and Florence D. Amamoto, "Teaching and Research in the California Desert (A Summary of a Report to the Bureau of Land Management, Sacramento, California, Submitted October 30, 1977)," Berkeley, 1977, pp. 13-14.
173. Bury *et al.*, *supra* note 168, at 13-15.
174. *Id.* p. 18.
175. *Id.* p. 14.
176. *Id.* p. 18.
177. R. Stebbins and N. Cohen, *supra* note 140.
178. *Yuha Desert, supra* note 140, at 43.
179. R. Stebbins and N. Cohen, *supra* note 140.
180. "Land Modifications," *supra* note 120, at 7-9.
181. "Field Guidebook," *supra* note 157, Figures 7-8.
182. J.M. Knott, in cooperation with the California Department of Water Resources, "Assessment of Erosion and Sedimentation in the Hungry Valley Area, Los Angeles and Ventura Counties, California," U.S. Geological Survey Open File Rep., 1978.
183. *Id.* pp. 1-2.
184. *Ibid.*
185. Onsite observations by the author, November 18, 1977; "Field Guidebook," *supra* note 157, at Figure 9.
186. Robert Stull, Susan Shipley, Eric Hovanitz, Scott Thompson, and Karen Hovanitz, *Effects of Off-Road Vehicles in Ballinger Canyon* (Los Angeles and Hayward: California State University, 1978).
187. Howard Wilshire, letter to Governor Edmund G. Brown, Jr., December 20, 1975, Figures 54-56.
188. "Seven Sites," *supra* note 66, at Table 4.
189. Laurens H. Silver, Sierra Club Legal Defense Fund, letter to the Regional Forester, Region 5, U.S. Forest Service, in support of Appeal, Sequoia National Forest ORV Plan, March 21, 1977, Exhibits D and E.
190. H.G. Wilshire, letter to Deborah Reames, Sierra Club Legal Defense Fund, Inc., September 21, 1977.
191. Laurens H. Silver, Sierra Club Legal Defense Fund, statement before Regional Forester, Region 5, U.S. Forest Service, in support of Appeal, Shasta-Trinity National Forest ORV Management Plan, June 1977, p. 13.
192. See *ibid.*; L. Silver, *supra* note 189; Laurens H. Silver, Sierra Club Legal Defense Fund, statement to Chief, U.S. Forest Service, in support of Appeal of Regional Forester's decision in Sequoia National Forest Off-Road Vehicle Management Plan, October 3, 1977, Exhibit 3.
193. Sierra Club, Wilderness Society, Red Buttes Wilderness Council, and Federation of Western Outdoor Clubs, Notice of Request for Reconsideration of Rogue River National Forest Off-Road Vehicle Use Plan, January 16, 1977, p. 3.
194. Robert L. Safran, Director of Recreation, Intermountain Region, U.S. Forest Service, letter to the author, March 23, 1978.
195. George Raine, "Officials Eye Tougher Canyon Ordinances," *Salt Lake City Tribune,* August 9, 1977.
196. Harold H. Ramsbaches, Acting Arizona State Director, Bureau of Land Management, letter to the author, February 16, 1978.
197. Daniel P. Baker, Wyoming State Director, Bureau of Land Management, letter to the author, February 7, 1978.
198. Dale R. Andrus, Colorado State Director, Bureau of Land Management, letter to the author, March 22, 1978; Edwin Zaidlicz, Montana State Director, Bureau of Land Management, letter to the author, March 17, 1978; M.J. Hassell, Regional Forester, Region 3, U.S. Forest Service, letter to the author, March 10, 1978; William L. Mathews, Idaho State Director, Bureau of Land Management, letter to the author, January 30, 1978.

199. Ted R. Hudson, "Hard Rock Mining: Modern Industry under an Ancient Law," Natural Resources Council of America, Washington, D.C., 1978, pp. 20-21.
200. Brad Marion, Wilderness Society, interview with the author, December 14, 1978.
201. "Orphaning," *supra* note 141, at 6.
202. B. Marion, *supra* note 200.
203. "Land Modifications," *supra* note 120.
204. D. Crandall, *supra* note 15.
205. M.B. Doyle, *Snowmobiling and Our Environment* (Washington, D.C.: Snowmobile Industry Association, 1976), p. 19.
206. Wallace J. Wanek and Donald V. Potter, *A Continuing Study of the Ecological Impact of Snowmobiling in Northern Minnesota (Final Research Report for 1973-74)* (Bemidji, Minn.: Bemidji State College, undated), p. 12.
207. S. Wimer, *supra* note 16, at 185-86.
208. Wallace J. Wanek and Lawrence H. Schumacher, *A Continuing Study of the Ecological Impact of Snowmobiling in Northern Minnesota (Final Research Report for 1974-75)* (Bemidji, Minn.: Bemidji State College, undated), pp. 8-32.
209. *Id.* p. 32.
210. *Bible, supra* note 13, at 142.
211. M. Doyle, *supra* note 205, at 18.
212. *Bible, supra* note 13, at 145.
213. *Research Summary, supra* note 23, at 47.
214. J. Hope, *supra* note 59.
215. *Research Summary, supra* note 23, at 43-48.
216. Dan E. Huff, Patrick J. Savage, David L. Urich, and Robert L. Watlov, *Wildlife-Snowmobile Interaction Project Preliminary Report*, prepared for the Minnesota Department of Natural Resources (Minneapolis: University of Minnesota, 1973), pp. 8-16.
217. *Id.* p. 8.
218. James E. Doherty, "Shame on the Snow," *National Wildlife*, February-March 1974, p. 29.
219. D. Crandall, *supra* note 15.
220. Julie A. Jarvinen and William D. Schmid, "Snowmobile Use and Winter Mortality of Small Animals," in *Proceedings, supra* note 1, at 131-39.
221. *Research Summary, supra* note 23, at 43-45.
222. John W. Lanier, U.S. Forest Service, "Snow Machine Use and Deer in Rob Brook," 1976.
223. *Research Summary, supra* note 23, at 43-45.
224. Joseph Wood Krutch, *The Best Nature Writing of Joseph Wood Krutch* (New York: William Morrow and Co., 1969), p. 196. Reprinted with permission.
225. Gary A. Rosenberg, "Regulation of Off-Road Vehicles," *Environmental Affairs* 5:176 (1976).
226. Jerry Buerer, "Members' Forum," *National Wildlife*, August-September 1975, p. 35.
227. Edgar A. Imhoff, interview with the author, March 6, 1978.
228. *Bible, supra* note 13, at 139.
229. Letters to the author from: Arthur W. Zimmerman, New Mexico State Director, Bureau of Land Management, February 24, 1978; R.E. Worthington, Regional Forester, Region 6, U.S. Forest Service, February 3, 1978; Dale R. Andrus, Colorado State Director, Bureau of Land Management, March 22, 1978; M.J. Hassell, Regional Forester, Region 3, U.S. Forest Service, March 10, 1978; Daniel P. Baker, Wyoming State Director, Bureau of Land Management, February 7, 1978; William L. Mathews, Idaho State Director, Bureau of Land Management, January 30, 1978; Harold H. Ramsbaches, Acting Arizona State Director, Bureau of Land Management, February 16, 1978; Robert L. Safran, Recreation Management Director, Intermountain Region, U.S. Forest Service, March 23, 1978.
230. A. Zimmerman, *supra* note 229.
231. Robert J. Badaracco, "ORVs: Often Rough on Visitors," *Parks & Recreation Magazine*, September 1976, p. 35; *Research Summary, supra* note 23, at 15-19.
232. R. Badaracco, *supra* note 231, at 35, 68-72; E. Fillmore, *supra* note 103, at 45.
233. Michael Weinstein, "Study of Off-Road Vehicles in Afton Canyon," Interim Rep. 2, prepared for the Bureau of Land Management, Riverside District, 1978, pp. 4-5.
234. *Ibid.*
235. W. Mathews, *supra* note 229, at 4.
236. Department of the Interior, Bureau of Land Management, California State Office, Environmental Impact Statement, *Proposed Barstow-Las Vegas Motorcycle Race* (final, October 22, 1974), p. II-13.
237. Roger McCoy and George Moeller, "Trail Users Compatibility in Ohio," Research Paper, U.S. Forest Service, Northeastern Forest Experiment Station, 1976, pp. 8-10. Also see Roger N. Clark *et al.*, "Values, Behavior, and Conflict in Modern Camping Culture," *Journal of Leisure Research* 3(3):74-79 (1971).
238. Robin Harrison, Mechanical Engineer, Equipment Development Center, U.S. Forest Service, San Dimas, California, interview with the author, February 7, 1978.
239. Robin Harrison, *Motorcycle Noise*, U.S. Forest Service, ED&T 2428 (Washington, D.C.: U.S. Government Printing Office, 1974), p. 8.
240. R. Harrison, *supra* note 238.
241. Claude Ferguson, former Staff Officer, Wayne-Hoosier National Forest, interview with the author, April 11, 1978.
242. Robin T. Harrison, *Sound Propagation and Annoyance under Forest Conditions*, U.S. Forest Service ED&T 7120-6 (Washington, D.C.: U.S. Government Printing Office, 1974), pp. 11-17.
243. R. Harrison, *supra* note 238.
244. *Proceedings, supra* note 1, at 138.
245. Robin Harrison, *Development of a Noise Standard for the Oregon Dunes National Recreation Area*, U.S. Forest Service Project Record (Washington, D.C.: U.S. Government Printing Office, 1973), p. 11.
246. International Snowmobile Industry Association, *Snowmobile Sound Level Reduction 1968-1975* (Washington, D.C., 1974).
247. M.B. Doyle, President, International Snowmobile Industry Association, letter to Charles Warren, Chair-

man, Council on Environmental Quality, August 28, 1978.

248. Jack C. Maloney, interview with the author, October 20, 1978.
249. Robert Badaracco, Recreational Planner, California Desert Plan Staff, Bureau of Land Management, interview with the author, January 11, 1978.
250. R. Badaracco, *supra* note 231, at 73.
251. *Id.* pp. 73-74. Reprinted with permission of *Parks & Recreation Magazine.*
252. R. Badaracco, *supra* note 249.
253. Robert J. Badaracco, "Conflicts Between Off-Road Vehicle Enthusiasts and Other Outdoor Recreationists—The ISD Syndrome" (Southern California Academy of Sciences, in press). Reprinted with permission.
254. *Barstow-Las Vegas Motorcycle Race, supra* note 236, at V-15.
255. "Don't Expect a Peaceful Winter Retreat," *National Parks and Conservation Magazine,* May 1977, p. 19.
256. Robert I. Kerr, Supervisor, Grand Teton National Park, interview with the author, February 17, 1978.
257. James W. Carico, Washington office, National Park Service, interview with the author, October 3, 1978.
258. Robert C. Stebbins, Theodore J. Papenfuss, and Florence D. Amamoto, "Teaching and Research in the California Desert," prepared for the Bureau of Land Management, Sacramento, October 30, 1977, pp. 8, 36-38.
259. Robert C. Stebbins, Professor of Zoology, University of California, Berkeley, "Scientists' Petition Requesting Reduction in Off-Road Vehicle Recreation on National Resource Lands in the California Desert Submitted to the Bureau of Land Management and Other Agencies and Persons Concerned with the Control and Regulation of Off-Road Vehicle Recreation," October 31, 1975.
260. Bruce Bury, Research Biologist, U.S. Fish and Wildlife Service, interview with the author, January 11, 1978.
261. Executive Office of the President, Energy Policy and Planning, *The National Energy Plan* (Washington, D.C.: U.S. Government Printing Office, 1977), p. 38.
262. For purposes of analysis, all ORVs are assumed to burn gasoline. In fact, some ORVs (those with two-stroke engines) consume a mixture of oil and gasoline.
263. Mortimer B. Doyle, *An Assessment of the Snowmobile Manufacturing Industry and Sport, 1977* (Washington, D.C.: International Snowmobile Industry Association, 1977), p. 27; Motorcycle Industry Council, Inc., *1977 Motorcycle Statistical Annual* (Newport Beach, Calif.: 1977), p. 36.
264. A. Nash, *supra* note 28, at 79.
265. M. Doyle, *supra* note 263, at 28.
266. Department of the Interior, Office of the Secretary, News Release, April 14, 1971.
267. U.S. Forest Service, Recreation Management Staff, "National Forest System Off-Road Vehicle Management Issue Paper," December 1974, p. 8.
268. *California Desert, supra* note 142, at 241.
269. *Id.* p. 209.
270. *Id.* p. 245.
271. *Id.* p. 290.
272. *Id.* p. 3.
273. Bureau of Land Management, California State Office, Off-Road Vehicle Advisory Council, *Operation ORVAC, Recommendations and Guidelines for the Management of Off-Road Vehicles on the Public Domain Lands of California* (Sacramento, 1970), pp. 19-20.
274. Bureau of Land Management, California State Office, "Minutes of the California Off-Road Vehicle Advisory Council," 1969, p. 67.
275. *ORVAC, supra* note 273.
276. Department of Agriculture, U.S. Forest Service, *Forest Service Manual,* Title 2100—Multiple Use Management, p. 2100-3.
277. Department of the Interior, "Off-Road Vehicle Task Force Report," 1971, p. 54.
278. *Id.* p. 52.
279. *Id.* p. 71.
280. *Id.* p. 70.
281. *Id.* p. 26.
282. *Id.* p. 70.
283. *Id.* p. 44.
284. *Id.* p. 71.
285. *Id.* p. 46.
286. Pub. L. 88-577, 78 Stat. 891, 16 U.S.C. § 1131 (1964).
287. "Task Force," *supra* note 277, at 66.
288. Thomas B. Stoel, Jr., Natural Resources Defense Council, Inc., letter to Burton Silcock, Director, Bureau of Land Management, May 10, 1973.
289. Environmental Impact Statement, *supra* note 19, at Appendix 2, pp. 553-66.
290. *National Wildlife Federation* v. *Morton et al.*, 393 F. Supp. 1286, 1292 (D.D.C. 1975).
291. *Id.* p. 1295.
292. *Id.* pp. 1297–98.
293. Environmental Impact Statement, *supra* note 19, at 46, 48-51.
294. "Interim Critical Management Program for Recreation Vehicle Use of the California Desert by the Bureau of Land Management," *Progress Report,* Section 2, 7(3):1 (1973).
295. Resource and Planning Staff Professionals, Riverside District, Desert Plan Program, California State Office, and other Bureau of Land Management Offices, memorandum to California State Director, Bureau of Land Management, September 20, 1976, p. 9.
296. *Id.* p. 11.
297. Zane G. Smith, Jr., Recreation Management Director, U.S. Forest Service, memorandum to Regional Foresters, March 12, 1976.
298. T.A. Schlapfer, Regional Forester, Region 6, U.S. Forest Service, memorandum to Forest Supervisor, Olympic National Forest, August 17, 1976.
299. Robert J. Boston, Staff, U.S. Forest Service, Washington, D.C., interview with the author, January 19, 1978.
300. Laurens H. Silver, Sierra Club Legal Defense Fund, Memorandum to the Regional Forester, Region 5, in

Support of Appeal, Sequoia National Forest ORV Plan, March 21, 1977, p. 36.

301. "Court Action Backs IWL Lawsuit in Hoosier Forest ORV Battle," *Hoosier Waltonian*, 13(2):1-3 (1974).
302. *Ibid.*; Claude Ferguson, former staff officer, Wayne-Hoosier National Forest, interview with the author, April 11, 1978; Joel Thomas, attorney, National Wildlife Federation, interview with the author, December 21, 1977.
303. Howard Wilshire, geologist, U.S. Geological Survey, interview with the author, November 18, 1977.
304. Howard Wilshire, letter to Deborah Reams, Sierra Club Legal Defense Fund, November 31, 1977.
305. U.S. Department of Agriculture, Forest Service, Off-Road Vehicle Management Plan, "Management Direction for Off-Road Vehicles, National Forests in North Carolina," Asheville, 1976, pp. 1, 7.
306. Laurens H. Silver, letter to Douglas R. Leisz, Regional Forester, Region 5, U.S. Forest Service, December 8, 1977, p. 3.
307. Department of Defense, Office of the Assistant Secretary (Health and Environment), Environmental Impact Statement, "Use of Off-Road Vehicles" (draft, March 1973), p. 2.
308. *Id.* p. 7.
309. *Id.* pp. 6, 10.
310. *Id.* p. 10.
311. *Id.* p. 14.
312. *ORV Monitor, supra* note 82, at 1-6.
313. *Ibid.*
314. Department of the Interior, Office of the Secretary, News Release, May 26, 1977; Len Shaw, Heritage Conservation and Recreation Service, Department of the Interior, interview with the author, January 5, 1978.
315. *Weekly Compilation of Presidential Documents* 13:790 (1977).
316. News Release, *supra* note 314.
317. The Institute of Rational Design, Inc., *Critical Area Programs, Guidebook for State and Local Governments,* prepared for the Department of the Interior, Geological Survey, Resource and Land Investigations Program (New York, 1977), p. 15.
318. The Interior Department employee quoted here did not wish to be identified.
319. Joel Thomas, interview with the author, December 21, 1977.
320. "Task Force," *supra* note 277, at 5.
321. Environmental Impact Statement, *supra* note 19, at 76.
322. L. Shaw, *supra* note 314.
323. Environmental Impact Statement, *supra* note 19, at 76.
324. Robert C. Stebbins, letter to the author, January 12, 1978, p. 5.
325. Memorandum, *supra* note 295, at 1, 8.
326. Bureau of Land Management, California State Office, Riverside District, *Evaluation Report,* October 4-8, 1976 (Riverside, 1976), p. 3.
327. Diana Dunn, Statement at Hearings on S. 1216 and S. 681 Before the Senate Committee on Interior and Consular Affairs, 92d Cong., 1st Sess. p. 114 (1971). See also Diana R. Dunn, "Motorized Recreation Vehicles . . . on Borrowed Time," *Parks & Recreation Magazine* 5(7):10-14 (1970).
328. Environmental Impact Statement, *supra* note 19, at 87.
329. Steven L. Smith, Ranger, Bureau of Land Management, interview with the author, November 17, 1977.
330. Robert Rasor, *Five State Approaches to Trailbike Recreation Facilities and their Management* (Westerville, Ohio: American Motorcyclist Association, 1977), p. v.
331. International Snowmobile Industry Association, *Summary of Snowmobile Laws and Regulations* (Washington, D.C., 1976).
332. "California's Studies on ORV Gas Use," *The ORV Monitor* 2(6):10-11 (1977).
333. R. Rasor, *supra* note 330, at 27.
334. *Id.* pp. 27-33; Joseph J. Wernex, ORV Supervisor, Washington Department of Natural Resources, interview with the author, October 13, 1978.
335. *Ibid.*
336. Indiana Department of Natural Resources, *Off the Road Vehicle Study* (Indianapolis, 1972).
337. *Id.* p. 4.
338. Environmental Impact Statement, *supra* note 19, at 104.
339. Indiana, *supra* note 336, at 70, 72.
340. *Id.* p. 72.
341. *Id.* p. 60.
342. *Id.* p. 78.
343. *Id.* pp. 54-55.
344. *Id.* p. 52.
345. *Id.* p. 3.
346. *Id.* p. 76.
347. *Ibid.*
348. Indiana, *supra* note 336, at 79.
349. John T. Costello, Deputy Director, Indiana Department of Natural Resources, letter to the author, January 31, 1978.
350. "Dune-Buggy Depredations," *The Washington Star,* December 12, 1977.
351. T. Sagnier, *supra* note 57.
352. Senator Barry Goldwater, letter to William D. Hurst, Regional Forester, Region 3, U.S. Forest Service, Albuquerque, New Mexico, March 23, 1973.
353. Environmental Impact Statement, *supra* note 19, at 260.
354. M. Doyle, *supra* note 205, at 5.
355. Society of American Foresters, "Use of Off-Road Vehicles on Forestlands: A Position of the Society of American Foresters," *Journal of Forestry,* March 1979, p. 197. Reprinted with permission.
356. *Proceedings, supra* note 1, at 109.
357. Arthur W. Zimmerman, New Mexico State Director, Bureau of Land Management, letter to the author, February 24, 1978.
358. Environmental Impact Statement, *supra* note 19, at 82.

359. "Management Direction," *supra* note 305, at 16.
360. *Barstow-Las Vegas Motorcycle Race, supra* note 236.
361. Bureau of Land Management, California State Office, "1974 Barstow-Las Vegas Motorcycle Race," Evaluation Report, Sacramento, 1975, p. 6.
362. "On the Trail with the Duck," *Cycle World* 17(3):31 (1978).
363. Environmental Impact Statement, *supra* note 19, at 241.
364. *Id.* p. 154.
365. The Gallup Organization, Inc., *National Opinions Concerning the California Desert Conservation Area,* prepared for the Bureau of Land Management (Princeton, N.J., January 1978), p. 11.
366. *Id.* p. 5.
367. *Id.* pp. 14-15.
368. Field Research Corporation, *California Public Opinion and Behavior Regarding the California Desert,* prepared for the Bureau of Land Management (San Francisco, October 1977), pp. 5, 11-14.
369. *Id.* pp. 28-30.
370. Thomas E. Dustin, "Changing Public Attitudes Now Supporting Preservation as First Priority for Forests New Summary by Forest Service Shows," *The Hoosier Waltonian,* Summer 1975, p. 3.
371. "Management Issue Paper," *supra* note 267, at 1.
372. Paul Weingart, interview with the author, January 23, 1978.
373. R. Rasor, *supra* note 330, at 1.
374. *Id.* pp. 1–6.
375. *Id.* p. 19.
376. Robert Sulenski and Denise Meridith, Bureau of Land Management, Las Vegas District Office, "Final Programmatic Environmental Analysis Record, Off-Road Vehicle Use in the Dry Lake Valley Area," January 1976, p. 54.
377. "Impacts," *supra* note 51, at 8. Reprinted with permission.
378. *Ibid.*
379. Pub. L. 95-87, 91 Stat. 486 (b)(19), 30 U.S.C. § 1265 (b)(19) (1977).
380. "Orphaning," *supra* note 141, at 6.
381. Pub. L. 95-87, 91 Stat. 486, 30 U.S.C. § 1265 (1977).
382. American Association for the Advancement of Science, Committee on Arid Lands, "Off-Road Vehicle Use," *Science* 184:500-501 (1974); "Impacts," *supra* note 51; "Petition," *supra* note 259.
383. Garrell E. Nicholes, Salt Lake City, interview with the author, October 13, 1978.
384. *Desert Awareness, supra* note 145, at 19.

APPENDIX 1
Executive Orders

EXECUTIVE ORDER 11644

Use of Off-Road Vehicles on the Public Lands

An estimated 5 million off-road recreational vehicles—motorcycles, minibikes, trail bikes, snowmobiles, dune-buggies, all-terrain vehicles, and others—are in use in the United States today, and their popularity continues to increase rapidly. The widespread use of such vehicles on the public lands—often for legitimate purposes but also in frequent conflict with wise land and resource management practices, environmental values, and other types of recreational activity—has demonstrated the need for a unified Federal policy toward the use of such vehicles on the public lands.

NOW, THEREFORE, by virtue of the authority vested in me as President of the United States by the Constitution of the United States and in furtherance of the purpose and policy of the National Environmental Policy Act of 1969 (42 U.S.C. 4321), it is hereby ordered as follows:

SECTION 1. *Purpose.* It is the purpose of this order to establish policies and provide for procedures that will ensure that the use of off-road vehicles on public lands will be controlled and directed so as to protect the resources of those lands, to promote the safety of all users of those lands, and to minimize conflicts among the various uses of those lands.

SEC 2. *Definitions.* As used in this order, the term:

(1) "public lands" means (A) all lands under the custody and control of the Secretary of the Interior and the Secretary of Agriculture, except Indian lands, (B) lands under the custody and control of the Tennessee Valley Authority that are situated in western Kentucky and Tennessee and are designated as "Land Between the Lakes," and (C) lands under the custody and control of the Secretary of Defense;

(2) "respective agency head" means the Secretary of the Interior, the Secretary of Defense, the Secretary of Agriculture, and the Board of Directors of the Tennessee Valley Authority, with respect to public lands under the custody and control of each;

(3) "off-road vehicle" means any motorized vehicle designed for or capable of cross-country travel on or immediately over land, water, sand, snow, ice, marsh, swampland, or other natural terrain; except that such term excludes (A) any registered motorboat, (B) any military, fire, emergency, or law enforcement vehicle when used for emergency purposes, and (C) any vehicle whose use is expressly authorized by the respective agency head under a permit, lease, license, or contract; and

(4) "official use" means use by an employee, agent, or designated representative of the Federal Government or one of its contractors in the course of his employment, agency, or representation.

SEC 3. *Zones of Use.* (a) Each respective agency head shall develop and issue regulations and administrative instructions, within six months of the date of this order, to provide for administrative designation of the specific areas and trails on public lands on which the use of off-road vehicles may be permitted, and areas in which the use of off-road vehicles may not be permitted, and set a date by which such designation of all public lands shall be completed. Those regulations shall direct that the designation of such areas and trails will be based upon the protection of the resources of the public lands, promotion of the safety of all users of those lands, and minimization of conflicts among the various uses of those lands. The regulations shall further require that the designation of such areas and trails shall be in accordance with the following—

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

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

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

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

(b) The respective agency head shall ensure adequate opportunity for public participation in the promulgation of such regulations and in the designation of areas and trails under this section.

(c) The limitations on off-road vehicle use imposed under this section shall not apply to official use.

SEC. 4. *Operating Conditions.* Each respective agency head shall develop and publish, within one year of the date of this order, regulations prescribing operating conditions for off-road vehicles on the public lands. These regulations shall be directed at protecting resource values, preserving public health, safety, and welfare, and minimizing use conflicts.

SEC 5. *Public Information.* The respective agency head shall ensure that areas and trails where off-road vehicle use is permitted are well marked and shall provide for the publication and distribution of information, including maps, describing such areas and trails and explaining the conditions on vehicle use. He shall seek cooperation of relevant State agencies in the dissemination of this information.

SEC. 6. *Enforcement.* The respective agency head shall, where authorized by law, prescribe appropriate penalties for violation of regulations adopted pursuant to this order, and shall establish procedures for the enforcement of those regulations. To the extent permitted by law, he may enter into agreements with State or local governmental agencies for cooperative enforcement of laws and regulations relating to off-road vehicle use.

SEC. 7. *Consultation.* Before issuing the regulations or administrative instructions required by this order or designating areas or trails as required by this order and those regulations and administrative instructions, the Secretary of the Interior shall, as appropriate, consult with the Atomic Energy Commission.

SEC. 8. *Monitoring of Effects and Review.* (a) The respective agency head shall monitor the effects of the use of off-road vehicles on lands under their jurisdictions. On the basis of the information gathered, they shall from time to time amend or rescind designations of areas or other actions taken pursuant to this order as necessary to further the policy of this order.

(b) The Council on Environmental Quality shall maintain a continuing review of the implementation of this order.

RICHARD NIXON

THE WHITE HOUSE,
February 8, 1972

EXECUTIVE ORDER 11989

Off-Road Vehicles on Public Lands

By virtue of the authority vested in me by the Constitution and statutes of the United States of America, and as President of the United States of America, in order to clarify agency authority to define zones of use by off-road vehicles on public lands, in furtherance of the National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321 *et seq.*), Executive Order No. 11644 of February 8, 1972, is hereby amended as follows:

SECTION 1. Clause (B) of Section 2(3) of Executive Order No. 11644, setting forth an exclusion from the definition of off-road vehicles, is amended to read "(B) any fire, military, emergency or law enforcement vehicle when used for emergency purposes, and any combat or combat support vehicle when used for national defense purposes, and".

SEC. 2. Add the following new Section to Executive Order No. 11644:

"SEC. 9. *Special Protection of the Public Lands.* (a) Notwithstanding the provisions of Section 3 of this Order, the respective agency head shall, whenever he determines that the use of off-road vehicles will cause or is causing considerable adverse effects on the soil, vegetation, wildlife, wildlife habitat or cultural or historic resources of particular areas or trails of the public lands, immediately close such areas or trails to the type of off-road vehicle causing such effects, until such time as he determines that such adverse effects have been eliminated and that measures have been implemented to prevent future recurrence.

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

JIMMY CARTER

THE WHITE HOUSE,
May 24, 1977

APPENDIX 2
An Annotated Bibliography of the Effects of Off-Road Vehicles on the Environment*

Robert H. Webb and Howard G. Wilshire

TABLE OF CONTENTS

*U.S. Geological Survey Open File Report 78–149. This report is preliminary and has not been edited or reviewed for conformity with Geological Survey standards and nomenclature.

GENERAL PAPERS

Baldwin, M. F., and Stoddard, D. H., Jr., 1973, The off-road vehicle and environmental quality: 2nd ed. Washington, D.C., The Conserv. Found., 61 p.
Contains general information on the effects of different ORVs (snowmobiles, trail bikes, dune buggies) on soil, vegetation, and wildlife, and makes recommendations on the ORV problem with reference to environmental and socioeconomic considerations. A good review of studies of the effects of ORVs prior to 1973.

Berry, K. H., (ed.), 1973, Preliminary studies on the effects of off-road vehicles on the northwestern Mojave Desert: a collection of papers: Ridgecrest, Calif., privately publ., 100 p.
Contains seven articles on off-road effects on the ecology of the northwestern Mojave Desert. Four of the articles have been published in journals and are reviewed in their journal form; the other three are reviewed as they appear in this collection.

Berry, K. H., (ed.), 1978, The physical, biological, and social impacts of off-road vehicles on the California Desert: Proceedings of the May 1976 symposium held at Santa Barbara, Calif., So. Calif. Acad. Scis. Spec. Publ., in press.
Contains eight articles on ORV effects on the California Desert, all of which are reviewed elsewhere in this bibliography.

Bureau of Land Management, 1975, Evaluation report: 1974 Barstow-Las Vegas motorcycle race: Sacramento, Calif., Bureau of Land Management, 130 p.
Significant increases in bulk density occurred in two-thirds of the sample areas in the 1974 Barstow-Las Vegas race course in the Mojave Desert. Seedlings that had germinated in the course were destroyed; vegetation was heavily impacted in parking areas. The California atmospheric particulate standards were exceeded on the day of the race and the day after at one station. The total impacted area increased 25%, and the area of impacted race course increased 31% after the 1974 race.

Geological Society of America, Committee on Environment and Public Policy, 1977, Impacts and management of off-road vehicles: Boulder, Colo., Geol. Soc. Amer., 8 p.
This article provides an overview of ORV effects on natural ecosystems, although no new quantitative information is given. Suggestions for environmental management of ORV-use areas are offered with reference to existing laws and standard methods for soil conservation and environmental monitoring.

Godfrey, P. J., Brodhead, J., Walker, J., Gilligan, J., and Davis, A., 1975, Ecological effects of off-road vehicles in Cape Cod National Seashore, Massachusetts: Univ. Mass., Natl. Park Service Coop. Park Studies Unit, Inst. for Man and Environ., 10 p.

Godfrey, P. J., 1976, Summary of the environmental effects of off-road vehicles and some tentative suggestions for management procedures in the Cape Cod National Seashore: Univ. Mass., Natl. Park Serv. Coop. Park Studies Unit, Inst. for Man and Environ., 10 p.

Godfrey, P. J., Leatherman, S. P., and Buckley, P. A., 1978, Impact of off-road vehicles on coastal ecosystems: San Francisco, Calif., Proceedings of the symposium on technical, environmental, socioeconomic, and regulatory aspects of coastal zone planning and management, pp. 581-600.
Results show that the sensitivity of coastal ecosystems to ORV stress increases with the environmental stability of the ecosystem. Vegetation can be totally destroyed by even low levels of continuous ORV pressures. Stable upland sites are most vulnerable and should be protected from ORV use. Vehicle-induced bare spots in low marsh cause accelerated erosion. Pedestrian traffic was found to be more of a problem to nesting birds than vehicles. Sand transport rates increase in ORV-impacted dune systems. The article also contains information for management of ORVs in coastal areas.

Hutchinson, C. F., and Huning, J. R., 1973, Application of ERTS-1 pre-enhanced imagery for arid land recreation planning: Tucson, Ariz., Proc. Fourth Annu. Conf. on Remote Sensing in Arid Lands, Univ. Arizona, pp. 1-19.
Contains possible applications of remote sensing techniques to recreation monitoring and planning, with emphasis on the Barstow-Las Vegas motorcycle race.

Luckenbach, R. A., 1975, What the ORVs are doing to the desert: Fremontia 2(4): 3-11.
This article qualitatively examines the effect of ORVs on the Mojave Desert. Contains information on seedling germination, plant ecology, and plant geography.

Stebbins, R. C., 1974, Off-road vehicles and the fragile desert: Amer. Biol. Teacher 36(4-5): 203-208, 294-304.
This article deals qualitatively with the effect of ORVs on the Mojave Desert. Stressing heavily the effect of ORVs on the entire ecosystem, Stebbins demonstrates the need for more research into ORV impacts and more stringent management plans to prevent the spread of ORV use.

Tauman, R., 1977, Summer effects of vehicles on beaches of Fire Island, New York: State Univ. New York at Binghampton, M.A. project, 49 p.
University of California, Irvine, 1974, Desert land use and management in California: its ecological and sociological consequences: Irvine, Calif., Final Rept., NSF Grant GY-11425, 268 p.
This study examined the effects of ORVs near Joshua Tree, California, in the southern Mojave Desert. Penetrance measurements showed significant compaction in soils of campsites and roads. Lower plant densities occurred around camping areas, creosote bushes in campsites were under less moisture stress than bushes on bajadas, and soil organic nitrogen contents were lower in disturbed areas. Based on arthropod community structure measurements, the authors observed a consistent pattern of community disruption through reduction of flood resources. Reptile populations were reduced in use areas, although horned lizard populations increased near campsites. Various changes in rodent populations and interactions were measured. Extreme polarizations between desert recreationists and conservationists were determined from user surveys. This study examines the effects

of ORVs from a total ecosystem point of view, but suffers from the use of inadequate techniques for many measurements and lack of organization in the report.

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

The effect of controlled truck traffic on vegetation and wildlife was measured in the northern Mojave Desert. Annual plant densities were significantly less in regularly driven tracks although annual densities in randomly driven and control areas were not different. The extent of damage to shrubs was directly related to the amount of traffic; shrubs in regularly driven tracks were heavily damaged. Changes in the densities of vertebrates were not conclusive. Similar numbers of rodents and lizards were present in the study areas before and after the experiment.

THE EFFECTS OF OFF-ROAD VEHICLES ON SOIL

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

Tractor traffic caused increased bulk density and surface strength, and decreased infiltration rates in a clay loam near Katherine, Australia.

Barnes, K. K., Carleton, W. M., Taylor, H. M., Throckmorton, R. I., and Vanden Berg, G. E., 1971, Compaction of agricultural soils: St. Joseph, Mich., Amer. Soc. Agri. Engr. Monogr., 471 p.

An excellent source for information on compaction effects on soils and plant growth.

Barry, W. J., and Schlinger, E. I., 1977, Inglenook Fen: a study and plan: Sacramento, Calif., Calif. Dept. Parks and Rec., pp. 87-91.

ORV activities resulted in destabilization and increased erosion of Ten Mile Dunes in Mendocino County, California. ORV use stripped protective vegetation from stable dunes, causing blowouts and accelerated dune migration.

Bowden, L. W., Huning, J. R., Hutchinson, C. F., and Johnson, C. W., 1974, Satellite photograph presents first comprehensive view of local wind: the Santa Ana: Science 184: 1077-1078.

Contains LANDSAT-1 photos of dust generated by ORV use in the Mojave Desert.

Challinor, J. L., and Gersper, P. L., 1975, Vehicle perturbation effects upon a tundra soil-plant system: II. Effects on the chemical regime: Soil Sci. Soc. Amer. Proc. 39(4): 689-695.

Soil chemical property changes associated with tracked-vehicle perturbation were studied near Barrow, Alaska. Soluble nutrient levels were higher in track-influenced soils 6 years after disturbance, and the high nutrient levels, coupled with warmer temperatures, increased the productivity and quality of vegetation in the tracks.

Fox, M., 1973, Compaction of soil by off-road vehicles at three sites in the Mojave Desert, *in* Berry, K. H., (ed.)., Preliminary studies of the effects of off-road vehicles on the northwestern Mojave Desert: a collection of papers: Ridgecrest, Calif., privately publ., pp. 1-13.

The bulk density of ORV-impacted soil increased significantly at three sites northeast of California City in the western Mojave Desert.

Gersper, P. L., and Challinor, J. L., 1975, Vehicle perturbation effects upon a tundra soil-plant system: I. Effects on morphological and physical environmental properties of the soils: Soil Sci. Soc. Amer. Proc. 39(4): 737-744.

Permafrost in vehicle tracks had higher bulk densities and temperatures, accelerated and deeper thaw, and lower moisture percentages than undisturbed soils near Barrow, Alaska. A slight amount of disturbance may be beneficial to plant growth (see Challinor above) but heavier disturbance results in subsidence and erosion which prevents revegetation of the disturbed areas.

Harrison, R., 1976, Environmental effects of off-road vehicles: U.S. Dept. Agri., Engr. Tech. Inform. Sys., Field Notes 8(6): 4-8.

Contains a basic overview of ORV effects, mainly on soils. Discusses surface disturbance caused by ORVs, with emphasis on the effect of different tires on soils.

Hill, R. R., and Kirby, F. L., 1948, Tread ruts lead to gullies: Colorado Conserv. Comments 10(7): 11-12.

One of the first articles describing the effects of ORVs on soil. The authors describe in general terms erosion and subsequent deterioration of wildlife habitat resulting from indiscriminate jeep use in the back-country.

Knott, J. M., 1978, Assessment of erosion and sedimentation in the Hungry Valley area, Los Angeles and Ventura Counties, California: U.S. Geol. Survey Open-file Rept., in press.

Unregulated ORV activity has resulted in many adverse erosional effects in the upper part of Hungry Valley. Long-term sediment yield of the catchment area including the Hungry Valley ORV area was estimated at 124 $m^3/km^2/yr$. Many suggestions are made concerning regulation of use, maintenance and treatment of denuded areas to mitigate damage, and monitoring of use areas to determine long-term erosional effects.

Nakata, J. K., Wilshire, H. G., and Barnes, G. G., 1976, Origin of Mojave Desert dust plumes photographed from space: Geology 4(11): 644-648.

Using LANDSAT-1 imagery described by Bowden (see above), the authors located the sources of large dust plumes generated by a Santa Ana wind in the Mojave Desert. Road-building, agriculture, urbanization, stream-channel modification, and ORV activities destabilized natural surfaces to provide particulates for the plumes.

Niedorada, A., 1975, The geomorphological effects of off-road vehicles on coastal systems of Cape Cod, Massachusetts: Univ. Mass., Natl. Park Serv. Coop. Res. Unit, Contract Rept. Di-NPS-CS 1600-5-0001, No. 17, 100 p.

ORVs are unlikely to significantly affect active beach

systems at Cape Cod, although back beach areas are very sensitive and should be protected from such traffic. Experiments indicate that low-pressure tires on vehicles minimizes the effects of ORVs (however, see Harrison (1976)).

Rickard, W. E., and Slaughter, C. W., 1973, Thaw and erosion on vehicular trails in permafrost landscapes: J. Soil and Water Conserv. 28(6): 263-266.
The effects of road building on permafrost soils was studied north of Fairbanks, Alaska. Bulldozed access roads had thaw depth increases of 300% to 500% and showed considerable accelerated erosion. A planned access road used only by low ground-pressure vehicles had thaw depth increases of 180% to 300% although less erosion was occurring. The authors suggested an insulating surface of organic or inorganic nature be installed in access trails.

Rickard, W. E., and Brown, J., 1974, Effects of vehicles on arctic tundra: Environ. Conserv. 1(1): 55-62.
Studies near Barrow, Alaska indicate that ORVs can have serious effects on arctic tundra. Vehicle trails made in the 1940s show a low rate of natural recovery and stabilization. The long-term impact of ORVs is dependent on the time of year of impact, type of substrate, vegetation, soil moisture, ground-contact pressure, vehicle propulsion, and operator technique.

Snyder, C. T., Frickel, D. G., Hadley, R. F., and Miller, R. F., 1976, Effects of off-road vehicle use on the hydrology and landscape of arid environments in central and southern California: U.S. Geol. Survey, Water Resources Investigations 76-99, 45 p.
Studies at Panoche Hills in central California and Dove Springs Canyon in the western Mojave Desert showed that ORVs cause accelerated erosion and increased sediment yield from impacted areas. The ORV area at Panoche Hills produced eight times as much runoff as the unused area; the used area produced 857 m^3/km^{-2} of sediment compared to an insignificant sediment yield from the unused area. Bulk density measurements showed compaction in trails to a depth of over 1 m. Erosion benchmarks showed a loss of 0.15 to 0.30 m of surface material from trails in Dove Springs Canyon during the period of 1973 to 1975.

Sparrow, S. D., Wooding, F. J., and Whiting, E. H., 1978, Effects of off-road vehicle traffic on soils and vegetation in the Denali Highway region of Alaska: J. Soil and Water Conserv. 33(1): 20-27.
A study of ORV activity south of Fairbanks, Alaska found that bulk densities increased and denudation of vegetation occurred with moderate to heavy ORV use. The greatest soil damage occurred in poorly drained or loose, gravel-free soils, while soils high in gravel content were least susceptible to damage.

Visco, C., 1977, The geomorphic effects of off-road vehicles on the beach, Fire Island, New York: Binghamton, New York, State Univ. New York, unpubl. M.A. thesis, 74 p.

Vorhees, W. B., Senst, C. G., and Nelson, W. W., 1978, Compaction and soil structure modification by wheel traffic in the northern corn belt: Soil Sci. Soc. Amer. J. 42: 344-349.
The effect of controlled traffic on soil physical properties was measured in a Minnesota silty clay loam. Wheel traffic associated with normal farming operations was found to compact the soil to depths of 30 to 45 cm. The bulk density increased by 20% and the soil strength increased by up to 400% in the wheel tracks. Freeze-thaw loosening did not completely alleviate the compaction effects. Definite soil structural changes, both in bulk and individual units, are caused by spring wheel traffic. The penetrometer resistance was a more sensitive indicator of compaction than bulk density. This paper has an excellent bibliography of methods for studying soil compaction.

Webb, R. H., 1978, The effects of off-road vehicles on desert soil in the Dove Springs Canyon, *in* Berry, K. H., (ed.), The physical, biological, and social impacts of off-road vehicles on the California Desert: So. Calif. Acad. Scis. Spec. Publ., in press.
The effects of ORVs on soils were studied in Dove Springs Canyon in the western Mojave Desert. Field and aerial photo mapping showed a 27% increase in disturbed areas of the study site between 1973 and 1976. The surface strength of disturbed soil varied more than undisturbed soil and the bulk density was less in disturbed areas, indicating a loosening of surface crust and compaction of the sub-surface soils. These changes, coupled with loss of vegetative cover and steep slopes, increased the potential for accelerated wind and water erosion.

Webb, R. H., Ragland, H. C., Godwin, W. H., and Jenkins, D., 1978, Environmental effects of soil property changes with off-road vehicle use: Environ. Manage. 2(3): 219-233.
Accelerated erosion displaced 0.3, 0.5, and 3.0 metric $tons/m^{-2}$ from three trails at Hollister Hills State Vehicular Recreation Area in central California. Bulk density and surface strength increased while soil moisture decreased in trails on four soil types while a clay loam had increased strength, variably increased bulk density, and no change in soil moisture in trails. Diurnal temperature fluctuations increased and organic material and soil exchangeable ions decreased in trails. The clay loam was the only soil type which showed a resilience to impact from ORV use.

Wilshire, H. G., and Nakata, J. K., 1976, Off-road vehicle effects on California's Mojave Desert: Calif. Geol. 29(6): 123-132.
Soil strength was measured in five categories of surface materials along the 1974 Barstow-to-Las Vegas race course in the Mojave Desert. Soil compaction and loss of vegetative cover were the major short-term consequences of the race. This paper describes ORV effects on different landforms of the Mojave Desert.

Wilshire, H. G., and Nakata, J. K., 1977, Erosion off the road: Geotimes 22(7): 27.
Soil loss from an ORV-used hillside near Red Rock Canyon State Recreation Area in the western Mojave Desert was estimated at 0.2 metric $tons/m^{-2}$, or 11 million kg total.

Wilshire, H. G., 1977, Study results of nine sites used by off-

road vehicles that illustrate land modifications: U.S. Geol. Survey Open-file Rept. 77-601, 19 p.

A layperson's guide to the effects of off-road vehicles on soil, this report contains 21 black-and-white photos and text describing the heavily used ORV areas in California.

Wilshire, H. G., and Nakata, J. K., 1978, Erosion of off-road vehicle sites in southern California, *in* Berry, K. H., (ed.), The physical, biological, and social impacts of off-road vehicles on the California Desert: So. Calif. Acad. Scis. Spec. Publ., in press.

The erosional effects of heavy rains were studied at 13 sites in Southern California. The rains caused accelerated erosion of the ORV-destabilized surfaces at rates higher than in the nearby natural surfaces. ORV use increases the erosion potential of natural areas by denudation of vegetative cover, destruction of crusts and lag gravel surfaces, compaction of soils, and loosening of sandy soils.

Wilshire, H. G., Nakata, J. K., Shipley, S., and Prestegaard, K., 1978, Impacts of vehicles on natural terrain at seven sites in the San Francisco Bay Area: Environ. Geol., in press.

The results show increased surface strength, increased bulk density, (to depths of 90 cm or more), reduced soil moisture (to depths of 30 cm), greatly reduced infiltration, increased diurnal temperature fluctuations, and reduction in organic carbon in loamy soils. Soil erosion from vehicle sites was measured at 7 to 1,180 kg/m^2. Contains a literature review of ORV articles and related studies.

Related Studies

Booth, W. E., 1941, Algae as pioneers in plant succession and their importance in erosion control: Ecology 22(1): 38-46.

Algal growth in disturbed soil is the pioneer step of plant succession in the Midwest. Algae protect soil from erosion by stabilizing soil surfaces with a crust while allowing water to infiltrate through. Decaying algae add organic material and nutrients to the soil which promotes the growth of higher plants.

Buol, S. W., 1965, Present soil-forming factors and processes in arid and semiarid regions: Soil Sci. 99(1): 45-49.

Cameron, R. E., and Blank, G. B., 1966, Desert Algae: soil crusts and diaphanous substrata as algal habitats: Pasadena, Calif., Jet Prop. Lab. Tech. Rept. 32-971, 41 p.

Algal and lichen crusts have important effects on the stabilization, erodibility, infiltration, and penetration of desert soils. These crusts prepare eroded or barren soil for pioneer succession because they are one of the most important sources of soil organic matter in desert regions. Algae grow in many xeric and mesic desert environments, and can be found under translucent surface materials.

Fletcher, J. E., and Martin, W. P., 1948, Some effects of algae and molds in the rain-crust of desert soils: Ecology 29(1): 95-100.

The presence of algae and mold in desert soil rain-crusts helps retard erosion and stabilize the surface soil. A mechanical sorting of soil particles occurs just under the surface, indicating a non-random ordering in the rain-crust. Organic carbon and nitrogen content are high in the crusts, and the additional nutrients aid in the establishment of plant seedlings in the desert.

Mather, K. B., 1963, Why do roads corrugate?: Sci. Amer. 208: 128-136.

Rhythmical bouncing of vehicle wheels causes the common "washboarding" effect common in unpaved roads.

Rickard, W. H., and Murdock, J. R., 1963, Soil moisture and temperature survey of a desert vegetation mosaic: Ecology 44(4): 821-824.

Soil moisture is related to the type of shrub habitat and not directly to elevation in the northern Mojave Desert. Soil temperature is also related to the type of shrub habitat, although temperatures vary with altitude.

Related Studies—soil erodibility and erosion predictions

Anderson, H. W., 1951, Physical characteristics of soils related to erosion: J. Soil and Water Conserv. 6(3): 129-133.

Andre, J. E., and Anderson, H. W., 1961, Variation of soil erodibility with geology, geographic zone, elevation, and vegetation type in Northern California wildlands: J. Geophys. Res. 66(10): 3351-3358.

Soil developed from acid igneous rocks produced 2.3 time as much suspended sediment as soil derived from basalt.

Branson, F. A., and Owen, J. B., 1970, Plant cover, runoff, and sediment yield relationships on Mancos shale in western Colorado: Water Resources Res. 6(3): 783-790.

Runoff is significantly related to percent of bare soil, but sediment yield is related to other geomorphic factors such as slope length and angle, relief ratios, and drainage area.

Dodge, M., Burcham, L. T., Goldhaben, S., McCulley, B., and Springer, C., 1976, An investigation of soil characteristics and erosion rates on California forest lands: Sacramento, Calif., Div. Forestry, 105 p.

Gumbs, F. A., and Warkentin, B. P., 1972, The effect of bulk density and initial water content on infiltration in clay soil samples: Soil Sci. Soc. Amer. Proc. 36(4): 720-724.

Small decreases in bulk density markedly decreased infiltration in a clay. Thin compacted layers swell in contact with water and the density of these layers decreases over time.

Lyles, L., 1975, Possible effects of wind erosion on soil productivity: J. Soil and Water Conserv. 30(6): 279-283.

Using the wind erosion equation, the author estimated yield reductions in agricultural crops.

Megahan, W. F., and Kidd, W. J., 1972, Effect of logging roads on sediment production rates in the Idaho Batholith: Ogden, Utah, Intermtn. For. and Range Exp. Sta., For. Serv. Res. Pap. INT-123, 14 p.

Erosion rates decrease rapidly with time; 85% of granitic soil erosion in roadcuts occurs during the first year after construction. Stabilization of soils reduced erosion rates as much as 99% in roadfills.

Megahan, W. F., 1974, Erosion over time on severely disturbed granitic soils: a model: Ogden, Utah, Intermtn. For. and Range Exp. Sta., For. Serv. Res. Pap. INT-156, 14 p.
A model developed for surface erosion in granitic soils shows that erosion rates are functions of time. This implies limitations to other quantitative soil loss equations such as the universal soil loss equation.

Megahan, W. F., 1974, Deep-rooted plants for erosion control on granitic road fills in the Idaho Batholith: Odgen, Utah, Intermtn. For. and Range Exp. Sta., For. Serv. Res. Pap. INT-161, 18 p.
Tree planting, straw mulching, and erosion netting reduced erosion 95% over 3 years. Trees alone reduced erosion by 32% to 51%.

Megahan, W. F., 1978, Erosion processes on steep granitic road fills in central Idaho: Soil Sci. Soc. Amer. J. 42: 350-357.
Erosion from bare granitic soils averaged 3.4 metric tons/km−2-day. Tree planting and straw mulching reduced erosion 44% and 95%, respectively. Dry creep accounted for 15% of the total erosion over 3 years, and was as high as 40% one year.

Meyer, G. J., Schoeneberger, P. J., and Huddleston, J. H., 1975, Sediment yields from roadsides: an application of the universal soil loss equation: J. Soil and Water Conserv. 30(6): 289-291.

Willen, D. W., 1965, Surface soil textural and potential erodibility characteristics of some southern Sierra Nevada forest sites: Soil Sci. Soc. Amer. Proc. 28: 430-432.
U.S. Department of Agriculture, 1975, Guides for erosion and sediment control in California: Davis, Calif., Soil Conserv. Serv., 32 p. (with appendices).
The best source for information on use of the universal soil loss equation.

Wischmeier, W. H., 1974, New developments in estimating water erosion, *in* Land Use, Persuasion or Regulation?: Proc. of the 29th Annu. Meet. Soil Conserv. Soc. Amer., Syracuse, New York, pp. 179-186.
A source paper for information on the universal soil loss equation.

Wischmeier, W. H., 1976, Use and misuse of the universal soil loss equation: J. Soil and Water Conserv. 31(1): 5-9.
Contains recommendations for use of the universal soil loss equation based on the equation's derivation assumptions.

Woolridge, D. D., 1964, Effects of parent material and vegetation on properties related to soil erosion in central Washington: Soil Sci. Soc. Amer. Proc. 28: 430-432.
Over 40% of the variation in soil erodibility was related to soil organic matter content, pH, porosity, and bulk density.

Related Studies—effect of soil properties on plant growth

Arndt, W., 1965, The nature of mechanical impedance to seedlings by surface seals: Aust. J. Soil Res. 3: 45-54.
Describes the mechanism for seedling emergence through surface seals.

Arndt, W., 1965, The impedance of soil seals and the forces of emerging seedlings: Aust. J. Soil Res. 3: 55-68.

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

Blake, G. R., Nelson, W. W., and Allmaras, R. R., 1976, Persistence of subsoil compaction in a mollisol: Soil Sci. Soc. Amer. J. 40: 943-948.
Soil bulk density below the plowed surface layer did not change over a 9 year period in a Minnesota clay loam. The results indicate that compacted soils require a long recovery time.

Eck, H. V., Hauser, V. L., and Ford, R. H., 1965, Fertilizer needs for restoring productivity on Pullman silty clay loam after various degrees of soil removal: Soil Sci. Soc. Amer. Proc. 29(2): 209-213.

Grable, A. R., and Siemer, E. G., 1968, Effects of bulk density, aggregate size, and soil water suction on oxygen diffusion, redox potentials, and elongation of corn roots: Soil Sci. Soc. Amer. Proc. 32: 180-186.

Grimes, D. W., Miller, R. J., Schweers, V. H., Smith, R. B., and Wiley, P. L., 1972, Soil strength modification of root development and soil water extraction: Calif. Agri. 26(11): 12-14.
Soil strengths of greater than 250 psi restricted growth of cotton and corn seedlings in a sandy loam.

Lowry, F. E., Taylor, H. M., and Huck, M. G., 1970, Growth rate and yield of cotton as influenced by depth and bulk density of soil pans: Soil Sci. Soc. Amer. Proc. 34(2): 306-309.
Growth rates and yield of cotton decreased with increasing bulk density and strength in loamy sand.

Nielsen, K. F., and Humphries, E. C., 1966, Effects of root temperature on plant growth: Soils and Fertilizers 29(1): 1-7.
A review of the literature prior to 1966 on the effect of soil temperatures on root development and growth.

Phillips, R. E., and Kirkham, D., 1962, Mechanical impedance and corn seedling root growth: Soil Sci. Soc. Amer. Proc. 26: 319-322.
The rate of corn seedling root elongation decreased as bulk density and surface strength of a clay increased. Corn seedling penetration was inversely related to strength in sand.

Taylor, H. M., 1974, Root behavior as affected by soil structure and strength, *in* Carson, E. W., (ed.), The plant root and its environment: Charlottesville, Univ. Press of Virginia, pp. 271-291.

Taylor, H. M., and Gardner, H. R., 1963, Penetration of cotton seedling taproots as influenced by bulk density, moisture content, and strength of soil: Soil Sci. 96: 153-156.
Decreased cotton taproot penetration was negatively correlated to strength in a sandy loam. Soil strength, not bulk density, was the critical limitation to plant growth.

Taylor, H. M., and Burnett, E., 1964, Influence of soil

strength on the root-growth habits of plants: Soil Sci. 98: 174-180.

Soil strength primarily controls the growth of roots through sandy loam. No apparent differences were observed between the ability of different species to penetrate high-strength soils.

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

Sunflower roots failed to penetrate sandy soils with a density of 1.9 gm/cm−3, and clay soils with densities of 1.6 to 1.7 gm/cm−3.

Vorhees, W. B., Amemiya, M., Allmaras, R. R., and Larson, W. E., 1971, Some effects of aggregate structure heterogeneity on root growth: Soil Sci. Soc. Amer. Proc. 35: 638-643.

Vorhees, W. B., Farrell, D. A., and Larson, W. E., 1975, Soil strength and aeration effects on root elongation: Soil Sci. Soc. Amer. Proc. 39: 948-953.

Root elongation decreased with increasing soil strength in sandy loam and clay soils.

Wittsell, L. E., and Hobbs, J. A., 1965, Soil compaction effects on field plant growth: Agron. J. 57: 534-537.

Wheat yields decreased in a silt loam of 1.6 gm/cm−3 density, although the effects were not significant after two years recovery. Surface and subsurface compaction variably affects growth of field crops.

Zimmerman, R. P., and Kardos, L. T., 1961, Effect of bulk density on root growth: Soi. Sci. 91: 280-288.

The weight of roots penetrating a section of soil correlated negatively with bulk density in a number of different soils. Bulk densities of 1.8, 1.9, and 2.0 gm/cm³ excluded root penetration in silty clay, sandy clay loam, and sandy loam, respectively.

THE EFFECTS OF OFF-ROAD VEHICLES ON VEGETATION

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

The results show that summer use of dunes at Cape Cod National Seashore in Massachusetts can completely destroy above-ground vegetation, but leave enough of the underground root systems for regrowth in late fall after use has stopped. Deflation rates may be high in the defoliated areas, especially in trails aligned with prevailing winds.

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

Results showed a decrease in herbaceous plant cover and an increase in soil bulk density at two sites in the Fremont Valley of the Mojave Desert.

Duck, T., 1978, The effects of off-road vehicles on vegetation in Dove Springs Canyon, *in* Berry, K. H., (ed.), The physical, biological, and social impacts of off-road vehicles on the California desert: So. Calif. Acad. Scis. Spec. Publ., in press.

ORV use caused decreases in vegetative density, cover, and diversity in Dove Springs Canyon in the western Mojave Desert. The main cause of damage was direct destruction of shrubs by vehicles, and recovery of vegetation will be slow because of soil losses.

Foresman, C. L., Ryerson, D. K., Walejko, R. N., Paulson, W. H., and Pendleton, J. W., 1976, Effect of snowmobile traffic on bluegrass (*Poa pratensis*): J. Environ. Quality 5(2): 129-130.

Controlled snowmobile traffic did not change soil bulk density or bluegrass biomass in Wisconsin. Snowmobiles caused a slow spring recovery and growth of bluegrass, but biomasses were the same in tracked and untracked areas by early summer.

Fribourg, H. A., Overton, H. A., and Mullines, J. A., 1975, Wheel traffic on regrowth and production of summer annual grasses: Agron. J. 67: 423-426.

The effect of tractor and trailer passes on growth of annual grasses (agricultural) was studied in a Tennessee silt loam. Dry matter regrowth of the two grasses studied decreases sometimes 15 to 20%, often 30%, and occasionally 50%. The greatest reduction was attributed to the first wheel passage.

Gibson, J., 1973, An initial study of the impact of desert motorcycle racing in the Mojave Desert: Fullerton, Calif., Calif. State Univ., Res. Paper, Dept. of Biology.

Henry, M. A., 1978, A look at the effects of off-road vehicle use on Eureka Dune grass (*Swallenia alexandrae*), *in* Berry, K. H., (ed.), The physical, biological, and social impacts of off-road vehicles on the California desert: So. Calif. Acad. Scis. Spec. Publ., in press.

The effects of ORVs on Eureka Dune grass (an endangered species) was studied in the northern Mojave Desert. ORV use caused a 25% decrease in grass hummocks between 1974 and 1976.

Hjeljord, A. O., 1971, Studier av revegetasjonsforlop i gamle traktorspor pa Svalbard (Studies in revegetation in vehicle tracks in Svalbard): Norsk Polar. Ar., pp. 31-42, (with English abstract).

Vegetation changes and erosion were studied in old vehicle tracks in Sweden. Revegetation appeared to be slow in dry soils; some 50-year-old tracks were still without significant plant growth because of delayed thawing and increased moisture in the tracks. Revegetation occurred quickly in wet soils provided significant erosion had not occurred.

Keefe, J., and Berry, K., 1973, Effects of off-road vehicles on desert shrubs at Dove Springs Canyon, *in* Berry, K. H., (ed.), Preliminary studies on the effects of off-road vehicles on the northwestern Mojave Desert: a collection of papers: Ridgecrest, Calif., privately publ. pp. 45-57.

Results showed that ORV use caused significant decreases in shrub densities and diversity in Dove Springs Canyon in the western Mojave Desert. At the time of the article (1973), the authors estimated 543 acres of the

5000 acre Dove Springs Canyon open area had been denuded.

Walejko, R. N., Pendleton, J. W., Paulson, W. H., Rand, R. F., Tenpas, G. H., and Schlough, D. A., 1973, Effect of snowmobile traffic on alfalfa: J. Soil and Water Conserv. 28(6): 272-273.
Alfalfa damage from snowmobile traffic depended upon the snow depth and condition in Wisconsin. Soil bulk densities were unchanged in tracked areas, indicating that damage to alfalfa was not a result of compaction.

Westoff, V., 1967, The ecological impact of pedestrian, equestrian, and vehicular traffic on vegetation: Proc. Int. Union for Conserv. of Nature and Natural Resources 10: 218-223.
The effects of vehicles on vegetation can be both beneficial and harmful to vegetation. Roadside compaction of soil creates an environmental ecotone which promotes the growth of rare or unusual species; however, traffic and extensive human trampling directly harm plants and compact soil. The degree of damage an ecosystem can sustain depends on the relative stability of vegetation and soils.

Related Studies

Cottam, G., and Curtis, J. T., 1956, The use of distance measurements in phytosociological sampling: Ecology 37(3): 451-460.
Recommends use of the point-quarter method for perennial vegetation sampling.

Cress, D. H., and Link, L. E., Jr., 1976, The use of remote sensing devices for acquiring data for environmental management purposes: U.S. Army Engineers Waterways Experiment Station, Tech. Rept. M-74-8, No. 2, 48 p.

Graves, W. L., Kay, B. L., and Williams, W. A., 1978, Revegetation of disturbed sites in the Mojave Desert with native shrubs: Calif. Agri. 32(3): 4-5.
Results indicate that artificial revegetation is feasible in low-rainfall sites.

Johnson, H. B., Vasek, F. C., and Yonkers, T., 1975, Productivity, diversity, and stability relationships in Mojave Desert roadside vegetation: Bull. Torrey Bot. Club 102(3): 106-115.
Roads enhance the productivity and diversity of roadside vegetation in the Mojave Desert because roads concentrate runoff and create an artificial pool of available water. Most of the increased production was attributed to creosote bush. The roadside enhancement was compared to similar enhancement near washes.

Kay, B. L., Ross, C. M., Brown, C. L., and Graves, W. L., 1977, Mojave revegetation notes No. 1-21: Davis, Calif., Univ. Calif., publ. in Agron. and Range Sci.
This set of papers describe the potentials of 21 species of desert shrubs for revegetation purposes in the Mojave Desert. An excellent source for information on revegetation and general information on the individual shrub species.

Lunt, O. R., Letey, J., and Clark, S. B., 1973, Oxygen requirements for root growth in three species of desert shrubs: Ecology 54(6): 1356-1362.
Creosote bush and big-basin sage are generally excluded from fine-textured and poorly-drained soils because of high soil oxygen requirements for growth.

McIntosh, R. P., 1967, An index of diversity and the relation of certain concepts to diversity: Ecology 48(3): 392-404.

Muller, C. H., 1940, Plant succession in the *Larrea—Flourensia* climax: Ecology 21(2): 206-212.
This paper concludes that succession does not occur in the Sonoran Desert in western Texas, although the author compared communities on different soil types and slopes.

Shreve, F., and Hinckley, A. L., 1937, Thirty years of change in desert vegetation: Ecology 18(4): 463-478.
After 30 years of protection from grazing and other disturbance, the plant population increased 42% to 851% in a desert shrub community near Tucson, Arizona. The total number of large perennials remained the same, while the increases occurred in newly established shrubs and perennial grasses. The floral diversity was unchanged, and no trend other than population increases was noted.

Sternberg, L., 1976, Growth forms of *Larrea tridentata:* Madroño 23(8): 408-417.
Gives estimated ages of between 1000 and 5500 years for creosote bush clumps and rings in Lucerne and Johnson Valleys in the southern Mojave Desert.

Vasek, F. C., Johnson, H. B., and Eslinger, D. H., 1975, Effect of pipeline construction on creosote bush scrub vegetation of the Mojave Desert: Madroño 23: 1-13.
This study provides information on revegetation of areas totally disrupted by pipeline construction in the Mojave Desert. The pioneer species seemed to be short-lived perennials which normally occupy lightly-disturbed environments (washes) and the dominant long-lived perennials of the creosote-bush-scrub community. One creosote bush was radiocarbon dated at 585 years old. Vegetation recovery time from extreme disturbance probably is on the order of centuries.

Vasek, F. C., Johnson, H. B., and Brum, G. D., 1975, Effects of power transmission lines on vegetation of the Mojave Desert: Madroño 23(3): 114-130.
Power line construction and operation were found to slightly increase vegetative cover under the wire, enhance vegetation along the road edge, and variably affect vegetation under pylons in the Mojave Desert. Variability in vegetation under pylons indicates a low predictability of the time required for vegetative recovery because vegetation had not completely recovered after 33 years.

Wallace, A., Bamberg, S. A., and Cha, J. W., 1974, Quantitative studies of roots of perennial plants in the Mojave Desert: Ecology 55(5): 1160-1162.

Wells, P. V., 1961, Succession in desert vegetation on streets of a Nevada ghost town: Science 134: 670-671.
A study of a ghost town in the northern Mojave Desert showed that vegetation occupying sites disturbed 33 years previously is generally composed of shrubs which normally occupy naturally disturbed sites (washes).

Went, F. W., 1942, The dependence of certain annual plants on shrubs in southern California deserts: Bull. Torrey Bot. Club 69(2): 100-114.

Some desert annuals depend on shrubs for growth, and the size of individual annuals increases with the frequency of occurrence with a shrub species. Contains good information on annual distribution within the desert floral community.

Went, F. W., 1948, Ecology of desert plants. I. Observations on germination in the Joshua Tree National Monument, California: Ecology 29(3): 242–253.
Gives descriptions of germination of annual and perennial vegetation in the Joshua Tree area in the southern Mojave Desert.

Went, F. W., 1949, Ecology of desert plants. II. The effect of rain and temperature on germination and growth: Ecology 30(1): 1–13.
Examination of desert soil samples showed that many more viable seeds were present than germinated in a given growing season. Several annuals were shown to be temperature and/or rainfall dependent for germination, and that dependency can govern the amount of growth in a given year, the species composition of the annual vegetation during the year, and the elevational distribution of annuals.

Yang, T. W., and Lowe, C. H., Jr., 1956, Correlation of major vegetation climaxes with soil characteristics in the Sonoran Desert: Science 123(3196): 542.
Different soils characterize and associate with the major vegetation types in the same macroclimate of the Sonoran Desert.

THE EFFECTS OF OFF-ROAD VEHICLES ON WILDLIFE

Adams, E. S., 1975, Effects of lead and hydrocarbons from snowmobile exhaust on brook trout (*Salvelinus fontinalus*): Trans. Amer. Fisheries Soc. 104(2): 363–373.
Fingerling brook trout showed an uptake of lead and hydrocarbons from snowmobile exhaust in a Maine lake. Hydrocarbons and lead entered the lake from contaminated snow melts. Stamina decreased in fingerlings exposed to the polluted water.

Berry, K., 1973, The effects of off-road vehicles on fauna at Dove Springs Canyon, *in* Berry, K. H., (ed.), Preliminary studies on the effects of off-road vehicles on the northwestern Mojave Desert: a collection of papers: Ridgecrest, Calif., privately publ. pp. 78–95.
A descriptive paper on the ecology of Dove Springs Canyon in the western Mojave Desert with comments on the disruption caused by ORVs.

Bury, R. B., Luckenbach, R. A., and Busack, S. D., 1977, Effects of off-road vehicles on vertebrates in the California desert: Washington, D.C., U.S. Fish and Wildlife Service, Wildl. Res. Rept. 8, 23 p.
The effect of ORVs on vertebrate population compositions and diversity was measured in Stoddard, Anderson, and Johnson Valleys of the Mojave Desert. ORV use causes a significant decrease in reptile and rodent species, individuals, and biomass. The number of individuals decreased 45% and 80% and the biomass decreased 77% and 83% in heavily used and pit areas, respectively. Breeding-bird censuses showed a decrease in diversity, density, and biomass estimates in ORV areas. The results indicate that ORVs disrupt wildlife populations over large areas, and the impact of ORVs on wildlife must be taken into consideration in formulating management plans for ORV-use areas.

Busack, S. D., and Bury, R. B., 1974, Some effects of off-road vehicles and sheep grazing on lizard populations in the Mojave Desert: Biol. Conserv. 6(3): 179–183.
Some effects of off-road vehicles on lizard populations were studied in Dove Springs Canyon in the western Mojave Desert. The number and biomass of lizards decreased in areas of moderate and heavy use, although the data is limited. The authors attribute the reduction to loss of cover, reduction in food sources, disturbance of social structure, and casualties.

Byrne, S., 1973, The effect of off-road vehicle use in the Mojave Desert on small mammal populations, *in* Berry, K. H., (ed.), Preliminary studies on the effects of off-road vehicles on the northwestern Mojave Desert: a collection of papers: Ridgecrest, Calif., privately publ. pp. 64–77.
Fremont Valley and Dove Springs Canyon of the western Mojave Desert were studied for rodent population densities and diversity. The results indicated that ORV-disturbed areas supported lower rodent densities and diversity than similar, undisturbed areas.

Hicks, D., Sanders, A., and Cooperider, A., 1976, Impacts of Barstow-Las Vegas motorcycle race on wildlife habitat: Riverside, Calif., Bureau of Land Management unpubl. rept., 46 p.
A marked decline in rodent populations occurred in the starting area of the 1974 Barstow-Las Vegas race in the Mojave Desert. One year after the race, the estimated densities of rodents in undisturbed areas were approximately eight times greater than the densities in impacted areas. Results indicate a reduction in productivity and habitat quality in ORV-impacted areas of the desert.

Hoover, B., 1973, Off-road vehicle problems on Federal lands: Proc. Annu. Meet., Assoc. Midwest Fish Game Comm. 40: 37–49.
Contains information on ORV harassment of wildlife in western states. Elk in a re-established herd on BLM lands in Wyoming were driven out of the test area by an ORV rally. Elk populations decreased 50% in national forest lands on Pinon Mesa in Colorado. Elk in southern Utah fled from noise created by snowmobiles without seeing the vehicles. BLM closed a grazing area in northern California to ORVs because of adverse effects on cattle and wildlife.

Jorgensen, P., 1974, Vehicle use at a desert bighorn watering area: 18th Annu. Bighorn Coun. Trans., pp. 18–24.

Bighorn sheep use of a watering site in the Anza-Borrego Desert decreased 50% when ORVs were used in the area.

Luckenbach, R. A., 1978, An analysis of off-road vehicle use on desert avifaunas: Paper presented at 43rd N. Amer. Wildl. Conf., Phoenix, Ariz., 19 p.
Moderate ORV use caused a 50% reduction in the number of species of breeding birds in the Mojave Desert. The number of breeding pairs and average biomass decreased 24% and 22%, respectively. A 90% reduction in the number of breeding species occurred in an impacted wash in the Colorado-Sonoran Desert. ORVs indirectly affect birds by removal of food sources, destruction of nesting sites and perches, and harassment. In addition, ORV users have vandalized gallinaceous guzzlers, thus removing water sources for birds.

Luckenbach, R. A., and Bury, R. B., 1978, Off-road vehicle impact on desert vertebrates: a review, *in* Berry, K. H., (ed.), The physical, biological, and social impacts of off-road vehicles on the California desert: So. Calif. Acad. Scis., Spec. Publ., in press.
A review of the effects of ORVs on wildlife populations. ORVs can affect vertebrates directly by killing and harassing local populations or indirectly by destruction of habitat and removal of food sources.

Related Studies

Beatley, J. C., 1969, Dependence of desert rodents on winter annuals and precipitation: Ecology 50(4): 721–724.
Rodent reproduction was correlated with the amount of winter annuals; rodents did not reproduce when annuals failed to grow.

Reichman, O. J., 1942, Relation of desert rodent diets to available resources: J. Mammal. 56(4): 731–751.
Seeds are the primary food of all rodent species in the Sonoran Desert. The availability of resources generally determines the pattern of seed utilization.

EFFECTS OF TRAMPLING ON THE ENVIRONMENT

Brown, J. H., Jr., Kalisz, S. P., and Wright, W. R., 1977, Effects of recreation use on forested sites: Environ. Manage. 1(5): 425–431.
Bulk density and surface strength of soils increased in picnic and camping areas in Vermont. Infiltration rates were greatly reduced in recreation areas. Surface soil recharged and lost moisture at greater rates in the undisturbed areas. Compaction occurred to a depth of 12.7 cm. Stress-resistant plant species replaced more sensitive species in trampled areas, and the amount of bare area increased. Tree trunks were damaged, and two species of trees were smaller in the recreation sites.

Burden, R. F., and Randerson, P. F., 1972, Quantitative studies of the effects of human trampling on vegetation as an aid to the management of semi-natural areas: J. Appl. Ecology 9: 439–458.
Two methods of relating trampling intensity to environmental change are proposed and illustrated with field study results. Reviews the literature and calls for more quantitative studies of trampling effects.

Chappell, H. G., Ainsworth, J. F., Cameron, F. A. D., and Redfern, M., 1971, The effect of trampling on a chalk grassland ecosystem: J. Appl. Ecology 8: 869–882.
Trampling decreased the occurrence of several species of plants and causes a selection process against species less resistant to mechanical damage. Analysis of soils indicated no change in the chemical regime but showed significant compaction of soils. The density of soil fauna decreased in trampled areas.

Dale, D., and Weaver, T., 1974, Trampling effects on vegetation of trail corridors of northern Rocky Mountain forests: J. Appl. Ecology 11: 767–772.
Trail systems were studied in Montana, and the results indicate that only a narrow (1–2 m) band of vegetation is affected and some selection of vegetation occurs in trailsides. Trail widths increase slowly with increasing traffic and horse trails are deeper than hiking trails.

Dotzenko, A. D., Papmichos, N. T., and Romine, D. S., 1967, Effect of recreational use on soil and moisture conditions in Rocky Mountain National Park: J. Soil and Water Conserv. 22(5): 196–197.
Bulk densities increased and moisture and organic material decreased in soils of campgrounds in Rocky Mountain National Park. Trampling affects soils with high organic matter contents less than coarse-textured soils with low organic matter contents.

Duffey, E., 1975, The effects of human trampling on the fauna of grassland litter: Biol. Conserv. 7(4): 255–274.
Treading reduced volume and proportion of air space in grassland litter. Invertebrate fauna numbers and species declined substantially, although variable effects occurred at the species level. Changes in invertebrate fauna occur at levels of trampling lower than those required for damage to plants.

Legg, M. H., and Schneider, G., 1977, Soil deterioration on campsites: Northern forest types: Soil Sci. Soc. Amer. J. 41: 437–441.
Bulk densities increased and litter cover decreased at campsites in northern Michigan. Although some recovery was noted, the effects of trampling increased from season to season.

Liddle, M. J., and Moore, K. G., 1974, The microclimate of sand dune tracks: the relative contribution of vegetation removal and soil compression: J. Appl. Ecology 11(3): 1057–1068.
Compaction from vehicles and trampling increased soil bulk density and thermal capacity in sand dunes in Wales. Vegetation removal increased diurnal soil temper-

ature fluctuations, but compaction reduced fluctuations. The combination of compaction and vegetation removal increased diurnal soil and air temperature fluctuations in trampled and vehicle-use areas.

Liddle, M. J., 1975, A selective review of the ecological effects of human trampling on natural ecosystems: Biol. Conserv. 7(1): 17–36.
Reviews the literature and calls for more detailed studies of trampling. A good source of information on the effects of trampling on natural ecosystems.

Liddle, M. J., 1975, A theoretical relationship between the primary productivity of vegetation and its ability to tolerate trampling: Biol. Conserv. 8(4): 251–255.
The vulnerability of vegetation to trampling is inversely related to its primary productivity. Trampling tolerances of different habitats may be predicted quantitatively in the future for use in recreation planning.

Liddle, M. J., and Grieg-Smith, P., 1975, A survey of tracks and paths in a sand dune ecosystem: I. Soils: J. Appl. Ecology 12(3): 893–908.
Compaction of sand dunes was studied in Wales. Increases in soil bulk density and penetration resistance were correlated with the number of vehicle passes and human treads. Car passes increased the bulk density 30% and the penetration resistance by 100% more than an equal number of human treads. The volume-percent moisture increased in trails, possibly providing a water source for invading plants.

Liddle, M. J., and Grieg-Smith, P., 1975, A survey of tracks and paths in a sand dune ecosystem: II. Vegetation: J. Appl. Ecology 12(3): 909–930.
Soil bulk density and moisture strongly affected the composition of vegetation in tracked sand dunes in Wales. Biomass and the number of species of vegetation decreased in trampled areas, although diversity was not always affected. The authors suggest that soil can be lightly compacted to influence the floral composition of recreation areas.

Packer, P. E., 1953, Effects of trampling disturbance on watershed condition, runoff, and erosion: J. Forestry 51(1): 28–31.
The effects of controlled trampling were studied in granitic soils of Idaho. Trampling decreased ground cover and increased overland flow and soil erosion. The results emphasize the importance of maintaining litter cover to retard runoff and erosion.

Power, W. E., 1974, Effects and observations of soil compaction in the Salem District (Oregon): Technical Note, Bureau of Land Management, 12 p.
Bulk densities increased in logged areas of Oregon. Trees growing in compacted soil were stunted. The major effect of compaction occurs during the first 10 to 30 years of tree growth.

Willard, B. E., and Marr, J. W., 1970, Effects of human activities on alpine tundra ecosystems in Rocky Mountain National Park, Colorado: Biol. Conserv. 2(4): 257–265.
Tundra ecosystems respond differentially to trampling effects. Areas with high soil-moisture contents are easily damaged, while turf-covered ground is most durable. A descriptive paper only.

EFFECTS OF NOISE ON THE ENVIRONMENT

Bondello, M. C., 1976, The effects of high intensity motorcycle sounds on the acoustical sensitivity of the desert iguana, *Dipsosaurus dorsalis:* Fullerton, Calif., State Univ., unpubl. M.A. thesis, 38 p.
Results show that the acoustical sensitivity of desert iguanas is lost after less than one hour of exposure to motorcycle sounds. Sensitivity loss occurred in less than one hour and full recovery time exceeds seven days. Permanent sensitivity losses occurred after both one and ten hours of exposure time.

Gibson, J., and Blend, H., 1974, Desert racing motorcycles exceed the hour-noise exposure limit recommended by O.S.H.A.: Fullerton, Calif., Calif. State Univ., unpubl. paper, Dept. Physics, 8 p.
Sound produced by 135 motorcycles range from 84 dB to 128 dB, most of which exceed the 90 dB standard recommended by the American Motorcycle Association. Ambient sound levels in a Johnson Valley pit area in the Mojave Desert were 124 dBA for 10 hours, 108 dBA for 6 hours, and 124 dBA until the start of the race. The start of the 1973 Barstow-Las Vegas race in the Mojave Desert produced a noise level in excess of 140 dBA. The Occupational Safety and Health Administration (O.S.H.A.) recommends maximum exposure times of 7.5 minutes for a noise level of 120 dBA and 47 seconds for levels in excess of 140 dBA.

Gibson, J., Blend, H., and Brattstrom, B., 1975, Sound levels transmitted into burrows of desert mammals: Fullerton, Calif., Calif. State Univ., unpubl. paper, Depts. Physics and Biology, 6 p.
Mammals trapped after the 1973 Barstow-Las Vegas motorcycle race in the Mojave Desert showed bleeding from ear and nasal passages, aggressiveness, and disorientation. The average noise level from a 100 cc motorcycle was 106 dB, while noise levels in open and closed burrows near the motorcycle were 97 dB and 78 dB, respectively. The authors conclude that desert rodents cannot easily escape motorcycle-generated noise.

Rennison, D. C., and Wallace, A. K., 1976, The extent of acoustic influence of off-road vehicles in wilderness areas: Paper presented at Natl. Sym. for Off-road Vehicles in Australia, Australian Natl. Univ., 19 p.
A theoretical model was derived for the variation of noise from ORVs with distance from the source. The results of the model and field tests show that 1 motorcycle can be heard for a distance of 2 km and 10 motorcycles can be heard for a distance of 4 km in open country. The authors suggest locating ORV facilities in areas of high ambient noise levels (eg. near freeways) to reduce the acoustical effects of ORVs on humans and wildlife.

Woodleif, C. B., Royster, L. H., and Huang, B. K., 1969, Effects of random noise on plant growth: J. Acoust. Soc. Amer. 46(8): 481–482.

The growth rate of tobacco plants decreased 41% when subjected to a high level of random noise.

OFF-ROAD VEHICLE MANAGEMENT

Badaracco, R. J., 1976, ORVs: Often rough on visitors: Parks and Recreation 4(9): 32–35, 68–75.
The first journal article on the effects of ORV use on other recreationists, this study indicates that ORV users disturb and eventually displace other, non-ORV recreationists from recreation areas.

Badaracco, R. J., 1978, Conflicts between off-road vehicle enthusiasts and other outdoor recreationists—the ISD syndrome, *in* Berry, K. H., (ed.), The physical, biological, and social impacts of off-road vehicles on the California Desert: So. Calif. Acad. Scis. Spec. Publ., in press.

Bennett, S., 1973, A trail rider's guide to the environment: Westerville, Ohio, The Amer. Motorcycle Assoc., 60 p.
A layperson's guide to the effects of ORVs on the environment, written for users in a very readable style.

Briggs, P., and Tellier, A. H., 1977, The desert alternative: Cycle Guide, January 1977, pp. 70–72, 77.
A popularized version of Wilshire and Nakata's 1976 article on the Barstow-Las Vegas motorcycle race with warnings to users about the possible consequences of abusing the desert.

Carter, J., 1977, Excutive order 11989: Off-road vehicles on public lands: Federal Register 42(101), 2 p.
Orders land managers to close public lands to ORV use if the use causes or will cause " . . . considerable adverse effects on the soil, vegetation, wildlife, wildlife habitat. . . . ".

Godfrey, P. J., 1976, Management guidelines for parks on barrier beaches: Boston, Mass., Natl. Park Service, pp. 5–10.
Contains suggestions for management of ORVs in coastal beach and dune areas.

Jaquish, O. W., and Loser, J. R., 1973, Motorcycle farm: Soil Conserv. 38(12): 262–263.
Describes a motorcycle park in Pennsylvania that was built with soil conservation principles in mind.

Nixon, R. M., 1972, Executive order 11644: Use of off-road vehicles on public lands: Federal Register 37(27).
Calls for regulation of ORVs on public lands to protect resources, promote safety, and minimize conflicts among the various users.

Rasor, R., 1976, Fair share: Amer. Motorcycle Assoc. News, August 1976, pp. 16–17.
Describes the state of Washington's trail-building and maintenance program for ORVs, mainly trail bikers.

Rosenberg, G. A., 1976, Regulation of off-road vehicles: Environ. Affairs 5(1): 175–206.
Contains a review of Federal laws applying to ORV use on public lands.

Smith, G. S., 1978, Eureka Sand Dune: a case study of frustrated scientists, *in* Berry, K. H., (ed.), The physical, biological, and social impacts of off-road vehicles on the California desert: So. Calif. Acad. Scis. Spec. Publ., in press.

Stebbins, R. C., Papenfuss, T. J., and Amamoto, F. D., 1977, The California Desert: multiple uses and conflicting demands: Bull. of Inst. of Gov. Studies, Public Affairs Rept. 18(6): 7 p.
Contains information on current research in the California desert and conflicts between research of natural areas and current land use policies.

Wilshire, H. G., 1978, Orphaning desert lands: Cry Calif. 13(1): 5–7.
Calls for advance planning of ORV areas to include reclamation similar to that required in strip-mining areas.

POPULAR ARTICLES ON OFF-ROAD VEHICLE USE

American Association for the Advancement of Science, 1974, Off-road vehicle use: Science 184: 500–501.

Anon, 1962, NPA opposes motor scooter use in National Forests: Natl. Parks Magazine 36: 16.

Anon, 1970, Mechanized monsters: Time 96: 41.

Anon, 1977, California's deserts increasingly damaged by off-road vehicles: Conserv. News 42(15): 15.

Broadbent, S., 1974, Scavengers on wheels: Sierra Club Bull. 59(4): 9–11.

Carter, L. J., 1974, Off-road vehicles: a compromise plan for the California desert: Science 183: 396–399.

Fialka, J., 1975, Running wild: Natl. Wild. 13(2): 36–41.

Grant, R. A., Jr., 1973, The fight for the California desert: conserve or destroy: Cry Calif. 8(1): 4–12.

Hope, J., 1972, The invasion of the awful machines: Audubon 74: 36–43.

Dunn, D. R., 1970, Motorized recreation vehicles . . . on borrowed time: Parks and Rec. 5(7): 10–14, 46–52.

Medders, S., 1973, Crisis in a ravaged land: the California desert: Natl. Parks and Conserv. 47(12): 14–19.

Murchie, D. R., 1973, What trackless desert: Sierra Club Bull. 58(3): 25–28.

Nowinson, D., 1972, Our diminishing desert: Ecology Today 2(3): 32–33.

Stebbins, R. C., and Cohen, N. W., 1976, Off-road menace: a survey of damage in California: Sierra Club Bull. 61(7): 33–37.
A descriptive article on ORV effects, of interest because of a location map of some ORV areas in California.

Watkins, T. H., 1969, Infernal machines on public lands: Cry Calif. 4: 6–19.

Wood, H. W., Jr., 1974, Death Valley: desert wilderness in danger: Natl. Parks and Conserv. 48(1): 4–9.

OFF-ROAD VEHICLE BIBLIOGRAPHIES

Albrecht, J., and Smith, D., 1977, Environmental effects of off-road vehicles: a selected bibliography of publications in the University of Minnesota Forestry Library: Univ. Minn., St. Paul Campus Libraries, Forestry Library, Biblio. Ser. No. 2: 9 p.

Bury, F. L., 1976, Off-road recreation vehicles: research results, administrative reports, and technical articles, 1970–1975: Coun. of Planning Librarians, Exchange Biblio. 1067: 23 p.

Bury, F. L., Wendling, R. C., and McCool, S. F., 1976, Off-road recreation vehicles—a research summary, 1969–1975: Texas Agri. Exp. Station, Texas A&M Univ. Sys: 84 p.

Lime, D. W., and Leatherberry, E. C., 1974, Off-road recreation vehicle (ORRV) bibliography: St. Paul, Minn., North Central Forest Exp. Station: 17 p.

Lodico, N. J., 1973, Environmental effects of off-road vehicles: U.S. Dept. Interior, Office of Library Services, Biblio. Series No. 29: 109 p.

ABSTRACTS

Blodgett, B. G., and Smith, D., 1976, The effects of off-road recreational vehicles on shorebird populations: Abstracts, First Conf. on Sci. Res. in the Natl. Parks, p. 214.

Bondello, M. C., 1977, The effect of high-intensity motorcycle sounds on the acoustical sensitivity of the desert iguana, *Dipsosaurus dorsalis: in* Abstracts, So. Calif. Acad. Scis. Annu. Meet., Pomona, Calif., p. 5.

Brodhead, J. M. B., and DiMaio, J., 1976, Off-road vehicle impact on a salt marsh in Cape Cod National Seashore, Massachusetts: *in* Abstracts, First Conf. on Sci. Res. in the Natl. Parks, p. 211.

Brodhead, J. M. B., DiMaio, J., Zaremba, R., and Elmer, D., 1976, Effect of off-road vehicle traffic on beach and dune vegetation: *in* Abstracts, First Conf. on Sci Res. in the Natl. Parks, p. 212.

Bury, R. B., 1976, The effects of off-road vehicles on vertebrates in the western Mojave Desert: *in* Abstracts, So. Calif. Acad. Scis. Annu. Meet., Santa Barbara, Calif., p. 47.

Coates, D. R., 1978, Geomorphology, vehicles, and legal affairs, Fire Island, New York: Geol. Soc. Amer., Abs. Progs., v. 10, no. 2, p. 37.

Duck, T. A., 1976, The effects of off-road vehicles on desert flora: *in* Abstracts, So. Calif. Acad. Scis., Annu. Meet., Santa Barbara, Calif., p. 44.

Gowdin, W. H., 1977, Off-road vehicle use and erosion at Hollister Hills Park: *in* Abstracts, So. Calif. Acad. Scis., Annu. Meet., Pomona, Calif., p. 5.

Hadley, R. F., and Snyder, C. T., 1975, Environmental impacts of off-road vehicles in arid areas: Geol. Soc. Amer. Abs. Prog., v. 7, p. 1095.

Henry, M. A. H., 1976, A living fossil—*Swallenia alexandrae: in* Abstracts, So. Calif. Acad. Scis., Annu. Meet., Santa Barbara, Calif., p. 45–46.

Leatherman, S. P., and Anders, F. J., 1978, The geomorphic effects of off-road vehicles on beaches and dunes: Geol. Soc. Amer., Abs. Progs., v. 10, no. 2, p. 72.

Leatherman, S. P., Hamilton, J. A., and Carey, W. L., 1976, The effects of off-road vehicles on the geomorphology of dunes in the Cape Cod National Seashore: *in* Abstracts, First Conf. on Sci. Res. in the Natl. Parks, p. 215.

Mispagel, M. E., Zembal, R., 1976, Effect of military maneuvers on Mojave Desert vegetation: *in* Abstracts, So. Calif. Acad. Scis., Annu. Meet., Santa Barbara, Calif., p. 44.

Ragland, H. C., 1977, The effects of off-road vehicles on soil temperature and nutrients: *in* Abstracts, So. Calif. Acad. Scis. Annu. Meet., Pomona, Calif., p. 7.

Smith, G. S., 1976, Eureka sand dune: A case study of frustrated scientists: *in* Abstracts, So. Calif. Acad. Scis. Annu. Meet., Santa Barbara, Calif., p. 46.

Turner, F. B., Vollmer, A. T., Maza, B. G., and Medica, P. A., 1976, Effects of off-road vehicles on a creosote-bush community in Southern Nevada: *in* Abstracts, So. Calif. Acad. Scis. Annu. Meet., Santa Barbara, Calif., p. 45.

Webb, R. H., 1976, The effect of off-road vehicles on desert soil: *in* Abstracts, So. Calif. Acad. Scis. Annu. Meet., Santa Barbara, Calif., p. 43.

Webb, R. H., 1977, Physical property changes with off-road vehicle soil modification: *in* Abstracts, So. Calif. Acad. Scis. Annu. Meet., Pomona, Calif., p. 6.

Wheeler, N. R., 1976, Effects of the predator *Polinices duplicatus* (Gastropoda) and off-road vehicles on the *Mya arenaria* (Pelecypoda) population in Hatchs Harbor, Cape Cod National Seashore, Massachusetts: *in* Abstracts, First Conf. on Sci. Res. in the Natl. Parks, p. 213.

Wilshire, H. G., Nakata, J. K., and Fitzgerald, C. S., 1976, Physical effects of off-road vehicle use of the land: *in* Abstracts, So. Calif. Acad. Scis. Annu. Meet., Santa Barbara, Calif., pp. 46–47.

Wilshire, H. G., and Nakata, J. K., 1976, Erosional consequences of off-road vehicle recreation in California: Geol. Soc. Amer., Abs. Prog., v. 8, no. 6, p. 1171–1172.

APPENDIX 3
Estimated Motorized Recreational Fuel Consumption

Snowmobiles:
53 gallons per year per vehicle
2.2 million snowmobiles
Fuel consumption = 116.6 million gallons

Motorcycles:
30 gallons per year per vehicle
(1,500 miles per year divided by 50 miles per gallon)
5.4 million ORV cycles
Fuel consumption = 162 million gallons

Dune Buggies:
33 gallons per year per vehicle
(500 miles per year divided by 15 miles per gallon)
250,000 dune buggies
Fuel consumption = 8.25 million gallons

Four-Wheel Drive Vehicles:
500 gallons per year per vehicle
(5,000 miles per year divided by 10 miles per gallon)
1.5 million 4x4s used off-road (very rough estimate)
Fuel consumption = 750 million gallons

Subtotal	1,036.85
+ other ORVs	13.15
Total	1,040 million gallons

APPENDIX 4

Department of the Interior

Office of the Secretary News Release

For Release May 26, 1977

INTERIOR SECRETARY SAYS OFF-ROAD VEHICLE USE WILL CONTINUE

Secretary of the Interior Cecil D. Andrus said today that the new Executive Order governing off-road vehicles on Federal lands will be applied to fragile areas which are actually threatened with serious damage.

"As we have said several times now, it does not amount to anything resembling a general ban against the use of off-road vehicles on Federal lands," he said, "and we have no intention of exceeding the scope of its limited intent."

He said much would depend on the voluntary actions of off-road vehicle users, who, he said, could prevent many problems by respect for land and its resources.

The Executive Order authorizes the heads of Federal land managing agencies to close off "particular areas or trails" where use of off-road vehicles "will cause or is causing considerable adverse effects on the soil, vegetation, wildlife, wildlife habitat or cultural or historic resources."

Andrus also noted the Executive Order's reference to "the type of off-road vehicle causing such effects," which clearly indicates that types of vehicles doing no harm will not be affected.

"Further, there is no new broad grant of authority to close off large blocks of land," the Secretary said. "The agency head can close off 'portions' of the lands his agency manages, and we interpret that to mean limited areas."

The Interior Department, he said, will continue to protect the resources of the lands it manages, using its authority at times and places where it becomes clearly necessary.

Some 80,000 concerned citizens have written to the White House and the Interior Department this spring expressing concern that the new Executive Order would result in a general ban against off-road vehicle use on Federal lands.

The Secretary urged off-road vehicle user organizations to spread the word about the actual language and intent of the order. He also expressed hope that user groups and the industries producing off-road vehicles would take part in public discussions leading to planning the uses of Federal lands, educate their members about the issues, develop and enforce good codes of conduct, and cooperate with Federal land managers on the ground.

"These are everyone's lands, and their public values must survive to be used and enjoyed by future generations," he said.

Andrus added that he will continue to oppose the idea of the Department adopting a system of individual vehicle permits for off-road use on public domain lands. Group permits will be required for special events as in the past, he said.

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