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Evaluation of Areas for Off-Road Recreational Motorcycle Use, Volume I: Evaluation Method

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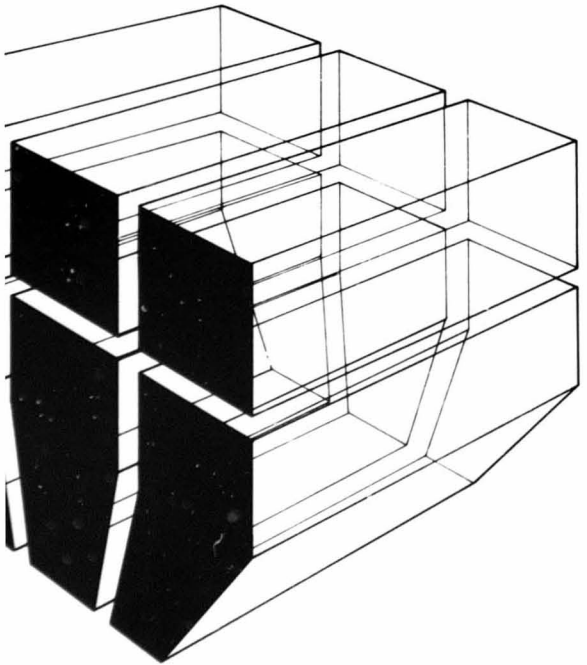
November 1980

Guidelines for Natural Resources Management and Land Use Compatibility

EVALUATION OF AREAS FOR OFF-ROAD RECREATIONAL MOTORCYCLE USE VOLUME I: EVALUATION METHODS



by
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To answer user demands for more areas on which to operate off-road recreational motorcycles (trailbikes), and to respond to Presidential Executive Orders which require that Federally-owned lands be evaluated for such use, Army land managers need a systematic way of determining land use suitability. This report describes the method developed by the U.S. Army Construction Engineering Research Laboratory (CERL) to help installation personnel comply with the policies, procedures, and criteria of Army Regulation (AR) 210-9, *Use of Off-Road Vehicles on Army Lands.*

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Volume I of this report describes the factors considered in CERL's evaluation method, including incompatible land uses, noise-sensitive land uses, user requirements, trail development, vehicle operating conditions, and methods to rate potential use areas in terms of soil suitability and the relative value and susceptibility to damage of biological resources. The evaluation method given in Volume I can be performed by personnel normally charged with land management planning and does not rely extensively on outside experts. This evaluation method may also be used for many public and private applications.

Volume II describes seven alternative soil evaluation methods which can be used with the evaluation method described in Volume I.

FOREWORD

This investigation was performed for the Directorate of Military Programs, Office of the Chief of Engineers (OCE), under Project 4A762720A896, "Environmental Quality for Construction and Operation of Military Facilities"; Task B, "Land Use Planning"; Work Unit 024, "Guidelines for Natural Resources Management and Land Use Compatibility." The applicable QCR is 3.01.001. The OCE Technical Monitor was Mr. Donald Bandel, DAEN-MPO-B.

The work was performed by the Environmental Division (EN), U.S. Army Construction Engineering Research Laboratory (CERL). Dr. E. W. Novak was Acting Chief of CERL-EN. The technical assistance of Mr. R. C. Lozar and Mr. J. C. McBryan of CERL, and the cooperation of the staff of the Soil Survey Interpretations Division, U.S. Department of Agriculture (USDA), Soil Conservation Service (SCS) is gratefully acknowledged.

COL Louis J. Circeo is Commander and Director of CERL and Dr. L. R. Shaffer is Technical Director.

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EVALUATION OF AREAS FOR OFF-ROAD RECREATIONAL MOTORCYCLE USE VOLUME I: EVALUATION METHOD

1 INTRODUCTION

Background

Over the past two decades, there has been a rapid increase in the production, sales, and use of off-road vehicles (ORVs). There are approximately 10 million ORVs in the United States. An ORV is defined as any motorized vehicle designed primarily for, or capable of, cross-country travel on or immediately over land, water, sand, snow, ice, marsh, swampland, or other natural terrain. This definition excludes any registered motorboat, any military, fire, ambulance, or law enforcement vehicle when used for emergency purposes; any combat or combat support vehicle when used for national defense purposes; and any vehicle authorized for official use. Most ORVs are used as off-road recreational vehicles (ORRVs). These vehicles include snowmobiles, dune buggies, trailbikes, all-terrain vehicles, swamp buggies, four-wheel drive trucks, and many more. The most common is the trailbike.

By the early 1970s, it was recognized that the widespread use of ORRVs was frequently in conflict with wise land and resource management practices. This prompted President Nixon to issue Executive Order 11644 in 1972 and President Carter to issue Executive Order 11989 in 1977.[1] These orders require that public lands in the custody of the Federal Government be evaluated for potential use by ORRVs. They establish policies and provide for procedures that would ensure that the use of ORRVs on public lands would be controlled and directed so as to protect natural resources, promote the safety of all users, and minimize conflicts among various land uses.

In response to these orders, Army Regulation (AR) 210-9 was issued in 1975 and revised 1 July 1978.[2] AR 210-9 establishes Army policies, procedures, and criteria for controlling off-road travel by ORRVs and prescribes appropriate operating conditions for the use of such vehicles. AR 210-9 also charges commanders of Army installations and activities with determining the suitability of installation lands for ORRV use. The policies and criteria in AR 210-9 require input from various Facilities Engineer (FE) elements. For example, Paragraph 7 of AR 210-9, Environmental Considerations, states that the environmental and related impacts of ORRV use will be assessed according to AR 200-1.[3] Significant responsibility for such assessments is normally delegated to FE elements. In addition, much of the information and technical expertise needed to meet the policy requirements described in AR 210-9 are found in the FE's natural resources sections.

To help Army personnel fulfill the requirements of the AR 210-9, the U.S. Army Construction Engineering Research Laboratory (CERL) has developed a systematic method of evaluating installation lands for suitability for use by trailbikes. This method can be used by installation environmental offices, FE natural resource sections, and installation master planning offices. The method was developed as part of the Army's environmental research program.*

[1] U.S. President (Richard Nixon) 1972, "Use of Off-Road Vehicles on the Public Lands, Executive Order 11644," *Federal Register*, Vol 37, No. 27, 2877-2878; and U.S. President (Jimmy Carter) 1977, "Off-Road Vehicles on Public Lands, Executive Order 11989, *Federal Register*, Vol 42, No. 101, 26959-26960.

[2] *Use of Off-Road Vehicles on Army Lands*, Army Regulation (AR) 210-9 (Department of the Army, 1 July 1978).

[3] *Environmental Protection and Enhancement*, AR 200-1 (Department of the Army, 7 December 1973).

* The information in Volume I of this report was published as an Engineer Technical Note (ETN), *Evaluation of Areas for Off-Road Recreational Motorcycle Use*, ETN No. 80-9 (U.S. Department of the Army, Office of the Chief of Engineers, 4 March 1980).

Objective

The objective of this study is to provide information for evaluating areas for off-road recreational motorcycle use. This volume describes how to use CERL's land use suitability evaluation method.

Approach

Efforts to develop the evaluation method described in this report began with a search of the literature to identify and analyze existing evaluation techniques. Although literature on the subject was extensive, most published techniques dealt with only one or more aspects of the subject, i.e., noise, soil damage, impact on vegetation, trail development, user profiles, or environmental monitoring. No *overall* planning, evaluation, or development techniques could be identified.

Therefore, CERL contacted other Federal agencies which, under Presidential mandate, are also responsible for this type of land evaluation. The extensive land holdings of the U.S. Forest Service and the Bureau of Land Management were found to be the prime targets for pressures to provide ORRV-use areas. Planning and development for ORRV use by these agencies is generally left to individual area, district, and forest supervisory personnel. While these agencies had developed many evaluation techniques, none met all the requirements of AR 210-9. A limited survey of state and private approaches to the problem yielded similar results.

Accordingly, a decision was made to develop the techniques necessary to meet the Army's unique requirements and to incorporate the useful portions of certain existing techniques into an overall method. This overall evaluation method is designed to be systematic in that it addresses, in a step-by-step fashion, the major environmental and operating concerns identified in AR 210-9.

The principal steps in this evaluation method are summarized below and developed in later chapters. The order in which these steps are completed will depend on the availability of data, the size of the installation, and the skill of the persons doing the evaluation. (For example, offices which have more people trained as fish and wildlife biologists than as agronomists may wish to evaluate biological factors before evaluating soils-related factors). The steps are:

1. Examine existing land use. CERL's evaluation method begins by eliminating from consideration all incompatible land uses.

2. Establish noise buffer zones. These zones are established around noise-sensitive land uses.

3. Choose candidate areas. Potential candidate areas are chosen with the idea that when trailbikes are using the area, no other use will be allowed.

4. Evaluate soil suitability. Soils of a candidate area are rated as having slight, moderate, or severe limitations for trailbike use.

5. Examine other environmental factors. The presence of significant plant and animal species, critical habitat, fragile land, etc., is also considered.

6. Designate site and/or choose alternative candidates. Acceptable areas may be designated as open to trailbikes provided that the other nonenvironmental policies and criteria established by AR 210-9 can be met. Before designating areas or trails as open or closed to ORRV use, an environmental assessment must be prepared.

Scope

The evaluation method described in this report is primarily oriented toward the environmental factors addressed in AR 210-9. While factors such as citizen participation, determination of demand, trail design, and operating conditions are included, they are not discussed in

depth. For all factors, policies and procedures addressed in Department of Defense (DOD) Directive 6050.2 and AR 210-9 apply.[4] The method focuses on the purely recreational use of trailbikes; neither competitive events nor other types of ORRVs are considered.

Mode of Technology Transfer

The information in Volumes I and II of this report will be incorporated into an Army Technical Manual.

[4] *Recreational Use of Off-Road Vehicles on DOD Lands*, Department of Defense (DOD) Directive 6050.2 (Office of the Secretary of Defense, 19 April 1979).

2 HOW TO EXAMINE EXISTING LAND USE

The objectives of AR 210-9 and those legal and regulatory requirements which prompted the regulation are intended to provide opportunities for persons to enjoy ORRV use while giving due consideration to the long-term stability of environmental resources. However, it is recognized that lands under Army control were acquired solely for the purpose of national defense; therefore, other uses are secondary to Army missions. As a result, CERL's evaluation method begins by eliminating from consideration for trailbike use those lands, among others, which are essential to Army mission requirements.

Input

Many FE elements have information which should be considered when studying an installation's existing land uses, including the Installation Master Plan, the Land Management Plan, the Endangered Species Inventory, and the Historic/Archaeologic Resources Management Program. The Office of the Directorate of Plans and Training is another source of information. These sources are not exclusive; any source which identifies the location of sensitive, fragile, and unique land uses or areas should be consulted.

Criteria for Incompatible Land Uses

After studying all available sources of information, certain areas of an installation must be eliminated from consideration as areas for trailbike use. Many incompatible land uses such as hospital zones and historic sites are specifically identified in the 1972 and 1977 Executive Orders and AR 210-9; others such as impact and maneuver areas are generally known to be in direct conflict with trailbike use. In brief, the four categories of land use which are incompatible with trailbike use are:

1. Areas where the mission, security, and operation of the installation would be adversely affected by ORRV use, e.g., explosive ordnance storage, impact areas, and drop zones.

2. Areas which because of existing land use cannot be used, e.g., housing areas and noise-sensitive outdoor recreation areas.

3. Areas where the operation of trailbikes would be unsafe for participants and nonparticipants, e.g., abandoned ordnance impact areas and trails set aside for horses and active hunting areas.

4. Areas which have been identified as, or are suspected to be, historically/ archaeologically significant, critical wildlife habitat, critical natural resource areas, etc.

Table 1 lists several examples of sensitive and incompatible land uses and considerations to be used when examining suspect areas for possible classification into any of these categories. Table 1 is not all-inclusive; any land use which uniformly exhibits one or more of the items in Table 1 should be eliminated from consideration as a trailbike-use area.

Mapping of Incompatible Land Uses

Once all incompatible land uses and areas from all available sources have been identified, they should be marked on an installation map. Figure 1 is a simplified example of such a map. This map can then be used as a working base map for other parts of the evaluation method.

Table 1

Examples of Land Uses Which Conflict With ORRV Use (Listed by Category of Conflict) and Considerations Which Place Land Uses in Categorical Conflict

Safety and Security of Military Mission -- Conflicts

Active bivouac areas	Airfield aprons & approach zones	Explosive storage
Active maneuver areas	Demolition areas	Impact areas
	Motor pools	

Safety and Security of Military Mission -- Conflict Considerations

National security	Physical security of personal property	Unexploded ordnance
Personal safety of Army personnel	Live fire	Quantity/distance limits
		Tactical vehicle operations

Incompatible Uses -- Conflicts

Administrative areas	Agricultural outleases	Campgrounds
Churches	Family housing	Hospitals
Libraries	Outdoor theaters	Troop housing
	Schools (military and dependent)	

Incompatible Uses -- Conflict Considerations

Noise	Dust	Aesthetics
Traffic congestion	Vehicle operations	Property security
	Vandalism	

Participant & Nonparticipant Safety -- Conflicts

Active landfills	Active maneuver areas	Horse (bridle) trails
Impact areas	Potable water storage	Active quarries
	Active hunting areas	

Participant & Nonparticipant -- Conflict Considerations

Steep slopes	Loose surface materials	Moving tactical vehicles
Unexploded ordnance		Unexpected animal actions
Live fire	Water quality	

Natural and Other Resources Locations -- Conflicts

Archaeological sites	Breeding, migration, or nesting areas	Food plots and feeding areas
Historic sites and structures	Watersheds	Paleontologic sites
Rare, endangered or threatened plants, animals and fish		Petroglyphs
		Scenic areas

Natural and Other Resources Locations -- Conflict Considerations

Noise	Soil compaction	Vegetation damage
Air emissions	Petroleum spills	Vandalism
Human presence and disruption	Soil erosion	Dust
	Aesthetics	Siltation
Animal harrassment	Turbidity	Poaching

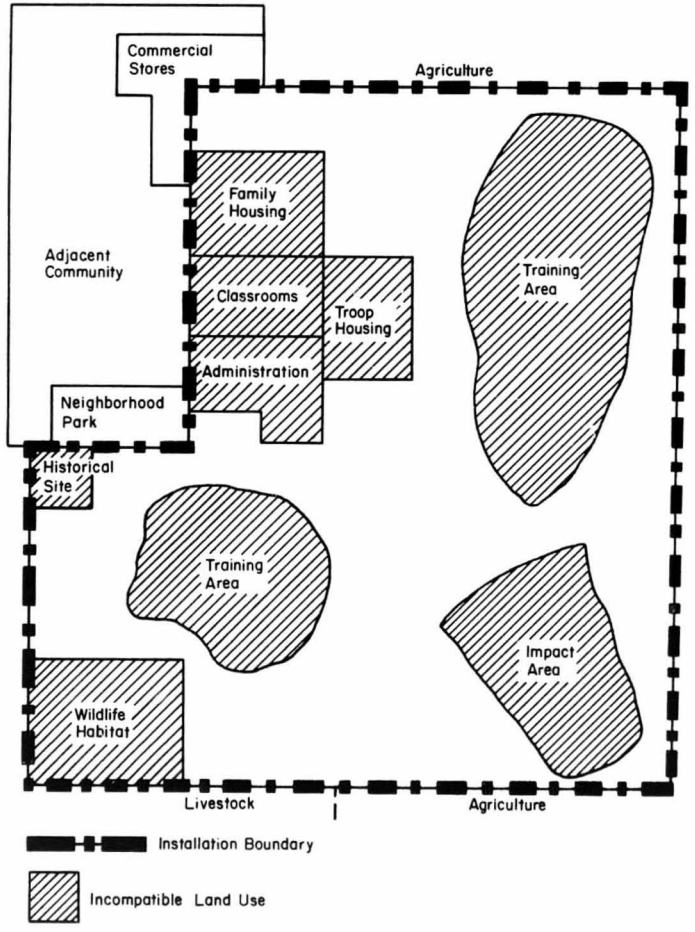


Figure 1. Base map identification of incompatible land uses.

3 HOW TO ESTABLISH NOISE BUFFER ZONES

Many land uses are sensitive to excessive noise levels. For example, a hospital or nursing home would be "sensitive" to trailbike noise. Therefore, it is necessary to insure that any trailbike-use area will be an appropriate distance away from any noise-sensitive land use; i.e., noise buffer zones should be established around noise-sensitive land uses.

To establish these buffer zones, three kinds of information are required:

1. The maximum acceptable sound-level requirements for those land uses which are considered noise-sensitive.

2. The average sound level (in A-weighted decibels [dBA]) generated by trailbikes expected to use the area.

3. The estimated demand for the proposed trailbike area, i.e., the number of trailbikes expected to be in operation during any one hour at the trailbike-use area.

When these factors are known, they can be used in a formula to determine how far away a trailbike-use area must be from a noise-sensitive land use to meet maximum acceptable sound-level requirements; i.e., the Distance Necessary for Noise Attenuation (DNNA).*

Equivalent Continuous Sound Level (L_{eq}) Requirements for Noise-Sensitive Land Uses.**

Table 2 lists the L_{eq} ratings of various noise-sensitive areas. This table was adapted from Figure 4-5 of TM 5-803-2, but its purpose is slightly different.[5] The levels shown in TM 5-803-2 assume that a new facility is to be constructed in an existing noise environment, while Table 2 assumes that a new noise-generating land use is being developed adjacent to an existing facility or land use. Therefore, some modification to the sound-level requirements was necessary. Since it was impractical to list all noise-sensitive land uses, any land use suspected to be noise sensitive should be included in that category which seems appropriate. Good judgment is essential in this determination.

Table 2 also gives maximum acceptable sound levels for activities conducted at outdoor music shells, theaters, and related land uses. Since these activities can be in direct conflict with activities at ORRV-use areas, Table 2 lists these land uses at a much lower maximum sound level. If activities at these types of land uses are concurrent with trailbike-area hours of operation, an additional 10 dBA penalty should be added. Therefore, the maximum acceptable sound level would be 45 dBA.

Noise Levels Generated by Trailbikes

The average sound levels generated by trailbikes vary. The average dual-purpose trailbike generates 83 dBA at 50 ft (15.24 m). Off-highway enduro models make slightly more noise and have been measured at 86 dBA. Motocross bikes can generate up to 120 dBA. A user survey can help determine the types of trailbikes expected to use the area. In addition, it is recommended that the sound levels of a representative sample of the type of trailbikes expected to

* There are several other factors which could be considered and alternative techniques which could be applied to determine the DNNA for ORRV use. The technique given in this report was chosen because it is simple to use. However, it does yield very conservative results -- that is, the resulting distances may be more than actually needed to ensure that noise-level requirements are not exceeded. If more precise measures of DNNA are desired, the user may wish to consider additional factors, such as ground cover or the presence of a barrier, and use an alternative technique. Two excellent sources for alternative considerations or techniques are: *Environmental Protection: Planning in the Noise Environment*, TM 5-803-2 (Department of the Army, Air Force, and Navy, 15 June 1978) and *Predicting Impact of Noise on Recreationist*, by Robin T. Harrison, Roger N. Clark, and George H. Stankey, ED&T Project No. 2688, Project Record 8023 1202 (U.S. Department of Agriculture, Forest Service, San Dimas Equipment Development Center, April 1980).

** The L_{eq} is the steady level, in dBA, that would produce the same A-weighted sound energy over a stated period of time as a time-varying sound.

[5] *Environmental Protection -- Planning in the Noise Environment*, Technical Manual (TM) 5-803-2 (Department of the Air Force, the Army, and the Navy, 15 June 1978).

Table 2

Maximum Acceptable Equivalent Sound Level (L_{eq}) Requirements for Selected Land Uses*

Land Use	Maximum Acceptable Sound Level (in dBA)
Agricultural (except livestock)	80
Bachelor housing	65
Campgrounds & picnic areas (not associated with ORRVs)	65
Classrooms, libraries, & churches	65
Commercial & retail stores, exchanges, movie theaters, restaurants & cafeterias, banks, credit unions, enlisted officer clubs	70
Dental clinic, medical dispensaries	70
Family housing	65
Flight line operations, maintenance & training	80
Gymnasiums, indoor pools	70
Hospitals, medical facilities, Nursing homes (24-hr occupancy)	65
Industrial, manufacturing & laboratories	70
Livestock farming, animal breeding	75
Neighborhood parks	70
Offices & administration buildings -- military	70
Offices -- business and professional	70
Outdoor music shells, outdoor theaters & cultural events	55
Outdoor sports arenas, outdoor spectator sports	70
Playgrounds, active sport recreational areas	70
Transient lodging -- hotel, motel, etc.	65
Troop housing	65

*Adapted from Figure 4-5, TM 5-803-2.

use the area actually be measured. On many installations, sound-measuring instruments are regularly used by and may be available from the Preventive Medicine Office, the Environmental Office, or the Provost Marshal. Generally, users will cooperate in making these measurements. If the average sound levels generated by users' bikes cannot be accurately estimated, the following are recommended:

1. Use 83 dBA for the average noise level if most of the trailbikes expected to use the ORRV area are dual-purpose bikes.

2. Use 86 dBA if most of the trailbikes are expected to be the enduro type.

3. Do not allow unregulated, unregisterable vehicles or trailbikes without mufflers to use the area.

Projected Demand

Projected demand is defined as the average daily peak use expected for the area. It is determined by predicting the maximum number of vehicles which will be using the area at any one time during the day, adding the peak numbers for each day of the week, and dividing by seven. A quantitative procedure to estimate peak use is not included in this report, since little information is currently available for projecting this type of demand. However, AR 210-9 specifically recognizes the need for user participation in site selection and development of ORRV-use areas. AR 210-9 also states that organized recreational activities involving ORVs are within the scope of the Outdoor Recreation Program of the Army Recreation Services. Therefore, user participation and assistance from installation outdoor recreation staffs who know how to predict recreation demand or who may have received requests from users are presently the best sources for projecting demand. The Heritage Conservation and Recreation Service may also be able to provide valuable information. It is recommended that estimates of user demand be generous enough to accommodate any unexpected demand and to allow for future increases in demand.

DNNA

The DNNA for each noise-sensitive land use is computed based on projected demand and estimated noise level. The DNNA is how far away a trailbike-use area would have to be from a noise-sensitive land use to meet recommended maximum acceptable noise-level requirements.

Calculation Description and Examples

The DNNA is determined by the following equation:

$$DNNA = A \times 10^{\left[\frac{B + 10(\log C) - (D - 5)^*}{20}\right]} \qquad \text{[Eq 1]}$$

where: DNNA = The Distance Necessary for Noise Attenuation.

A = The distance (feet or meters) from which sound-level measurements were taken to determine the average noise level of the trailbikes which will use the ORRV area.

B = The average noise level (in dBA) of the trailbikes which will use the ORRV area.

*The term "D-5" in the argument of Eq 1 represents a 5 dB penalty in the L_{eq} for land uses. This penalty is included because the sound of motorcycles is generally believed to be intrusive and annoying.

C = The estimated average daily peak use of the ORRV area (projected demand). This value is determined by projecting the maximum number of vehicles which will use the area at any one time for each day of the week, adding these numbers, and dividing by seven).

D = The L_{eq} for the land use for which a buffer zone is being established or for which adjacent limited use is necessary (Table 1).

For example, assume that the projected demand for a potential trailbike-use area is an average daily peak of 30 trailbikes, and that each trailbike generates an average of 86 dBA at 50 ft (15.24 m). Further assume that it is necessary to establish a noise buffer zone around a family housing area. From Table 2 it is known that the maximum acceptable L_{eq} for family housing is 65 dB; therefore:

A = 15.24 m
B = 86 dBA
C = 30 trailbikes
D = 65 dB for family housing

$$DNNA = 15.24 \times 10^{\left[\frac{86 + 10(\log 30) - (65 - 5)}{20}\right]}$$

$$DNNA = 15.24 \times 10^{\left[\frac{86 + 10(1.477) - 60}{20}\right]}$$

$$DNNA = 15.24 \times 10^{\left[\frac{86 + 14.77 - 60}{20}\right]}$$

$$DNNA = 15.24 \times 10^{\left[\frac{40.77}{20}\right]}$$

$$DNNA = 15.24 \times 10^{(2.038)}$$

$$DNNA = 15.24 \times 109.27$$

$$DNNA = 1666\ m$$

Based on this DNNA calculation, a noise buffer zone of a minimum of 1666 m should be established around the family housing area. That is, any trailbike-use area with a projected demand of 30 trailbikes, each generating an average of 86 dBA, should be no closer than 1666 m from family housing.

For the reader's convenience, Appendix A of this report lists precalculated DNNAs for various noise level requirements.

Mapping Noise Buffer Zones

Once DNNAs for each noise-sensitive land use are identified, they must be marked on the base map (see Chapter 2). To do this, lines are drawn around each noise-sensitive land use at that distance (corresponding to the scale of the map) which illustrates the minimum distance

outside of which a trailbike area could be located (Figure 2 is a simplified example). The areas between these lines and the noise-sensitive land uses are the noise buffer zones. The acreage of these zones and the noise-sensitive land use should be eliminated from consideration as trailbike-use areas. Again, it is recommended that the noise buffer zones be based on generous estimates of projected demand to accommodate any unexpected demand and to allow for future growth in demand.

Limited-Use Alternative

On many installations, demand may be such that the area required for buffer zones will eliminate nearly all available acreage. In these cases, it will be necessary, despite demand, to limit use at any established trailbike area. The limited-use alternative for ensuring that maximum acceptable sound levels are not exceeded requires that the evaluation steps be completed in a different order. The limited-use alternative requires that (1) candidate areas be chosen (Chapter 4), (2) soil suitability be evaluated (Chapter 5), and (3) other environmental factors be examined (Chapter 6) before Eq 1 or the table in Appendix A is used. If an environmentally acceptable area is identified, the distance a candidate area is from noise-sensitive land uses becomes a known variable, and the number of trailbikes which may be allowed to use the area becomes the unknown factor. By using all known variables as input and solving Eq 1, the average daily maximum number of trailbikes which can reasonably use the area at one time is determined.

For example, assume that the projected demand for a potential trailbike-use area is an average daily peak of 50 trailbikes, each generating 86 dBA at 50 ft (15.24 m). Further assume that the area is 1666 m from family housing. Based on the sample calculation of Eq 1, if a trailbike-use area is established at the potential site, the use *must be limited to a daily average of 30 trailbikes at any one time.* This number cannot be exceeded without unacceptable noise impacts on adjacent land uses.

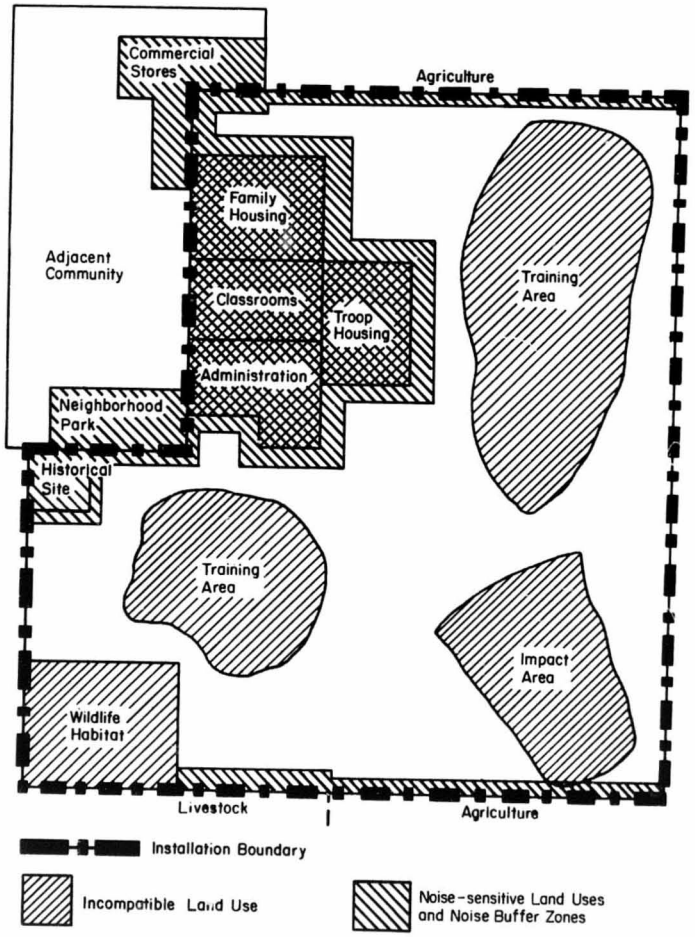


Figure 2. Noise-sensitive land uses and noise buffer zones.

4 HOW TO CHOOSE CANDIDATE AREAS

The base map described in Chapters 2 and 3 is used to decide which areas on an installation may be candidate trailbike-use areas. Other factors which must be considered are projected demand, user preferences, and site accessibility.

Necessary Acreage

Areas used by ORRVs commonly range in size from 5 to 800 ha, depending on intensity of user demand, type of terrain, and available land area. It is estimated that candidate areas for an average installation should be between 40 and 100 ha; however, this does not imply that the final trailbike-use area will be this size. Further site evaluation may indicate that portions of candidate areas are unacceptable, thus reducing the actual area available for trailbike use. The exact size and shape of a specific candidate area will depend on available acreage.

Choosing the Areas

Two or more alternative areas should be chosen as candidate areas. These areas should be selected from the acreage which remains after all incompatible and noise-sensitive land uses and the noise buffer zones have been eliminated from consideration. (If it becomes necessary to use the limited-use alternative, the acreage in noise buffer zones is not eliminated before choosing candidate areas.) Candidate areas should be easy to reach by road; this will eliminate cross-country travel to the site by users. Natural resource persons who have worked on an installation for some time can supply general information about an installation's physical and environmental resources which can be used to choose candidate areas. If possible, the candidate areas should have variable terrain and vegetation type, since these characteristics are preferred by users. Candidate areas should be marked on the base map as described in Chapters 2 and 3.

5 HOW TO EVALUATE SOIL SUITABILITY

Once candidate areas of the necessary acreage have been chosen, a soil suitability analysis must be made to determine if the soils within these areas are acceptable for trailbike use. To do this, it will be necessary to develop a soil limitations map. (Soil limitations maps are often used by land use planners to help select sites for a variety of activities, e.g., regional parks and subdivisions.)[6] However, before a soil limitations map can be developed, a recent soil survey of the candidate area and a limitations rating for each soil in the area must be obtained.

Soil Surveys

An examination of the availability of published county and area soil surveys for 175 counties in which there are 150 active Army installations indicates that approximately 70 percent of the installations should at least be partially covered by a U.S. Department of Agriculture (USDA) Soil Conservation Service (SCS) soil survey. Nearly half of these surveys were done after 1950 and can, therefore, be used to develop a soil limitations map. These surveys are available from state and local SCS offices.

Limitations Ratings

The SCS has recorded (on computer tape) the properties and characteristics of every identified soil in the United States. Using this information and special rating criteria, every SCS-identified soil in the United States has been rated as to its suitability for trailbike use. (There are approximately 13,000 identified soils). Figure 3 is a sample of these ratings. The rating was accomplished with the aid of a computer and with assistance from the SCS and the Statistical Laboratory and Department of Statistics at Iowa State University where the soil records are kept.

The special soil rating criteria that were used are listed in Table 3. They illustrate eight different soil properties which were identified as having the potential to restrict or limit a soil's suitability for trailbike use: USDA texture; the weight percentage of stones greater than 3 in. (76 mm); depth to the high water table; erosion factor (K); slope; unified texture; weight percentage of coarse fragments less than 3 in. (76 mm), but greater than 2 mm; and flooding. Variations in these properties create up to 11 possible restrictive features which might limit a soil's suitability for trailbike use. (Note that restrictive feature 12 in Table 3 could not be determined by computer analysis. It can only be determined in the field and through professional experience.)

Each of the 11 restrictive features in Table 3 are listed in the order of their importance as a limiting factor. The properties of soils were examined in the order of importance of the restrictive features. For example, when the computer was examining the properties of a particular soil, it would search for an indication of permafrost before an indication of large stones or wetness.

Using the criteria in Table 3, soils can be rated as having slight, moderate, or severe limitations for trailbike use. These ratings are defined as follows:

1. Slight. Given to soils that have properties acceptable for trailbike use. The degree of limitation is minor and environmental damage is expected to be below average. Good performance and low maintenance can be expected.

2. Moderate. Given to soils that have properties moderately acceptable for trailbike use. The degree of limitation can be overcome or modified by special planning, design, or trail maintenance. Some soils rated as moderate require artificial drainage, runoff control to reduce erosion, some modification of certain features through manipulation of the soil, etc.

[6] L. J. Bartelli, et al. (Editors), *Soil Survey and Land Use Planning* (Soil Science Society of America and American Society of Agronomy, 1966).

SOIL SERIES	RECORD NUMBER	DEPTH (IN.)	PHASE	LIMITATION	RESTRICTION
ADELPHIA	NJ0024	0-14	0-6% SL,FSL	MODERATE	WETNESS
			6-10% SL,FSL	MODERATE	WETNESS, ERODES EASILY
			0-6% SIL	MODERATE	WETNESS, DUSTY
			6-10% SIL	MODERATE	WETNESS, ERODES EASILY, DUSTY
ADENA	CO0194	0-5	0-5% L,SIL	MODERATE	DUSTY
			5-11% L,SIL	MODERATE	ERODES EASILY, DUSTY
			11-12% L,SIL	SEVERE	ERODES EASILY
ADGER	MT0001	0-7	0-4% C,SIC	MODERATE	TOO CLAYEY
			4-8% C,SIC	MODERATE	ERODES EASILY, TOO CLAYEY
			0-4% SICL	SLIGHT	
			4-8% SICL	MODERATE	ERODES EASILY
ADILIS	CO0468	0-4	0-8% GR-SL	MODERATE	SMALL STONES
			0-8% GR-L	MODERATE	SMALL STONES, DUSTY
			0-8% SL	SLIGHT	
			0-8% L	MODERATE	DUSTY
ADJUNTAS	PR0063	0-24	40-60% C	SEVERE	ERODES EASILY, TOO CLAYEY
ADKINS, ALKALI	WA0249	0-11	0-3% FSL	MODERATE	WETNESS
ADKINS, GRAVELLY SUBSTRATUM	WA0470	0-4	0-6% FSL	SLIGHT	
			6-13% FSL	MODERATE	ERODES EASILY
			13-25% FSL	SEVERE	ERODES EASILY
ADKINS, WET	WA0623	0-12	0-6% FSL	MODERATE	WETNESS
			6-13% FSL	MODERATE	WETNESS, ERODES EASILY
			13-15% FSL	SEVERE	ERODES EASILY
ADLER	MS0024	0-7	0-2% SICL,RARE,OCCAS	SLIGHT	
			0-2% SICL,FREQ	MODERATE	FLOODS
			0-2% SIL,SI,RARE,OCCAS	MODERATE	DUSTY
			0-2% SIL,SI,FREQ	MODERATE	DUSTY, FLOODS
ADOLPH	MN0188	0-13	0-1% SICL,SIL	SEVERE	WETNESS
ADRIAN	MI0028	0-34	0-2% SP	SEVERE	PONDING, EXCESS HUMUS
AECET	ID0045	0-5	0-12% SL	SLIGHT	
			0-6% L	MODERATE	DUSTY
			6-12% L	MODERATE	ERODES EASILY, DUSTY
AECET, STONY	ID0046	0-5	0-12% STV-SL,STV-LS	SEVERE	LARGE STONES

Figure 3. Sample soils limitations ratings.

Table 3

Guide for Rating Soil Limitations for Trailbike Use

Property	Limits: Slight	Limits: Moderate	Limits: Severe	Restrictive Feature
1. USDA Texture	---	---	ICE	Permafrost
2. Fraction > 3 in. (wt %) (surface layer)*	<10	10 - 25	>25	Large stones
3. Depth to high water table (ft)*	>2 ---	1 - 2 ---	0 - 1 +	Wetness Ponding
4. Erosion factor (K) x % slope	<2	2 - 4	>4	Erodes easily
5. USDA Texture (surface layer)[1]	---	---	SC,SIC,C	Too clayey
6. USDA Texture (surface layer)	---	LCOS,VFS	COS,S,FS	Too sandy
7. Unified (surface layer)	---	---	OL,OH,PT	Excess humus
8. Slope (%)	0 - 25	25 - 40	>40	Slope
9. Coarse fragments (wt %) (surface layer)[2]	<40	40 - 65	>65	Small stones
10. USDA Texture (surface layer)	---	SIL,SI VFSL,L	---	Dusty
11. Flooding	NONE,RARE, OCCASSIONAL	FREQUENT	---	Floods
12. Other[3]	---	---	---	Fragile

* 1 in. = 25.4 mm; 1 ft = 0.3048 m.
[1] Soils in UST, TOR, ARID, BOR, or XER suborders, great groups, or subgroups rate one class better.
[2] 100 minus the percent passing No. 10 sieve.
[3] If the soil is easily damaged by use or disturbance, rate as "Severe-Fragile."

3. Severe. Given to soils that have one or more properties that are unacceptable for trailbike use, such as steep slopes, large stones, flooding, a seasonal high water table, or a high erodibility factor. This degree of limitation generally requires major soil reclamation, special design, or intensive maintenance. Some of these soils, however, can be improved by reducing or removing the soil feature that limits use; but in most situations, it is difficult and expensive to alter the soil or to design the trail to compensate for a severe degree of limitation.

Restrictive features were examined on a worst-case basis, with severe limitations being the worst case. For example, if 15 percent of the weight percentage of a particular soil is caused by large stones (moderate limitation) and another 70 percent is caused by small stones (severe limitation), the soil will be rated as having severe limitations due to small stones. The moderate restriction caused by large stones is not indicated in the computer-determined rating even though large stones are a more important restrictive feature.

Another worst-case factor which should be noted is that the limitations rating for a particular soil will identify a maximum of three restrictive features and that these restrictive features will be given in order of importance. For example, consider a particular soil that has severe limitations because it has a very high water table, erodes easily, is too clayey, and has excess humus. The output from the computer will only indicate that the soil has severe limitations for wetness, erodes easily, and too clayey. Of the four limitations, these three are considered more important (as indicated by their order as restrictive features in Table 3).

Soil Ratings

Limitations ratings for soils can be obtained from either state or local SCS offices or MACOM natural resource offices.

SCS Offices

Table 3 was developed in a cooperative effort between CERL and the SCS. The SCS has developed similar guides for other uses, e.g., playgrounds and septic tank absorption fields. The interpretation of soil suitability for these other uses is part of the National Cooperative Soil Survey being conducted by the SCS. Table 3 has been included in the National Soils Handbook with these other guides. As a result, the state or local SCS offices should be familiar with Table 3 and should be able to quickly assess soil suitability for trailbike use.

To obtain the ratings for the soils of a candidate area the user should:

1. Identify the candidate areas on the installation's soil survey map(s).
2. Prepare a list of each soil series included in the candidate areas.
3. Take the survey map(s), a copy of Table 3, and the soil list to the appropriate state or local SCS office and ask for help in rating the soils.

MACOM Offices

The command natural resource offices of TRADOC and FORSCOM, and the natural resources section of the Installation and Services Activity, DARCOM have been provided an entire set of soil ratings, a detailed explanation of how soils were evaluated and a description of the output. To obtain soil ratings from these offices, the user should list each soil series included on the soil survey map of the candidate area(s) and request their limitations ratings from the appropriate MACOM office. The soil's limitations ratings available from the MACOM natural resource offices contain the following (see Figure 3):

1. Soil Series. Soil series names of soils which have been identified and classified by the SCS are listed in alphabetical order under the first column in the soil limitations ratings. In many cases, a series name will be listed two or more times -- once by itself, the second (or more) times followed by a property or phase modifier (e.g., stony, moderately wet, flooded). The limitations of a soil modified by a certain property or phase can be very different from the limitations of the unmodified soil.

2. Record Number. The record number is used by the SCS for soils data records and it indicates the state in which the record for the soil is kept. It also lists a four-digit number which can be used to request additional information from the appropriate SCS state office in case there is any uneasiness about a rating or if suggestions for soil maintenance are desired.

3. Depth in Inches. This number identifies the soil depth to which a rating has been applied. Soil surface layers are analyzed at varying depths, and a soil's properties can change at varying depths. If a soil has eroded to a depth greater than that indicated in the rating, it will be necessary to consult a professional soil scientist to determine the correct limitation rating of the exposed soil.

4. Phase. A soil series can have several phases, depending on (a) the slopes on which it is found, (b) its predominant surface texture at a particular location, (c) the presence of stones, and (d) flooding potential and other characteristics. A soil's limitations and/or restrictive feature can and generally does change from phase to phase. All possible phases of a particular soil series are included in the limitations ratings. Table 4 lists abbreviations which are used to interpret these phase differences. For example, "6-10% SL, FSL" is one possible phase for a soil found in New Jersey (Adelphia in Figure 3). The abbreviations indicate that the corresponding limitation for this phase (moderate) is applied to this soil if it is found on 6 to 10 percent slopes and the predominant surface texture is sandy loam or fine sandy loam.

5. Limitation. This identifies the limitation rating which applies to each soil series phase, and indicates whether the phase has slight, moderate, or severe limitations.

6. Restriction. This identifies why the soil phase was given a moderate or severe limitation, e.g., too sandy, slope. No restrictions are provided if the phase has only slight limitation.

For example, the Adena soil series in Figure 3 is found in Colorado and records of its properties are on file at the Colorado SCS office under record number CO 0194. Limitations ratings for various phases of this soil apply to the first 3 in. (76 mm) of soil. If the soil is found on 0 to 5 percent slopes and its predominant texture is loam (L) or silt loam (SIL), it has moderate limitations for trailbike use because it is dusty. If the same textures are found on 5 to 11 percent slopes, the soil still has moderate limitations. However, the principal restrictive feature in this case is that it erodes easily when found on these slopes (even though it is still dusty).

To determine the limitations rating for a particular soil phase, the different phases of each soil series (as provided in the limitations ratings) are compared with the descriptions of the series or map symbol in the soil survey. The limitation for the soil phase in the ratings list which most closely approximates the phase description in the survey is the limitation given to the soil.

In most soil surveys, there will be a few areas that are mapped but not identified as containing a singular soil series or phase. These may be areas where the soils have been disturbed, e.g., landfills; areas where the soil exhibits no particular properties which would give it a special classification, e.g., alluvial soils; areas where a variety of intermingled series exist such that it would be difficult to plot their boundaries on a map; or areas where no soil has developed, e.g., granite outcrops. In these cases, the identification of a degree of limitation may be difficult since it will not be listed in the limitations ratings.

Many times a soil survey will have brief written descriptions of these mapping units. These descriptions can be compared to the rating criteria to obtain an estimate of the degree of limitation. However, for most cases it is recommended that a professional soil scientist be consulted to obtain a more accurate estimate of their degree of limitation.

Because SCS soil files are always being updated and because the criteria for the trailbike ratings have not been tested extensively, the SCS and CERL recommend that trailbike ratings and soil evaluation method be coordinated with or reviewed by local SCS field personnel. Also because of the unique nature of tropical and permafrost soils, it is recommended that a professional soil scientist be asked to help rate soils in Alaska and Hawaii.

Table 4

Soil Phase Interpretation Abbreviations*

Abbreviations for Texture Modifiers

BY	Bouldery	GRC	Coarse gravelly
BYV	Very bouldery	GRF	Fine gravelly
BYX	Extremely bouldery	GRV	Very gravelly
CB	Cobbly	MK	Mucky
CBA	Angular Cobbly	PT	Peaty
CBV	Very cobbbly	SH	Shaly
CN	Channery	SHV	Very shaly
CNV	Very channery	SR	Stratified
CR	Cherty	ST	Stony
CRC	Coarse cherty	STX	Extremely stony
FL	Flaggy	SY	Slaty
FLV	Very flaggy	SKV	Very slaty
GR	Gravelly		

Abbreviations for Texture

COS	Coarse sand	VFSL	Very fine sandy loam
S	Fine Sand	SIL	Silt loam
FS	Fine sand	SIL	Silt loam
VFS	Very fine sand	SI	Silt
LCOS	Loamy coarse sand	SCL	Sandy clay loam
LS	Loamy sand	CL	Clay loam
LFS	Loamy fine sand	SICL	Silty clay loam
LVFS	Loamy very fine sand	SC	Sandy clay
COSL	Coarse sandy load	SIC	Silty clay
SL	Sandy loam	C	Clay
FSL	Fine sandy loam		

Abbreviations for Terms Used in Lieu of Texture

CE	Coprogenous earth	MARL	Marl
CEM	Cemented	MPT	Mucky-peat
DE	Diatromaceius earth	MUCK	Muck
FB	Fibric material	PEAT	Peat
FRAG	Fragmental material	SG	Sand and gravel
G	Gravel	SP	Sparic material
GYP	Gypsiferous material	UWB	Unweathered bedrock
HM	Hemic material	VAR	Variable
ICE	Ice or frozen soil	WB	Weathered bedrock
IND	Indurated	CIND	Cinders

Abbreviations for Frequency of Flooding

NONE	NONE (No reasonable possibility of flooding)
RARE	RARE (Flooding unlikely but possible under abnormal conditions)
COMMON	COMMON (Flooding likely under normal conditions)
OCCAS	OCCASIONAL (Less often than once in 2 years)
FREQ	FREQUENT (More often than once in 2 years)
PROT	PROTECTED (Soil protected from flooding; e.g., levees)

* From USDA, SCS Form SCS-SOILS-5, *Soil Survey Interpretation Instructions*

Limitations Map

The limitations map of the soils within each candidate area helps document site suitability as it relates to soils. To prepare the limitations map, the soil series map(s) in the SCS soil survey which corresponds to the candidate area(s) is reproduced. This map will show the boundaries of each soil series or phase. (In most cases, the soil limitations map will be prepared separately from the previous base map; only if the scale of the limitations map and the base map are the same, or can be made to correspond through reproduction, can the boundaries of each soil series phase be placed on the base map.)

The limitations of the soils shown on the map are identified by coloring the soil series phases or map units within their respective boundaries. Soil phases with severe limitations are colored red (stop); soil phases with moderate limitations are colored yellow (caution); and soil phases with slight limitations are colored green.

Based on the soil limitations map, candidate areas or portions of candidate areas can be eliminated from consideration. Generally, those areas which are eliminated contain soils which have severe limitations. However, certain areas where soils have severe or moderate limitations may be considered if proper maintenance procedures can be used to mitigate the effects of the restrictive feature, i.e., removal of large stones or construction of runoff control terraces. TM 5-630 provides some guidance on possible mitigation procedures.[7] Areas with slight limitations can be considered acceptable for use, subject to further evaluation.

If acreage where the soils are acceptable is insufficient for trailbike use (i.e., less than 5 ha), it may be necessary to choose new candidate areas before continuing the evaluation. All areas in which the soils are unacceptable and, if necessary, all new candidate areas should be marked on the base map. The soils of any new candidate areas should be evaluated.

Alternative Input

The method of evaluating soil suitability presented in this report assumes that the soils of a candidate area have been identified and that there is a recent SCS soil survey available for the area. However, this may not always be the case. The soils of a candidate area -- or of an entire installation -- may never have been surveyed. Or, if a survey has been completed, it may only represent general soil associations or it may be out of date. Even if a county survey has been prepared, the lands within installation boundaries may not have been included. In all these instances, the methods described in this report is not readily applicable. Instead, more technical soil analysis and rating methods must be used; these methods are described in Volume II of this report.

[7] *Repairs and Utilities: Grounds Maintenance and Land Management*, TM 5-630 (Department of the Army, 4 December 1967)

6 HOW TO EXAMINE OTHER ENVIRONMENTAL FACTORS

The final environmentally related step in the evaluation method is a site visit and visual survey of each candidate area to determine if significant plant and animal species, critical habitat, fragile land, or other environmental factors are present.

Biological Factors

AR 210-9 requires that the biological resources of areas being evaluated for potential ORRV use be examined and assessed. This examination and assessment should, at the minimum, determine the value of the biological elements within candidate areas. If possible, it should also consider the possible impact of ORRV use on those elements.

To comply with this requirement, each candidate area should be field checked by a qualified fish and wildlife biologist. If a biologist is not assigned to the installation, the U.S. Fish and Wildlife Service (USFWS) should be consulted; AR 420-74 gives the conditions for USFWS cooperative agreements.[8]

Endangered Species

If the site visit indicates that any candidate area may contain a rare, endangered, or threatened plant species (as defined by Federal or state law) or locally important plant and animal populations (i.e., remnant prairie land), the area should be eliminated from consideration. No area containing a rare, endangered, or threatened animal species at any season of the year should be opened to trailbike use until a site visit by the USFWS has confirmed that the species will not be adversely affected by trailbike use on or adjacent to that area.

Biological Assessment

Research designed to quantify the biological effects of trailbike operation and describe the mechanism of such effects is primarily restricted to desert regions. Biological effects for other regions are only generalized; i.e., trailbike operation will (1) cause habitat loss because soil compaction will restrict plant growth, (2) directly destroy habitat by causing mechanical injury to plants, and (3) have generalized adverse effects on animal population by increasing the presence of humans and/or their machines. However, an exact prediction of how much damage will be caused by how many machines is not possible. Considering this, CERL developed systematic ways of making a biological examination and assessment of potential trailbike-use areas. These methods can be used even if quantitative data are not available.

CERL's methods allow the biologist to evaluate alternative areas either by determining the relative value of the biological resources found in each area in comparison to the rest of the installation or, if the biologist is more familiar with the types of damage which can occur to biological communities as a result of trailbike use, by predicting an area's susceptibility to ORRV damage.

The following paragraphs describe how to use CERL's examination and assessment methods and give examples for a hypothetical area. The example for the Relative Value Method is shown in Figure 4; the example for the Susceptibility to ORRV Damage Method is shown in Figure 5. A blank, reproducible copy of the form used in Figures 4 and 5 is in Appendix B. The circled numbers by each step in the instructions refer to corresponding numbers on Figures 4 and 5. They show what portion of the rating form relates to each step.

[8] *Natural Resources -- Land, Forest, and Wildlife Management*, AR 420-74 (Department of the Army, 1 July 1977)

① Area Area 1

⑥ Rating 3.7 Rank 3 ⑧

Biological Limitation Terrestrial game animals, particularly good habitat for squirrels ⑦

② Biological Resources	③ Relative Value	④ Categorical Value	Susceptibility to ORRV Damage	Categorical Susceptibility	Combined Resource Value	Notes
Ground Cover		3				
Grasses, Moss	3, 2					On north slopes
Trees or Dominant Vegetation		4				
Oak, Ash	4, 3					
Terrestrial Game Animals		5				
Deer, Quail, Squirrel, Rabbit	3, 1, 5, 2					Many den trees
Terrestrial Nongame Animals		4				
Boy Turtle, Bluebird, Skunk, Cooper's Hawk, Robin	4, 3, 1, 2, 3					
Fish		3				
Bass, Catfish	1, 3					
Pest species		3				
Starling	3					Small winter roost
Other		4				
Den Trees	4					
⑤ Total Area Value		26	Total Combined Resource Value			

Figure 4. The relative value method of evaluating of ORRV-use potential.

Area Area 1

⑤ Rating 10.0 Rank 3 ⑦

Biological Limitation Terrestrial, nongame animals, particularly the presence of box turtles ⑥

Biological Resources	① Relative Value	② Categorical Value	Susceptibility to ORRV Damage	③ Categorical Susceptibility	④ Combined Resource Value	Notes
Ground Cover		3		2	6	
Grasses, Moss	3, 2		2, 4			On north slopes
Trees or Dominant Vegetation		4		3	12	
Oak, Ash	4, 3		3, 2			
Terrestrial Game Animals		5		3	15	
Deer, Quail, Squirrel, Rabbit	3, 1, 5, 2		2, 2, 2, 2			Many den trees
Terrestrial Nongame Animals		4		4	16	
Box Turtle, Bluebird, Skunk, Cooper's Hawk, Robin	4, 3, 1, 2, 3		4, 4, 2, 5, 5			
Fish		3		2	6	
Bass, Catfish	1, 3		2, 2			
Pest species		3		1	3	
Starling	3		1			Small winter roost
Other		4		3	12	
Den trees	4		3			
Total Area Value			Total Combined Resource Value		70	

Figure 5. The susceptibility to ORRV damage method of evaluating ORRV-use potential.

The Relative Value Method

1 Area. Assign a special designation to each alternative candidate area to identify one area from another (e.g., "Area 1"). If a candidate area represents two or more distinct biological communities, the areas covered by the different communities should be considered separately.

2 Biological Resources. Several categories of biological resources are listed in this column, e.g., "Ground Cover," or "Trees or Dominant Vegetation." Under each category, list specific biological resources which are known to exist either in the area being examined or on the installation, e.g., "Oak" and "Ash." If dominant vegetation is applicable for placement into both "Ground Cover" and "Trees or Dominant Vegetation," it is to be included in both categories. "Terrestrial Nongame Animals" includes both birds and reptiles. If a water body or stream is in or near the area being examined, include fish. Identify any other species or biological factor which is not easily categorized by listing it under the category "Other." The list of biological resources should be compiled from existing data, but a site visit is also required. The last column in the special rating form gives space for any remarks or notes which may be necessary to help rate an area.

3 Relative Value. In this column of the evaluation form, rate each listed biological resource. The value of the resources at each site should be rated relative to their value on the rest of the installation. When determining this value, consider the past, present, and future carrying capacity of the area in relation to the rest of the installation. The relative value is determined using the five-point scale in Table 5.

Table 5

Relative Value Rating Scale

1. The resource has little importance at this location when compared to the rest of the installation.
2. The resource has some importance at this location, but its value is somewhat below average as compared to the rest of the installation.
3. The resource at this location is representative of the entire installation.
4. The area is one of the better examples of this resource relative to the rest of the installation. The value of the resource at this location can be described as somewhat above average.
5. This area is one of the very best examples of this resource as compared to the rest of the installation. The value of the resource at this location can be described as much more valuable than at other locations on the installation.

4 Categorical Value. Next, determine the relative value of each of the resource categories for which biological resources were identified. To do this, take the highest individual biological resource value under each category and assign that value to the entire category. For example, in Figure 4, the biological resources "Oak" and "Ash" have been given values of 4 and 3, respectively. Since "Oak" was given a value of 4, the entire resource category of "Trees or Dominant Vegetation" should be given a value of 4, the highest relative value in the category.

5 Total Area Value. Determine the relative value of the entire area by adding the category values. For example, the total area value of 26 in Figure 4 was determined by adding the values for the categories "Ground Cover," "Trees or Dominant Vegetation," "Terrestrial Game Animals," "Terrestrial Nongame Animals," "Fish," "Pest Species," and "Other."

6 Rating. Determine the biological rating of the area by dividing the total area value by the number of resource categories for which values have been determined. In Figure 4, 26 has been divided by 7 for a value of 3.7. If the category "Other" had not contained a value, the total area value would have been divided by 6. After determining the area rating, write it in the space provided near the top of the form. This allows for a quick comparison of alternative areas.

7 Biological Limitation. For decision making purposes, it is necessary to note the biological limitation of the area. The biological limitation is the resource category which has received the highest categorical value. For example, in Figure 4, the biological limitation for the hypothetical area is the presence of "Terrestrial Game Animals," particularly squirrels. The biological limitation shows which resource places the greatest restriction on possible trailbike use in the area. When describing the limitation, briefly explain the importance of the resource. Word the explanation so a nonbiologist can understand the logic.

8 Rank. The final step in this approach is to rank alternative areas. To do this, compare the biological ratings and limitation of each area. Rank the area with the *lowest* numerical rating No. 1. This indicates that the area is the most acceptable for trailbike use. Rank the area with the second lowest rating No. 2. Indicate any area with a biological rating of greater than or equal to 4 as unacceptable. An area with an overall rating of 4 indicates that it is one of the better examples of biological resources relative to the rest of the installation. Therefore, the area should not be used. If two areas receive the same rating, use individual judgment to determine the importance of the biological limitation before assigning the areas a ranking number. The area which is most important biologically should always receive the highest numerical value in rank.

The Susceptibility to Damage Method

This method is used only if the biologist examining the alternative areas feels qualified to determine the susceptibility to damage of those biological resources known to exist in the area. Susceptibility to damage depends on use intensity.

1 Initial Steps. The first steps of this method are the same as the first four listed in the Relative Value Method. After completing those steps, go on through the steps listed below.

2 Susceptibility to ORRV Damage. Determine the susceptibility to damage of each of the biological resources listed under the resource categories and, in this column, assign a susceptibility value to each resource. Since the importance of damage to various resources is perceived differently, use the two separate scales in Table 6 to assign the values. One scale applies to all resource categories except "Pest Species"; the other is used exclusively for "Pest Species."

Table 6

Damage Rating Scales

SUSCEPTIBILITY TO DAMAGE FOR ALL NONPEST CATEGORIES

1. This resource will receive some damage as a result of ORRV use. Recovery time for the resource would be within 1 year **OR** the area is already so badly damaged from other factors that it has no logical present or future biological value.
2. This resource will be damaged by ORRV use. Recovery time for the resource would be from 1 to 5 years.
3. ORRV use would be destructive to this resource. Recovery time would be from 5 to 10 years.
4. ORRV use would be highly destructive. Recovery time for this resource would be from 10 to 100 years.
5. ORRV use would be extremely destructive to this resource. If use is allowed, the recovery time would be greater than 100 years.

SUSCEPTIBILITY TO DAMAGE FOR PEST SPECIES

1. ORRV use would cause no increase in this species through habitat improvement and/or a reduction in competition **OR** there is a predicted decrease in the species.
2. ORRV use would cause a slight increase in this species.
3. A moderate increase in this species is expected as a result of ORRV use.
4. A large increase in this species is expected as a result of ORRV use.
5. ORRV use would reduce competition and/or improve habitat for this species such that a very large increase in the pest population is expected.

3 Categorical Susceptibility. Determine the susceptibility to ORRV damage for each resource category by assigning to the entire category the susceptibility of that resource which received the *highest relative value*. For example, in Figure 5, the biological resource "Box Turtle" has a relative value of 4. Since it has the highest relative value for any resource in the category "Terrestrial Nongame Animals," the entire category receives a susceptibility to ORRV damage value of 4, the susceptibility value for the box turtle.

4 Combined Resource Value. Determine the combined resource value of each resource category by multiplying the relative values by the susceptibility to damage values. In Figure 5, the relative value of the category Ground Cover, 3, is multiplied by the susceptibility to ORRV damage value, 2. This results in a combined resource value of 6. Determine the combined resource value of the entire area by adding the combined resource values for each category. In Figure 5, this results in a total combined resource value of 70.

5 Rating. Determine the biological rating for the entire area by dividing the total combined resource value by the number of resource categories for which combined resource values have been determined. In Figure 5, 70 has been divided by 7 for a rating value of 10.0. (Note that if the category "Other" had not contained a susceptibility value, the area's combined resource value would have been divided by 6.) As in the Relative Value Method, the area rating is placed in the space provided on the evaluation form.

6 Biological Limitation. To help in the decision-making process, the biological limitation of an area must be recorded. Determine the limitation by examining the combined resource value of each resource category. The highest individual category value determines the biological limitation. In Figure 5, the limiting factor is "Terrestrial Nongame Animals." This resource category has a combined resource value of 16, the highest of all categories. In this case, the presence of box turtles (which will be significantly affected by trailbike use) presents the greatest biological restriction.

7 Rank. To rank areas, compare the biological rating for each alternative site. Rank the area with the *lowest* numerical rating No. 1. The area with this ranking is the most acceptable for ORRV use. Any area which has a rating of greater than or equal to 16 is not normally acceptable for trailbike use. A rating of 16 or greater indicates that the area has excellent resources relative to the rest of the installation and ORRV use would be relatively more destructive.

Assessment Interpretation

As stated in the instructions to both methods, the area which receives the lowest numerical rating is ranked No. 1. The area ranked No. 1 is more acceptable for trailbike use than the area ranked No. 2. To make evaluations comparable, the same rating method should be used for each area being evaluated. When choosing a site for trailbike use, special consideration should be given to those areas ranked No. 1 or 2. If possible, the use area should be the one ranked No. 1. This will help minimize damage to the biological resources of the installation as required by AR 210-9 and AR 200-1.

Other Factors

During the site visits and visual survey of each candidate area, special note should be taken of any environmental factors which have not been discussed in Chapters 1 through 6. If any unique or unusual environmental or natural resource is identified, professional persons from appropriate fields should be consulted. Any environmental or natural resource which is found within a candidate area and which could be adversely affected by trailbike use should be considered during the site selection process and *must* be discussed in an environmental assessment.

7 HOW TO ESTABLISH A TRAILBIKE-USE AREA

The wording of AR 210-9 leaves no doubt that establishment of any ORRV-use area should come only in response to an expressed need. In practice, extensive unauthorized use may serve to inform the Army planner that such need exists. The initial demand may come from off-installation organizations seeking a place to operate their trailbikes. This is specifically anticipated by the regulation, and is permissible.

These organizations become one segment of the public from which ideas must be solicited before an ORRV-use area is finally established. However, the concept of public participation is that all identifiable groups and persons should be able to provide input into the process, not just known ORRV proponents. Appropriate *informal* workshops and meetings should be held at least twice: first when initial plans and use criteria are being established, and again when candidate sites have been selected. These meetings are not hearings; they are intended to collect constructive input before any firm decisions are made.

Institute for Water Resources (IWR) Research Report 75-R4, a pamphlet describing public involvement as it applies to Corps of Engineers Civil Works actions, provides guidance in obtaining appropriate public participation[9] Further guidance relating to the concept of public involvement as it applies to water resources planning, including associated ORRV development, may be found in ER 1105-2-800.[10] It is stressed that an area which fails to meet the needs of the potential users will be a failure. Once input from users and the public sector has been obtained, a use area can be chosen from the alternative sites.

Site Selection

One of several goals of AR 210-9 is that a designated ORRV-use area should be seen by ORRV operators as *better* than the undesignated areas they may have been using without authorization. If this goal cannot be met, then diffuse, unregulated use will continue to create environmental and safety problems. Increased levels of enforcement could theoretically confine ORRV use to the designated area, but the program would then be perceived as punitive, rather than constructive. Site selection should be approached from the point of view of trying to provide an area that will be used voluntarily by the majority of trailbike operators, rather than of trying to find some place to "stick" an unattractive nuisance.

Many factors presented in this report as restrictions on the development of an area for trailbike use will be *desired* by at least some classes of riders, e.g., steep slopes, water crossings, and/or muddy areas. In general, terrain variety is an absolute requirement for all users except the absolute novice -- and he or she will progress beyond this stage within a few hours, at most. Trailbike-use areas, therefore may include some "restricted" terrain at the expense of absolute environmental protection. For example, if variety of vegetation type is available, 25 percent slopes should provide experiences for the large majority of users without exceeding the least damaging slope in the soil evaluation criterion. If slope is the only soil limitation in an area, a few slopes in the 30 to 40 percent range (a moderate restriction) will accommodate reasonably safe public use.

Before making a site decision, it is recommended that at least three alternative sites be selected which meet the exclusionary criteria outlined in this report. The absolute minimum size for such a site is about 5 ha. The maximum is open to judgment, but it appears that no more than 50 to 100 ha may be safely maintained and policed by most installations.

When choosing these candidate sites, it must be remembered that these areas may eventually have to support sanitary facilities, safe parking areas, resting areas, and possibly picnic areas. If onpost personnel will be the primary users, fewer of these facilities are required, but the guidance in

[9] James R. Hanchey, *Public Involvement in the Corps of Engineers' Planning Process*, IWR Research Report 75-R4 (U.S. Army Engineer Institute for Water Resources, October 1975).

[10] *Planning -- Public Involvement: General Policies*, Engineer Regulation (ER) 1105-2-800 (Department of the Army, Office of the Chief of Engineers, 2 April 1975).

TM 5-803-12 should be followed.[11] Access near installation entrances should be considered, since travel to many otherwise suitable areas will cause difficult or congested public travel routes within the installation. Once these alternatives are chosen, the actual site decision should consider not only environmental factors, but the input of the public sector.

Trail Development

Once a site is chosen, and until detailed criteria are developed, the following brief outline of development suggestions should be used. It is emphasized that trail development should be such that the safety of trailbike operators is not compromised. User participation and public involvement will help identify potential safety hazards. Regular inspection by qualified safety personnel is also recommended.

Length

All trails should be at least 200 m in continuous, nonrepetitive length, and should be designated for one-way traffic. Maximum length depends on the site, and may be up to 2 to 3 km.

Width

All trails should have a cleared surface of not less than 0.6 m and no more than 2 m. The suggested width is 0.75 m, and natural obstructions such as rocks and trees can be used to prevent uncontrolled spread in width. However, location and/or placement of these barriers should be evaluated so that artificial safety hazards are not created. Trail width through turns should be larger than that on straightaways to allow turns to be safely executed.

Slope

Some portions of all trails should climb slopes of up to 25 percent, if such terrain is available. If alternate trails are to be developed, some climb areas of up to 40 percent slope are desirable, but must be indicated as being for experienced riders only. Normally, trails should not laterally traverse slopes of more than 15 percent for beginners or 30 percent for more experienced riders.

Surface

Natural soil materials will be the most commonly used material. If improvement is necessary, the best material is crushed or broken rock ranging in size from 10 to 40 mm. Natural gravel and round rock should not be used unless completely incorporated into the natural surface.

Turns

Many varied turns with few, if any, long, straight runs are suggested, since vehicle operation, not transport efficiency, is the goal. Turn radii should be variable (in the range of 2 to 10 m) with many turns of both more and less than 90 degrees. No single, straight section should exceed 100 m. Natural obstructions should be used to prevent shortcutting turns. Again, these barriers should not present a safety hazard.

Water Obstacles

If trails cross natural perennial streams, reinforced-surface fords, culverts, or bridges should be built. At least one novice trail which is free of water features should be planned. Highly developed and heavily used trailbike areas may include one or more artificially maintained water features, preferably supplied by artifically channelled runoff water.

[11] *Planning and Design of Outdoor Recreation Facilities*, TM 5-803-12 (U.S. Department of the Army, Washington, DC, 1 October 1975)

Clearances

Trees, brush, fences, and other obstacles should be removed to provide clearance for handlebars, arms, and legs. A lateral cleared distance of 0.6 m from the edge of the defined trail is necessary; vertical clearance should be at least 2.25 m.

Operating Conditions

The installation commanding officer has authority, through AR 210-9, to allow a wide variety of activities at his or her discretion. In the absence of demonstrated requirements to the contrary, it is recommended that the following minimum operating criteria initially be adopted.

License and Inspection

All vehicles operated by military personnel and/or their dependents will be inspected by the Provost Marshal for compliance with all applicable safety regulations, whether or not the vehicle is licensed for operation on public roads. No noncomplying vehicle will be allowed to use the ORRV area. All vehicles operated by unsponsored civilians residing off the installation will be licensed for street operations, and will be inspected as necessary to meet state and local requirements. No unlicensed vehicles may be operated on the installation. All operators will be licensed vehicle operators under the requirements of the state, or of their state of residence. No unlicensed operators will be allowed to operate a vehicle on the installation, regardless of whether or not certain types of vehicle operation are permitted under state law. At the discretion of the commanding officer, unlicensed operators 10 years of age or older may operate a complying vehicle while under the direct control of a parent or legal guardian who is concurrently operating a complying vehicle.

Muffler

All trailbikes must be equipped with factory-equivalent mufflers in good working condition and must have a Forest Service-approved spark arrestor. (Forest Service-approved mufflers have this approval stamped into the metal of the muffler.)

Passengers

No passengers will be carried on trailbikes under any circumstances.

Direction of Traffic

All trails will be clearly and conspicuously posted for one-way traffic. If certain areas must carry two-way traffic, the trail at this place must be a minimum of 3 m wide, and must be posted for 2-way use. All traffic is required to use trails, and no generalized use of off-trail lands is permitted. However, a flat, cleared area for beginners may be provided. Use of this area is restricted to beginners.

Hours of Operations

No trailbike will be allowed to use the area between 15 minutes after sunset and 15 minutes before sunrise, regardless of whether it is equipped with functional headlights and taillights. This operating condition is imposed for the safety of participants. No trailbike will be allowed to operate in the area between 2200 and 0700 hours, regardless of the time of sunrise and sunset. This operating condition is imposed to avoid disturbing nonparticipants during normal sleeping hours.

Supervision and Violations

To ensure that operating conditions are complied with and to restrict use to only designated trails and areas, it is recommended that there be supervision at trailbike-use areas, especially during periods of peak use. Organized recreational activities involving ORRVs are within the scope of the Outdoor Recreation Program, and supervision may be by Recreation Services personnel or by the Military Police, at the commanding officer's discretion.

Violations of the operating conditions listed above and other posted operating regulations should be treated as traffic violations. Citations may be issued upon the complaint of the trailbike-area

supervisor or other officer by any installation enforcement person authorized to issue other vehicle and traffic citations.

8 ENVIRONMENTAL ASSESSMENT AND MONITORING

Before opening areas or trails to trailbikes, an environmental impact assessment or statement must be prepared. This should be required in every case because of the controversial nature of ORRV use. Much of the information obtained from the evaluation method described in this report should be used in preparing these documents.

Once an ORRV area has been established, use and changes in use intensity can significantly impact the area. AR 210-9 requires commanders of Army installations and activities to establish appropriate procedures to monitor the effects of the use of ORRVs on their installations. This monitoring is to be the basis for changes in installation policy concerning ORRV use.

Table 7 outlines a method of monitoring the environmental effects of trailbike use. It was adapted from Appendix D of ER 1130-2-405.[12] It is emphasized that the method is not intended to take the place of a disciplined scientific study, but is a limited method designed to monitor effects while taking into consideration budgetary constraints and personnel ceilings. This monitoring plan is very similar to those established by other Federal agencies with similar constraints.

A comparison of all data records collected over 5 years will help to determine the environmental effects of trailbike use. However, at this time, only professional judgment can be used to determine if impacts are significant and if changes in installation policy concerning ORRV use in a specific area should be implemented. This judgment should be solicited from professionals with expertise in various environmental disciplines, particularly biology, earth science, and soils.

[12] *Project Operation: Use of Off-Road Vehicles on Civil Works Projects*, ER 1130-2-405 (U.S. Department of the Army, Office of the Chief of Engineers, 17 January 1974).

Table 7

Method of Monitoring Environmental Effects of Trailbike Use

1. Estimate use of the area or trails by trailbike users.
2. Determine impact of ORRV use on vegetation, soil, and water.
   a. Map existing trails in designated ORRV area.
   b. Record mileage and average width of existing trails.
   c. Rate existing trails according to light, medium, or heavy use.
   d. Select random sample plots on existing trails which are representative of a variety of terrain, vegetative, and soil conditions.
      (1) Photograph sample plots.
      (2) Record trail width and rut depths at selected intervals. Also record other notable features, such as potholes, along entire trail length.
      (3) Record inventory of vegetative community within the sample plot. Inventory should include species composition, size of woody vegetation, and number of dead stems greater than 20 mm in diameter.
      (4) Record general condition of vegetation in sample plot. Note damaged tree bark and roots.
   e. Record initially, and at intervals of 1, 3, and 5 years, those items included in d, above.
   f. Define control plots near test plots to determine impact with and without ORRV use. Control plots should be approximately 18 m from trail center. Record all appropriate information on control plots for comparison with sample plots.
   g. Permanently but inconspicuously mark all control and test plots so that photographs and data collection can be done in the same area in subsequent years.
   h. Determine the following from test sections:
      (1) Impact on young vegetative growth.
      (2) Impact on larger trees and shrubs (compaction, direct damage, root exposure).
      (3) Impact on soil (erosion, compaction, lateral movement).
      (4) Trail width and depth variation from year to year.
      (5) Extent of impact on either side of trail. Changes in trail such as expansion of potholes.
      (6) Comparison of ORRV impact on test plots with control plots.
   i. Annually spot-check vulnerable areas such as steep slopes, creek banks, and lake shoreline. Record any noticeable increases in erosion or other damage.
3. Determine ORRV impact on wildlife.
   a. Record track counts of big game animals such as deer, antelope, and elk in ORRV area and compare to those outside ORRV area.
   b. Count songs of game birds and nongame birds.
   c. If hunting is permitted, compare wildlife harvest in ORRV area to that of other areas on the installation.
   d. Record sightings of game and nongame species in and outside ORRV-use area.
4. Determine ORRV impact on other activities.
   a. Survey type and amount of recreation and other use in areas adjacent to designated ORRV areas.
   b. Record attitudinal response of persons who are surveyed as accurately as possible.
   c. Record distance between area where survey is made and the ORRV area.

9 SUMMARY

Pressure from trailbike enthusiasts for land on which to operate their vehicles and the expressed concerns of environmental groups continues to make the ORRV issue controversial. Federal agency response to user and nonuser interests can be improved through proper land evaluation, planning, and management. The land evaluation method described in this report provides Army land managers with a reliable tool for meeting user demands while giving due consideration to the long-term stability of environmental resources.

While the method described in this report was developed specifically for the evaluation of Army military lands, it is applicable, with modification, to Army Civil Works land and many other public and private agencies and organizations.

APPENDIX A:

SELECTED PRECALCULATED DNNAs

Before selecting sites for trailbike use, noise buffer zones should be established around noise-sensitive land uses. These zones are based on DNNAs and are established to ensure that the noise from a trailbike-use area will not disturb the activities at nearby land uses.

Table A1 lists the DNNA for various maximum equivalent sound-level (L_{eq}) requirements for land uses and projected use parameters. All distances in the table were calculated using the equation described in Chapter 3. To find an appropriate DNNA in Table A1, it is necessary to determine:

1. The L_{eq} of the land use for which a buffer zone is needed or for which use limits must be determined.
2. The average daily peak use in numbers of trailbikes (projected demand).
3. The average sound level (in dBA) generated by these trailbikes.

The L_{eq} for various noise-sensitive land uses are listed in Table 2, Chapter 3. Once these use parameters are known, the DNNAs for many noise-sensitive land uses are easily found in Table A1; Figure A1 shows how to use Table A1. The example in Figure A1 assumes an L_{eq} of 75 dBA and a projected demand of 40 trailbikes generating an average sound level of 85 dBA. The DNNA is 542 m.

Table A1 can also be used to establish limits on the use of a potential trailbike area. Using the example shown in Figure A1, assume that a proposed trailbike area is 542 m away from a livestock grazing area (L_{eq} = 75 dBA). Also, the trailbikes expected to use the area generate an average sound level of 85 dBA. Therefore, use of the proposed area *must be limited* to an average daily use of 40 trailbikes at any one time in order to ensure that maximum acceptable sound levels are not exceeded.

Table A1

Selected Precalculated DNNAs for Establishment of Trailbike-Use Areas (Distance in Meters)

Maximum Acceptable Equivalent Sound Level (L_{eq}) for Land Use (dBA)	Estimated Number of Motorcycles Using the Area									Average Sound Level for Motorcycles Using the Area (dBA at 15 m [50 ft])
	10	15	20	25	30	40	50	60	80	
65	681	834	963	1077	1179	1362	1523	1668	1926	83 dBA
70	383	469	542	605	663	766	856	938	1083	
75	215	264	305	341	373	431	482	527	609	
80	121	148	171	192	210	242	271	297	343	
65	764	936	1081	1208	1323	1528	1704	1871	2161	84 dBA
70	430	526	608	679	744	859	961	1052	1215	
75	242	296	342	382	419	483	540	592	683	
80	136	166	192	215	235	272	304	333	384	
65	857	1050	1212	1355	1485	1715	1917	2100	2425	85 dBA
70	482	590	682	762	835	964	1078	1181	1364	
75	271	332	383	429	470	542	606	664	767	
80	152	187	216	241	264	305	341	373	431	
65	962	1178	1360	1521	1666	1924	2151	2356	2721	86 dBA
70	541	662	765	855	937	1082	1209	1325	1530	
75	304	373	430	481	527	608	680	745	860	
80	171	210	242	270	296	342	383	419	484	
65	1079	1322	1526	1706	1869	2158	2413	2644	3052	87 dBA
70	607	743	858	960	1051	1214	1357	1487	1717	
75	341	418	483	540	591	683	763	836	965	
80	192	235	271	303	332	384	429	470	543	

Table A1 (Cont'd)

Maximum Acceptable Equivalent Sound Level (L_{eq}) for Land Use (dBA)	Estimated Number of Motorcycles Using the Area									Average Sound Level for Motorcycles Using the Area (dBA at 15 m [50 ft])
	10	15	20	25	30	40	50	60	80	
65	1211	1483	1712	1915	2097	2422	2708	2966	3245	88 dBA
70	681	834	963	1077	1179	1362	1523	1668	1926	
75	383	469	542	605	663	766	856	938	1083	
80	215	264	305	341	373	431	482	527	609	
65	1359	1664	1921	2148	2353	2717	3038	3328	3843	89 dBA
70	764	936	1081	1208	1323	1528	1704	1871	2161	
75	430	526	608	679	744	859	961	1052	1215	
80	242	296	342	382	419	483	540	592	683	
65	1524	1867	2156	2410	2640	3048	3409	3734	4312	90 dBA
70	857	1050	1212	1355	1485	1715	1917	2100	2425	
75	482	590	682	762	835	964	1078	1181	1364	
80	271	332	383	429	470	542	606	664	767	
65	1710	2095	2419	2704	2963	3421	3825	4190	4838	91 dBA
70	962	1178	1360	1521	1666	1924	2151	2356	2721	
75	541	662	765	855	937	1082	1209	1325	1530	
80	304	373	430	481	527	608	680	745	860	
65	1929	2350	2714	3034	3324	3838	4291	4701	5428	92 dBA
70	1079	1322	1526	1706	1869	2158	2413	2644	3052	
75	607	743	858	960	1051	1214	1357	1487	1717	
80	341	418	483	540	591	683	763	836	965	
65	2153	2637	3045	3405	3730	4306	4815	5274	6090	93 dBA
70	1211	1483	1712	1915	2097	2422	2708	2966	3245	
75	681	834	963	1077	1179	1362	1523	1668	1926	
80	383	469	542	605	663	766	856	938	1083	

Table A1 (Cont'd)

Maximum Acceptable Equivalent Sound Level (L_{eq}) for Land Use (dBA)	Estimated Number of Motorcycles Using the Area									Average Sound Level for Motorcycles Using the Area (dBA at 15 m [50 ft])
	10	15	20	25	30	40	50	60	80	
65	2416	2959	3417	3820	4185	4832	5402	5918	6834	94 dBA
70	1359	1664	1921	2148	2353	2717	3038	3328	3843	
75	764	936	1081	1208	1323	1528	1704	1871	2161	
80	430	526	608	679	744	859	961	1052	1215	
65	2711	3320	3834	4286	4695	5422	6062	6640	7667	95 dBA
70	1524	1867	2156	2410	2640	3048	3409	3734	4312	
75	857	1050	1212	1355	1485	1715	1917	2100	2425	
80	482	590	682	762	835	964	1078	1181	1364	
65	3042	3725	4301	4809	5268	6083	6801	7450	8603	96 dBA
70	1710	2095	2419	2704	2963	3421	3825	4190	4838	
75	962	1178	1360	1521	1666	1924	2151	2356	2721	
80	541	662	765	855	937	1082	1209	1325	1530	
65	3413	4180	4826	5396	5911	6925	7631	8359	9653	97 dBA
70	1919	2350	2714	3034	3324	3838	4291	4701	5428	
75	1079	1322	1526	1706	1869	2158	2413	2644	3052	
80	607	743	858	960	1051	1214	1357	1487	1717	
65	3829	4690	5415	6054	6632	7658	8562	9379	10830	98 dBA
70	2153	2637	3045	3405	3730	4306	4815	5274	6090	
75	1211	1483	1712	1915	2097	2422	2708	2966	3425	
80	681	834	963	1077	1179	1362	1523	1668	1926	
65	4296	5262	6076	6793	7441	8593	9607	10524	12152	99 dBA
70	2416	2959	3417	3820	4185	4832	5402	5918	6834	
75	1359	1664	1921	2148	2353	2717	3038	3328	3843	
80	764	936	1081	1208	1323	1528	1704	1871	2161	
65	4821	5904	6817	7622	8349	9641	10779	11808	13635	100 dBA
70	2711	3320	3834	4286	4695	5422	6062	6640	7667	
75	1524	1867	2156	2410	2640	3048	3409	3734	4312	
80	857	1050	1212	1355	1485	1715	1917	2100	2425	

Maximum Acceptable Equivalent Sound Level (L_{eq}) for Land Use (dBA)	Estimated Number of Motorcycles Using the Area									Average Sound Level for Motorcycles Using the Area (dBA at 15 m [50 ft])
	10	15	20	25	30	40	50	60	80	
65	681	834	963	1077	1179	1362	1523	1668	1926	83 dBA
70	383	469	542	605	663	766	856	938	1083	
75	215	264	305	341	373	431	482	527	609	
80	121	148	171	192	210	242	271	297	343	
65	764	936	1081	1208	1323	1528	1704	1871	2161	84 dBA
70	430	526	608	679	744	859	961	1052	1215	
75	242	296	342	382	419	483	540	592	683	
80	136	166	192	215	235	272	304	333	384	
65	857	1050	1212	1355	1485	1715	1917	2100	2425	85 dBA
70	482	590	682	762	835	964	1078	1181	1364	
75	271	332	383	429	470	542	606	664	767	
80	152	187	216	241	264	305	341	373	431	

Figure A1. Example of finding the DNNA of an area using Table A1.

APPENDIX B:

BIOLOGICAL RATING FORM

This appendix provides a blank copy of the rating form to be used in the procedure to evaluate the biological resources of areas. This form is provided in order that it may be reproduced and used in the field.

Area _____

Rating _____ Rank _____

Biological Limitation _____

_____

Resources	Relative Value	Categorical Value	Susceptibility to ORRV Damage	Categorical Susceptibility	Combined Resource Value	Notes
Ground Cover						
_____						
Trees or Dominant Vegetation						
_____						
Terrestrial Game Animals						
_____						
Terrestrial Nongame Animals						
_____						
Fish						
_____						
Pest species						
_____						
Other						
_____						
Total Area Value			Total Combined Resource Value			

Figure B1. Biological rating form for ORRV-use potential.

APPENDIX C:

EVALUATION METHOD FIELD TEST: EVALUATION OF AREAS AT FORT ORD, CALIFORNIA FOR POTENTIAL TRAILBIKE USE

Introduction

Fort Ord, California, is just north of Monterey, California, about 160 km south of San Francisco and 560 km northwest of Los Angeles. The installation is bounded on the west by 6.6 km of Pacific Ocean coast and has a total land acreage of roughly 11 340 ha (Figure C1). Fort Ord is the Headquarters for the 7th Infantry Division, and roughly one-fifth of the installation land has been improved (developed) in order to support the military mission. The remaining unimproved land area is primarily used for training purposes.

A field test of CERL's trailbike evaluation method was conducted at Fort Ord during June 1979 by CERL personnel and members of Fort Ord's FE office.

Incompatible Land Uses

The cantonment area of Fort Ord contains a variety of land uses (e.g., troop housing, schools, and family housing) which are considered to be incompatible with trailbike use. Many of the land uses on the unimproved land (e.g., impact areas and firing ranges) are also incompatible with trailbike use. Based on onsite investigations, master plan maps, natural resource information, and training schedules, a considerable amount of Fort Ord was eliminated from consideration for trailbike use. Figure C2 illustrates those areas.

Noise-Sensitive Land Uses

At Fort Ord, it was estimated that as many as 100 to 160 trailbikes might be used in an established trailbike-use area in a single day. It was further estimated that up to 50 trailbikes might be using the area during a single hour of a day (e.g., on weekends) and that many of these trailbikes would be the enduro type which generate at least 86 dBA.

When figures for this fairly heavy use were put into Eq 1, it was determined that any established use area would need to be at least than 2151 m away from any land use with a maximum acceptable sound-level requirement of 65 dB. When appropriate buffer zones were then drawn on a base map, a considerable portion of the acreage of Fort Ord was within these excluded zones. As a result, it was decided to advance to the next step in the evaluation method and pick candidate areas before establishing noise buffer zones. Once these areas were chosen, Eq 1 would be used to determine use limits for any proposed trailbike-use area.

Candidate Areas at Fort Ord

Four candidate areas were chosen at Fort Ord (Figure C2) after consulting with personnel in the installation's Environmental Quality and Outdoor Recreation offices. One area, located north of the installation's airfield, was roughly 50 ha; the area, named Fritzsche Pasture, was primarily gently rolling grassland with small thickets of California sage and coyote bush.

A second candidate area was chosen just south of the airfield. This area was about 40 ha, gently rolling, and covered with light brush and Coast Live Oak in open stands. Much of this area was already receiving some limited unauthorized use. This area was named South of the Airfield.

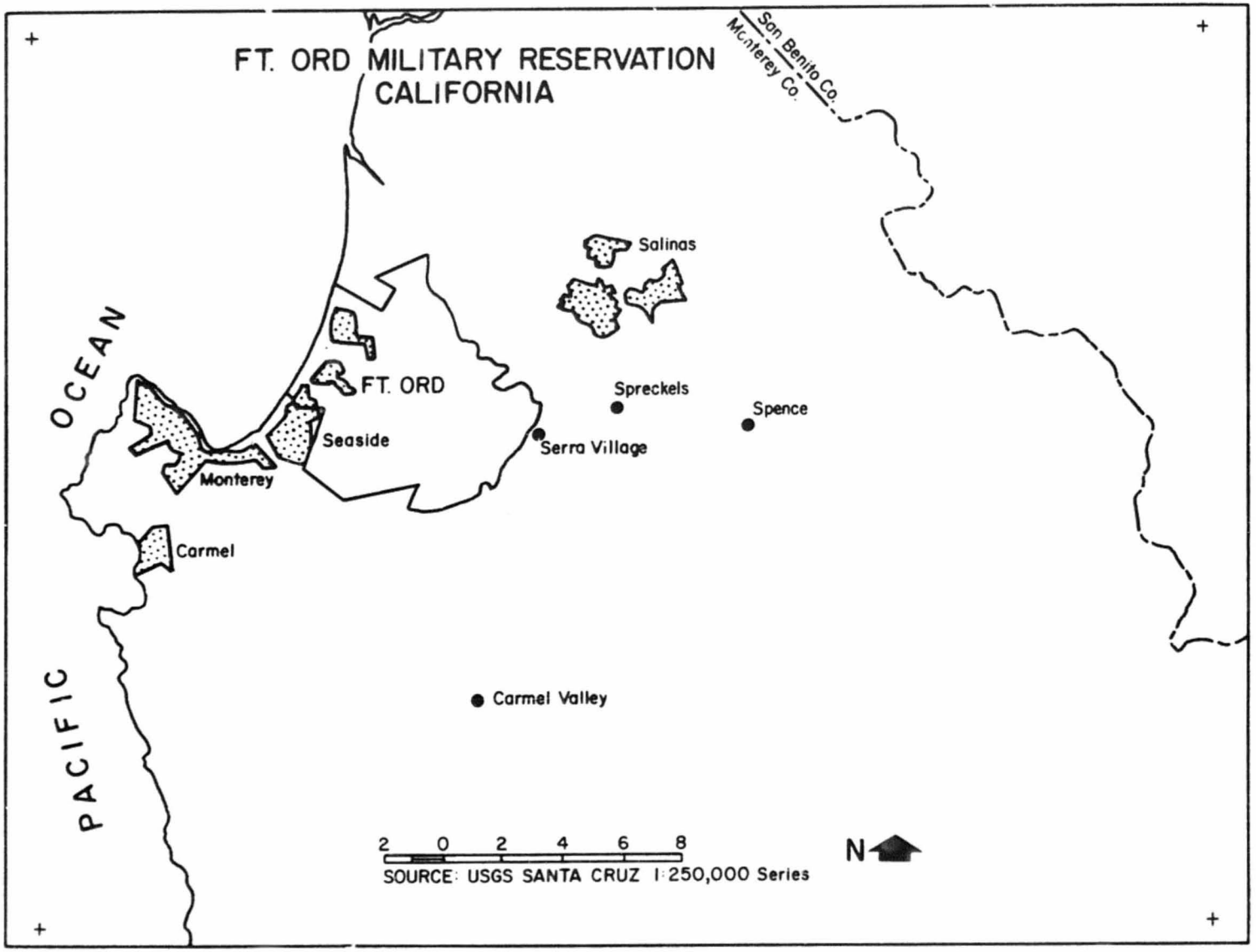


Figure C1. Fort Ord, California and vicinity.

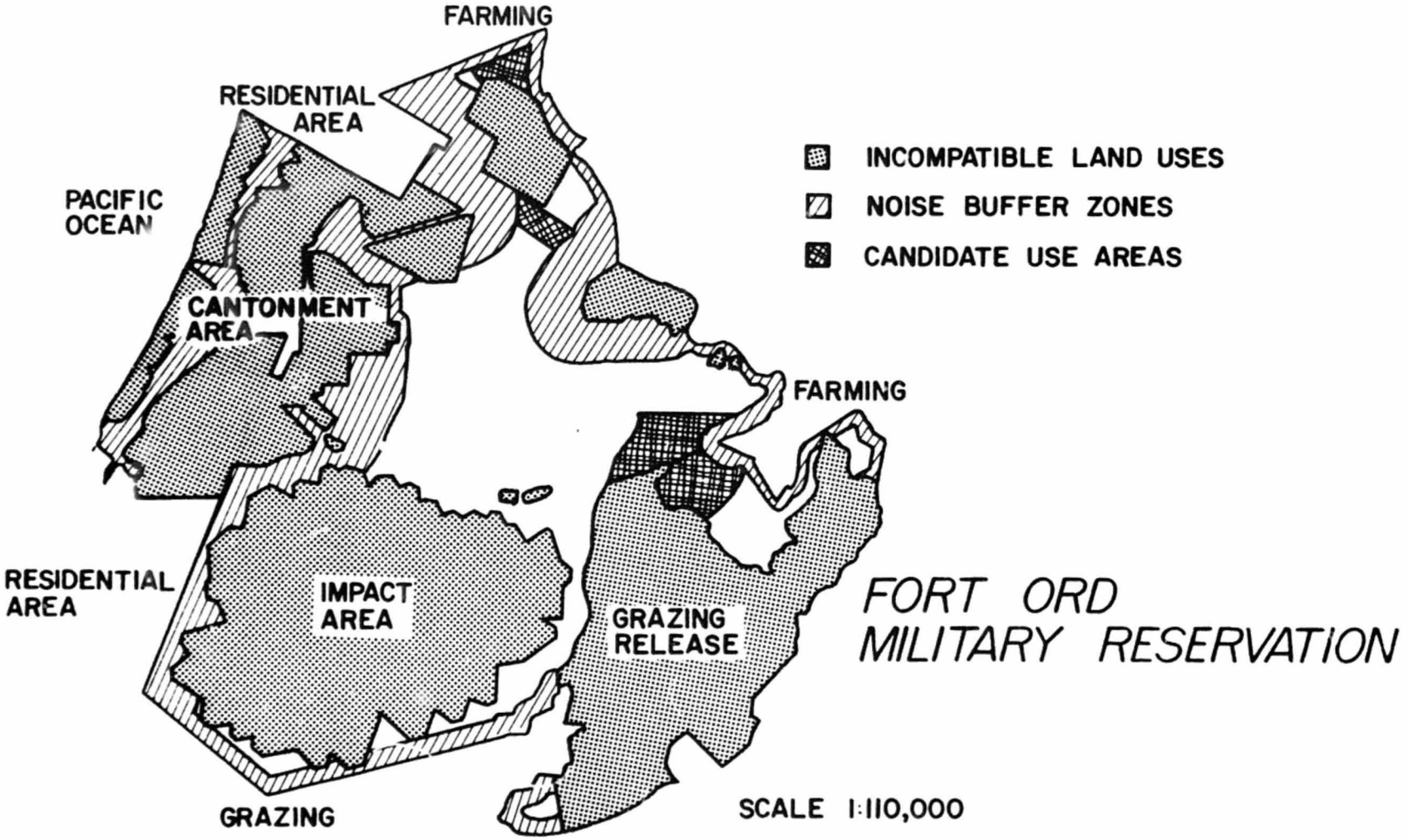


Figure C2. Land evaluation for trailbike use.

The third and fourth candidate areas were on the eastern side of the installation. Both areas were moderately to steeply sloping. Ground cover was light to heavy brush with considerable open stands of Coast Live Oak. The northernmost area was about 120 ha and bisected by a steep ridge. This area was named Sandstone Ridge. The southernmost area was also bisected by a ridge and was about 100 ha; it was named Pilarcitos Ridge.

After the candidate areas were chosen, their location relative to noise-sensitive land uses was examined. It was determined that no more than 10 trailbikes could be operated at any one time in any area. This was determined by entering into the noise equation (1) the distance each area was located away from various noise-sensitive land uses (2) and the expected noise level of 86 dBA per trailbike.

For example, the candidate area, South of the Airfield, was located such that the western boundary was about 960 m from a Fort Ord family housing area. The eastern boundary was also roughly 960 m from an off-installation residential area. The recommended L_{eq} for residential areas is 65 dB. When the data A = 15.24 m, B = 86 dBA, D= 65 dB, and DNNA = 960 m were put into Eq 1, the value of C became about 10. Therefore, only 10 trailbikes, generating an average of 86 dBA, should be allowed to operate in the area at any one time. However, if the average noise level of the trailbikes expected to use a candidate area is actually lower than that expected, more trailbikes might be allowed to use the area.

Once location and noise factors were examined, noise buffer zones were established around all noise-sensitive land uses on and around Fort Ord (Figure C2). These zones reflected the DNNAs which were calculated using the demand and limited-use assumptions discussed above. No trailbike use should be allowed in these zones.

Fort Ord Soil Suitability

The soils of each candidate area on Fort Ord were mapped according to their degree of limitation. Figures C3, C4, C5, and C6 are reproductions of those maps* The bottom half of each figure lists the soil series in each area along with the soil series' phases, limitations, and restrictions.

As illustrated by the figures, the Fritzsche Pasture area appeared to be the most suitable candidate area in terms of soils. However, the South of the Airfield area also had a considerable amount of area where the soils were acceptable. Both the Sandstone Ridge and Pilarcitos Ridge areas had considerable acreage where the soils had severe limitations for trailbike use.

Biological Ranking of the Fort Ord Candidate Areas

Fort Ord's fish and wildlife biologist ranked all four candidate areas. The Susceptibility to ORRV Damage Method was used because the biologist was familiar with trailbike damage caused by the unauthorized use which had been occurring. The results of these evaluations are in Figures C7, C8, C9, and C10.

As these figures illustrate, the Fritzsche Pasture area was the most acceptable candidate area in terms of biological value. The South of the Airfield area was the next most acceptable. Both the Pilarcitos Ridge and Sandstone Ridge areas had fairly high biological values. The primary biological restriction (limitation) in these areas was that they provided important wildlife habitat. (Stands of Coast Live Oak provide excellent cover for a variety of terrestrial animals. The lake located between the two areas is one of only two on the installation and both areas are important roosting and/or display areas for quail.)

* The soil series boundaries on the maps in Figures C3, C4, C5, and C6 were reproduced from USDA SCS soil survey maps in *Soil Survey of Monterey County, California* (U.S. Government Printing Office, April 1978).

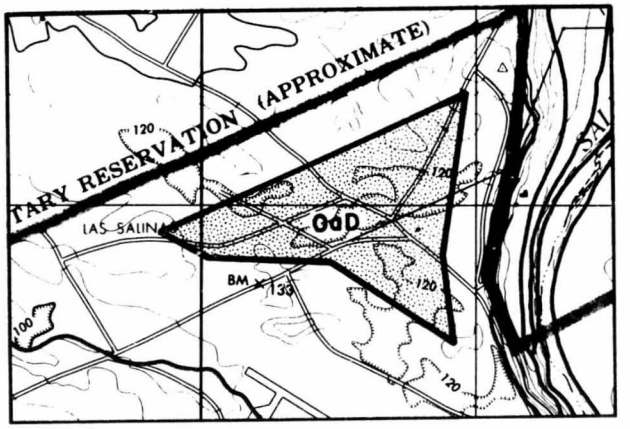
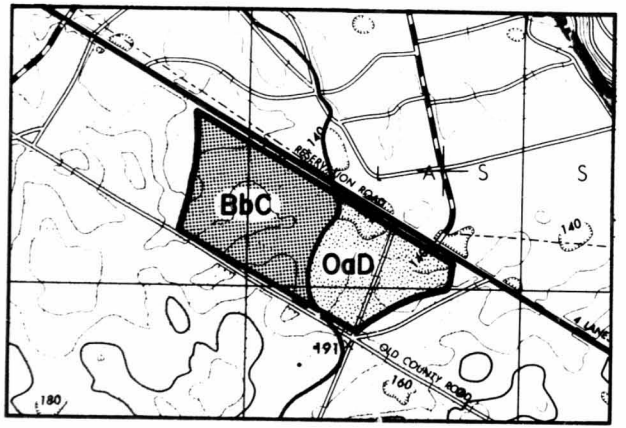


Figure C3. Fritzsche Pasture soil limitations map.

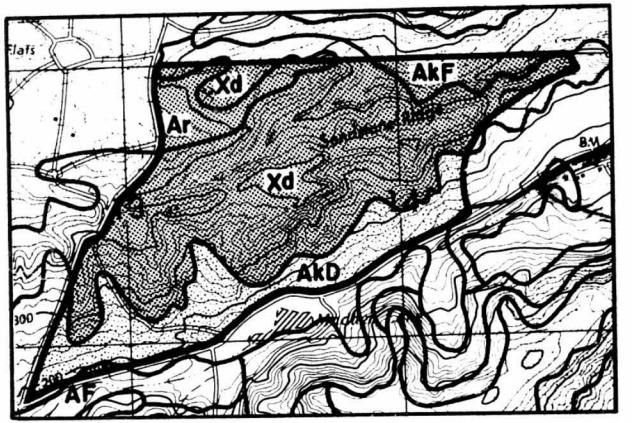


LEGEND: SCALE = 1:16,500 N

- SLIGHT SOIL LIMITATIONS
- SEVERE SOIL LIMITATIONS

BbC	BAYWOOD	2-15% SAND	SEVERE	TOO SANDY
OaD	OCEANO	2-15% LOAMY SAND	SLIGHT	

Figure C4. South of the Airfield soil limitations map.

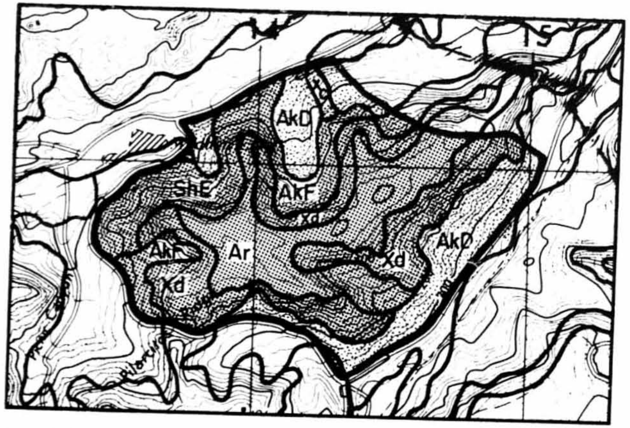


LEGEND SCALE = 1:16,500 N

- SLIGHT SOIL LIMITATIONS
- MODERATE SOIL LIMITATIONS
- SEVERE SOIL LIMITATIONS

Af	ACQUITIC XEROFLUVENTS	0-15% SAND, SANDY LOAM, SILT LOAM	MODERATE	FLOODS
AkD	ARNOLD	9-15% LOAMY SAND	SLIGHT	
AkF	ARNOLD	15-50% LOAMY SAND	SEVERE	ERODES EASILY
Ar	ARNOLD-SANTA YNEZ COMPLEX	9-30% SAND, LOAMY SAND	SEVERE	ERODES EASILY
Xd	XERORTHENTS	35-90% SANDY LOAM, COARSE SANDY LOAM	SEVERE	SLOPE

Figure C5. Sandstone Ridge soil limitations map.



LEGEND: SCALE = 1:16,500 N

- ☐ SLIGHT SOIL LIMITATIONS
- ☐ MODERATE SOIL LIMITATIONS
- ☐ SEVERE SOIL LIMITATIONS

AkD	ARNOLD	9-15% LOAMY SAND	SLIGHT	
AkF	ARNOLD	15-50% LOAMY SAND	SEVERE	ERODES EASILY
Ar	ARNOLD-SANTA YNEZ COMPLEX	9-30% SAND, LOAMY SAND	SEVERE	ERODES EASILY
ShE	SANTA YNEZ	15-30% FINE SANDY LOAM	SEVERE	ERODES EASILY
Xc	XERORTHENTS	15-50% LOAM, SILT LOAM, CLAY LOAM, CLAY	MODERATE	SLOPE, DUSTY
Xd	XERORTHENTS	35-90% SANDY LOAM, COARSE SANDY LOAM	SEVERE	SLOPE

Figure C6. Pilarcitos Ridge soil limitations map.

Area Fritzsche Pasture

Rating 6.6 Rank 1

Biological Limitation Terrestrial Nongame Animals - Valuable soaring area for vultures

Biological Resources	Relative Value	Categorical Value	Susceptibility to ORRV Damage	Categorical Susceptibility	Combined Resource Value	Notes
Ground Cover		1		1	1	
Annual Ryegrass Bur Clover Filaree	1 1 1		1 1 1			90% Annual range lands
Trees or Dominant Vegetation		2		3	6	
Coyote Brush California Sage	2 1		3 3			
Terrestrial Game Animals		3		3	9	
Blacktail Deer CA Valley Quail Cottontail Rabbit	3 2 3		3 2 1			Scarce
Terrestrial Nongame Animals		4		3	12	
Red Tail Hawk Meadow Lark Starling Turkey Vulture W. Western Fence Lizard Gopher Snake Badger	4 3 2 4 3 2 2		1 1 1 3 1 1 2			Common soaring area for hawks and vultures
Fish		—		—	—	
N/A	—		—			
Pest species		1		5	5	
Ground Squirrel	1		5			Much damage to range
Other		—		—	—	
N/A	—		—			
	Total Area Value	11	Total Combined Resource Value		33	

Figure C7. Biological rating for Fritzsche Pasture area.

Area South of the Airfield

Rating 8.6 Rank 2

Biological Limitation Terrestrial Nongame Animals - valuable habitat for Nuttall's Woodpecker

Biological Resources	Relative Value	Categorical Value	Susceptibility to ORRV Damage	Categorical Susceptibility	Combined Resource Value	Notes
Ground Cover		3		3	9	
Annual Ryegrass Bracken Fern [illegible] Oak Coast Live Oak	2 3 3 3		2 2 2 3			Excellent Oak woodland environment
Trees or Dominant Vegetation		3		3	9	
Coast Live Oak	3		3			
Terrestrial Game Animals		4		2	8	
Blacktail Deer Cal. Valley Quail Cottontail Rabbit Jack Rabbit	3 4 4 2		3 2 1 1			
Terrestrial Nongame Animals		4		3	12	
Gopher Snake Wood Rat Badger Gray Fox Skunk Raccoon Nuttall's Woodpecker	3 3 3 3 2 2 4		4 3 1 3 3 2 4			Lots of terrestrial mammals
Fish		—		—	—	
N/A	—		—			
Pest species		1		[illegible]	[illegible]	
Ground squirrel	1		[illegible]			
Other		—		—	—	
N/A	—		—			

Total Area Value 15 Total Combined Resource Value 43

Figure C8. Biological rating for South of the Airfield area.

Area Sandstone Ridge

Rating 12.7 Rank 4

Biological Limitation Important roosting and display area for quail.

Biological Resources	Relative Value	Categorical Value	Susceptibility to ORRV Damage	Categorical Susceptibility	Combined Resource Value	Notes
Ground Cover		5		3	15	
California Sage Cal. Buckwheat Toro Manzanita Chamise	3 3 5 1		2 3 3 2			Rare species of manzanita
Trees or Dominant Vegetation		3		4	12	
Monterey Manzanita Coast Live Oak	2 3		4 4			Both manzanita and Oak are cover trees (roosting)
Terrestrial Game Animals		3		3	9	
Blacktail Deer Cottontail Rabbit Cal. Valley Quail Mourning Dove	3 3 3 2		3 1 2 1			One of the best wildlife areas
Terrestrial Nongame Animals		4		2	8	
Redtail Hawk Roadrunner Western Bluebird Red Fox Coyote Wood Rat Western Fence Lizard	1 4 2 3 2 4 4		3 2 2 3 2 1 1			Lake is one of only two areas on post
Fish		5		3	15	
Largemouth Bass Bluegill Sunfish Channel Catfish	5 5 5		3 2 1			
Pest species		1		[illegible]	[illegible]	
Ground Squirrel	1		[illegible]			
Other		5		5	25	
Strutting and Display Area for Quail	5		5			Important display area for quail

Total Area Value 26 Total Combined Resource Value 89

Figure C9. Biological rating for Sandstone Ridge area.

Area *Pilarcitos Ridge*

Rating *10.1* Rank *3*

Biological Limitation *Important roosting area for Quail.*

Biological Resources	Relative Value	Categorical Value	Susceptibility to OBRV Damage	Categorical Susceptibility	Combined Resource Value	Notes
Ground Cover		3		2	6	
California [illegible] Buckwheat Monterey Manzanita Chamise	3 3 2 1		2 2 3 2			Good diversity of plants for wildlife
Trees or Dominant Vegetation		3		4	12	
Coast Live Oak	3		4			Cover
Terrestrial Game Animals		3		3	9	
Blacktail Deer Cottontail Rabbit Ca. Valley Quail	3 3 3		3 1 2			
Terrestrial Nongame Animals		4		2	8	
Redtail Hawk [illegible] Western Bluebird Red Fox Coyote [illegible] Western Fence Lizard	1 4 2 3 2 4 4		3 2 2 3 2 1			Reptiles and other nongame benefit from water - Nesting trees for Hawks
Fish		5		3	15	
Large Mouth Bass Bluegill Sunfish Channel Catfish	5 5 5		3 2 1			Lake is one of only two areas on post
Pest species		1		5	5	
Ground Squirrel	1		5			Pest - many burrows
Other		4		4	16	
Roosting area for Quail	4		4			

Total Area Value 23 Total Combined Resource Value 71

Figure C10. Biological rating for Pilarcitos Ridge area.

Conclusions and Recommendations

Conclusions

1. Of the four candidate areas examined for potential use, either the Fritzsche Pasture or South of the Airfield areas would be acceptable for trailbike use. The entire Fritzsche Pasture area had soil with slight limitations and was ranked No. 1 in terms of biological acceptability. A considerable portion of the South of the Airfield area also had soils with slight limitations and was rated as the second most acceptable in terms of biological acceptability.

2. The Sandstone Ridge and Pilarcitos Ridge areas would be much less acceptable for a potential trailbike-use area. The majority of each of these areas contained soils which had severe limitations; i.e., soils that eroded easily on the slopes where they were found. There was, however, some acreage in each area which contained soils with slight limitations. These portions of the candidate areas might possibly be acceptable except for the fact that they were biologically valuable. This biological value would be substantially damaged as a result of any trailbike use; i.e., trailbike noise would affect their importance as roosting and display areas for quail and could also increase sediments in the nearby lake, thereby affecting fish populations.

3. Considering the high estimated demand for trailbike use (and the expected type of vehicle which would use the area), a considerable portion of the installation would be unavailable because of noise factors. Therefore, use limits would have to be established if *any* of the candidates were picked as a potential trailbike-use area. This limit would be 10 trailbikes in operation at any one time, if the expected use was to be by enduro-model trailbikes which generate an average of 86 dBA. However, if use were restricted to only dual-purpose model trailbikes (street legal but capable of being used off-road) which generate an average of 83 dBA, then this use limit could be expanded to possibly 20 trailbikes. Note that the above limitations only apply to the candidate areas examined during the study.

Recommendations

1. If it is desirable to establish a trailbike-use area at one of the candidate areas examined, it should be established in either the Fritzsche Pasture or South of the Airfield area. In either case, selection of a trailbike-use area should be based on the appropriate considerations; i.e., average noise level generated by the trailbikes actually using the area. If an area is established, supervision should be provided to ensure that use limits are not exceeded. Organized recreational activities involving ORVs are within the scope of the Outdoor Recreation Program, and supervision may be by Recreation Services personnel or by the military police, at the commanding officer's discretion.

2. Before establishing a trailbike-use area, an environmental assessment should be prepared. Much of the information obtained through the evaluation method could be used in the assessment.

3. If an area is to be established, the methods for establishing a trailbike-use area described in this report should be used.

4. The evaluation criteria used in this study did not apply to competitive events, but solely to individual recreational use. Should an area be established, competitive events should not be allowed until further evaluation is possible.

5. If an area is to be opened to trailbike use, the necessary environmental monitoring procedures should also be implemented.

6. It is possible that other candidate areas at Fort Ord should be examined. These candidate areas should be located such that use would not be as restricted as it would be if any of the candidate areas examined for this study were used. This examination and the subsequent loosening of use limits, and provisions for public and user participation in the decision-making process may tend to alleviate many potential problems which might arise if such an area is established.

Summary

The conclusions and recommendations above are not intended to promote or condemn establishment of a trailbike use area at Fort Ord. They are presented only as results of the field test of the evaluation method. Decisions on trailbike use at Fort Ord should be made by installation personnel and only after more detailed examination of user demand and site alternatives.

The field test was successful in identifying problems with the evaluation method; primarily problems with data availability assumptions. Modifications to the method have been made and are included in this report. The evaluation method described in Chapters 2 through 7 can be used by the majority of installations when there is a demand for a trailbike-use area.

APPENDIX D:

BIBLIOGRAPHY

This bibliography is intended for persons, including Army installation and MACOM natural resources and environmental personnel, who want to examine a variety of published technical and general studies related to off-road recreational motorcycle use.

This bibliography was derived from (1) referenced materials in other published works, (2) telephone and mail solicitation of known or potential authors and publishers of related materials, and (3) examination of available documents and articles on the general subject of ORVs. Most of the cited articles have been examined for direct, rather than general, applicability to the subject.

References are arranged in three sections. The first section contains references to general information on ORVs. Most of these materials are available either in technical and scientific literature or from the sponsoring organization. These references are arranged in alphabetical order. The second section, also arranged in alphabetical order, contains references to Army-sponsored and Army-scientific documents, including technical reports of Army research laboratories. Many of these documents are of interest only to Army installation personnel. The third section contains a list of relevant environmental impact statements or related assessment documents; these are arranged by agency, since no authors are cited.

All material in this appendix was selected with the specific needs of a land manager dealing with trailbikes in mind. Certain otherwise excellent sources which dealt exclusively with other vehicles types were excluded for that reason. Other articles were included for their background value and potential relevance to trailbikes, even though another vehicle type was their basic subject. The Army regulations and publications are all of general applicability.

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