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OFF-ROAD VEHICLE SITE SELECTION

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ABSTRACT

The general site selection process described is applicable to most types of non-competitive off-road vehicles (ORVs). Land and recreational use compatibility, environmental assessment and trail development are several factors considered. Variations in procedure and planning criteria due to vehicle type, planning for uncommon vehicles such as swamp buggies, and competitive use are special considerations that are included. Recreation planners and land managers will be primary users of the process. Results can be used to provide ORV use opportunities while giving due consideration to natural and integrated resource management.

INTRODUCTION

In recent years, use of off-road vehicles (ORVs) for recreational purposes has become both popular and controversial. An ORV is defined as any motorized vehicle designed for cross-country travel on or immediately over land, water, snow, ice, marsh, swampland, or other natural terrain (trailbikes, dune buggies, all-terrain vehicles, swamp buggies, etc.). By 1979, ten million ORVs in the U.S. were being used for recreation [1]. Widespread use of these vehicles has become controversial due to frequent conflict with land and resource management goals.

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The process and planning considerations for site selection presented here were developed by applying theoretical and subjective analysis to the results of ORV-related research. Research efforts and results that were used are described as follows:

1. a literature search was conducted, existing ORV management programs were examined, and techniques for ORV area planning, evaluation, and management were identified;
2. through adaptation of existing techniques and development of additional techniques, a land evaluation method—which was oriented toward evaluation of areas for non-competitive trailbike use—was developed [2];
3. this method was field-tested, modified and refined [3, 4]; and
4. additional literature review and program examination were conducted to modify the methods for other types of vehicles, specifically non-competitive snowmobile and four-wheel drive (4WD) vehicle use [5, 6].

PLANNING FOR NON-COMPETITIVE ORV USE

The first step in the process is to develop planning goals and objectives. These can be developed through examination of existing literature and by working with users to determine their preferences for vehicle use. Once planning goals and objectives are tentatively identified, three major tasks remain. They are: candidate area selection, environmental evaluation, and area development. Each of these tasks requires collection and evaluation of information and represents a decision point. Figure 1 is a flow diagram of the steps involved in the site evaluation method. This article deals with procedures necessary to complete each of the steps in the site selection process.

Candidate Area Selection

Existing land use—When planning for non-competitive ORV use there are two possible approaches that might be used to address candidate area selection. The choice of approach depends on the status and comprehensiveness of the existing outdoor recreation plan.

If an up-to-date, comprehensive plan is available, candidate area selection will be easy since potential land allocation for ORV use may already be addressed by the plan. As an example, consider the planning approach used when applying the recreation opportunity spectrum (ROS) concept to outdoor recreation planning [7-9]. The ROS concept provides an approach for resources inventory, specifying recreation opportunities, resource capability and suitability analysis, selection of management objectives and practices, and impact assessment. It also considers motorized recreation as a major recreation experience or opportunity class. Once the ROS approach is applied and recreation and integrated resource suitability analysis is performed, the land and water resources that can be allocated to motorized recreation will have been identified. This

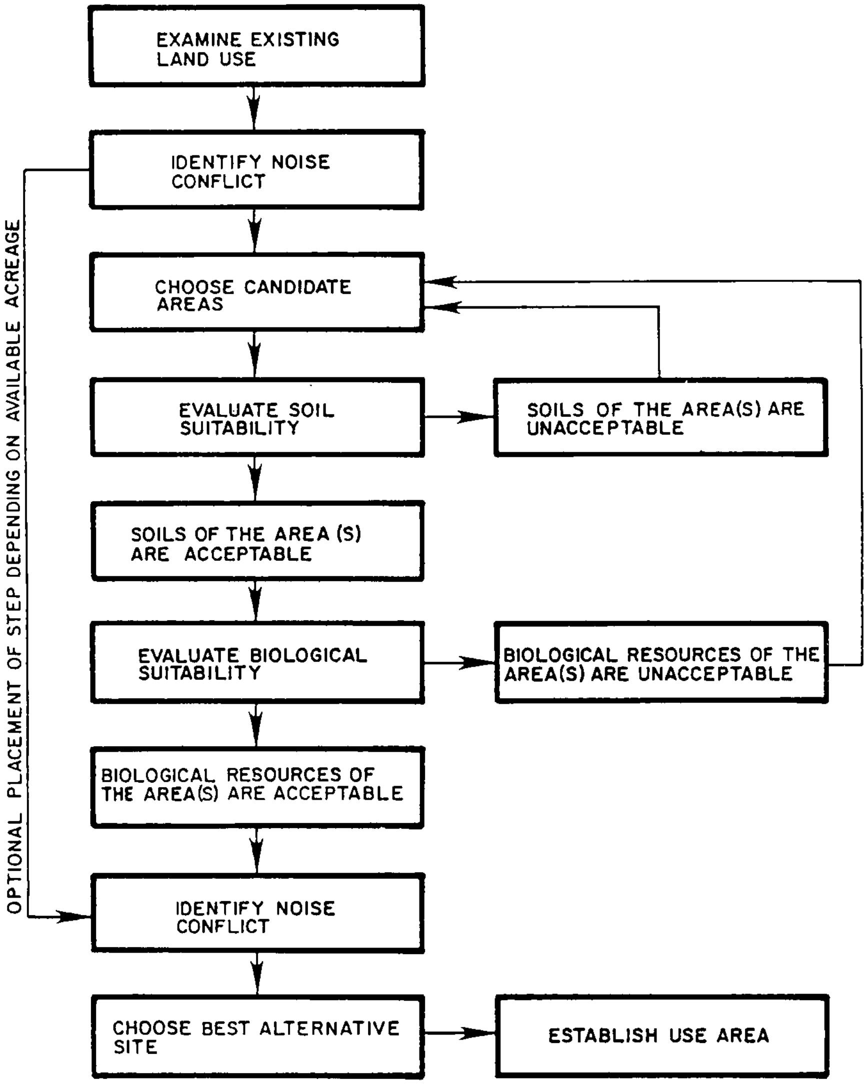

Figure 1. Steps in the ORV site evaluation method.

allocation is done on a map on which selection of candidate ORV use areas can be delineated.

If a different approach is used to develop the outdoor recreation plan, the same capability of selecting candidate areas—directly from the plan map—might still be available. Care should be taken to ensure that the plan and plan map consider ORV use a potential use of land. If not, the steps leading to candidate area selection should be as follows.

The first step is to examine the available area and adjacent land use. This examination is done to identify land uses that would be sensitive to or incompatible with ORV use. Three categories of land use which are sensitive or incompatible have been identified. These are:

1. areas where the primary use of the land would be adversely affected by ORV use i.e., areas which cannot be used because of existing land use, e.g., residential areas;
2. areas where the operation of ORVs would be unsafe for participants and non-participants, e.g., trails set aside for horseback riding, and active hunting areas; and
3. areas which have been identified as, or are suspected to be historically or archaeologically significant, critical wildlife habitat, critical natural resource areas, etc.

Any land use which is categorized as sensitive, or which exhibits or could be affected by one or more conflict condition should be eliminated from consideration as a candidate area (See Table 1).

Once all sensitive and incompatible land uses and areas are identified, they should be marked on a map (See Figure 2). This map is used as a working base map for other parts of the candidate area selection procedure.

Noise considerations–The next step is to identify noise-sensitive land uses, e.g., hospitals or nursing homes, and establish noise buffer zones. To establish these zones, as least three types of information are required:

1. the maximum acceptable sound-level (L_{eq}) requirement for those land uses which are considered to be noise-sensitive (See Table 2);
2. the estimated average sound level (in A-weighted decibels [dBA]) generated by the ORVs expected to use a proposed area (See Table 3); and
3. the estimated demand for the proposed ORV area, i.e., the number of vehicles expected to be operated in the area.

Once this information is obtained, it is used to determine Distances Necessary for Noise Attenuation (DNNAs) (Appendix A). DNNAs are distances that a proposed ORV use area should be located away from noise-sensitive land uses in order to meet maximum acceptable noise level requirements. After determining the DNNAs for each noise sensitive land use, noise buffer zones can than be marked on an appropriate base map.

Site and terrain conditions–Once the base map has been developed, it is used, along with topographic maps, to decide which areas would be most suitable for ORV use. Input should also be gathered from users to determine site preferences, e.g., steep slopes, water crossings, and/or muddy areas.

Table 1. Land Uses and Areas Which Are Incompatible With ORV Use

Land Uses Which Conflict With ORV Use	*Conditions Which Place Land Uses in Conflict*
Incompatible Land Uses	
Land Uses	*Conflict Conditions*
• Offices and Working areas	• Aesthetics
• Agriculture/grazing outleases	• Dust
• Campgrounds	• Encroachment
• Churches	• Noise
• Residential	• Property security
• Hospitals	• Traffic congestion
• Industrial sites	• Vandalism
• Libraries	• Vehicle Operation
• Outdoor theaters	
• Schools	
Participant and Nonparticipant Safety	
Land Uses	*Conflict Conditions*
• Active hunting areas	• Loose surface material
• Active landfills	• Noise
• Active quarries and mines	• Personal safety
• Frozen water bodies	• Recreation conflict
• Hiking trails	• Steep slopes
• Horse (bridle) trails	• Thin ice
• Passive outdoor recreation	• Unexpected animal actions
• Potable water storage	• Water quality
Natural and Other Resource Locations	
Land Uses	*Conflict Conditions*
• Archaeological sites	• Aesthetics
• Breeding, migration, or nesting areas	• Animal harassment
	• Dust
• Cemeteries	• Encroachment
• Food plots and feeding area	• Human presence and disruption
• Historic sites and structures	• Noise
• Paleontologic sites	• Poaching
• Petroglyphs	• Petroleum spills
• Rare, endangered, or threatened plants, animals, and fish	• Siltation
	• Soil compaction
• Timber plantations	• Soil erosion
• Wetlands	• Turbidity
	• Vandalism
	• Vegetation damage

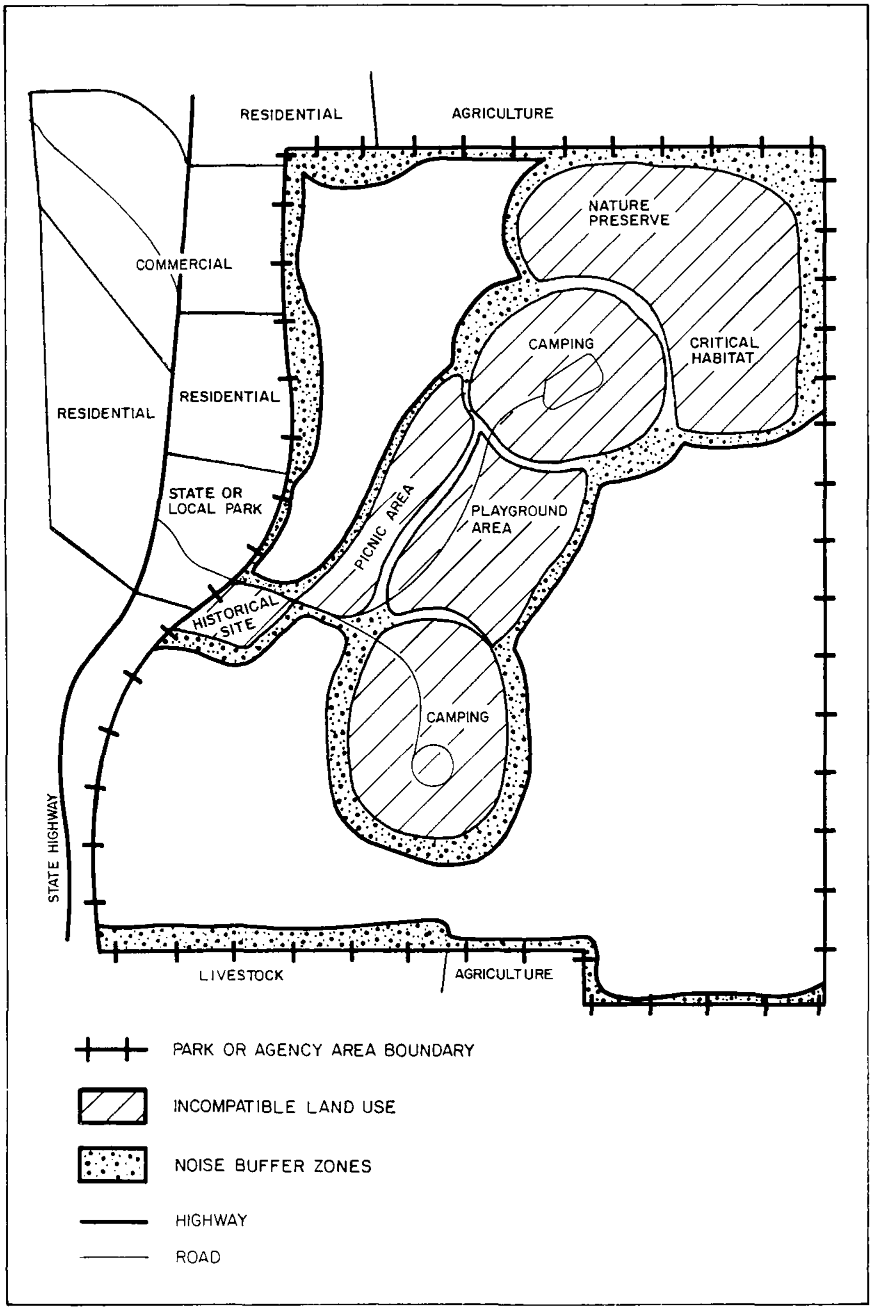

Figure 2. Base map identification of incompatible land uses.

Table 2. Maximum Acceptable Equivalent Sound Level (L_{eq}) Requirements

Land Use	*Maximum Acceptable Sound Levels (in dBA)*
Agricultural (except livestock)	80
Campgrounds & picnic areas (not associated with ORVs)	65
Classrooms, libraries and churches	65
Commercial and retail stores, exchanges, movie theaters, restaurants and cafeterias, banks, credit unions	70
Dental clinic, medical dispensaries	70
Residential	65
Gymnasiums, indoor pools	70
Hospitals, medical facilities, Nursing homes (24 hour occupancy)	65
Industrial, manufacturing and laboratories	70
Livestock farming, animal breeding	75
Neighborhood parks	70
Offices—business and professional	70
Outdoor music shells, outdoor theater and cultural events	55
Outdoor sports arenas, outdoor spectator sports	70
Playgrounds, active sport recreational areas	70
Transient lodging—hotel, motel, etc.	65

Source: Adapted from TM 5-803-2, *Environmental Protection Planning in the Noise Environment*, Figure 4-5, Departments of the Air Force, Army, and Navy, 15 June 1978.

The major factors to be considered in selecting appropriate candidate areas are size, site requirements, and terrain characteristics. The minimum size for an ORV-use area is about 5 ha; the maximum size can be up to 800 ha. The area provided will mainly depend upon the intensity of user demand and the ability of the sponsoring agency to provide maintenance and supervision for the area.

Candidate areas should be easy to reach by road in order to eliminate cross-country travel to the site. If trail rather than cross-country use is preferred, selection of an existing trail system would be desirable, e.g., fire breaks or an unpaved road system that could be closed to general traffic. Snowmobile trails, in particular, should be located in some form of existing trail system [5].

Table 3. Noise Levels dBA Generated by ORVs at 15.24 m (50 ft)[a]

Type of ORV	Noise Level *(in dBA)*
Trailbikes	
Dual purpose	83
Off highway enduro models	86
Motocross	120
Snowmobiles	
Traveling 15 mph	73
Full throttle	78
Older models/modified machines	120
4WD Vehicles	
Light trucks/ATV's	
Non-defective mufflers	76
Defective or modified mufflers	80

[a]Noise levels generated by these vehicles vary depending on 1) the type of vehicle, 2) whether (and how) the user has modified the vehicle, 3) the mode of operation, and 4) vehicle speed during operation. These levels are only provided as general guidance.
Source: R. M. Lacey, et al., references [3, 5, 6].

In general, terrain variety is an absolute requirement for all ORV users. As a rule, slopes for trail development should not exceed 30 per cent. Trails should not be developed in areas which contain several streams, streams with steep banks, or cliffs and/or deep gullies. Areas which will require the least amount of site preparation should receive first consideration as candidate areas. Areas where the water table depth is less than 1.2 meters should be avoided. Required snow conditions for snowmobile trail development are discussed later. By selecting areas which provide for scenic views along the trails, users will be given incentives for remaining on the trails.

Environmental Evaluation

Soil factors– Once candidate areas or corridors have been chosen, an analysis of soil suitability is necessary. A soil limitations map is developed for this purpose [10]. Before a soil limitations map can be developed, a recent soil survey of the candidate area and limitations ratings for soils in the area must be obtained. In most areas there is at least partial coverage by a U.S. Department of Agriculture, Soil Conservation Service (SCS) Soil Survey. (If the soils of a candidate area have never been surveyed or if available survey data is out of date, a different procedure is followed. More technical soils analysis and rating procedures which have been developed to supplement the

ORV evaluation procedures can be used [4]. The SCS has developed special soils rating criteria to evaluate soil suitability for trailbike use. These criteria are listed in Appendix B.

To prepare the limitations map, the soil series map(s) in the soil survey which correspond to the candidate area(s) are reproduced. These maps will show the boundaries of each soil series or phase. The limitations map is prepared by coloring the soil series phases or map units within their respective boundaries. Soils with slight, moderate, and severe limitations are each given a different color.

Based on the soil limitations, candidate areas or portions of candidate areas can be eliminated from consideration for use. Generally, those areas which are eliminated contain soils which have severe limitations. However, certain areas where soils have severe limitations, as well as areas where soils have moderate limitations, may be considered for use if proper maintenance or mitigation procedures can be implemented to balance the effect of the restrictive features, e.g., construction of runoff control terraces to reduce erosion.

Biological factors– An evaluation of areas for potential ORV use should include an examination and assessment of the biological resources of those areas (Appendix C). This examination should determine the value of the biological elements within candidate areas and, if possible, the impact of ORV use on biological resources. Such factors as habitat destruction, noise disturbances and mechanical injury to plants must be taken into account. After thorough examination of each alternative site, areas or corridors are ranked according to their acceptability for use.

Any candidate area which contains a rare, endangered, or threatened plant species, or locally important plant or animal population 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 ORV use until a site visit has confirmed that the species will not be adversely affected.

Area Development

Once areas have been selected according to the procedures discussed above, trail development can begin. It is emphasized that trail development should ensure safety for vehicle operators. Regular inspection of trails by qualified safety personnel is recommended. The criteria used to develop a trail for trailbikes, snowmobiles, and 4WD vehicles are summarized in Table 4. Minimum equipment requirements and passenger limits for trailbikes, snowmobiles, and 4WD vehicles are listed in Table 5.

CONSIDERATIONS FOR SPECIFIC VEHICLE TYPES

The various types of ORVs were designed to be used for different purposes and to travel across different surfaces, therefore, flexible techniques are

Table 4. Trail Development Criteria

	Trailbikes	*Snowmobiles*	*4WD*
Length	200 m minimum 3 km maximum	6.5 km minimum To handle 80 vehicles per each 8 km	6.4 km minimum
Width	0.6 m to 2 m One-way traffic only	3 m one-way traffic 5 m two-way traffic	1.8 m to 3 m one-way traffic 3.75 to 5 m two-way traffic
Slope	25% climb—beginners 40% climb—experienced riders 15% for lateral slopes—beginners 30% for lateral slopes—experienced riders	25% climb—maximum	15-20% climb—maximum
Surfaces	Natural soils Crushed rock for improved surface	Leveled ground 5-in. snowcover 3 in. compacted snow	Natural soils Crushed rock 10-40 mm for improved surface Bumps to control vehicle speed
Turns	Turn radii 2-10 m Turns of $>$ and $<90^\circ$ No straights $>$100 m	Gradual Trail curve radius $>$7.5 m No banked curves	Varied turns of $>$ and $<90^\circ$ No straights $>$100 m No steep banked curves
Clearances	Lateral clearance - 0.6 m from edge Vertical clearance - 2.25 m	Lateral clearance - 0.3 m from edge Vertical clearance - 2.5 m	Lateral clearance - 0.3 m from edge Vertical clearance - 3 m
Water Hazards	Reinforced-surface fords; culverts; or bridges should be built Artificially channelled runoff water if added water features desired	Culverts or bridges should be built	Reinforced-surface fords; culverts; or bridges should be built Artificially channelled runoff water if added water features desired
Vistas	Scenic and rest areas	Scenic and rest areas	Scenic and rest areas
Turnouts/ Spurs	Provide access to scenic and rest areas	Provide access to scenic and rest areas	Provide access to scenic and rest areas
Signing	Regulatory, trail markers and informational Per Federal and State requirements for roads and highways	Regulatory, trail markers, and informational Consult appendix in CERL Tech Report N-105	Regulatory, trail markers, and informational Per Federal and State requirements for roads and highways

Source: R. M. Lacey, et al., [references 3, 5, 6].

Table 5. Minimum Equipment Requirements

	Trailbikes	*Snowmobiles*	*4WD*
Lights	Headlights and taillights for street use (No trail use allowed during evening hours)	Headlights and taillights for nighttime operation and during poor visibility conditions	Headlights and taillights for nighttime operaion and during poor visibility conditions
Seatbelts	N/A	N/A	For each passenger and driver
Muffler	Factory equivalent; spark arresting	Factory equivalent	Factory equivalent
Roll Bar	N/A	N/A	Permanently attached to vehicle

needed for evaluating areas where they should be operated. In addition to the differences in trail development criteria and vehicle equipment, other considerations and variations should be taken into account. This increases safety and reduces the environmental impact that is likely to occur.

Trailbikes

Trail straightaway lengths for trailbikes should not exceed 100 m because these vehicle may reach such speeds that loss of control can result. Natural obstructions, such as boulders, can be used to prevent shortcutting of turns. Normally, trails should not laterally cross slopes of more than 15 per cent for beginners or 30 per cent for more experienced riders.

4WD Vehicles

4WD vehicles are larger and heavier than trailbikes, have four wheels touching the ground, and are generally operated at a much lower average speed. These differences make 4WD vehicles more stable, but also make them more likely to become stuck and damage soil surfaces, therefore increasing or decreasing the severity of soil limitation for 4WD vehicle use as compared to trailbike use.

Recreational 4WD vehicles are better able to travel over surfaces with a considerable number of large stones (from 76 mm to 250 mm in length or width). If the surface coverage of large stones is greater than 35 per cent the soil can have severe limitations for 4WD vehicle use, while coverage of less than 35 per cent results in only slight or moderate limitations. Soils rated as having moderate or severe limitations for trailbike use due to wetness or sandy conditions will have severe limitations for 4WD vehicle use. Soils with a seasonally high water table at a depth of 0.6 to 1.2 m will have moderate limitations while a depth greater than 1.2 m will have slight limitations due to wetness. For 4WD vehicles, slopes have moderate limitations if they are between 15 and 35 per cent and severe limitations if they are greater than 35 per cent.

Soils that are subject to flooding more often than once in two years have moderate limitations for trailbike use, but create severe limitations for 4WD vehicle use. Soils that are subject to occasional flooding but less than once in two years, have slight limitations for trailbike use but moderate limitations for 4WD vehicle use. These soil characteristics can generally be determined from the soil survey description of the soil, or from topographic maps and field surveys. Simple procedures to determine these characteristics (i.e., surface coverage of large stones, depth to water table, slope) are also available [4].

Recreational 4WD vehicle use is somewhat unique in that it can be done throughout the year. Therefore, special seasonal conditions related to wildlife and vegetation apply for determining incompatible land uses and areas. During the winter months, wildlife are generally weak due to a shortage of food. This condition can be compounded if animal activity increases exhaustion or exposure. The wintering condition of resident animals in candidate areas should be examined before an area or trail is opened for winter use. Special attention should be given to identifying and eliminating from consideration for trail development, areas where wildlife concentrate and feed during winter months, e.g., deer yards. When 4WD vehicles run over plants or compact the snow too firmly, the early spring growth of vegetation can be affected. Special consideration should be given to prohibiting 4WD operation where predominant vegetation is being managed for commercial or other use–e.g., winter wheat or alfalfa fields, timber plantations, and grassland preserves.

Snowmobiles

Rolling topography interrupted by wide floodplain areas should recieve primary consideration as a candidate snowmobile trail area. Slopes for trail development should not exceed 30 per cent.

There are few limits on the types of suitable vegetation in snowmobile candidate areas, except for those places identified as incompatible because of commercial use or environmental sensitivity. However, it is important to note that immature trees can be damaged by snowmobile use, and a significant number of stumps and wire fences in a candidate area can present a safety hazard. Areas where tree planting or harvesting are in progress should also be avoided.

It is recommended that areas with extremely rocky soil surfaces or wetlands be avoided. Rocky surfaces are avoided for user safety; wetlands for environmental reasons–i.e., certain wetland soils, even when snow covered, cannot support repetitive snowmobile traffic and the delicate biological balance of the area can be affected. Trail length will vary considerably depending on available acreage and system design. A well-designed trail can handle eighty snowmobiles for each 8 km (5 mi) of trail [11]. Trail width through turns should be greater than on straightaways to allow for safe execution of turns.

For safety reasons, trails normally should not laterally cross slopes. But if this is necessary, the trail should be cut and filled to provide a level surface for operation, and precautionary erosion control measures should be taken for summer months. Curves in trails should be as gradual as possible. Banked curves are to be avoided because they may encourage high speed and unwarranted operator confidence. Before snow cover, trail surfaces should be made as level as possible through grading and cut and fill operations.

Snowmobile use should not be allowed until the snow is 130 mm (5 in.) deep on the trail. Once this depth has been reached and use has compacted the snow, a minimum recommended depth of 75 mm (3 in.) of compacted snow should be present for continued trail use. All trails which have spots where soil is exposed must be closed to use, or the bare spots replenished with snow.

Snowmobiles, like 4WD vehicles, operate during the winter months, and therefore, have a similar impact on the wildlife and vegetation in a snowcovered area. The previous considerations of 4WD impacts to wildlife and vegetation apply.

Other Vehicles—Dune Buggies, All Terrain Vehicles, Swamp Buggies

Major considerations in choosing trail sites for dune buggies, all terrain vehicles (ATVs), and swamp buggies are dependent upon local soil and terrain conditions and biological limitations of the area. For these vehicles, candidate areas should be selected where there will be minimal damage to the local vegetation and wildlife.

Because dune buggies are normally driven in sand dune areas, they have the potential to cause serious erosion problems. This occurs when these vehicles are driven over dunes that have been stabilized by vegetation. Once vegetation is crushed or uprooted, wind and water erosion may greatly increase, thereby leading to the destruction of these dunes. Relatively flat sandy beaches would be the most appropriate areas for dune buggy trails. Areas containing sand dunes considered to be fragile ecosystems should be eliminated from consideration. The susceptibility to impact can be determined by the density and diversity of annual vegetation, the existence of rare or threatened vegetation of wildlife, and the presence of burrows or other forms of wildlife habitat in the dune areas.

Dune buggies are equipped to function in sandy areas, and the surface materials can be much finer than surfaces for ATV trails. Trail development for ATVs should occur in areas dry enough to keep large tracks and ruts from forming. Because ATVs, swamp buggies, and other amphibious vehicles are able to travel over wet areas, their major impact is on the wildlife and aquatic vegetation inhabiting these areas. In many wet areas, long-range impacts can occur due to soil compaction from the weight of these vehicles. There are some areas, however, where the climatic conditions and vegetative types are more likely to induce rapid regeneration, obscuring vehicle tracks, even though the area may often be wet. Any swamplands, marshes, or other wetlands containing rare or endangered wildlife or vegetation should be eliminated from consideration as a trail site.

SUMMARY

The planning criteria described will supply planners with specific factors to consider for the planning and operation of different types of ORVs. Planners and land managers can use this information to choose appropriate ORV sites and develop trails in a manner that will have a minimum impact on the area's environmental resources and on concurrent human activities.

APPENDIX A

HOW TO DETERMINE THE DISTANCE NECESSARY FOR NOISE ATTENUATION (DNNA) WHEN ESTABLISHING OFF-ROAD VEHICLE AREAS

This appendix provides a step-by-step example of how to calculate the Distance Necessary for Noise Attenuation (DNNA) or to establish the limits for ORV areas. There are several considerations and more detailed methods which can be applied to determine the DNNA for ORV use [12, 13]. The method described here was chosen for its simplicity. However, it yields very conservative results.

Calculation Description and Examples

The DNNA is determined by the following equation:

$$\mathrm{DNNA} = A \times 10^{\left| \frac{B + 10(\log c) - (D - 5)}{20} \right|}$$ [1]

where: DNNA = The Distance Necessary for Noise Attenuation.

[1]The term "D - 5" in the argument of Eq 1 represents a 5-dB penalty in the Leq for land uses. This penalty is included as a precaution because the sound of ORV vehicles can be intrusive and annoying especially if their muffling systems are modified.

A = The distance (feet or meters) from which sound-level measurements were taken to determine the average noise level of the vehicles which will use the area or trail.
B = The average noise level (in dBA) of the vehicles which will use the area or trail.
C = The estimated average daily use of the area or trail (projected demand). Determined by projecting the maximum number of vehicles which will use the area or trail for each day of the use season, adding these numbers, and dividing by the number of days in the season.
D = The maximum acceptable equivalent sound level (Leq) for the land use for which a buffer zone is being established or for which adjacent limited use is necessary (See Table 2).

To find an appropriate DNNA on Table A1, it is necessary to determine the values for A, B, C, and D. For example, assume that the projected demand for a potential vehicle trail is an average daily use of ten vehicles and that each vehicle generates an average of 76 dBA at 15.24 m. Further assume that a noise buffer zone must be established around a campground. The Leq for campgrounds is 65 dBA; therefore:

A = 15.24 m
B = 76 dBA
C = 10 4WD vehicles
D = 65 dBA for campgrounds

Based on the DNNA calculation, a noise buffer zone of a minimum of 304 m (say 300 m) should be established around the campground. In other words, any trail with a projected average concurrent use of ten ORVs, each generating an average of 76 dBA, should be located no closer than 300 m from a campground. Table A1 provides several precalculated DNNA's. The example above is highlighted.

The same example can be used to illustrate limited-use alternative for ensuring that maximum acceptable sound levels for noise-sensitive land uses are not exceeded. Assume that the projected demand for a potential vehicle trail is an average daily use of thirty vehicles, each generating 76 dBA at 15.24 m. Further assume that the trail is located 300 m from a campground. Based on the above calculation, if a trail is established along the potential route, the use *must be limited to an average daily use of ten vehicles.* By inserting different known variables into the equation, either the size of buffer zones or use limits are determined.

Table A1. DNNA for Establishment of ORV Use Areas (Distance in Meters)

Maximum Acceptable Equivalent Sound Level (Leq) for Land Use (dBA)	*Estimated Number of Vehicles Using the Area*									*Average Sound Level for Vehicles Using the Area (dBA at 15.24 m)*
	5	*10*	*15*	*20*	*25*	*30*	*40*	*50*	*60*	
65	100	100	100	100	100	100	100	108	118	60 dBA
70	100	100	100	100	100	100	100	100	100	
75	100	100	100	100	100	100	100	100	100	
80	100	100	100	100	100	100	100	100	100	
65	100	100	100	100	100	105	121	136	149	62 dBA
70	100	100	100	100	100	100	100	100	100	
75	100	100	100	100	100	100	100	100	100	
80	100	100	100	100	100	100	100	100	100	
65	100	100	100	108	121	132	153	171	187	64 dBA
70	100	100	100	100	100	100	100	100	105	
75	100	100	100	100	100	100	100	100	100	
80	100	100	100	100	100	100	100	100	100	
65	100	100	118	136	152	167	192	215	236	66 dBA
70	100	100	100	100	100	100	108	121	133	
75	100	100	100	100	100	100	100	100	100	
80	100	100	100	100	100	100	100	100	100	
65	100	121	148	171	192	210	242	271	297	68 dBA
70	100	100	100	100	108	118	136	152	167	
75	100	100	100	100	100	100	100	100	100	
80	100	100	100	100	100	100	100	100	100	
65	108	152	187	216	241	264	305	341	373	70 dBA
70	100	100	105	121	136	149	172	192	210	
75	100	100	100	100	100	100	100	108	118	
80	100	100	100	100	100	100	100	100	100	
65	136	192	235	271	303	332	384	429	470	72 dBA
70	100	108	132	153	171	187	216	241	264	
75	100	100	100	100	100	105	121	136	149	
80	100	100	100	100	100	100	100	100	100	

65	100	242	296	342	382	419	483	540	592	74 dBA
70	100	136	166	192	215	235	272	304	333	
75	100	100	100	108	121	132	153	171	187	
80	100	100	100	100	100	100	100	100	105	
65	215	304	373	430	481	527	608	680	745	76 dBA
70	121	171	210	242	270	296	342	383	419	
75	100	100	118	136	152	167	192	215	236	
80	100	100	100	100	100	100	108	121	133	
65	271	383	469	542	605	663	766	856	938	78 dBA
70	152	215	264	305	341	373	431	482	527	
75	100	121	148	171	192	210	242	271	297	
80	100	100	100	100	108	118	136	152	167	
65	341	482	590	682	762	835	964	1078	1181	80 dBA
70	192	271	332	383	429	470	542	606	664	
75	108	152	187	216	241	264	305	341	373	
80	100	100	105	121	136	149	172	192	210	
65	429	607	743	858	960	1051	1214	1357	1487	82 dBA
70	241	341	418	483	540	591	683	763	836	
75	136	192	235	271	303	332	384	429	470	
80	100	108	132	153	171	187	216	241	264	
65	540	764	936	1081	1208	1323	1528	1704	1871	84 dBA
70	304	430	526	608	679	744	859	961	1052	
75	171	242	296	342	382	419	483	540	592	
80	100	136	166	192	215	235	272	304	333	
65	680	962	1178	1360	1521	1666	1924	2151	2356	86 dBA
70	382	541	662	765	855	937	1082	1209	1325	
75	215	304	373	430	481	527	608	680	745	
80	121	171	210	242	270	296	342	383	419	
65	856	1211	1483	1712	1915	2097	2422	2708	2966	88 dBA
70	481	681	834	963	1077	1179	1362	1523	1668	
75	271	383	469	542	605	663	766	856	938	
80	152	215	264	305	341	373	431	482	527	

Table A1. (Cont'd.)

Maximum Acceptable Equivalent Sound Level (Leq) for Land Use (dBA)	*Estimated Number of Vehicles Using the Area*									*Average Sound Level for Vehicles Using the Area (dBA at 15.24 m)*
	5	*10*	*15*	*20*	*25*	*30*	*40*	*50*	*60*	
65	1078	1524	1867	2156	2410	2640	3048	3409	3734	90 dBA
70	606	857	1050	1212	1355	1485	1715	1917	2100	
75	341	482	590	682	762	835	964	1078	1181	
80	192	271	332	383	429	470	542	606	664	
65	1357	1929	2350	2714	3034	3324	3838	4291	4701	92 dBA
70	763	1079	1322	1526	1706	1869	2158	2413	2644	
75	429	607	743	858	960	1051	1214	1357	1487	
80	241	341	418	483	540	591	683	763	836	
65	1708	2416	2959	3417	3820	4185	4382	5402	5918	94 dBA
70	960	1359	1664	1921	2148	2353	2717	3038	3328	
75	540	764	936	1081	1208	1323	1528	1704	1871	
80	304	430	526	608	679	744	859	961	1052	
65	2150	3042	3725	4301	4809	5268	6083	6801	7450	96 dBA
70	1209	1710	2095	2419	2704	2963	3421	3825	4190	
75	680	962	1178	1360	1521	1666	1924	2151	2356	
80	382	541	662	765	855	937	1082	1209	1325	
65	2707	3829	4690	5415	6054	6632	7658	8562	9379	98 dBA
70	1522	2153	2637	3045	3405	3730	4306	4815	5274	
75	856	1211	1483	1712	1915	2097	2422	2708	2966	
80	481	681	834	963	1077	1179	1362	1523	1668	
65	3408	4821	5904	6817	7622	8349	9641	10779	11808	100 dBA
70	1916	2711	3320	3834	4286	4695	5422	6062	6640	
75	1078	1524	1867	2156	2410	2640	3048	3409	3734	
80	606	857	1050	1212	1355	1485	1715	1917	2100	

APPENDIX B

SOIL CONSIDERATIONS FOR EVALUATING AREAS FOR RECREATIONAL VEHICLE USE

Introduction

Areas with soil properties which might be adversely affected by ORVs should be eliminated from consideration as ORV-use areas. To help identify such soil properties, a guide for rating soil limitations for off-road motorcycle trails (Table B1) has been developed in cooperation with the USDA-SCS [4].

By considering certain distinct differences between trailbikes and 4WD vehicles and their use, the rating guide can be applied to evaluating areas for recreational 4WD vehicle use. This appendix briefly describes the soil limitations rating guide. Special considerations which apply to using them to evaluate areas for 4WD vehicle use were described in the text of this article.

Use of the Rating Guide

The rating criteria identify eight different soil properties which have the potential to restrict or limit a soil's suitability for use. These are USDA texture, the weight percentage of stones greater than 76 mm, depth to high water table, erosion factor (K), slope, unified texture, the weight percentage of coarse fragments less than 76 mm but greater than 2 mm, and flooding. The differences in these properties create up to eleven possible restrictive features. (Restrictive feature 12 on Table B1 is determined in the field and through professional experience.)

Each of the eleven possible restrictive features are in the order of their importance as a limiting factor. The properties of each soil in an area should be examined according to this order. 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. Of the four limitations, severe limitations for wetness, erodes easily, and too clayey, these three are considered the most important as indicated by their order as restrictive features on Table B1.

The examination of soil properties should also be done on a worst-case basis with severe limitations being the worse case. For example, if 15 per cent of the weight percentage of a particular soil is due to large stones (a moderate limitation) and another 70 per cent is due to small stones (a severe limitation), the soil should be rated as having severe limitations due to small stones. The moderate restriction due to large stones receives less consideration, even though large stones are higher in importance as a restrictive feature. Only the worst-case or severest limitations and appropriate restrictive features should be identified.

Limitations are defined as follows:

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

Moderate—Given to soil phases that have properties moderately acceptable for use. The degree of limitation can be overcome or modified by special planning,

Table B1. Guide for Rating Soil Limitations for Off-Road Recreational Vehicle Trails[e]

Property	Limits: Slight	Limits: Moderate	Limits: Severe	Restrictive Feature
1. USDA Texture	---	---	ICE	Permafrost
2. Fraction >3 in. (86 mm) (wt pct) (surface layer)[a]	<10	10-25	>25	Large stones
3. Depth to high water table, (ft)[a]	>2 ---	1-2 ---	0-1 +	Wetness Ponding
4. Erosion factor (K) x pct slope	<2	2-4	>4	Erodes easily
5. USDA Texture (surface layer)[b]	---	---	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 (pct)	0-25	25-40	>40	Slope
9. Coarse fragments (wt pct) (surface layer)[c]	<40	40-65	>65	Small stones
10. USDA Texture (surface layer)	---	SIL, SI VFSL, L	---	Dusty
11. Flooding	NONE, RARE, OCCAS	FREQUENT	---	Floods
12. Others[d]	---	---	---	Fragile

[a]1 in. = 25.4 mm; 1 ft = 0.3048 m.
[b]Soil in UST, TOR, ARID, BOR, or XER suborders, great groups, or subgroups rate one class better.
[c]100 minus the percent passing No. 10 sieve.
[d]If the soil is easily damaged by use or disturbance, rate as "Severe-Fragile."
[e]"Guide for Rating Soil Limitation for Off-Road Motorcycle Trails," Sec. 403.6(b) National Soils Handbook, USDA.

design, or trail maintenace. Some soils rated as *moderate* require artificial drainage, control of runoff to reduce erosion, some modification of certain features through manipulation of the soil, etc.

Severe—Given to soils that have one or more properties that are unacceptable for 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.

How Ratings are Obtained

The first step in identifying the soil limitations for the soils in a particular candidate area is to reproduce the soil survey map(s) which correspond to the candidate area. This map should show the location and boundaries of each soil series and/or phase in the candidate area. Next, a list of each series and/or phase in the area should be prepared. This information is obtained from the mapping unit symbols, the map legend and the soil description that is found in the survey.

Once this is done, the phase and soil characteristics description provided for each mapping unit is compared to the rating guide. (Table B2 lists abbreviations which can be used to interpret phase differences.) The worst-case limitation which most closely approximates the phase soil characteristic description in the survey is the degree of limitation given to the soil or mapping unit.

The limiting descriptions on the rating guide and in the survey do not have to, and, in fact, generally will not, correspond exactly. Good judgment should be used to pick the rating which most closely applies to the survey description. Figure B1 shows how soil limitations ratings are generated by computer.

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 or intermingled series exist such that it would be difficult to plot their boundaries on a map; and/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 they will not be listed in the limitations ratings.

Many planners who will use the process described in this article may have a certain degree of expertise in soil interpretation and can use the rating guide as described above with considerable accuracy. However, for best results, it is recommended, at the request of SCS personnel, that the use of the ratings and the soil evaluation method be coordinated with and/or at least reviewed by local SCS field personnel.

The SCS has developed a similar rating guide for other uses and their interpretation is part of the National Cooperative Soil Survey being conducted by the SCS. Since its development, Table B1 has been included in the National Soils Handbook with these other guides. State or local SCS personnel should be familiar with this table and can provide invaluable assistance in determining soil suitability.

SOIL SERIES	RECORD NUMBER	DEPTH (IN.)	PHASE	LIMITATION	RESTRICTION
ADELPHIA	WJ0024	0 - 14	0-6% SL, FSL	MODERATE	WETNESS
			6-10% SL, FSL	MODERATE	WETNESS, ERODES EASILY
			0-6% SIL	MODERATE	WETNESS, DUSTY
ADENA	C00194	0 - 3	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	C00468	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	µ40249	0 - 11	0-3% FSL	MODERATE	WETNESS
ADKINS, GRAVELLY SUBSTRATION	µ40470	0 - 4	0-6% FSL	SLIGHT	
			6-13% FSL	MODERATE	ERODES EASILY
			13-15% FSL	SEVERE	ERODES EASILY
ADKINS, WET	µ40623	0 - 12	0-6% FSL	MODERATE	WETNESS
			6-13% FSL	MODERATE	WETNESS, ERODES EASILY
			13-15% FSL	SEVERE	ERODES EASILY
ADLER	µ50024	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	µ10028	0 - 34	0-2% SP	SEVERE	PONDING, EXCESS HUMUS
ACET	100045	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 B1. Sample soil limitations ratings.

Table B2. Soil Phase Interpretation Abbreviations

Abbreviations for Texture Modifiers

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

Abbreviation for Texture

COS	Coarse sand	VFSL	Very fine sandy loam
S	Sand	L	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 loam	SIC	Silty clay
SL	Sandy loam	C	Clay
FSL	Fine sandy loam		

Abbreviations for Terms Used in Lieu of Texture

CE	Coprogeneous earth	MARL	Marl
CEM	Cemented	MPT	Mucky-peat
DE	Diatomaceous earth	MUCK	Muck
FBI	Fibric material	PEAT	Peat
FRAG	Fragmented material	SG	Sand and gravel
G	Gravel	SP	Sapric material
GYP	Gypsiferous material	UWB	Unweathered bedrock
HM	Hemic material	VAR	Variable
ICE	Icr 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)

Source: Soil Survey Interpretation Instructions, Form SCS-SOILS-5, USDA Soil Conservation Service.

APPENDIX C

METHOD TO BIOLOGICALLY RATE AREAS FOR OFF-ROAD RECREATIONAL VEHICLE USE

This appendix describes a method which can be used to make a biological examination and assessment of potential ORV use areas. The method is systematic and is designed to be used even if quantitative data are not available. Its use requires a site visit and visual survey of alternative areas, and the input of a professional biologist. Alternative candidate areas can be rated in either of two ways: 1) the "relative value" of the biological resources of alternative areas is compared with the rest of the local region, or 2) the "susceptibility to ORV damage" of alternative areas is examined (Figure C1). For both methods, year-round as well as seasonal conditions should be considered.

The "Relative Value" Approach

Area–Assign a special designation to each alternative area that can be used to identify one area from another. If a candidate area represents two or more distinct biological communities, the areas covered by the different communities should be considered separately.

Biological resources–Under each category of biological resource, e.g., "Ground Cover" or "Trees or Dominant Vegetation" list specific biological resources which are known to exist in the area being examined, e.g., "Ashe Juniper" or "Live Oak." If dominant vegetation can be placed into both "Ground Cover" and "Trees or Dominant Vegetation," it is to be included in both categories. "Terrestrial Nongame Animals" include 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 last column in the special rating form gives space for any remarks or notes which may be necessary to help rate an area.

Relative value–Rate the value of each listed biological resource relative to their value to the rest of the area. The past, present, and future carrying capacity should be considered. Relative value is determined using the following five-point scale:

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

Area: Area 1

Rating ________ Rank ________

Biological Limitation: Terrestrial Game Animals, particularly the presence of fox squirrel

Resources	Relative Value	Categorical Value	Susceptibility to ORRV Damage	Categorical Susceptibility	Combined Resource Value	Notes
Ground Cover		3		4	12	
Grasses	2		2			
Cactus	3		4			on rocky surfaces
Trees or Dominant Vegetation		4		3	12	
Ashe Juniper	2		3			
Live Oak	4		3			
Terrestrial Game Animals		5		5	25	
White-tailed Deer	3		3			
Fox Squirrel	5		5			many den trees
Eastern Cottontail	4		2			
Bobwhite	5		2			
Mourning Dove	4		2			
Turkey	2		4			
Terrestrial Nongame Animals		3		3	9	
Texas Mouse	3		2			
Collared Lizard	2		3			
Turkey Vulture	2		2			
Lark Sparrow	3		3			
Cardinal	3		3			
Fish		3		4	12	
Longnosed Gar	1		2			
Carp	2		2			
Flathead Catfish	1		2			
Gizzard Shad	2		3			
Channel Catfish	3		4			
Pest species		3		3	9	
Starling	2		4			wintering area/ periodic high concentrations
Black Rat	2		3			
Rattlesnake	3		3			
Other		4		4	16	
Den Trees	4		4			
Total Area Value		25	Total Combined Resource Value		95	

Figure C1. Sample biological rating form.

Categorical value—Determine the "relative value" of each resource category 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, since biological resources "Ashe Juniper" and "Live Oak" have been given values of 2 and 4, respectively, the entire resource category of "Trees or Dominant Vegetation" should be given a value of 4.

Total area value—Determine the "relative value" of the entire area by adding the category values.

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 (25 has been divided by 7 for a value of 3.6). If the category "Other" had not contained a value, the total area value would have been divided by 6. Write this in the space provided near the top of the form.

Biological limitation—For decision-making purposes, the biological limitation of the area must be noted. The biological limitation is the resource category which has received the highest "categorical" value. The biological limitation shows which resource places the greatest restriction on possible ORV use in the area and should briefly explain the importance of the resource.

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 ORV use. An area with an overall rating of 4 is one of the better local examples of biological resources and should not be used.

The "Susceptibility to Damage" Approach

This approach 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.

Initial steps—The first steps of this approach are the same as the first four listed in the "relative value" approach.

Susceptibility to ORV damage—Determine the susceptibility to damage of each biological resource listed and assign a susceptibility value to each resource. Since the importance of damage to various resources is perceived differently, use the two separate scales below to assign the values. One scale applies to all resource categories except, "Pest Species"; the other is used exclusively for "Pest Species."

Susceptibility to Damage for All Nonpest Categories

1. This resource will receive some damage as a result of ORV use. Recovery time for the resource would be within one year *or* the area is already so badly damaged from other factors that it has no logical point or future biological value.
2. This resource will be damaged by ORV use and recovery time would be from one to five years.

3. ORV use would be destructive to this resource and recovery time would be from five to ten years.
4. ORV use would be highly destructive and recovery time would be from ten to 100 years.
5. ORV use would be extremely destructive to this resource and recovery time would be greater than 100 years.

Susceptibility to Damage for Pest Species

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

Categorical susceptibility–Determine the "susceptibility to ORV damage" for each resource category by assigning to the entire category the susceptibility value of that resource which received the *highest relative value.*

Combined resource value–Determine the combined resource value of each resource category by multiplying the relative values by the susceptibility to damage values. Determine the combined resource value of the entire area by adding the combined resource values for each category.

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 C1, 95 has been divided by 7 for a rating value of 13.6. (Note that if the category "Other" had not contained a susceptibility value, the area's combined resource value would have been divided by 6.)

Biological limitation–Same as "Relative Value" approach.

Rank–Same as "Relative Value" approach, except that an overall rating of 16 or greater indicates that the area has excellent resources relative to the other areas. ORV use would be relatively more destructive in this area, therefore it should be eliminated from consideration.

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